INSTRUCTIONAL PRACTICES IN PHYSICS AND THEIR INFLUENCE ON INTERESTS AND ACHIEVEMENT AMONG SECONDARY SCHOOL STUDENTS

Thesis
submitted to the University of Calicut
for the award of the degree of

DOCTOR OF PHILOSOPHY IN EDUCATION

By

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2025

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Dedication

"To my daughter, Sheen Shyma Safeer, who unknowingly made this journey both harder and infinitely more meaningful. Thank you for letting me write—even when all you wanted was another bedtime story."

Acknowledgement

This journey has been one of both intellectual growth and personal transformation, and I believe God placed the right mentors in my path. Words fall short in expressing my gratitude to my research supervisor, Prof. (Dr.) Mumthas N. S., for her unwavering support, insightful guidance, and constant encouragement that turned this research into a deeply enriching experience. Always available and willing to help, she ensured that I never felt burdened. More than a guide, she provided space to study, ensured I was well-fed, and created a nurturing environment where research became a shared life experience. Her empathy, wisdom, and motherly care made her not just a mentor, but a confidante. Even during her most difficult times, she gave her best to fulfill the responsibilities of a research supervisor with dedication and grace. I am deeply grateful that she consistently valued my opinions and involved me in every step of the research process. Her openness to learning from me made our journey truly collaborative.

I would like to extend my heartfelt gratitude to Prof. (Dr.) Kunnathodi Abdul Gafoor, Department of Education, University of Calicut, who has been a true father figure throughout this journey. Humble and approachable, he always treated me with warmth and equality, never creating a sense of hierarchy. With him, I felt free to speak openly—to talk, debate, or even argue—knowing he would respond with patience, insight, and genuine care. A guiding light, he often appeared just when my supervisor and I were stuck, offering clarity and wisdom that left me wonderstruck. His words had the power to shift my perspective instantly. With foresight and sensitivity, he anticipated academic hurdles from proposal to submission and prepared me to face them with confidence. In my supervisor's absence, he stepped in seamlessly, elevating the quality of my work.

The dedication of my professors has shown me what real research means—not just as a process of inquiry, but as a way of life, driven by curiosity, discipline, compassion, and resilience.

I am deeply grateful to Dr. T. Mohamed Saleem (Principal) and Dr. C. A. Jawahar (Former Principal), Farook Training College, the visionary leaders of the research centre, for their unwavering support and for providing essential facilities that enabled the smooth progress of this study. Their openness and approachability, even during their busy schedule, were truly encouraging.

I deeply appreciate Dr. Umer Farooque T. K., Associate Professor and Research Coordinator at Farook Training College, for his efficient coordination throughout my Ph.D. tenure. He meticulously organized all key milestones—SRF upgradation viva, Preliminary Qualifying Examination and regular progress reviews—ensuring every procedure was conducted smoothly and on time through his commitment.

I am especially thankful to the Research Advisory Committee Members, Prof. (Dr.) C. Naseema, Prof. (Dr.) K. P. Meera, Prof. (Dr.) A. Hameed, University of Calicut, for their thoughtful guidance and practical recommendations provided during each six-monthly progress evaluation. I sincerely thank Prof. (Dr.) Bindu R. L., University of Kerala, for evaluating my SRF upgradation and PQE viva, and for her valuable suggestions and insightful feedback.

I am truly thankful to Dr. Anees Mohammed C. (Associate Professor, Farook Training College) for meticulously proofreading nearly all my research tools, often on short notice and without hesitation. I am also deeply grateful to the experts—Dr. Manoj Praveen G. (Associate Professor, University of Calicut), Ms. Bindu A. P. (H.S.T., Farook H.S.S.), Dr. M. P. Ravishanker (Assistant Professor, N.S.S. Training College, Ottapalam), Dr. Irshana Shahanaz Ulladan (Assistant Professor, Farook Training College), Dr. Mohammed Nasimudheen T. (Assistant Professor, Farook Training College), Mr. Abdul Samad P. K. (H.S.S.T., G.V.H.S.S., Ambalavayal), and Ms. Deepthi E. P. (State Resource Group, HS Physics)—for generously reviewing my tool and offering valuable insights for its validation.

I sincerely thank Dr. Rajitha K. V. and Dr. Mohamed Sareef K. (Assistant Professors, Farook Training College) in assisting with Malayalam translation of tools and abstract. Many thanks to my fellow scholars, Dr. Himna P. A., Ms. Naslamol K., Ms. Lulu S. Kappil and other co-scholars for proofreading the thesis and providing suggestions for improving the research work.

I am grateful to Ms. Sabira M. (Former librarian) and Ms. P. M. Sayyida Tahani (Librarian), for their kind support, and to Mr. Basheer, Mr. Faez, and Mr. Arsal, for their assistance throughout my research journey. I also acknowledge other teaching and non-teaching staff of the research centre. Special thanks to the staff of Bina Photostat for their assistance in compiling and binding the thesis.

At the start of my Ph.D. journey, I faced a year-long complication with the UGC fellowship. I owe to my uncle, P. V. Abdul Wahab, whose timely intervention and direct communication with the UGC swiftly resolved the issue.

My wholehearted gratitude goes to my Umma, P. V. Ramlath, and Daddy, K. A. Usman, without whom this Ph.D. would not have been possible. Their selfless support and strength were the foundation of this journey. They willingly relocated with me and took full responsibility for my daughter's care throughout these demanding years. Despite age and health challenges, they handled everything gracefully and without external help. I also thank my siblings, Dr. Shybin Usman, Dr. Shaeez Usman Abdulla, and Shahana Usman Abdulla, whose constant encouragement pushed me to pursue this path. Their faith in me, even when I doubted myself, gave me the courage to begin. I am equally grateful to my husband, Safeer Kunnath Bavutty, for respecting my need for uninterrupted focus and for thoughtfully planning timely breaks and vacations that helped me maintain balance.

I thank everyone—named or unnamed—who has been part of this journey.

Shyma Usman Abdulla

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ABSTRACT

Physics as a separate subject is introduced at high school level, and the subject is considered to be the toughest among science subjects. Toughness of the subject is usually accompanied with students' lack of interest, and hence, they underperform in the subject. Meanwhile, the literature shows that instructional strategies employed by the physics teachers can be a core factor that can aid tackling such issues. The study explores the extant Instructional Practices of physics teachers at secondary level in various teaching-learning situations and then analyses the influence of these practices on the types of Interests, namely, Domain Interest, Situational Interest and Individual Interest, and Achievement in Physics among secondary school students. These objectives are also substantiated in the case of the transaction of major concepts in physics, viz., Equations of Motion and Gravitation, which students perceive to be difficult while learning. Two-phase quantitative survey design is employed for this study. Phase-I of the survey is conducted on a sample of 623 students and Phase-II on 913 students. Percentage analysis, Test of Significance of Difference Between the Means for Large Independent Samples and Effect Size (Cohen's d) are used to fulfill the objectives. The results showed that, in secondary school physics teaching, irrespective of the difficulty level of the concepts the same pattern of instructions is practiced by teachers within each of the identified teaching-learning situations of physics. The frequently used instructional practices are Teacher Dominant Instruction (while introducing a concept and its consolidation, mathematical problem-solving), working-out problems related to graph, Formative Assessment, Test Previewing and Reviewing Strategies. The Instructional Practices that favour both Interest and Achievement in Physics are Teacher Dominant Instruction while Introducing New Concepts and Working-out Mathematical Problems, Transacting Methodical Tactics of Mathematical Problem-solving, Introducing Graph and Related problems, Addressing Misconceptions, Formative and Mastery Oriented Assessment, Student Participatory Individual Instruction while Providing Follow-up Activities, Directing to take part in Science Club Activities, Test Previewing and Reviewing Strategies for Examination Preparedness. The Instructional Practices that favour both Interest and Achievement in difficult concepts are Transacting Methodical Tactics of Mathematical Problem-solving and Introducing Graph and Related Problems. The study provides valuable insights for educational interventions, emphasizing the importance of employing situation specific practices to enhance interest and achievement among students.

Keywords: instructional practices, interest, achievement, physics, secondary school students

സംഗ്രഹം

ഹൈസ്കൂൾ തലത്തിലെ പഠനവിഷയങ്ങളിൽ ഏറ്റവും പ്രയാസമേറിയ വിഷയമാണ് ഭൗതികശാസ്ത്രം. ഇക്കാരണം കൊണ്ട് തന്നെ ഈ വിഷയത്തോട് കുട്ടികൾക്ക് താല്പര്യക്കുറവും കുറഞ്ഞ പഠനനേട്ടവുമാണ് ഉള്ളത്. എന്നാൽ അധ്യാപകർ ഉപയോഗിക്കുന്ന ബോധനരീതികൾ ഇത്തരം പ്രശ്നങ്ങൾക്ക് പരിഹാരമാണെന്ന് പല പഠനങ്ങളും കാണിക്കുന്നുണ്ട്. സെക്കൻഡറി തലത്തിൽ ഭൗതികശാസ്ത്ര അധ്യാപകർ വിവിധ അധ്യാപന-പഠന സാഹചര്യങ്ങളിൽ ഉപയോഗിക്കുന്ന നിലവിലെ ബോധനരീതികളെ പഠന വിധേയമാക്കുകയും അവ വിദ്യാർത്ഥികളുടെ വിവിധ തരത്തിലുള്ള താല്പര്യത്തിലും (ഡൊമൈൻ ഇന്ററസ്റ്റ്, സിറ്റുവേഷണൽ ഇന്ററസ്റ്റ്, വ്യക്തിഗത ഇന്ററസ്റ്റ്) പഠനനേട്ടത്തിലും എങ്ങനെ ബാധിക്കുമെന്നും വിശകലനം ചെയ്യുകയാണ് ഈ പഠനത്തിൽ. വിദ്യാർത്ഥികൾക്ക് ഏറ്റവും പ്രയാസമേറിയ 'ചലന സമവാക്യങ്ങൾ', 'ഗുരുത്വാകർഷണം' എന്നീ ആശയങ്ങളുടെ വിനിമയത്തിൽ ഈ രീതികൾ എങ്ങനെ സ്വാധീനിക്കുന്നു എന്നും കണ്ടെത്തുന്നു. ഈ പഠനത്തിനായി ക്വാണ്ടിറ്റേറ്റീവ് സർവ്വേ ഡിസൈൻ (രണ്ട് ഘട്ടത്തിലൂടെ) ആണ് ഉപയോഗിച്ചിട്ടുള്ളത്. സർവ്വേയുടെ ഒന്നാം ഘട്ടം 623 വിദ്യാർത്ഥികളുടെയും രണ്ടാം ഘട്ടം 913 വിദ്യാർത്ഥികളുടെയും സാമ്പിളുകളിലാണ് പഠനം നടത്തിയത്. പെർസന്റേജ് അനാലിസിസ്, ടെസ്റ്റ് ഓഫ് സിഗ്നിഫിക്കൻസ് ഓഫ് ഡിഫറെൻസ് ബിറ്റ്വീൻ ദി മീൻസ് ഫോർ ലാർജ് ഇൻഡിപെൻഡന്റ് സാംപിൾസ്, എഫക്ട് സൈസ് (കോഹെൻസ് ഡി) എന്നീ സ്റ്റാറ്റിസ്റ്റിക്കൽ രീതികളാണ് ഈ പഠനത്തിൽ ഉപയോഗിച്ചത്. സെക്കൻഡറി സ്കൂൾ ഭൗതികശാസ്ത്ര അധ്യാപനത്തിൽ, ആശയങ്ങളുടെ ബുദ്ധിമുട്ട് നില പരിഗണിക്കാതെ, എല്ലാ അധ്യാപന-പഠന സാഹചര്യങ്ങളിലും അധ്യാപകർ ഒരേ ബോധന രീതികളുടെ പാറ്റേൺ പ്രയോഗിക്കുന്നുവെന്നാണ് പഠനഫലങ്ങൾ മുന്നോട്ട വെക്കുന്നത്. പതിവായി ഉപയോഗിക്കുന്ന ബോധന രീതികളിൽ ടീച്ചർ ഡോമിനന്റ് ഇൻസ്ട്രക്ഷൻ (ആശയാവതരണവും അതിന്റെ ഏകീകരണവും, ഗണിതശാസ്ത്രപരമായ പ്രശ്നപരിഹാരം), ഗ്രാഫുമായി ബന്ധപ്പെട്ട പ്രശ്നങ്ങൾ പരിഹരിക്കൽ, ഫോർമേറ്റീവ് അസ്സെസ്സ്മെന്റ്, ടെസ്റ്റ് പ്രിവ്യൂയിങ് റിവ്യൂയിങ് തന്ത്രങ്ങൾ എന്നിവ ഉൾപ്പെടുന്നു. ഭൗതികശാസ്ത്രത്തിൽ താൽപ്പര്യത്തിനും പഠന നേട്ടത്തിനും അനുകൂലമായ ബോധന രീതികളിൽ പുതിയ ആശയങ്ങളും ഗണിതശാസ്ത്ര പ്രശ്നങ്ങളും അവതരിപ്പിക്കുമ്പോൾ അധ്യാപക ഡോമിനന്റ് ഇൻസ്ട്രക്ഷൻ, ഗണിതശാസ്ത്ര പ്രശ്നപരിഹാരത്തിന്റെ രീതിശാസ്ത്ര തന്ത്രങ്ങൾ കൈകാര്യം ചെയ്യൽ, ഗ്രാഫും അനുബന്ധ പ്രശ്നങ്ങളും അവതരിപ്പിക്കൽ, തെറ്റിദ്ധാരണകൾ പരിഹരിക്കൽ, ഫോർമേറ്റീവ്, മാസ്റ്ററി അധിഷ്ഠിത അസ്സെസ്സ്മെന്റ്, തുടർ പ്രവർത്തനങ്ങൾ നൽകുമ്പോൾ വിദ്യാർത്ഥി പങ്കാളിത്ത വ്യക്തിഗത ബോധന രീതി, സയൻസ് ക്ലബ് പ്രവർത്തനങ്ങളിൽ പങ്കെടുക്കാൻ നിർദ്ദേശിക്കൽ, പരീക്ഷാ തയ്യാറെടുപ്പിനുള്ള ടെസ്റ്റ് പ്രിവ്യൂയിങ് റിവ്യൂയിങ് തന്ത്രങ്ങൾ എന്നിവ ഉൾപ്പെടുന്നു. സങ്കീർണ്ണമായ ആശയങ്ങളിൽ താൽപ്പര്യത്തിനും പഠന നേട്ടത്തിനും അനുകൂലമായ ബോധന രീതികൾ ഗണിതശാസ്ത്ര പ്രശ്നപരിഹാരത്തിന്റെ രീതിശാസ്ത്ര തന്ത്രങ്ങൾ കൈകാര്യം ചെയ്യലും ഗ്രാഫും അനുബന്ധ പ്രശ്നങ്ങളും അവതരിപ്പിക്കലുമാണ്. വിദ്യാർത്ഥികളിൽ താൽപ്പര്യവും പഠന നേട്ടങ്ങളും വർദ്ധിപ്പിക്കുന്നതിന് സാഹചര്യത്തിനനുസരിച്ച് ബോധന രീതികൾ പ്രയോഗിക്കേണ്ടതിന്റെ പ്രാധാന്യം ഊന്നിപ്പറയുന്ന ഈ പഠനം വിദ്യാഭ്യാസ ഇടപെടലുകൾക്ക് വിലപ്പെട്ട ഉൾക്കാഴ്ചകൾ നൽകും.

പ്രധാന സൂചകവാക്യങ്ങൾ: ബോധന രീതികൾ, താൽപ്പര്യം, പഠന നേട്ടം, ഭൗതികശാസ്ത്രം, സെക്കൻഡറി സ്കൂൾ വിദ്യാർത്ഥികൾ

Chapter One

INTRODUCTION

- Need and Significance
- Statement of the Problem
- Definition of Key Terms
- Variables
- Research Questions
- Objectives
- Hypotheses
- Methodology
- Scope and Delimitations of the Study

The rapid technological advancements taking place in the world depicts the proliferation of science. The developing country like India is also striving hard to meet the advancements that the modern world demands. Science is about the procedures and practices that make man more aware about the world he lives in (Ogunleye, 2002) and his dynamic activity can extent from his local environment to beyond universe. Nowadays, it won't be wrong to say that there is nothing that the horizon of human mind and thought cannot accommodate. All these convey the extent to which science and its advancements have stretched.

"[S]cience. It's more than a school subject, or the periodic table, or the properties of waves. It is an approach to the world, a critical way to understand and explore and engage with the world, and then have the capacity to change that world…" (Obama, 2015).

Educators and policy makers, through proper research, are rigorously trying to implement science education in the most robust manner so that it equips the learners with scientific literacy, making them capable enough to be productive citizens and to tackle hurdles in their lives (Tytler, 2014). The ultimate prerequisite for scientific literacy is the true interest in science (Rutherford & Ahlgren, 1991). The young students who lack interest towards science are likely to become scientific illiterate and

unproductive citizens who are unable to address and solve societal science related problems (Swarat et al., 2012; Trumper, 2006).

Even though science education is given prime importance right from the school phase, it is seen that the interest towards the subject is declining among the learners even at their young age (Hoffmann, 2002) and many educational research have the objective of how to deal with this situation (Potvin & Hasni, 2014a; Renninger & Hidi, 2011). Trumper (2006) attempted to study the interest in science among high school learners to conclude that they held a neutral interest (neither positive nor negative) towards the subject, with boys possessing better interest levels than girls.

Krajcik et al. (2003), on the contrary, reported that there is substantial interest level among the students at the school, later which the science interest gets declined due to ineffective practices through which the content is delivered to them. Mitchell (1993) studied and found the sources of mathematics interest as the meaningfulness of the content and the nature and form of activities employed. Palmer (2009) proved the extent to which demonstration and experiment can bring better science interest among secondary level learners.

Despite the fact that science incorporates a wide variety of branches, as far as the school education is considered, the three subjects are physics, chemistry and biology. Physics is the branch of science that deals with energy and matter (Daramola & Omosewo, 2012; Faridi et al., 2021; Okafor, 2010). It is one of the domains of knowledge that is cardinal to the physical universe and contributes ceaselessly to mankind. The learning of physics is of utmost relevance to humanity, as it explains

natural phenomenon and that in turn caters to the proliferating theories and principles that act as a base for technological development (Ikwa, 1997). This produces trained manpower needed to utilize scientific breakthroughs and discoveries, which highlights the justification for focussing on physics education and its quality in all levels of learning.

Need and Significance

Citizens with scientific skills are very much required for the scientific development of a nation. It is through the experiences obtained during the learning process that they can acquire and learn to practice these skills. Resources that support teaching-learning process can either be in the form of human resource or material resource. Appropriate resources catalyse the smooth functioning of the process of content transaction in educational institutions, by accomplishing the pre-planned objectives within the stipulated period in the most effective way. Here the role of teachers is important to encourage the students to think out of the box and bring forth their innovative ideas (Korsun, 2019).

In the fast-progressing world with innovations in the field of education and research, the focus is always upon the teachers as they are bestowed with the duty of dissecting the prescribed curriculum into meaningful bits and parts and effectively transacting it with the best instructional practices within the classroom. In the school context, the experiences provided to the pupils via appropriate teaching-learning methods and instructional strategies by teachers, help the shaping of the learning environments to cater to effective learning (Ugwu & Eze, 2019). It is important for the teachers to be evaluated in terms of their behaviour, practices and skills and to be

trained professionally. Without quality teachers we cannot expect the nation to become politically, socially and economically developed (Oyedeji & Oke, 2020).

Instructional strategies employed to transact concepts within the classroom can be a core factor that influence the level of performance of the students (Akale, 1990; Ugwu et al., 2019). It is prominent that each teacher should rule out the techniques and strategies in which he could bring out the best in students (Akinbobola, 2015). National Education Policy 2020 has pinpointed that it is the pedagogical practices that determine the quality of learning experiences received by the students, which directly supplement the attainment of learning outcomes (Ministry of Human Resource Development, Government of India, 2020).

The overall achievement in science is not satisfactory among school students (Keller et al., 2017). They consider physics to be one of the most difficult subjects in science (Blajvaz et al., 2022; Hoffmann, 2002; Olasimbo & Rotimi, 2012; Rivard & Straw, 2000) without any practical application in future life (de Silva, 2015). Students have depicted relatively low performance in the subject (Akanbi et al., 2018; Barmby et al., 2008; Christian et al., 2019; Omosewo, 1999; Oon & Subramaniam, 2011) at secondary as well as tertiary level. Among the three branches of science discussed at school, the performance in physics is found relatively lower than the other two (Ugwuanyi et al., 2020). During the academic years, 2024-25 and 2023-24, the statistical data of SSLC results showed that the number of A+ holders in physics is less than that in chemistry and biology across fourteen districts of Kerala (Kerala Pareeksha Bhavan, n.d.).

The difficulty has led the students to lose interest and eventually to refrain from the subject. The number of students who opt physics-related courses for higher studies is seen declining irrespective of development of the countries (Gudyanga et al., 2015; Osborne et al., 2003; Simpson & Oliver, 1990). Students should possess a minimum level of subject competency to have interest towards it (Lepper & Henderlong, 2000). This may be the reason why the high achiever in the subject is intrinsically motivated and have interest in learning the concepts in the subject, while the underperformers are least interested in the same.

The reasons for decline in students' achievement can be broadly classified into two- as internal and external factors (Slameto, 2010). Internal factors take the form of motivation, interest, attitude, knowledge, skill, goal etc., while the external factors comprise of the learning environment that include the teaching strategies, learning materials, family background etc. Teaching a student who is least motivated is a tough task. So, it becomes relevant to learn the root cause of demotivation (Baran, 2016; Chow & Yong, 2013) and the measures to be taken to uproot the issue.

Being a fundamental branch of science, keen and special attempt is needed for its efficient learning. Physics teachers have the responsibility of helping students in tackling their difficulties in learning the subject. It is their task to make the subject more understandable as well as interesting to the learners who find it complex. The issue related to the mathematical and abstract nature of the subject that they find difficult to visualise, can be solved successfully if teachers largely bring their deliberate effort to make students realise the link between the concepts and their mathematical representations. Diagnosing student misconceptions, linking to prior

knowledge, learning through interaction, implementing diagnostic and formative assessment etc., can bring down the issues in dealing with the subject. The researchers and teachers have to put in rigorous effort to find out innovative practices to bring an element of interest into physics teaching and learning. Poor experience while learning physics as a school subject is another reason for underperformance among students (Barmby & Defty, 2006). So, it is high time for a paradigm shift in the nature of instructional strategies employed by teachers, so that the level of interest towards physics gets elevated and paves way for better academic performance of the students.

Regarding pedagogy, utmost focus should be laid on construction of knowledge, which requires instructional practices that spotlight pupil involvement in learning (Kaur & Raman, 2016; Nayak, 2007). In agreement with this, there have been research in the field of science education which focus on exploring various student-oriented methods of teaching physics aiming better academic performances in students (Nwankwo et al., 2019). Research have shown that the student-centred constructivist approaches have positive influence on both students' achievement and motivation (AgwuUdu, 2017; Kaur & Raman 2016). Such techniques and approaches adopted by teachers appear to motivate pupils as they find it more easy and pleasant to grasp, which in turn ensures retention (Ames & Ames, 1989). Interest is dependent on what a student has perceived from a particular study in a provided instructional pattern. Among the pool of personality characteristics, interest is that which has a drastic impact upon academic achievement of students (Ugwu & Eze, 2019). So, rather than the pupils' deficiency of capacity to learn, poor curriculum and methods

of teaching can hinder the students to showcase better performance (Carnine, 1997; Jones et al.,1997).

Inculcating interest in physics especially in the high school stage of schooling is very important (Blankenburg et al., 2016) as it is the beginning where students deal with it as a single main subject. This interest can pave the way for making better understanding with the concepts during their higher levels of education and in making better career choices. But, in reality, it is seen that the interest towards the subject is declining as the students advance from high school to upper levels of schooling (Potvin & Hasni, 2014a), as they find it more boring as they advance through various stages of education (Williams et al., 2003).

In the secondary level of school education, specifically in IX standard, physics as a school subject brings a wide variety, yet huge amount of information, which the learners are not previously used to. All the learners may not be able to assimilate it to the same extent, which results in the decline in interest while dealing with the subject. So, to inculcate positive outlook towards the subject, the innovativeness in planning and executing the learning process is inevitable.

The National Curriculum Framework 2005 supports that "improved textbooks that are carefully written and designed, professionally edited and tested, offering not merely factual information but also interactive spaces for children are important" (National Council of Educational Research and Training, 2005). "Though activity-based teaching has been accepted as a paradigm for science education and is also reflected in some measure in the textbooks developed at the national and state levels, it has hardly been translated to actual classroom practice. There is a general feeling

that activity-based teaching is expensive, takes more time that could be otherwise 'fruitfully' used for 'text-based' teaching, and does not prepare the child for examinations and competitive tests" (Mishra & Yadav, 2013).

Previously, while conducting a study based on the understanding of physics concepts by students and their ability to solve related problems involving mathematical applications, the researcher had interviewed 20 physics teachers from Malappuram, Thrissur and Palakkad districts. Almost half of them had the opinion that they found it very difficult to follow the activity-centred instructional strategies suggested in handbook, thus opting conventional methods of transaction. This may hinder the correct and deeper perception of physics concepts by the pupils. This may also result in mushrooming misconceptions which in turn hampers achievement and interest towards learning the discipline. In a nutshell, the extent of practice of activity-based teaching, interactive sessions and activities suggested in the textbook and handbook proposed by SCERT board, in the real classroom setting is still doubtful.

The extent of misunderstandings of the learners, which further lead to misconceptions, can be reduced by adopting a particular or a set of teaching strategies that the situation demands. Meanwhile, discrepancy is found between interest of students in physics and the type of instruction selected and adopted by teachers for the classroom teaching (Haussler & Hoffmann, 2000). It is recommended that the physics teachers must employ appropriate strategies in accordance with the learning attitude of students and the nature of the concept to be taught (Omeodu, 2019). Thus, flexibility in teaching strategies adopted is in demand for transacting varied concepts

in physics that can cater to both cognitive and affective factors of learning among students.

Recapitulating the ideas from literature, the researcher came up with the interrogations: Which strategies do physics teachers practice while transacting physics concepts at secondary level? Do they follow a common pattern of strategies throughout all the concepts in the textbook, or do they alter their practices depending upon the nature of concept, in terms of difficulty as perceived by the students to learn? Do the instructional practices of teachers have any influence on the level of three types of interests, viz., domain interest, situational interest and individual interest, of the learners? Do the instructional practices of teachers influence the achievement of students in physics? Do the instructional practices have any influence on the interest and achievement in difficult concepts in physics? All these queries persuaded the researcher to explore the practices employed by the physics teachers in secondary level classrooms and to investigate their influence on learners' interest and achievement in the subject.

Statement of the Problem

The present study is entitled as INSTRUCTIONAL PRACTICES IN PHYSICS AND THEIR INFLUENCE ON INTERESTS AND ACHIEVEMENT AMONG SECONDARY SCHOOL STUDENTS.

The study explores the extant Instructional Practices of physics teachers at secondary level in various teaching-learning situations and then analyses the influence of these practices on the types of Interests, namely, Domain Interest, Situational

Interest and Individual Interest, and Achievement in Physics among secondary school students. These objectives are also substantiated in the case of transaction of major concepts in physics, viz., Equations of Motion and Gravitation, which students perceive to be difficult while learning.

Definition of Key Terms

Instructional Practices in Physics

Instruction is defined as the kind of teaching that obligates the instructor to furnish the learner with some lasting direction and is accountable for pupil performances commensurate with precise statements of educational objectives (Good, 1959).

In this study, Instructional Practices in Physics is approached in three ways as follows.

- Instructional Practices in Physics
- Instructional Practices for Equations of Motion
- Instructional Practices for Gravitation

Instructional Practices in Physics

In this study, Instructional Practices in Physics denotes the pedagogic strategies used in various teaching-learning situations to transact the concepts in physics at secondary level. Operationally, it is the extent of usage of the distinct types of Instructional Practices in Physics as reported by the students through the 'Scale on Instructional Practices in Physics'.

Instructional Practices for Equations of Motion

Instructional Practices for Equations of Motion denotes the pedagogic strategies used in various teaching-learning situations to transact the major concept in physics, Equations of Motion, at secondary level. Operationally, it is the extent of usage of the distinct types of Instructional Practices for Equations of Motion as reported by the students through the 'Checklist on Instructional Practices for Equations of Motion'.

Instructional Practices for Gravitation

Instructional Practices for Gravitation denotes the pedagogic strategies used in various teaching-learning situations to transact the major concept in physics, Gravitation, at secondary level. Operationally, it is the extent of usage of the distinct types of Instructional Practices for Gravitation as reported by the students through the 'Checklist on Instructional Practices for Gravitation'.

Interests

"Interest is defined as a state of motivation or set that guides behaviour in a certain direction or toward certain goals" (Atkinson et al., 1987).

For the present study, Interests is approached in five ways as follows.

- Domain Interest in Physics
- Domain Interest in Equations of Motion
- Domain Interest in Gravitation
- Situational Interest in Physics
- Individual Interest in Physics

Domain Interest in Physics

"Domain Interest is an individual's interest towards a particular school subject or to particular topics and activities within a subject domain" (Krapp & Prenzel, 2011). "A student's interest in the contents of a domain that are taught in the lessons of a particular school subject constitutes Domain Interest" (Haussler & Hoffmann, 2000).

Operationally, Domain Interest in Physics is defined as the interest of the student towards the various concepts in physics taught at the secondary level. It is taken as the total interest score obtained by the student in the 'Domain Interest Scale in Physics'.

Domain Interest in Equations of Motion

It is operationally defined as the interest of the student towards the concept in physics, 'Equations of Motion', taught at the secondary level. It is taken as the total interest score obtained by the student for the sub-concepts under 'Equations of Motion' in the 'Domain Interest Scale in Physics'.

Domain Interest in Gravitation

It is defined as the interest of the student towards the concept in physics, 'Gravitation', taught at the secondary level. It is taken as the total interest score obtained by the student for the sub-concepts under 'Gravitation' in the 'Domain Interest Scale in Physics'.

Situational Interest in Physics

Situational interest refers to "the focused attention and the affective reaction that is triggered in the moment by environmental stimuli, which may or may not last over time" (Hidi, 1990; Hidi & Baird, 1986)

Situational Interest in Physics is operationally defined as the level of excitement that a student has towards a classroom learning situation or a life circumstance that is related to either physics as a school subject or any of the concepts in physics that they have learnt at secondary level. It is taken as the total score obtained by the student in 'Situational Interest Scale in Physics'.

Individual Interest in Physics

"Individual Interest refers to a person's relatively enduring predisposition to reengage in a particular content over time, which is characterized by high amount of emotion, value, knowledge and engagement" (Hidi & Renninger, 2006; Krapp & Fink, 1992; Renninger, 2000; Renninger & Wozniak, 1985)

Individual Interest in Physics is operationally defined as an aggregate of knowledge-, emotion-, value- and engagement- based affinity or alignment of a student towards physics as a discipline or as a school subject. It is taken as the total score obtained by the student in the 'Individual Interest Scale in Physics'.

Achievement

Achievement is defined as "the overall accomplishment that student achieve in a specific course measured by their scores" (Gora, 2001).

For the present study, Achievement is approached in three ways: Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation. Achievement in Physics is considered as the average mark obtained by the student in first and second terminal examinations conducted in schools. Achievement in Equations of Motion and Achievement in Gravitation is the score obtained by the student in tests, viz., Achievement Test in Equations of Motion and Achievement Test in Gravitation, respectively.

Secondary School Students

Secondary School Students are those who pursue the level of education which comes after the completion of seven years of schooling. Usually, it refers to those students who are attending VIII, IX, and X standards, which lead to the entry into higher secondary level of school education. For the present study, students of IX standard are taken into consideration.

Variables

The independent variables in the study are Instructional Practices in Physics (Instructional Practices in Physics, Instructional Practices for Equations of Motion and Instructional Practices for Gravitation). The dependent variables are Interests in Physics (Domain Interest in Physics, Domain Interest in Equations of Motion, Domain Interest in Gravitation, Situational Interest in Physics and Individual Interest in Physics) and Achievement in Physics (Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation).

Research Questions

The problem under study is systematically investigated through the following questions.

1. Which major physics concepts taught in secondary school are considered the most to least difficult by the students?
2. Which are the extant Instructional Practices of teachers in physics at secondary level?
3. Does the extent of usage of distinct types of Instructional Practices in various teaching-learning situations influence Secondary School Students' Interests in physics, namely:
    a) Domain Interest in Physics and in select difficult concepts?
    b) Situational Interest in Physics?
    c) Individual Interest in Physics?
4. Does the extent of usage of distinct types of Instructional Practices in various teaching-learning situations influence Secondary School Students' Achievement in:
    a) Physics?
    b) select difficult concepts in physics?

Objectives

The objective of the study is to explore the extant Instructional Practices in Physics and to find out the influence of these practices on Interests and Achievement

among secondary school students. The objective of the study will be attained through the following specific objectives.

1. To rank the major concepts in physics taught at secondary level in the order of difficulty for the secondary school students.
2. To explore the extant Instructional Practices of teachers in physics at secondary level.
3. To examine the influence of each type of Instructional Practice in various teaching-learning situations on Secondary School Students' interests, namely:
    a) Domain Interest in Physics and in select difficult concepts
    b) Situational Interest in Physics
    c) Individual Interest in Physics
4. To examine the influence of each type of Instructional Practice in various teaching-learning situations on Secondary School Students' Achievement in:
    a) Physics
    b) select difficult concepts in physics

Hypotheses

The hypotheses formulated for this study are as follows.

1. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in Physics among secondary school students.

2. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in difficult concepts in physics among secondary school students.
3. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Situational Interest in Physics among secondary school students.
4. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Individual Interest in Physics among secondary school students.
5. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in Physics among secondary school students.
6. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in difficult concepts in physics among secondary school students.

Methodology

The objective of the study is to explore the extant Instructional Practices in Physics and to analyse the influence of these practices on Interests and Achievement among secondary school students. This influence is also analysed in the case of concepts in physics that secondary students find difficult to learn. Two-phase quantitative survey design is employed for this study.

Procedure of the Study

The study is carried out in two phases as explained below.

Phase-I

Phase-I is descriptive in nature and is meant to rank the major concepts in physics in the order of difficulty for IX standard students to learn. The required data is collected both from students and teachers using respective tools. Based on their responses the difficult concepts are identified.

Phase-II

Phase-II is analytical in nature. Based on the difficult concepts identified in Phase-I, tests, checklists and scales are prepared. These tools are administered to IX standard students and based on their responses the extant Instructional Practices in Physics and their influence on Interests and Achievement in students are analysed.

Sample Used for the Study

Phase-I of the survey is conducted on a sample of 623 students of IX standard selected using stratified sampling technique from Malappuram and Kozhikode districts and 30 physics teachers from Malappuram, Kozhikode and Kannur districts.

In Phase-II of the study, the sample is IX standard students selected using stratified sampling technique from Malappuram, Kozhikode, Thrissur and Palakkad districts. The survey is conducted on 913 students for finding out the extant Instructional Practices for select difficult concepts and their influence on Domain Interest and Achievement in difficult concepts. For finding out the extant Instructional

Practices in Physics and their influence on Interests (Domain Interest, Situational Interest, Individual Interest) in Physics and Achievement in Physics, the survey is conducted on select 785 students.

Tools Used for the Study

The tools used for the study are given below.

Phase-I

1. Conceptual Understanding Test in Physics (Abdulla & Mumthas, 2023)

Phase-II

2. Scale on Instructional Practices in Physics (Abdulla & Mumthas, 2024)
3. Checklist on Instructional Practices for Equations of Motion / Gravitation (Abdulla & Mumthas, 2024)
4. Domain Interest Scale in Physics (Abdulla & Mumthas, 2024)
5. Situational Interest Scale in Physics (Abdulla & Mumthas, 2024)
6. Individual Interest Scale in Physics (Abdulla & Mumthas, 2024)
7. Achievement Test on Equations of Motion (Abdulla & Mumthas, 2024)
8. Achievement Test on Gravitation (Abdulla & Mumthas, 2024)

Statistical Techniques Used in the Study

The statistical techniques used in the study are given below.

Percentage analysis

To find out the extent of usage of Instructional Practices in various teaching-learning situations in physics at secondary level, percentage analysis is used.

Test of Significance of Difference Between the Means for Large Independent Samples

Test of significance of difference between the means for large independent samples is used to find out the influence of Instructional Practices on select dependent variables, viz., Domain Interest in Physics, Situational Interest in Physics, Individual Interest in Physics, Domain Interest in Equations of Motion, Domain Interest in Gravitation, Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation among secondary school students.

Effect Size (Cohen's d)

Cohen's *d* is used to determine how much is the effect of Instructional Practices on select dependent variables, viz., Domain Interest in Physics, Situational Interest in Physics, Individual Interest in Physics, Domain Interest in Equations of Motion, Domain Interest in Gravitation, Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation among secondary school students.

Scope and Delimitations of the Study

Physics as a separate subject is introduced at high school level, and the subject is considered to be the toughest among science subjects (Blajvaz et al., 2022;

Hoffmann, 2002; Olasimbo & Rotimi, 2012; Rivard & Straw, 2000). Toughness of the subject is usually accompanied with students' lack of interest, and they underperform in the subject. Meanwhile, the literature shows that instructional strategies employed by the physics teachers can be a core factor that can aid tackling of such issues (Akale, 1990; Rotgans & Schmidt, 2011; Tobin et al., 2001; Ugwu & Eze, 2019; Ugwuanyi et al., 2020). At this juncture, the investigator puts an effort to analyse the existing Instructional Practices of teachers to transact physics concepts at secondary level and to explore the influence of those Instructional Practices on Interests and Achievement of students at secondary level. This influence is also substantiated in the case of concepts that students find most difficult to learn and recapitulate.

This investigation initially focuses on ranking the major physics concepts based on the difficulty as perceived by the students. For this purpose, the survey using Conceptual Understanding Test on students and unstructured interview on teachers is done in Phase-I of the study. Consolidating the scores obtained by students in the test (Section C), ranking done by students in the test (Section B) and ranking done by teachers, the concepts, viz., Equations of Motion and Gravitation are identified as the difficult concepts.

Then the focus is redirected on learning the existing instructional practices of teachers used for transacting physics at secondary level. During the preparation of tools to be employed to accomplish this objective, after consulting physics teachers, various teaching-learning situations in which the teachers employ various strategies depending on the nature of academic context are identified. Based on these teaching-

learning situations, the tools, viz., Scale on Instructional Practices in Physics and Checklist on Instructional Practices for Equations of Motion / Gravitation are developed. Percentage Analysis of the responses of students on the scale and checklist provided the extent of usage of each type of Instructional Practice for transacting physics in general and also for difficult concepts, viz., Equations of Motion and Gravitation.

The next objective is to find out the influence of Instructional Practices on Interests and Achievement among students. In the light of literature, three types of interests, viz., Domain Interest, Situational Interest and Individual Interest, are taken into consideration. Required scales to measure these interests, viz., Domain Interest Scale in Physics, Situational Interest Scale in Physics and Individual Interest Scale in Physics are developed. To measure achievement in physics, the first and the second terminal examination marks of students are collected from respective schools and to measure the achievement in identified difficult concepts, tests, viz., Achievement Test on Equations of Motion and Achievement Test on Gravitation, are developed. The Test of Significance of Difference Between the Means for Large Independent Samples is used to find out the influence of usage of various types of Instructional Practices in each teaching-learning situation on Interests and Achievement among students.

This investigation thus explores the instructional strategies which will be better to transact physics concepts in specific teaching-learning situations, so that the student will have comparatively improved achievement and interest in those concepts. This would explain why it becomes necessary that teachers should employ the

correctly planned activities and strategies that would effectively cater to deep rooted knowledge of physics concepts among high school students.

Delimitations of the study are explained as follows.

- This study is carried out in two phases. Even though the population of the study is secondary school students, considering the practicality, only the students studying in IX standard from Kerala State Board schools are used as sample. The sample are selected from four districts, viz., Malappuram, Kozhikode, Palakkad and Thrissur, only. In Phase-I, the students from government, aided and unaided schools are selected. Meanwhile, in Phase-II, students from unaided schools are excluded from the sample.

- In Phase-II, Achievement in Physics is taken as the average mark obtained by the student in first and second terminal examinations conducted in schools. No separate test was prepared and administered due to practical difficulties and time constraints.

- Even though the main focus of the study is on Instructional Practices in Physics, only those practices which are currently being used by the teachers for teaching physics in nineth standard is considered for this study.

- There are seven major concepts in IX standard physics textbook. As per the suggestions given by secondary school physics teachers, only the first five concepts are considered for the development of Conceptual Understanding Test in Physics.

Chapter Two

REVIEW OF RELATED LITERATURE

- Conceptual Overview
- Review of Related Studies
- Conclusion

Being a crucial part of research, Review of Related Literature emphasizes in examining the studies that have been carried out in the research area concerned. Thorough reviewing of the earlier studies acts as a beacon light for further studies, not only to prove the relevance of the study by identifying the research gaps, but also to design the study as a whole including fixing the methodology to be followed and statistical techniques to be adopted. So, for strengthening the research framework, reviewing the related studies has to be continued throughout the research, from beginning to end.

This study is aimed at identifying the influence of Instructional Practices of teachers on Interests and Achievement in Physics of Secondary School Students. The review related to the problem is presented under the following heads.

- Conceptual Overview
- Review of Related Studies

Conceptual Overview

The conceptual overview of the study is presented under the following heads.

- Understanding Instruction and Instructional Design
- Shaping Instruction from Insights on Theories of Learning
- Strategic Approaches to Instruction

- Dynamics of Interest in Education
- Determinants of Student Achievement
- Barriers to Physics Teaching and Learning
- Conceptual Framework of the Study

Understanding Instruction and Instructional Design

Meaning of Instruction

Instruction is a noun having Latin origin, which means structure or built (Vocabulary.com, n. d.).

The word 'Instruction' is used interchangeably for 'teaching' (Bruner, 1960; Garman, 2022). It is the proper amalgam of teaching and learning (Akdeniz, 2016). The difference between teaching and instruction can be explained based on the context and setting in which it takes place (Bengtsson, 2011; Wright, 2011). Teaching can take place in both formal and informal settings, while instruction is more formal in nature (Lowell & Urena-Rodriguez, 2023).

Instruction describes the act of inculcating knowledge, skills and attitudes among the learners through a well-planned, sequenced and curated set of activities (Gagne, 1974) and experiences usually done by a teacher or an instructor. It is defined as the kind of teaching that obligates the instructor to furnish the learner with some lasting direction and is accountable for pupil performances commensurate with precise statements of educational objectives (Good, 1959).

Gustafson (1993) explains the process of instruction in terms of four basic questions- what is to be transacted, how is it to be transacted, how to try-out the transaction on the sample and finally, how to check whether the transaction has taken place or not. It is not an accidental process, but a purposeful one (Driscoll, 1994) executed intelligently, where the learners' thought process gets modified. Instruction makes learning more path-driven and focused. Teaching is an integral part of education and learning. Instruction is sometimes defined as well-planned directions provided by a person who can guide and expand the horizon of wisdom of another person.

Instruction can imply collaboration between teacher and the taught that involve exchange of ideas or subject matter to the students, giving pupil proper commands and support on how to learn being mentally active throughout the process, by planning and arranging all the facilities and arrangement needed for the conducive environment for learning to take place (Moore, 2000), and also making judgments regarding the level of thoughts and performance of the students. The whole process becomes meaningful when the learners can apply what they have learnt in their daily life outside the classroom, thus, not only improving one's own but others' mental, social, cultural and political stature.

Instructional Design and its Importance

The University of Michigan has defined, "Instructional Design as the systematic development of instructional specifications using learning and instructional theory to ensure the quality of instruction". It involves the methodical and highly organized set of process involved in planning, designing, creating,

executing and implementing the instruction to meet its objectives in the most effective way, ensuring fruitful learning (Kemp et al., 1998).

Instructional design can be described in four forms (West, 2018). Firstly, *as a process*, Instructional design stands for analyzing the essentials of the learners, so as to materialize resources accordingly, to plan the activities and tasks, to test them on the sample and to evaluate the effectiveness of the instruction and the performance of the learners. Secondly, *as discipline*, instructional design deals with the in-depth study of which instructional strategy is beneficial to which people, working out new and sophisticated strategies that make the purpose of instruction the most meaningful etc. Thirdly, *as science* of designing the specifications needed for generating, executing, appraisal of the instructional procedure to the audience concerned. And lastly, bringing the idea of an instructional delivery into *reality* and analyzing its worth.

Andrews and Goodson (1980) explained the major activities within instructional design: Improving learning and instruction through problem-solving; improving monitoring and control of instructional process; improving evaluation by proper feedback and reviews; building instructional theory. Based on the duration of the planning and execution, Gagne (1974), has categorized instructional designs into two. A long-range design, usually handled by a group involving a committee of instructional designers and textbook writers, the by-product of which is meant for a long-term execution, is the first type. While the next type, short-range design, is done by a teacher for the short-term or immediate purpose, like that of a lesson plan. In both cases, the overall principles followed while designing will be same.

For instructional design to meet the expectations of the planners, the stakeholders should enjoy the experience of learning. Learning that is meaningful will persist. The ancient philosophers, Pestalozzi, Froebel and John Dewey, who are the pioneers in child-centered teaching and learning, have always proposed this idea of experiential learning. Backing Dewey, Dale (1946) proposed 'Cone of Experience', through 'Audiovisual Methods in Teaching'. The bottom portion of the cone stands for the direct experiences, in which the learners actually perform or do the activity by themselves, which provides the most scope for concrete learning. The next level corresponds to the learning through observations from teacher demonstrations, field visits etc. Towards the peak of the cone lies the most abstract level of learning that takes place through language or symbols. This model still is valued in the present-day classrooms while the teachers plan and develop tasks for effective transactions.

Design denotes the overall structure or plan of flow of teaching-learning activities that supports meaningful learning. Addressing misconceptions among learners is also another important requirement of proper instructional design. Misconceptions contradict the proved scientific theory (Eryilmaz, 2002), which comes as a result of partial knowledge and understanding. Unless taken a deliberate effort to tackle, it would elevate further instruction and learning to more and more complications (Stein et al., 2008; Stephens, 2006). Misconceptions usually arise in the beginning when learners are in their primary classes when they start to acquaint with the concept in the grass root level (Hestenes et al., 1992). To address this, age appropriate and 'sufficient and complete' information have to be transacted to the

learners (Kuczmann, 2017), at the earliest, by employing proper tasks and audio-visual experiences within the instructional design.

Shaping Instruction from Insights on Theories of Learning

Behaviorism Vs. Constructivism

Behaviorism and Constructivism are the most glorified and influential learning theories that have brought paradigm shift from the 'traditional' method of teaching to the 'experiential' one.

Behaviorism focused on the transfer of knowledge from tutors to pupils, which was identified as learning. The teacher is considered of prime importance and holds high power and authority over the knowledge and content to be taught. The student is provided with a subsidiary position, where he has to act as a mere receiver of knowledge that has been transacted to him (Luan & Bakar, 2008). The knowledge that is being passed on has a defined structure and it is not being questioned or put into discussion.

The curriculum is more static in nature, where there is well planned and pre-defined outline and structure; subject area and contents which are arranged logically from simple to complex. The facts and concepts in the content are of prime relevance. Since the focus of learning is on the product, behaviorism is more of a product-oriented approach in teaching- learning.

On the contrary, the role of students is of prime importance when it comes to the constructivist approach of learning. Teachers hold back for setting the environment and facilitate so that students can construct knowledge of their own.

Transformation of knowledge rather than transmission is the highlight of this approach (Driver et al., 1994). The perception and opinion of pupils are of utmost importance, and it sets the pace of the whole teaching-learning process. The students are active in constructing personal knowledge and the teacher takes the role equally as a learner among the students.

Constructive classes are more of a problem-solving session through cooperation and collaboration between pupils and teachers (Cobern, 1993). There is continuous dialogue and exchange of ideas between the teacher and the taught. The learning process is more engaging for the students as the curriculum has a dynamic nature and the contents are loosely organized. Instead of product, the learning process and skill acquisition is valued. The student factors such as prerequisites, intrinsic motivation and interest are completely exploited in executing constructivist lessons.

Gagnon and Collay (2001) proposed the Constructivist Learning Design (CLD) in which construction refers to the development of knowledge within the human mind, by incorporating personal meanings and shared meanings that are received from others. Humans cannot accept and internalize concepts as it is which is received externally. Learning, development and improvement - is the primary goal of constructivism, where the focus is more on the role of the teacher as a guide.

Models of Instructional Design

Gagne's Nine Events of Instruction. According to Gagne (1974), learning is the main aim of instruction. But learning does not come solely because of instruction. The variables within the learner and those from the environment both have their own

role in shaping the behavior of the learner. Variables within the learner can be in the form of innate abilities, internal motivation and other qualities that may positively enhance the level of understanding and learning in an individual. The next set of variables will be in the form of external stimuli that usually corresponds to the supportive environment or the learning situation to which the student is exposed. The plausible situation may work on their level of attention and the level of performance.

Gagne explains that the internal factors and external factors individually cannot bring learning, at the same time have to complement each other for effective and long-term learning to take place. It is the instruction that glues these two factors together. He further exquisitely elucidates the role of instruction is arranging the external variables in accordance with the innate abilities of the learner to attain the learning outcomes, which are of five types- verbal skill, attitudes, intellectual ability, cognitive expertise and motor skills.

He explains how the instructor has to function taking care of the 'Nine Events of Instruction': (i) Dragging attention of the learners to an external stimuli planned and produced by the instructor, (ii) Communicating the learner regarding the objective of the instruction, (iii) Recalling the learner of the prerequisites, (iv) Encouraging the performance from the learner, (v) Presentation of the content in proper sequence, (vi) Prompting and guiding the learner, (vii) Consolidation and generalization of the learnt concept, (viii) Evaluating the learning outcomes of the students and (ix) Strengthening the level of retention and transfer of knowledge. Even though explicit instruction has to be provided to the students in their lower grades, as they advance to graduate level,

there will be no need for such planned and structured instruction because most of the students identify and employ their abilities to initiate 'self-instruction', where they can keep track on what and how they have to learn.

The ADDIE Model. The Florida State University designed the ADDIE Model of Instructional Design in the 1970s for military training purposes and later has undergone transformations over years. The basic principles in the model were adopted by instructors for effective execution of the instruction. ADDIE stands for the five cyclic processes viz., Analysis, Design, Development, Implementation and Evaluation (Liu et al., 2004; Lohr, 1998, Wahira et al., 2023).

The initial step is the need analysis of the recipients of instruction, which is followed by the planning phase based on the data received through initial phase. What are the objectives of the instruction, how it will be accomplished, and which strategies have to be followed are all the concerns of the second stage. The next is the stage for production of instruction, in which the designers bring the design into reality using appropriate resources. The product is executed in the next stage. Rosenberg (1982) puts forth that the process of evaluation goes along with each and every step. During analysis, it is important to evaluate how well the needs of the audience have been recognized by the designers. The evaluation of the materials and resources planned to meet the objective of the instruction is important in the designing stage. In the development stage, it has to be cross-checked whether the instructional media and materials are in line with the design. And finally, the effectiveness of the whole

instructional design developed is evaluated and this process gives more scope for bringing further improvement.

Merrill's First Principles of Instruction. Merrill (2002) proposed the model that explains the five principles of instructional design namely, task centered principle, activation principle, demonstration principle, application principle and integration principle. The principles work in a cyclic and continuous manner leading to meaningful learning involving relevance to the transfer of knowledge.

According to the researcher, the disequilibrium caused within the learner when encountered with a real-world problem, act as a probe for initializing the process of learning. So, exposure to the problems from real and practical tasks is relevant to instigate the critical thinking and reasoning skills among learners. Secondly, it is proposed that the prerequisites must be activated, so that the new knowledge is built upon it. The link to previous experiences provides a strong base for further conceptual understanding.

The learners have to experience certain examples related to the learning outcomes. The examples can take the form of demonstrations and case studies, from which the patterns can be identified by the learners. Learning can never be complete without applying it in the new contexts. The teacher can provide activities involving hypothetical problems for the students to apply the principles and theories they have learnt so far. In the final stage, the learner must be capable enough to apply those tactics and ideas to solve real world problems, which is the integration principle.

Strategic Approaches to Instruction

Instructional Strategy

The means, ways and approaches adopted by the teacher for the purpose of fulfilling the aims of instruction is known as instructional strategies. It comprises of different instructional methods that are arranged in the form of specialized phases that are targeted in accordance with the objectives of learning the content and the skill to be taught (Silver et al., 1996). The quality of the instructional strategy can improve the overall quality of learning. So, the decision-making process regarding which activity has to be included, which method and technique has to be used to implement the activity, are crucial (Baker & Dwyer, 2005).

It is preferred to include a variety of teaching methods within the instructional strategy. The instructional goals are complex, and the development anticipated within the learner is comprehensive. Therefore, the instructor is responsible for bringing forth an array of instructional methods and techniques that are domain specific like cognitive, affective and psychomotor (Williams, 2004).

The effectiveness of a teacher is mainly based on how effective the instructional strategies are. Strategies that can grab student attention for a longer period can make learning interesting. Instead of using a single method always, the teacher should put effort into planning and implement many varieties of methods and techniques, making the instructional strategy a wholesome experience for students. The greater the variety of strategies employed, better will be the learning experience,

more effective will be the teaching and better will be the performance of the learners (Lim, 2002).

The concept of Four Levels of Instructional Strategies put forward by Merrill (2012) explains how the strategies become effective as the level advances. In level 0, which is the lowest one, is named as the information level. The level is characterized by the teacher providing information on concepts, linkages between concepts, examples, events, procedures, their consequences etc. In level 1, the demonstration is accompanied by information and the teacher provides demonstrations of examples of procedures along with the explanation. In level 2, application is added to information and demonstrations. In level 3, the learners are provided with the opportunity to apply the concepts and skills they acquired. Then, finally comes level 4 in which problem-centered strategy is added to information and application. Identification, critically analysing and solving the problem using the learnt skills, is the ultimate form of learning according to the researcher. So, in this model, as the level advances, the additions within the strategies make the learning experience enriched and effective.

Also, the instructional process should never take place in an odd, mysterious and unplanned manner. Instructional strategies are powerful enough to bring achievement among learners and to elevate them to accomplish the learning objectives. So, it is mandatory that the process must be systematically designed, structured, implemented and evaluated with proper view of the target of objectives (Marzano, 2003).

Raba (2017) explains nine characteristics of effective instructional practices. (i) Good practices are those which provide the students opportunity for discussion and

cooperative learning, (ii) students are actively engaged in the process, (iii) there should be enough scope for getting feedback on students' progress so that the teacher can improve the practices accordingly, (iv) Students must be put in challenging situations, that make them skillful enough to solve the real-world problems, (v) good practices considers the individuality of students such as their interest, learning styles, motivation etc. and help the students identify their own areas of interest, (vi) the instructors stand for punctuality and regularity of works and deadlines, (vii) Instructors must have a good rapport with the taught, (viii) good practices inculcate self-confidence and self-reliance among learners and (ix) continuous education, training and updating of knowledge and pedagogic skills among teachers.

Determinants for the Choice of Appropriate Instructional Strategy

The teacher is the designer of instructional strategies, and his reasoning and decision-making skills should work remarkably in the process of planning, execution and evaluation. Different instructional strategies fit different situations (Mondal & Majumder, 2020). There are certain factors that a teacher should look upon while deciding the strategy to be used.

The instructional strategy to be adopted depends on the subject matter to be transacted. The requirement for any instructional design model is that the instructional objectives should go hand in hand with the subject matter and the requirements of the learner (Andrews & Goodson, 1980). The same strategy cannot work for the contents of different nature (Shulman, 1987).

What the student should know and able to do after the accomplishment of a course comprises the learning outcomes (Oyenka, 2000). The instructional strategy chosen should be planned and executed to achieve the learning outcomes of the course. The instructional strategy to be used depends on the domain (verbal, intellectual skill, cognitive, psychomotor skill, attitude etc.) to which the learning outcome belong (Hill & Jordan, 2021).

The developmental stage of the learner is important in choosing the strategy with which he has to be taught (Eristi & Akdeniz, 2012). The decision of the right strategy depends on the student factors such as their prerequisites (Anderson et al., 1990), level of comprehension, needs, interests, learning style, educational and socio-economic background and entry behavior (Oyenka, 2000). The teacher must have a clear idea regarding all these prior to the planning, selection and design of strategies and teaching learning activities.

In-depth knowledge in the subject matter is inevitable as far as a teacher is concerned. It is the responsibility of the teacher to provide conceptual clarifications when students raise doubts. But apart from that, the teacher must be equally well-versed with the learning theories and pedagogical practices, the technicalities of planning and implementing the appropriate strategy, and evaluating it accordingly. Even then, he should look upon the fact that the choice of the strategies should also be based on one's own capabilities and the methods and its principles chosen should be known to the teacher.

The learning environment is very important as it is the place where the transaction takes place between students and teachers (Lund & Stains, 2015;

McChesney & Cross, 2023; Nguyen et al., 2021). The classroom space should be contented to accommodate the planned teaching-learning activities. The amount of time allocated to bring desirable changes in the learner is another factor based on which the decision of strategy is to be made (Oyenka, 2000).

Instructional materials are important teaching and learning tools (Kochhar, 2012) that decide the efficiency of the instructional process (Ajoke, 2017). The extent of accomplishment of instructional objectives rests on the aptness of instructional materials employed (Olaitan & Agusiobo, 1994) which makes the process of instruction and learning easier for the teachers and students respectively (Olumorin et al., 2010). It is to be added that even though the teacher designs and plans the strategies to be implemented in the classroom, it must be flexible enough for the teacher to make changes within the instruction accordingly to meet the immediate and unexpected needs of the learner and the learning environment.

Classification of Instructional Strategies

Instructional strategies can be of different types which can depend on the nature of the content to be transacted and the skill to be trained among the learners. There is no well-established, clear-cut classification of instructional strategies. The researchers and educators have categorized them based on their perception and area, need and context of the research undertaken. The studies based on classification of strategies have set many criteria like focus of the teaching-learning process, methods and techniques used within the strategy, how knowledge is gained by students etc.

Saskatchewan Education Department (1991) proposed a taxonomy of instructional strategies with five categories, viz., Direct instruction, Indirect instruction, Interactive instruction, Experiential instruction and Independent study. Direct instruction is deductive in nature and denotes the strategy in which the teacher plays a central role in explicitly teaching the students. Students are in passive state and this strategy works when the teacher has to provide lectures on some content or to explain certain skills systematically. Indirect instruction refers to the student-centered strategy in which the students are considered more important than the teachers. The terminologies used by the proponents are inquiry, problem-solving and discovery to explain this strategy which is inductive in nature. The exchange and sharing of information and ideas is the highlight of Interactive instruction, in which the pupils are provided opportunities to work in groups and to generate thoughts through communication, which can improve their social skills. Experiential learning is also student- centered which is activity oriented. The learners perform experiments, observe, analyze and infer the findings. The strategy in which the students are held responsible for setting pace in their own studies and carrying out the learning process through self-initiation is the independent instruction.

Focus strategies and Process strategies are two broad classifications made by Eristi and Akdeniz (2012). Focus strategies include the instructor-oriented and the learner-oriented strategies. Process strategies include problem-solving and case studies strategies, discussion and brainstorming strategies, modeling simulation and role playing strategies, thinking-criticize-comment strategies, presentation strategies,

question-answer strategies, writing, summarizing and taking notes strategies, and project investigation strategies.

Teacher-centered Instruction. The instruction in which the teacher is more dominant than the students is the teacher centered instruction. Here, the teacher controls the whole teaching-learning process taking place within the classroom. Teacher decides, sets the pace and controls what the students have to learn and perform during the learning process (Knowles, 1980). The teacher provides knowledge and information to the students through expository teaching and the process is deductive in nature (Borich, 1988). The learning materials are provided directly to the students through lectures, presentations, explanations, consolidations etc. (Ormrod, 2004).

Behr (1988) explains that lectures are an extensively used teacher centered strategy, which focuses on giving explanations for anything and everything. Explanations are of three types: descriptive, interpretative and reason-giving (Brown & Atkins, 1986). Descriptive explanation is used to tell the student how a process takes place. To tell about the meaning, definition or theme of a word or a sentence, comprises the interpretative explanation. Explaining the reason or cause of some incident or phenomenon is the reason-giving explanation.

Brown et al. (1984) describes the five lecturing styles. Oral presenters systematically communicate the content orally by providing detailed information without employing any kind of aid. Exemplary presenter, instead of providing lengthy oral information, uses the visual aids while explaining that represents the examples and gives proper summary. Information presenters tend to provide a large set of

information mainly by reading out lecture notes but in a systematic manner. Amorphous presenters explain the content which lacks systematic arrangement and structured objectives. Lastly, the self-doubters, as the name suggests, find difficulty in arranging the content and presenting it in a systematic way. They are not sure whether the objectives are accomplished or not.

Even though the lecture is said to be a teacher centered approach, it can be made interesting by adopting certain techniques. Maphosa and Ndebele (2014) describes that there is the need for careful lecture introduction which has to be well planned for making it effective. The purpose of proper lecture introduction includes grabbing the attention of students, presenting the objectives, providing the overview, stimulating the prerequisites of students, discussing safety issues, building interest, arousing curiosity and motivating the learning.

The teacher performing any technical procedure or activity in front of the students, so that they can watch and learn how to perform it, constitutes the method of demonstration (Chikuni, 2003; Mutasa & Wills, 1995). The teacher acts and explains the step-by-step procedure how to do the activity, including background knowledge and precautions (Ameh et al., 2007; McKeachie, 1978). Here also, the teacher plays the main role, while students watch and learn (Mundi, 2006). This method comes into use when there is a shortage of materials and resources for students to perform the activity together. This method can also save time. This method is much more effective than employing lecturing only, as the students can visually experience the activity in addition to the verbal transmission of knowledge.

Student-centered Instruction. Student-centered instruction is driven by the needs, developmental level, interest of the learner. The emotional state of the learners is given more importance while planning the execution of this type of instruction. Adopting student-centered principles on the classroom instructional process can make the students active learners and may result in well-developed individual interest (Waltner et al., 2007). The first-hand experience of students, when provided with opportunities to learn by doing, will pave the way for in depth conceptual understanding and inculcating the problem-solving skills, especially for the middle school science learners (Baggott, 1998).

As a problem-based learning strategy, Inventive Tasks, which is an amalgam of logical, computational as well as experimental tasks, are employed to instill both interest and creative thinking among the learners (Korsun, 2019). The need for such problem-based tasks is that the students in a classroom may assimilate different types and varied volumes of information. These tasks provide a scope for differentiated learning process where the diversities among the learners are given due importance.

Inquiry-based instruction is more of a science-based approach in which certain questions instill a state of disequilibrium among the learners, and they are in search for its answers, by finding supporting data and evidence (Crawford, 2000). This strategy can promote scientific literacy, student understanding and engagement in the science discipline (Hudson, 1995; National Research Council, 1996). Banchi and Bell (2008) proposed the types of inquiry as confirmative (results are known to students, they need to verify the results), structured (results are known to students, they have to explain certain phenomena), focused (the research question is posed by the teacher,

to which the students have to find the answer) and open-enquiry (students themselves formulate questions and methodically enquire to find the solutions).

Project-based strategy also caters to better understanding and retention. Here, "students plan, implement, and evaluate projects that have real-world applications beyond the classroom" (Railsback, 2002). This also has the base of constructivism, in which students construct their own knowledge based on their past and present experiences (Karlin & Viani, 2001). It provides scope for first-hand investigation, with self-evaluation in every stage, along with the assessment of peers and teacher.

ICT-mediated Instruction. ICT incorporation in the process of instruction is always a game changer. The richness in the learning experience that grabs the attention of students can eventually elevate the level of interest in learning. The cognitive theory of multimedia learning proposed by Mayer (2005) explains that the use of multimedia provides an amalgamation of visual, auditory and verbal elaboration of the content to be learnt. These stimulate multiple senses of learner that provide a deep-rooted conceptual understanding by the students, which remains in the memory for long.

The rapid development in information technology has conferred on the computer as a powerful cognitive device for elevating the scientific enquiry and problem-solving skill among the learners (Lajoie & Derry, 1993). To attain the ultimate goals of science education, the educators are researching in blending computer assistance along with the pedagogy and psychological theories of learning.

Using computer assisted instruction and animations for classroom transaction has been researched to improve the attainment of learning outcomes and learner attributes such as retention, interest, achievement (Abidoye & Omotunde, 2015; Edo, 2017; Salisu, 2015), composing skills (Etim et al., 2016). Ejimonye et al. (2020a) and Ejimonye et al. (2020b) have explored that the employing of two-dimensional animations during instruction have enhanced the level of achievement as well as motivation towards mathematics related content in economics and the researchers further imply that the same can be used in teaching science subjects with mathematical nature, such as physics and chemistry. The practical aspects of many contents in science can be taught better using computer animation instructional packages (Hamzat et al., 2017). The web-based learning when incorporated with the appropriate learning materials, open discussion and interactive platform and evaluation activities will elevate student engagement in learning and subsequently their performance (Khwaja, 2018; Zakir & Hidayat, 2018).

Microsoft PowerPoint is very easy to prepare and use as far as the teachers are concerned. It is one of the simplest ways in which technology can be incorporated in classroom teaching. PowerPoint presentations work better than traditional 'chalk and talk' method', when used intelligently (Erdemir, 2011), especially in enhancing the achievement in learners (Anigbo & Orie, 2018; Ugwuanyi et al., 2019).

Internet browsing itself leads the information seekers to a sea of knowledge and information. In the case of science education, it is a platform for collaborative learning where everyone can share their ideas, learning materials, resources, simulations etc., which can catalyze the learning process. Research shows that virtual

laboratory instruction, for science subjects, brings out better performance among learners, as those engaging in usual laboratory activities (Daineko et al., 2017; Darrah et al., 2014; El Kharki et al., 2021). Virtual laboratories can be a boon in inculcating science process skills in situations where the educational institutions lack enough space to accommodate the students to carry out the experiments on their own and in cases of insufficient supply and availability of laboratory equipment.

Blended instructional strategy involves the thoughtful blend of online and offline teaching (Garrison & Kanuka, 2004). This strategy has, therefore, both the benefits of face-to-face and ICT mediated teaching (Graham, 2006). Allen and Seaman (2010) added that the proportion of online teaching must be substantial, i.e., between 30 to 79 percent. The various models of hybrid learning were put forward as rotation model (the students move from station to station out of which at least one will be online), flex model (initially the content to learnt will be provided through online mode, after which the student move to various stations), self-blend model (the traditional courses are provided with one or more online courses), enriched virtual model (students attend traditional classes from their institutions after which they receive online session from remote areas) (Staker & Horn, 2012).

Flipped or inverted classrooms emerged with the concept of inverting the school and home activities with each other, i.e., the activities which were traditionally done in the classrooms are shifted to be done at home and that was assigned earlier to be done at home is shifted to the classroom (Lage et al., 2000). There will be interactive group learning activities designed to take place within the classroom and

direct technology mediated individualized instruction designed for outside the classroom (Bishop & Verleger, 2013).

Computer-based and mobile apps are nowadays available to students and can be employed for independent and self-study practices. Teachers can incorporate them within the usual classroom teaching-learning process, to make learners more engaged in what is being studied. The components in the applications, such as the summary of the content, simulations and videos, practice papers and worksheets are expected to encourage students to learn physics easily (Liliana et al., 2020).

Gamification is about introducing the elements of game into non-game contexts in education (Hanus & Fox, 2015). Usage of online gamified platforms has improved attention, motivation, interest, engagement and accomplishment of learning objectives (Batista, 2023; Buckley & Doyle, 2014; Silva et al., 2019). Research reveal that students show positive learning outcomes in gamified science education contexts (Alahmari et al., 2023).

Augmented and virtual reality is extensively used in the field of education for the purpose of improving the teaching-learning experience, for both the students and teachers (Gudoniene & Rutkauskiene, 2019). Augmented Reality (AR) provides an extended perception of reality, while the real world is replaced with a simulated world in Virtual Reality (VR) (Blazauskas & Gudoniene, 2020). Both provide a multi-sensory experience through ‘immersive multimodal environment’, thus proving to be powerful and effective instructional tool especially for students during their school education (Zhou et al., 2020).

Online discussion forums, Interactive whiteboards, Interactive simulations and Virtual field trips are also widely used in school science education to enhance the learning outcomes and experiences (Alazmi & Alemtairy, 2024; Alqawasmi et al., 2024; Camara & Lapinid, 2024; Zhang et al., 2023).

Independent Instruction. The independent instruction is based on the fact that students learn at different paces, and this instruction is meant to inculcate self-regulatory learning skills among the students. The students decide what to learn and how (Knowles, 1973). The students themselves keep the pace of their learning, plan and design how they have to learn, systematically search for knowledge, arrange them in the understandable form and prepare timely reports regarding the advancement in their work. Self-reliance and independence are the two prime qualities improved within the learner who is being taught using this strategy. Even though the students carry out learning on their own, regular and timely feedback of the instructor is mandatory that facilitates the individualized strategy as a whole.

Flipped classroom strategy is a mixing of traditional classroom teaching with tech-mediated instruction (Qu et al., 2024). It involves a pre-class session, which may be online, in which the students are meant to learn and make an understanding of the concept independently, which is followed by a discussion in the traditional classroom setting (Eichler, 2022). So, this approach involves ‘learning before teaching’ rather than ‘teaching before learning’ (Hew & Lo, 2018). Self-learning habits and problem-solving skills are improved among the students along with the deeper understanding of the concepts (Han & Klein, 2019).

Project-based learning as a constructivist approach can also be assigned as individual work, that ensures their active engagement. Students seek knowledge that is significant to their life and make an understanding by themselves through in-depth inquiry and demonstrate and present the collected information in a systematic manner, the whole process being carried out for an extended period (Laffey et al., 1998). This approach promotes critical thinking skills, self-regulatory learning skills, collaboration and communication skills (Trilling & Hood, 1999). Project can take the form of finding a solution to the problem or constructing artifacts or equipment (Ravitz, 2010).

Project work employing design-and-make approach is a form of learning activity that employes the students art, craft and creative skills, which increases the chance for better achievement among the low performers (Anwar et al., 2012; Kim, 2005). The students are asked to prepare toy-aids based on the physics-concepts to be learned, using cheap, easily available and recycled materials. It is practiced upon students who are less academically motivated by the traditional methods of teaching (Amir & Abdullah, 2021) and is highly benefitted to instill interest, curiosity, internal motivation and positive attitude in learners (Amir, 2018; Amir & Subramaniam, 2015; Sidawi, 2009; Zubrowski, 2002).

Interactive Instruction. Interactive instruction utilizes communication among students and between students and teachers, ensuring active participation of students in the learning process. Cooperation, communication and interaction between pupils and between pupils and teachers boost the buildup of the conceptual understanding of the content to be learned and strengthen a healthy friendly

environment within the classrooms, where students are free to express their thoughts and consolidate the peer works as a team effort.

The common form of interaction is the classroom discussion in which the students are given a question or a topic upon which the students discuss in groups and finally present their point of views accompanied by the arguments (Weston & Cranton, 1986). Interactive strategies have always paved for better achievement (Hanze & Berger, 2007), better levels of attention and self-efficacy (Dou et al., 2018), higher cognitive levels of learning like analysis, synthesis and evaluation, and affective domains (McKeachie, 1978) among the students. Studies also add that student collaborations that result in construction of knowledge in groups can bring better understanding (Alexopoulou & Driver, 1996; Stump, et al., 2011).

Group projects can be assigned if the students in the group share similar as well as complementary interests. In this case, the merit is that the students benefit from interaction in one way or the other. The instruction reaches its completion when the instructor acts as a manager, who supervises and provides suggestions accordingly for the fruitful completion of the project work.

Peer instruction caters to interaction among learners in which those who face difficulty in learning are being taught by another student (Crouch, 1998). Such discussions can benefit both the students- who helped, in attaining mastery, and who sought help, in attaining deeper understanding. In fact, such instruction brings better academic performance when compared to that provided by the teacher. The most important advantage of using this instruction is its adaptability, that it needs no extra equipment or tools for execution.

Think-pair-share strategy that involves cooperative discussion taking place in three stages- thinking, pairing and sharing (Robertson, 2006)- ensures critical thinking skills among learners (Kaddoura, 2013). The teacher poses the question upon which the student has to initially think about their own solutions, then, pair with the partner to discuss with the views and ideas on the solution, and finally to share their findings with the teachers and others.

Inclusivity within a classroom is guaranteed in cooperative strategy (Farmer et al., 2019), in which students interact with each other and learn together. Students stay active throughout the process and contribute significantly towards their peers' learning (Slavin, 2011). Socialization along with academic progress are the advantages of both cooperative (Casey & Goodyear, 2015) and collaborative strategies (Nokes-Malach et al., 2015). Student team-achievement divisions, learning together, group investigations and jigsaw are some of such popular interactive strategies.

Active learning through group training is the specialty of Fishbowl strategy. It is meant to improve both intrapersonal and interpersonal skills among the learners. In this strategy, the learners form two groups, in which one group (Inner circle) is involved in discussing the subject, while the other (Outer circle) watches and prepares questions based on the first group's discussion (Obeidat, 2018).

Framework for Appraisal of Instructional Strategies

The teaching and the strategies employed can be evaluated through self-assessment by the teachers, peer evaluation and student evaluation. Self-assessment

itself can be done in many ways. To analyze the lesson plan, teachers can use a standardized checklist of quality criteria that should be followed during planning of the lesson plan. Teachers can rate their own performance on a scale (Wilkerson et al., 2000). Keeping log or a reflective journal can help the teacher to note down whether the lesson plan was executed according to the plan or not, what incidents took place in the classroom while concept transaction, what were the blocks in the execution etc. This is an effective method to track down one's own progress as a teacher and to plan for betterment in future. During teaching, they can observe the clues regarding the interestingness of their teaching from the overt excitement and pleasantness with which students attend the class and their participation in the teaching-learning activities. The classes can be videotaped and watched later to get an accurate picture of the whole teaching as an outsider. The score of the students in achievement tests can also imply the quality of teaching to some extent.

Peer evaluation is also effective for getting feedback regarding classroom teaching. Colleagues can make classroom visits or can watch the videotapes and mark their measures on rubrics based on the standards that the instructor is expected to follow and achieve.

Student evaluation can be carried out by distributing a questionnaire or a scale upon which the students have to rate their teachers and their teaching. The students have their own perception on every aspects of a class, be it the concept delivery, instructional practices (Bada & Jita, 2023) and teacher behavior (Kyriakides, 2005; Worrell & Kuterbach, 2001). Student valuations have its own pros and cons. Advantage of this valuation is in terms of the cost and time efficiency and that the

only need for its execution is a questionnaire having the items which the students can understand and easily respond. Even though, this valuation strategy has the disadvantage of lack of knowledge of teaching among the respondents (Aleamoni, 1987), since students are the firsthand consumers of instruction, their perception is considered valuable (Uddin et al., 2008; Wilkerson et al., 2000).

Dynamics of Interest in Education

Theoretical Underpinnings on Interest

With the view of interest as a 'motivational variable', Hidi and Renninger (2006) defined interest as "the psychological state of engaging or the predisposition to reengage with particular classes of objects, events, or ideas over time". According to Schraw and Lehman (2001), interest is "liking and willful engagement in a cognitive activity". Edelson and Joseph (2003) defined it as "a motivation to engage with a topic or an activity".

The higher the level of interest, the easier will be learning (Crouch et al., 2018; Jansen et al., 2016; Palmer et al., 2017). Surplus research is being carried out on this construct as it is directly involved in enhancing the learning experiences. At the same time, there is a large mass who are involved in learning activities in which they are not at all interested. Such struggling learners also strive hard to attain more knowledge to attain real conceptual understanding (Azevedo, 2013).

One of the most accepted theoretical elucidation regarding the construct interest is put forward by Renninger and Hidi (2015) who explained that interest has two dimensions: Firstly, as a psychological variable that is related to the affinity of an

individual to engage in an activity and secondly, as an inner urge in the form of motivation that drags him to reengage in that same activity afterwards. These researchers proposed the Four-Phase Model on Development of Interest, in which they explain about the various phases in which interest is grown within an individual (Hidi & Renninger, 2006). The four phases are namely triggered situational, maintained situational, emerging individual and well-developed individual interest. This model underwent many revisions and modifications later (Renninger & Hidi, 2011; Renninger & Hidi, 2015).

Situational Interest. The first two phases represent the less developed interest phases, whereas the latter two correspond to more deep-rooted interest. The very initial instance of interest development happens when an individual's attention is caught on some stimuli (Hidi & Baird, 1986). This attention is the trigger for interest. Triggered situational interest is short-term sustained which bring cognitive and affective fluctuations that help in temporary engagement, that has been the result of the initial trigger (Fredricks et al., 2004). The person may have positive or negative feelings towards the content or activity. External support is essential to explain and guide what has to be performed or learnt. There are very high chances to back off from the process when encountering constraints.

The individual is expected to have focused attention that may comparatively live longer in the maintained situational interest phase. Here the knowledge regarding a particular content and its value is in a developing stage within the individual's mind structure, that the person reengages in the same activity towards which he had felt some triggered situational interest earlier. Even though external support is essential to

guide through the content, the person is expected to have positive feelings towards the content.

Individual Interest. In the phase of emerging individual interest, the person will have a deep-rooted knowledge and value towards the content. The individual questions themselves regarding the content and is reflective in nature. This interest is sustained and maintained over time so that he reengages in the same independently, without any external insistence. But when encountered with any difficulty, there still exist chances of getting retrieved. Feedback from others will not be appreciated in this phase.

Lastly, well-developed individual interest, as the name suggests, represents the more concrete interest within an individual, in which they are reflective, open to questions and feedback. There is no going back in this case, that the person will have a deep-rooted positive feeling towards the content and the value of knowledge is highly appreciated. Whatever kind of situation is, he will be willing to reengage.

The theoretical construct of interest consists of three dimensions – emotional, value-based and cognitive component (Hidi & Renninger, 2006; Krapp & Prenzel, 2011; Zoechling et al., 2022b). Academic interest comprises of four components, viz., emotion, value, knowledge and engagement. Emotion refers to the positive affective features like happiness and excitement in connection with some activities (Csikszentmihalyi & Hunter, 2003; Hidi & Renninger, 2006). Value refers to one's own perception about the importance of a specific object in their life or personal prosperity (Schiefele, 1991; Hidi & Renninger, 2006). Knowledge refers to the perception regarding the level of knowhow on a specific domain or subject (Krapp,

2000). Engagement refers to the inclination to take part and engage in certain activities that can deepen interest (Renninger, 2000).

Summing up, a person's interest which can be called as 'operating interest' can be an interest based on temperament, which is the individual interest, otherwise known as academic interest, or the interest caused due to the external conditions like classroom teaching-learning activities in the case of a school student, which stand for situational interest. Students who have better individual interests are supposed to engage and enjoy the learning activities more (Schiefele, 1991; Mazer, 2013).

Domain Interest. Among the various psychological constructs on motivation, interest stands out in terms of its specificity with respect to content and object (Krapp, 2005), i.e., domain specificity (Gogol et al., 2017). The domain can be considered in two levels. Firstly, in the broader or generalized level, domain can be considered a wider range of knowledge, for example, science and interest in science. Secondly, in the concrete level, the domain is more specific, for instance, it can be the interest towards a branch in science, like physics, biology etc., or interest towards a particular topic or activities related to the topic (Krapp & Prenzel, 2011).

Domain Interest was also explained and distinguished from Subject Interest by Haussler and Hoffmann (2000). The interest of a student in the content of a domain that is taught in a particular school subject is Domain Interest. Student's interest towards a subject in accordance with how it is being taught to them comprises the Subject Interest. So, the interest of the student in a subject is determined by both the Domain Interest and Subject Interest. Encapsulating, interest being a domain specific

construct, the interest varies across school subjects and these interests have to be measured separately for different subjects (Luo et al., 2019).

Assessing Learner Interest

Interest is one of the most relevant constructs in education, as it is the driving force for learning to be carried out smoothly and efficiently (Rotgans, 2015). If a student is interested in a subject, he will find more time to be engaged in the activities related to the subject and his knowledge level on its content will be high (Alexander et al., 1995; Lawless & Kulikowich, 2006). Interest is also a compelling predictor of future career and study choices (Harackiewicz et al., 2002; Hauer et al., 2008).

Pattayev (2024) used a Likert scale and some open-ended questions, respectively, to collect quantitative and qualitative data on interest in university students towards Alternative Energy Sources in physics. Vakarou et al. (2024) employed 5-point Likert Scale, which was similar to that used in the study conducted by Pantazis et al. (2021). The only change was that instead of 'science' the researchers used 'physics'. Brakhage et al. (2023) measured interest in two ways. Firstly, a 5-pointLikert scale was used to measure Students' Interest in Physics-Related Activities in Leisure Time and another scale to measure Students' Interest in Physics Classes.

Neito et al. (2023) used a 5-point Likert scale to measure the individual interest of students in physics, in which the statements were taken from the enjoyment dimension of PISA 2015 (OECD, 2017). The 'science' in the tool was replaced with 'physics'. The second tool used by the investigators was the Experience Sampling Method questionnaire for measuring situational interest. The questionnaire in this

method contains statements in the self-reporting forms based on the respondents' real experience during certain incidents and the tool was administered three times to the sample.

Zoechling et al. (2022) developed a tool with rating scale items to measure the interest of students in Particle Physics and Kwarikunda et al. (2020) constructed a five-point Likert scale to measure the individual interest of the students. Dopatka et al. (2020) constructed a scale constituting items on four facets, i.e., for measuring topic-related interest with emotional and value-related valences and subject-related interest with emotional and value-related valences. This scale was a combination of Topic and Subject-related interest theory by Haussler and Hoffman (2000) and Person-object theory by Krapp (2007). Krapp (2007) explains that the interest of a person can be influenced by the object either emotionally or by its value. According to Haussler and Hoffman (2000) the interest towards a school discipline has two dimensions- interest towards the topics learned and the interest towards the subject as a whole.

Determinants of Interest

Research on the factors that influence the interest in physics learning is basically summed up into four, viz., content, context, tasks and learning environment (Sjoberg & Schreiner, 2012; Zoechling, 2023). Gardner (1985) proposed that interest of an individual towards a particular content can change with time and that too is dependent on gender, age and the instructional approaches employed. Lind (1982) described that the high school students' interest towards physics is of four components

- Interest in observation, Interest in practical activity, Interest in theory and Interest in mathematical problem-solving in physics.

Haussler et al. (1998) explained interest as construct that depends on, firstly, the content taught, secondly, the context through which the content is presented and thirdly, the nature of the task or learning activity that allows one to have firsthand experience and finally, the learning environment (Dierks et al., 2014). The interest among the learners can also be seen high if they can establish the link of the concept learned with their real-world issues (Perkins et al., 2006).

Swarat et al. (2012) conducted a comparative study to find which among the three elements related to learning - content, activity and learning objective - is more influential on the interest of students. The study showed that it is the nature of the activity that influenced the students more as their interest is instilled through the activities that involved practical hands-on experiences with technology mediation.

Bennett et al. (2007) also explained that the context is more influential upon the interest than the content. Trumper (2006) explained learners' interest in physics as an amalgam of individual interest, situational interest and the social climate within the classrooms. Interest in learning physics can be in the form of interest in physics content, interest in the context in which the content is discussed, the interest towards the learning activity, interest towards the instructional strategy employed etc. (Lavonen et al., 2005).

Krapp and Prenzel (2011) stated that the age of early secondary education is very crucial for development of interest, especially in science. If the student loses

interest or is deprived of a chance to develop interest, then it is difficult to reignite it back (Lindahl, 2003). The development of interest is mainly dependent on two factors- firstly, the 'attractiveness' of the content to be learned and secondly, the 'manner' in which the content is taught (Krapp & Prenzel, 2011). So, the role of teachers in triggering and maintaining interest during the secondary level of schooling is relevant.

Teacher as Catalyst for Student Interest

As far as the learners are concerned, their initial period of interest development is highly dependent on the nature and level of trigger that they receive from external sources. External stimuli can take many forms. Bergin (2016) explains that the interest in a learner begins with the realization of need from a social setting. This may occur through the interaction with parents, friends and other people to which the learner is exposed. It is here the researcher brings forth the role of schools in influencing the interest development among the students. Teachers within the schools have a prime role in instilling interest among the learners through wide variety of curated and well-planned teaching–learning activities (Rotgans & Schmidt, 2011).

Development of interest takes place in a regular sequence starting from childhood and it can extend beyond late adolescence (Travers, 1978). Students in between their preschool and primary school age will have interest in all the natural phenomena, from which they love to experience and learn. In between the primary and secondary school level, students develop their own preferences and choices, based on their areas of strengths and weaknesses. These preferences formed are the consequence of the type of exposure that the learners receive in the classroom during

the teaching-learning process (Todt & Schreiber, 1998). Adolescence is marked as the critical period for development of interest towards science.

Schraw et al. (2001) said that the situational interest can be cultivated among the learners in three different ways. Within the classrooms, the students must be provided with the freedom to choose what they have to study and the method in which the content have to be studied. Teachers have to select the learning materials and design learning tasks very distinctly that snatches the student's attention and interest. The prerequisite knowledge has to be checked before presenting new concepts, and if needed, has to provide enough background knowledge to fill the gaps. They also add that students can be made active participants in the whole teaching-learning process through hands-on activities, puzzles, games etc. (Mitchell, 1993) and the longer they engage in such activities more will be the situational interest in them.

The teacher's level of interest in the subject matter and content knowledge will reflect in the way he teaches in the classroom. Research also show that this interest of teacher will be gradually transformed to the situational interest in the student (Long & Murphy, 2005). Also, when teacher dominancy decreases, students are expected to get more limelight, which further can instill interest. This is one of the reasons why Problem-based learning classrooms are found to be effective in this aspect (Schmidt et al., 2009). Students are also provided with ample scope to talk, interact and work with peers through discussion on the questions raised by the teacher, based on which the student performance is being evaluated.

Summing up, it is proved that the nature of triggers is the one that instills interest in the audience. Triggers can be demonstrations, projects (Pressick-Kilborn,

2015), simulations (Knogler et al., 2015), laboratory activities and co-curricular works related to the subject, especially physics (Oon & Subramaniam, 2011), that can bring novel and at the same time challenging classroom experiences. The teacher must be capable enough to mix, match and plan accordingly to the maturity of learners, their attention span and their level of interest.

Determinants of Student Achievement

If it is matter of education, then limelight is on student achievement. Stakeholders of education hold the primary need of elevating the achievement level of learners that makes them completely equipped to meet their future needs. It is the gravity of the content and it's learning that is relevant while explaining achievement in a broad sense. In narrow terms, achievement can be explained as the quantity of the content that is being learnt by a student in a given period of time (Pooja, 2017).

Achievement is the prime indicator based on which all the innovations and policy making is done, not only at the national level, but also within the school, which can be considered as the micro level. The student achievement can be considered a multivariate complex construct, which can have large number of factors and predictors. Research are carried out in two ways, either by considering one factor by another at a time, or by studying the predictors as a whole to get a comprehensive picture.

Teacher factor is one of the major factors that determines the level of performance of students (Azuka, 2013). It is the teacher who acts as the allrounder in bringing forth innovations in instructions and its execution and collecting back the

feedback to improve educational reforms with the aim of improving the level of achievement in their students (Tobin et al., 2001). Teacher functions through the prescribed curriculum and vests the power to bring alterations in the attitude and in the extent of performance of the learners (Kalu & Ali, 2004).

Instructional strategy used by teachers is an important factor that influences achievement. How well the teachers are qualified and have subject knowledge, if they refrain from the use of innovative teaching strategies, that reflect in the achievement of students (Ugwuanyi et al., 2020). Teachers should have updates not only in their subject content but also on the pedagogic advancements and innovations, which are possibly accomplished through rigorous professional development activities such as attending workshops, symposiums, seminars etc. These would lead to betterment in terms of teacher effectiveness and further its reflection on student achievement (Johnson et al., 2007).

The instructional materials in improvised and standardized form can bring better achievement among learners (Oladejo et al., 2011; Onasanya & Omosewo, 2011). Educational settings that lack enough learning materials are always a hindrance for teachers to execute what they have planned (Jegede & Okebukola, 1992), which further affects the learning of students.

Cultural background of the students determines the level with which they perform in classroom learning and assessment activities (Aikenhead & Ogawa, 2007; Muller et al., 2001). If the student finds a lack of harmony between his nature and self-identity and the dynamics of the classroom, there are high chances of him

showcasing overall underperformance. Such situations can be handled with appropriate inclusive pedagogical strategies.

Positive attitude among pupils towards learning and better achievement comes hand in hand (Weinburgh, 1995). Motivation level of the learners along with their interest (von Rhoneck et al., 1998) and peer interaction and participation in group activities (Stamovlasis et al., 2006) can contribute to student achievement. Lawrenz et al. (2009) finds teacher quality, positive interactive classroom environment, interest and attitude of learners and their access to the learning resources mainly decide the level of their achievement.

Barriers to Physics Teaching and Learning

Physics is an important branch of science that deals with the universe and related phenomena and events that we observe around us. Since it is important in understanding the existence of life and the universe, the relevance of physics education has been increasing day by day, both at school and collegiate level. Physics learning can equip the learners with scientific attitude and skills to think scientifically and critically. It makes them capable enough to be part of the advancing technologies and their applications in this developing world (Bada & Jita, 2023). Physics is a pivot discipline that holds connections with various science allied subjects like chemistry and mathematics (Bada & Akinbobola, 2020).

Physics and mathematics are mutually interrelated. To understand the concepts in physics, mathematics is crucial (Tasar, 2010). Learning physics is

challenging as far as students are concerned. They have to deal with various illustrations that may take the form of equations, formulas, graphs, numerical operations and many concepts that may be abstract in nature (Sitotaw & Tadele, 2016). Students find it difficult to transform physics into mathematics and vice-versa (Basson, 2002). Some students have these as the reasons why it is the least interesting school subject for them.

Students initially start learning physics with the prerequisite knowledge about what they had observed from their near environment and the beliefs that have passed on to them. This may result in causing false pre-notions and misunderstanding among them which can result in scientifically imprecise opinions and thoughts. When not corrected, there are high chances of these being carried over their lives. So, with the advancement of the world that surrounds us, there should be innovation in the way in which physics is being transacted to learners in their educational setting.

There are many factors that hinder the conceptual learning of physics discipline at school. Physics educational research is mainly built on the construct of addressing these issues; finding, investigating and proposing solutions to chalk out those disputes and concerns.

Gunta and Ousman (2015) studied the problems in teaching and learning physics at secondary and higher secondary level in Ethiopia. The study was conducted extensively by collecting data from principals, teachers and students. The results of the study show that the teachers face workload as a result of many classes to handle, which makes them exhausted. They are also found least interested in teaching and

demonstrating experiments to the students. It was also found that teachers lack enough instructional and subject competency, and the procedural skills to employ laboratory equipment within the classroom. Some even show reluctance to attend professional development programmes such as workshops, seminars etc. The class size is very large and teachers cannot manage the students in their learning and follow-up activities. So, lack of enough supervising and monitoring makes the students lag in the subject physics. The schools taken for the study lacked resources such as library, laboratory and internet facilities. Students lack basic mathematical skills which are needed to deal with the subject and have only a moderate level of interest in physics due to its difficulty in learning and understanding.

Aykutlu et al. (2015) investigated qualitatively the conceptual difficulties in teaching physics concepts such as mechanics, modern physics and electricity at high school level in Turkey. The results of the study show the students lack of basic conceptual understanding, inability to visualize abstract concepts, existence of misconceptions, lack of mathematical skills and stringent time duration that hinders the teacher in transacting physics effectively to the students. Okafor (2015) found the difficulties of the students in dealing with the mathematical problems in physics as the abstractness of the subject and teacher factors such as inappropriate or ineffective teaching methods employed, lack of knowledge on learning techniques, lack of usage of inquiry methods, experiential activities and practical works.

The abstractness of the concepts affects the learner's level of understanding and performance (Kwarikunda et al., 2020). Liliana et al. (2020) describes the subject

to be assumed as a tough one to understand and also boring. Studies also show that apart from the abstractness of the subject as a reason, the underperformance and difficulty in learning can also be due to teaching practices employed (Ma et al., 2017). The use of learning media and teaching strategies which do not fit the context are some of the reasons for decline in students' interest in subjects such as physics, chemistry and biology (Nasution et al., 2018).

According to Wenno (2015), there is a significant positive relation between interest and (i) students' basic mathematical ability and (ii) students' ability in solving problems in physics. So, the deprived motivation and interest towards the subject result in the poor achievement of students (Potvin & Hasni, 2014a; Tuan et al., 2005). This would further affect badly the decision making towards physics learning (Schumm & Bogner, 2016). Researchers are therefore very keen in developing and implementing innovative pedagogic practices to make the learning more effective and to increase learners' interest towards the subject (Chekour et al., 2015; Heering & Hottecke, 2014).

Conceptual Framework of the Study

Development of interest is important for easy and effective learning (Crouch et al., 2018; Hidi et al., 2004; Jansen et al., 2016; Palmer et al., 2017). As far as science is concerned, the development of interest is trivial during the early secondary education level (Zoechling et al., 2021). But interest towards physics declines as the students enter higher educational levels at school (Djudin, 2018; Guido, 2018; Oon & Subramaniam, 2011; Potvin & Hasni, 2014b, Williams et al., 2003). So, it is

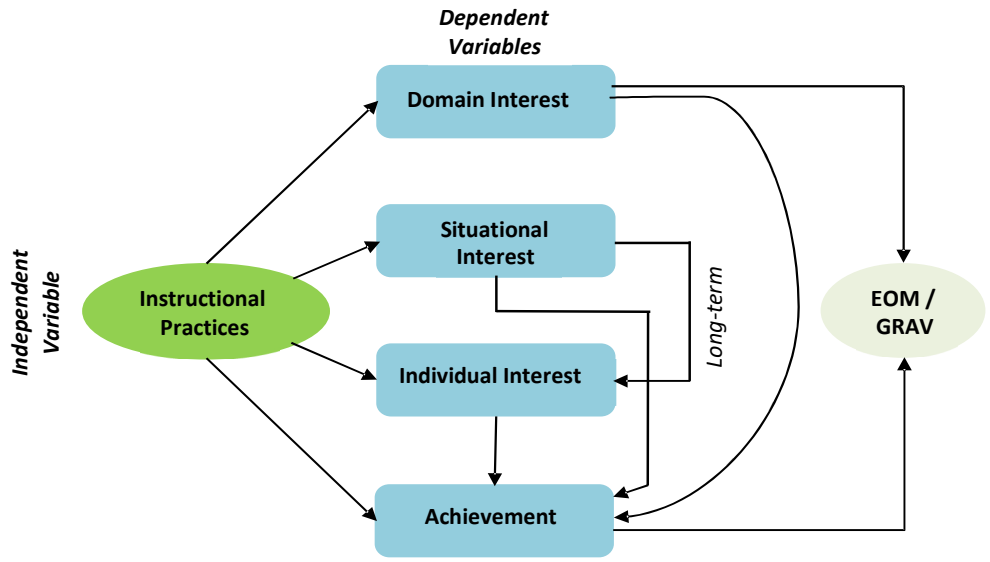
imperative to research on the affective construct of interest in relation to physics as a school subject.

This study deals with three versions of interest that exist in students towards physics. Firstly, when considered within the classroom context, the interest towards physics, can take the form of that which is aligned towards the concept or topic under discussion, which stands for the Domain Interest in that particular concept (Gogol et al., 2017, Krapp & Prenzel, 2011). Secondly, the interest may be triggered due the context or the situation in which the content is presented, which is the Situational Interest (Bennett et al., 2007; Krapp & Prenzel, 2011). This interest can also be evident when the learner expresses a positive affinity towards the life situations (outside the school) that are related to the learnt physics concepts (Hidi & Renninger, 2006). Both the Domain and Situational Interests may contribute to the academic performance of the students, specifically, the student achievement in the subject. The Situational Interest can pave way to maintained interest known as Individual Interest or Academic Interest (Hidi & Renninger, 2006) within the student.

The conceptual framework of the study is presented in Figure 1.

Figure 1

Conceptual Framework of the Study



The role of instructional strategies is crucial in this whole process of inculcating interest (Rotgans & Schmidt, 2011) and enhancing achievement (Ugwuanyi et al., 2020). "In different subject areas, at different levels of instruction, and with different instructors, any one method may or may not be effective, and even within one class, individual students will respond in varying ways to the same teaching method (Weston & Cranton, 1986)". This study tries to find out the influence of Instructional Practices of teachers on the Domain Interest (which is also substantiated by selecting the difficult concepts that students find difficult to learn), Situational Interest, Achievement and Individual Interest in physics of secondary school students.

Review of Related Studies

The relevant related studies reviewed are given under the following heads.

- Instructional Practices in Physics
- Instructional Practices and Interest in Physics
- Instructional Practices and Achievement in Physics
- Instructional Practices, Interest and Achievement in Physics

Instructional Practices in Physics

Studies in the International Context

Ozmen (2024) assessed how undergraduate physiotherapy students' conceptual understanding on simple electric circuits changed from 2018 to 2023. The data from 296 students at a private university were analysed over those years. The Simple Electric Circuits Diagnostic Test (SECDT) was administered to evaluate students' conceptual understanding. Five common misconceptions were found to be clashing current model, short circuit misconception, power supply as constant current source model, sequential reasoning and local reasoning. Over the period of five years, minimal changes were seen in the conceptual understanding of the students, which proved that misconceptions were prevalent among them which were left unaddressed. The study provided the implication that specific and targeted instructional strategies that address these misconceptions is needed to enhance the conceptual understanding of the students.

Bada and Jita (2023) researched on the students' rating on the classroom practices (instructional material, method and classroom management) employed by physics teachers at secondary level. The study involved a descriptive survey design, and the data was gathered from 1256 students randomly selected from Ondo, Nigeria. The data gathered using Questionnaire on Students' Rating of Physics Teachers was statistically analysed and the results showed that the students rated that the teacher's usage of instructional materials and methods to be low. Meanwhile, the teachers were rated high in the case of classroom management. This study implied that the students' opinion is crucial in evaluating the instructional practice of the teachers and the betterment in the teaching-learning of physics can be expected if the teacher pay heed to instructional materials and methods along with classroom management.

Mazzola et al. (2023) studied the effective teaching strategies employed in high schools in Italy during the COVID pandemic. The researchers designed and implemented a physics vocational training project known as 'Percorsi per le Competenze Trasversali e l'Orientamento' (PCTO) (which meant 'Paths for Transversal Skills and School Guidance') over two consecutive academic years, 2020-21 and 2021-22. The project incorporated webinars by professors on Sound waves and Acoustics, laboratory activities carried out using software such as Physics Toolbox Suite, Spectroid, SonicVisualizer, Audacity etc., and presentations by students and student peer evaluation. After implementation, the researchers focused on identifying whether this project was appreciated by students and whether the student evaluation was comparable with the teacher evaluation. The analysis of responses made by 42 students in the questionnaire showed that the students

appreciated the whole project. Statistically, the students gave more scores for presentations than teachers; hence, this study concludes that, for formative assessment, peer evaluation can be considered reliable.

Hansson et al. (2021) investigated the views of teachers regarding physics teaching at higher secondary level in connection with the curriculum emphases and role of mathematics in physics. A nation-wide online survey was conducted using the questionnaire that consisted of three parts: Part A asking views of teachers on physics curriculum emphases (Fundamental Physics (FP), Knowledge Development in Physics (KDP) and Physics, Technology and Society (PTS)), Part B collecting views regarding the views of nature of mathematics and physics and Part C regarding teaching practices in physics and the role of mathematics in physics. The data were collected from 379 physics teachers from Sweden. The results showed that teachers have substantially higher emphases on KDP. The teacher responses also showed that the teachers employed teacher-centered instruction more than student centered instruction, but neither of them was at extreme levels, which implied that teachers used a combination of both instructions. Lack of time to cover huge content and requirement of mathematics for learning physics were the problems in teaching physics in the view of teachers. Teachers who put emphasis on FP believed more that mathematics is the issue than the other teachers.

Jarry-Shore and Anantharajan (2021) identified the types of struggles faced by students while engaging in collaborative problem-solving activities. The study was conducted on students from seventh grade. The researchers observed the students while they worked in groups. The major categories of struggles were of two types –

mathematical and social. Mathematical struggles involved understanding the concepts and procedures to be done to solve the problem. Social struggle included difficulty in reaching agreements and having their questions and doubts answered by their peers. Students were found able to tackle the mathematical struggles slightly more than the social struggles.

Kang and Seo (2021) investigated the physics high school teaching practices in South Korea during COVID-19 pandemic. The study focused on the online teaching practices of teachers during the school lockdown period. The sample included eight high school teachers. The investigators observed the online classes and the learning materials employed by the teachers. Interviews with them also served as the source of relevant data for the study. The findings showed that the practices emphasized three aspects: Content Explanation, Student Participatory Learning and Independent First-hand Experience. Technology was the key factor in shaping these aspects of instruction. Content was delivered through direct teaching like video- and pre-recorded lectures. Student Participatory Learning involved discussions, collaborative assignments and quizzes. Home-based experiments and problem-solving tasks provided Independent First-hand Experience to the students. However, some teachers struggled in adapting with the digital technology incorporation in teaching. The study further highlighted that pedagogical values and subject-specific practices of teachers influenced how they adapted to online instruction. The study lime lighted the need and importance of adaptability with new digital competencies among teachers in crisis situations.

Bunyamin et al. (2020) qualitatively analysed how far the physics teachers' current teaching practices align with integrated STEM teaching framework. Three physics teachers from Johor, Malaysia, who had experience with STEM related activities were purposefully selected for the study. Initially, three teachers were interviewed to find out their teaching goals and teaching practices. The second phase involved the classroom observations of the teachers, to find how far their responses match with their actual classroom practices. In the third step, the teachers were again interviewed to find out their conception regarding STEM teaching. As the final step, the guiding framework on integrated STEM teaching was analysed and data triangulation was conducted. The findings showed that three teachers had similar teaching practices and similar conception on STEM teaching. For two teachers, there existed huge contradictions between their conception on STEM teaching and their actual practices, since they used teacher centered approaches instead of student-centered practices. Meanwhile, all teachers employed teamwork and communication among students and real-world applications of concepts, and the study suggested that these practices should be continued in the classroom teaching.

Pejaner and Mistades (2020) conducted a case study of physics teaching practices of the Obo Monuvu Tribe in Philippines used for Culturally Responsive Science Teaching (CRST). This qualitative research employed observation, interview and focus group discussion to gather data from two physics teachers and ten students. The teaching practices were identified through classroom observation of the teaching of physics concepts (Force, Laws of Motion, Uniform Circular Motion, Work, Energy, Power), FGD of students and interview of teachers. Ethnographic strategies

were used to analyse the data gathered. The findings showed that there were 12 common teaching practices, viz., Using the 'simplest term possible'; giving contextualized examples and definitions; lecture and discussion; using vernacular in teaching (most used); demonstrating affective attributes (most used); doing simple, challenging activities and experiments; using teaching methods and materials that maximizes on students' visual learning style; reviewing the basics; using strategies to monitor and assess learning; using teaching strategies in preparation to higher grade level; homework (least used); and spoon-feeding (least used). The teachers opined that their practices improved as they taught the students because of the factors like teachers' adjustment, students' view in education and students' difficulties.

Ates et al. (2018) investigated how far the instructional practices of prospective teachers in physics are in alignment with their constructivist beliefs. The data required for the study were collected through semi-structured interviews, lesson plan analysis and classroom observation. Eleven teachers from Turkish University were the sample. One interview was meant to identify the views of prospective teachers regarding physics teaching and the second to get description regarding their teaching style, self-evaluation of teaching and to know whether they could execute activities as they had planned. Their lesson transcripts were then analysed to understand the level of incorporation of constructivist principles in the lesson. Classroom observation was meant to check whether teachers' views aligned with what they practiced and how far they could implement constructivist approach. Both the interview schedule and the classroom observation checklist employed were prepared in accordance with 5E instructional model. Based on the ratings in the checklist, the

teachers were classified into three categories, viz., traditional, transitional and constructivist. Out of 11, seven teachers were in the transitional state. Six teachers' practices aligned with their know-how on constructivism. So, the study concluded that nearly half of the teachers don't implement the constructivist principles in the classroom teaching.

Chekour et al. (2018) examined the pedagogic approaches which are adequate for teaching scientific disciplines, especially physics, in the Moroccan context. The study highlights that teaching needs adaptation in accordance with the needs of the learner, subject matter to be transacted and the teaching context. There is no universally accepted approach to teach physics, and the use of approaches is flexible in accordance with the situation. Certain approaches, namely, Objective-based approach, Competency approach, Project-based approach, Problem solving approach are discussed. The historical investigation approach along with simulation is also emphasized as it is more effective by bringing historical context-based teaching with technology incorporation to meet the needs of the learner.

Retnawati et al. (2018) investigated the challenges faced by physics teachers in teaching concepts involving mathematics and the practices employed by the teachers to tackle this situation. The participants of this qualitative study were 15 senior high school physics teachers and one expert in mathematics education from Indonesia. The focus group discussions were coded and the findings showed that there is lack of curricular synchronization between mathematics and physics. Most of the skill in mathematics and statistics is needed from grade X onwards for learning

physics concepts but they are introduced only in grade XII. This result in very deep impact which includes physics subject to be perceived as a tough subject, difficulty faced by physics teachers in explaining mathematics as prerequisite and in realizing curricular targets, difficulty in using non-ideal assessment model, difficulty in teaching to cater to higher order thinking skills. To manage all these difficulties, the teachers carry out discussion with mathematics teacher, integrated the mathematics material into physics, the prerequisites are delivered before the real physics teaching and special time is allocated outside for teaching mathematics and physics. The study highlighted the fact that physics teachers are used to these difficulties, and they adjust themselves to the regulations. They expect that government bodies will take initiatives to rearrange the subject materials in the curriculum of mathematics and physics.

Demirci (2015) investigated the prospective high school physics teachers' beliefs on traditionalist to constructivist approaches in teaching practices. The study was conducted on 135 teachers from Balikesir University, Turkey. The data related to the traditional constructivist beliefs were gathered using Teacher Belief Survey. Later written responses on how physics should be taught were collected. Their perspectives on physics teaching were gathered through the interview which was conducted on 11 of the participants. The analysis of data showed that majority of the teachers exhibited an intermediate belief, i.e., a mix of traditional and constructivist views, in teaching physics. Ninety percent of the participants criticized the current curriculum, which overemphasized examination preparedness, not on conceptual understanding. The opinion on incorporating more links between the physics concepts and daily life

instances, lab activities and technology integration were also expressed by the teachers. Only minority mentioned about preconceptions and misconceptions in physics, innovative assessment strategies and relevance of affective domain while deciding the practices.

Mokiwa (2014) investigated the understanding of physical science teachers on scientific inquiry and their classroom practices. The case study was conducted on four participants from Limpopo Province, South Africa, teaching from grade X to XII. Interviews and classroom observations were used to collect qualitative data. The analysis of data revealed that the teachers did not possess a clear understanding of what an inquiry is and how to facilitate it within classroom. They practiced the traditional teacher centered methods of teaching in which the students are always provided the data by the teacher and restrict their thinking.

Mudau (2013) implemented Classroom Practice Diagnostic Framework (CPDF) to analyze and report the difficulties in teaching the topic in physics, Projectile Motion, which the school students found difficult in learning. This case study was conducted on a physical science teacher of XII standard from the Gauteng Province in South Africa. The methodology included interviews, classroom observations and the data gathered through CPDF. Interview was conducted prior to and after the class to understand the teacher's insights and reflections. The data regarding the actual execution of teaching practices and interactions were gathered using classroom observation. CPDF dissected the teaching process based on four aspects: Teacher Knowledge (teachers' know-how on the concept), Instructional

Strategies (methods employed for content delivery), Classroom Interactions (nature of communication between teacher and student) and Accountability (teacher's commitment and integrity). The CPDF revealed that misconceptions existed within the teacher regarding the content. There was a minimal use of student teacher interactions, which hindered student inquiry and engagement. The teacher put over emphasis on completion of topics and examination results than the deep conceptual understanding of the concepts by the students. Thus, it was concluded that CPDF was effective in identifying the root cause of difficulties in teaching and hence, cater to focus on the particular aspects of professional development and improvement.

Karamustafaoglu (2009) studied the opinion of using active learning strategies in teaching physics. The relevant data was collected from 40 secondary school physics teachers selected randomly from Amasya, Turkey. The initial insights regarding physics teaching strategies were collected through semi-structured interview. Based on the responses obtained in the interview a questionnaire was prepared in which the various strategies, both traditional and active, and their usefulness were listed. The teachers had to mark their responses based on the strategies they use and what reasons do they have for not using certain strategies. The findings showed that the secondary science curriculum is transacted through traditional means, like solving problems and question-answer method, not student-centric. Most teachers are aware of active learning strategies, but they doubt their applicability in physics classrooms. The hindrances for implementing active strategies are over emphasis on university entrance examination and overcrowded classes. So, the teachers are compelled to

follow the prescribed textbooks completely, with no role playing, laboratory works, practical, brainstorming, demonstration etc. The teachers also stated that there are insufficient facilities at school to implement active strategies. Demonstration, student games, debate, individual study, models and analogies, question-answer, watching video, computer programming, role playing and taking notes are effective teaching methods. Student games, doing worksheets, case study, concept mapping, brainstorming, computer programming, models and analogies were never used by teachers. It is concluded that the teachers do not use strategies in which the students are active learners.

Abrahams and Millar (2008) conducted a study to evaluate the effectiveness of practical work in science on students' understanding and cognitive development. The researchers observed 25 science lessons in English secondary schools that employed practical work for the study. Interviews were also carried out on teachers and students to understand their perception and experience in learning through practical work. The analytical frame work of Millar et al. (1999) was used to study the effectiveness of practical works. The findings of the study showed that students often failed to understand the underlying concepts of the experiments, but rather focused on following the instructions provided and carrying out the procedure using the physical materials and objects. The study highlighted that students need explicit guidance from the teacher to connect observations with the scientific concepts and theories.

Stein et al. (2004) described how the direct instructions have to be designed for the effective mathematics learning and problem-solving. Providing systematic procedures is important in improving student outcomes in mathematics. Explicit teaching and teacher-guided practice have to be emphasized. The teachers have to provide step-by-step procedure for teaching mathematical problem solving, for gaining the procedural fluency and for ensuring clarity and consistency in the underlying concepts and principles. Methods for identifying and addressing common student errors have to be incorporated. The students have to be given enough exposure to problem-solving through repeated practice. The paper also gives guidelines for adapting the existing math programs with the principles of direct instruction.

Lazarowitz and Tamir (1994) carried out a review analysis to identify the factors that determine the effectiveness of practical work and laboratory instruction in meeting its goals. The authors concluded that the factors include effective guidance and facilitation of teachers, pre-lab activities and imbibing the clear objectives by the students and usage of appropriate evaluation techniques to measure student outcomes such as conceptual understanding and development of scientific process skills.

Kiewra (1985) investigated the relative effectiveness of instructor provided notes, student prepared notes and a combination of both on the student performance. This investigation was based on existing reviews on note preparation practices. The investigator reported that student prepared notes were often found incomplete and thus not suitable for reviewing purpose. The students who reviewed the teacher provided notes performed better during exams. The students who reviewed both self-made and

teacher-made notes showcased higher academic performance than the other two groups.

Studies in the Indian Context

Biswal (2023) explained the teaching methods that hinder the student learning. Dominance of teacher-centered approaches, the pace of teaching like teacher talking too much and covering the concepts faster than the students pace, age inappropriate teaching strategies, failing to give proper consolidation in the last 10 minutes of the lesson, lack of ample revision practices of the taught concepts, lack of explicit teaching, little opportunity for self-learning, providing too little feedback on student's performance and their mistakes, lack of ample disciplinary interventions, ineffective assessment and questioning strategies are some of the hurdles discussed.

Kumar and Raju (2021) studied the perception of physical science teachers (in terms of demographic variables, viz., gender, age, locality, school management and qualifications) towards the ten factors, viz., teaching strategies, content knowledge, resources, teacher commitment, teacher support, learner attitude, curricular issues, assessment practices and socio-economic conditions of learner, that affect the teaching of physical science. The sample of the study comprised of 120 teachers from Vizianagaram district, Andhra Pradesh. The study employed a survey using a questionnaire that was constructed on the ten areas. The data collected was analysed using t-test and ANOVA and the results showed that gender, age and educational qualifications of the teachers did not have any influence on their perceptions regarding teaching methods. The teachers from urban schools perceived higher when compared to teachers from rural schools in the case of teaching strategies such as project method,

group work method, heuristic method, problem-based method, doing experiments and teaching through suitable examples.

Kumar and Panda (2020) examined the pedagogical beliefs of pre-service teachers about the nature and the way in which physical science have to be taught at the secondary level. The participants of the study comprised of 97 pre-service teachers from RIE, Bhubaneswar. The data was collected using questionnaire and five-point Likert scale. The findings showed that the respondents held strong belief in teaching physical science through assignments, experiments and activities, project work, field visit etc. They believed that these methods had significant impact on achievement of the students and use of different strategies and approaches that involve student participation in groups cater to better student performance. These teachers had prior knowledge regarding the effective utilization of learning resources and ICT and held the opinion that common assessment strategies should be implemented. The teachers opined that students must be encouraged to raise questions, debate and discuss.

Narayanan and Gafoor (2017) investigated the perception of teachers and the taught on integrated instructional strategies in physics at the higher secondary level in Kerala context. Through the study, the investigators focused on the perception of teachers and students regarding the present teaching practices, the frequency with which the inquiry-based strategy was used and the barriers for its usage. Questionnaire consisting of both dichotomous and open-ended questions is used for gathering data from both the teachers and students. 121 students and 82 teachers were the respondents. The study showed that the students who have opted for science stream have the least interest towards physics compared to other science subjects. The

teachers claimed that they employed multiple instructional strategies, but the students believed they received lecture more. Teachers had control of the incorporation of improved strategies, but the need of infrastructural facilities for its implementation was highlighted by them.

Narayanan and Gafoor (2015) highlighted the strength and need for integrated instruction in transacting physics, rather than using either teacher-centered or student-centered instruction. The investigators proposed that a single strategy may not be enough for a subject like physics, which needs both conceptual understanding and problem-solving. The role of a teacher should not shrink to a mere facilitator, but an active and enthusiastic co-learner. The pros and cons of both the teacher-centered and student-centered strategies are discussed and the investigators explained that the focus should not be laid on the type of strategy, but on the fact that the strategy chosen should be appropriate with the needs of the student, the content area and its difficulty.

Laad (2013) explained that the traditional methods of teaching can no longer sustain interest in learners towards physics. Physics teaching should be modified with innovative practices that are potential enough to motivate the students and improve the overall quality of physics education. The features and advantages of practices such as Improvised lectures and webinars, implementing self-assessment practices, use of analogy, culturally responsive teaching, project and research-based curriculum transaction and ICT-incorporation and simulations, are discussed in the study.

Mariamma and Nair (2004) conducted a study on the theory-practical integration in the teaching of physical science at high school level in Kerala. The study consisted of both survey and experimental phase. The tools used for the study were

questionnaire for teachers ($N = 214$), checklist of equipment and materials in schools, checklist for students ($N = 513$), lesson transcripts of activity method (for experimental group) and conventional method (for control group) on select topics in physical science and questionnaire for teachers ($N = 98$) regarding the revised syllabus of eighth standard. The experimental phase consisted of a sample of 263 students from Alappuzha district. The findings of the study are explained as- majority of the teachers were well aware of all the topics in physical science at high school level; majority of teachers employed lecture cum demonstration method; pre-service and in-service training is beneficial in the opinion of majority of teachers; majority of teachers only employed experiment to some extent within the classroom fearing the issues of discipline among students; the extent and skill in conducting experiments increases with the years of teaching experience.

Instructional Practices and Interest in Physics

Studies in the International Context

Pattayev (2024) studied the influence of STEAM projects (focused on Integrative Scientific and Technological, Engineering, Art and Mathematical Education) on the interest of students. The experimental study was conducted on 212 university students from Kazakh-Turkish University. The topic, 'Alternative Energy Sources', was taught in experimental group using STEAM project method and the control group using traditional method. The analysis of the data showed that the STEAM project can uplift the interest of students to a significant level.

Vakarou et al. (2024) researched the effect of didactic intervention on the interest of students in Einsteinian physics. The experiment was conducted on a sample of 325 students from sixth, ninth and eleventh standard from Greece. The results of the t-test showed that the intervention improved the level of interest of learners in all the three levels. After performing ANOVA, it was confirmed that across the levels, the interest declined as the levels of the classes advanced.

Brakhage et al. (2023) investigated the influence of an intervention on the situational interest of students. The intervention was executed in the experimental group, containing 60 German secondary school students, in such a way that the students were asked to link the application of Semi-Conductor Physics to their leisure interest (such as sports, music etc.). The analysis showed that the intervention helped in improving the situational interest of students towards physics.

Neito et al. (2023) attempted to predict situational interest from individual interest and instructional activities in physics classes. In this study, a teaching module on real-world oscillations was executed to 179 secondary school students in the form of a workshop with breaks in between. The individual interest scale was administered in the beginning while the situational interest was measured using experience sampling method questionnaire which was provided thrice in between the module. The sample comprised of a mix of eighth and ninth standard students from Estonia. The analysis of the data showed that the situational interest cannot be predicted from instructional activities; meanwhile, the individual interest was a strong predictor of situational interest.

Zoechling et al. (2022) identified the meaningful contexts that make Particle Physics more interesting for students. The participants included 1049 students from Austria, Switzerland and Germany. The data was collected through online survey using the Instrument to measure Particle Physics Interest (IPPI), which consisted of life related contexts such as medical applications, space research, energy production, fundamental physics, followed by rating scale items. The results of the study revealed that the contexts related to medical applications brought better interest among students. Boys found space research and energy production more appealing, while girls were interested towards the medical and health applications of Particle Physics.

Amir and Abdullah (2021) studied how the interest and engagement in physics is promoted through physics-based toy preparation. The artful and game -like practice was done on two high school students in Singapore, in which they were directed to prepare a project-toy, 'Dancing Dolls in Resonance', and this experience was fruitful to arouse curiosity and interest towards the concept and its learning.

Carreno et al. (2021) investigated the effectiveness of mobile application in laboratory activities in elevating the level of interest in physics of high school students from Chile. Another objective of the study was also to find the effect of intervention on the learning of students on the topic, Understanding Graphs. The sample selected was 268 students and the analysis of data confirmed that the intervention improved the interest of students. Better interest due to the intervention was showcased by girls than boys. Meanwhile, the mobile application laboratory didn't help the students in learning Understanding Graphs.

Lavonen et al. (2021) explored the factors that determined situational interest in physics among upper primary school students of Chile and Finland. The research focussed on how frequently scientific practices (questioning, interpreting data and evidence scientifically, explaining phenomena, collaboration) and traditional classroom practices (listening, writing and calculation) were used in physics classrooms and how these influenced situational interest. The study also analysed situational interest based on gender and personal interest in physics. The Experience Sampling Method was used to gather data regarding situational interest from moment-to-moment. The teaching modules designed and executed by the teachers based on the curricula followed in Chile and Finland, were undergone observation by the researchers. Questionnaire on personal interest was also employed. The findings revealed that the scientific practices of teaching positively impacted the situational interest of the students from both the countries. Collaborative learning was more effective for Chilian students. In Chile, there were no significant gender differences in personal interest, while boys from Finland showed better interest than girls. Students from Finland reported frequent use of listening and interpreting data, while in Chile it was listening, questioning and scientific investigation. In Finland, the situational interest decreased in the order of calculating, interpreting data and questioning, while in Chile, the order was writing, collaborating and explaining phenomena scientifically. Personal interest was a significant predictor of situational interest.

Zoechling et al. (2021) investigated the factors that determine high school students' interest towards Particle Physics. The study aimed at identifying which

aspect of Particle Physics do students find interesting, analysing the role of self-concept in shaping student interest and comparing the interest towards Particle Physics and Classical Physics. The survey employed an online questionnaire which was administered to 99 German students from ninth grade. The questionnaire contained 33 items on interest towards Particle Physics, 6 items on physics self-concept and 4 items on perceived recognition. The findings revealed that the students found the Particle Physics interesting when it is connected to human life and nature, the interest towards the topic had no significant influence on self-concept and this topic was equally interesting to all students, unlike classical physics.

Maison et al. (2020) developed, implemented and evaluated E-assessment questionnaire and analysed the interest of students towards physics using the tool. The questionnaire was developed based on six indicators in three aspects of interest: Cognitive (attention in learning and student involvement), Affective (feelings of pleasure, curiosity and teaching materials and teacher attitudes) and Psychomotor (benefits of subject). Thirty Likert type items including both positive and negative statements were prepared in total under the six indicators. The participants included 265 students of tenth to twelfth grade from higher secondary school in Batanghari, Indonesia. The results showed that nearly 55 percent of students responded ‘good’, 9 percent of students responded ‘very good’ and 40 percent of students responded ‘not good’ interest towards physics. The study suggested e-assessment more engaging and effective in educational settings than traditional paper-based assessments.

Nugroho and Waslam (2020) studied how the high school students’ interest in physics is influenced by experimentation accompanied by thought provoking

questions provided by the teacher. The study was carried out on 72 students from grade XI from Indonesia. The researchers used Classroom Action Research (CAR) Approach in two cycles of learning. Cycle 1 is the initial implementation in which students in groups (36 students) were asked to perform experiment on the topic, 'Centre of Gravity' based on the instructions provided by the researchers and to complete the worksheets provided. During this cycle, the researchers observed whether students' actions went in the way they had planned or not. After Cycle 1, the students were administered with the questionnaire to assess their interest, open-ended test to assess their reasoning ability and interviews to obtain their opinion regarding the learning experience. The researchers identified that the students had difficulty with certain terms used in the worksheet. Students also responded that they preferred such reasoning tasks over formulas and solving mathematical problems. The researchers improved their guidelines and worksheets and implemented the Cycle 2 in another set of 36 students. After Cycle 2, the same tools were again implemented on those students. The analysis of students' responses after the cycles showed that there was an increase of 89 percent to 94 percent in interest among students from Cycle 1 to Cycle 2. The understanding of the concepts elevated from 78 percent to 86 percent. The percent of student who felt inspired by the learning activities rose from 56 percent to 64 percent. 94 percent in Cycle 2 preferred understanding the mechanism of physics concepts over merely applying formula, which was 58 percent in Cycle 1. Students performed better in reasoning-based tasks compared to mathematical problem solving.

Korsun (2019) studied the effectiveness of Inventive Tasks during physics teaching on interest of students in science. The study used quasi-experimental design in which 87 students from tenth and eleventh grade, from Ternopil, Ukraine, participated. The experimental group was provided with a list of Inventive Tasks, from which each student had to choose one, and complete it within the semester and present the findings. The control group was dealt with traditional teaching. An open-ended questionnaire to measure students' interest was used as pre-test and post-test tool. The result of Pearson's chi-square test showed that the intervention has significantly increased the interest of experimental group than that of control group.

Korsun (2017) conducted an experimental study to find the effectiveness of use of Interdisciplinary Approach in physics on students' situational interest in physics. Eighty-seven Ukrainian students from tenth and eleventh grades participated in the study. The Interdisciplinary Approach employed in the experimental group incorporated the link of physics with biology, geography, sports and application of physics in medicine, engineering, aviation, agriculture etc. The control group was taught with traditional means. A questionnaire with 10 open-ended test items was also employed as pre-test and post-test. The analysis of the scores showed that the Interdisciplinary approach brought significantly higher situational interest than the traditional approach of teaching.

Gonzalez and Paoloni (2015) analysed the influence of two classroom instructional strategies such as 'providing opportunities of choice' and 'making explicit the relevance of contents', on the personal interest and two dimensions of maintained situational interest, which are value and feeling. The second objective of

the research was to evaluate how these variables influenced the level of disaffection, engagement and performance in physics. The study was focused on second year science and technology Baccalaureate students. All the variables were measured using scales and the data was collected from 430 students selected from secondary schools of Galicia, Spain. The results of the study showed that both the strategies enhanced situational and personal interest. Both the strategies and the interest had a combined positive effect on student performance and engagement.

Leung (2015) conducted a study to identify the learning experiences that helped in increasing situational interest in physics among the students. The data regarding the learning activities in physics which triggered interest was collected from 49 senior secondary students in Hong Kong through open ended questionnaire. Later, an interview was carried out on 5 students to attain an in-depth understanding of how Investigative Study, as a learning experience, affected situational interest among them. The analysis of data gathered showed that the Investigative Study was the most popular that students found more interested in, as they had a very engaging experience with the strategy.

Hong and Lin-Siegler (2012) conducted an experimental study to find out how learning about scientists influences the perception of students on scientists, the level of interest and the learning in physics. The experiment was conducted on 271 low-achieving tenth standard students from public high school, Taiwan. One experimental group was provided with achievement-oriented background information of the scientists, the other experimental group with the struggle-oriented background information and finally the control group with no such background information. The

results of the study showed that the first experimental group presented a negative perception regarding scientists and no effect on interest, recall and problem-solving ability. The second experimental group showcased better perception of scientists, increased interest, recalling and problem-solving ability.

Palmer (2009) investigated the fluctuations in situational interest among grade IX students during inquiry in science lesson. The lesson consisted of the stages such as demonstration and proposal by the researcher which was followed by student experimentation and reporting. The small groups of students were made to engage in experimentation tasks which involved proposing research questions, making observations, explaining phenomena and reporting findings. The researcher carried out observations and informal interviews while students were engaged in the tasks. To study the variations in interest at frequent intervals, a Likert scale was constructed and administered. The analysis of student responses revealed that their interest fluctuated throughout the process depending upon the specific task performed. The factors that triggered situational interest were introducing new elements, allowing students to make their choices, hands-on-tasks and movement-based activity and collaborative work.

Kofoed (2006) conducted a study to find out whether role-plays in physics influenced the interest among the learners. The role-play with the theme regarding the Hiroshima-Nagasaki bomb attacks during World War II was executed among the lower and upper secondary school students in Denmark. After execution of the role play, the participants opined that the strategy provided with them a different experience which they found very interesting in learning physics.

Lavonen et al. (2005) studied how the extent of interest towards physics among IX standard Finnish students varied across factors such as gender and contexts/content (viz., Fantasy context, Astronomical context, Science-Technology-Society context, and School physics context). For the survey study, the responses from 3626 pupils were collected using a four-point Likert scale with responses varying from 'Very Interested' to 'Not Interested'. The study showed that for both boys and girls the interest towards physics were below average. Girls found the context related to human being more interesting and that artefacts and technological processes least interesting. Astronomical content was interesting for both boys and girls. Boys were found interested towards electrical and mechanical aspects of physics.

Haussler et al. (1998) developed a typology of students based on their interest towards physics and explained how they are distributed across age and gender. The survey was carried out on 2350 students studying in fifth, seventh and ninth standard from Germany. The data was collected using five-point Likert scale which comprised of items on personal interest towards eight topics in physics, value and self-concept related to physics. Based on cluster analysis, six types of interest (clusters) were identified as 'generally interested', 'selectively interested', 'disinterested', 'ambivalent', 'gender-typed interests' and 'unclear or mixed interest types'. Three meaningful types of interest were identified from these clusters as Type A (high interest, generally boys), Type B (selective interest, Mostly boys and some girls) and Type C (low interest, mostly girls). Boys were found more into technology related interest, while girls found the life related applications more interesting. Interest

towards physics was also seen declining with age and it was more profound in girls than boys.

Zahorik (1996) studied the practices of teachers that make student learning interesting. The reflective writing technique was used for the study to gather the data from 65 teachers regarding the qualities of good teaching-learning experience, details of an interesting activity they have implemented, what they do to elevate interest among students and the details of the concepts that they found interesting for the students. The qualitative analysis of the data showed that the teachers massively supported hands-on activities and projects that grab student interest. They also mentioned about usage of personalized content, building student trust and collaborative work as other sources of interest. Massive content delivery and rote learning were identified as the sources of disinterest among learners.

Studies in the Indian Context

John and Sreedevi (2020) developed Social Media Enabled Learning (SMEL) module and studied its effectiveness on the higher secondary school students' interest in learning physics. The experiment was done on a sample of 120 students from Tamil Nadu. The interest towards physics was measured using interest inventory which was used as pre-test and post-test. The analysis of the test scores revealed that the SMEL strategy resulted in better interest among students. There was significant difference between gender in terms of post-test scores in interest. Meanwhile, the interest of students from urban area had better interest than that from rural areas with the administration of SMEL.

Studies in Other Subjects

Sarif et al. (2020) carried out a qualitative study on students' interest and learning difficulty in Geography and teaching methods adopted in secondary schools of Meghalaya. The open-ended questionnaire was administered to 57 students from IX standard. The results of percentage analysis showed that majority of the students were interested towards the subject, at the same time felt difficulty in learning it. The students revealed that the teaching methods used by their teachers to teach difficult concepts were mainly textbook reading, followed by lecture method and finally the use of teaching aids such as maps, globes, blackboard etc. To minimize the learning difficulties, the students suggested the use of ICT by the teachers, conducting proper teacher training programmes, teacher's content mastery, and use of variety of teaching methods giving due consideration to the students' interests.

Vennila et al. (2020) conducted a survey on the interest of high school students from Thiruvallur district towards mathematics. The sample consisted of 300 students and an adapted tool on Interest in Mathematics was employed. The results of analysis of the responses indicated that the students had moderate interest towards mathematics. There existed significant difference in interest among the students based on gender, locale and management of the school and medium followed. Meanwhile, there existed no significant difference in interest among the students based on their father's qualification, family income and family types.

Kishor and Meena (2016) conducted a survey to find out the mathematical interest of higher secondary school students in Punjab. The Mathematics Interest Inventory was administered on 240 students from four districts. The results of t-test

analysis showed that the rural and urban students significantly differed in their mathematical interest. But the difference was not significant between the subsamples based on gender of student and the syllabus followed by the school (PSEB and CBSE).

Dohn et al. (2009) identified the particular situational factors that trigger situational interest among undergraduate students of zoo physiology course. The data was collected from 70 students from Aarhus University, Denmark. The researchers initially observed the students performing experiments and conducted informal interviews to find out the aspects that trigger situational interest in them. Based on their responses, the researchers identified the themes and then prepared a two-point Likert scale, with an open ended question at the end. The analysis of the students' responses in the scale showed that working with live animals, sudden moments of insights during experiments, finding meaningfulness in the content, social interaction during group work and incorporating humor triggered interest among the students.

Instructional Practices and Achievement in Physics

Studies in the International Context

Pongsophon (2024) conducted an extensive study across nine countries to analyse the relation between Collaboration between Teachers on fostering active learning and engagement among students, and achievement in physics. The sample comprised of 1729 physics teachers from nine nations. The analysis showed that the collaboration significantly influenced the active learning and engagement among students. The achievement in physics was significantly influenced by teacher collaboration, but at a minimal level.

Tugirinshuti et al. (2024) studied the influence of Video-based Multimedia (VBM) Instructional Strategy on the performance of the senior secondary school students in terms of their achievement in Astrophysics. The study adopted quasi-experimental non-equivalent group design which was implemented on a sample of 294 students from Rwanda, Africa. The analysis of the data collected from pre-test and post-test showed that the achievement of the experimental group (taught with VBM) had better achievement than the control group. Moreover, the female students performed marginally better than male in terms of achievement. Also, the achievement among rural students were less compared to the urban ones.

Uko and Uko (2024) investigated the effect of Interdisciplinary Teaching Strategies on the achievement in difficult topics in physics among first year senior secondary students from Akwa Ibom state, Nigeria. The experimental study was conducted on a sample of 115 students selected randomly. The findings showed that the students showcased better achievement when taught with interdisciplinary strategy than conventional method. But there was no gender disparity in mean scores of achievements within the experimental group.

Akpokiniovo and Akudolu (2023) studied the effect of two strategies, viz., Guided Inquiry and Peer Tutoring Teaching Strategies, on the achievement of second year secondary school students. The quasi-experimental group design was employed on a sample of 289 students selected randomly from six schools from Delta district, Nigeria. Achievement test in physics and three instructional packages on the topics, Reflection on plane and curved mirror, Refraction through prism and lenses, were used for the study. There were two experimental groups, one taught with guided

inquiry approach and the other with peer tutoring strategy. The control group was taught with lecture method. The findings showed that peer tutoring strategy helped more in enhancing the achievement in physics, followed by lecture method and guided inquiry strategy.

Al-Nabhan (2023) studied the effectiveness of two strategies, Read-Ask-Answer-Feedback (RAAF) Strategy and Immediate Feedback Strategy on the achievement of secondary school students in Iraq. There were 29 students in first experimental group (RAAF strategy), 30 students in second experimental group (immediate feedback strategy) and 29 students in the control group (traditional method). The results showed that the students in two innovative strategies outperformed equally when compared to that of control group.

Omopekunola et al. (2023) conducted a study in Nigeria which focused on the effect of Just-in-Time-Teaching (JiTT) Strategy on the performance of secondary school students in physics concept, Measurement of Physical Quantities. The pre-test post-test control group design was executed on 100 pupils selected from two randomly chosen schools. The study proved that JiTT strategy influenced in elevating the achievement of the students, even though, the gender of the students had no significant interaction effect on the performance.

Twahirwa and Ntivuguruzwa (2023) studied the efficacy of the innovative strategy, Remediation-based Learning and Teaching Strategy in improving the achievement level of secondary school students in the difficult concepts in physics. A sample of 67 pupils was selected from Kirehe District, Rwanda, Africa. The study showed significant improvement in the level of achievement of students of first-,

second- and third-year secondary education, irrespective of their gender, after the intervention. Among the second-year students, male outperformed females, whereas no such disparity was observed within first- and the third-year sample.

Benben and Bug-os (2022) carried out a study to find out the effectiveness of Gamified Formative Assessment Strategy on achievement in physics and motivation among junior high school students in Maramag, Philippines. The researchers used one-group pre-test post-test experimental design in which the whole sample was provided with online gamified assessment in physics using Quizizz. The results showed that both achievement and motivation level of students improved after the intervention of gamified assessment strategy.

Ernita (2022) investigated the effect of Participatory Learning Model employing Critical Problem Solving Techniques on the achievement of high school students in physics. The experimental study was carried out using the sample of 61 eighth standard students from the same school in Batukliang, Indonesia. The t-test on the data collected through pre-test and post-test proved that the experimental group which was taught using the participatory model brought better achievement in physics than that of the students in the control group.

Oluwaseyi (2022) investigated the relative effectiveness of the teaching strategies, Guided Inquiry and Collaborative Learning Instructional Strategies on the achievement and retention of students in physics. The study was conducted on 113 senior secondary students from Ondo State, Nigeria. The quasi-experimental design consisted of two experimental groups which underwent the above mentioned interventions, while the expository teaching was performed in control group. The

results highlighted that it is the collaborative learning strategy that brings better effect in terms of both achievement and retention, followed by guided inquiry and expository teaching method.

Appiah-Twumasi et al. (2021) studied the influence of 5E Instructional Model on the achievement in physics among high school students based on their gender and student ability. The quasi-experimental design was used and the sample consisted of 80 students from Berekum Senior High Schools, Ghana. The results of the independent sample t-test showed that the achievement level was better in the experimental group compared to that of control group, which was taught in the traditional way. The high ability students in experimental group performed better than the high ability students of control group. But in the case of low-ability students, no such disparity was seen. In the case of gender, boys in experimental group depicted better achievement than girls in the same group.

Njoka and Julius (2021) conducted a quasi-experimental research to find out the influence of Investigative Science Process Skill Teaching Strategy on achievement in physics concept of Electricity among third form students selected from eighth schools in Kenya. The findings proved that the strategy improved the achievement level among students and the researcher put forward the suggestion to implement it by the teachers.

Uside et al. (2021) studied the influence of Collaborative Teaching Strategy and learner ability interaction on achievement in physics in Kenya. It was an experimental research conducted on a sample of 173 students who are studying in the fourth year of secondary education, who were selected purposively from four schools.

The Solomon four group design was used, in which the experimental group was dealt with the collaborative strategy and control group with the conventional method. The tools used for the study consisted of tests including pre-test and post-test. The finding of the study revealed that the innovative strategy elevates the achievement among students. So, the teachers have to employ this strategy more frequently after receiving proper training on it.

Agommuoh and Akanwa (2020) conducted a descriptive survey on the students' perception on the Assessment Strategies employed by physics teachers and its relation with their achievement in the subject. The participants of the survey were 150 senior secondary students from Umuahia Education Zone, Abia State, Nigeria. The relevant data was collected using Likert scale with 19 items, each item denoting each assessment strategy. The t-test analysis showed that the students agreed that out of 19, 17 assessment strategies bring better achievement in them. Some of those are using conventional test items (objective, short answer and essay), providing guidance regarding the type of homework given, informal observation, implementing students' self-assessment, diagnostic, formative, summative assessment, use of rubrics etc.

Silitonga et al. (2020) investigated the effectiveness of Metacognitive Learning Strategy with Reflective-Lesson Log on achievement of secondary school students in physics. The participants of this experimental study comprised of 117 students from Indonesia. The results of t-test depicted that the students in the experimental group had higher achievement than the students taught with traditional method.

Achor et al. (2019) studied the influence of classroom interaction practices such as teacher-centered instruction and student-centered instruction on the learning outcomes of students in physics. The learning outcomes like achievement and attitude in the topic, Dynamics, were taken into consideration. The study was conducted on 139 senior secondary students of Kogi State, Nigeria. The first part of the study was an observational survey using Teacher-Student Classroom Observation Schedule (TSCOS) which was meant to identify the type of interaction –whether teacher centered or student centered- in the classroom. Based on the data obtained on TSCOS, the type of interaction received by the group was finalized. The Student Attitude Questionnaire and Physics Achievement Test were used to measure students' learning outcome. The result of the study showed that the student-centered instruction yielded better achievement and attitude among students than the teacher-centered instruction.

Aurah and Wesonga (2019) conducted an extensive experimental study to find out the influence of Teacher's Instructional Strategies, viz., Guided-Inquiry, Cooperative Learning and Direct Instruction, and student learning styles, viz., visual, auditory and kinesthetic on academic performance in physics, which is measured in terms of achievement and process skills attained. A quasi-experimental design was implemented on 519 secondary school students from Kakamega, Kenya. For students with visual learning style, it was found that the cooperative learning strategy elevates achievement level. Guided- inquiry was confirmed to be more effective in bringing better achievement, while cooperative learning enhanced the process skills. When coming to gender-wise study, boys outperformed in their process skills in all the three

strategies and girls showcased better physics achievement across cooperative learning and direct teaching strategy.

Chen et al. (2019) studied the impact of misconceptions on students' likelihood in completing a Massive Open Online Course (MOOC) on astronomy. The data from 12,913 students were used to meet the objectives of the study. The misconceptions of the students were assessed prior to the course. Statistical analyses were carried out to correlate the presence of misconceptions and the course completion rates. The results revealed that the students with more misconceptions were less likely to complete the course. Thus, misconceptions were identified as the significant predictor of dropout rates.

Omeodu (2019) investigated the various Instructional Strategies used by physics teachers, hence, to find out the influence of extent to which instructional strategies used on the achievement of senior secondary students. The data from 28 physics teachers were collected using questionnaire (in the form of 4-point scale) and an achievement test was administered to 140 students from River state, Nigeria. The study employed both descriptive research and quasi-experimental design. The results of the study depicted that the mostly used strategies are lecture method, demonstration method, laboratory method and problem-solving method of teaching. Fieldtrip and simulation gaming method are rarely used and buzz group method, programmed method and debate method are not used. Among these strategies, it was the demonstration method that paved way for better achievement of students. When tested the effect of demonstration method and lecture method together, it was demonstration method that resulted in better achievement in physics. Similarly, on comparing

laboratory method and problem-solving method, it was the latter that brought better achievement than the former.

Omole and Komolafe (2019) conducted an experimental study to determine the effect of three strategies, Demonstration, Programmed and Projects Instructional Strategies on performance of secondary school students in terms of achievement in physics. The sample used for the study was 240 students selected from eight schools in Ekiti State, Nigeria. The students in the control group were taught with traditional chalk and talk method. After analyzing the data collected, the analysis showed that among the four strategies, it was programmed strategy that was most effective in bringing up the achievement of students, which was followed by demonstration, project and finally, the chalk and talk method.

Saleh and Subramaniam (2019) studied the influence of Brain-based Teaching Method (BBTM) on physics achievement among secondary school students. The experimental study was conducted on a sample of 90 students selected from ordinary schools from Penang, Malaysia. The experimental group was treated with BBTM on the topics, Forces and Motion. Physics achievement test on these topics was used as the pre-tests and post-tests. The results of the study proved that the students of the experimental group showcased better achievement scores than the control group, which was taught with the conventional method. BBTM also reduced the gender gap that prevailed in the achievement levels of the students.

Usman and Mankilik (2019) investigated how the Concept Mapping Strategy influences the achievement of higher secondary school students in physics. A quasi-experimental group design was employed on a sample of 221 students selected from

two schools in Jos, Nigeria. The study proved that concept mapping enhanced the achievement among students, even though there was no gender disparity in achievement in post-test results. Also, there was no significant difference between the achievement level of students from private and public schools after the intervention.

Bigozzi et al. (2018) investigated the impact of teaching approaches on the conceptual learning in physics among high school students. The study analyzed the teaching approaches adopted by the teachers in real-life classroom teaching in physics. The conceptual knowledge in Force and Motion, science beliefs and critical thinking skills of 84 tenth standard students from Central Italy, were measured twice, one at the starting of the academic year and one at the end. The teachers were interviewed to find the classroom teaching approaches (Content-centered and student-centered). The results of the study revealed that, keeping students' science beliefs and critical thinking skills as controlled factor, student-centered approach resulted in better conceptual understanding among students than the content-centered approach.

Cetin and Ozdemir (2018) studied the effect of teaching modes (Blended vs. Face-to-Face Mode), teaching methods (Expository vs. Inquiry) and their interaction on the achievements, science process skills and attitude towards physics. The experimental study was carried out with four treatments groups on a sample of 314 ninth standard students in Cankaya, Turkey. The intervention was on the topic, Electricity, and the data were collected using achievement test and scales. The results of MANOVA revealed that the effect brought by blended mode in achievement and science process skills is independent of the teaching methods used. There was no significant difference in the effect brought by expository and inquiry-based

instruction. Blended mode was more effective in enhancing the dependent variables than the face-to-face mode.

Ntibi et al. (2018) investigated the effect of Mnemonics Instruction Strategy (MIS) on achievement and retention in physics and chemistry among secondary school students. The experimental study was carried out on a sample of 200 students from Cross River State, Nigeria. There were two treatment and control groups in this study. The treatment groups were taught with MIS and the control groups with lecture method. The topics selected for the instruction was Electrochemical Series from chemistry and Simple Harmonic Motion from physics. The Chemistry performance Test (CPT) and Physics Performance Test (PPT) were used as pre-test and post-test. Statistical analysis of student responses gave the result that the treatments groups taught with mnemonics in physics and chemistry had significantly better achievement than their control group counterparts.

Sugiarti (2017) conducted descriptive research on how the mnemonic learning strategy influences the level of performance in physics among seventh grade students in Palembang. The sample of the study included 40 students. The strategy was employed over three instructional sessions. The first session dealt with 'Physics and Measurement of Quantities' which was followed by a test on those topics. The second session dealt with 'International System of Units and presentation of Measurement Results' which was again followed by another test. In the third, session a test was conducted to determine the overall performance. The analysis of test results showed that the level of understanding increased as the sessions advanced from first to the

third. So, the study confirmed that the mnemonic strategy improved the academic performance of students.

Sogoni and Musasia (2016) conducted an experimental study to explore the effect of Cooperative Learning Method on the achievement of secondary school students in Kinematics. The sample used for the study consisted of 272 form three students from Sabatia Sub-county, Kenya. The inferential analysis of the experiment proved that the achievement of the students in the experimental group, who were taught using cooperative learning, was higher than that of those in control group (conventional method). Meanwhile, no gender and school type effected the achievement of the students in Kinematics.

Akinbobola (2015) studied the influence of learning styles and instructional strategies on achievement in physics among senior secondary school students from Nigeria. This experimental study was carrid out on 250 participaants. Guided Discovery and Demonstration strategies were implemented in two treatment groups and conventional method was used in control group to teach the concept of Electricity. Physics Achievement Test and Index of Learning Style Questionnaire are the two tools employed in the study. The results showed that guided discovery, demonstration and conventional methods were effective for the students with sensing/intuitive, sequential/global and visual/verbal learning styles respectively. The study recommended the use of instructional strategies in accordance with the learning styles of students in the physics classrooms.

Gambari et al. (2015) researched on the influence of two strategies, Computer Assisted Student Team Achievement Division (STAD) and Learning Together Model

(LTM) on achievement in physics and motivation among secondary students from Nigeria. The experiment was performed on 90 students. Experimental group 1 was taught with computer assisted STAD, experimental group 2 with LTM and the control group with individualized computer instruction. The results explained that the students in the experimental groups outperformed than those in the control group in terms of physics achievement.

Kamkaen et al. (2015) studied the efficiency of Role-playing Game Strategy in terms of achievement of high school students from Thailand, in the concept, Rotational Motion. The experiment was of one group pre-test post-test design consisting of 29 students from tenth standard. The findings showed that the average score on achievement increased after the students were taught with the game strategy.

Olaoluwa and Olufunke (2015) conducted a comparative study on the effect of Learning-Cycle Approach (LCA) and Inquiry-Teaching Approaches (ITA) on the learning outcomes of higher secondary school students in physics. Achievement/ retention and attitude were the specific learning outcomes focused by the researchers. The sample consisted of 103 students from Ekiti State, Nigeria. The investigation showed that both the approaches were effective in bringing better retention and attitude scores than control group. LCA was comparatively more effective than ITA in terms of enhancing retention and attitude.

Bulunuz et al. (2014) studied the effect of formative assessment probes integrated with extra-curricular hands-on learning activities on secondary school students' conceptual understanding in science. For this ecperimental study, 197 students from grade VIII in Turkey were selected. Both the treatment and control

groups were administered with eight formative assessment probes on five physics topics, namely, Mass, Weight, Gravity, Inertia and Friction. The probes consisted of both multiple-choice and open-ended questions and were meant to measure the level of understanding and misconceptions among students. The students in the treatment group were provided extra-curricular lessons focusing on hands-on tasks and experiments in physics with frequent formative assessments throughout the intervention. No intervention was provided to the control group. The analysis of student responses showed that students had poor conceptual understanding in physics, with predominant misconceptions. The conceptual understanding of the students improved significantly with the usage of the intervention, which was absent in the control group.

Fakcharoenphol and Stelzer (2014) carried out an experimental investigation to find out which among three methods of physics exam preparation influenced the achievement of students. The experiment was conducted on a sample of 76 students from University of Illinois at Urbana-Champaign. The students were randomly assigned into four groups: practice exam with solution feedback, practice exam with solution feedback and related homework, practice exam with solution feedback, related homework and tutoring sessions, and the control group with no treatment. The topic selected for the experiment was calculus-based Introduction to Classical Mechanics. The results of the analysis showed that the three experimental groups performed better than the control group in the common mid-term test and among the three experimental groups, the performance of the students had no significant difference from each other after the treatment.

Agommuoh and Ifeanacho (2013) studied the first year senior secondary students' opinion on whether the innovative teaching strategies enhance their achievement in the subjects, physics and mathematics. The data required was collected using a Likert five –point scale from sample of 190 students from Abia State, Nigeria. Findings showed that both boys and girls were with the opinion that brainstorming, inquiry learning, team teaching, cognitive apprenticeship, discovery learning, simulation, experiential learning, cooperative learning, role play and peer tutoring will improve their physics and mathematics achievement.

Cheema and Mirza (2013) investigated the effect of using concept-mapping strategy on the level of achievement of seventh grade students in science. The experiment was carried out on a sample of 167 students from Pakistan. Experimental group was taught with concept maps while the control group received traditional teaching. Achievement test constructed by the researchers were used as pre-test and post-test. The results of ANOVA showed that the intervention significantly improved students' achievement in science compared to traditional teaching. The study put forth implication to incorporate concept mapping strategy in science teaching to enhance student performance and retension.

Akcay et al. (2012) tested the influence of Cooperative Learning Model, specifically, the Reading-Writing-Presentation Technique, on the achievement in the concepts of Force and Motion among graduate level students in Turkey. The strategy was applied in experimental group and the teacher centered strategy in control group. Tests and interview schedule were used for the study. The findings showed that the reading-writing-presentation technique brought better achievement among students in

the physics concepts, Force and Motion. The students also held a positive attitude towards employing this technique.

Veen and Berg (2012) compared the effect of Interactive White Board (IWB) Teaching with Ordinary White Board Teaching (OWB) on achievement of students in physics from Netherlands. A cross over experimental design was used for the study on two ninth standard classes. During the first intervention, Mechanics was chosen as the lesson and the experimental group was taught with IWB and the control group with OWB. During the second intervention period, the teaching strategy was swapped between the groups and the topic chosen was Electricity. In the case of mechanics, no significant difference in achievement was observed between the groups. While in Electricity, more achievement was seen in the students taught with IWB.

Campbell et al. (2011) conducted an experimental study to find out the influence of Model Based Inquiry on the attitude, skill and knowledge of high school students in physics. The study comprised of a total sample of 54 students in which the experimental group was taught with the Model Based Instruction and the control group with traditional lecture and demo instruction on the difficult concept, Buoyancy. The Physics Attitudes Skills and Knowledge Survey (PASKS) was used as pre-test, post-test and for delayed measures. The analysis of data showed that both the groups showcased improved achievement in the aspects such as skills and knowledge, meanwhile in attitude there was no improvement. There was no significant difference between the results of the groups who were taught with inquiry and traditional instruction.

McKenna (2011) conducted a study to determine whether the use of formative assessment and progress charts improved student attitude and achievement in science. The study was conducted on grade VII students from Michigan. Initially, Student Attitude Survey was carried out to measure the baseline attitude and a summative test was administered for measuring the baseline achievement of student. Next was the intervention phase in which every day lessons were followed by formative assessment practices like quiz or practice question. The students were scored depending on their performance and the correct answers were discussed with the teachers. Students then entered their scores in the progress charts to keep track of one's own learning and growth. Simultaneously, the teacher also maintained a reflective journal in which the students' progress and engagement were recorded. After completing four units, survey and test were again conducted. Interviews were also carried out to know the students' perceptions on formative assessment strategies. The analysis of responses showed that the students were more engaged during science lessons in the intervention phase. Above 90 percent of the students admitted that the intervention were helpful in keeping track of their studies. The test scores also improved with the intervention, with the low achieving students showcasing notable improvement in their achievement.

Gok and Sylay (2010) researched the impact of Cooperative Problem-solving Strategies in elevating the level of achievement, motivation and attitude among high school students. The experiment was carried out using instructional materials on physics topics, Kinematics and Dynamics. The sample consisted of 46 tenth standard students from Turkey, who were congregated into experimental and control groups.

The students in the experimental group were involved in problem-solving through cooperative method, while the control group employed conventional problem-solving strategy. The analysis of the data collected concluded that in case of achievement, attitude, motivation and strategy level, the experimental group outperformed the control group. Moreover, in the experimental group, gender-wise difference was not found in any relevant aspect under study.

Afolabi and Akinbobola (2009) experimented to find the effect of Constructivist Problem-based Learning Technique on the achievement in physics among the low ability higher secondary students. The experiment was executed on a sample of 105 students to whom the achievement test and ability test were administered. The result proved that among the low ability students, the achievement was enhanced with the usage of Constructivist Problem based Learning technique when compared to the conventional method.

Le et al. (2006) examined the impact of reform-oriented instructional practices on achievement of the student in mathematics and science. One of the key aspects of reform-oriented instruction discussed in the study was the collaborative mathematical problem-solving activities among students. This practice involved students working in groups to solve problems which were meant to encourage active participation, to develop higher-order thinking skills and to learn from one another. Even though this collaborative practice enhanced student engagement, this study showed that the impact of this practice on student achievement in mathematics and science measured using standardized test is limited or weak.

Yang and Heh (2007) experimented to find out the effect of Internet Virtual Physics Laboratory instruction on the achievement in physics, science process skills and computer attitudes of tenth standard students. The sample consisted of 150 students selected randomly from Taoyuan Country, Taiwan, who were equally divided into experimental and control groups. The physics achievement test was prepared on concepts such as Mechanics, Optics, and Electricity. The analysis of pre-test and post-test scores showed that there was significant improvement in physics achievement and science process skills among the experimental group. Meanwhile, no significant difference was found in computer attitudes after the intervention.

King (2003) investigated the effect of formative assessment on self-regulation, motivational beliefs and achievement in science among fifth grade students. The experimental study was carried out on 63 students from elementary schools in United States. The experimental group received instruction with formative assessment including student reflections, teacher feedback, goal setting, peer and self-assessment practices, while the control group was taught with the standard method and usual assessment. Science Achievement Test and self-reporting surveys on self-regulation strategies and motivational beliefs were administered as pre-test and post-test. The analysis of student scores showed that the students in the treatment group had significantly greater achievement scores, improved motivational belief and better self-regulation skills than their counterparts in control group.

Jimoyiannis and Komis (2001) conducted an experiment to understand whether usage of computer simulation, 'Interactive Physics', can influence the students' understanding. The experiment was conducted focusing on the topic,

Velocity and Acceleration in Trajectory Motion, and involved 90 high school students from Ioannina, Greece. As a result of the intervention, the students showcased better achievement and understanding in the concepts than the control group.

Studies in the Indian Context

Ghosh et al. (2024) carried out a comparative study on teaching of physical science (physics and chemistry) at secondary level of different boards, in three different states in India, viz., West Bengal, Tripura and Odisha. Three hundred tenth grade students each from three states were the sample of the study. The independent variables were teaching methodology, gender and habitat and dependent variables were achievement score in Intelligence Test (IT), in Secondary Students Physics Achievement Test (SSPAT) and in Madhyamik Examination. The methods of classroom teaching, obtained after content analysis of textbook and curriculum, and achievement were compared and analysed. The findings revealed that all states followed traditional lecture-cum-demonstration method. Apart from that, project work was used in West Bengal, while practical classes were followed in Tripura only. In Odisha, no such student-oriented activity-based methodology was followed. Both in the case of intelligence and achievement in physics, there were significant difference between the scores of West Bengal and Tripura, and West Bengal and Odisha, but not between Tripura and Odisha. The Pearson coefficient of correlation between the scores in science in Madhyamik Examinations and that of scores in IT and SSPAT are positive and significant.

Acharjee et al. (2023) studied the effectiveness of Kinesthetic learning Activity (KLA) for teaching physics on the achievement of higher secondary students.

Firstly, the investigators approached 20 physics teachers to find the toughest topic that students had to learn at higher secondary level. Based on their opinion and the literature review, 'Photo-electric Effect' was identified to be the toughest. Then a sample of 50 students from XII grade were taught the concept in a traditional method. Later, the students were tested with multiple choice questions on the topic and their responses were recorded. Then, pre-KLA test was administered after which KLA in a play-way method was implemented on them for the same topic. The post-KLA test was conducted in the end. The results of t-test revealed that the KLA intervention has led to high scores in post-KLA test when compared to the pre-KLA scores. The study concluded that KLA was effective in teaching 'Photo-electric Effect' to higher secondary school students.

Kauts and Singh (2022) experimentally studied the effect of Cooperative Learning Strategy on the achievement in physics topics such as Force and Friction among secondary students who were randomly chosen from schools in Punjab. In total, 160 students (Experimental group = 80; Control group = 80) participated in the research and they were evaluated using tests. The result showed that the Cooperative strategy helped the students to outperform in physics in the domains of knowledge, understanding and application.

Chandrashekar and Veena (2020) studied the effectiveness of Creative Teaching Model using Robots on creativity and achievement of IX standard students in physics. The experimental study was conducted using experimental group-control group post-test only design in which the control group was taught with conventional method of teaching. Physics Learning Achievement Test and Non-verbal Test of

Creativity were the other tools used for the study. Two parallel sets of experiment were conducted on 60 students from Kannada medium and 60 from English medium. The analysis of the test scores showed significant difference between the achievement and creativity scores of experimental and control groups of both the mediums. The model was proved to be effective in enhancing achievement and creativity in physics.

Lekshmi and Remadevi (2019) studied the effectiveness of Blended Learning Practices on achievement in Physics among secondary school students. The quasi-experimental research was conducted on a sample of 168 students from IX standard from Palakkad district. The experimental group was taught with Blended Learning Practices while the control group was taught with activity-oriented method. The analysis of pre-test and post-test scores showed a significantly higher achievement among students in experimental group than in control group.

Radhakrishnan and Rajeshkumar (2019) analysed the effectiveness of using blog for teaching physics on the attitude and achievement of XI grade students. In the experiment, 240 higher secondary school students participated. The control group was taught with conventional method and the experimental group with the blog. A blog was developed by the investigators on ten select topics in physics based on the Tamil Nadu syllabus, such as Escape velocity and orbital velocity, weightlessness, satellite motion, rocket propulsion, viscosity, law of conservation of energy, etc. Achievement test and Scale on attitude towards blog were the other tools employed. The findings revealed that the achievement and attitude scores in the experimental group are higher than that of control group.

Barai (2018) studied the effectiveness of Activity Based Method of Learning (ABML) over the traditional method on the achievement in physical science among secondary school students. The participants of the experiment comprised of 200 nineth grade students from Alipurduar district, West Bengal. Low-cost experimental models were developed by the investigator along with the teacher-made achievement test for the experiment. The results of t-test revealed that the ABML uplifted the level of achievement among students than the traditional method.

Siddiqui and Khatoon (2013) investigated which among Teacher-Centered CAI or Student-centered CAI in teaching physical science contribute to achievement among students. The experimental study was conducted on a sample of 120 tenth standard students randomly selected from higher secondary schools in Aligarh, Uttar Pradesh. Forty students were taught with teacher-centered CAI, forty with student-centered CAI and the rest forty with traditional method. Physical Science Achievement Test was used as post-test and pre-test. The results of ANCOVA revealed that Teacher-centered CAI was effective than traditional method and student-centered CAI in enhancing the level of achievement among students.

Sunitha and Ramakrishnan (2013) compared the effectiveness of hand out and concept mapping teaching strategies on the performance in the topic 'Light' for eleventh grade students. Handout teaching strategy was implemented to the control group, while the experimental group was taught with concept mapping strategy. The criterion referenced Achievement Test on Light was used as pre-test, post-test and retention test which was administered after six weeks from post-test. The experimental study was conducted on a sample of 66 students from eleventh grade.

The results showed that there were no significant difference in achievement scores in post-test between the experimental and control group. Meanwhile, with respect to the retention scores, concept mapping proved more effective than handout teaching strategy.

Pandey et al. (2011) studied the effectiveness of Enquiry Training Model on the achievement in physical science among secondary school students. Hundred students were randomly selected for the experiment. The control group was dealt with traditional method of teaching. Achievement Test on Physical Science (ATPS) was used for testing. The analysis of scores on ATPS showed that the enquiry training model brought significantly better achievement among students than those who were taught with the conventional method.

Kumuda (2000) studied the influence of Concept Mapping and Vee Mapping Strategies on the achievement of higher secondary school students in 'Atomic and Nuclear Physics', when compared to Traditional Lecture Method. Three-group experimental design was used on a sample of 251 students from Chennai. The results showed the concept mapping most effective among the three, followed by Vee mapping strategies and lecture method, in elevating the level of achievement of the students.

Studies in Other Subjects

Colak and Aydin (2022) studied the effect of using mnemonic strategy on achievement in social science among grade VI students in Turkey. In this experimental study, the treatment group and the control group were taught with

mnemonic strategy and traditional method respectively. Focus group interviews were conducted for selected students to understand the perceptions regarding the intervention. The analysis of pre-test and post-test scores showed that the mnemonic strategy demonstrated higher achievement and retention in social science. Students also reported that the strategy was enjoyable and engaging.

Ahmed et al. (2021) studied the effect of concept-mapping teaching strategy on higher secondary schools students' achievement and retention in biology. One hundred and forty-nine students from Lagos State, Nigeria were selected as sample for the study. The experiment was carried out using two student groups. The treatment group was dealt with the concept mapping strategy while the traditional lecture method was implemented in the control group. Biology Achievement- Test (BAT) was used as pre-test and post-test and Biology Retention Test was used after two weeks after the post-test to measure the level of retention. The study revealed that the students in the treatment group showcased better achievement and retention compared to that of the control group.

Francisco and Celon (2020) conducted a descriptive-correlational survey study to find the instructional practices of schoolteachers and their effect on student achievement in English, Mathematics, Science, Filipino and Araling Panlipunan (Social Science). The responses obtained using the questionnaire on instructional practices from 55 teachers were used to find the extent of usage of the practices in terms of planning practices, teaching practices and assessment practices. Then the achievement scores in five subjects of 295 students from private schools in Philippines were gathered through documentary analysis of classroom e-record. The regression

analysis and ANOVA results showed that the three practices had effect on achievement in the subjects to different extents, but had no combined effect on the dependent variable.

Ozan and Kincal (2018) carried out an experimental study to study the effects of formative assessment practice on fifth grade students' achievement and attitude towards social science and self-regulation skills in learning the subject. The study involved 45 students from secondary schools in Erzurum, Turkey. Social Studies Performance Test, Attitude Inventory for Social Studies and Semi-structured Interview Schedule were used for collecting data. The findings showed that the experimental group, in which formative assessment was practiced, showcased better achievement and attitude towards social science. Meanwhile, no significant difference was found between the control and experimental groups in self-regulatory skills. In the interview, students expressed positive opinion on implementing formative assessment practices by their teachers.

Labobar et al. (2017) studied the effectiveness of implementing cognitive conflict strategy on conceptual change in acid-base concept in chemistry. The study was conducted on 51 students from grade XI. Diagnostic test was used before and after the intervention to measure the conceptual understanding of the students. The results revealed a notable decrease in the level of misconceptions among students with the usage of cognitive conflict strategy. This study showed the importance of adopting specific strategy to address misconceptions among students.

Morgan et al. (2015) conducted a longitudinal study to analyse the extant instructional practices of first-grade mathematics teachers of United States and

investigated the influence of practices on achievement of students with and without mathematical difficulty. The objectives of the study were to identify various practices by teachers and their frequency of usage and to find out whether teachers vary the frequency of usage of practices while teaching the student groups with and without difficulty. Scale on Mathematics Instructional Activities and Skills Taught was used to collect data from teachers and ECLS-K's Mathematics Test was administered on 2,486 students. By undergoing factor analysis, four types of practices were identified: teacher-directed, student-centered, with manipulatives/calculators and with movement/music. The results of regression analysis showed that the group with mathematical difficulty was associated with the high usage of practices involving manipulatives/calculators and movement/music. Teacher-directed teaching, with drill and practice, was the strongest predictor of the achievement of students with difficulty. Meanwhile, both teacher-centered and student-centered practices were found to be equally significant predictors for achievement of students without difficulty.

Awofala (2011) investigated the effect of concept-mapping strategy on achievement in mathematics among high school students. The experimental study comprised of 88 Nigerian students, in which the experimental group was treated with the C-mapping instruction and the control group with regular teaching. The topics selected were 'Plane, Shape and Angles in a Polygon'. Mathematics Achievement Test was used for pre-test and post-test. The results of the study showed that the concept mapping improved the achievement level of the experimental group compared to that of control group.

Hwang and Chang (2011) studied the influence of mobile learning with formative assessment strategy on attitude and achievement in local culture among fifth grade students. The experimental study was conducted on a sample of 92 students from southern Taiwan. The experimental group was engaged in mobile learning supported with formative assessment with feedback and supplementary materials based on the student responses in the assessment. Traditional method of teaching was used in control group. Achievement test and questionnaire on attitude were used for pre-test and post-test. The findings of the study revealed that the students who received formative assessment in mobile learning environment showcased significantly better achievement and attitude than those who received traditional method of teaching.

Bloomquist (2010) conducted an experimental study to find out the effectiveness of closure in mathematics lessons on achievement of middle school students. The participants in the experiment comprised of 106 students from Oregon, USA. Two methods of closure viz., structured lesson closure and teacher closure were used along with lessons with no closure at all. The intervention extended to 30 days. Students were assessed every day after each lesson using tests. The analysis of scores showed significant differences in achievement after three methods of closure. The structured closure brought better achievement in mathematics than the teacher closure and no closure.

Tekin (2010) studied the effect of formative assessment on academic performance and attitude towards mathematics learning. The students from eighth grade from Turkey were selected as sample for this experimental study. Mathematics

achievement test and mathematics attitude scales were the instruments used for this study. The experimental group received instruction incorporated with formative assessment techniques including continuous feedback and interactive evaluation methods. Traditional method of teaching with no formative assessment was implemented in control group. The results of the study revealed that the students of the experimental group showcased better achievement and positive attitude towards the subject, which indicated increased interest and engagement of the learners.

Kroesbergen et al. (2004) compared the effectiveness of explicit instruction (EI) and constructivist instruction (CI) on performance in mathematics, automaticity in basic multiplication, self-concept and motivation towards mathematics learning among low-achievers in Netherlands. The study involved 265 elementary school students. The experiment consisted of two treatment and one control group (no intervention). One treatment group was taught with explicit teacher-led instruction and the second with the constructivist instruction in which the students had to construct their own understanding on multiplication. The analysis of pre-test and post-test scores showed that both EI and CI led to better mathematical performance than the regular method of teaching, in which the students who received EI outperformed those who received CI. The EI group demonstrated more diverse strategy use than the CI group. In terms of automaticity and self-concept, no significant difference was found between EI and CI groups. Motivation levels changed only minimally across the groups under study.

Garnett and Treagust (1992) explored the conceptual and propositional knowledge of high school students on electric circuits and oxidation-reduction

equations in electrochemistry. The study was conducted based on the data collected from 32 students from Western Australia. Semi-structured interviews were used by the researchers. The findings of the study showed that the students who studied both chemistry and physics had more confusion in differentiating between the current flow in metals and electrolytic solutions, than those who studied only chemistry. Misconceptions prevailed in application of definitions of oxidation and reduction, leading to errors in representation of reactions. The students often relied on their existing knowledge that conflicted with scientific explanations, leading to persistent misconceptions. The study put forward implications for teachers to take deliberate effort to address misconceptions, to bridge the gap between prior knowledge and actual concepts and to prevent cross-disciplinary confusions.

Kiewra et al. (1988) evaluated the effectiveness of three note formats, namely, complete text note, linear outlines and matrix notes, on student recall and transfer. Forty-four undergraduate students from the University of Nebraska–Lincoln participated in the study. There were four groups in the experimental study. All the groups were taught with lectures on the topic, Human Information Processing from Cognitive Psychology, following which the review notes in three forms were provided by the researchers for the three treatment groups, while no note was offered to control group. Later, the students in all the groups were administered with Recall Test and Transfer Test. The analysis of the test scores showed that all the groups that received notes outperformed the control group in both the tests.

Instructional Practices, Interest and Achievement in Physics

Studies in the International Context

Pilit et al. (2024) experimentally studied the influence of Image-Based Mnemonics (IBM) as supplementary learning tool on the vocabulary skills in physics among Filipino students. The students from seventh grade (N = 102) participated in the experimental study. Three topics viz., Sound, Light and Electricity were taught in three sessions in both treatment and control groups. The scores on three pre-tests and three post-tests were added to get the total pre-test and post-test scores which is used for analysis. To study the perception of students on the strategy, an adapted Likert scale was used. The students were also interviewed to find out the extent to which they enjoyed learning using mnemonics. The results showed that the students in the treatment group exhibited better vocabulary skills in comprehending complex concepts easily than the control group. The responses in the scale and interview revealed that the students were highly satisfied and enjoyed the learning which involved IBM.

Liliana et al. (2020) attempted to study the influence of Online Interactive Learning Media prepared using Lectora Inspire on the Achievement and Interest in physics. The model of DDD-E (Decide, Design, Develop, and Evaluate) was employed to develop the package. The experiment was conducted on a sample of 108 higher secondary school students of Samarinda, Indonesia. The findings showed that there is a significant increase in the learning achievement and interest in physics after the incorporation of the interactive digital media package.

Hochberg et al. (2018) studied the effect of usage of Smartphone as Experimental Tools (SETs) on the level of interest, curiosity and learning achievement in physics among students. The participants of this experimental study comprised of 245 pupils from secondary schools of Germany. The experimental group conducted experiments on Harmonic Mechanic Oscillations using smartphones with in-built acceleration sensors, while the control group conventionally calculated acceleration from displacement and time. Scales containing Likert type test items were used to measure interest and curiosity and learning achievement was measured using a concept test consisting of multiple choice and true or false test items. The analysis revealed that the interest and curiosity among the smartphone group is significantly higher than that of control group. Meanwhile, no significant difference between the groups were found in the case of post-test scores of learning achievement, which proved that the students of the experimental group were not distracted with the use of smartphones for learning.

Snetinova et al. (2018) studied the influence of students' hands-on experimentation in Interactive Physics Laboratory (IPL) and the sessions of Demonstration by the lecturer (DEMOS) on the intrinsic motivation and understanding of higher secondary school students in physics. The sample consisted of 1122 students from Prague, in which 303 students attended IPL and 819 students attended DEMOS. Intrinsic Motivation Inventory was administered to the students after they attended the sessions. The t-test of the responses showed that there is no significant difference between the two groups in terms of Interest and Value components of motivation. To study whether IPL influences the level of

understanding of the students, 46 students were divided into two groups, who attended IPL sessions on Optics. First group received IPL on geometrical optics while the second group on wave optics. After the intervention the questionnaire on the topics were administered to the groups in such a way that, the responses of the students who had attended the IPL session on a topic is compared with that of the students who had not received IPL session on the same topic. The qualitative analysis of responses showed that the students showcased better understanding of the concepts that they learned through IPL, compared to those who didn't attend the IPL sessions on that concept.

Nuni et al. (2016) conducted a correlational survey study to examine the influence of science club activities on interest and achievement in physics among secondary school students in Kenya. The sample comprised of 217 students and the instruments used were Student Motivation Questionnaire (SMQ) and Physics Achievement Test (PAT). Sixty teachers were administered with Teacher Questionnaire (TQ) and Science Patron Interview Schedule (SPIS). The results showed that majority of teachers were with the opinion that club activities improved students' interest and motivation towards physics. Students who participated in the activities performed better than the non-participants in terms of achievement and interest.

Nwankwo and Okoye (2015) conducted a survey study to find out the influence of science club on the interest and achievement of senior secondary science students. The sample consisted of 140 students from Anambra. The data was collected using Science Club Participation Questionnaire. Based on the responses of the

students in the questionnaire, the study showed that science clubs were active in their schools. The students agreed that their membership in the club had influence on their level of interest and achievement in science.

Vartiainen and Aksela (2013) studied the effect of club activities on the engagement and achievement of small children aged 3 to 6. The science club activities were organized by Finland's Science Education Centre LUMA, with the aim of training the skills such as inquiry, discussion etc., supporting social and emotional learning (SEL) with joy and achievement. There were 25 children who participated in the activities along with their guardians. The feedback from the parents revealed that the activities had boosted the kids thinking skills, positive attitude and interest towards science and mathematics.

Bozdogan and Yalcin (2009) experimentally studied the influence of Science Exhibition Center Training Program (including exhibitions and activities) on interest and achievement of eighth standard students from Ankara. The sample consisted of 31 elementary school students. Single group pre-test post-test design was employed, and the data was collected using Interest Scale and Academic Success Test. The results of One-way ANOVA showed that the exhibition program brought permanent increase in both interest and achievement among students.

Studies in the Indian Context

Kadlimatti (2021) conducted action research to find which teaching strategies enhance the level of proficiency of IX grade students in physics. Twenty-four students from Karnataka Middle Secondary School participated in the study. Observations,

class tests and questionnaire were used for gathering data for the study. The intervention comprised of usage of frequent demonstration and investigation, using diagrams to solve problems, using acronyms for easy learning, addressing daily-life application and assessment and evaluation. Observation of students during the execution of the intervention gave the first thought on their level of engagement, in the form of raising of question, teacher-pupil interaction, initiation in group tasks etc. Test was used to measure the level of improvement after intervention. Questionnaire comprised of Likert type items that measured the level of interest towards the subject. The analysis of data gathered via. three sources revealed that the interest and the performance of students have enhanced with the intervention.

Singh and Pancholi (2020) studied the role of Art Integrated Learning (AIL) in enhancing interest and achievement in science and mathematics among primary school students. The sample were selected from 17 AIL schools and 17 non-AIL schools from Delhi. In order to understand the perception of primary teachers, Perception Scale was constructed on the dimensions of meaning of AIL, teaching strategy, impact on the child and justice with the course content and administered on 102 teachers, including 34 teachers who received training on AIL, 34 teachers who did not receive training and 34 teachers from non-AIL schools. Class Observation Schedule (3-point scale) on teaching-learning environment, personal characteristics, teaching strategies and evaluation was used by the investigators for the three categories of teachers. Principal's Interview Schedule was administered to 34 principals to understand their views on AIL. To learn about the obstacles of implementing AIL, Resource Person Interview Schedule was administered to five

resource persons. Checklist including activity and material checklist was also used by the investigators. The achievement scores of 5100 students from final examination results were gathered and their interest levels were inferred through classroom observation, teacher perception and informal feedback. The results of the analysis revealed that the teachers who were both trained and untrained had positive attitude towards AIL, while the teachers in non-AIL schools had indifference towards AIL. The students from I to III grades who received AIL had no significantly better improvement in achievement with the usage of AIL, but the students from IV grade had significantly better scores. The investigators witnessed better student engagement among learners with AIL. Both principals and resource persons viewed implementation of AIL positively.

Bindu and Rajagopalan (2019) carried out an experimental study to find the effectiveness of corrective instruction strategy on achievement and interest in science among secondary school students. The experiment was conducted on 60 students studying in ninth standard CBSE schools in Coimbatore. The treatment group was taught with corrective instruction strategy and the control group with traditional method. Raven's Standard Progressive Matrices was used for equating the groups on IQ. Achievement Test in Science and Science Interest Inventory were the tools used for pre-test and post-test. The analysis of responses showed that corrective instructional strategy was effective in enhancing achievement and interest in science. Also, there was significant difference in the gain scores of achievement in physics, chemistry and biology in post-test of experimental and control groups.

Ligi and Raja (2019) carried out an experimental study to find the effectiveness of flip teaching in interest and achievement in physics among high school students. Eighty students from ninth standard from Karungal, Tamil Nadu took part in the experimentation. On the topic Sound, the experimental group was taught in the flip method while the control was taught in traditional method. The tools used for pre-test and post-test included LiWi's Achievement Test in Physics and LiWi's Interest Inventory in Physics. Delayed post-test was also initiated. The analysis of responses gave the result that the experimental group had better gain in achievement, retention and interest in physics compared to that of the control group after the intervention.

Prakash and Vamadevappa (2019) studied the effectiveness of Activity-based Teaching Learning Strategies (ABTLS) on secondary students' attitude, interest and achievement in science. The sample selected for the experiment comprised of 100 ninth standard students from Haveri. Certain topics were selected from physics, chemistry and biology and the treatment group was taught with ABTLS and the control group with traditional method of teaching. Achievement Test in Science which was constructed by the investigators and the adopted tools such as Attitude towards Science Scale and Scientific Interest Inventory were used to measure the dependent variables before and after the experimentation. The analysis of the responses of the students showed that the increase in attitude, interest and achievement among the students from pre-test to post-test is significantly greater in experimental group than in control group, proving that the developed programme is effective in enhancing the dependent variables.

Joy and Jacob (2014) conducted an experimental study to find the effectiveness of 5E learning cycle model on the secondary students' scientific creativity, scientific interest and achievement in physics. The dependent variables were also analysed in terms of learning styles of the students. Three hundred and twelve ninth standard students from Idukki and Ernakulam districts were selected as the sample. Before the pre-test, the mental ability of both the students in the experimental and control group were matched using the tool, Raven's Standard Progressive Matrices. The experimental group was taught with 5E learning cycle model and the control group with activity-oriented method. The pre-test and post-test were conducted with the tools Scientific Creativity Test, Scientific Interest Inventory and Achievement Test in Physics. A delayed post-test was also conducted with the achievement test. The results of the analysis showed that students of the experimental group had significantly higher scientific interest, scientific creativity, achievement in physics and retention in learning than the control group.

Sattanathan and Muthaiyan (2013) studied the effectiveness of advanced visualization tools on students' achievement and interest in science at secondary level. In total, 80 students studying in ninth standard from Thanjavur district were selected as the sample of the study. The experimental group was dealt with advanced visualization tool while the control group was taught with ordinary visualization tool. The topics selected for the intervention were 'Motion and Liquids' and 'Addiction and Healthy Lifestyles'. Achievement Test in Science, Science Interest Inventory and Pupil's Attitude towards Advanced Visualization Tools Scale were used as pre-test and post-test. It was inferred through the study that the advanced visualization tools

were effective in enhancing achievement in science, attitude towards the tools and interest in science when compared to the ordinary visualization tools.

Studies in Other Subjects

Pandey and Yadav (2023) developed instructional package based on blended learning approach on Geometry meant for seventh standard students and checked its effectiveness on student achievement and interest towards the topic, and their attitude towards the intervention. In total, 84 students from Prayagraj city participated in the study. The experimental group was taught with blended learning and the control group with conventional method. Achievement Test in Geometry, Interest Inventory in Geometry and Attitude towards Blended Learning scale are used as pre-test and post-test. Analysis of the responses showed that the blended learning approach is more effective in enhancing achievement and interest among students than the conventional method. It is also seen more effective in developing positive attitude towards geometry among students.

Muraleedharan and Raveendranathan (2022) studied the effectiveness of brain-based teaching approach on achievement and interest in biology among higher secondary school students. One hundred sixty-two students studying in eleventh standard from Malappuram district became the part of the study. Brain based learning is the treatment variable while activity method of teaching is the control variable. Achievement Test in Biology and Interest Inventory in Biology were the tools used as pre-test and post-test. The brain based teaching was found effective in developing achievement and interest in biology than the activity method of teaching.

Basanagouda and Talawar (2021) studied the effectiveness of constructivist approach (5E model) on secondary school students' scientific temperament, scientific interest and achievement in science. The experiment was done specifically in the subject of chemistry. The experimental group was taught with the 5E model constructivist approach and the control group with conventional approach. The sample selected for the study consisted of 80 students studying in nineth standard from Dharwad district. The tools employed for pre-test and post-test are Scientific Interest Inventory, Scientific Temperament Tool and Achievement Test in Chemistry. The study concluded that the constructivist approach significantly improved scientific temperament, scientific interest and achievement in chemistry.

Matthew (2020) investigated the influence of improvised teaching materials on interest and achievement on Mensuration among higher secondary first year students. The experimental study was conducted on 185 students from Ogun state, Nigeria. The treatment group was taught with improvised aids and the control group with traditional method. The instruments used were Mensuration Achievement Test (MCQ-based) and Mensuration Interest Scale (four-point). The results of ANCOVA showed that the use of improvised instructional materials brought better achievement and interest among students than the traditional method of teaching.

Thangam and Rengaraj (2022) attempted to study the contemporary ICT facilities at school, its impact on students' attitude and interest towards ICT usage, and achievement of ninth standard students in English. The tools used for the survey were ICT Knowledge Test (ICTKT), Attitude Towards Multimedia Teaching Aids

Scale (ATMMTAS), ICT Interest Inventory (ICTII) and ICT Infrastructure Scale along with scale defining level of achievement of students. The sample constituted of 300 high school students in Tiruvallur, Kanchipuram and Chengalpattu Districts of Tamil Nadu. The results of the study revealed that a majority of students reported access to internet (62.7 percent) and virtual learning platforms (60.7 percent) at school, though infrastructure quality varied, with only 40.3 percent rating it as good. Significant correlations were found between ICT usage (both for personal and academic purposes), virtual learning environments, and students' attitudes and interest in using multimedia and internet-based learning, indicating a generally positive impact on engagement.

Mishra and Nehru (2021) conducted an experimental study to find the influence of constructivist 7E model in teaching algebra on the mental ability, mathematical interest and academic achievement of secondary school students. The sample selected for the experiment consisted of 312 students in total who were studying in ninth standard at government schools from Bargarh. The experimental group was dealt with the constructivist 7E approach while traditional method was used for control group. Mental Ability Test, Mathematical Interest Inventory and Achievement Test in Mathematics were employed for pre-test and post-test of the groups. The ANCOVA results concluded that the constructivist 7E model was effective in terms of catering to mental ability, interest and achievement in algebra.

Bagul and Joshi (2020) studied the effect of computer assisted instruction (CAI) and traditional method of teaching on achievement in mathematics in relation

to reasoning ability and interest. Ninety eight students studying in eighth grade from Dhule participated in the experiment. Reasoning ability and interest are the moderating variables. Reasoning Ability Test and Interest Inventory were administered as pre-tests. The treatment group was taught with CAI and the control group with traditional method. After experimentation, the post test was administered with the tool, Achievement Test. The responses were analysed and the results showed that the high reasoning ability students in experimental group performed better in terms of achievement than the high reasoning ability students in control group. Similar result is found in the case of low reasoning ability students. Similar results were also found between the high interest and low interest students in the experimental and control groups.

Bala and Sharma (2020) studied the impact of remedial teaching approaches viz., Multimedia Approach (MMA) and Mastery Learning Approach (MLA), on the achievement and interest of the students in fifth standard having mathematical difficulties. Four hundred twenty-three students with difficulties were identified by distributing Teacher Referral Form (TRF) to their teachers. Output Difficulties, Organizational Difficulties, Language Difficulties, Attention Difficulties, and Visual Spatial Ordering Difficulties, were the difficulties mentioned in the TRF. By looking into the previous two year's average mathematics achievement scores, the students who scored less than 40 percent marks, i.e., 384 students, were selected. Then, General Mathematical Achievement Test was administered to these students, and those who scored less than 40 percent were selected. Thus, 356 students were identified to be having mathematical difficulties and from them 240 students were

randomly picked and were made to participate in the experimentation phase. There were three groups: experimental group 1 taught with MMA, experimental group 2 taught with MLA and control group with Conventional method of teaching (CMT). The interventions were based on the topic, Area and its Boundary. Mathematics Achievement Test (MAT) and Mathematical Interest Inventory were the tools used as pre-test and post-test. Analysis of the responses showed that there was significant improvement in mathematics achievement and interest after using MMA and MLA. MMA and MLA significantly improved students' mathematics achievement, elevating them from the poor to the high achievement category and students' mathematical interest increased, shifting from the low to the high interest category. Meanwhile, in CMT, the students enhanced their interest and achievement from low to average level. Both MMA and MLA had almost equal impact on achievement. MMA had greater impact on interest compared to MLA.

Muthulakshmi and Deepa (2020) studied the influence of TIGER method (Teacher as a facilitator, Individual work, Group work, Evaluation, Reinforcement) on IXth standard students' achievement and interest in mathematics. The experimental group was taught with TIGER method and the control group with conventional method. In total, 60 students participated in the experiment. Non-verbal Intelligence Test was administered to confirm homogeneity of the groups. The other tools used for pre-test and post-test were Mathematical Interest Inventory and Mathematics Achievement Test. The study concluded that the TIGER method enhanced achievement and interest in mathematics in low and average intelligent students better than the conventional method of teaching.

Pandey and Nayal (2020) carried out a survey on mathematical achievement, mathematical interest, mathematical attitude and academic achievement motivation of higher secondary school students of Kumaun Region. The selected sample consisted of 1200 students from three districts of Uttarakhand. Mathematical Interest Scale (MIS), Mathematics/Mathematical Attitude scale (MAS), Academic Achievement Motivation Test (AAMT) and Mathematical Achievement Test (MAT) were the tools employed. The study found that higher achievement was observed among females, urban students, science stream students, general caste students, those with graduate parents, and students whose parents held government jobs. The students' mathematical interest was generally higher among females, science stream students, those with graduate parents, and those with parents in government jobs, while factors like location and caste showed little to no difference. Mathematical attitude was generally higher among female, science stream students, those with graduate parents, and those whose parents held government jobs, while location and caste showed little to no effect. Academic achievement motivation was generally higher among female students, science stream students, those with graduate parents, and those whose parents held government jobs, while factors like location, caste, and stream differences among females had minimal impact. Secondary school students with high mathematical interest, attitude, and academic achievement motivation were found to have superior mathematical achievement compared to those with lower levels in these areas. Significant positive relationships among all variables, with mathematical achievement showing low correlations with mathematical interest and attitude, a negligible correlation with academic achievement motivation, while

mathematical interest and attitude were highly correlated, and both showed moderate correlations with academic achievement motivation.

Anuraba and Krishnamurthy (2019) conducted a normative survey to study the relationship of scientific aptitude, science interest and learning environment on achievement in chemistry among higher secondary school students in Pondicherry. The sample selected were 618 students from eleventh standard. The adopted tools such as K.K. Agarwal Bareilly and Saroj Arora's Test Battery for Scientific Aptitude, Science Interest Test and Learning Environment Scale were used. Achievement Test in Chemistry was constructed. The results of the analysis showed that there is positive relationship between the dependent variables such as scientific aptitude, science interest, learning environment and the independent variable achievement in chemistry.

Blihi and Bestur (2019) developed a package on blended learning approach (PBLA) and studied its effectiveness on writing expressions, achievement and interest in English among undergraduate students of English in Colleges of Education in Yemen. Eighty students were taken as sample. The developed package was used in treatment group, while the traditional method was used in the control group. Written expressions and interest were pre-tested for both the groups. The Written Expression Test, Test of Achievement in English Grammar and Scale of Interest in English were used as post-tests. The analysis of response collected gave the result that PBLA was effective in enhancing written expressions, achievement in grammar and interest in English.

Jijimol and Jacob (2019) studied the effectiveness of flipped learning-based strategy on multiphasic interest, academic anxiety and achievement in biology of secondary school students. One hundred and twenty students studying in ninth grade from Ernakulam district were the sample selected for the study. The treatment group was taught with flipped learning-based strategy and the control group with activity-oriented method. Raven's Standard Progressive Matrices was used to equalise the groups. Multiphasic Interest Inventory, Academic Anxiety Scale and Achievement Test in Biology were used as pre-test and post-test. The analysis of responses showed that the teachers do not use many of the teaching strategies due to time constraints and a smaller number of teachers use technology-based learning. The flipped learning was found effective to enhance multiphasic interest, to enhance achievement in biology and to minimize academic anxiety among students than the activity-oriented method.

Marieswari and Prema (2019) studied the influence of peer tutoring on achievement in terms of self-reliance and interest in English language of VIII standard students in Kancheepuram district. Twenty students participated in the study. All the students underwent a MCQ test to divide the students into below average and average categories. Average students acted as tutors and the below average students were the tutees. Rotational method of intervention was carried out. In the first round, Group-A is the experimental group and Group-B is the control group. In the second round, Group-A is the control and Group-B is the experimental group. Achievement Test in English Language, Self-reliance Questionnaire and Interest in English Language Questionnaire were used for this research. The result of analysis showed that the peer

tutoring is effective than the traditional method irrespective of tutors and tutees in Achievement in English language, Self-reliance and Interest in English language.

Ingles (2018) analysed the perception of students on closure activities employed for consolidation and studied its influence in enhancing engagement and student performance in EFL classrooms. The study was based on four types of closure activities such as competitive, cooperative, recreational and conversational activities. The activities were employed to both sixth standard students ($N = 25$) and second year high school students ($N = 37$) in Chile. After the intervention, a rating scale was distributed among the students to collect their perception on various activities. The analysis of the responses showed that the competitive activities significantly enhanced the engagement, motivation and speaking and vocabulary skills.

Mamatha and Dange (2018) studied the effectiveness using transitional background music while teaching mathematics on the achievement, interest and attitude among secondary school students. The sample consisted of 60 students studying in ninth standard from a school at Jayapura, Koppa. The experimental group was taught with transitional background music while no music was used in control group. The tools employed for conducting pre-test and post-test for both the group and delayed post-test in the treatment group were Interest in Learning Mathematics Scale, Interest in Music Scale, Achievement in Mathematics Test and Attitude towards Mathematics. t-test and ANOVA were the statistical procedures undertaken. The findings of the study explained that there was significant difference in the pre-

test, post-test and delayed test scores of achievement, interest and attitude of students in the treatment group.

Premachandran and Jaleel (2017) developed an interactive compensatory learning model in chemistry based on constructivism and studied its effectiveness in enhancing scientific reasoning, scientific interest and achievement among secondary school students. The experimental study was conducted on a sample of 176 ninth standard students from Kottayam district. There were a pair of treatment and control group each in the selected aided and government school. The treatment groups were taught with the developed model while the control groups with activity-oriented method. Scientific Reasoning Test, Scientific Interest Inventory and Achievement Test in Chemistry were the tools used for the study. The findings of the study revealed that the treatment group showcased better scores in terms of scientific reasoning, scientific interest and achievement in chemistry. Also, government experimental group had better scientific reasoning, scientific interest and achievement in chemistry than aided experimental group.

Ramhari and Anupama (2017) experimentally studied the influence of co-operative learning strategies such as Jigsaw, STAD, group investigation, pair compare, Think pair share, number heads together, round robin techniques and three minutes review on academic achievement, interest and problem-solving ability of eighth standard students in mathematics. To study the status on teaching of mathematics, a survey was conducted using questionnaire on 60 teachers. The survey revealed that teachers mostly employed inductive-deductive method, which is

followed by analysis-synthesis method. Very low percentage of teachers used cooperative strategy, but majority of them were ready to use it in mathematics classes. For evaluation, written examination was mostly employed in mathematics. To study the status on achievement, interest and problem-solving ability of students, survey was carried out on 400 students using Achievement Test in Mathematics, Mathematics Interest Test and Problem-solving Ability Test. Most of the students had average mathematics ability, mathematics interest and problem-solving ability. The programme was then developed based on cooperative strategy and the experiment was carried out on 60 students. The tools for measuring dependant variables were administered. The analysis of the responses showed that the programme was effective in terms of achievement, interest and problem-solving ability when compared to control group.

Naik and Barik (2016) conducted a survey on motivational strategies employed by teachers to enhance interest for achievement among secondary school students. The sample consisted of 200 teachers from arts and science colleges and 1000 students (500 students from ninth and 500 from tenth grades) from Bargarh district. The data was collected using School Information Sheet to collect previous year's academic scores of students, questionnaire on motivational strategies adopted by teachers, questionnaire on students' interest towards academic achievement, observation schedule to note down the motivational strategies used by teachers. The analysis of responses gave that the academic performance of students showed a noticeable improvement across classes, with average marks rising from class VIII to IX and subject-wise gains particularly in Math, Social Science, and General Science.

Students reported high levels of engagement and motivation, favouring lectures over textbooks, valuing clear guidance from teachers, and appreciating opportunities to contribute to their learning. Most students expressed positive attitudes toward their teachers' support, discipline, and classroom practices, which they felt enhanced their academic experience and personal growth. Teachers widely used various motivational and instructional strategies, including identifying student strengths, providing feedback, and linking new learning with past knowledge, though their usage varied in frequency. Overall, both student feedback and teacher practices reflected a learning environment supportive of academic improvement, emotional well-being, and active student participation.

Pandey and Rathore (2016) carried out an experimental study to explore the influence of Cooperative Learning Strategy Based Instructional Material (CLSBIM) (including Learning Together, Group Investigation, Jigsaw Method, Teams Games Tournament and Student Team Achievement Division) on civic sense, civic responsibility, interest and achievement among high school students. The sample constituted 167 students from eighth standard from Varanasi. Four units from civics, 'Social and Political Life- III' were taught with cooperative learning in experimental group and with traditional method in control group. Test of Civic Sense, Test of Civic Responsibility, Interest Scale and Academic Achievement Test were used for the study. The results of the analysis revealed that CLSBIM brought better scores of civic responsibility, interest and achievement than the traditional method. Both the methods had same effect on civic sense of the students.

Ramesha and Narayanaswamy (2014) studied the effectiveness of two tutorial teaching strategies namely Group Tutorial Teaching Strategy (GTTS) and Supervised Tutorial Teaching Strategies (STTS) on achievement and interest in mathematics of secondary school students. Seventy-five students studying in ninth standard from Bangalore City were distributed into two experimental groups and a control group. Six units from mathematics were selected as the content for the interventions. Traditional method was used in control group, GTTS in the first experimental group and STTS in the second. Achievement Test in Mathematics and Interest in Mathematics Scale were used as pre-tests and post-tests to measure the dependent variables. The results of the study said that GTTS was effective in enhancing both achievement and interest in mathematics, while STTS was only effective in enhancing achievement but not interest.

Deepa and Muthaiyan (2012) developed an e-learning package and studied its effectiveness on high school students' achievement and interest in mathematics and attitude towards computer and mathematics. Achievement Test in Mathematics, Mathematics Interest Inventory Scale, Students' Attitude towards Computer Scale and Mathematics Attitude Scale were used as pre-tests and post-tests. Hundred students studying in ninth standard from Thanjavur took part in the experiment. The topic selected was Coordinate Geometry and the treatment and control group were taught with e-learning strategy and traditional method respectively. The results revealed that e-learning strategy was effective in enhancing achievement and interest in mathematics and attitude towards computer and mathematics.

Youssef and Mansour (2012) studied the effect of concept mapping strategy on achievement and interest of senior-level baccalaureate nursing students from Taif University. Forty-six students participated in the experimental study. The students were introduced with the concept and construction of concept maps and they utilized it throughout the course. The achievement was measured using test and the questionnaire assessed interest and level of satisfaction of the students. The analysis of pre-test and post-test scores showed that concept mapping strategy significantly enhanced achievement and interest of students than the traditional method of teaching.

Karwande and Garg (2010) studied the effectiveness of constructivist approach in enhancing interest and achievement in mathematics among secondary school students. The topic Fractions was used for developing lesson transcripts using constructivist approach and traditional method. Eighty-five students studying in VII standard from Mumbai were selected for the experiment. The experimental group was dealt with the constructivist approach while the traditional method was used to teach the control group. The pre-test and post-test were carried out with the tools such as Mathematics Interest Inventory and Mathematics Achievement Test. The analysis of the responses gave the result that the gain in interest between the pre-test and post-test of the treatment group was significantly greater than that of control group. In the case of achievement, the gain in the scores between pre-test and post-test of both the groups were found to be significant.

Chiou (2008) assessed the impact of concept mapping strategy on achievement and interest among students in accountancy. The experiment was carried out on 124

undergraduate students from University of Taiwan. Experimental group received concept mapping technique while traditional expository teaching was used in control group. The students in the treatment group initially were trained to construct concept maps. Then they received the instruction involving teacher made concept maps after which the students were asked to create concept maps by their own. These maps were collaboratively reviewed by the teacher and the students. Achievement test was used as pre-test and post-test and an additional satisfaction questionnaire was implemented on the treatment group students after the intervention. The statistical analysis of the student responses revealed that the concept mapping instruction enhanced the level of achievement and interest of the students in accounting when compared to that of traditional teaching.

Kaur and Gakhar (2002) conducted an experimental study to find out the effectiveness of five classroom teaching strategies on achievement and interest in political science. The classroom teaching strategies selected were question answer, group discussion, assignment, question answer and assignment, question answer discussion and assignment strategies. The sample consisted of 120 students studying in eleventh standard from Jagraon, Punjab. There were five experimental groups and one control group (lecture strategy). Achievement Test in Political Science and Political Interest Scale were used for pre-test and post-test. The summary of results showed that for enhancing interest and achievement in political science, group discussion strategy is the most effective, which is followed by question answer assignment group discussion strategy and question answer strategy.

Conclusion

Initial insights from the literature, though inconclusive and tentative, suggested the following directions that ultimately helped the investigator in shaping the objective of this study.

Physics is a tough subject for students and hence students are not very interested

The survey among students has always made it evident that they have an average or below average level of interest in physics subject (Djudin, 2018; Oon & Subramaniam, 2011; Trumper, 2006; Vakarou et al., 2024; Williams et al., 2003). Almost all studies open with the discussion that physics is a tough subject to deal with, especially for students. Students are also hence least interested in the subject. Even the parents hold the same opinion on physics as a tough subject to deal with. Because of the difficulty and lack of interest among pupils, physics instruction is always under investigation, worldwide.

The prime reason for the subject being difficult is its abstractness and lack of connect with the daily life experiences of learners (Aykutlu et al., 2015; Kwarikunda et al., 2020; Ozmen, 2024; Ramma et al., 2017). This incongruity with real-world scenarios make physics more meaningless. Students have to struggle to imbibe physics concepts (Ozmen, 2024; Neidorf et al., 2020). Misconceptions are also prevalent because of abstract nature of the subject and the inappropriate teaching strategies of teachers (Ma et al., 2017; Okafor, 2015; Ozmen, 2024). Mathematical applications in physics is also hardship for students because of their lack of mathematical skills (Aykutlu et al., 2015; Basson, 2002; Hansson et al., 2021; Sitotav

& Tadele, 2016). All these have been mentioned as the core rationale for extensive research, both in international and national context, with the objective of implementing innovative physics instructions or improving the existing instructional practice.

Dominance of Conventional Practices in Physics Instruction

Physics teachers hold the opinion that student-centred practices, such as debates, discussion, project method, problem-based method, performing experiments, group works, field visit etc., which can be equally engaging and is capable of catering to the performance of students in the subject, are needed to be incorporated in the physics teaching-learning situations. But, on contrary, they rely on traditional means for concept transaction, which is evident from the research carried out in both international and Indian context (Bada & Jita, 2023; Biswal, 2023; Bunyamin et al., 2020; Ghosh et al., 2024; Hansson et al., 2021; Narayanan & Gafoor, 2017). Those studies pinpoint that teacher authoritative strategies including lectures, demonstrations, chalk- and-talk method, expository mathematical problem-solving, minimal usage of analogies, rare dialogues and participation of students etc. are the part of usual routine in physics learning environment.

Studies report that the physics teachers put less or inconsistent effort into making the class engaging and interesting for the students. There is a lack of logical presentations of the content while teaching, use of ample examples and clarity in teacher explanations. Teachers highly emphasize content delivery with minimal student participation and providing notes via. teacher-dominated means. Students are

not given enough opportunities to gather first-hand experience through their direct independent involvement in the process of inquiry and experimentation. Less frequent usage of instructional materials in general, those which are relevant to the concept being taught, and improvised and locally available aids, are also evident from the findings of prior research.

The Belief-Practice Divide in Teaching Physics

Regardless of the teachers employed within the country and abroad, there exists inconsistency in teacher beliefs and the classroom implementation. The concept of constructivist teaching practices is substantially imbibed by the teachers, but when it comes to the implementation phase, the teachers are seen stuck in the traditional teaching methods or in the transitional stage. There are also studies that explain that neither the usage of teacher-dominated nor the student-centered approaches are at an extreme level (Ates et al., 2018; Demirci, 2015; Hansson et al., 2021). The physics teachers can be rather said to be in a transitional stage, slightly inclined towards the teacher-centered end.

Teachers have understanding on STEM elements and approaches, such as the integration of science, technology and mathematics, use of scientific inquiry and engineering design, connecting with real-world context, student-centered approaches and teamwork among students. But the translation of these concepts to the real classroom setting is still a matter of dilemma among the physics teachers.

There are also situations in which teachers have limited content knowledge, insufficient understanding regarding the nature of science and the pedagogical skills

necessary to plan and execute student-centered methods and strategies in accordance with the learning environment and resources available. Even though they intend to implement learner-centered strategies, they finally end up with some methods which lack the essential features of the authentic strategy, and they are unaware that their practices do not have the real essence of inquiry or experiential learning (Ates et al., 2018; Bunyamin et al., 2020; Mokiwa, 2014).

Teachers Struggle in Delivering Physics Lessons

Teachers face many hurdles in the physics transactional process. The apprehensions are related to many aspects such as curriculum, role of mathematics in the subject, student understanding and practicality in implementing effective instruction.

Mathematical knowledge and skills among students are meagre. Students cannot imbibe the role of mathematics in learning physics and are unable to connect the physics concepts with their corresponding mathematical representations. This further creates complexity in understanding reasoning and deductions, and application of theories and laws in mathematical tasks. Meanwhile, teachers do not have enough time allocated in their regular class hours to bridge the gap in students' basic mathematical skills. The extensive curriculum to be taught within the limited time, itself is a humongous task as far as the physics teachers are concerned. Students too feel the same way regarding the syllabus that they learn.

The existence of curricular misalignment, in which the students have to learn the physics topics involving certain mathematical applications prior to its discussion

in the mathematics syllabus, adds fuel to the fire. Lack of collaboration and interdisciplinary communication between the physics and math teachers can also elevate the degree of this issue. Lack of material needs like inadequate laboratory and technological facilities are also the barriers for effective teaching-learning in physics, which affect both the teachers and the students gravely.

Unknown Consistency of Measures for Mitigating Challenges in Teaching Physics

Several strategies to mitigate the existing challenges in physics teaching-learning have been adopted by teachers. They include collaboration with mathematics teachers in teaching the prerequisite mathematical operations to the students prior to the introduction of physics concepts, providing additional math problems related to physics concepts for practice, developing joint learning materials etc. Teachers also put effort into using technology mediated aids for providing visual experiences on the concepts for the students to tackle their difficulty in conceptual understanding. But the frequency and consistency of these practices of physics teachers are yet to be deeply researched on.

Students' Insights on Teacher Practices are Less Sought After

According to the studies, the evaluation of methods and strategies employed by teachers is mainly the task of administrators, management and principal of educational institutions. For the purpose of educational research, carrying out live class observations by the researcher and interviewing the physics teachers are the two

mostly seen methods employed to make an understanding of the existing practices of teaching the subject.

Views of the students, who are the live audiences and receptors of teaching, are overlooked for this aspect. Even though their views and opinion on the classroom practices are of great relevance for educational decision making, they are most often ignored. The research with methodology that involves seeking of the student's views and perception of how their teachers teach physics in their classrooms, what strategies and how frequently they are employed, the instructional materials used etc., are less in number when compared to that of administering questionnaires on the physics teachers or carrying out class observations by the researcher.

Beyond Achievement: A Call for Deeper Exploration into Types of Student Interest in Indian Research, with a Kerala Focus

Several studies conducted abroad examined the role of pedagogical innovations in catering to the level of interest and achievement among the learners (Hochberg et al., 2018; Liliana et al., 2020; Pilit et al., 2024; Snetinova et al., 2018). The inclusion of relevant and meaningful learning contexts to which students can actually connect to, and incorporation of scientific practices such as project-based learning, scientific inquiry, collaborative works, question-answer method etc. in physics classrooms, are studied in terms of their effectiveness in reinforcing student interest and better academic achievement. In the case of interest, either situational or personal interests are discussed as dependent variables in most of such studies. The studies commonly explain that the diverse instructional practices in physics

transactional setting hold its own role in boosting the interest and achievement of the students.

The psychological construct of interest is less explored in the Indian context when compared to the number of studies conducted overseas. Also, situational interest is the least explored within the nation. The research on three interest types, viz., domain interest, situational interest and individual interest, is not seen to be undertaken in Indian or Kerala context. Meanwhile, achievement of students is vastly explored across the globe, be it in physics or in other subjects.

Experimental Studies Dominate; Surveys Remain Limited

When it comes to the influence on interest and achievement in physics among students, there are many studies carried out in experimental settings that compare the innovative practices to the traditional practices in which the researcher designs lesson transcripts and teach the experimental and control groups within the students (Carreno et al., 2021; Ligi & Raja, 2019; Prakash & Vamadevappa, 2019; Tugirinshuti, 2024; Uko & Uko, 2024). The surveys that focus on studying the existing teacher practices and to what extent they influence the interest and achievements in physics among students are less frequently conducted.

The themes of experimental studies include incorporation of STEM materials and resources, didactic approaches in teaching, investigative methods, contextualized learning, use of application and software, historical and interdisciplinary approaches, role-plays etc. and its influence on student interest in physics. In the case of achievement in physics, the practices taken include problem-solving method,

laboratory method, mnemonic learning strategy, team teaching, peer tutoring, technology mediated strategy, guided inquiry strategy, feedback strategy, remedial teaching, concept mapping strategy, brain-based learning, cooperative and collaborative learning, blended learning strategies, activity-based learning, various consolidation and assessment strategies, etc.

Meagre Research on 'Aligning Instructional Strategy with the Full Spectrum of Teaching-Learning Continuum'

The relevance of usage of 'one or two specific' instructional strategies for transacting physics in 'a specific' teaching-learning situation is explored extensively. And influence of that particular strategy/strategies on attributes of students, such as interest and achievement are studied. As mentioned earlier, this relation is being discussed in mostly experimental design studies too. There are not much investigations carried out by considering 'various' teaching-learning situations in physics classrooms and exploring the instructional strategies that teachers practice currently within each situation. By having the comprehensive view of progression of a typical physics classroom, starting from initial engagement to final assessment, the investigation of 'which practice suits best with each situation' is limited.

In a nutshell, within the school, the secondary level is the base where students must deal with physics subject separately for the first time. From the essence of reviews, it is evident that physics is a difficult subject for students across the globe and their interest towards the subject, be it domain, situational or individual, is also seen to be at minimal level. Meanwhile, research show that instructional strategies

can influence the level of interest and achievement of the learners. So, the teachers' usage of inappropriate methods and strategies in various teaching-learning situations might be the reason for students' decline in interest and achievement. Depending upon the sequential developmental stages of teaching-learning process and nature of topic to be transacted, the situation demands assorting of the most appropriate instructional strategy. In Kerala, there are limited studies that have examined such practices of physics teachers, and how they are related to student characteristics like interest and achievement. Subsequently, the investigator decided to study the existing practices of physics teachers (giving due importance to each teaching-learning situation) at secondary level in Kerala, and to find out the influence of these practices on interest and achievement among secondary school students.

Chapter Three

METHODOLOGY

- Variables
- Research Questions
- Objectives
- Hypotheses
- Design and Phases of the Study
- Tools Used for the Study
- Sample Selected for the Study
- Data Collection Procedure, Scoring and Consolidation of Data
- Data Preparation and Statistical Techniques

Research methodology deals with all methods, tools and techniques that is involved in fulfilling the objectives of the research. The reliability and validity of the research and its findings, which decides the extent of accomplishment of the study, is based on the methods used by the researcher. So, initially, the selection and design of the sequential and systematic path and means and later its implementation is necessary to find the solution to the research problem most effectively.

This study analyses the instructional practices of physics teachers at secondary level and their influence on the interests and achievement of students. The methodology of this study is described in this chapter under the heads, viz.,

- Variables
- Research questions
- Objectives
- Hypotheses
- Design and phases of the study
- Tools used for the study
- Sample selected for the study
- Data collection procedure, scoring and consolidation of data
- Data Preparation and statistical techniques

The detailed description of each is as follows.

Variables

The independent variables in the study are Instructional Practices in Physics (Instructional Practices in Physics, Instructional Practices for Equations of Motion and Instructional Practices for Gravitation). The dependent variables are Interests in Physics (Domain Interest in Physics, Domain Interest in Equations of Motion, Domain Interest in Gravitation, Situational Interest in Physics and Individual Interest in Physics) and Achievement in Physics (Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation).

Research Questions

The problem under study is systematically investigated through the following questions.

1. Which major physics concepts taught in secondary school are considered the most to least difficult by the students?

2. Which are the extant Instructional Practices of teachers in physics at secondary level?

3. Does the extent of usage of distinct types of Instructional Practices in various teaching-learning situations influence Secondary School Students' Interests in physics, namely:

    a) Domain Interest in Physics and in select difficult concepts?

    b) Situational Interest in Physics?

    c) Individual Interest in Physics?

4. Does the extent of usage of distinct types of Instructional Practices in various teaching-learning situations influence Secondary School Students' Achievement in:

    a) Physics?

    b) select difficult concepts in physics?

Objectives

The objective of the study is to explore the extant Instructional Practices in Physics and to find out the influence of these practices on Interests and Achievement among secondary school students. The objective of the study will be attained through the following specific objectives.

1. To rank the major concepts in physics taught at secondary level in the order of difficulty for the secondary school students.

2. To explore the extant Instructional Practices of teachers in physics at secondary level.

3. To examine the influence of each type of Instructional Practice in various teaching-learning situations on Secondary School Students' interests, namely:

    a) Domain Interest in Physics and in select difficult concepts

    b) Situational Interest in Physics

    c) Individual Interest in Physics

4. To examine the influence of each type of Instructional Practice in various teaching-learning situations on Secondary School Students' Achievement in:

    a) Physics

    b) select difficult concepts in physics

Hypotheses

The hypotheses formulated for this study are as follows.

1. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in Physics among secondary school students.

2. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in difficult concepts in physics among secondary school students.

3. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Situational Interest in Physics among secondary school students.

4. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Individual Interest in Physics among secondary school students.

5. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in Physics among secondary school students.

6. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in difficult concepts in physics among secondary school students.

Design and Phases of the Study

Two-phase quantitative survey design is employed for this study. Phase-I is descriptive and Phase-II is analytical in nature. Each phase is described as below.

Phase-I

The main aim of the investigator in Phase-I is to rank the major concepts in physics taught in IX standard in the order of difficulty for students to learn. This is attained based on the data collected from IX standard students and IX standard physics teachers.

For collecting data from IX standard students, the investigator developed 'Conceptual Understanding Test in Physics'. The test had three sections: Section A (General information section), Section B (Ranking section) Section C (Test section). In Section B, the students are asked to rank the concepts based on the difficulty and in Section C, multiple choice questions on the major concepts taught in IX standard are provided.

Based on the experience in teaching physics in IX standard, the teachers are asked regarding their perception on the physics concepts that the students find difficult to learn and reproduce. In unstructured interview, the teachers ranked the concepts based on the difficulty as perceived by students.

Consolidating the ranking done by both the students and teachers and the scores obtained by students in the test, the difficult concepts as perceived by the students are identified.

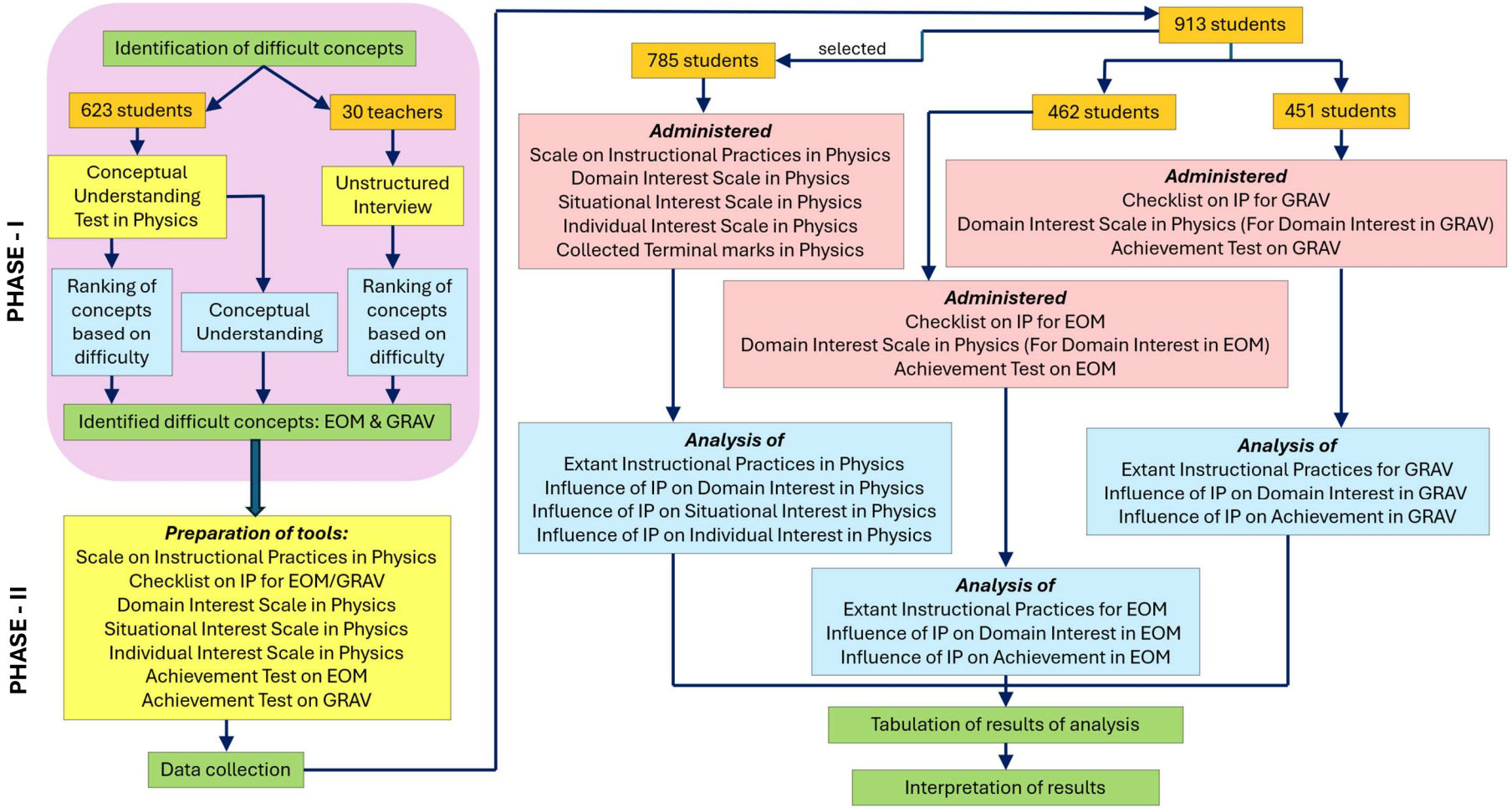
Phase-II

The objectives of Phase-II are to find out the extant Instructional Practices of teachers to transact the physics concepts at secondary level and to analyse the influence of these practices on Interests and Achievement in Physics among secondary school students. To meet these objectives, tools such as 'Scale on Instructional Practices in Physics', 'Checklist on Instructional Practices for Equations of Motion / Gravitation', 'Domain Interest Scale in Physics', 'Situational Interest Scale in Physics', 'Individual Interest Scale in Physics', 'Achievement Test on Equations of Motion' and 'Achievement Test on Gravitation' are developed and administered to the students. The responses are analysed statistically to find the dependency of Interests and Achievement in Physics on Instructional Practices of teachers.

The summarized view of the design and the whole procedure of the study is provided in Figure 2.

Figure 2

Design of the Study



Tools Used for the Study

Collection of relevant data is an important aspect of any research work. The preparation or selection of suitable tool is of vital importance for successful research. Research tool is the soul factor in determining sound data and in arriving at perfect conclusions about the problem or study in hand, which ultimately helps in providing appropriate solution to the problem concerned.

For the present study, the investigator has used the tools, namely,

1. Conceptual Understanding Test in Physics
2. Scale on Instructional Practices in Physics
3. Checklist on Instructional Practices for Equations of Motion / Gravitation
4. Domain Interest Scale in Physics
5. Situational Interest Scale in Physics
6. Individual Interest Scale in Physics
7. Achievement Test on Equations of Motion
8. Achievement Test on Gravitation

The detailed description of the development and validation of the tools are as follows.

Conceptual Understanding Test in Physics

The tool, Conceptual Understanding Test in Physics, is meant to rank the major concepts in physics taught at IX standard level based on the difficulty of students to learn. This ranking is done based on the level of conceptual understanding

that students possess in each major concept. The detailed description of the development of the test is presented under the heads,

- Planning of the test
- Preparation of the test
- Try-out of the test
- Finalization of the test

Planning of the Test

The investigator planned to develop the test based on the major concepts in physics taught in IX standard, by following the Revised Bloom's Taxonomy of instructional objectives. For the comprehensive coverage of the content, it is also forethought of developing three parallel forms of the test, with each student appearing for any one form. The items in the test are planned in the form of multiple-choice questions with four alternative responses.

There are seven major concepts in IX standard physics textbook. When the idea of preparing the test and its objective is conveyed with the physics teachers of IX standard, they suggested to consider first five concepts for the development of the test. The last two concepts are covered in the third term of the academic year at school. So, the concepts taught to students during the first two terms of the academic year are taken into account for the test, since the covering of the last two concepts may clash with the data collection period anticipated by the investigator. The five major concepts are listed as follows.

a) Forces in Fluids

b) Equations of Motion

c) Motion and Laws of Motion

d) Gravitation

e) Work, Energy, Power

Preparation of the Test

In the Conceptual Understanding Test in Physics, there are three sections: Section A, Section B and Section C. The Section A is the general information section which is meant for collecting the preliminary details of the student like name, name of the school, type of management and the first terminal marks in physics obtained by the student.

The Section B included the list of the major physics concepts learnt in IX standard and the students have to rank them based on the difficulty in such a way that the rank '1' is provided to the most difficult concept, '2' for the second most difficult concept, '3' for the third difficult concept etc.

The Section C consisted of multiple-choice test items on the major concepts, which are provided with four alternative responses. Three parallel forms of the test: SET A, SET B and SET C, are designed in such a way that, a set had five items from each major concept. Hence, each set of the test constituted 25 items in total. The items are prepared in accordance with the Revised Bloom's Taxonomy (Anderson et al., 2001). Appropriate weightage to difficulty levels (easy, average, and difficult) is given.

All the three parallel forms of the test are prepared in accordance with the same blueprint. The blueprint of the test is given in Table 1.

Table 1

Blueprint for the Conceptual Understanding Test in Physics

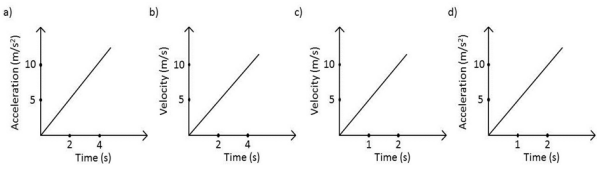
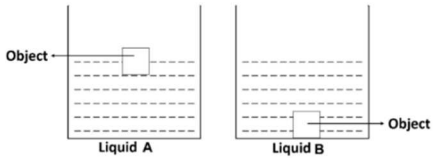
Objectives / Content	Remembering	Understanding	Applying	Analysing	Evaluating	Total
Forces in Fluids	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	5
Equations of Motion	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	5
Laws of Motion	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	5
Gravitation	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	5
Work, Energy, Power	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	$(1)^1$	5
Total	5	5	5	5	5	25

Note: Numbers outside the brackets indicate marks and those inside denotes the number of questions

Examples of item under each objective is given in Table 2.

Table 2

Illustrative Items From Conceptual Understanding Test in Physics for Each Objective

Objective	SET	Item no.	Illustrative item
Remembering	**A**	**21**	Select the correct statement. a) Work is said to be done only when a body undergoes displacement perpendicular to the applied force. b) Work-energy principle states that work done is equal to change in potential energy. c) The energy possessed by a body by virtue of its position is the potential energy. d) Power is the ratio of work done to the displacement.
Understanding	**B**	**17**	When a mango falls from a mango tree, a) Only the Earth attracts the mango. b) Only the mango attracts the Earth. c) Both the mango and the Earth attract each other. d) The tree repels and the Earth attracts the mango.
Applying	**C**	**8**	A train starts from rest and moves with uniform acceleration $0.1\ m/s^2$ for 2 minutes. The distance travelled by the train is a) 0.05 m c) 360 m b) 20 m d) 720 m
Analysing	**A**	**14**	Select the graph that represents the motion of a body of mass 4 kg, if the force acting on it is 10 N 
Evaluating	**B**	**5**	Select the correct statement based on the figures.  i. In liquid A, the buoyant force acting on the object is greater than that in liquid B. But the gravitational force on object is greater in liquid B than in Liquid A. ii. In Liquid A, buoyant force is less than the gravitational force on the object. While in liquid B, gravitational force on the object is less than the buoyant force. iii. The density of the liquid B is less than that of the density of the object and liquid A. iv. The relative density of the object is greater than that of liquid A and liquid B. a) Only (i) is correct. c) Both (ii) and (iv) are correct. b) Only (iv) is correct. d) Both (i) and (iii) are correct.

Scoring Procedure. For the responses of students in Section B, the ranks 1, 2, 3, 4 and 5 are scored as 5, 4, 3, 2 and 1 respectively. In Section C, each multiple-choice test item has four alternative responses as (a), (b), (c) and (d) out of which only one is correct. The student must mark the response by darkening the circle as indicated below on the correct response of each item.

Example: ⓐ ● ⓒ ⓓ where (b) is the correct response.

One mark is assigned for every correct response and zero for every incorrect response. Considering all the test items, the maximum mark obtainable on the test is 25. The draft of the three parallel forms of the test, SET A, B and C, in Malayalam are attached as Appendices 1, 2 and 3 respectively. The English translation of the draft test is attached as Appendices 4, 5 and 6 and the response sheet is given as Appendix 7. Their respective scoring keys are attached as Appendices 8, 9 and 10.

Try-out of the Test

The try-out of the draft Conceptual Understanding Test in Physics is administered on 47 students of IX standard. The main objective of administering the test is to identify misunderstandings and ambiguities among students with the language of test items, if any, and to make a rough estimate of duration of the test, within which the students can answer all the test items provided.

Finalisation of the Test

Considering the feedback obtained from the try-out of the test, minor structural modifications are brought in the items. Then the test is finalised with 25 multiple choice test items and the maximum mark for the test is 25. The time limit of the test

is 60 minutes. The total score obtained in 25 items denotes the conceptual understanding of students in physics.

The copy of the final test and its English translation are attached as Appendices 11, 12, 13 and Appendices 14, 15, 16 respectively, along with the response sheet (Appendix 17) and their respective scoring keys (Appendices 18, 19, 20).

Reliability. By adopting test-retest method, the Pearson Correlation Coefficients are calculated to be 0.82 (N = 48), 0.87 (N = 46) and 0.89 (N = 47) respectively for SET A, B and C. Also, the parallel form reliability is established in between SET A and SET B (N = 35), SET B and SET C (N = 35), and SET C and SET A (N = 33) for which the correlation coefficients obtained are 0.65, 0.60 and 0.61 respectively.

Validity. The validity of the Conceptual Understanding Test in Physics is established through face validity, content validity and criterion validity.

Since the test is tried out on a sample of 47 students and the suggestions received are incorporated before the finalisation, the investigator ensured that the test items and the common instructions provided in the test are in the least ambiguous manner, thus, confirming the face validity.

To ensure the content validity, the items in each parallel form are prepared in accordance with the blueprint of the test. Also, the tool is scrutinised by five physics teachers to ensure that the content covered in the test completely matches with the content of physics SCERT textbook taught in IX standard.

The scores obtained by the students in the Conceptual Understanding Test in Physics and their average scores on the first and second terminal examination in physics are correlated and the obtained coefficient correlation of 0.74 ensured the criterion validity of the test.

By undergoing the steps explained above, it is concluded that the tool is reliable and valid to measure the level of conceptual understanding among the IX standard students in physics.

Scale on Instructional Practices in Physics

The Scale on Instructional Practices in Physics is used to collect data from the IX standard students regarding the way in which their teachers transact the concepts in physics classroom. The tool development is explained under the following heads.

- Planning of the scale
- Preparation of the scale
- Try-out of the scale
- Finalization of the scale

Planning of the Scale

Initially, it is planned to approach the physics teachers of IX standard and gather idea regarding the possible ways that they use while transacting physics in the classroom. It is also planned to analyse the IX standard physics handbook developed by SCERT, subsequently, to obtain the idea regarding the instructional strategies prescribed by the Kerala state board. Combining both these ideas, the investigator

planned to identify the various teaching-learning situations in which the teachers employ various strategies depending on the nature of academic situation. It is planned to develop a four-point scale on which the respondents can mark the extent to which various ways are used by their teacher to transact physics.

Preparation of the Scale

As a part of preparation of the Scale on Instructional Practices in Physics, the teaching-learning situations identified by the researcher are explained below.

Introducing New Concepts. When a teacher introduces a physics concept for the first time in the classroom, it can be conveyed through different ways viz., by providing proper examples from the textbook or from daily life instances that students can easily relate with, by demonstrating simple examples, by eliciting responses from the students through proper sequential questioning, by using videos, presentations, handouts, and the like. Students can also be directed to make an understanding on the new concept by themselves prior to the class, with or without providing learning materials by the teacher.

Performing Experiments or Activities. This teaching-learning situation deals with the transacting of physics concepts through experiments and activities. The teacher can execute these by various ways like demonstrating experiments in front of the students and explaining the findings or asking the students to reach the conclusion, by assigning the students to do the learning activity either individually or in group, by providing timely supervision while students perform the task etc.

Working-out Mathematical Problems. Transacting problems in physics that involve mathematical operations is one of the important teaching-learning situations that have to be handled by the physics teachers. They can execute this task in many ways like working out the problems on the blackboard, demonstrating the problem-solving using videos, by providing step-by-step instruction to the students on how to solve the problem, by asking the students to work individually or in groups etc. Teacher can also assist the students while they work on problems.

Transacting Methodical Tactics of Mathematical Problem-solving. This situation discusses on how the teacher have transacted the step wise procedure in solving the mathematical problems in physics. According to the nature of problems in physics of IX standard, the procedure of treating to find its solution can be explained in the steps viz., identifying what is being given in the question, identifying what is being asked in the question, converting the question into symbolic or diagrammatic form, finding the most appropriate equation to solve, substituting the known and rearranging the equations and cross checking and reviewing the answer.

Introducing Graph and Working-out Related Problems. The SCERT curriculum is set in such a way that the concept of 'graph' is introduced for the first time through the IX standard physics textbook. Apart from understanding the concept, the students have to learn how to solve problems in physics that involve graphical representations. So, the teacher will have to explain what a graph is, its use in real life, its components such as x-axis, y-axis and origin, how to read a graph, the translation of graphs into tabular representations and vice versa, and the like.

Executing Project Works. To understand certain concepts in physics deeply, the teacher can assign projects to students where the students can explore and learn by themselves in a social or natural setting within a stipulated time. This situation can be dealt by the teacher by providing the topic of the project directly or by introducing the topic through a challenging situation and further into a problem during classroom discussion. The project work can be assigned individually or in groups to students. Teacher can either provide the related information and resources to the students or can ask them to find it by themselves. Students can be asked to present their findings in front of the class, after which the teacher can summarize the key theme and provide suggestions to the students on what they have presented.

Facilitating Note-making Process. Preparing notes is a way of concreting the sequential learning and helps the students to converge their focus on the important points easily. As a part of note-making, the students can be asked to prepare notes by themselves individually or in groups. Directing to take down lecture notes is yet another method to implement note-taking in the class. Later, the notes prepared by the students can be checked for correction by the teacher. Also, the teacher can either provide notes by dictating or by availing in PDF or printed form.

Miscellaneous Ways of Teaching. Under this umbrella, the researcher grouped the other ways of concept transaction such as peer teaching, use of mnemonics / concept mapping, addressing misconceptions and its elimination by providing ample examples, conducting debates, team teaching etc.

Conducting Assessment. Teacher has to assess the level of understanding of the students during the teaching-learning process. For this, teacher can enquire the

students if they have understood the concept or not and can clarify their doubts, if any. Questions can be raised to the students after teaching a concept and check whether they can answer it correctly or not. Students can be asked to prepare questions on the taught concept by themselves and conduct quiz sessions in the classrooms. Apart from the terminal examinations, class tests can also be used for assessment. Online assessment tools such as Kahoot, Socrative, Google forms, Quizizz can also be helpful to teachers for accomplishing this task.

Consolidation of Concepts. After teaching a concept, it must be consolidated so that students will get a comprehensive picture of what they have learnt so far. Teacher can summarize by conveying orally, or by supplementing it using videos or slides. Students can also be asked to consolidate what they have learned by themselves individually or by discussing in groups, to which the teacher can provide corrections and suggestions.

Providing Follow-up Activity. Follow-up activity is the teaching-learning situation in which students can extend the knowledge and skills acquired in the classroom to new situation. It often holds the nature of formative assessment where the practical skill or application ability of each student can be measured. Teacher can initiate follow-up-activity in the form of homework or worksheets or assignment that can be done by students individually and in groups. The students work can be later checked and provided suggestions by the teacher.

Enriching Learning Experiences. The enrichment of teaching-learning process can be provided in the form of field trips in which students can have first-hand experience of the learnt concepts from classrooms. Encouragement from

teachers to take part in science club activities and suggesting extra learning resources can also help the students to widen their horizon of understanding.

Examination Preparedness. Examination is an instance where teacher must put special care on students' learning and their performance. Teachers can discuss old question papers so that students can familiarise the nature of questions being asked. Individualised support to the high performers and slow learners is important. After the examination, the teacher can discuss the question papers in the classrooms so that students can identify their mistakes. Teaching the common tough concept again after the examination can be useful to the students in such situations.

Under each teaching-learning situation, the possible strategies are listed, which are later restructured into items. The items are framed in such a way that the students are asked to respond to what extent does their physics teacher teach in a particular way in the classroom while transacting physics concepts, for which the respondents can mark their opinion on a four-point scale. The students are also provided with an open-ended question at the end of the scale where they can mention if any other way of teaching is practised by their teacher, apart from those discussed in the items of the tool. A total number of 81 items are prepared for the draft tool and illustration of some items is provided below.

- How often does your teacher use the following ways (items 1-4) while 'Introducing new concepts'?

    1. By conveying orally
    2. By providing the examples given in the textbook

3. By connecting with the concepts that are already known to us
4. By relating to examples from daily life

- How often does your teacher use the following ways (items 44-48) while 'Facilitating note-making process'?

44. By dictating
45. By providing in printed form/pdf/slides
46. By asking us to prepare it individually
47. By asking us to prepare it after group discussion
48. By checking and if needed, by providing suggestions

Scoring Procedure. The response options set for the four-point scale are 'Often', 'Sometimes', 'Rarely' and 'Never' and the scores assigned are 3, 2, 1 and 0 respectively. The draft Scale on Instructional Practices in Physics, in Malayalam and English versions are attached as Appendices 21 and 22.

Try-out of the Scale

The draft scale is administered to 47 students of IX standard to know whether the students are able to comprehend the item without any ambiguity. For the open-ended item, students mentioned some of the ways employed by their teacher for physics transaction apart from those mentioned in the draft scale.

Finalization of the Scale

After incorporating the suggestions given by the students in the try-out stage, the tool is modified and the final form of the tool had 83 items in total, provided with proper instructions for respondents in the beginning. The final tool and its translated version in English are provided as Appendix 23 and Appendix 24 respectively.

Reliability and Validity. The reliability of the Scale on Instructional Practices in Physics is established using test-retest method. The correlation coefficient obtained is 0.81 (N = 47). The scale had undergone scrutiny by four physics teachers, thus confirming the face validity of the tool.

Checklist on Instructional Practices for Equations of Motion/ Gravitation

Checklist on Instructional Practices for Equations of Motion / Gravitation, in phase-II of this study, is meant to identify the Instructional Practices of physics teachers while they transact the major concepts, Equations of Motion (EOM) or Gravitation (GRAV). The students of IX standard are the respondents for the tool. The development of the tool is explained in detail under the following heads.

- Planning of the checklist
- Preparation of the checklist
- Try-out of the checklist
- Finalization of the checklist

Planning of the Checklist

It is planned to prepare the items of the checklist in accordance with the teaching-learning situations that are already identified by the researcher. The identified teaching-learning situations are listed as follows.

a) Introducing New Concepts

b) Working-out Mathematical Problems

c) Transacting Methodical Tactics of Mathematical Problem-solving

d) Introducing Graph and Working-out Related Problems

e) Executing Project Works

f) Facilitating Note-making Process

g) Miscellaneous Ways of Teaching

h) Conducting Assessment

i) Consolidation of Concepts

j) Providing Follow-up Activity

k) Enriching Learning Experiences

l) Examination Preparedness

The detailed explanation of the situations is provided under the section in which the development of Scale on Instructional Practices in Physics is being explained.

Preparation of the Checklist

Items are prepared under each teaching-learning situation in accordance with the nature of the concepts, Equations of Motion (EOM) and Gravitation (GRAV). The

items coming under the situation 'Introducing the Basics of Graph and Related Problems' are not applicable to the concept Gravitation (GRAV). The students are also provided with an open-ended question at the end of the checklist where they can mention if any other way of teaching is practised by their teacher for transacting Equations of Motion or Gravitation, apart from those discussed in the items of the tool. There are 70 items in the draft checklist and examples of the items are provided below.

- Does your teacher use the following ways (items 9-12) while 'Working-out Mathematical Problems' in Equations of Motion / Gravitation?

    9. By working out on the blackboard
    10. By demonstrating using slides/ videos
    11. By asking us to follow the step-by-step instruction provided
    12. By asking one of us randomly to work out problem on the blackboard and later asking rest of us to check its correctness

- Does your teacher use the following ways (items 32-36) for 'Consolidation of concepts' in Equations of Motion / Gravitation?

    32. By conveying orally
    33. By using slide/video presentations
    34. By directing us individually to do it
    35. By directing us to do it after group discussion
    36. By commenting and suggesting corrections after our presentations

Scoring Procedure. For the checklist, the students can mark their responses by putting tick mark (✓) against those items which described the Instructional Practice used by their teacher while transacting the major concept, Equations of Motion (EOM) or Gravitation (GRAV). The ticked responses are scored 1 and the others with 0.

The draft checklist and its English version are attached as Appendices 25 and 26 respectively.

Try-out of the Checklist

The try-out of the checklist is done on 47 students to find and rewrite the items that cause any sort of misunderstanding or ambiguity among students.

Finalization of the Checklist

After incorporating suggestions provided by the students in the try-out stage, the checklist is finalized with appropriate instructions for the respondents in the beginning. There are 73 items in the final checklist and the items coming under the situation 'Introducing the Basics of Graph and Related Problems' (items 66 to 73) are not applicable to the concept Gravitation (GRAV). The final tool and its English version are attached as Appendices 27 and 28 respectively.

Reliability and Validity. The reliability of the checklist is established through test-retest method in which the correlation coefficient obtained is 0.80 ($N = 48$). The face validity is confirmed by four experts after undergoing the scrutiny of the items in the checklist.

Domain Interest Scale in Physics

Interest is a domain specific construct. Domain can be broad (e.g. science) and narrow (e.g. branch of science) (Krapp & Prenzel, 2011). Here, interest towards the concepts in physics is considered as Domain Interest in Physics. The Domain Interest Scale is meant to study the extent of interest of students towards the sub-concepts learnt in their IX standard physics classes. The development of this scale is explained under the headings given below.

- Planning of the scale
- Preparation of the scale
- Try-out and finalization of the scale

Planning of the Scale

The investigator had the plan of developing a scale through which the students can express their level of interest towards the sub-concepts that they learnt in physics in IX standard. So, it is planned to analyse the SCERT textbook of physics and identify the concepts that is included in the IX syllabus. Out of seven major concepts discussed as seven chapters in the textbook, the investigator thought of considering the first five major concepts transacted to students during the first two terms at the school for this scale.

Preparation of the Scale

For the preparation of the scale, the IX standard physics textbook is analysed and the five major concepts, namely, Forces in Fluids, Equations of Motion, Laws of

Motion, Gravitation and Work, Energy and Power, are listed. Later the sub-concepts like Buoyant force, First Equation of Motion, Conservation of Momentum, Acceleration due to Gravity, Potential Energy etc. are listed which come under the major concepts. Name of each sub-concept is provided as each item in the scale. In total, there are 35 sub-concepts. The details of number of sub-concepts under each major concept is provided in Table 3.

Table 3

The Major Concepts and the Number of Sub-concepts/Items in Domain Interest Scale in Physics

No.	Major Concepts	Number of sub-concepts/items
1.	Forces in Fluids	7
2.	Equations of Motion	6
3.	Motion and Laws of Motion	10
4.	Gravitation	5
5.	Work, Energy and Power	6

Scoring Procedure. The students are asked to mark their extent of interest against each sub-concept. The response categories of the three-point scale are 'Not Interested', 'Somewhat Interested' and 'Very Interested', to which the scores assigned are 0, 1 and 2 respectively.

Try-out and Finalization of the Scale

The try-out of the draft scale (Appendices 29 and 30) is administered among 44 students of IX standard to know whether there is any ambiguity in any of the instructions provided to the students in the scale. The suggestions of the students are incorporated for the final scale, and it has 35 items in total. The sum of scores obtained

in 35 items denotes the Domain Interest of students in physics. The finalised scale and its English translation is attached as Appendices 31 and 32 respectively.

Reliability and Validity. The Pearson's Coefficient of Correlation calculated for the scale after adopting the test-retest method is 0.97 (N = 45). The face validity of the test is ensured by three experts by scrutinising the scale.

Situational Interest Scale in Physics

To study the interest in academics as a variable, one of the most accepted models and extensively used is the Four-Phase Interest Development Model of Hidi and Renninger (2006). The first two phases correspond to Situational Interest and the last two phases explains Individual Interest. Situational Interest constitutes the amalgam of attention, excitement and curiosity that a person feels towards or is caused by an external environmental stimulus and is mainly temporarily sustained within the person. Taking the first two stages of this model into consideration, the investigator developed the Situational Interest Scale to measure the level of interest among students while they encounter any sort of learning situations or life activities which is related to physics in one way or the other. The detailed description of the development and validation of the scale is explained under the headings provided below.

- Planning of the scale
- Preparation of the scale
- Try-out of the scale
- Finalization of the scale

Planning of the Scale

The investigator planned to identify the curricular or life related situations in which the physics concepts are involved which are familiar to IX standard students. So, as an initial step, it is planned to analyse the physics concepts learnt by the students in VIII and IX standard and to construct items related to those concepts, so that the students will be able to relate and connect easily with the situations discussed in each item. It is also planned to construct Likert type items with three response options.

Preparation of the Scale

In the item preparation stage, the investigator developed curricular, or life related hypothetical situations connected with physics concepts that students have already learnt from school. The students are asked to assume themselves to be in the hypothetical situations described in each item and respond on how they feel being in such situations. The draft scale consists of 25 items. Examples for the item is provided below.

- If my teacher asked me to exhibit 'working model of hydraulic lift' in the school science exhibition, I will feel _____. (Item 3)

- If my mom gifts me the book 'A Brief History of Time' written by Stephen Hawking, I will feel _____. (Item 6)

Scoring Procedure. Students are asked to respond in accordance with how thrilled they will be while they assume to be in the hypothetical situations described. The students can mark their responses on a three-point scale with the levels,

'Indifferent', 'Curious' and 'Thrilled', for which the scores assigned are 0, 1 and 2 respectively.

The draft scale and its English translation are attached as Appendices 33 and 34 respectively.

Try-out of the Scale

The try-out of the scale is done on 47 students of IX standard to know whether any of the items cause confusions among the respondents so that they can be corrected.

Item Analysis. The scale is undergone item analysis in the procedure proposed by Edwards (1957) for items in the form of Likert statements. The scale is administered to 370 students of IX standard and their responses are scored and tabulated. The students are arranged in the decreasing order of the total score obtained. The students with upper 27 percent and lower 27 percent scores are grouped as upper group and lower group respectively. The scores obtained for each item for the upper and lower groups are calculated separately. Then, the *t* value for each item is calculated using the formula (Best & Kahn, 2006),

$$t = \frac{\overline{X}_1 - \overline{X}_2}{\sqrt{\frac{S_1^2}{N_2} + \frac{S_2^2}{N_2}}}$$

where,

$\overline{X}_1$ = Mean score on a given item for the upper group

$\overline{X}_2$ = Mean score on a given item for the lower group

S_1^2 = Variance of the distribution of responses of the upper group to the item

S_2^2 = Variance of the distribution of responses of the lower group to the item

N_1 = Number of subjects in the upper group

N_2 = Number of subjects in the lower group

The *t* value for each item in the draft scale is provided in Table 4.

Table 4

The Result of Item Analysis of the Situational Interest Scale in Physics

Item No. (Draft Scale)	$\overline{X}_1$	$\overline{X}_2$	S_1	S_2	*t* value
1	1.29	0.30	0.62	0.48	12.55
2	1.50	0.63	0.58	0.63	10.18
3	1.47	0.51	0.59	0.67	10.69
4	1.43	0.33	0.66	0.51	13.21
5	1.63	0.51	0.56	0.70	12.44
6	1.58	0.55	0.55	0.69	11.67
7	1.82	1.23	0.48	0.90	5.80
8	1.14	0.14	0.68	0.38	12.84
9	1.53	0.31	0.54	0.53	16.18
10	1.65	0.43	0.54	0.62	14.80
11	1.41	0.51	0.65	0.61	10.06
12	1.65	0.84	0.56	0.65	9.49
13	0.79	0.09	0.78	0.35	8.160
14	1.64	0.32	0.54	0.58	16.57
15	1.35	0.23	0.64	0.49	13.88
16	1.71	0.90	0.48	0.72	9.39
17	1.48	0.43	0.59	0.59	12.53
18	1.36	0.16	0.61	0.44	15.89
19	1.08	0.13	0.76	0.39	11.09
20	1.73	0.38	0.47	0.60	17.75
21	1.65	0.69	0.52	0.56	12.53
22	1.79	0.81	0.46	0.77	10.90
23	1.70	0.57	0.46	0.71	13.30
24	1.64	0.40	0.50	0.62	15.54
25	1.70	0.61	0.50	0.69	12.71

The *t* value obtained for all the items is greater than 2.58, which means that all the items are selected for the final scale.

Finalization of the Scale

The finalized Situational Interest Scale in Physics consisted of 25 items. The total score obtained in 25 items denotes the Situational Interest of students in physics. The final scale along with its English version are provided as Appendices 35 and 36 respectively.

Reliability and Validity. The reliability of the Situational Interest scale is established through test-retest method in which the Pearson's correlation coefficient found is 0.97 (N = 42). The validity of the scale is confirmed through face validity and construct validity. The scale underwent scrutiny by three experts, thus establishing its face validity. The construct validity of the scale is established by correlating the scores on the scale with the marks obtained in school terminal examination in physics and it is found to be 0.68. Thus, the scale is reliable and valid for measuring Situational Interest in physics.

Individual Interest Scale in Physics

According to the Four-Phase Interest Development Model proposed by Hidi and Renninger (2006), the last two phases of interest correspond to the Individual Interest in which the interest is mainly sustained within the individual by oneself and partially with the influence of others. The Individual Interest can be further classified into four components, viz., Knowledge, Emotion, Engagement and Value. Knowledge is about the perception and insight of knowledge (Krapp, 2000); Emotion refers to the

level of pleasure and excitement one feel while getting involved in an activity (Csikszentmihalyi & Hunter, 2003; Hidi & Renninger, 2006); Engagement is one's willingness to get engaged in a particular activity (Renninger, 2000) and Value refers to imbibing of the importance of an object in one's own life (Schiefele, 1991; Hidi & Renninger, 2006).

The development of the scale is explained under four heads as follows.

- Planning of the scale
- Preparation of the scale
- Try-out of the scale
- Finalization of the scale

Planning of the Scale

It is planned to develop the Individual Interest Scale in Physics taking into consideration the four dimensions of Individual Interest viz., Knowledge, Emotion, Engagement and Value. The items of the three-point Likert type scale will be in the form of statements regarding physics and physics learning, in which it is planned to include both positive and negative statements within each dimension. The respondents can express their level of agreement through the responses.

Preparation of the Scale

The investigator prepared nine items under knowledge dimension and 11 items each under emotion, engagement and value dimension. So, in total, the draft scale has

42 items, including 24 positive and 18 negative statements. Examples of some items are given below.

- I feel physics is a boring science subject. (Item 2)
- Physics is not a good option for higher studies. (Item 4)
- I enjoy participating in extracurricular activities related to physics. (Item 11)
- If physics was removed from schools, I would have performed well to bring good grades. (Item 17)

The details of the dimensions and the corresponding item number in the scale are given in Table 5.

Table 5

The Dimensions and the Corresponding Item Numbers in the Individual Interest Scale in Physics

Dimension	Nature	Item number in draft scale
Knowledge	Positive	5, 15, 23, 25, 32
	Negative	7, 17, 26, 33
Emotion	Positive	1, 2, 10, 20, 30, 34, 36
	Negative	1, 12, 21, 31, 35
Engagement	Positive	8, 11, 18, 27, 40, 41
	Negative	9, 19, 28, 37, 39
Value	Positive	3, 6, 13, 16, 22, 29, 38
	Negative	4, 14, 24, 42

Scoring Procedure. The students are meant to respond in accordance with their extent of agreement to the statements related to physics discipline and its learning. The response categories in the three-point scale are ‘Correct’, ‘Partially Correct’ and ‘Incorrect’, to which the scores assigned are 2, 1 and 0 respectively in the case of positive statements and 0, 1 and 2 respectively for negative statements.

The draft Individual Interest Scale in Physics and its English version are attached as Appendices 37 and 38 respectively.

Try-out of the Scale

The draft scale is administered to 47 students with the aim of finding out the items which causes any ambiguity or misunderstanding among students.

Item analysis. The scale is administered to 370 students of IX standard and their responses are analysed. The *t* value is calculated for each item undergoing the procedure explained in the item analysis section of Situational Interest Scale in Physics. The *t* value obtained for each item in the draft Individual Interest Scale in Physics is provided in Table 6.

Table 6

The Result of Item Analysis of the Individual Interest Scale in Physics

Item No. (Draft Scale)	$\overline{X}_1$	$\overline{X}_2$	S_1	S_2	t value
1	1.69	0.49	0.46	0.56	16.50
2	1.65	0.85	0.59	0.83	7.82
3	1.82	1.02	0.44	0.71	9.60
4	1.58	0.94	0.67	0.83	6.02
5	1.12	0.11	0.46	0.35	17.67
6	1.68	0.65	0.51	0.74	11.42
7	1.31	0.54	0.68	0.78	7.43
8	0.71	0.04	0.71	0.24	8.87
9	1.55	0.41	0.63	0.71	12.03
10	1.53	0.19	0.52	0.44	19.59
11	1.42	0.23	0.59	0.47	15.81
12	1.69	0.46	0.56	0.76	13.03
13	1.57	0.89	0.56	0.65	7.960
14	1.94	0.37	0.24	0.60	24.41
15	1.33	0.19	0.64	0.46	14.46
16	1.49	0.27	0.54	0.55	15.84

Item No. (Draft Scale)	$\overline{X}_1$	$\overline{X}_2$	S_1	S_2	t value
17	1.79	0.37	0.46	0.65	17.96
18	1.83	0.35	0.40	0.56	21.51
19	1.47	0.52	0.54	0.72	10.58
20	1.53	0.12	0.50	0.36	22.92
21	1.90	0.21	0.33	0.50	28.19
22	1.57	0.79	0.59	0.64	8.96
23	0.99	0.13	0.36	0.34	17.36
24	1.75	0.70	0.56	0.77	11.03
25	1.57	0.38	0.52	0.56	15.54
26	1.45	0.23	0.64	0.57	14.26
27	1.67	0.88	0.55	0.87	7.68
28	1.74	0.75	0.46	0.81	10.62
29	1.86	0.93	0.38	0.78	10.72
30	1.69	0.52	0.51	0.69	13.69
31	1.84	0.40	0.44	0.68	17.71
32	1.28	0.17	0.51	0.43	16.60
33	1.89	0.47	0.40	0.76	16.57
34	1.40	0.12	0.57	0.36	19.08
35	1.55	0.26	0.69	0.56	14.53
36	1.55	0.12	0.56	0.38	21.14
37	1.90	0.32	0.33	0.57	24.04
38	1.91	1.14	0.29	0.77	9.41
39	1.60	0.78	0.62	0.88	7.60
40	1.45	0.10	0.59	0.30	20.31
41	1.63	0.41	0.51	0.62	15.23
42	1.97	0.72	0.22	0.74	16.18

The *t* value obtained for all items is greater than 2.58. Therefore, all the items in the draft are taken for the final scale.

Finalization of the Scale

After the process of item analysis, all the 42 items are retained. The total score obtained in 42 items denotes the Individual Interest of students in physics. The final scale and its English version are attached as Appendices 39 and 40 respectively.

Reliability and Validity. The reliability of the scale is established using test-retest method in which the Pearson's Coefficient of Correlation obtained is 0.93 (N = 45). The validity is confirmed using face validity and construct validity. The construct validity of the scale is established by correlating the scores on the scale with the average marks obtained in first and second terminal examination in physics and it is found to be 0.65 (N = 55). Thus, the scale is reliable and valid for measuring Situational Interest in physics.

Achievement Test on Equations of Motion

The test is meant to measure the level of achievement of students in the concept, Equations of Motion (EOM), which is the toughest concept as perceived by nineth standard students. The development of the test is explained under the following heads.

- Planning of the test
- Preparation of the test
- Try-out of the test
- Finalization of the test

Planning of the Test

The investigator planned to develop an achievement test on Equations of Motion, in accordance with Revised Bloom's Taxonomy. For that, it is planned to analyse the content in SCERT textbook coming under the concept and to construct multiple-choice test items with four alternative responses each. It is also planned to develop the test with maximum marks of 25 with a duration of 60 minutes.

Preparation of the Test

The sub-concepts under Equations of Motion (EOM) are identified. Blueprint for the test is prepared in such a way that proper weightage is given to the objectives under cognitive domain, namely, Remembering, Understanding, Applying, Analysing and Evaluating. The blueprint of the achievement test is provided in Table 7.

Table 7

Blueprint of the Achievement Test on Equations of Motion

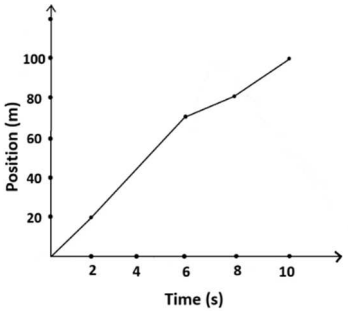
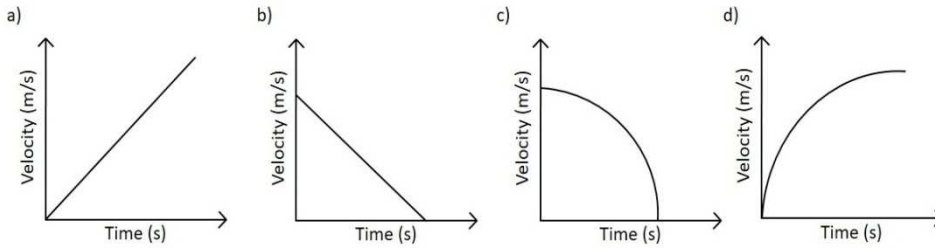
Objectives / Content	Remembering	Understanding	Applying	Analysing	Evaluating	Total
Graph and table	$(1)^1$					1
Position-time graph		$(2)^2$		$(1)^1$		3
Velocity-time graph	$(1)^1$	$(9)^9$		$(4)^4$	$(1)^1$	15
First equation of motion			$(2)^2$	$(2)^2$		4
Second equation of motion			$(1)^1$			1
Third equation of motion	$(1)^1$					1
Total	3	11	3	7	1	25

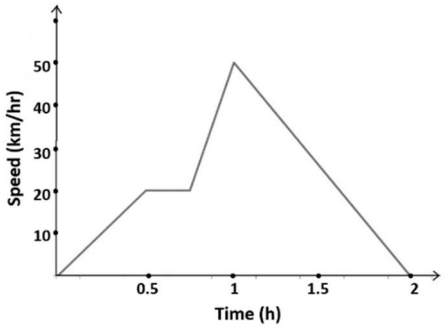
Note: Numbers outside the brackets indicate marks and those inside denotes the number of questions

Keeping in accordance with the blueprint, the investigator constructed 32 items (number of items greater than mentioned in the blueprint) for the draft test, expecting the item rejection during the item analysis of the test. Examples of items for each objective is provided in Table 8.

Table 8

Illustrative Items From Achievement Test on Equations of Motion for Each Objective

Objective	Item no.	Illustrative item
Remembering	**6**	_____ of a body within a definite interval of time is equal to the area of the portion under velocity-time graph. a) Displacement c) Velocity b) Distance d) Time of motion
Understanding	**2**	Given below is the graph that shows motion of a car. The distance travelled by it in 8 secs is _____  a) 200 m c) 80 m b) 100 m d) 60 m
Applying	**3**	A car accelerates uniformly from rest to a velocity of $30\ m/s$ in 10 seconds. What is the acceleration of the car? a) $2\ m/s^2$ c) $10\ m/s^2$ b) $3\ m/s^2$ d) $30\ m/s^2$
Analysing	**24**	Select the graph showing the acceleration of a body when thrown vertically upward. 

Objective	Item no.	Illustrative item
Evaluating	**10**	A train moves from one station to another in 2 hrs time. Its speed-time graph during the motion is shown in figure. Identify the correct statement regarding the graph. i. The maximum acceleration during the journey is in between 0.75 hr to 1 hr.  ii. The distance covered during the time interval from 0.5 hr to 0.75 hr is (0.25 x 20) kms. iii. From the beginning of the journey to 0.5 hrs, the train moves with constant velocity. a) Only (i) is correct. c) Both (i) and (ii) are correct. b) Only (ii) is correct. d) All statements are correct.

Scoring Procedure. Each multiple-choice question is provided with four alternative responses, (a), (b), (c) and (d), out of which only one is correct. One mark is assigned for every correct response and zero for every incorrect response. The student must mark the response by darkening the circle as indicated on the correct response of each item. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response.

The maximum marks that can be obtained on the draft test is 32. The draft test, its English translation, the response sheet and the scoring key are attached as Appendices 41, 42 43 and 44 respectively.

Try-out of the Test

The test is tried out on a sample of 370 students of IX standard to sustain quality test items in the final test.

Item analysis. For item analysis, the procedure suggested by Ebel and Frisbie (1991) is followed. The 370 response sheets obtained after try-out of the test is scored. The total marks obtained by each student is calculated. The whole score set is arranged in descending order of the total marks obtained. The highest 27 percent and lowest 27 percent of 370 responses (i.e., 100 responses) are grouped into two, viz., upper group and lower group, respectively. The total number of correct responses for the item in upper group, *U* and that in the lower group, *L*, are computed, after which, the difficulty index (*DI*) and the discriminating power (*DP*) of each item is calculated using the formula given.

$$DI = \frac{U+L}{2N} \text{ and } DP = \frac{U-L}{N}$$

where, U = Number of right responses of an item in the upper group

L = Number of right responses of an item in the lower group

$N = 100$ = Size of upper group or lower group

The calculated values for each item in the draft test with its selection details are provided in Table 9.

Table 9

Data and Results of Item Analysis of Achievement Test on Equations of Motion

Item no. in draft test	*U*	*L*	*DI*	*DP*	Item no. in final test
1	71	20	0.46	0.51	1
2	96	37	0.67	0.59	2
3	82	15	0.49	0.67	3
4	37	9	0.23	0.28	4
5	24	21	0.23	0.03	-
6	64	17	0.41	0.47	5
7	61	31	0.46	0.30	6
8	56	24	0.40	0.32	7
9	69	17	0.43	0.52	8
10	30	10	0.20	0.20	9
11	31	11	0.21	0.20	10
12	87	36	0.62	0.51	11
13	61	31	0.46	0.30	12
14	91	27	0.59	0.64	13
15	41	18	0.30	0.23	14
16	67	18	0.43	0.49	15
17	17	9	0.13	0.08	-
18	32	9	0.21	0.23	16
19	14	14	0.14	0.00	-
20	8	11	0.10	-0.03	-
21	25	19	0.22	0.06	-
22	33	12	0.23	0.21	17
23	35	10	0.26	0.25	18
24	31	11	0.21	0.20	19
25	14	7	0.11	0.07	-
26	52	32	0.42	0.20	20
27	89	23	0.56	0.66	21
28	19	6	0.13	0.13	-
29	36	15	0.26	0.21	22
30	73	23	0.48	0.50	23
31	47	19	0.33	0.28	24
32	43	10	0.27	0.33	25

The items with DI in between 0.20 and 0.80 and DP greater than 0.20 are selected for the final test.

Finalization of the Test

The items with required difficulty index and discriminating power are selected to satisfy the requirement of the blueprint. There are 25 items in the final test and the time duration for the test is set as 60 minutes. The total score obtained in 25 items denotes the Achievement of students in Equations of Motion. The final test, its English version, the response sheet and the final scoring key are given as Appendices 45, 46, 47 and 48 respectively.

Reliability and Validity. The reliability of the test is established by carrying out test-retest method. The test is administered twice to the same set of students (N = 30) within a time interval of three weeks. The Pearson's correlation coefficient between the test and retest responses are found to be 0.86.

The test is given to three physics teachers and 10 students studying in IX standard to know whether the items in the test are constructed in the least ambiguous manner. Their suggestions are incorporated in the final preparation of the test item. The teachers also conveyed that the content of the test is synchronous to the concept and also with the blueprint of the test. Thus, face validity and content validity is established.

To establish criterion-related validity, the scores of Achievement Test on Equations of Motion by 55 students of IX standard are correlated with their average scores in physics obtained in the first and second terminal examination conducted by the Kerala State Board. The Pearson's Correlation coefficient is obtained as 0.72, which ensured the required validity.

Achievement Test on Gravitation

The test is meant to measure the achievement of students in the concept, Gravitation (GRAV), which is perceived to be the second toughest physics concepts in IX standard level. The development and the standardisation of the test is explained under the following headings.

- Planning of the test
- Preparation of the test
- Try-out of the test
- Finalization of the test

Planning of the Test

The investigator planned to develop an achievement test on the concept, Gravitation (GRAV) based on Revised Bloom's taxonomy. It is planned to prepare multiple choice test items with four responses each, with maximum marks of 25 for a duration of 60 minutes.

Preparation of the Test

After identifying the sub-concepts coming under Gravitation (GRAV), a blueprint is designed by providing enough weightage to the objectives under cognitive domain. The blueprint of the test is provided in Table 10.

Table 10

Blueprint of the Achievement Test on Gravitation

Objectives / Content	Remembering	Understanding	Applying	Analysing	Evaluating	Total
Universal law of Gravitation	$(3)^3$	$(2)^2$	$(1)^1$			6
Force of Gravity		$(3)^3$				3
Acceleration due to Gravity	$(2)^2$	$(2)^2$	$(1)^1$	$(1)^1$		6
Mass and Weight		$(1)^1$	$(2)^2$	$(2)^2$	$(1)^1$	6
Freefall		$(3)^3$		$(1)^1$		4
Total	5	11	4	4	1	25

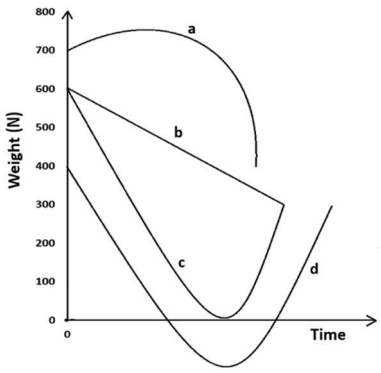
Note: Numbers outside the brackets indicate marks and those inside denotes the number of questions

Holding the expectation of rejecting items during item analysis, the investigator constructed 33 items for the draft test. Illustration of items is given in Table 11.

Table 11

Illustrative Items From Achievement Test on Gravitation for Each Objective

Objective	Item no.	Illustrative item
Remembering	**29**	The 'G' in the mathematical expression of Universal Law of Gravitation a) Depends on the value of 'g' at the place of observation b) Is universal gravitational constant c) Is used only when the Earth is one of the two masses d) Is greatest at the surface of the Earth
Understanding	**31**	A body of mass 1 kg is attracted by the earth with a force which is equal to a) 6.67×10^{11} N c) 9.8 N b) 100 N d) 1 N
Applying	**12**	If the distance between the sun and the earth is increased to three times, then the attraction between the two will become a) 3 times c) 9 times b) $\frac{1}{3}$ times d) $\frac{1}{9}$ times

Objective	Item no.	Illustrative item
Analysing	**25**	If the gravitational force of attraction of the Earth suddenly disappears, which one of the following will be true? a) The weight of the body will become zero, but the mass will remain same. b) The weight of the body will remain same, but the mass will become zero c) Both mass and weight become zero d) Neither mass nor weight becomes zero
Evaluating	**10**	Suppose the acceleration due to gravity at the earth's surface is 10 $m\|s^2$and at the surface of Mars is 4 $m\|s^2$. A passenger having weight 60 kg goes from the Earth to the Mars in a spaceship moving with a constant velocity. Neglect all other objects in the sky. Which part of the figure represents the weight of the passenger with respect to time? 

Scoring Procedure. The multiple-choice items are provided with four response options (a), (b), (c) and (d), out of which only one is correct. The correct response will be scored 1 and 0 for an incorrect response. The respondents are meant to mark their responses by darkening the circle as indicated on the correct response of each item. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response.

The maximum mark of the draft test is 33. The draft test, its English version, the response sheet and the scoring key are attached as Appendices 49, 50, 51 and 52 respectively.

Try-out of the Test

The draft test is tried out on a sample of 370 students of IX standard for the purpose of performing item analysis using the responses obtained.

Item Analysis. The same procedure as described in the item analysis of the Achievement Test on Equations of Motion is repeated with the responses obtained from the students through try-out of the draft Achievement Test on Gravitation. The calculated data for each item in the draft test with its selection details are provided in Table 12.

Table 12

Data and Results of Item Analysis of Achievement Test on Gravitation

Item no. in draft test	*U*	*L*	*DI*	*DP*	Item no. in final test
1	67	18	0.43	0.49	1
2	69	18	0.44	0.51	2
3	57	20	0.39	0.37	3
4	34	10	0.22	0.24	4
5	27	16	0.22	0.11	-
6	36	16	0.26	0.20	5
7	71	36	0.54	0.35	6
8	48	15	0.32	0.33	7
9	66	23	0.45	0.43	8
10	77	20	0.49	0.57	9
11	67	19	0.43	0.48	10
12	15	9	0.12	0.06	-
13	32	10	0.21	0.22	11
14	23	5	0.14	0.18	-
15	68	24	0.46	0.44	12
16	39	14	0.27	0.25	13
17	49	11	0.30	0.38	14
18	25	16	0.21	0.09	-
19	48	19	0.34	0.29	-
20	46	26	0.36	0.20	-

Item no. in draft test	*U*	*L*	*DI*	*DP*	Item no. in final test
21	61	10	0.36	0.51	15
22	41	11	0.26	0.30	16
23	62	21	0.42	0.41	17
24	33	18	0.26	0.15	-
25	60	22	0.41	0.38	18
26	40	19	0.30	0.21	19
27	49	10	0.30	0.39	-
28	77	18	0.48	0.59	20
29	75	22	0.49	0.53	21
30	65	20	0.43	0.45	22
31	35	15	0.25	0.20	23
32	50	17	0.34	0.33	24
33	61	18	0.40	0.43	25

The items with DI in between 0.20 and 0.80 and DP greater than 0.20 are selected for the final test. In order to keep the final test in accordance with the blueprint, items 19, 20 and 27 are not considered for the final test.

Finalization of the Test

The test is finalized with 25 items with a duration of 60 minutes. The total score obtained in 25 items denotes the Achievement of students in Gravitation. The final test, its translated version in English, the response sheet and the scoring key are attached as Appendices 53, 54, 55 and 56 respectively.

Reliability and Validity. The test is found reliable by undergoing the procedure of test-retest method. After administering the test to the same students within a time interval of three weeks, the test and retest scores are correlated. The Pearson's correlation coefficient is obtained as 0.86 ($N = 42$).

The test is given to three physics teachers and 12 students studying in IX standard to know whether the items in the test are constructed in the least ambiguous manner. The teachers also conveyed that the content of the test matches with the depth of the concept taught in IX standard and the items in the test are constructed in accordance with the blueprint. Thus, face validity and content validity is established.

The test scores obtained by the students (N = 53) is correlated with their average marks in physics in the first and second terminal examination conducted by the state board to establish criterion validity of the Achievement Test on Gravitation. The correlation coefficient is found to be 0.78, which ensured the required validity.

Sample Selected for the Study

The study is conducted in two phases- Phase-I and Phase-II. The details of sample used for the phases are explained below.

Sample Selected for the Phase-I of the Study

The phase-I aimed at identifying the most difficult concepts in physics at IX standard level and the data is collected both from teachers and students. The unstructured interview is conducted on 30 physics teachers of IX standard. The Conceptual Understanding Test in Physics (in three parallel forms) is administered to 623 students of IX standard selected using stratified sampling technique from 13 schools in Malappuram and Kozhikode districts, giving due regard to gender of the student and type of management of the school. The list of schools from which the sample is drawn in Phase-I of the study is given as Appendix 58. The breakup of the sample in Phase-I of the study is provided in Table 13.

Table 13

The Breakup of the Sample in Phase-I of the Study

Sample	Sample size		
Teachers	**30**		
Students	**623**		
	SET A = 210	Boys = 272	Government = 250
	SET B = 207	Girls = 351	Aided = 243
	SET C = 206		Unaided = 130

Sample Selected for Phase-II of the Study

The objective of the Phase-II of the study is to find out the influence of Instructional Practices in Physics on Interests and Achievement of the students. In Phase-II, two approaches are followed for data analysis, viz., (i) extant Instructional Practices for EOM / GRAV and their influence on Domain Interest in EOM / GRAV and Achievement in EOM / GRAV and (ii) extant Instructional Practices in Physics and their influence on Domain Interest in Physics, Situational Interest in Physics, Individual Interest in Physics and Achievement in Physics. Sample used for the first approach is 913 students of IX standard and that used for the second is 785 students.

The sample is selected using stratified sampling technique from 33 schools of Malappuram, Kozhikode, Thrissur and Palakkad districts, giving due consideration to the gender of the student and type of management of the school. The list of the schools from which the sample is drawn in Phase-II of the study is provided as Appendix 59. The breakup of the sample in Phase-II of the study is given as Table 14.

Table 14

The Breakup of the Sample in Phase-II of the Study

Approaches of data analysis	Sample size			
Extant Instructional Practices **for EOM / GRAV** and their influence on Interests and Achievement **in EOM / GRAV**	**913**			
	Equations of Motion (462)		Gravitation (451)	
	Boys = 209	Government =284	Boys = 205	Government = 278
	Girls = 253	Aided = 178	Girls = 246	Aided = 173
Extant Instructional Practices **in Physics** and their influence on Interests and Achievement **in Physics**	**785**			
	Boys = 348		Government = 514	
	Girls = 437		Aided = 271	

Data Collection Procedure, Scoring and Consolidation of the data

Data Collection Procedure

After conveying the objective and relevance of the study, permission is sought from the school headmasters to approach the students and teachers to gather data from them. After getting permission, the purpose of the study and the importance of the co-operation of the respondents are conveyed by meeting them personally and they are asked to provide reliable and accurate data. Proper instructions are provided initially in accordance with the needs of each tool, which is followed by the distribution of tools. The marked response sheets are gathered back from the respondents afterwards.

Scoring and Consolidation of Data

The marked response sheets are scored and tabulated carefully in Microsoft Excel Sheets in accordance with the scoring procedure of each tool. The incomplete response sheets are discarded.

Data Preparation and Statistical Techniques

The main objective of the study is to find out the extant instructional Practices of physics teachers and their influence on Interests and Achievement in Physics among IX standard students. The study also attempts to substantiate the influence in the case of transaction of major concepts in physics that students perceive to be difficult while learning.

The aim of Phase-I of the study is to find the difficult concepts in physics that IX standard students find difficult to learn. This is determined from the ranking of the concepts by students, ranking based on conceptual understanding of students and ranking of the concepts by teachers. From the ranking provided by the students for the concepts in Section B of Conceptual Understanding Test in Physics, the weighted average is calculated. Percentage analysis of the responses of students in Section C of the test is carried out. The weighted average is calculated for the ranking done by teachers for the physics concepts.

The responses gathered through administration of tools in Phase-II of the study aimed in finding out the extant Instructional Practices of physics teachers and their influence on Interests and Achievement in Physics among IX standard students. To find the extant instructional practices, the responses obtained in the Scale on Instructional Practices in Physics and the Checklist on Instructional Practices for Equations of Motion/Graviation are undergone percentage analysis.

The descriptive analysis (mean, median, mode, standard deviation, skewness, kurtosis) of the scores obtained for the dependent variables, viz., Domain Interest in

Physics, Situational Interest in Physics, Individual Interest in Physics, Domain Interest in Equations of Motion, Domain Interest in Gravitation, Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation are carried out.

For finding the influence of Instructional Practices in Physics on dependent variables, the Test of Significant Difference between the Means for Large Independent Sample is used. Cohen's *d* is used to find the effect size.

Data Preparation

For meeting the objectives of the study, data preparation is done, and its procedure is given below.

Procedure for Ranking of the Major Concepts in Physics

For the purpose of ranking the major concepts in physics at secondary level in the order of difficulty, the investigator decided to rank the concepts using three procedures, as

a) Ranking of the concepts by students

b) Ranking based on conceptual understanding of students

c) Ranking of the concepts by teachers

Ranking of the Concepts by Students. In Section B of Conceptual Understanding Test, the students are asked to rank the major concepts in order of their difficulty to learn. The students ranked the concepts in such a way that rank 1 is given for the toughest concept, rank 2 for the second toughest concept, etc. The 'weighted

score of difficulty' from the ranks provided by the students are calculated for each concept using the formula,

$$\text{Weighted score of difficulty for a concept} = \frac{5(N_1)+4(N_2)+3(N_3)+2(N_4)+1(N_5)}{N_1+N_2+N_3+N_4+N_5}$$

where N_1 = Number of students who gave rank 1 for the concept

N_2 = Number of students who gave rank 2 for the concept

N_3 = Number of students who gave rank 3 for the concept

N_4 = Number of students who gave rank 4 for the concept

N_5 = Number of students who gave rank 5 for the concept

Based on the 'weighted score of difficulty' obtained, the major concepts are again ranked by the investigator in such a way that the concept with highest value of 'weighted score of difficulty' is given rank 1 and the concept with least value of 'weighted score of difficulty' is given rank 5.

Ranking Based on Conceptual Understanding of Students. This ranking is based on the responses of students in Section C of the Conceptual Understanding Test in Physics. Under each concept, the percent of correct responses of the students in the three parallel forms, SET A, SET B and SET C is calculated separately. 'Total percent of correct responses' is then calculated by finding the mean of these values. Based on the 'total percent of correct responses', the major concepts are ranked by the investigator in such a way that the concept with highest value of 'total percent of correct responses' is given rank 5 and the concept with lowest value of 'total percent of correct responses' is given rank 1.

Ranking of the Concepts by Teachers. In the unstructured interview, the teachers are asked to rank the major concepts in the order of their difficulty to learn by students. The teachers ranked the concepts in such a way that rank 1 is given for the toughest concept, rank 2 for the second toughest concept, etc. The 'weighted score of difficulty' from the ranks provided by the teachers are calculated for each concept using the formula,

$$\text{Weighted score of difficulty for a concept} = \frac{5(N_1)+4(N_2)+3(N_3)+2(N_4)+1(N_5)}{N_1+N_2+N_3+N_4+N_5}$$

where N_1 = Number of teachers who gave rank 1 for the concept

N_2 = Number of teachers who gave rank 2 for the concept

N_3 = Number of teachers who gave rank 3 for the concept

N_4 = Number of teachers who gave rank 4 for the concept

N_5 = Number of teachers who gave rank 5 for the concept

Based on the Weighted Scores of Difficulty obtained, the major concepts are ranked by the investigator in such a way that the concept with highest value of Weighted Score of Difficulty is given rank 1 and the concept with least value of Weighted Score of Difficulty is given rank 5.

By undergoing these three procedures, the difficult concepts are identified and taken for further analysis.

Procedure for Finding Extant Instructional Practices of Physics Teachers and Their Influence on Dependent Variables

The extant Instructional Practices of physics teachers at secondary level and their influence on dependent variables is analysed in two different aspects- based on existing Instructional Practices in physics and existing Instructional Practices for difficult concepts in physics. Existing Instructional Practices in physics is analysed based on the responses obtained by the administration of 'Scale on Instructional Practices in Physics' and existing Instructional Practices for difficult concepts in physics is analysed based on the responses obtained by the administration of 'Checklist on Instructional Practices for Equations of Motion / Gravitation'.

Instructional Practices in Physics. For attaining the objective of finding out the extant 'Instructional Practices in Physics', by examining the nature of instruction mentioned in items under each teaching-learning situation of the scale, the items are sorted into categories, which are the 'Types of Instructional Practices' defined by the investigator for the purpose of the study. The 'Types of Instructional Practices' are defined as below.

Teacher Dominant Instruction (TDI): Teacher Dominant Instruction is a highly teacher-directed way of teaching in which the students are supposed to listen or perform based on the decisions made by the teacher. The strategies of this type are highly structured, sequenced and led by teachers, where the students are always considered to have a secondary role in the teaching-learning process. Students are not given a chance to think by themselves and develop an understanding of the concepts

by themselves. Students are, here, considered to be passive listeners. Lecturing, expository teaching, teacher demonstrations and explanations are examples of TDI.

ICT-mediated Instruction (ICTI): The ICT-mediated Instruction is the type of instruction in which teachers employ digital technology and resources. Incorporation of video presentations, PowerPoint slides are some of the examples.

Student Participatory Individual Instruction (SPII): The instruction in which the students participate and make contributions individually within the teaching-learning process is the Student Participatory Individual Instruction. In this process, the students are active learners, and they work individually to construct knowledge or to accomplish the tasks assigned by the teachers. The aim of implementing this strategy is to make students self-reliant learners, who can handle the responsibilities of planning, keeping track and carrying out the learning process by themselves.

Student Participatory Group Instruction (SPGI): The instruction in which the students participate and make contributions in groups within the teaching-learning process is the Student Participatory Group Instruction. Here the students are active learners, and they work in groups to construct knowledge or to accomplish the tasks assigned by the teachers. This involves interaction and exchange of ideas between students. Developing social interaction skills, interpersonal skills, rational thinking skills among the students along with the learning are the important purpose of this strategy. Question-answer techniques, classroom discussion and student team works are some of the examples.

Supervisory Instruction (SI): The instruction in which the teacher acts as a facilitator of the teaching-learning process is known as Supervisory Instruction. The students undergo the task with the supervision of the teacher. The teacher will scaffold the students in achieving their immediate goals. Providing suggestions or feedback on the student's work whenever required comes under this category of instruction.

The above mentioned five types of instructions are common for the teaching-learning situations, viz., 'Introducing New Concepts', 'Performing Experiments or Activities', 'Working-out Mathematical Problems', 'Executing Project Works', 'Facilitating Note-making Process', 'Consolidation of Concepts', and 'Providing Follow-up Activity'. Apart from the five types of instructions, other types of strategies under the teaching-learning situation of 'Conducting Assessment' are Formative Assessment Strategy (FAS), Mastery-oriented Assessment Strategy (MOAS), Question Generation Strategy (QGS) and Facilitated Assessment Strategy (FCAS) and the strategies under 'Examination Preparedness' are Test Previewing Strategy (TPS), Test Reviewing Strategy (TRS) and Differentiated Strategy (DS). These instructions are defined as follows.

Formative Assessment Strategy (FAS): Formative Assessment is conducted during or in between the course of instruction or learning process for the purpose of getting immediate feedback from students regarding their level of understanding. The teachers can enquire whether the students have understood the concepts or need any clarification during the process of instruction. Moreover, questions can be raised by

the teacher in between the instruction to the students and check their understanding of the concept.

Mastery-oriented Assessment Strategy (MOAS): In Mastery-oriented Assessment, the teacher ensures that the students have thoroughly understood what is being transacted, before going to the next concept. The teacher can raise questions to students before beginning new lessons to assess whether the mastery has achieved or not. The level of deep understanding among students can also be ensured by frequently conducting class tests apart from mid-term and terminal examinations.

Question Generation Strategy (QGS): Question generation is the assessment strategy in which the students are asked to frame questions based on the concepts learnt. This works on the notion that, only those who have deep understanding and grasp of the content will be able to frame questions at different levels.

Facilitated Assessment Strategy (FCAS): The assessment strategy in which the teacher supervises, mediates and supports the student group activity like quiz session, which is initiated and conducted by students after they have framed questions on their own based on the learnt concept, is known as Facilitated Assessment Strategy.

ICT-mediated Assessment Strategy (ICTMAS): The assessment strategies implemented by the teacher with the help of computer or mobile applications and software on both synchronous and asynchronous mode, constitutes ICT-mediated Assessment. Teachers can employ tools such as Kahoot, Socrative, Google forms, Quizizz etc., for this purpose.

Test Previewing Strategy (TPS): Test Previewing Strategy is used as a part of preparing the students to perform better in the examinations. By implementing this strategy, the teachers ensure that the students are acquainted with the pattern of questions, by discussing the old question papers prior to the real examination.

Test Reviewing Strategy (TRS): Test Reviewing Strategy is used as a part of reviewing the examination that has already been conducted to students. The answers to the questions asked in the examination can be put into discussion within the classroom. The students can also be asked to answer the question paper after the examination. The questions on the concepts that the majority of students failed in answering correctly for the examination can be retaught by the teacher as a strategy for reviewing tests.

Differentiated Strategy (DS): For enhancing performance, special attention and support to the students based on their capabilities can be provided by the teachers as Differentiated Strategy. The high performers can be provided with extra learning materials and remedial instruction can be arranged for the slow learners.

The details of the items of the scale categorised under each type of instructional practice within each teaching-learning situation is given in Table 15.

Table 15

Details of Items of Scale on Instructional Practices in Physics Under Each Type of Instructional Practice

T-L situations	Instructional Practices	Items of Scale on Instructional Practices in Physics
Introducing New Concepts	Teacher Dominant Instruction	1,2,3,4
	Student Participatory Group Instruction	5
	Student Participatory Individual Instruction	8,9
	ICT- mediated Instruction	6,7
Performing Experiments or Activities	Teacher Dominant Instruction	18
	Student Participatory Individual Instruction	20
	Supervisory Instruction	22
	Student Participatory Group Instruction	19, 21
	ICT- mediated Instruction	17
Working-out Mathematical Problems	Teacher Dominant Instruction	10, 12
	Student Participatory Individual Instruction	14
	Supervisory Instruction	16
	Student Participatory Group Instruction	13, 15
	ICT- mediated Instruction	11
*Transacting Methodical Tactics of Mathematical Problem-solving		70, 71, 72, 73, 74, 75
*Introducing Graph and Working out Related Problems		76, 77, 78, 79, 80, 81, 82, 83
Executing Project Works	Teacher Dominant Instruction	23, 24
	Student Participatory Group Instruction	26
	Student Participatory Individual Instruction	25, 28
	Supervisory Instruction	27, 29, 30
Facilitating Note-making Process	Teacher Dominant Instruction	46, 47
	Supervisory Instruction	50
	Student Participatory Individual Instruction	45, 48
	Student Participatory Group Instruction	49
Miscellaneous Ways of Teaching	Addressing Misconceptions	56
	Using Mnemonics/Concept Mapping	55
	Peer Teaching	54
	Conducting Debate	57
	Team Teaching	58, 59
Conducting Assessment	Formative Assessment	31, 32, 33
	Mastery-oriented Assessment	34, 39
	Facilitated Assessment	37
	Question Generation Strategy	35, 36
	ICT-mediated Assessment	38
Consolidation of Concepts	Teacher Dominant instruction	40
	Student Participatory Individual Instruction	42
	Supervisory Instruction	44
	ICT-mediated Instruction	41
	Student Participatory Group Instruction	43
Providing Follow-up Activity	Student Participatory Individual Instruction	51
	Supervisory Instruction	53
	Student Participatory Group Instruction	52
Enriching Learning Experiences	Directing to take part in Science Club Activities	68
	Suggesting Extra Reference Materials/Web Resources	69
	Directing to Exhibit Works on Public Platforms	67
	Organizing Field Trips	66
Examination Preparedness	Test Previewing Strategy	60
	Test Reviewing Strategy	61, 62, 63
	Differentiated Strategy	64, 65

*Have both the nature of teaching-learning situation and instructional practice

The scores of the items under each type of instruction in each teaching-learning situation are gathered. The weighted average percentage of the scores gives the extent of usage of the instruction.

For example, the extent of usage of Teacher Dominant (TDI) Instruction for 'Introducing New Concepts' is calculated using the formula given below.

$$\text{Weighted Average Percentage of TDI for 'Introducing New Concepts'} = \frac{\sum\left(\frac{\text{Sum of scores obtained by the student for the items under TDI for 'Introducing New Concepts'}}{\text{Number of Items under TDI}}\right)}{\text{Total number of student} \times \text{Maximum mark obtained for an item}} \times 100$$

Similarly, the extent of usage of each instruction is found under each teaching-learning situation and it is interpreted as follows.

Extent of usage	Interpretation
100.00 - 83.33	Very often
83.33 - 66.67	Frequently
66.67 – 50.00	Sometimes
50.00 – 33.33	Occasionally
33.33 – 16.67	Rarely
16.67 – 0.00	Almost never

Procedure for Finding Influence of Instructional Practices in Physics on Dependent Variables: As the next step, depending upon the weighted average score obtained by the student under each type of instruction, the student has to be grouped into two: who had experienced High- and Low-levels of usage of that instruction.

For this, less than cumulative frequency table of the weighted average score obtained under each type of instruction is prepared. The details of cut-off points set for the High- and Low- grouping of the students based on the extent of each type of Instructional Practice is given in Table 16.

Table 16

Cut-off Points for High- and Low- Levels of Usage of the Types of Instructions on 'Scale on Instructional Practices in Physics'

T-L situations	Instructional Practices	High group	Low group
Introducing New Concepts	Teacher Dominant Instruction	≥ 2.25	< 2.25
	Student Participatory Group Instruction	≥ 1.00	< 1.00
	Student Participatory Individual Instruction	≥ 0.50	< 0.50
	ICT- mediated Instruction	≥ 0.50	< 0.50
Performing Experiments or Activities	Teacher Dominant Instruction	≥ 2.00	< 2.00
	Student Participatory Individual Instruction	≥ 1.00	< 1.00
	Supervisory Instruction	≥ 1.00	< 1.00
	Student Participatory Group Instruction	≥ 1.00	< 1.00
	ICT- mediated Instruction	≥ 1.00	< 1.00
Working-out Mathematical Problems	Teacher Dominant Instruction	≥ 2.50	< 2.50
	Student Participatory Individual Instruction	≥ 2.00	< 2.00
	Supervisory Instruction	≥ 2.00	< 2.00
	Student Participatory Group Instruction	≥ 1.00	< 1.00
	ICT- mediated Instruction	≥ 1.00	< 1.00
*Transacting Methodical Tactics of Mathematical Problem-solving		≥ 11.00	< 11.00
*Introducing Graph and Working out Related Problems		≥ 7.00	< 7.00
Facilitating Note-making Process	Teacher Dominant Instruction	≥ 1.50	< 1.50
	Supervisory Instruction	≥ 1.00	< 1.00
	Student Participatory Individual Instruction	≥ 0.50	< 0.50
	Student Participatory Group Instruction	≥ 1.00	< 1.00
Miscellaneous Ways of Teaching	Addressing Misconceptions	≥ 2.00	< 2.00
	Using Mnemonics/Concept Mapping	≥ 2.00	< 2.00
	Peer Teaching	≥ 1.00	< 1.00
	Conducting Debate	≥ 1.00	< 1.00
Conducting Assessment	Formative Assessment	≥ 2.67	< 2.67
	Mastery-oriented Assessment	≥ 2.00	< 2.00
	Facilitated Assessment	≥ 1.00	< 1.00
	Question Generation Strategy	≥ 0.50	< 0.50
	ICT-mediated Assessment	≥ 1.00	< 1.00
Consolidation of Concepts	Teacher Dominant Instruction	≥ 2.00	< 2.00
	Student Participatory Individual Instruction	≥ 1.00	< 1.00
	Supervisory Instruction	≥ 1.00	< 1.00
	ICT-mediated Instruction	≥ 1.00	< 1.00
	Student Participatory Group Instruction	≥ 1.00	< 1.00
Providing Follow-up Activity	Student Participatory Individual Instruction	≥ 2.00	< 2.00
	Supervisory Instruction	≥ 1.00	< 1.00
	Student Participatory Group Instruction	≥ 1.00	< 1.00
Enriching Learning Experiences	Directing to take part in Science Club Activities	≥ 1.00	< 1.00
	Suggesting Extra Reference Materials/Web Resources	≥ 1.00	< 1.00
	Directing to Exhibit Works on Public Platforms	≥ 1.00	< 1.00
	Organizing Field Trips	≥ 1.00	< 1.00
Examination Preparedness	Test Previewing Strategy	≥ 3.00	< 3.00
	Test Reviewing Strategy	≥ 2.30	< 2.30
	Differentiated Strategy	≥ 0.50	< 0.50

*Have both the nature of teaching-learning situation and instructional practice

Instructional Practices for Equations of Motion / Gravitation. Similar to the data preparation procedure for Instructional Practices in Physics, the investigator categorised the items in the Checklist on Instructional Practices for Equations of Motion / Gravitation. The details of the items of the checklist categorised under each type of instructional practice within each teaching-learning situation is given in Table 17.

Table 17

Details of Items of Checklist on Instructional Practices for Equations of Motion / Gravitation Under Each Type of Instructional Practice

T-L situations	Instructional Practices	Items of Checklist on Instructional Practices for EOM / GRAV
Introducing New Concepts	Teacher Dominant Instruction	1, 2, 3, 4
	Student Participatory Group Instruction	5
	Student Participatory Individual Instruction	8, 9
	ICT- mediated Instruction	6, 7
Working-out Mathematical Problems	Teacher Dominant Instruction	10, 12
	Student Participatory Individual Instruction	14
	Supervisory Instruction	16
	Student Participatory Group Instruction	13, 15
	ICT- mediated Instruction	11
*Transacting Methodical Tactics of Mathematical Problem-solving		60, 61, 62, 63, 64, 65
*Introducing Graph and Working out Related Problems		66, 67, 68, 69, 70, 71, 72, 73
Executing Project Works	Teacher Dominant Instruction	17, 18
	Student Participatory Group Instruction	20
	Student Participatory Individual Instruction	19, 22
	Supervisory Instruction	21, 23, 24
Facilitating Note-making Process	Teacher Dominant Instruction	40, 41
	Supervisory Instruction	44
	Student Participatory Individual Instruction	39, 42
	Student Participatory Group Instruction	43
Miscellaneous Ways of Teaching	Addressing Misconceptions	50
	Using Mnemonics/Concept Mapping	49
	Peer Teaching	48
	Team Teaching	51, 52
Conducting Assessment	Formative Assessment	25, 26, 27
	Mastery-oriented Assessment	28, 33
	Facilitated Assessment	31
	Question Generation Strategy	29, 30
	ICT-mediated Assessment	32
Consolidation of Concepts	Teacher Dominant instruction	34
	Student Participatory Individual Instruction	36
	Supervisory Instruction	38
	ICT-mediated Instruction	35
	Student Participatory Group Instruction	37
Providing Follow-up Activity	Student Participatory Individual Instruction	45
	Supervisory Instruction	47
	Student Participatory Group Instruction	46
Enriching Learning Experiences	Suggesting Extra Reference Materials/Web Resources	59
Examination Preparedness	Test Previewing Strategy	53
	Test Reviewing Strategy	54, 55, 56
	Differentiated Strategy	57, 58

*Have both the nature of teaching-learning situation and instructional practice

The scores of the items under each type of instruction in each teaching-learning situation are gathered. The weighted average percentage of the scores gives the extent of usage of the instruction.

For example, the extent of usage of Teacher Dominant (TDI) Instruction for 'Introducing New Concepts' in Equations of Motion / Gravitation is calculated using the formula given below.

$$Weighted\ Average\ Percentage\ of\ TDI\ for\ 'Introducing New\ Concepts'$$
$$= \frac{\Sigma\left(\frac{Sum\ of\ scores\ obtained\ by\ the\ student\ for\ the\ items\ under\ TDI\ for\ 'Introducing New\ Concepts'}{Number\ of\ items\ under\ TDI}\right)}{Total\ number\ of\ students\ \times Maximum\ mark\ obtainable\ for\ an\ item} \times 100$$

Similarly, the extent of usage of each instruction is found under each teaching-learning situation and it is interpreted as follows.

Extent of usage	Interpretation
100.00 - 83.33	Very often
83.33 - 66.67	Frequently
66.67 – 50.00	Sometimes
50.00 – 33.33	Occasionally
33.33 – 16.67	Rarely
16.67 – 0.00	Almost never

Procedure for Finding Influence of Instructional Practices for Equations of Motion / Gravitation on Dependent Variables: The same procedure as in the case of Instructional Practices in Physics is followed. The details of cut-off points set for the High- and Low- grouping of the students based on the extent of each type of Instructional Practice for Equation of Motion / Gravitation is given in Table 18.

Table 18

Cut-off Points for High- and Low- Levels of Usage of the Types of Instruction on 'Checklist on Instructional Practices for Equations of Motion / Gravitation'

T-L situations	Instructional Practices	Concepts	High group	Low group
Introducing New Concepts	Teacher Dominant Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Student Participatory Group Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Student Participatory Individual Instruction	EOM & GRAV	≥ 0.50	< 0.50
	ICT- mediated Instruction	EOM & GRAV	≥ 0.50	< 0.50
Working-out Mathematical Problems	Teacher Dominant Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Student Participatory Individual Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Supervisory Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Student Participatory Group Instruction	EOM & GRAV	≥ 0.50	< 0.50
	ICT- mediated Instruction	EOM & GRAV	≥ 1.00	< 1.00
*Transacting Methodical Tactics of Mathematical Problem-solving		EOM & GRAV	≥ 5.00	< 5.00
*Introducing Graph and Working out Related Problems		EOM	≥ 7.00	< 7.00
Executing Project Works	Teacher Dominant Instruction	EOM & GRAV		-
	Student Participatory Group Instruction	EOM & GRAV		-
	Student Participatory Individual Instruction	EOM & GRAV		-
	Supervisory Instruction	EOM & GRAV		-
Facilitating Note-making Process	Teacher Dominant Instruction	EOM & GRAV	≥ 0.50	< 0.50
	Supervisory Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Student Participatory Individual Instruction	EOM & GRAV	≥ 0.50	< 0.50
	Student Participatory Group Instruction	EOM & GRAV	≥ 1.00	< 1.00
Miscellaneous Ways of Teaching	Addressing Misconceptions	EOM & GRAV	≥ 1.00	< 1.00
	Using Mnemonics/Concept Mapping	EOM & GRAV	≥ 1.00	< 1.00
	Peer Teaching	EOM & GRAV	≥ 1.00	< 1.00
	Team Teaching	EOM & GRAV		-
Conducting Assessment	Formative Assessment	EOM & GRAV	≥ 1.00	< 1.00
	Mastery-oriented Assessment	EOM & GRAV	≥ 1.00	< 1.00
	Facilitated Assessment	EOM	≥ 0.70	< 0.70
		GRAV	≥ 1.00	< 1.00
	Question Generation Strategy	EOM	≥ 0.50	< 0.50
		GRAV	≥ 0.10	< 0.10
	ICT-mediated Assessment	EOM & GRAV	≥ 1.00	< 1.00
Consolidation of Concepts	Teacher Dominant Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Student Participatory Individual Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Supervisory Instruction	EOM & GRAV	≥ 1.00	< 1.00
	ICT-mediated Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Student Participatory Group Instruction	EOM & GRAV	≥ 1.00	< 1.00
Providing Follow-up Activity	Student Participatory Individual Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Supervisory Instruction	EOM & GRAV	≥ 1.00	< 1.00
	Student Participatory Group Instruction	EOM & GRAV	≥ 1.00	< 1.00
Enriching Learning Experiences	Suggesting Extra Reference Materials/Web Resources	EOM & GRAV	≥ 1.00	< 1.00
Examination Preparedness	Test Previewing Strategy	EOM & GRAV	≥ 1.00	< 1.00
	Test Reviewing Strategy	EOM & GRAV	≥ 1.00	< 1.00
	Differentiated Strategy	EOM & GRAV	≥ 0.50	< 0.50

*Have both the nature of teaching-learning situation and instructional practice

Procedure for Finding Domain Interest in Equations of Motion

Domain Interest in Equations of Motion is obtained by adding the scores obtained for the items numbered 8, 9, 10, 11, 12 and 13 of the Domain Interest Scale in Physics.

Procedure for Finding Domain Interest in Gravitation

Domain Interest in Gravitation is obtained by adding the scores obtained for the items numbered 24, 25, 26, 27 and 28 of the Domain Interest Scale in Physics.

Statistical Techniques Used for Analysis of Data

Percentage Analysis

Percentage analysis is used to find the extant

- Instructional Practices in Physics,
- Instructional Practices for Equations of Motion and
- Instructional Practices for Gravitation of physics teachers at secondary level.

Test of Significance of Difference between the Means for Large Independent Samples

Test of Significance of Difference between the Means for Large Independent Samples is used to find the influence of

- Instructional Practices on Domain Interest in Physics,
- Instructional Practices on Situational Interest in Physics,
- Instructional Practices on Individual Interest in Physics,

- Instructional Practices on Domain Interest in Equations of Motion and
- Instructional Practices on Domain Interest in Gravitation among secondary school students.

The critical ratio *t* is calculated using the formula (Best & Kahn, 2006),

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$

where,

$\overline{X}_1 =$ Mean score of dependent variable for the high group

$\overline{X}_2 =$ Mean score of dependent variable for the low group

$S_1^2 =$ Variance of the distribution of responses of the high group for the dependent variable

$S_2^2 =$ Variance of the distribution of responses of the low group for the dependent variable

$N_1 =$ Number of subjects in the high group

$N_2 =$ Number of subjects in the low group

Effect Size (Cohen's d)

Cohen's *d* is calculated to determine how much is the effect of

- Instructional Practices on Domain Interest in Physics,
- Instructional Practices on Situational Interest in Physics,
- Instructional Practices on Individual Interest in Physics,

- Instructional Practices on Domain Interest in Equations of Motion and
- Instructional Practices on Domain Interest in Gravitation among secondary school students.

Cohen's *d* is calculated using the formula (Cohen, 1965),

$$d = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2 + S_2^2}{2}}}$$

where,

$\overline{X}_1$ = Mean score for the upper group

$\overline{X}_2$ = Mean score for the lower group

S_1 = Standard deviation of the upper group

S_2 = Standard deviation of the lower group

The effect varies according to the varying indices of Cohen's *d*. The indices are as follows.

$0.00 \leq d \leq 0.20$	Negligible Effect	
$0.20 \leq d \leq 0.50$	Small Effect	
$0.50 \leq d \leq 0.80$	Medium Effect	
0.80 or more	Large Effect	(Gaciu, 2021)

Chapter Four

ANALYSIS AND INTERPRETATION

- Preliminary Analysis
- Difficulty in Major Concepts in Physics at Secondary Level
- Instructional Practices of Teachers in Physics at Secondary Level
- Influence of Instructional Practices on Interests in Physics Among Secondary School Students
- Influence of Instructional Practices on Achievement in Physics Among Secondary School Students
- Tenability of Hypotheses

Analysis holds a crucial role in the process of research as it helps in converting data to provide meaningful insights to the problem under investigation. Identification of relationships, trends, differences and patterns in the data collected, confirming and refuting hypotheses, catalyzing the process of reaching evidence-based conclusion which are reliable and valid and, finally, providing interpretations that cater to further actions and policy decisions sum up the function of analysis and interpretation.

This study is meant to analyse the existing Instructional Practices of physics teachers at secondary level and to find out their influence on Interests and Achievement in Physics among secondary school students. Analysis of this study is based on the following hypotheses.

1. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in Physics among secondary school students.
2. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in difficult concepts in physics among secondary school students.
3. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Situational Interest in Physics among secondary school students.

4. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Individual Interest in Physics among secondary school students.
5. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in Physics among secondary school students.
6. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in difficult concepts in physics among secondary school students.

The statistical analysis to check the tenability of hypotheses of the study is explained under the following headings.

- Preliminary analysis
- Difficulty in major concepts in physics at secondary level
- Instructional Practices of teachers in physics at secondary level
- Influence of Instructional Practices on Interests in Physics among secondary school students
- Influence of Instructional Practices on Achievement in Physics of secondary school students
- Tenability of hypotheses

Each of the above-mentioned sections are described below in detail.

Preliminary Analysis

The initial step in the analysis process is to understand the nature of data collected and scored. So, the descriptive statistics (mean, median, mode, standard deviation, skewness, kurtosis) of the dependent variables of the study, viz., Interests in Physics (Domain Interest in Physics, Domain Interest in Equations of Motion, Domain Interest in Gravitation, Situational Interest in Physics, Individual Interest in Physics) and Achievement in Physics (Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation) is calculated and given in Table 19.

Table 19

Statistical Constants for the Distribution of Scores of Dependent Variables

Variables	*N*	Mean	Median	Mode	*SD*	Skewness	Kurtosis	*z* value of skewness	*z* value of kurtosis
Domain Interest in Physics	785	39.89	40.00	38.00	10.91	-0.16	0.11	-1.85	0.63
Domain Interest in Equations of Motion	462	6.95	7.00	9.00	2.79	-0.16	-0.55	-1.40	-2.41
Domain Interest in Gravitation	451	5.62	6.00	5.00	2.36	-0.11	-0.57	-0.93	-2.47
Situational Interest in Physics	785	26.37	27.00	25.00	6.91	-0.40	0.39	-4.63	2.22
Individual Interest in Physics	785	43.23	43.00	38.00	13.58	0.02	-0.45	0.21	-2.56
Achievement in Physics	785	16.07	14.00	12.00	8.56	0.57	-0.30	6.55	-1.71
Achievement in Equations of Motion	462	8.92	9.00	6.00	3.38	0.44	0.33	3.83	1.45
Achievement in Gravitation	451	8.82	8.00	7.00	3.70	0.79	1.16	6.90	5.08

The values of mean, median, mode, standard deviation, skewness, kurtosis, *z* value of skewness and *z* value of kurtosis in Table 19 show that the distributions of Domain Interest in Physics, Domain Interest in Equations of Motion, Domain Interest in Gravitation. Situational Interest in Physics, Individual Interest in Physics, Achievement in Physics, Achievement in Equations of Motion and Achievement in

Gravitation is not significantly deviated from normality. The *P-P* plots of the dependent variables are attached as Appendix 60.

Difficulty in Major Concepts in Physics at Secondary Level

The ranking of major concepts in IX standard physics, viz., Forces in Fluids, Equations of Motion, Motion and Laws of Motion, Gravitation and Work, Energy, Power, based on difficulty in learning, is done after undergoing three procedures as

a) Ranking by students

b) Ranking based on conceptual understanding of students

c) Ranking by teachers

Each one of the above is explained in detail.

Ranking by Students

Based on the responses given by students in Conceptual Understanding Test (Section B), the weighted score of difficulty of the ranks is calculated for each concept. Based on this weighted score of difficulty, the concepts are listed in Table 20.

Table 20

Weighted Score of Difficulty of Major Concepts in Physics Based on Student Ranking

No.	Major concepts	Weighted score of difficulty	Rank
1.	Forces in Fluids	2.10	5
2.	Equations in Motion	3.41	1
3.	Motion and Laws of Motion	3.32	3
4.	Gravitation	3.40	2
5.	Work, Energy, Power	2.76	4

Table 20 reveals that the concepts in the order of seriousness of difficulty (in the perception of students) are Equations of Motion followed by Gravitation, Motion and Laws of Motion, Work, Energy, Power and finally, Forces in Fluids.

Ranking Based on Conceptual Understanding of Students

This ranking is based on the responses of students in the Conceptual Understanding Test (Section C). Under each concept, the percent of correct responses of the students in parallel forms, SET A, SET B and SET C are calculated separately and then the average percent of correct responses is found. The concepts are ranked based on the average percent of correct responses. The ranking of concepts based on the seriousness of difficulty is given in Table 21.

Table 21

Ranking of Major Concepts in Physics Based on Seriousness of Difficulty

Major concepts	Item no.	Percent of correct responses				Rank
		SET A	SET B	SET C	Average	
Forces in Fluids	1-5	43.90	47.34	36.89	42.71	5
Equations of Motion	6-10	29.52	45.31	24.85	33.23	2
Motion and Laws of Motion	11-15	41.43	33.43	35.05	36.64	4
Gravitation	16-20	34.29	37.39	35.53	35.74	3
Work, Energy, Power	21-25	22.00	29.18	28.93	26.70	1

In Table 21, the results of Conceptual Understanding Test in Physics reveal that the toughest concept for the students to learn is Work, Energy, Power, followed by Equations of Motion, Gravitation, Motion and Laws of Motion and finally, Forces in Fluids, which is the easiest.

Ranking by Teachers

Based on the responses given by teachers in the unstructured interview, the weighted score of difficulty of the ranks is calculated for each concept. Based on this weighted score of difficulty, the concepts are listed in Table 22.

Table 22

Weighted Score of Difficulty of Major Concepts in Physics Based on Teacher Ranking

No.	Major concepts	Weighted score of difficulty	Rank
1.	Forces in Fluids	2.47	4
2.	Equations of Motion	4.07	1
3.	Motion and Laws of Motion	3.60	2
4.	Gravitation	3.13	3
5.	Work, Energy, Power	1.73	5

Table 22 reveals that the concepts in the order of seriousness of difficulty (as perceived by teachers) are Equations of Motion followed by Motion and Laws of Motion, Gravitation, Forces in Fluids and finally, Work, Energy, Power.

Discussion of Results

The cross examination of the ranks obtained through the three procedures gives the consolidated ranking of major concepts in physics in the order of difficulty to learn, which is provided in Table 23.

Table 23

Consolidated Ranking of Major Concepts in Physics Based on Seriousness of Difficulty

Major concepts	Ranking by students	Ranking based on conceptual understanding	Ranking by teachers	Consolidated ranking
Forces in Fluids	5	5	4	5
Equations of Motion	1	2	1	1
Motion and Laws of Motion	3	4	2	3
Gravitation	2	3	3	2
Work, Energy, Power	4	1	5	4

Consolidating the ranking done by students, the scores obtained by students in the test and the ranking done by teachers, it is found that the highest ranking of difficulty for IX standard students is for the major concept, Equations of Motion, which is followed by Gravitation, Motion and Laws of Motion, Work, Energy, Power and finally the easiest, Forces in Fluids. For fulfilling the further objectives of the study, the two most difficult concepts, viz., Equations of Motion and Gravitation, are taken into consideration.

Instructional Practices of Teachers in Physics at Secondary Level

The 13 identified teaching-learning situations (explained under development of 'Scale on Instructional Practices in Physics') are 'Introducing New Concepts', 'Performing Experiments or Activities', 'Working out Mathematical Problems', 'Transacting Methodical Tactics of Mathematical Problem-solving', 'Introducing Graph and Related Problems', 'Executing Project Works', 'Facilitating Note-making Process', 'Miscellaneous Ways of Teaching', 'Conducting Formative Assessment', 'Consolidation of Concepts', 'Providing Follow-up Activity', 'Enriching Learning Experiences' and 'Examination Preparedness'. Under each situation, the 'Weighted Average Percentage Score of Usage' of various types of Instructional Practices in Physics as reported by the students (N = 785) and in the two select difficult concepts, viz., Equations of Motion (EOM) (N = 462) and Gravitation (GRAV) (N = 451) are arranged in the order of extent of usage in Table 24.

Table 24

Extant Instructional Practices Within Various Teaching-Learning Situations in Physics and in Select Difficult Concepts at Secondary Level

T-L situations	Instructional Practices	Extent of usage (%)		
		in Physics	in EOM	in GRAV
Introducing New Concepts	Teacher Dominant Instruction	73.22	77.62	77.38
	Student Participatory Group Instruction	32.23	34.20	31.71
	Student Participatory Individual Instruction	21.95	23.59	25.28
	ICT- mediated Instruction	15.24	17.42	15.41
Performing Experiments or Activities	Teacher Dominant Instruction	45.14	-	-
	Student Participatory Individual Instruction	30.57	-	-
	Supervisory Instruction	27.30	-	-
	Student Participatory Group Instruction	23.61	-	-
	ICT- mediated Instruction	14.86	-	-
Working-out Mathematical Problems	Teacher Dominant Instruction	74.37	79.55	76.50
	Student Participatory Individual Instruction	59.19	65.80	65.85
	Supervisory Instruction	47.26	54.33	52.77
	Student Participatory Group Instruction	26.58	33.12	28.71
	ICT- mediated Instruction	13.97	13.85	12.64
*Transacting Methodical Tactics of Mathematical Problem-solving		55.73	61.36	62.60
*Introducing Graph and Working out Related Problems		78.40	78.82	-
Executing Project Works	Teacher Dominant Instruction	0.00	0.00	0.00
	Student Participatory Group Instruction	0.00	0.00	0.00
	Student Participatory Individual Instruction	0.00	0.00	0.00
	Supervisory Instruction	0.00	0.00	0.00
Facilitating Note-making Process	Teacher Dominant Instruction	38.92	44.26	42.57
	Supervisory Instruction	35.33	38.96	38.58
	Student Participatory Individual Instruction	20.47	26.84	23.17
	Student Participatory Group Instruction	4.46	5.84	3.55
Miscellaneous Ways of Teaching	Addressing Misconceptions	58.77	67.75	70.95
	Using Mnemonics/Concept Mapping	51.55	61.04	64.08
	Peer Teaching	9.85	11.47	9.09
	Conducting Debate	9.34	-	-
	Team Teaching	0.00	0.00	0.00
Conducting Assessment	Formative Assessment	78.36	83.98	85.51
	Mastery-oriented Assessment	58.87	65.15	64.86
	Facilitated Assessment	8.54	9.96	7.10
	Question Generation Strategy	7.30	8.44	7.76
	ICT-mediated Assessment	4.42	6.28	3.55
Consolidation of Concepts	Teacher Dominant Instruction	51.51	77.92	78.49
	Student Participatory Individual Instruction	23.44	26.41	26.83
	Supervisory Instruction	16.01	19.05	18.40
	ICT-mediated Instruction	11.89	11.47	13.30
	Student Participatory Group Instruction	5.65	8.87	5.54
Providing Follow-up Activity	Student Participatory Individual Instruction	51.51	62.99	62.97
	Supervisory Instruction	32.87	39.18	37.25
	Student Participatory Group Instruction	10.66	16.45	9.09
Enriching Learning Experiences	Directing to take part in Science Club Activities	36.31	-	-
	Suggesting Extra Reference Materials/Web Resources	19.24	24.00	20.40
	Directing to Exhibit Works on Public Platforms	8.28	-	-
	Organizing Field Trips	4.50	-	-
Examination Preparedness	Test Previewing Strategy	71.34	72.94	75.39
	Test Reviewing Strategy	68.24	72.51	67.85
	Differentiated Strategy	18.34	19.37	20.62

*Have both the nature of teaching-learning situation and instructional practice

Table 24 shows that for 'Introducing New Concepts' in Physics, in EOM and in GRAV at secondary level, Teacher Dominant Instruction is used frequently, Student Participatory Group Instruction is employed either occasionally or rarely, Student Participatory Individual Instruction is practiced rarely and ICT-mediated Instruction is used either rarely or almost never.

While 'Performing Experiments or Activities' in Physics, Teacher Dominant Instruction is employed either occasionally or sometimes, Student Participatory Individual Instruction, Student Participatory Group Instruction and Supervisory Instruction are used rarely and ICT-mediated Instruction is used almost never.

For 'Working out Mathematical Problems', in Physics, in EOM and in GRAV, Teacher Dominant Instruction is employed frequently, Student Participatory Individual Instruction is used sometimes, Supervisory Instruction is used either sometimes or occasionally, Student Participatory Group Instruction is employed rarely and ICT-mediated Instruction is practiced almost never.

While teaching Physics, EOM and GRAV, 'Transacting Methodical Tactics of Mathematical Problem-solving' is practiced sometimes. 'Introducing Graph and Working out Related Problems' are practiced frequently while teaching Physics and EOM.

'Executing Project Works' in Physics, in EOM and in GRAV is never practiced by any teachers.

For 'Facilitating Note-making Process' in Physics, in EOM and in GRAV, Teacher Dominant Instruction and Supervisory Instruction are used occasionally,

Student Participatory Individual Instruction is employed rarely and Student Participatory Group Instruction is practiced almost never.

Under 'Miscellaneous Ways of Teaching' in Physics, in EOM and in GRAV, the instructional strategy of 'Addressing Misconceptions' is done either frequently or sometimes, 'Using Mnemonics/ Concept Mapping' is done sometimes, 'Peer Teaching' and 'Conducting Debate' is performed almost never and 'Team Teaching' is never employed.

While 'Conducting Assessment' in Physics, in EOM and in GRAV, Formative Assessment is used very often or frequently, Mastery-oriented Assessment is practiced sometimes, Facilitated Assessment, Question Generation Strategy and ICT-mediated Assessment are employed almost never by teachers.

For 'Consolidation of Concepts' in Physics, Teacher Dominant Instruction is practiced sometimes. While in EOM and in GRAV, it is used frequently. For 'Consolidation of Concepts' in Physics, in EOM and in GRAV, Student Participatory Individual Instruction is used rarely, Supervisory Instruction is employed either rarely or almost never, ICT-mediated Instruction and Student Participatory Group Instruction are practiced almost never.

While 'Providing Follow-up Activity' in Physics, in EOM and in GRAV, Student Participatory Individual Instruction is used sometimes, Supervisory Instruction is employed either occasionally or rarely and Student Participatory Group Instruction is practiced almost never.

For ‘Enriching Learning Experiences’, ‘Suggesting Extra Reference Materials/Web Resources’ in Physics, in EOM and in GRAV is done rarely, ‘Directing to take part in Science Club Activities’ is done occasionally, ‘Directing to Exhibit Works on Public Platforms’ and ‘Organizing Field Trips’ are performed almost never.

For performing ‘Examination Preparedness’ in Physics, in EOM and in GRAV, both Test Previewing Strategy and Test Reviewing Strategy are employed frequently and Differentiated Strategy is used rarely.

Discussion of Results

In secondary school physics teaching, irrespective of the difficulty level of the concepts the same pattern of instructions is practiced by teachers within each of the eight identified teaching-learning situations of physics, viz., ‘Introducing New Concepts’, ‘Working out Mathematical Problems’, ‘Transacting Methodical Tactics of Mathematical Problem-solving’, ‘Introducing Graph and Related Problems’, ‘Facilitating Note-making Process’, ‘Miscellaneous Ways of Teaching’, ‘Conducting Formative Assessment’, ‘Consolidation of Concepts’, ‘Providing Follow-up Activity’ and ‘Examination Preparedness’.

At secondary level, physics teachers put more emphasis on teaching-learning situations namely, ‘Introducing New Concepts’, ‘Working out Mathematical Problems’, ‘Introducing Graph and Working out Related Problems’, ‘Conducting Assessment’ and ‘Examination Preparedness’. Moderate emphasis of teaching is observed in ‘Addressing Misconceptions’, ‘Performing Experiments or Activities’, ‘Transacting Methodical Tactics of Mathematical Problem-solving’, ‘Using Mnemonics/Concept Mapping’, ‘Consolidation of Concepts’ and ‘Providing Follow-

up Activity'. Less emphasis is observed in, 'Enriching Learning Experiences' and 'Facilitating Note-making Process'.

Formative Assessment is carried out either very often or frequently. Teacher Dominant Instruction is frequently used for 'Introducing New Concepts', 'Working out Mathematical Problems' and 'Consolidation of Concepts'. Test Previewing and Reviewing Strategies and 'Introducing Graph and Working out Related Problems' are also frequently practiced by physics teachers.

Student Participatory Individual Instruction is either sometimes or rarely used and Student Participatory Group Instruction is either rarely or almost never used. The ICT-mediated Instruction is almost never used in secondary physics classrooms. For 'Conducting Assessment', strategies such as Facilitated Assessment and Question Generation Strategy are never used. Other strategies that teacher almost never use are Peer Teaching, Conducting Debate, Directing to Exhibit Works on Public Platforms and Organizing Field Trips. The strategies namely, 'Executing Project Works' and 'Team Teaching' are not even attempted by the physics teachers at secondary level.

Influence of Instructional Practices on Interests in Physics Among Secondary School Students

The influence of extant Instructional Practices, within 12 identified teaching-learning situations, on secondary school students' Interests in Physics are analysed separately and explained as follows.

Influence of Instructional Practices for 'Introducing New Concepts' on Student Interests in Physics

'Does the Instructional Practices for 'Introducing New Concepts' influence student Interests in Physics at secondary level?' is investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Domain Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in Physics, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Interests in Physics of secondary school students by the levels of usage of each of the four Instructional Practices for 'Introducing New Concepts' are given in Table 25.

Table 25

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Introducing New Concepts'

Interests	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Teacher Dominant Instruction		463	41.33	10.52	322	37.83	11.14	4.47**	0.32
	Student Participatory Group Instruction		428	40.46	10.93	357	39.22	10.87	1.58	-
	Student Participatory Individual Instruction		435	39.13	10.82	350	40.84	10.96	2.19*	0.16
	ICT- mediated Instruction		332	39.60	10.24	453	40.11	11.38	0.66	-
Domain Interest in difficult concepts	Teacher Dominant Instruction	EOM	218	7.11	2.80	244	6.81	2.78	1.15	-
		GRAV	216	5.85	2.29	235	5.41	2.42	1.98*	0.19
	Student Participatory Group Instruction	EOM	158	6.67	2.76	304	7.10	2.80	1.57	-
		GRAV	143	5.68	2.29	308	5.60	2.40	0.34	-
	Student Participatory Individual Instruction	EOM	177	6.89	2.90	285	6.99	2.72	0.36	-
		GRAV	183	5.44	2.31	268	5.75	2.40	1.34	-
	ICT- mediated Instruction	EOM	128	7.12	2.82	334	6.89	2.78	0.79	-
		GRAV	111	5.20	2.30	340	5.76	2.37	2.19*	0.24
Situational Interest in Physics	Teacher Dominant Instruction		463	27.01	6.80	322	25.46	6.97	3.10**	0.23
	Student Participatory Group Instruction		428	26.59	6.93	357	26.12	6.89	0.95	-
	Student Participatory Individual Instruction		435	26.06	7.02	350	26.76	6.76	1.40	-
	ICT- mediated Instruction		332	26.97	6.65	453	25.94	7.07	2.08*	0.15
Individual Interest in Physics	Teacher Dominant Instruction		463	45.24	13.04	322	40.35	13.83	5.03**	0.36
	Student Participatory Group Instruction		428	43.34	13.70	357	43.10	13.42	0.25	-
	Student Participatory Individual Instruction		435	43.87	13.49	350	42.44	13.65	1.47	-
	ICT- mediated Instruction		332	44.37	13.48	453	42.40	13.60	2.01*	0.15

**$p \leq .01$, *$p \leq .05$

Table 25 shows that the mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' is significantly higher than that of those who had low Teacher Dominant Instruction at .01 level (d = 0.32). The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' is significantly less than that of those who had low Student Participatory Individual Instruction at .05 level (d = 0.16). The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' is significantly higher than that of those who had low Teacher Dominant Instruction at .05 level (d = 0.19).

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Domain Interest

in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory individual Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' is significantly less than that of those who had low ICT-mediated Instruction at .05 level ($d = 0.24$).

The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' is significantly higher than that of those who had low Teacher Dominant Instruction at .01 level ($d = 0.23$). The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Introducing

New Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high ICT- mediated Instruction for 'Introducing New Concepts' is significantly higher than that of those who had low ICT- mediated Instruction at .05 level ($d = 0.15$).

The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' is significantly higher than that of those who had low Teacher Dominant Instruction at .01 level ($d = 0.36$). The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high ICT- mediated Instruction for 'Introducing New Concepts' is significantly higher than that of those who had low ICT- mediated Instruction at .05 level ($d = 0.15$).

Discussion of Results

While 'Introducing New Concepts', the secondary school students who had high Teacher Dominant Instruction has significantly higher interests in physics, viz., Domain Interest in Physics (small effect), Domain Interest in difficult concept in physics (GRAV) (negligible effect), Situational Interest in Physics (small effect) and Individual Interest in Physics (small effect). The students who had high ICT-mediated Instruction have significantly high Situational Interest (negligible effect) and Individual Interest in Physics (negligible effect). However, the students who had high ICT-mediated Instruction has significantly less Domain Interest in Gravitation (small effect), a difficult concept in physics. The students who had high Student Participatory Individual Instruction has significantly less Domain Interest in Physics (negligible effect). Student Participatory Group Instruction has no significant influence on Interests in Physics among students.

Influence of Instructional Practices for 'Performing Experiments and Activities' on Student Interests in Physics

'Does the Instructional Practices for 'Performing experiments and activities' influence student Interests in Physics at secondary level?' was investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Situational Interest in Physics and iii) Individual Interest in Physics, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the means scores of Interests in Physics by the levels of each of the five Instructional Practices for 'Performing experiments and activities' are given in Table 26.

Table 26

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Performing Experiments and Activities'

Interests	Instructional Practices	High			Low			*t*	Cohen's *d*
		N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Teacher Dominant Instruction	361	40.74	10.93	424	39.17	10.85	2.00*	0.14
	Student Participatory Individual Instruction	375	41.58	10.15	410	38.35	11.35	4.20**	0.30
	Student Participatory Group Instruction	338	39.87	10.79	447	39.91	11.01	0.05	-
	Supervisory Instruction	341	40.99	9.99	444	39.05	11.51	2.51*	0.18
	ICT- mediated Instruction	217	39.48	10.46	568	40.05	11.08	0.66	-
Situational Interest in Physics	Teacher Dominant Instruction	361	26.65	7.27	424	26.14	6.59	1.02	-
	Student Participatory Individual Instruction	375	26.98	6.74	410	25.82	7.02	2.37*	0.17
	Student Participatory Group Instruction	338	26.28	7.18	447	26.45	6.71	0.33	-
	Supervisory Instruction	341	26.83	7.12	444	26.02	6.73	1.62	-
	ICT- mediated Instruction	217	26.08	6.57	568	26.49	7.04	0.74	-
Individual Interest in Physics	Teacher Dominant Instruction	361	43.56	13.94	424	42.96	13.27	0.62	-
	Student Participatory Individual Instruction	375	45.62	13.61	410	41.05	13.19	4.78**	0.34
	Student Participatory Group Instruction	338	43.25	13.60	447	43.22	13.57	0.02	-
	Supervisory Instruction	341	45.54	13.23	444	41.46	13.59	4.22**	0.30
	ICT- mediated Instruction	217	44.55	13.43	568	42.73	13.61	1.69	-

**$p \leq .01$, *$p \leq .05$

Table 26 shows that the mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Performing Experiments and Activities' is significantly higher than that of those who had low Teacher Dominant Instruction at .05 level (d = 0.14). The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Performing Experiments and Activities' is significantly higher than that of those who had low Student Participatory Individual Instruction at .01 level (d = 0.30). The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had

low Student Participatory Group Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Performing Experiments and Activities' is significantly higher than that of those who had low Supervisory Instruction at .05 level (d = 0.18). The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level.

The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Performing Experiments and Activities' is significantly higher than that of those who had low Student Participatory Individual Instruction at .05 level (d = 0.17). The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high ICT-

mediated Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level.

The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Performing Experiments and Activities' is significantly higher than that of those who had low Student Participatory Individual Instruction at .01 level (d = 0.34). The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Performing Experiments and Activities' is significantly higher than that of those who had low Supervisory Instruction at .01 level (d = 0.30). The mean score of Individual Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level.

Discussion of Results

While 'Performing Experiments and Activities', the secondary school students who had high Student Participatory Individual Instruction has significantly higher interests in physics, viz., Domain Interest in Physics (small effect), Situational Interest in Physics (negligible effect) and Individual Interest in Physics (small effect). The students who had high Supervisory Instruction have significantly higher Domain Interest (negligible effect) and Individual Interest in Physics (small effect). The students who had high Teacher Dominant Instruction have significantly higher Domain Interest in Physics (negligible effect). Student Participatory Group Instruction and ICT-mediated Instruction has no significant influence on Interests in Physics among students.

Influence of Instructional Practices for 'Working-out Mathematical Problems' on Student Interests in Physics

'Does the Instructional Practices for 'Working-out Mathematical Problems' influence student Interests in Physics at secondary level?' was investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in Physics between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Interests in Physics of secondary school students by the levels of usage of each of the five Instructional Practices for 'Working-out Mathematical Problems' are given in Table 27.

Table 27

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Working-out Mathematical Problems'

Interests	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Teacher Dominant Instruction		436	41.05	10.59	349	38.44	11.14	3.35**	0.24
	Student Participatory Individual Instruction		488	39.85	11.20	297	39.96	10.44	0.14	-
	Supervisory Instruction		390	40.73	10.43	395	39.07	11.32	2.13*	0.15
	Student Participatory Group Instruction		376	39.67	10.87	409	40.10	10.95	0.56	-
	ICT- mediated Instruction		188	38.84	10.00	597	40.23	11.17	1.62	-
Domain Interest in difficult concepts	Teacher Dominant Instruction	EOM	293	7.21	2.79	169	6.51	2.74	2.61**	0.25
		GRAV	267	5.81	2.29	184	5.36	2.45	1.98*	0.19
	Student Participatory Individual Instruction	EOM	304	7.02	2.80	158	6.83	2.78	0.68	-
		GRAV	297	5.77	2.34	154	5.34	2.40	1.85	-
	Supervisory Instruction	EOM	251	7.10	2.79	211	6.78	2.78	1.24	
		GRAV	238	5.43	2.41	213	5.84	2.30	1.85	-
	Student Participatory Group Instruction	EOM	246	7.06	2.87	216	6.83	2.69	0.89	-
		GRAV	222	5.68	2.30	229	5.57	2.43	0.51	-
	ICT- mediated Instruction	EOM	64	7.13	2.61	398	6.92	2.82	0.53	-
		GRAV	57	5.47	2.09	394	5.64	2.40	0.51	-
Situational Interest in Physics	Teacher Dominant Instruction		436	26.89	6.65	349	25.73	7.19	2.33*	0.17
	Student Participatory Individual Instruction		488	26.60	7.13	297	26.00	6.54	1.20	-
	Supervisory Instruction		390	26.63	6.68	395	26.12	7.13	1.02	-
	Student Participatory Group Instruction		376	26.14	7.21	409	26.59	6.62	0.91	-
	ICT- mediated Instruction		188	26.40	6.83	597	26.37	6.94	0.06	-
Individual Interest in Physics	Teacher Dominant Instruction		436	44.36	13.75	349	41.83	13.24	2.60**	0.19
	Student Participatory Individual Instruction		488	43.43	13.56	297	42.91	13.63	0.52	
	Supervisory Instruction		390	45.63	12.76	395	40.86	13.96	5.00**	0.36
	Student Participatory Group Instruction		376	43.65	12.74	409	42.85	14.31	0.83	-
	ICT- mediated Instruction		188	43.31	12.63	597	43.21	13.87	0.10	-

**$p \leq .01$, *$p \leq .05$

Table 27 shows that the mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' is significantly higher than that of those who had low Teacher Dominant Instruction at .01 level (d = 0.24). The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' does not

significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' is significantly higher than that of those who had low Supervisory Instruction at .05 level (d = 0.15). The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' is significantly higher than that of those who had low Teacher Dominant Instruction at .01 level (d = 0.25). The mean score of Domain Interest in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' is significantly higher than that of those who had low Teacher Dominant Instruction at .05 level (d = 0.19).

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high

Student Participatory Individual Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high ICT-mediated Instruction for

'Working-out Mathematical Problems' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level.

The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' is significantly higher than that of those who had low Teacher Dominant Instruction at .01 level (d = 0.17). The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high ICT- mediated Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low ICT- mediated Instruction even at .05 level.

The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' is significantly higher than that of those who had low Teacher Dominant Instruction at .01 level (d = 0.19). The mean score of Individual Interest in Physics of

secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' is significantly higher than that of those who had low Supervisory Instruction at .01 level (d = 0.36). The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low ICT- mediated Instruction even at .05 level.

Discussion of Results

While 'Working out Mathematical Problems', the secondary school students who had high Teacher Dominant Instruction has significantly higher interests in physics, viz., Domain Interest in Physics (small effect), Domain Interest in difficult concepts in physics, viz., Equations of Motion (small effect) and Gravitation (negligible effect), Situational Interest in Physics (negligible effect) and Individual Interest in Physics (negligible effect). The students who had high Supervisory Instruction have significantly high Domain Interest (negligible effect) and Individual Interest in Physics (small effect). Student Participatory Instructions and ICT-mediated Instruction have no significant influence on Interests in Physics among students.

Influence of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working-out Related Problems' on Student Interests in Physics

'Do 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working-out Related Problems' influence student Interests in Physics at secondary level?' was investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in Physics between high and low levels of usage of the instructional practice. Data and results of the tests of significance of difference between the mean scores of Interests in Physics of secondary school students by the levels of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working out Related Problems' are given in Table 28.

Table 28

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working-out Related Problems'

T-L situation/ Instructional practice	Interests in Physics		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Transacting Methodical Tactics of Mathematical Problem-solving	Domain Interest in Physics		398	42.96	10.86	387	36.74	10.03	8.35**	0.60
	Domain Interest in difficult concepts	EOM	201	7.49	2.54	261	6.54	2.90	3.77**	0.35
		GRAV	207	5.91	2.35	244	5.38	2.36	2.37*	0.23
	Situational Interest in Physics		398	27.28	6.70	387	25.44	7.01	3.75**	0.27
	Individual Interest in Physics		398	46.48	13.84	387	39.89	12.47	7.02**	0.50
Introducing Graph and Working out Related Problems	Domain Interest in Physics		443	41.94	11.18	342	37.24	9.96	6.22**	0.44
	Domain Interest in EOM		259	7.19	2.78	203	6.65	2.77	2.10*	0.19
	Situational Interest in Physics		443	26.84	6.77	342	25.78	7.06	2.13*	0.15
	Individual Interest in Physics		443	44.99	13.46	342	40.96	13.41	4.17**	0.30

**$p \leq .01$, *$p \leq .05$

Table 28 shows that the mean score of Domain Interest in Physics of secondary school students who had high level of usage of 'Transacting Methodical Tactics of

Mathematical Problem-solving' is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' at .01 level (d = 0.60). The mean score of Domain Interest in Equations of Motion of secondary school students who had high level usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' at .01 level (d = 0.35). The mean score of Domain Interest in Gravitation of secondary school students who had high level usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' at .05 level (d = 0.23). The mean score of Situational Interest in Physics of secondary school students who had high level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' at .01 level (d = 0.27). The mean score of Individual Interest in Physics of secondary school students who had high level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' at .01 level (d = 0.50).

The mean score of Domain Interest in Physics of secondary school students who had high level of usage of 'Introducing Graph and Working out Related Problems' is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' at .01 level (d = 0.44). The mean score of Domain Interest in Equations of Motion of secondary school students who had high level usage of 'Introducing Graph and Working out Related Problems'

is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' at .05 level ($d = 0.19$). The mean score of Situational Interest in Physics of secondary school students who had high level of usage of 'Introducing Graph and Working out Related Problems' is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' at .05 level ($d = 0.15$). The mean score of Individual Interest in Physics of secondary school students who had high level of usage of 'Introducing Graph and Working out Related Problems' is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' at .01 level ($d = 0.30$).

Discussion of Results

The secondary school students who had high level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working out Related Problems' have significantly higher interests in physics, viz., Domain Interest in Physics (medium effect and small effect respectively), Domain Interest in Equations of Motion (both having small effect), Situational Interest in Physics (small effect and negligible effect respectively) and Individual Interest in Physics (both having small effect). The students who had high 'Transacting Methodical Tactics of Mathematical Problem-solving' have significantly higher Domain Interest in Gravitation (negligible effect).

Influence of Instructional Practices for 'Facilitating Note-making Process' on Student Interests in Physics

'Does the Instructional Practices for 'Facilitating Note-making Process' influence student Interests in Physics at secondary level?' was investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in Physics between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Interests in Physics of secondary school students by the levels of usage of each of the four Instructional Practices for 'Facilitating Note-making Process' are given in Table 29.

Table 29

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Facilitating Note-making Process'

Interests	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Teacher Dominant Instruction		464	40.39	11.15	321	39.18	10.53	1.52	-
	Supervisory Instruction		380	40.31	10.24	405	39.50	11.50	1.03	-
	Student Participatory Individual Instruction		399	39.42	10.75	386	40.39	11.06	1.25	-
	Student Participatory Group Instruction		69	39.99	9.45	716	39.88	11.05	0.07	-
Domain Interest in difficult concepts	Teacher Dominant Instruction	EOM	363	6.97	2.83	99	6.88	2.64	0.30	-
		GRAV	351	5.75	2.32	100	5.18	2.48	2.13*	0.24
	Supervisory Instruction	EOM	180	7.02	2.80	282	6.91	2.79	0.43	-
		GRAV	174	5.58	2.26	277	5.65	2.43	0.30	-
	Student Participatory Individual Instruction	EOM	200	6.84	2.77	262	7.04	2.81	0.79	-
		GRAV	182	5.67	2.21	269	5.59	2.47	0.35	-
	Student Participatory Group Instruction	EOM	27	6.78	1.76	435	6.96	2.84	0.51	-
		GRAV	16	5.38	3.10	435	5.63	2.34	0.43	-
Situational Interest in Physics	Teacher Dominant Instruction		464	26.80	6.77	321	25.75	7.07	2.10*	0.15
	Supervisory Instruction		380	27.17	7.05	405	25.62	6.70	3.16**	0.23
	Student Participatory Individual Instruction		399	26.66	7.01	386	26.08	6.80	1.16	-
	Student Participatory Group Instruction		69	26.51	7.36	716	26.36	6.87	0.17	-
Individual Interest in Physics	Teacher Dominant Instruction		464	44.08	13.85	321	42.02	13.10	2.09*	0.15
	Supervisory Instruction		380	44.74	13.65	405	41.82	13.37	3.03**	0.22
	Student Participatory Individual Instruction		399	42.76	13.99	386	43.73	13.13	1.00	-
	Student Participatory Group Instruction		69	43.26	13.04	716	43.23	13.64	0.02	-

**$p \leq .01$, *$p \leq .05$

Table 29 shows that the mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' is significantly higher than that of those who had low Teacher Dominant Instruction at .05 level ($d = 0.24$).

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making

Process' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process'

is significantly higher than that of those who had low Teacher Dominant Instruction at .05 level (d = 0.15). The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' is significantly higher than that of those who had low Supervisory Instruction at .01 level (d = 0.23). The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' is significantly higher than that of those who had low Teacher Dominant Instruction at .05 level (d = 0.15). The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' is significantly higher than that of those who had low Supervisory Instruction at .01 level (d = 0.22). The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high

Student Participatory Group Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

Discussion of Results

While 'Facilitating Note-making Process', the secondary school students who had high Teacher Dominant Instruction and Supervisory Instruction have significantly higher Situational Interest (negligible and small effect respectively) and Individual Interest in Physics (negligible and small effect respectively). The students who had high Teacher Dominant Instruction have significantly higher Domain Interest in Gravitation (small effect). Student Participatory Group Instruction and Student Participatory Individual Instruction have no significant influence on Interests in Physics among students.

Influence of Instructional Practices under 'Miscellaneous Ways of Teaching' on Student Interests in Physics

'Does the Instructional Practices under 'Miscellaneous Ways of Teaching' influence student Interests in Physics at secondary level?' was investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in Physics between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Interests in Physics of secondary school students by the levels of usage of each of the four Instructional Practices are given in Table 30.

Table 30

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Each Practice Under 'Miscellaneous Ways of Teaching'

Interests	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Addressing Misconceptions		488	41.68	10.36	297	36.96	11.17	6.02**	0.44
	Using Mnemonics/Concept Mapping		435	41.08	10.83	350	38.42	10.84	3.41**	0.25
	Peer Teaching		125	41.90	9.84	660	39.51	11.07	2.25*	0.23
	Conducting Debate		135	39.70	9.84	650	39.93	11.12	0.22	-
Domain Interest in difficult concepts	Addressing Misconceptions	EOM	313	7.13	2.74	149	6.58	2.87	2.00*	0.20
		GRAV	320	5.72	2.30	131	5.39	2.51	1.34	-
	Using Mnemonics/ Concept Mapping	EOM	282	7.11	2.76	180	6.70	2.83	1.56	-
		GRAV	289	5.83	2.37	162	5.25	2.31	2.55*	0.25
	Peer Teaching	EOM	53	8.08	2.58	409	6.81	2.79	3.15**	0.47
		GRAV	41	5.59	2.51	410	5.63	2.35	0.11	-
Situational Interest in Physics	Addressing Misconceptions		488	27.17	6.73	297	25.07	7.01	4.17**	0.31
	Using Mnemonics/ Concept Mapping		435	26.84	7.12	350	25.80	6.61	2.10*	0.15
	Peer Teaching		125	27.74	6.48	660	26.12	6.96	2.41*	0.24
	Conducting Debate		135	26.62	7.03	650	26.32	6.89	0.46	-
Individual Interest in Physics	Addressing Misconceptions		488	45.36	13.49	297	39.73	12.99	5.75**	0.43
	Using Mnemonics/Concept Mapping		435	44.99	13.68	350	41.05	13.14	4.07**	0.29
	Peer Teaching		125	45.14	13.91	660	42.87	13.49	1.72	-
	Conducting Debate		135	46.16	13.77	650	42.63	13.47	2.76**	0.26

$^{**}p \leq .01$, $^{*}p \leq .05$

Table 30 shows that the mean score of Domain Interest in Physics of secondary school students who had high 'Addressing Misconceptions' is significantly higher than that of those who had low 'Addressing Misconceptions' at .01 level ($d = 0.44$). The mean score of Domain Interest in Physics of secondary school students who had high 'Using Mnemonics/Concept Mapping' is significantly higher than that of those who had low 'Using Mnemonics/Concept Mapping' at .01 level ($d = 0.25$). The mean score of Domain Interest in Physics of secondary school students who had high 'Peer Teaching' is significantly higher than that of those who had low 'Peer Teaching' at .05 level ($d = 0.23$). The mean score of Domain Interest in Physics of secondary school students who had high 'Conducting Debate' does not significantly differ from that of those who had low 'Conducting Debate' even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high 'Addressing Misconceptions' is significantly higher than that of those who had low 'Addressing Misconceptions' at .05 level (d = 0.20). The mean score of Domain Interest in Gravitation of secondary school students who had high 'Addressing Misconceptions' does not significantly differ from that of those who had low 'Addressing Misconceptions' even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high 'Using Mnemonics/Concept Mapping' does not significantly differ from that of those who had low 'Using Mnemonics/Concept Mapping' even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high 'Using Mnemonics/Concept Mapping' is significantly higher than that of those who had low 'Using Mnemonics/Concept Mapping' at .05 level (d = 0.25).

The mean score of Domain Interest in Equations of Motion of secondary school students who had high 'Peer Teaching' is significantly higher than that of those who had low 'Peer Teaching' at .01 level (d = 0.47). The mean score of Domain Interest in Gravitation of secondary school students who had high 'Peer Teaching' does not significantly differ from that of those who had low 'Peer Teaching' even at .05.

The mean score of Situational Interest in Physics of secondary school students who had high 'Addressing Misconceptions' is significantly higher than that of those who had low 'Addressing Misconceptions' at .01 level (d = 0.31). The mean score of Situational Interest in Physics of secondary school students who had high 'Using Mnemonics/Concept Mapping' is significantly higher than that of those who had low

'Using Mnemonics/Concept Mapping' at .05 level (d = 0.15). The mean score of Situational Interest in Physics of secondary school students who had high 'Peer Teaching' is significantly higher than that of those who had low 'Peer Teaching' at .05 level (d = 0.24). The mean score of Situational Interest in Physics of secondary school students who had high 'Conducting Debate' does not significantly differ from that of those who had low 'Conducting Debate' even at .05 level.

The mean score of Individual Interest in Physics of secondary school students who had high 'Addressing Misconceptions' is significantly higher than that of those who had low 'Addressing Misconceptions' at .01 level (d = 0.43). The mean score of Individual Interest in Physics of secondary school students who had high 'Using Mnemonics/Concept Mapping' is significantly higher than that of those who had low 'Using Mnemonics/Concept Mapping' at .01 level (d = 0.29). The mean score of Individual Interest in Physics of secondary school students who had high 'Peer Teaching' does not significantly differ from that of those who had low 'Peer Teaching' even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high 'Conducting Debate' is significantly higher than that of those who had low 'Conducting Debate' at .01 level (d = 0.26).

Discussion of Results

The secondary school students who had high 'Addressing Misconceptions' have significantly higher interests in physics, viz., Domain Interest in Physics (small effect), Domain Interest in Equations of Motion (negligible effect), Situational Interest in Physics (small effect) and Individual Interest in Physics (small effect). The students who had high 'Using Mnemonics/Concept Mapping' have significantly higher interests in physics, viz., Domain Interest in Physics (small effect), Domain

Interest in Gravitation (small effect), Situational Interest in Physics (negligible effect) and Individual Interest in Physics (small effect). The students who had high 'Peer Teaching' have significantly higher interests in physics, viz., Domain Interest in Physics (small effect), Domain Interest in Equations of Motion (small effect) and Situational Interest in Physics (small effect). The students who had high 'Conducting Debate' have significantly higher Individual Interest in Physics.

Influence of Instructional Practices for 'Conducting Assessment' on Student Interests in Physics

'Does the Instructional Practices for 'Conducting Assessment' influence student Interests in Physics at secondary level?' was investigated by comparing the mean score of interests, namely, i) Domain Interest in Physics, ii) Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in Physics between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean score of Interests in Physics of secondary school students by the levels of usage of each of the five Instructional Practices for 'Conducting Assessment' are given in Table 31.

Table 31

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Conducting Assessment'

Interests	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Formative Assessment		440	41.35	10.83	345	38.03	10.74	4.29**	0.31
	Mastery Oriented Assessment		409	40.74	11.16	376	38.97	10.56	2.28*	0.16
	Facilitated Assessment		125	39.80	8.30	660	39.91	11.34	0.13	-
	Question Generation Strategy		174	40.06	10.02	611	39.84	11.16	0.25	-
	ICT- mediated Assessment		64	37.94	9.76	721	40.07	10.99	1.50	-
Domain Interest in difficult concepts	Formative Assessment	EOM	299	7.08	2.80	163	6.72	2.76	1.34	-
		GRAV	305	5.76	2.30	146	5.34	2.47	1.75	-
	Mastery Oriented Assessment	EOM	219	7.11	2.84	243	6.81	2.75	1.15	-
		GRAV	215	5.78	2.21	236	5.48	2.49	1.33	-
	Facilitated Assessment	EOM	46	6.76	2.23	416	6.97	2.85	0.60	-
		GRAV	32	5.63	2.30	419	5.62	2.37	0.01	
	Question Generation Strategy	EOM	62	6.65	2.43	400	7.00	2.84	0.93	-
		GRAV	67	5.45	2.34	384	5.65	2.37	0.66	-
	ICT- mediated Assessment	EOM	29	6.62	2.35	433	6.97	2.82	0.66	-
		GRAV	16	4.81	2.40	435	5.65	2.36	1.40	-
Situational Interest in Physics	Formative Assessment		440	27.13	6.75	345	25.42	7.01	3.46**	0.25
	Mastery Oriented Assessment		409	26.77	6.51	376	25.95	7.31	1.65	-
	Facilitated Assessment		125	26.26	6.71	660	26.40	6.95	0.20	-
	Question Generation Strategy		174	26.74	6.39	611	26.27	7.05	0.78	-
	ICT- mediated Assessment		64	25.67	6.90	721	26.44	6.91	0.85	-
Individual Interest in Physics	Formative Assessment		440	45.35	13.36	345	40.53	13.39	5.01**	0.36
	Mastery Oriented Assessment		409	45.66	13.42	376	40.59	13.26	5.32**	0.38
	Facilitated Assessment		125	43.03	10.24	660	43.27	14.13	0.22	-
	Question Generation Strategy		174	44.19	12.21	611	42.96	13.94	1.13	-
	ICT- mediated Assessment		64	43.61	11.81	721	43.20	13.73	0.23	-

**$p \leq .01$, *$p \leq .05$

Table 31 shows that the mean score of Domain Interest in Physics of secondary school students who had high Formative Assessment while 'Conducting Assessment' is significantly higher than that of those who had low Formative Assessment at .01 level (d = 0.31). The mean score of Domain Interest in Physics of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' is significantly higher than that of those who had low Mastery Oriented Assessment at .05 level (d = 0.16). The mean score of Domain Interest in Physics of secondary

school students who had high Facilitated Assessment for ‘Conducting Assessment’ does not significantly differ from that of those who had low Facilitated Assessment even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high Question Generation Strategy while ‘Conducting Assessment’ does not significantly differ from that of those who had low Question Generation Strategy even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Assessment for ‘Conducting Assessment’ does not significantly differ from that of those who had low ICT-mediated Assessment even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Formative Assessment while ‘Conducting Assessment’ does not significantly differ from that of those who had low Formative Assessment even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Formative Assessment while ‘Conducting Assessment’ does not significantly differ from that of those who had low Formative Assessment even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Mastery Oriented Assessment while ‘Conducting Assessment’ does not significantly differ from that of those who had low Mastery Oriented Assessment even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Mastery Oriented Assessment while ‘Conducting Assessment’ does not significantly differ from that of those who had low Mastery Oriented Assessment even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' does not significantly differ from that of those who had low Facilitated Assessment even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' does not significantly differ from that of those who had low Facilitated Assessment even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' does not significantly differ from that of those who had low Question Generation Strategy even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' does not significantly differ from that of those who had low Question Generation Strategy even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high ICT-mediated Assessment for 'Conducting Assessment' does not significantly differ from that of those who had low ICT-mediated Assessment even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high ICT-mediated Assessment for 'Conducting Assessment' does not significantly differ from that of those who had low ICT-mediated Assessment even at .05 level.

The mean score of Situational Interest in Physics of secondary school students who had high Formative Assessment while 'Conducting Assessment' is significantly

higher than that of those who had low Formative Assessment at .01 level (d = 0.25). The mean score of Situational Interest in Physics of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' does not significantly differ from that of those who had low Mastery Oriented Assessment even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' does not significantly differ from that of those who had low Facilitated Assessment even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' does not significantly differ from that of those who had low Question Generation Strategy even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high ICT-mediated Assessment for 'Conducting Assessment' does not significantly differ from that of those who had low ICT-mediated Assessment even at .05 level.

The mean score of Individual Interest in Physics of secondary school students who had high Formative Assessment while 'Conducting Assessment' is significantly higher than that of those who had low Formative Assessment at .01 level (d = 0.36). The mean score of Individual Interest in Physics of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' is significantly higher than that of those who had low Mastery Oriented Assessment at .01 level (d = 0.38). The mean score of Individual Interest in Physics of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' does not significantly differ from that of those who had low Facilitated Assessment

even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' does not significantly differ from that of those who had low Question Generation Strategy even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high ICT-mediated Assessment for 'Conducting Assessment' does not significantly differ from that of those who had low ICT-mediated Assessment even at .05 level.

Discussion of Results

While 'Conducting Assessment', the secondary school students who had high Formative Assessment has significantly higher interests in physics, viz., Domain Interest in Physics (small effect), Situational Interest in Physics (small effect) and Individual Interest in Physics (small effect). The students who had high Mastery Oriented Assessment have significantly high Domain Interest (negligible effect) and Individual Interest in Physics (small effect). Supervisory Instruction, Question Generation Strategy and ICT-mediated Instruction have no significant influence on Interests in Physics among students.

Influence of Instructional Practices for 'Consolidation of Concepts' on Student Interests in Physics

'Does the Instructional Practices for 'Consolidation of Concepts' influence student Interests in Physics at secondary level?' was investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in

Physics between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Interests in Physics of secondary school students by the levels of usage of each of the five Instructional Practices for 'Consolidation of Concepts' are given in Table 32.

Table 32

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Consolidation of Concepts'

Interests	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Teacher Dominant Instruction		409	40.82	11.13	376	38.89	10.59	2.49*	0.18
	Student Participatory Individual Instruction		296	40.80	10.63	489	39.35	11.05	1.81	-
	Supervisory Instruction		206	40.69	10.56	579	39.61	11.03	1.23	-
	ICT- mediated Instruction		160	38.57	9.89	625	40.23	11.14	1.72	-
	Student Participatory Group Instruction		77	37.88	10.55	708	40.11	10.93	1.70	-
Domain Interest in difficult concepts	Teacher Dominant Instruction	EOM	360	7.05	2.73	102	6.61	2.98	1.42	-
		GRAV	354	5.64	2.33	97	5.57	2.49	0.26	-
	Student Participatory Individual Instruction	EOM	122	7.26	2.76	340	6.84	2.80	1.43	-
		GRAV	121	5.88	2.10	330	5.53	2.45	1.48	-
	Supervisory Instruction	EOM	88	7.02	2.79	374	6.94	2.79	0.26	-
		GRAV	83	5.19	2.08	368	5.72	2.42	2.02*	0.23
	ICT- mediated Instruction	EOM	53	6.72	2.91	409	6.98	2.78	0.65	-
		GRAV	60	5.47	2.33	391	5.65	2.37	0.55	-
	Student Participatory Group Instruction	EOM	41	6.63	2.53	421	6.98	2.81	0.77	-
		GRAV	25	5.84	2.17	426	5.61	2.38	0.47	-
Situational Interest in Physics	Teacher Dominant Instruction		409	26.70	6.54	376	26.02	7.29	1.37	-
	Student Participatory Individual Instruction		296	27.44	6.53	489	25.73	7.06	3.39**	0.25
	Supervisory Instruction		206	27.41	6.28	579	26.01	7.09	2.52*	0.21
	ICT- mediated Instruction		160	26.56	6.87	625	26.33	6.93	0.39	-
	Student Participatory Group Instruction		77	27.51	6.79	708	26.25	6.92	1.52	-
Individual Interest in Physics	Teacher Dominant Instruction		409	44.09	13.92	376	42.30	13.15	1.85	-
	Student Participatory Individual Instruction		296	45.56	12.55	489	41.82	13.99	3.87**	0.28
	Supervisory Instruction		206	44.84	12.50	579	42.66	13.90	2.08*	0.16
	ICT- mediated Instruction		160	44.28	12.65	625	42.96	13.80	1.10	-
	Student Participatory Group Instruction		77	45.00	11.92	708	43.04	13.74	1.35	-

**$p \leq .01$, *$p \leq .05$

Table 32 shows that the mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' is significantly higher than that of those who had low Teacher Dominant

Instruction at .05 level (d = 0.18). The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for

'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' is significantly less than that of those who had low Supervisory Instruction at .05 level ($d = 0.23$).

The mean score of Domain Interest in Equations of Motion of secondary school students who had high ICT - mediated Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low ICT - mediated Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high ICT - mediated Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low ICT - mediated Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had

low Student Participatory Group Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' is significantly higher than that of those who had low Student Participatory Individual Instruction at .01 level (d = 0.25). The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' is significantly higher than that of those who had low Supervisory Instruction at .05 level (d = 0.21). The mean score of Situational Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' is significantly higher than that of those who had low Student Participatory Individual Instruction at .01 level (d = 0.28). The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' is significantly higher than that of those who had low Supervisory Instruction at .05 level (d = 0.16). The mean score of Individual Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

Discussion of Results

While 'Consolidation of Concepts', the secondary school students who had high Student Participatory Individual Instruction and Supervisory Instruction has significantly higher interests in physics, viz., Situational Interest in Physics (both having small effect) and Individual Interest in Physics (small effect and negligible effect respectively). The students who had high Teacher Dominant Instruction has

significantly high Domain Interest in Physics (negligible effect). The students who had high Supervisory Instruction has significantly low Domain Interest in Gravitation (small effect). ICT-mediated Instruction and Student Participatory Group Instruction have no significant influence on Interests in Physics among students.

Influence of Instructional Practices for 'Providing Follow-up Activity' on Student Interests in Physics

'Does the Instructional Practices for 'Providing Follow-up Activity' influence student Interests in Physics at secondary level?' was investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in Physics between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Interests in Physics of secondary school students by the levels of usage of each of the three Instructional Practices for 'Providing Follow-up Activity' are given in Table 33.

Table 33

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Providing Follow-up Activity'

Interests	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Student Participatory Individual Instruction		409	40.82	11.13	376	38.89	10.59	2.49*	0.18
	Supervisory Instruction		394	40.87	10.34	391	38.91	11.38	2.52*	0.18
	Student Participatory Group Instruction		159	38.47	10.80	626	40.25	10.92	1.84	-
Domain Interest in difficult concepts	Student Participatory Individual Instruction	EOM	291	7.19	2.80	171	6.54	2.73	2.43*	0.24
		GRAV	284	5.81	2.27	167	5.30	2.50	2.24*	0.21
	Supervisory Instruction	EOM	181	7.48	2.62	281	6.62	2.85	3.27**	0.31
		GRAV	168	5.54	2.38	283	5.67	2.36	0.60	-
	Student Participatory Group Instruction	EOM	76	6.83	2.79	386	6.98	2.79	0.42	-
		GRAV	41	5.68	2.14	410	5.62	2.39	0.17	-
Situational Interest in Physics	Student Participatory Individual Instruction		409	26.70	6.54	376	26.02	7.29	1.37	-
	Supervisory Instruction		394	27.00	6.85	391	25.74	6.92	2.55*	0.18
	Student Participatory Group Instruction		159	26.13	6.52	626	26.44	7.01	0.51	-
Individual Interest in Physics	Student Participatory Individual Instruction		409	44.09	13.92	376	42.30	13.15	1.85	-
	Supervisory Instruction		394	45.08	13.54	391	41.37	13.38	3.86**	0.28
	Student Participatory Group Instruction		159	43.47	12.92	626	43.17	13.75	0.24	-

**$p \leq .01$, *$p \leq .05$

Table 33 shows that the mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' is significantly higher than that of those who had low Student Participatory Individual Instruction at .05 level ($d = 0.18$). The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' is significantly higher than that of those who had low Supervisory Instruction at .05 level ($d = 0.18$). The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' is significantly higher than that of those who had low Student Participatory Individual Instruction at .05 level ($d = 0.24$). The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' is significantly higher than that of those who had low Student Participatory Individual Instruction at .05 level ($d = 0.21$).

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' is significantly higher than that of those who had low Supervisory Instruction at .01 level ($d = 0.31$). The mean score of Domain Interest in Gravitation of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' is significantly higher than that of those who had low Supervisory Instruction at .05 level (d = 0.18). The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' is significantly higher than that of those who had low Supervisory Instruction at .01 level (d = 0.28). The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

Discussion of Results

While 'Providing Follow-up Activity', the secondary school students who had high Student Participatory Individual Instruction and Supervisory Instruction has significantly higher Domain Interest in Physics (both having negligible effect) and in Equations of Motion (both having small effect). The students who had high Supervisory Instruction have significantly higher Situational Interest in Physics (negligible effect) and Individual Interest in Physics (small effect). Those who had high Student Participatory Individual Instruction has higher Domain Interest in Gravitation (small effect). Student Participatory Group Instruction has no significant influence on Interests in Physics among students.

Influence of Instructional Practices for 'Enriching Learning Experiences' on Student Interests in Physics

'Does the Instructional Practices for 'Enriching Learning Experiences' influence student Interests in Physics at secondary level?' was investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Domain Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in Physics, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Interests in Physics of secondary school students by the levels of usage of each of the four Instructional Practices for 'Enriching Learning Experiences' are given in Table 34.

Table 34

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Enriching Learning Experiences'

Interests	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Directing to take part in Science Club Activities		334	37.77	11.30	451	41.47	10.34	4.76**	0.34
	Suggesting Extra Reference Materials/Web Resources		515	39.56	11.48	270	40.53	9.71	1.26	-
	Directing to Exhibit Works on Public Platforms		656	39.90	11.06	129	39.87	10.16	0.03	-
	Organizing Field Trips		732	39.92	10.91	53	39.55	10.99	0.24	-
Domain Interest in difficult concepts	Suggesting Extra Reference Materials/ Web Resources	EOM	350	6.84	2.79	112	7.29	2.76	1.49	-
		GRAV	359	5.60	2.40	92	5.70	2.23	0.33	-
Situational Interest in Physics	Directing to take part in Science Club Activities		334	25.84	7.33	451	26.77	6.57	1.86	-
	Suggesting Extra Reference Materials/Web Resources		515	26.12	7.21	270	26.85	6.28	1.46	-
	Directing to Exhibit Works on Public Platforms		656	26.31	6.93	129	26.71	6.84	0.61	-
	Organizing Field Trips		732	26.26	6.92	53	27.92	6.62	1.69	-
Individual Interest in Physics	Directing to take part in Science Club Activities		334	40.71	13.32	451	45.10	13.47	4.54**	0.33
	Suggesting Extra Reference Materials/Web Resources		515	42.44	14.22	270	44.75	12.14	2.39*	0.17
	Directing to Exhibit Works on Public Platforms		656	42.84	13.64	129	45.22	13.12	1.83	-
	Organizing Field Trips		732	43.11	13.70	53	44.94	11.81	0.95	-

$^{**}p \leq .01$, $^{*}p \leq .05$

Table 34 shows that the mean score of Domain Interest in Physics of secondary school students who had high 'Directing to take part in Science Club Activities' for 'Enriching Learning Experiences' is significantly higher than that of those who had low 'Directing to take part in Science Club Activities' at .01 level (d = 0.34). The mean score of Domain Interest in Physics of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high 'Directing to

Exhibit Works on Public Platforms' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Directing to Exhibit Works on Public Platforms' even at .05 level. The mean score of Domain Interest in Physics of secondary school students who had high 'Organizing Field Trips' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Organizing Field Trips' even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' even at .05 level.

The mean score of Situational Interest in Physics of secondary school students who had high 'Directing to take part in Science Club Activities' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Directing to take part in Science Club Activities' even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high 'Directing

to Exhibit Works on Public Platforms' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Directing to Exhibit Works on Public Platforms' even at .05 level. The mean score of Situational Interest in Physics of secondary school students who had high 'Organizing Field Trips' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Organizing Field Trips' even at .05 level.

The mean score of Individual Interest in Physics of secondary school students who had high 'Directing to take part in Science Club Activities' for 'Enriching Learning Experiences' is significantly higher than that of those who had low 'Directing to take part in Science Club Activities' at .01 level (d = 0.33). The mean score of Individual Interest in Physics of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' is significantly higher than that of those who had low 'Suggesting Extra Reference Materials/Web Resources' at .05 level (d = 0.17). The mean score of Individual Interest in Physics of secondary school students who had high 'Directing to Exhibit Works on Public Platforms' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Directing to Exhibit Works on Public Platforms' even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high 'Organizing Field Trips' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Organizing Field Trips' even at .05 level.

Discussion of Results

While 'Enriching Learning Experiences', the secondary school students who had high 'Directing to take part in Science Club Activities' has significantly higher Domain Interest (small effect) and Individual Interest in Physics (small effect). The students who had high 'Suggesting Extra Reference Materials/Web Resources' have significantly high Individual Interest in Physics (negligible effect). 'Directing to Exhibit Works on Public Platforms' and 'Organizing Field Trips' have no significant influence on Interests in Physics among students.

Influence of Instructional Practices for 'Examination Preparedness' on Student Interests in Physics

'Does the Instructional Practices for 'Examination Preparedness' influence student Interests in Physics at secondary level?' was investigated by comparing the mean scores of interests, namely, i) Domain Interest in Physics, ii) Domain Interest in select difficult concepts, iii) Situational Interest in Physics and iv) Individual Interest in Physics, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Interests in Physics of secondary school students by the levels of usage of each of the four Instructional Practices for 'Examination Preparedness' are given in Table 35.

Table 35

Data and Results of Comparison of Interests in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Examination Preparedness'

Interests	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Domain Interest in Physics	Test Previewing Strategy		344	37.95	10.51	441	41.41	10.98	4.47**	0.32
	Test Reviewing Strategy		396	38.66	10.86	389	41.15	10.83	3.22**	0.23
	Differentiated Strategy		426	39.42	11.04	359	40.45	10.74	1.32	-
Domain Interest in difficult concepts	Test Previewing Strategy	EOM	125	6.17	2.52	337	7.24	2.83	3.93**	0.40
		GRAV	111	5.54	2.62	340	5.65	2.28	0.39	-
	Test Reviewing Strategy	EOM	253	6.85	2.75	209	7.08	2.84	0.87	-
		GRAV	274	5.57	2.40	177	5.70	2.31	0.56	-
	Differentiated Strategy	EOM	312	6.92	2.74	150	7.02	2.90	0.36	-
		GRAV	301	5.57	2.39	150	5.73	2.32	0.70	-
Situational Interest in Physics	Test Previewing Strategy		344	25.60	7.58	441	26.98	6.29	2.73**	0.20
	Test Reviewing Strategy		396	25.48	7.08	389	27.29	6.62	3.69**	0.26
	Differentiated Strategy		426	26.02	7.38	359	26.79	6.30	1.58	-
Individual Interest in Physics	Test Previewing Strategy		344	42.74	13.72	441	43.61	13.47	0.89	-
	Test Reviewing Strategy		396	41.68	13.10	389	44.82	13.88	3.26**	0.23
	Differentiated Strategy		426	41.90	13.71	359	44.82	13.26	3.01**	0.22

$^{**}p \leq .01$, $^{*}p \leq .05$

Table 35 shows that the mean score of Domain Interest in Physics of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' is significantly higher than that of those who had low Test Previewing Strategy at .01 level (d = 0.32). The mean score of Domain Interest in Physics of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' is significantly higher than that of those who had low Test Reviewing Strategy at .01 level (d =0.23). The mean score of Domain Interest in Physics of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Differentiated Strategy even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' is significantly higher than that of those who had low Test Previewing Strategy at .01 level (d = 0.40). The mean score of Domain Interest in Gravitation of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Test Previewing Strategy even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Test Reviewing Strategy even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Test Reviewing Strategy even at .05 level.

The mean score of Domain Interest in Equations of Motion of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Differentiated Strategy even at .05 level. The mean score of Domain Interest in Gravitation of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Differentiated Strategy even at .05 level.

The mean score of Situational Interest in Physics of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' is

significantly higher than that of those who had low Test Previewing Strategy at .01 level ($d = 0.20$). The mean score of Situational Interest in Physics of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' is significantly higher than that of those who had low Test Reviewing Strategy at .01 level ($d = 0.26$). The mean score of Situational Interest in Physics of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Differentiated Strategy even at .05 level.

The mean score of Individual Interest in Physics of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Test Previewing Strategy even at .05 level. The mean score of Individual Interest in Physics of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' is significantly higher than that of those who had low Test Reviewing Strategy at .01 level ($d = 0.23$). The mean score of Individual Interest in Physics of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' is significantly higher than that of those who had low Differentiated Strategy at .01 level ($d = 0.22$).

Discussion of Results

While 'Examination Preparedness', the secondary school students who had high Test Previewing Strategy has significantly higher interests in physics, viz., Domain Interest in Physics (small effect), Domain Interest in Equations of Motion (small effect) and Situational Interest in Physics (negligible effect). The students who

had high Test Reviewing Strategy have significantly high interests in physics, viz., Domain Interest (small effect), Situational Interest (small effect) and Individual Interest in Physics (small effect). The students who had high Differentiated Strategy have significantly higher Individual Interest in Physics (small effect).

Influence of Instructional Practices on Achievement in Physics Among Secondary School Students

The influence of extant Instructional Practices, within 12 identified teaching-learning situations, on secondary school students' Achievement in Physics are analysed separately and explained as follows.

Influence of Instructional Practices for 'Introducing New Concepts' on Student Achievement in Physics

'Does the Instructional Practices for 'Introducing New Concepts' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Achievement in Physics, Achievement in Equations of Motion (EOM) and Achievement in Gravitation (GRAV) of secondary school students by the levels of usage of each of the four Instructional Practices for 'Introducing New Concepts' are given in Table 36.

Table 36

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Introducing New Concepts'

Achievement	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Achievement in Physics	Teacher Dominant Instruction		322	14.65	8.72	463	17.06	8.31	3.93**	0.28
	Student Participatory Group Instruction		357	15.61	8.39	428	16.45	8.69	1.37	-
	Student Participatory Individual Instruction		350	16.39	8.87	435	15.81	8.30	0.94	-
	ICT- mediated Instruction		453	16.16	8.35	332	15.95	8.85	0.33	-
Achievement in difficult concepts	Teacher Dominant Instruction	EOM	244	8.72	3.25	218	9.15	3.50	1.37	-
		GRAV	235	8.66	3.81	216	9.00	3.58	0.99	-
	Student Participatory Group Instruction	EOM	304	9.05	3.22	158	8.67	3.65	1.14	-
		GRAV	308	8.70	3.69	143	9.07	3.72	0.98	-
	Student Participatory Individual Instruction	EOM	285	9.06	3.54	177	8.69	3.09	1.16	-
		GRAV	268	9.00	3.84	183	8.55	3.47	1.27	-
	ICT- mediated Instruction	EOM	334	9.16	3.44	128	8.28	3.11	2.53**	0.27
		GRAV	340	9.06	3.78	111	8.10	3.35	2.38**	0.27

**$p \leq .01$, *$p \leq .05$

Table 36 shows that the mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' is significantly higher than that of those who had low Teacher Dominant Instruction at .01 level ($d = 0.28$). The mean score of Achievement Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Achievement Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Achievement Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Introducing

New Concepts' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' does not significantly differ

from that of those who had low Student Participatory Individual Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' is significantly less than that of those who had low ICT-mediated Instruction at .01 level (d = 0.27). The mean score of Achievement in Gravitation of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' is significantly less than that of those who had low ICT-mediated Instruction at .01 level (d = 0.27).

Discussion of Results

While 'Introducing New Concepts', the secondary school students who had high Teacher Dominant Instruction has significantly higher Achievement in Physics (small effect). The students who had high ICT-mediated Instruction has significantly less Achievement in difficult concepts, Equations of Motion (small effect) and Gravitation (small effect). Meanwhile, Student Participatory Instructions has no significant influence on Achievement in Physics and in difficult concepts among students.

Influence of Instructional Practices for 'Performing Experiments and Activities' on Student Achievement in Physics

'Does the Instructional Practices for 'Performing experiments and activities' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of Achievement in Physics between high and low levels

of usage of each of the instructional practices. Data and results of the tests of significance of difference between the means scores of Achievement in Physics by the levels of each of the five Instructional Practices for 'Performing experiments and activities' are given in Table 37.

Table 37

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Performing Experiments and Activities'

Achievement	Instructional Practices	High			Low			*t*	Cohen's *d*
		N	Mean	*SD*	*N*	Mean	*SD*		
Achievement in Physics	Teacher Dominant Instruction	424	15.47	8.21	361	16.78	8.92	2.12*	0.15
	Student Participatory Individual Instruction	410	16.24	8.44	375	15.89	8.69	0.58	-
	Student Participatory Group Instruction	447	16.34	8.47	338	15.71	8.68	1.03	-
	Supervisory Instruction	444	16.14	8.47	341	15.98	8.68	0.27	-
	ICT- mediated Instruction	568	16.43	8.64	217	15.12	8.28	1.93	-

**$p \leq .01$, *$p \leq .05$

Table 37 shows that the mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Performing Experiments and Activities' is significantly higher than that of those who had low Teacher Dominant Instruction at .05 level ($d = 0.15$). The mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Group Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for

'Performing Experiments and Activities' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high ICT-mediated Instruction for 'Performing Experiments and Activities' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level.

Discussion of Results

While 'Performing Experiments and Activities', the secondary school students who had high Teacher Dominant instruction has significantly higher Achievement in Physics (negligible effect). Student Participatory Instructions, Supervisory instruction and ICT-mediated instruction has no significant influence on Achievement in Physics among students.

Influence of Instructional Practices for 'Working-out Mathematical Problems' on Student Achievement in Physics

'Does the Instructional Practices for 'Working-out Mathematical Problems' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Achievement in Physics, Achievement in Equations of Motion (EOM) and Achievement in Gravitation (GRAV) of secondary school students by the levels of usage of each of the five Instructional Practices for 'Working-out Mathematical Problems' are given in Table 38.

Table 38

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Working-out Mathematical Problems'

Achievement	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Achievement in Physics	Teacher Dominant Instruction		349	15.31	8.48	436	16.68	8.58	2.23*	0.16
	Student Participatory Individual Instruction		297	16.76	8.59	488	15.65	8.52	1.76	-
	Supervisory Instruction		395	16.39	8.82	390	15.75	8.29	1.04	-
	Student Participatory Group Instruction		409	17.01	8.52	376	15.05	8.50	3.23**	0.23
	ICT- mediated Instruction		597	16.57	8.55	188	14.47	8.43	2.95**	0.25
Achievement in difficult concepts	Teacher Dominant Instruction	EOM	169	8.79	3.08	293	9.00	3.54	0.64	-
		GRAV	184	8.70	3.96	267	8.91	3.52	0.59	-
	Student Participatory Individual Instruction	EOM	158	8.61	3.27	304	9.08	3.42	1.44	-
		GRAV	154	9.15	3.76	297	8.65	3.67	1.36	-
	Supervisory Instruction	EOM	211	9.29	3.61	251	8.61	3.13	2.14*	0.20
		GRAV	213	8.80	3.87	238	8.84	3.56	0.10	-
	Student Participatory Group Instruction	EOM	216	9.40	3.52	246	8.50	3.19	2.91**	0.27
		GRAV	229	9.16	3.77	222	8.47	3.61	1.97*	0.19
	ICT- mediated Instruction	EOM	398	9.06	3.41	64	8.03	3.00	2.28*	0.32
		GRAV	394	8.91	3.70	57	8.19	3.70	1.37	-

**$p \leq .01$, *$p \leq .05$

Table 38 shows that the mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' is significantly higher than that of those who had low Teacher Dominant Instruction at .05 level ($d = 0.16$). The mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students

who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' is significantly less than that of those who had low Student Participatory Group Instruction at .01 level (d = 0.23). The mean score of Achievement in Physics of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' is significantly less than that of those who had low ICT-mediated Instruction at .01 level (d = 0.25).

The mean score of Achievement in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical

Problems' is significantly less than that of those who had low Supervisory Instruction at .05 level (d = 0.20). The mean score of Achievement in Gravitation of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' is significantly less than that of those who had low Student Participatory Group Instruction at .01 level (d = 0.27). The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' is significantly less than that of those who had low Student Participatory Group Instruction at .05 level (d = 0.19).

The mean score of Achievement in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' is significantly less than that of those who had low ICT-mediated Instruction at .05 level (d = 0.32). The mean score of Achievement in Gravitation of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level.

Discussion of Results

While 'Working out Mathematical Problems', the secondary school students who had high Teacher Dominant Instruction has significantly higher Achievement in

Physics (negligible effect). However, the students who had high Student Participatory Group Instruction has significantly less Achievement in Physics (small effect) and in difficult concepts in physics, viz., Equations of Motion (small effect) and Gravitation (negligible effect). The students who had high ICT-mediated Instruction has significantly less Achievement in Physics (small effect) and Achievement in Equations of Motion (small effect). The students who had high Supervisory Instruction has significantly less Achievement in Equations of Motion (negligible effect). Student Participatory Individual Instruction has no significant influence on Achievement in Physics and in difficult concepts among students.

Influence of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working-out Related Problems' on Student Achievement in Physics

'Do 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working-out Related Problems' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts, between high and low levels of usage of the instructional practice. Data and results of the tests of significance of difference between the mean scores of Achievement in Physics, Achievement in Equations of Motion (EOM) and Achievement in Gravitation (GRAV) of secondary school students by the levels of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working out Related Problems' are given in Table 39.

Table 39

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working-out Related Problems'

T-L situation/ Instructional practice	Achievement		High			Low			t	Cohen's *d*
			N	Mean	SD	N	Mean	SD		
Transacting Methodical Tactics of Mathematical Problem-solving	Achievement in Physics		387	14.10	8.27	398	17.99	8.41	6.55**	0.47
	Achievement in difficult concepts	EOM	261	8.41	3.06	201	9.59	3.65	3.70**	0.35
		GRAV	244	8.17	3.71	207	9.59	3.55	4.14**	0.39
Introducing Graph and Working out Related Problems	Achievement in Physics		342	14.68	8.53	443	17.15	8.43	4.05**	0.29
	Achievement in EOM		203	8.21	3.00	259	9.48	3.56	4.18**	0.39

**$p \leq .01$, *$p \leq .05$

Table 39 shows that the mean score of Achievement in Physics of secondary school students who had high level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' at .01 level (d = 0.47). The mean score of Achievement in Equations of Motion of secondary school students who had high level usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' at .01 level (d = 0.35). The mean score of Achievement in Gravitation of secondary school students who had high level usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' at .01 level (d = 0.39).

The mean score of Achievement in Physics of secondary school students who had high level of usage of 'Introducing Graph and Working out Related Problems' is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' at .01 level (d = 0.29). The mean score of Achievement in Equations of Motion of secondary school students who had high level usage of 'Introducing Graph and Working out Related Problems' is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' at .01 level (d = 0.39).

Discussion of Results

The secondary school students who had high level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working out Related Problems' have significantly higher Achievement in Physics (both having small effect) and in Equations of Motion (both having small effect). The students who had high 'Transacting Methodical Tactics of Mathematical Problem-solving' have significantly higher Achievement in Gravitation (small effect).

Influence of Instructional Practices for 'Facilitating Note-making Process' on Student Achievement in Physics

'Does the Instructional Practices for 'Facilitating Note-making Process' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of

difference between the mean scores of Achievement in Physics, Achievement in EOM and Achievement in GRAV of secondary school students by the levels of usage of each of the four Instructional Practices for 'Facilitating Note-making Process' are given in Table 40.

Table 40

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Facilitating Note-making Process'

Achievement	Instructional Practices		High			Low			*t*
			N	Mean	*SD*	*N*	Mean	*SD*	
Achievement in Physics	Teacher Dominant Instruction		321	16.73	9.09	464	15.62	8.15	1.76
	Supervisory Instruction		405	15.80	8.65	380	16.37	8.46	0.93
	Student Participatory Individual Instruction		386	16.25	8.43	399	15.89	8.69	0.59
	Student Participatory Group Instruction		716	16.22	8.54	69	14.55	8.63	1.55
Achievement in difficult concepts	Teacher Dominant Instruction	EOM	99	9.13	3.59	363	8.86	3.32	0.70
		GRAV	100	8.60	3.83	351	8.88	3.67	0.68
	Supervisory Instruction	EOM	282	8.94	3.30	180	8.88	3.50	0.19
		GRAV	277	9.09	3.87	174	8.40	3.38	1.93
	Student Participatory Individual Instruction	EOM	262	9.05	3.37	200	8.75	3.38	0.95
		GRAV	269	8.67	3.48	182	9.05	4.00	1.08
	Student Participatory Group Instruction	EOM	435	8.98	3.39	27	7.89	2.93	1.64
		GRAV	435	8.86	3.71	16	7.63	3.26	1.32

$^{**}p \leq .01$, $^{*}p \leq .05$

Table 40 shows that the mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual

Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low

Student Participatory Individual Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

Discussion of Results

The usage of Teacher Dominant Instruction, Student Participatory Instructions, and Supervisory Instruction have no significant influence on Achievement in Physics and Achievement in difficult concepts among students.

Influence of Instructional Practices under 'Miscellaneous Ways of Teaching' on Student Achievement in Physics

'Does the Instructional Practices under 'Miscellaneous Ways of Teaching' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts, between high and low levels of usage of

each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Achievement in Physics, Achievement in Equations of Motion (EOM) and Achievement in Gravitation (GRAV) of secondary school students by the levels of usage of each of the four Instructional Practices are given in Table 41.

Table 41

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Each Practice Under 'Miscellaneous Ways of Teaching'

Achievement	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Achievement in Physics	Addressing Misconceptions		297	14.84	8.66	488	16.82	8.42	3.18**	0.23
	Using Mnemonics/Concept Mapping		350	15.65	8.82	435	16.41	8.34	1.24	-
	Peer Teaching		660	16.19	8.66	125	15.45	7.99	0.89	-
	Conducting Debate		650	16.44	8.59	135	14.32	8.24	2.62**	0.25
Achievement in difficult concepts	Addressing Misconceptions	EOM	149	8.58	3.21	313	9.08	3.45	1.48	-
		GRAV	131	8.27	3.33	320	9.04	3.83	2.01*	0.21
	Using Mnemonics/Concept Mapping	EOM	180	8.79	3.40	282	9.00	3.36	0.67	-
		GRAV	162	8.46	3.65	289	9.02	3.72	1.54	-
	Peer Teaching	EOM	409	8.83	3.28	53	9.64	3.99	1.66	-
		GRAV	410	8.78	3.66	41	9.27	4.07	0.81	-

**$p \leq .01$, *$p \leq .05$

Table 41 shows that the mean score of Achievement in Physics of secondary school students who had high 'Addressing Misconceptions' is significantly higher than that of those who had low 'Addressing Misconceptions' at .01 level ($d = 0.23$). The mean score of Achievement in Physics of secondary school students who had high 'Using Mnemonics/Concept Mapping' does not significantly differ from that of those who had low 'Using Mnemonics/Concept Mapping' even at .05 level. The mean score of Achievement in Physics of secondary school students who had high 'Peer Teaching' does not significantly differ from that of those who had low 'Peer

Teaching' even at .05 level. The mean score of Achievement in Physics of secondary school students who had high 'Conducting Debate' is significantly less than that of those who had low 'Conducting Debate' at .01 level ($d = 0.25$).

The mean score of Achievement in Equations of Motion of secondary school students who had high 'Addressing Misconceptions' does not significantly differ from that of those who had low 'Addressing Misconceptions' even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high 'Addressing Misconceptions' is significantly higher than that of those who had low 'Addressing Misconceptions' at .05 level ($d = 0.21$).

The mean score of Achievement in Equations of Motion of secondary school students who had high 'Using Mnemonics/Concept Mapping' does not significantly differ from that of those who had low 'Using Mnemonics/Concept Mapping' even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high 'Using Mnemonics/Concept Mapping' does not significantly differ from that of those who had low 'Using Mnemonics/Concept Mapping' even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high 'Peer Teaching' does not significantly differ from that of those who had low 'Peer Teaching' even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high 'Peer Teaching' does not significantly differ from that of those who had low 'Peer Teaching' even at .05 level.

Discussion of Results

The secondary school students who had high 'Addressing Misconceptions' have significantly higher Achievement in Physics (small effect) and Achievement in Gravitation (small effect). The students who had high 'Conducting Debate' has significantly less Achievement in Physics (small effect). 'Using Mnemonics / Concept Mapping' and 'Peer Teaching' have no significant influence on Achievement in Physics and in difficult concepts among students.

Influence of Instructional Practices for 'Conducting Assessment' on Student Achievement in Physics

'Does the Instructional Practices for 'Conducting Assessment' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Achievement in Physics, Achievement in Equations of Motion (EOM) and Achievement in Gravitation (GRAV) of secondary school students by the levels of usage of each of the five Instructional Practices for 'Conducting Assessment' are given in Table 42.

Table 42

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Conducting Assessment'

Achievement	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Achievement in Physics	Formative Assessment		345	14.84	8.50	440	17.04	8.49	3.60**	0.26
	Mastery Oriented Assessment		376	15.33	8.83	409	16.76	8.25	2.34*	0.17
	Facilitated Assessment		660	16.37	8.67	125	14.51	7.79	2.23*	0.23
	Question Generation Strategy		661	16.26	8.50	174	15.41	8.78	1.15	-
	ICT- mediated Assessment		721	16.26	8.58	64	13.92	8.04	2.10*	0.28
Achievement in difficult concepts	Formative Assessment	EOM	163	8.57	3.48	299	9.11	3.31	1.65	-
		GRAV	146	8.65	3.47	305	8.90	3.81	0.67	-
	Mastery Oriented Assessment	EOM	243	8.70	3.28	219	9.16	3.47	1.45	-
		GRAV	236	9.05	3.76	215	8.57	3.62	1.39	-
	Facilitated Assessment	EOM	416	9.02	3.39	46	7.98	3.13	2.00*	0.32
		GRAV	419	8.95	3.73	32	7.19	2.80	2.61**	0.53
	Question Generation Strategy	EOM	400	9.00	3.31	62	8.39	3.78	1.34	-
		GRAV	384	8.95	3.74	67	8.07	3.41	1.79	-
	ICT- mediated Assessment	EOM	433	8.99	3.39	29	7.90	2.94	1.69	-
		GRAV	435	8.86	3.71	16	7.75	3.26	1.18	-

$^{**}p \leq .01$, $^{*}p \leq .05$

Table 42 shows that the mean score of Achievement in Physics of secondary school students who had high Formative Assessment while 'Conducting Assessment' is significantly higher than that of those who had low Formative Assessment at .01 level (d = 0.26). The mean score of Achievement in Physics of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' is significantly higher than that of those who had low Mastery Oriented Assessment at .05 level (d = 0.17). The mean score of Achievement in Physics of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' is significantly less than that of those who had low Facilitated Assessment at .05 level (d = 0.23). The mean score of Achievement in Physics of secondary school students

who had high Question Generation Strategy while ‘Conducting Assessment’ does not significantly differ from that of those who had low Question Generation Strategy even at .05 level. The mean score of Achievement in Physics of secondary school students who had high ICT-mediated Assessment for ‘Conducting Assessment’ is significantly less than that of those who had low ICT-mediated Assessment at .05 level (d = 0.28).

The mean score of Achievement in Equations of Motion of secondary school students who had high Formative Assessment while ‘Conducting Assessment’ does not significantly differ from that of those who had low Formative Assessment even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Formative Assessment while ‘Conducting Assessment’ does not significantly differ from that of those who had low Formative Assessment even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Mastery Oriented Assessment while ‘Conducting Assessment’ does not significantly differ from that of those who had low Mastery Oriented Assessment even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Mastery Oriented Assessment while ‘Conducting Assessment’ does not significantly differ from that of those who had low Mastery Oriented Assessment even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Facilitated Assessment for ‘Conducting Assessment’ is significantly less than that of those who had low Facilitated Assessment at .05 level (d = 0.32). The mean score of Achievement in Gravitation of secondary school

students who had high Facilitated Assessment for 'Conducting Assessment' is significantly less than that of those who had low Facilitated Assessment at .01 level ($d = 0.53$).

The mean score of Achievement in Equations of Motion of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' does not significantly differ from that of those who had low Question Generation Strategy even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' does not significantly differ from that of those who had low Question Generation Strategy even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high ICT-mediated Assessment while 'Conducting Assessment' does not significantly differ from that of those who had low ICT-mediated Assessment even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high ICT-mediated Assessment while 'Conducting Assessment' does not significantly differ from that of those who had low ICT-mediated Assessment even at .05 level.

Discussion of Results

While 'Conducting Assessment', the secondary school students who had high Formative Assessment and Mastery Oriented Assessment has significantly higher Achievement in Physics (small and negligible effect respectively). The students who had high Facilitated Assessment has significantly less Achievement in Physics (small effect) and in difficult concepts (small effect and medium effect respectively) and

those who had high ICT-mediated Assessment has significantly less Achievement in Physics (small effect). Question-generation Strategy has no significant influence on Achievement in Physics and in difficult concepts among students.

Influence of Instructional Practices for 'Consolidation of Concepts' on Student Achievement in Physics

'Does the Instructional Practices for 'Consolidation of Concepts' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Achievement in Physics, Achievement in Equations of Motion (EOM) and Achievement in Gravitation (GRAV) of secondary school students by the levels of usage of each of the five Instructional Practices for 'Consolidation of Concepts' are given in Table 43.

Table 43

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Consolidation of Concepts'

Achievement	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Achievement in Physics	Teacher Dominant Instruction		376	14.53	8.24	409	17.49	8.61	4.92**	0.35
	Student Participatory Individual Instruction		489	16.11	8.40	296	16.00	8.83	0.18	-
	Supervisory Instruction		579	16.69	8.77	206	14.33	7.70	3.65**	0.29
	ICT- mediated Instruction		625	16.16	8.69	160	15.73	8.06	0.56	-
	Student Participatory Group Instruction		708	16.37	8.51	77	13.30	8.56	3.01**	0.36
Achievement in difficult concepts	Teacher Dominant Instruction	EOM	102	8.83	3.63	360	8.94	3.30	0.29	-
		GRAV	97	8.87	3.62	354	8.81	3.73	0.14	-
	Student Participatory Individual Instruction	EOM	340	9.04	3.20	122	8.59	3.83	1.16	-
		GRAV	330	8.85	3.70	121	8.74	3.71	0.30	-
	Supervisory Instruction	EOM	374	9.20	3.33	88	7.75	3.31	3.66**	0.44
		GRAV	368	8.99	3.81	83	8.08	3.07	2.01*	0.26
	ICT- mediated Instruction	EOM	409	9.03	3.38	53	8.08	3.24	1.94	-
		GRAV	391	8.95	3.72	60	7.95	3.49	1.96*	0.28
	Student Participatory Group Instruction	EOM	421	9.06	3.32	41	7.46	3.59	2.92**	0.46
		GRAV	426	8.87	3.74	25	8.00	2.86	1.14	-

**$p \leq .01$, *$p \leq .05$

Table 43 shows that the mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' is significantly higher than that of those who had low Teacher Dominant Instruction at .01 level (d = 0.35). The mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' is significantly less than that of those who had low Supervisory Instruction at .01 level (d = 0.29). The mean score of

Achievement in Physics of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' is significantly less than that of those who had low Student Participatory Group Instruction at .01 level (d = 0.36).

The mean score of Achievement in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Teacher Dominant Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Consolidation of is significantly less than that of those who had low Supervisory Instruction at .01 level (d = 0.44). The mean score of Achievement in Gravitation of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' is significantly less than that of those who had low Supervisory Instruction at .05 level (d = 0.26).

The mean score of Achievement in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low ICT-mediated Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' is significantly less than that of those who had low ICT-mediated Instruction at .05 level (d = 0.28).

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' is significantly less than that of those who had low Student Participatory Group Instruction at .01 level (d = 0.46). The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

Discussion of Results

While 'Consolidation of Concepts', the secondary school students who had high Teacher Dominant Instruction has significantly higher Achievement in Physics (small effect). The students who had high Student Participatory Group Instruction has significantly less Achievement in Physics (small effect) and Achievement in Equations of Motion (small effect). The students who had high Supervisory Instruction has significantly less Achievement in Physics (small effect) and Achievement in difficult concepts (small effect). The students who had high ICT-mediated Instruction has significantly less Achievement in Gravitation (small effect). Student Participatory Individual Instruction has no significant influence on Achievement in Physics and Achievement in difficult concepts among students.

Influence of Instructional Practices for 'Providing Follow-up Activity' on Student Achievement in Physics

'Does the Instructional Practices for 'Providing Follow-up Activity' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Achievement in Physics, Achievement in Equations of Motion (EOM) and Achievement in Gravitation (GRAV) of secondary school students by the levels of usage of each of the three Instructional Practices for 'Providing Follow-up Activity' are given in Table 44.

Table 44

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Providing Follow-up Activity'

Achievement	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Achievement in Physics	Student Participatory Individual Instruction		376	14.53	8.24	409	17.49	8.61	4.92**	0.35
	Supervisory Instruction		391	15.69	8.35	394	16.45	8.76	1.24	-
	Student Participatory Group Instruction		626	16.66	8.65	159	13.77	7.81	4.07**	0.35
Achievement in difficult concepts	Student Participatory Individual Instruction	EOM	171	8.54	3.24	291	9.14	3.44	1.87	-
		GRAV	167	8.98	3.93	284	8.73	3.56	0.71	-
	Supervisory Instruction	EOM	281	8.89	3.29	181	8.96	3.51	0.21	-
		GRAV	283	8.75	3.69	168	8.94	3.73	0.53	-
	Student Participatory Group Instruction	EOM	386	9.06	3.46	76	8.20	2.81	2.36*	0.27
		GRAV	410	8.90	3.79	41	8.05	2.63	1.40	-

**$p \leq .01$, *$p \leq .05$

Table 44 shows that the mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' is significantly higher than that of those who had low Student Participatory Individual Instruction at .01 level ($d = 0.35$). The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' is significantly less than that of those who had low Student Participatory Group Instruction at .01 level ($d = 0.35$).

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Providing

Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Individual Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Supervisory Instruction even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' is significantly less than that of those who had low Student Participatory Group Instruction at .05 level (d = 0.27). The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' does not significantly differ from that of those who had low Student Participatory Group Instruction even at .05 level.

Discussion of Results

While 'Providing Follow-up Activity', the secondary school students who had high Student Participatory Individual Instruction has significantly higher Achievement in Physics (small effect). The students who had high Student Participatory Group Instruction has significantly less Achievement in Physics (small effect) and Achievement in Equations of Motion (small effect). Supervisory Instruction has no significant influence on Achievement in Physics and Achievement in difficult concepts among students.

Influence of Instructional Practices for 'Enriching Learning Experiences' on Student Achievement in Physics

'Does the Instructional Practices for 'Enriching Learning Experiences' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts, between high and low levels of usage of each of the instructional practices. Data and results of the tests of significance of difference between the mean scores of Achievement in Physics, Achievement in Equations of Motion (EOM) and Achievement in Gravitation (GRAV) of secondary school students by the levels of usage of each of the four Instructional Practices for 'Enriching Learning Experiences' are given in Table 45.

Table 45

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Enriching Learning Experiences'

Achievement	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Achievement in Physics	Directing to take part in Science Club Activities		334	14.56	8.41	451	17.19	8.51	4.30**	0.31
	Suggesting Extra Reference Materials/Web Resources		515	15.99	8.50	270	16.23	8.68	0.37	-
	Directing to Exhibit Works on Public Platforms		656	16.21	8.26	129	15.37	9.96	0.90	-
	Organizing Field Trips		732	16.28	8.64	53	13.13	6.72	3.23**	0.41
Achievement in difficult concepts	Suggesting Extra Reference Materials/Web Resources	EOM	350	9.04	3.31	112	8.54	3.55	1.39	-
		GRAV	359	8.92	3.75	92	8.41	3.51	1.18	-

**$p \leq .01$, *$p \leq .05$

Table 45 shows that the mean score of Achievement in Physics of secondary school students who had high 'Directing to take part in Science Club Activities' for 'Enriching Learning Experiences' is significantly higher than that of those who had low 'Directing to take part in Science Club Activities' at .01 level (d = 0.31). The mean score of Achievement in Physics of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' even at .05 level. The mean score of Achievement in Physics of secondary school students who had high 'Directing to Exhibit Works on Public Platforms' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Directing to Exhibit Works on Public Platforms' even at .05 level. The mean score of Achievement in Physics of secondary school students who had high 'Organizing Field Trips' for 'Enriching Learning Experiences' is significantly less than that of those who had low 'Organizing Field Trips' at .01 level (d = 0.41).

The mean score of Achievement in Equations of Motion of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' even at .05 level.

Discussion of Results

While 'Enriching Learning Experiences', the secondary school students who had high 'Directing to take part in Science Club Activities' has significantly higher Achievement in Physics (small effect). The students who had high 'Organizing Field Trips' has significantly less Achievement in Physics (small effect). 'Suggesting Extra Reference Materials/Web Resources' and 'Directing to Exhibit Works on Public Platforms' has no significant influence on Achievement in Physics and in difficult concepts among students.

Influence of Instructional Practices for 'Examination Preparedness' on Student Achievement in Physics

'Does the Instructional Practices for 'Examination Preparedness' influence student Achievement in Physics at secondary level?' was investigated by comparing the mean scores of achievements, namely, Achievement in Physics and Achievement in select difficult concepts, between high and low levels of usage of each of the

instructional practices. Data and results of the tests of significance of difference between the mean scores of Achievement in Physics, Achievement in Equations of Motion (EOM) and Achievement in Gravitation (GRAV) of secondary school students by the levels of usage of each of the four Instructional Practices for 'Examination Preparedness' are given in Table 46.

Table 46

Data and Results of Comparison of Achievement in Physics of Secondary School Students by the Levels of Usage of Instructional Practices for 'Examination Preparedness'

Achievement	Instructional Practices		High			Low			*t*	Cohen's *d*
			N	Mean	*SD*	*N*	Mean	*SD*		
Achievement in Physics	Test Previewing Strategy		344	14.51	8.66	441	17.29	8.29	4.58**	0.33
	Test Reviewing Strategy		396	14.96	8.42	389	17.21	8.56	3.71**	0.27
	Differentiated Strategy		426	16.24	8.55	359	15.87	8.58	0.61	-
Achievement in difficult concepts	Test Previewing Strategy	EOM	125	8.78	3.15	337	8.97	3.46	0.56	-
		GRAV	111	8.86	3.86	340	8.81	3.65	0.12	-
	Test Reviewing Strategy	EOM	253	8.92	3.34	209	8.92	3.42	0.01	-
		GRAV	274	8.76	3.79	177	8.91	3.57	0.41	-
	Differentiated Strategy	EOM	312	9.19	3.33	150	8.36	3.41	2.49*	0.25
		GRAV	301	8.93	3.55	150	8.59	3.98	0.92	-

**$p \leq .01$, *$p \leq .05$

Table 46 shows that the mean score of Achievement in Physics of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' is significantly higher than that of those who had low Test Previewing Strategy at .01 level (d = 0.33). The mean score of Achievement in Physics of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' is significantly higher than that of those who had low Test Reviewing Strategy at .01 level (d = 0.27). The mean score of Achievement in Physics of secondary school students who had high Differentiated Strategy for 'Examination

Preparedness' does not significantly differ from that of those who had low Differentiated Strategy even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Test Previewing Strategy even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Test Previewing Strategy even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Test Reviewing Strategy even at .05 level. The mean score of Achievement in Gravitation of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Test Reviewing Strategy even at .05 level.

The mean score of Achievement in Equations of Motion of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' is significantly less than that of those who had low Differentiated Strategy at .05 level (d = 0.25). The mean score of Achievement in Gravitation of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' does not significantly differ from that of those who had low Differentiated Strategy even at .05 level.

Discussion of Results

While 'Examination Preparedness', the secondary school students who had high Test Previewing and Reviewing Strategies has significantly higher Achievement in Physics (both having small effect). The students who had high Differentiated Instruction has significantly less Achievement in Equations of Motion (small effect).

Tenability of Hypotheses

1. The first hypothesis states that *the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in Physics among secondary school students*.

The findings of the study show that Domain Interest in Physics is found significantly influenced only by the Instructional Practices, viz., Teacher Dominant Instruction while 'Introducing New Concepts'; Teacher Dominant Instruction, Student Participatory Individual Instruction and Supervisory Instruction while 'Performing Experiments / Activities'; Teacher Dominant Instruction and Supervisory Instruction while 'Working-out Mathematical Problems'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; 'Addressing Misconceptions', 'Using Mnemonics/ Concept Mapping' and 'Peer Teaching'; Formative Assessment and Mastery Oriented Assessment while 'Conducting Assessment; Teacher Dominant Instruction while 'Consolidation of Concepts'; Student Participatory Individual Instruction and Supervisory Instruction while 'Providing Follow-up Activity'; Directing to take part in Science Club Activities for 'Enriching Learning Experiences'; Test Previewing and

Test Reviewing Strategies while performing 'Examination Preparedness'. Thus, the first hypothesis is only partially substantiated.

2. The second hypothesis states that *the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in difficult concepts in physics among secondary school students*.

The findings of the study show that Domain Interest in difficult concepts is found significantly influenced only by the Instructional Practices, viz., Teacher Dominant Instruction and ICT-mediated instruction while 'Introducing New Concepts', Teacher Dominant Instruction while 'Working-out Mathematical Problems'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; Teacher Dominant Instruction while 'Facilitating Note-making Process'; 'Addressing Misconceptions', 'Using Mnemonics/ Concept Mapping' and 'Peer Teaching'; Supervisory Instruction while 'Consolidation of Concepts'; Student Participatory Individual Instruction and Supervisory Instruction while 'Providing Follow-up Activity'; Test Previewing Strategy while performing 'Examination Preparedness'. Thus, the second hypothesis is only partially substantiated.

3. The third hypothesis states that *the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Situational Interest in Physics among secondary school students*.

The findings of the study shows that Situational Interest in Physics is found significantly influenced only by the Instructional Practices, viz., Teacher Dominant

Instruction and ICT-mediated Instruction while 'Introducing New Concepts'; Student Participatory Group Instruction while Performing Experiments and Activities; Teacher Dominant Instruction while 'Working-out Mathematical Problems'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; Teacher Dominant Instruction and Supervisory Instruction while 'Facilitating Note-making Process'; 'Addressing Misconceptions', 'Using Mnemonics/ Concept Mapping' and 'Peer Teaching'; Formative Assessment while 'Conducting Assessment; Student Participatory Individual Instruction and Supervisory Instruction while 'Consolidation of Concepts'; Supervisory Instruction while 'Providing Follow-up Activity'; Test Previewing and Test Reviewing Strategies while performing 'Examination Preparedness'. Thus, the third hypothesis is only partially substantiated.

4. The fourth hypothesis states that *the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Individual Interest in Physics among secondary school students.*

The findings of the study shows that Individual Interest in Physics is found significantly influenced only by the Instructional Practices, viz., Teacher Dominant Instruction and ICT-mediated Instruction while 'Introducing New Concepts'; Student Participatory Individual Instruction and Supervisory Instruction while 'Performing Experiments / Activities'; Teacher Dominant Instruction and Supervisory Instruction while 'Working-out Mathematical Problems'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; Teacher Dominant Instruction and Supervisory Instruction while 'Facilitating Note-

making Process'; 'Addressing Misconceptions', 'Using Mnemonics/ Concept Mapping' and 'Conducting Debate'; Formative Assessment and Mastery Oriented Assessment while 'Conducting Assessment; Student Participatory Individual Instruction and Supervisory Instruction while 'Consolidation of Concepts'; Supervisory Instruction while 'Providing Follow-up Activity'; Directing to take part in science club activities and Suggesting extra references and web resources for 'Enriching Learning Experiences'; Test Reviewing Strategies and Differentiated Strategy while performing 'Examination Preparedness'. Thus, the fourth hypothesis is only partially substantiated.

5. The fifth hypothesis states that *the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in Physics among secondary school students*.

The findings of the study shows that Achievement in Physics is found significantly influenced only by the Instructional Practices, viz., Teacher Dominant Instruction while 'Introducing New Concepts', 'Performing Experiments / Activities'; Teacher Dominant Instruction, Student Participatory Group Instruction and ICT-mediated Instruction while 'Working-out Mathematical Problems'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; 'Addressing Misconceptions', 'Conducting Debate'; Formative, Mastery Oriented, Facilitated and ICT-mediated Assessment; Teacher Dominant Instruction, Student Participatory Group Instruction and Supervisory Instruction while 'Consolidation of Concepts'; Student Participatory Individual Instruction and Student Participatory Group Instruction while 'Providing Follow-up Activity';

'Directing to take part in Science Club Activities', 'Organizing field trip'; Test Previewing and Test Reviewing Strategies while performing 'Examination Preparedness'. Thus, the fifth hypothesis is only partially substantiated.

6. The sixth hypothesis states that *the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in difficult concepts in physics among secondary school students*.

The findings of the study shows that Achievement in difficult concepts is found significantly influenced only by the Instructional Practices, viz., ICT-mediated Instruction while 'Introducing New Concepts'; Student Participatory Group Instruction, Supervisory Instruction and ICT-mediated Instruction while 'Working-out Mathematical Problems' and 'Consolidation of Concepts'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; Facilitated Assessment; Student Participatory Group Instruction while 'Providing Follow-up Activity'; 'Addressing Misconceptions'; Differentiated Instruction while 'Examination Preparedness'. Thus, the sixth hypothesis is only partially substantiated.

Chapter Five

SUMMARY AND FINDINGS

- Restatement of the Problem
- Variables
- Research Questions
- Objectives
- Hypotheses
- Methodology
- Major Findings of the Study
- Findings in Brief and Tenability of Hypotheses
- Conclusion

This chapter constitutes the summary of the significant stages of the study and further highlights the findings systematically.

Restatement of the Problem

The problem was entitled as Analysis of Instructional Practices in Physics and Their Influence on Interests and Achievement among Secondary School Students.

The study identified the extant Instructional Practices of physics teachers at secondary level and their influence on Interests and Achievement in Physics among secondary school students. These objectives were also substantiated in the case of transaction of major concepts in physics that students perceive to be difficult while learning.

Hence, the present study was restated as Analysis of Instructional Practices in Physics and Their Influence on Interests and Achievement among Secondary School Students.

Variables

The independent variables in the study were Instructional Practices in Physics (Instructional Practices in Physics, Instructional Practices for Equations of Motion and Instructional Practices for Gravitation). The dependent variables were Interests in Physics (Domain Interest in Physics, Domain Interest in Equations of Motion, Domain

Interest in Gravitation, Situational Interest in Physics and Individual Interest in Physics) and Achievement in Physics (Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation).

Research Questions

The problem under study was systematically investigated through the following questions.

1. Which major physics concepts taught in secondary school are considered the most to least difficult by the students?
2. Which are the extant Instructional Practices of teachers in physics at secondary level?
3. Does the extent of usage of distinct types of Instructional Practices in various teaching-learning situations influence Secondary School Students' Interests in physics, namely:

    a) Domain Interest in Physics and in select difficult concepts?

    b) Situational Interest in Physics?

    c) Individual Interest in Physics?

5. Does the extent of usage of distinct types of Instructional Practices in various teaching-learning situations influence Secondary School Students' Achievement in:

    a) Physics?

    b) select difficult concepts in physics?

Objectives

The objective of the study was to analyse the extant Instructional Practices in Physics and their influence on Interests and Achievement among secondary school students. The objective of the study was attained through the following specific objectives.

1. To rank the major concepts in physics taught at secondary level in the order of difficulty for the secondary school students.

2. To explore the extant Instructional Practices of teachers in physics at secondary level.

3. To examine the influence of each type of Instructional Practice in various teaching-learning situations on Secondary School Students' interests, namely:

    a) Domain Interest in Physics and in select difficult concepts
    b) Situational Interest in Physics
    c) Individual Interest in Physics

4. To examine the influence of each type of Instructional Practice in various teaching-learning situations on Secondary School Students' Achievement in:

    a) Physics
    b) select difficult concepts in physics

Hypotheses

The hypotheses formulated for this study are as follows.

1. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in Physics among secondary school students.

2. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in difficult concepts in physics among secondary school students.

3. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Situational Interest in Physics among secondary school students.

4. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Individual Interest in Physics among secondary school students.

5. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in Physics among secondary school students.

6. The extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in difficult concepts in physics among secondary school students.

Methodology

Method of the Study

Two-phase quantitative survey design was employed in this study for analysing the extant Instructional Practices in Physics and their influence on Interests and Achievement among secondary school students.

Procedure of the Study

The study was carried out in two phases as explained below.

Phase-I

Phase-I of the survey was descriptive in nature and was meant to rank the major concepts in physics in the order of difficulty for IX standard students to learn. The required data was collected both from students and teachers using respective tools. Based on their responses the difficult concepts were identified.

Phase-II

Phase-II of the survey was analytical in nature. Based on the difficult concepts identified in Phase-I, tests, checklists and scales were prepared. These tools were administered to IX standard students and based on their responses the extant Instructional Practices in Physics and their influence on Interests and Achievement in students were analysed.

Sample Used for the Study

Phase-I of the survey was conducted on a sample of 623 students of IX standard selected using stratified sampling technique from Malappuram and Kozhikode districts and 30 physics teachers from Malappuram, Kozhikode and Kannur districts.

In Phase-II of the study, the sample was IX standard students selected using stratified sampling technique from Malappuram, Kozhikode, Thrissur and Palakkad districts. The survey was conducted on 913 students for finding out the extant Instructional Practices for select difficult concepts and their influence on Domain Interest and Achievement in difficult concepts. For finding out the extant Instructional Practices in Physics and their influence on Interests (Domain Interest, Situational Interest, Individual Interest) in Physics and Achievement in Physics, the survey was conducted on select 785 students.

Tools Used for the Study

The tools used for the study are given below.

Phase-I

1. Conceptual Understanding Test in Physics (Abdulla & Mumthas, 2023)

Phase-II

2. Scale on Instructional Practices in Physics (Abdulla & Mumthas, 2024)

3. Checklist on Instructional Practices for Equations of Motion / Gravitation (Abdulla & Mumthas, 2024)

4. Domain Interest Scale in Physics (Abdulla & Mumthas, 2024)

5. Situational Interest Scale in Physics (Abdulla & Mumthas, 2024)

6. Individual Interest Scale in Physics (Abdulla & Mumthas, 2024)

7. Achievement Test on Equations of Motion (Abdulla & Mumthas, 2024)

8. Achievement Test on Gravitation (Abdulla & Mumthas, 2024)

Statistical Techniques Used in the Study

The statistical techniques used in the study are given below.

Percentage analysis

To find out the extent of usage of Instructional Practices in various teaching-learning situations in physics at secondary level, percentage analysis was used.

Test of Significance of Difference Between the Means for Large Independent Samples

Test of significance of difference between the means for large independent samples was used to find out the influence of Instructional Practices on select dependent variables, viz., Domain Interest in Physics, Situational Interest in Physics, Individual Interest in Physics, Domain Interest in Equations of Motion, Domain Interest in Gravitation, Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation among secondary school students.

Effect Size (Cohen's d)

Cohen's *d* was used to determine how much is the effect of Instructional Practices on select dependent variables, viz., Domain Interest in Physics, Situational Interest in Physics, Individual Interest in Physics, Domain Interest in Equations of Motion, Domain Interest in Gravitation, Achievement in Physics, Achievement in Equations of Motion and Achievement in Gravitation among secondary school students.

Major Findings of the Study

The findings of the study are summarized as follows.

Difficulty in Major Concepts in Physics at Secondary Level

In physics, the highest ranking of difficulty for secondary school students is for the major concept, Equations of Motion, which is followed by Gravitation, Motion and Laws of Motion, Work, Energy, Power and finally the easiest, Forces in Fluids.

Instructional Practices of Teachers in Physics at Secondary Level

i. For 'Introducing New Concepts' in Physics, in Equations of Motion and in Gravitation at secondary level, Teacher Dominant Instruction is used frequently, Student Participatory Group Instruction is employed either occasionally or rarely, Student Participatory Individual Instruction is practiced rarely and ICT-mediated Instruction is used either rarely or almost never.

ii. While 'Performing Experiments or Activities' in Physics, Teacher Dominant Instruction is employed either occasionally or sometimes, Student

Participatory Individual Instruction, Student Participatory Group Instruction and Supervisory Instruction are used rarely and ICT-mediated Instruction is used almost never.

iii. For 'Working out Mathematical Problems', in Physics, in Equations of Motion and in Gravitation, Teacher Dominant Instruction is employed frequently, Student Participatory Individual Instruction is used sometimes, Supervisory Instruction is used either sometimes or occasionally, Student Participatory Group Instruction is employed rarely and ICT-mediated Instruction is practiced almost never.

iv. While teaching Physics, Equations of Motion and Gravitation, 'Transacting Methodical Tactics of Mathematical Problem-solving' is practiced sometimes. 'Introducing Graph and Working out Related Problems' are practiced frequently while teaching Physics and Equations of Motion.

v. 'Executing Project Works' in Physics, in Equations of Motion and in Gravitation is never practiced by any teachers.

vi. For 'Facilitating Note-making Process' in Physics, in Equations of Motion and in Gravitation, Teacher Dominant Instruction and Supervisory Instruction are used occasionally, Student Participatory Individual Instruction is employed rarely and Student Participatory Group Instruction is practiced almost never.

vii. Under 'Miscellaneous Ways of Teaching' in Physics, in Equations of Motion and in Gravitation, the instructional strategy of 'Addressing Misconceptions' is done either frequently or sometimes, 'Using Mnemonics/ Concept

Mapping' is done sometimes, 'Peer Teaching' and 'Conducting Debate' is performed almost never and 'Team Teaching' is never employed.

viii. While 'Conducting Assessment' in Physics, in Equations of Motion and in Gravitation, Formative Assessment is used very often or frequently, Mastery-oriented Assessment is practiced sometimes, Facilitated Assessment, Question Generation Strategy and ICT-mediated Assessment are employed almost never by teachers.

ix. For 'Consolidation of Concepts' in Physics, Teacher Dominant Instruction is practiced sometimes. While in Equations of Motion and in Gravitation, it is used frequently. For 'Consolidation of Concepts' in Physics, in Equations of Motion and in Gravitation, Student Participatory Individual Instruction is used rarely, Supervisory Instruction is employed either rarely or almost never, ICT-mediated Instruction and Student Participatory Group Instruction are practiced almost never.

x. While 'Providing Follow-up Activity' in Physics, in Equations of Motion and in Gravitation, Student Participatory Individual Instruction is used sometimes, Supervisory Instruction is employed either occasionally or rarely and Student Participatory Group Instruction is practiced almost never.

xi. For 'Enriching Learning Experiences', 'Suggesting Extra Reference Materials/Web Resources' in Physics, in Equations of Motion and in Gravitation is done rarely, 'Directing to take part in Science Club Activities'

is done occasionally, 'Directing to Exhibit Works on Public Platforms' and 'Organizing Field Trips' are performed almost never.

xii. For performing 'Examination Preparedness' in Physics, in Equations of Motion and in Gravitation, both Test Previewing Strategy and Test Reviewing Strategy are employed frequently and Differentiated Strategy is used rarely.

Influence of Instructional Practices on Interests in Physics Among Secondary School Students

Influence of Instructional Practices for 'Introducing New Concepts' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' (Mean = 41.33, $N = 463$, $SD = 10.52$) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 37.83, $N = 322$, $SD = 11.14$) [$t = 4.47$, $p \leq .01$, $d = 0.32$].

ii. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' (Mean = 40.46, $N = 428$, $SD = 10.93$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 39.22, $N = 357$, $SD = 10.87$) [$t = 1.58$, $p > .05$].

iii. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' (Mean = 39.13, $N = 435$, $SD = 10.82$) is significantly less than

that of those who had low Student Participatory Individual Instruction (Mean = 40.84, $N = 350$, $SD = 10.96$) [$t = 2.19$, $p \leq .05$, $d = 0.19$].

iv. The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' (Mean = 39.60, $N = 332$, $SD = 10.24$) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 40.11, $N = 453$, $SD = 11.38$) [$t = 0.66$, $p > .05$].

v. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' (Mean = 7.11, $N = 218$, $SD = 2.80$) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 6.81, $N = 244$, $SD = 2.78$) [$t = 1.15$, $p > .05$].

vi. The mean score of Domain Interest in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' (Mean = 5.85, $N = 216$, $SD = 2.29$) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 5.41, $N = 235$, $SD = 2.42$) [$t = 1.98$, $p \leq .05$].

vii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' (Mean = 6.67, $N = 158$, $SD = 2.76$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 7.10, $N = 304$, $SD = 2.80$) [$t = 1.57$, $p > .05$].

viii. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' (Mean = 5.68, N = 143, SD = 2.29) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 5.60, N = 308, SD = 2.40) [t = 0.34, $p > .05$].

ix. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' (Mean = 6.89, N = 177, SD = 2.90) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 6.99, N = 285, SD = 2.72) [t = 0.36, $p > .05$].

x. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' (Mean = 5.44, N = 183, SD = 2.31) does not significantly differ from that of those who had low Student Participatory individual Instruction (Mean = 5.75, N = 268, SD = 2.40) [t = 1.34, $p > .05$].

xi. The mean score of Domain Interest in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' (Mean = 7.12, N = 128, SD = 2.82) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 6.89, N = 334, SD = 2.78) [t = 0.79, $p > .05$].

xii. The mean score of Domain Interest in Gravitation of secondary school students who had high ICT-mediated Instruction for 'Introducing New

Concepts' (Mean = 5.20, N = 111, SD = 2.30) is significantly less than that of those who had low ICT-mediated Instruction (Mean = 5.76, N = 340, SD = 2.37) [t = 2.19, $p \leq .05$, d = 0.24].

xiii. The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' (Mean = 27.01, N = 463, SD = 6.80) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 25.46, N = 322, SD = 6.97) [t = 3.10, $p \leq .01$, d = 0.23].

xiv. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' (Mean = 26.59, N = 428, SD = 6.93) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 26.12, N = 357, SD = 6.89) [t = 0.95, $p > .05$].

xv. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' (Mean = 26.06, N = 435, SD = 7.02) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 26.76, N = 350, SD = 6.76) [t = 1.40, $p > .05$].

xvi. The mean score of Situational Interest in Physics of secondary school students who had high ICT- mediated Instruction for 'Introducing New Concepts' (Mean = 26.97, N = 332, SD = 6.65) is significantly higher than that of those

who had low ICT- mediated Instruction (Mean = 25.94, $N = 453$, $SD = 7.07$) [$t = 2.08$, $p \leq .05$, $d = 0.15$].

xvii. The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' (Mean = 45.24, $N = 463$, $SD = 13.04$) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 40.35, $N = 322$, $SD = 13.83$) [$t = 5.03$, $p \leq .01$, $d = 0.36$].

xviii. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' (Mean = 43.34, $N = 428$, $SD = 13.70$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 43.10, $N = 357$, $SD = 13.42$) [$t = 0.25$, $p > .05$].

xix. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' (Mean = 43.87, $N = 435$, $SD = 13.49$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 42.44, $N = 350$, $SD = 13.65$) [$t = 1.47$, $p > .05$].

xx. The mean score of Individual Interest in Physics of secondary school students who had high ICT- mediated Instruction for 'Introducing New Concepts' (Mean = 44.37, $N = 332$, $SD = 13.48$) is significantly higher than that of those who had low ICT- mediated Instruction (Mean = 42.40, $N = 453$, $SD = 13.60$) [$t = 2.01$, $p \leq .05$, $d = 0.15$].

Influence of Instructional Practices for 'Performing Experiments and Activities' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Performing Experiments and Activities' (Mean = 40.74, N = 361, SD = 10.93) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 39.17, N = 424, SD = 10.85) [$t = 2.00$, $p \leq .05$, $d = 0.14$].

ii. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Performing Experiments and Activities' (Mean = 41.58, N = 375, SD = 10.15) is significantly higher than that of those who had low Student Participatory Individual Instruction (Mean = 38.35, N = 410, SD = 11.35) [$t = 4.20$, $p \leq .01$, $d = 0.30$].

iii. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Performing Experiments and Activities' (Mean = 39.87, N = 338, SD = 10.79) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 39.91, N = 447, SD = 11.01) [$t = 0.05$, $p > .05$].

iv. The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Performing Experiments and Activities' (Mean = 40.99, N = 341, SD = 9.99) is significantly higher than

that of those who had low Supervisory Instruction (Mean = 39.05, N = 444, SD = 11.51) [t = 2.51, $p \leq .05$, d = 0.18].

v. The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Performing Experiments and Activities' (Mean = 39.48, N = 217, SD = 10.46) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 40.05, N = 568, SD = 11.08) [t = 0.66, $p > .05$].

vi. The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Performing Experiments and Activities' (Mean = 26.65, N = 361, SD = 7.27) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 26.14, N = 424, SD = 6.59) [t = 1.02, $p > .05$].

vii. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Performing Experiments and Activities' (Mean = 26.98, N = 375, SD = 6.74) is significantly higher than that of those who had low Student Participatory Individual Instruction (Mean = 25.82, N = 410, SD = 7.02) [t = 1.37, $p \leq .05$, d = 0.17].

viii. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Performing Experiments and Activities' (Mean = 26.28, N = 338, SD = 7.18) does not

significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 26.45, $N = 447$, $SD = 6.71$) [$t = 0.33$, $p > .05$].

ix. The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Performing Experiments and Activities' (Mean = 26.83, $N = 341$, $SD = 7.12$) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 26.02, $N = 444$, $SD = 6.73$) [$t = 1.62$, $p > .05$].

x. The mean score of Situational Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Performing Experiments and Activities' (Mean = 26.08, $N = 217$, $SD = 6.57$) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 26.49, $N = 568$, $SD = 7.04$) [$t = 0.74$, $p > .05$].

xi. The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Performing Experiments and Activities' (Mean = 43.56, $N = 361$, $SD = 13.94$) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 42.96, $N = 424$, $SD = 13.27$) [$t = 0.62$, $p > .05$].

xii. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Performing Experiments and Activities' (Mean = 45.62, $N = 375$, $SD = 13.61$) is significantly higher than that of those who had low Student Participatory

Individual Instruction (Mean = 41.05, $N = 410$, $SD = 13.19$) [$t = 4.78$, $p \leq .01$, $d = 0.34$].

xiii. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Performing Experiments and Activities' (Mean = 43.25, $N = 338$, $SD = 13.60$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 43.22, $N = 447$, $SD = 13.57$) [$t = 0.02$, $p > .05$].

xiv. The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Performing Experiments and Activities' (Mean = 45.54, $N = 341$, $SD = 13.23$) is significantly higher than that of those who had low Supervisory Instruction (Mean = 41.46, $N = 444$, $SD = 13.59$) [$t = 4.22$, $p \leq .01$, $d = 0.30$].

xv. The mean score of Individual Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Performing Experiments and Activities' (Mean = 44.55, $N = 217$, $SD = 13.43$) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 42.73, $N = 568$, $SD = 13.61$) [$t = 1.69$, $p > .05$].

Influence of Instructional Practices for 'Working-out Mathematical Problems' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' (Mean = 41.05, $N = 436$, $SD = 10.59$) is significantly higher than

that of those who had low Teacher Dominant Instruction (Mean = 38.44, N = 349, SD = 11.14) [t = 3.35, $p \leq .01$, d = 0.24].

ii. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' (Mean = 39.85, N = 488, SD = 11.20) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 39.96, N = 297, SD = 10.44) [t = 0.14, $p > .05$].

iii. The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' (Mean = 40.73, N = 390, SD = 10.43) is significantly higher than that of those who had low Supervisory Instruction (Mean = 39.07, N = 395, SD = 11.32) [t = 2.13, $p \leq .05$, d = 0.15].

iv. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' (Mean = 39.67, N = 376, SD = 10.87) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 40.10, N = 409, SD = 10.95) [t = 0.56, $p > .05$].

v. The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' (Mean = 38.84, N = 188, SD = 10.00) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 40.23, N = 597, SD = 11.17) [t = 1.62, $p > .05$].

vi. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' (Mean = 7.21, $N = 293$, $SD = 2.79$) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 6.51, $N = 169$, $SD = 2.74$) [$t = 2.61$, $p \leq .01$, $d = 0.25$].

vii. The mean score of Domain Interest in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' (Mean = 5.81, $N = 267$, $SD = 2.29$) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 5.36, $N = 184$, $SD = 2.45$) [$t = 1.98$, $p \leq .05$, $d = 0.19$].

viii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' (Mean = 7.02, $N = 304$, $SD = 2.80$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 6.83, $N = 158$, $SD = 2.78$) [$t = 0.68$, $p > .05$].

ix. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' (Mean = 5.77, $N = 297$, $SD = 2.34$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 5.34, $N = 154$, $SD = 2.40$) [$t = 1.85$, $p > .05$].

x. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' (Mean = 7.10, N = 251, SD = 2.79) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 6.78, N = 211, SD = 2.78) [t = 1.24, $p > .05$].

xi. The mean score of Domain Interest in Gravitation of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' (Mean = 5.43, N = 238, SD = 2.41) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 5.84, N = 213, SD = 2.30) [t = 1.85, $p > .05$].

xii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' (Mean = 7.06, N = 246, SD = 2.87) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 6.83, N = 216, SD = 2.69) [t = 0.89, $p > .05$].

xiii. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' (Mean = 5.68, N = 222, SD = 2.30) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 5.57, N = 229, SD = 2.43) [t = 0.51, $p > .05$].

xiv. The mean score of Domain Interest in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' (Mean = 7.13, N = 64, SD = 2.61) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 6.92, N = 398, SD = 2.82) [t = 0.53, $p > .05$].

xv. The mean score of Domain Interest in Gravitation of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' (Mean = 5.47, N = 57, SD = 2.09) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 5.64, N = 394, SD = 2.40) [t = 0.51, $p > .05$].

xvi. The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' (Mean = 26.89, N = 436, SD = 6.65) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 25.73, N = 349, SD = 7.19) [t = 2.33, $p \leq .01$, d = 0.17].

xvii. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' (Mean = 26.60, N = 488, SD = 7.13) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 26.00, N = 297, SD = 6.54) [t = 1.20, $p > .05$].

xviii. The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical

Problems' (Mean = 26.63, N = 390, SD = 6.68) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 26.12, N = 395, SD = 7.13) [t = 1.02, $p > .05$].

xix. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' (Mean = 26.14, N = 376, SD = 7.21) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 26.59, N = 409, SD = 6.62) [t = 0.91, $p > .05$].

xx. The mean score of Situational Interest in Physics of secondary school students who had high ICT- mediated Instruction for 'Working-out Mathematical Problems' (Mean = 26.40, N = 188, SD = 6.83) does not significantly differ from that of those who had low ICT- mediated Instruction (Mean = 26.37, N = 597, SD = 6.94) [t = 0.06, $p > .05$].

xxi. The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' (Mean = 44.36, N = 436, SD = 13.75) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 41.83, N = 349, SD = 13.24) [t = 2.60, $p \leq .01$, d = 0.19].

xxii. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' (Mean = 43.43, N = 488, SD = 13.56) does not

significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 42.91, $N = 297$, $SD = 13.63$) [$t = 0.52$, $p > .05$].

xxiii. The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' (Mean = 45.63, $N = 390$, $SD = 12.76$) is significantly higher than that of those who had low Supervisory Instruction (Mean = 40.86, $N = 395$, $SD = 13.96$) [$t = 5.00$, $p \leq .01$, $d = 0.36$].

xxiv. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' (Mean = 43.65, $N = 376$, $SD = 12.74$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 42.85, $N = 409$, $SD = 14.31$) [$t = 0.83$, $p > .05$].

xxv. The mean score of Individual Interest in Physics of secondary school students who had high ICT- mediated Instruction for 'Working-out Mathematical Problems' (Mean = 44.31, $N = 188$, $SD = 12.63$) does not significantly differ from that of those who had low ICT- mediated Instruction (Mean = 43.21, $N = 597$, $SD = 13.87$) [$t = 0.10$, $p > .05$].

Influence of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working-out Related Problems' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high level of usage of 'Transacting Methodical Tactics of

Mathematical Problem-solving' (Mean = 42.96, N = 398, SD = 10.86) is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 36.74, N = 387, SD = 10.03) [t = 8.35, $p \leq .01$, d = 0.60].

ii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high level usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 7.49, N = 201, SD = 2.54) is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 6.54, N = 261, SD = 2.90) [t = 3.77, $p \leq .01$, d = 0.35].

iii. The mean score of Domain Interest in Gravitation of secondary school students who had high level usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 5.91, N = 207, SD = 2.35) is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 5.38, N = 244, SD = 2.36) [t = 2.37, $p \leq .05$, d = 0.23].

iv. The mean score of Situational Interest in Physics of secondary school students who had high level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 27.28, N = 398, SD = 6.70) is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 25.44, N = 387, SD = 7.01) [t = 3.75, $p \leq .01$, d = 0.27].

v. The mean score of Individual Interest in Physics of secondary school students who had high level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 46.48, N = 398, SD = 13.84) is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 39.89, N = 387, SD = 12.47) [t = 7.02, $p \leq .01$, d = 0.50].

vi. The mean score of Domain Interest in Physics of secondary school students who had high level of usage of 'Introducing Graph and Working out Related Problems' (Mean = 41.94, N = 443, SD = 11.18) is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' (Mean = 37.24, N = 342, SD = 9.96) [t = 6.22, $p \leq .01$, d = 0.44].

vii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high level usage of 'Introducing Graph and Working out Related Problems' (Mean = 7.19, N = 259, SD = 2.78) is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' (Mean = 6.65, N = 203, SD = 2.77) [t = 2.10, $p \leq .05$, d = 0.19].

viii. The mean score of Situational Interest in Physics of secondary school students who had high level of usage of 'Introducing Graph and Working out Related Problems' (Mean = 26.84, N = 443, SD = 6.77) is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out

Related Problems' (Mean = 25.78, $N = 342$, $SD = 7.06$) [$t = 2.13$, $p \leq .05$, $d = 0.15$].

ix. The mean score of Individual Interest in Physics of secondary school students who had high level of usage of 'Introducing Graph and Working out Related Problems' (Mean = 44.99, $N = 443$, $SD = 13.46$) is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' (Mean = 40.96, $N = 342$, $SD = 13.41$) [$t = 4.17$, $p \leq .01$, $d = 0.30$].

Influence of Instructional Practices for 'Facilitating Note-making Process' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' (Mean = 40.39, $N = 464$, $SD = 11.15$) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 39.18, $N = 321$, $SD = 10.53$) [$t = 1.52$, $p > .05$].

ii. The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' (Mean = 40.31, $N = 380$, $SD = 10.24$) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 39.50, $N = 405$, $SD = 11.50$) [$t = 1.03$, $p > .05$].

iii. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating

Note-making Process' (Mean = 39.42, N = 399, SD = 10.75) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 40.39, N = 386, SD = 11.06) [t = 1.25, $p > .05$].

iv. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' (Mean = 39.99, N = 69, SD = 9.45) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 39.88, N = 716, SD = 11.05) [t = 0.07, $p > .05$].

v. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' (Mean = 6.97, N = 363, SD = 2.83) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 6.88, N = 99, SD = 2.64) [t = 0.30, $p > .05$].

vi. The mean score of Domain Interest in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' (Mean = 5.75, N = 351, SD = 2.32) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 5.18, N = 100, SD = 2.48) [t = 2.13, $p \leq .05$, d = 0.24].

vii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' (Mean = 7.02, N = 180, SD = 2.80) does not significantly

differ from that of those who had low Supervisory Instruction (Mean = 6.91, $N = 282$, $SD = 2.79$) [$t = 0.43$, $p > .05$].

viii. The mean score of Domain Interest in Gravitation of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' (Mean = 5.58, $N = 174$, $SD = 2.26$) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 5.65, $N = 277$, $SD = 2.43$) [$t = 0.30$, $p > .05$].

ix. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' (Mean = 6.84, $N = 200$, $SD = 2.77$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 7.04, $N = 262$, $SD = 2.81$) [$t = 0.79$, $p > .05$].

x. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' (Mean = 5.67, $N = 182$, $SD = 2.21$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 5.59, $N = 269$, $SD = 2.47$) [$t = 0.35$, $p > .05$].

xi. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' (Mean = 6.78, $N = 27$, $SD = 1.76$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 6.96, $N = 435$, $SD = 2.84$) [$t = 0.51$, $p > .05$].

xii. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' (Mean = 5.38, $N = 16$, $SD = 3.10$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 5.63, $N = 435$, $SD = 2.34$) [$t = 0.43$, $p > .05$].

xiii. The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' (Mean = 26.80, $N = 464$, $SD = 6.77$) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 25.75, $N = 321$, $SD = 7.07$) [$t = 2.10$, $p \leq .05$, $d = 0.15$].

xiv. The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' (Mean = 27.17, $N = 380$, $SD = 7.05$) is significantly higher than that of those who had low Supervisory Instruction (Mean = 25.62, $N = 405$, $SD = 6.70$) [$t = 3.16$, $p \leq .01$, $d = 0.23$].

xv. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' (Mean = 26.66, $N = 399$, $SD = 7.01$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 26.08, $N = 386$, $SD = 6.80$) [$t = 1.16$, $p > .05$].

xvi. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-

making Process' (Mean = 26.51, N = 69, SD = 7.36) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 26.36, N = 716, SD = 6.87) [t = 0.17, $p > .05$].

xvii. The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' (Mean = 44.08, N = 464, SD = 13.85) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 42.02, N = 321, SD = 13.10) [t = 2.09, $p \leq .05$, d = 0.15].

xviii. The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' (Mean = 44.74, N = 380, SD = 13.65) is significantly higher than that of those who had low Supervisory Instruction (Mean = 41.82, N = 405, SD = 13.37) [t = 3.03, $p \leq .01$, d = 0.22].

xix. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' (Mean = 42.76, N = 399, SD = 13.99) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 43.73, N = 386, SD = 13.13) [t = 1.00, $p > .05$].

xx. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' (Mean = 43.26, N = 69, SD = 13.04) does not significantly

differ from that of those who had low Student Participatory Group Instruction (Mean = 43.23, $N = 716$, $SD = 13.64$) [$t = 0.02$, $p > .05$].

Influence of Instructional Practices under 'Miscellaneous Ways of Teaching' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high 'Addressing Misconceptions' (Mean = 41.68, $N = 488$, $SD = 10.36$) is significantly higher than that of those who had low 'Addressing Misconceptions' (Mean = 36.96, $N = 297$, $SD = 11.17$) [$t = 6.02$, $p \leq .01$, $d = 0.44$].

ii. The mean score of Domain Interest in Physics of secondary school students who had high 'Using Mnemonics/Concept Mapping' (Mean = 41.08, $N = 435$, $SD = 10.83$) is significantly higher than that of those who had low 'Using Mnemonics/Concept Mapping' (Mean = 38.42, $N = 350$, $SD = 10.84$) [$t = 3.41$, $p \leq .01$, $d = 0.25$].

iii. The mean score of Domain Interest in Physics of secondary school students who had high 'Peer Teaching' (Mean = 41.90, $N = 125$, $SD = 9.84$) is significantly higher than that of those who had low 'Peer Teaching' (Mean = 39.51, $N = 660$, $SD = 11.07$) [$t = 2.25$, $p \leq .05$, $d = 0.23$].

iv. The mean score of Domain Interest in Physics of secondary school students who had high 'Conducting Debate' (Mean = 39.70, $N = 135$, $SD = 9.84$) does not significantly differ from that of those who had low 'Conducting Debate' (Mean = 39.93, $N = 650$, $SD = 11.12$) [$t = 0.22$, $p > .05$].

v. The mean score of Domain Interest in Equations of Motion of secondary school students who had high 'Addressing Misconceptions' (Mean = 7.13, $N = 313$, $SD = 2.74$) is significantly higher than that of those who had low 'Addressing Misconceptions' (Mean = 6.58, $N = 149$, $SD = 2.87$) [$t = 2.00$, $p \leq .05$, $d = 0.20$].

vi. The mean score of Domain Interest in Gravitation of secondary school students who had high 'Addressing Misconceptions' (Mean = 5.72, $N = 320$, $SD = 2.30$) does not significantly differ from that of those who had low 'Addressing Misconceptions' (Mean = 5.39, $N = 131$, $SD = 2.51$) [$t = 1.34$, $p > .05$].

vii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high 'Using Mnemonics/Concept Mapping' (Mean = 7.11, $N = 282$, $SD = 2.76$) does not significantly differ from that of those who had low 'Using Mnemonics/Concept Mapping' (Mean = 6.70, $N = 180$, $SD = 2.83$) [$t = 1.56$, $p > .05$].

viii. The mean score of Domain Interest in Gravitation of secondary school students who had high 'Using Mnemonics/Concept Mapping' (Mean = 5.83, $N = 289$, $SD = 2.37$) is significantly higher than that of those who had low 'Using Mnemonics/Concept Mapping' (Mean = 5.25, $N = 162$, $SD = 2.31$) [$t = 2.55$, $p \leq .05$, $d = 0.25$].

ix. The mean score of Domain Interest in Equations of Motion of secondary school students who had high 'Peer Teaching' (Mean = 8.08, $N = 53$, $SD = 2.58$) is significantly higher than that of those who had low 'Peer Teaching' (Mean = 6.81, $N = 409$, $SD = 2.79$) [$t = 3.15$, $p \leq .01$, $d = 0.47$].

x. The mean score of Domain Interest in Gravitation of secondary school students who had high 'Peer Teaching' (Mean = 5.59, N = 41, SD = 2.51) does not significantly differ from that of those who had low 'Peer Teaching' (Mean = 5.63, N = 410, SD = 2.35) [t = 0.11, $p > .05$].

xi. The mean score of Situational Interest in Physics of secondary school students who had high 'Addressing Misconceptions' (Mean = 27.17, N = 488, SD = 6.73) is significantly higher than that of those who had low 'Addressing Misconceptions' (Mean = 25.07, N = 297, SD = 7.01) [t = 4.17, $p \leq .01$, d = 0.31].

xii. The mean score of Situational Interest in Physics of secondary school students who had high 'Using Mnemonics/Concept Mapping' (Mean = 26.84, N = 435, SD = 7.12) is significantly higher than that of those who had low 'Using Mnemonics/Concept Mapping' (Mean = 25.80, N = 350, SD = 6.61) [t = 2.10, $p \leq .05$, d = 0.15].

xiii. The mean score of Situational Interest in Physics of secondary school students who had high 'Peer Teaching' (Mean = 27.74, N = 125, SD = 6.48) is significantly higher than that of those who had low 'Peer Teaching' (Mean = 26.12, N = 660, SD = 6.96) [t = 2.41, $p \leq .05$, d = 0.24].

xiv. The mean score of Situational Interest in Physics of secondary school students who had high 'Conducting Debate' (Mean = 26.62, N = 135, SD = 7.03) does not significantly differ from that of those who had low 'Conducting Debate' (Mean = 26.32, N = 650, SD = 6.89) [t = 0.46, $p > .05$].

xv. The mean score of Individual Interest in Physics of secondary school students who had high 'Addressing Misconceptions' (Mean = 45.36, $N = 488$, $SD = 13.49$) is significantly higher than that of those who had low 'Addressing Misconceptions' at .01 level (Mean = 39.73, $N = 297$, $SD = 12.99$) [$t = 5.75$, $p \leq .01$, $d = 0.43$].

xvi. The mean score of Individual Interest in Physics of secondary school students who had high 'Using Mnemonics/Concept Mapping' (Mean = 44.99, $N = 435$, $SD = 13.68$) is significantly higher than that of those who had low 'Using Mnemonics/Concept Mapping' at .01 level (Mean = 41.05, $N = 350$, $SD = 13.14$) [$t = 4.07$, $p \leq .01$, $d = 0.29$].

xvii. The mean score of Individual Interest in Physics of secondary school students who had high 'Peer Teaching' (Mean = 45.14, $N = 125$, $SD = 13.91$) does not significantly differ from that of those who had low 'Peer Teaching' even at .05 level (Mean = 42.87, $N = 660$, $SD = 13.49$) [$t = 1.72$, $p > .05$].

xviii. The mean score of Individual Interest in Physics of secondary school students who had high 'Conducting Debate' (Mean = 46.16, $N = 135$, $SD = 13.77$) is significantly higher than that of those who had low 'Conducting Debate' at .01 level (Mean = 42.63, $N = 650$, $SD = 13.47$) [$t = 2.76$, $p \leq .01$, $d = 0.26$].

Influence of Instructional Practices for 'Conducting Assessment' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high Formative Assessment while 'Conducting Assessment' (Mean

= 41.35, N = 440, SD = 10.83) is significantly higher than that of those who had low Formative Assessment (Mean = 38.03, N = 345, SD = 10.74) [t = 4.29, $p \leq .01$, d = 0.31].

ii. The mean score of Domain Interest in Physics of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' (Mean = 40.74, N = 409, SD = 11.16) is significantly higher than that of those who had low Mastery Oriented Assessment (Mean = 38.97, N = 376, SD = 10.56) [t = 2.28, $p \leq .05$, d = 0.16].

iii. The mean score of Domain Interest in Physics of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' (Mean = 39.80, N = 125, SD = 8.30) does not significantly differ from that of those who had low Facilitated Assessment (Mean = 39.91, N = 660, SD = 11.34) [t = 0.13, $p > .05$].

iv. The mean score of Domain Interest in Physics of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' (Mean = 40.06, N = 174, SD = 10.02) does not significantly differ from that of those who had low Question Generation Strategy (Mean = 39.84, N = 611, SD = 11.16) [t = 0.25, $p > .05$].

v. The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Assessment for 'Conducting Assessment' (Mean = 37.94, N = 64, SD = 9.76) does not significantly differ from that of those

who had low ICT-mediated Assessment (Mean = 40.07, $N = 721$, $SD = 10.99$) [$t = 1.50$, $p > .05$].

vi. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Formative Assessment while 'Conducting Assessment' (Mean = 7.08, $N = 299$, $SD = 2.80$) does not significantly differ from that of those who had low Formative Assessment (Mean = 6.72, $N = 163$, $SD = 2.76$) [$t = 1.34$, $p > .05$].

vii. The mean score of Domain Interest in Gravitation of secondary school students who had high Formative Assessment while 'Conducting Assessment' (Mean = 5.76, $N = 305$, $SD = 2.30$) does not significantly differ from that of those who had low Formative Assessment (Mean = 5.34, $N = 146$, $SD = 2.47$) [$t = 1.75$, $p > .05$].

viii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' (Mean = 7.11, $N = 219$, $SD = 2.84$) does not significantly differ from that of those who had low Mastery Oriented Assessment (Mean = 6.81, $N = 243$, $SD = 2.75$) [$t = 1.15$, $p > .05$].

ix. The mean score of Domain Interest in Gravitation of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' (Mean = 5.78, $N = 215$, $SD = 2.21$) does not significantly differ from that of those who had low Mastery Oriented Assessment (Mean = 5.48, $N = 236$, $SD = 2.49$) [$t = 1.33$, $p > .05$].

x. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' (Mean = 6.76, N = 46, SD = 2.23) does not significantly differ from that of those who had low Facilitated Assessment (Mean = 6.97, N = 416, SD = 2.85) [t = 0.60, $p > .05$].

xi. The mean score of Domain Interest in Gravitation of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' (Mean = 5.63, N = 32, SD = 2.30) does not significantly differ from that of those who had low Facilitated Assessment (Mean = 5.62, N = 419, SD = 2.37) [t = 0.01, $p > .05$].

xii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' (Mean = 6.65, N = 62, SD = 2.43) does not significantly differ from that of those who had low Question Generation Strategy (Mean = 7.00, N = 400, SD = 2.84) [t = 0.93, $p > .05$].

xiii. The mean score of Domain Interest in Gravitation of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' (Mean = 5.45, N = 67, SD = 2.34) does not significantly differ from that of those who had low Question Generation Strategy (Mean = 5.65, N = 384, SD = 2.37) [t = 0.66, $p > .05$]

xiv. The mean score of Domain Interest in Equations of Motion of secondary school students who had high ICT-mediated Assessment for 'Conducting

Assessment' (Mean = 6.62, N = 29, SD = 2.35) does not significantly differ from that of those who had low ICT-mediated Assessment (Mean = 6.97, N = 433, SD = 2.82) [t = 0.66, $p > .05$].

xv. The mean score of Domain Interest in Gravitation of secondary school students who had high ICT-mediated Assessment for 'Conducting Assessment' (Mean = 4.81, N = 16, SD = 2.40) does not significantly differ from that of those who had low ICT-mediated Assessment (Mean = 5.65, N = 435, SD = 2.36) [t = 1.40, $p > .05$]

xvi. The mean score of Situational Interest in Physics of secondary school students who had high Formative Assessment while 'Conducting Assessment' (Mean = 27.13, N = 440, SD = 6.75) is significantly higher than that of those who had low Formative Assessment (Mean = 25.42, N = 345, SD = 7.01) [t = 3.46, $p \leq .01$, d =0.25].

xvii. The mean score of Situational Interest in Physics of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' (Mean = 26.77, N = 409, SD = 6.51) does not significantly differ from that of those who had low Mastery Oriented Assessment (Mean =25.95, N = 376, SD = 7.31) [t = 1.65, $p > .05$].

xviii. The mean score of Situational Interest in Physics of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' (Mean = 26.26, N = 125, SD = 6.71) does not significantly differ from that of those who

had low Facilitated Assessment (Mean =26.40, $N = 660$, $SD = 6.95$) [$t = 0.20$, $p > .05$].

xix. The mean score of Situational Interest in Physics of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' (Mean = 26.74, $N = 174$, $SD = 6.39$) does not significantly differ from that of those who had low Question Generation Strategy (Mean =26.27, $N = 611$, $SD = 7.05$) [$t = 0.78$, $p > .05$].

xx. The mean score of Situational Interest in Physics of secondary school students who had high ICT-mediated Assessment for 'Conducting Assessment' (Mean = 25.67, $N = 64$, $SD = 6.90$) does not significantly differ from that of those who had low ICT-mediated Assessment (Mean =26.44, $N = 721$, $SD = 6.91$) [$t = 0.85$, $p > .05$].

xxi. The mean score of Individual Interest in Physics of secondary school students who had high Formative Assessment while 'Conducting Assessment' (Mean = 45.35, $N = 440$, $SD = 13.36$) is significantly higher than that of those who had low Formative Assessment (Mean = 40.53, $N = 345$, $SD = 13.39$) [$t = 5.01$, $p \leq .01$, $d = 0.36$].

xxii. The mean score of Individual Interest in Physics of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' (Mean = 45.66, $N = 409$, $SD = 13.42$) is significantly higher than that of those who had low Mastery Oriented Assessment (Mean = 40.59, $N = 376$, $SD = 13.26$) [$t = 5.32$, $p \leq .01$, $d = 0.38$].

xxiii. The mean score of Individual Interest in Physics of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' (Mean = 43.03, N = 125, SD = 10.24) does not significantly differ from that of those who had low Facilitated Assessment (Mean = 43.27, N = 660, SD = 14.13) [t = 0.22, $p > .05$].

xxiv. The mean score of Individual Interest in Physics of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' (Mean = 44.19, N = 174, SD = 12.21) does not significantly differ from that of those who had low Question Generation Strategy (Mean = 42.96, N = 611, SD = 13.94) [t = 1.13, $p > .05$].

xxv. The mean score of Individual Interest in Physics of secondary school students who had high ICT-mediated Assessment for 'Conducting Assessment' (Mean = 43.61, N = 64, SD = 11.81) does not significantly differ from that of those who had low ICT-mediated Assessment (Mean = 43.20, N = 721, SD = 13.73) [t = 0.23, $p > .05$].

Influence of Instructional Practices for 'Consolidation of Concepts' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' (Mean = 40.82, N = 409, SD = 11.13) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 38.89, N = 376, SD = 10.59) [t = 2.49, $p \leq .05$, d = 0.18].

ii. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' (Mean = 40.80, $N = 296$, $SD = 10.63$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 39.35, $N = 489$, $SD = 11.05$) [$t = 1.81$, $p > .05$].

iii. The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' (Mean = 40.69, $N = 206$, $SD = 10.56$) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 39.61, $N = 579$, $SD = 11.03$) [$t = 1.23$, $p > .05$].

iv. The mean score of Domain Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' (Mean = 38.57, $N = 160$, $SD = 9.89$) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 40.23, $N = 625$, $SD = 11.14$) [$t = 1.72$, $p > .05$].

v. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' (Mean = 37.88, $N = 77$, $SD = 10.55$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 40.11, $N = 708$, $SD = 10.93$) [$t = 1.70$, $p > .05$].

vi. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for

'Consolidation of Concepts' (Mean = 7.05, N = 360, SD = 2.73) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 6.61, N = 102, SD = 2.98) [t = 1.42, $p > .05$].

vii. The mean score of Domain Interest in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' (Mean = 5.64, N = 354, SD = 2.33) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 5.57, N = 97, SD = 2.49) [t = 0.26, $p > .05$].

viii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' (Mean = 7.26, N = 122, SD = 2.76) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 6.84, N = 340, SD = 2.80) [t = 1.43, $p > .05$].

ix. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' (Mean = 5.88, N = 121, SD = 2.10) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 5.53, N = 330, SD = 2.45) [t = 1.48, $p > .05$].

x. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' (Mean = 7.02, N = 88, SD = 2.79) does not significantly differ from

that of those who had low Supervisory Instruction (Mean = 6.94, $N = 374$, $SD = 2.79$) [$t = 0.26$, $p > .05$].

xi. The mean score of Domain Interest in Gravitation of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' (Mean = 5.19, $N = 83$, $SD = 2.08$) is significantly less than that of those who had low Supervisory Instruction (Mean = 5.72, $N = 368$, $SD = 2.42$) [$t = 2.02$, $p \leq .05$, $d = 0.23$].

xii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high ICT - mediated Instruction for 'Consolidation of Concepts' (Mean = 6.72, $N = 53$, $SD = 2.91$) does not significantly differ from that of those who had low ICT - mediated Instruction (Mean = 6.98, $N = 409$, $SD = 2.78$) [$t = 0.65$, $p > .05$].

xiii. The mean score of Domain Interest in Gravitation of secondary school students who had high ICT - mediated Instruction for 'Consolidation of Concepts' (Mean = 5.47, $N = 60$, $SD = 2.33$) does not significantly differ from that of those who had low ICT - mediated Instruction (Mean = 5.65, $N = 391$, $SD = 2.37$) [$t = 0.55$, $p > .05$].

xiv. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' (Mean = 6.63, $N = 41$, $SD = 2.53$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 6.98, $N = 421$, $SD = 2.81$) [$t = 0.77$, $p > .05$].

xv. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' (Mean = 5.84, N = 25, SD = 2.17) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 5.61, N = 426, SD = 2.38) [t = 0.47, $p > .05$].

xvi. The mean score of Situational Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' (Mean = 26.70, N = 409, SD = 6.54) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 26.02, N = 376, SD = 7.29) [t = 1.37, $p > .05$].

xvii. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' (Mean = 27.44, N = 296, SD = 6.53) is significantly higher than that of those who had low Student Participatory Individual Instruction (Mean = 25.73, N = 489, SD = 7.06) [t = 3.39, $p \leq .01$, d = 0.25].

xviii. The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' (Mean = 27.41, N = 206, SD = 6.28) is significantly higher than that of those who had low Supervisory Instruction (Mean = 26.01, N = 579, SD = 7.09) [t = 2.52, $p \leq .05$, d = 0.21].

xix. The mean score of Situational Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts'

(Mean = 26.56, N = 160, SD = 6.87) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 26.33, N = 625, SD = 6.93) [t = 0.39, $p > .05$].

xx. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' (Mean = 27.51, N = 77, SD = 6.79) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 26.25, N = 708, SD = 6.92) [t = 1.52, $p > .05$].

xxi. The mean score of Individual Interest in Physics of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' (Mean = 44.09, N = 409, SD = 13.92) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 42.30, N = 376, SD = 13.15) [t = 1.85, $p > .05$].

xxii. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' (Mean = 45.56, N = 296, SD = 12.55) is significantly higher than that of those who had low Student Participatory Individual Instruction (Mean = 41.82, N = 489, SD = 13.99) [t = 3.87, $p \leq .01$, d = 0.28].

xxiii. The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' (Mean = 44.84, N = 206, SD = 12.50) is significantly higher than that of those who

had low Supervisory Instruction (Mean = 42.66, N = 579, SD = 13.90) [t = 2.08, $p \leq .05$, d = 0.16].

xxiv. The mean score of Individual Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' (Mean = 44.28, N = 160, SD = 12.65) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 42.96, N = 625, SD = 13.80) [t = 1.10, $p > .05$].

xxv. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' (Mean = 45.00, N = 77, SD = 11.92) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 43.04, N = 708, SD = 13.74) [t = 1.35, $p > .05$].

Influence of Instructional Practices for 'Providing Follow-up Activity' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' (Mean = 40.82, N = 409, SD = 11.13) is significantly higher than that of those who had low Student Participatory Individual Instruction (Mean = 38.89, N = 376, SD = 10.59) [t = 2.49, $p \leq .05$, d = 0.18].

ii. The mean score of Domain Interest in Physics of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' (Mean = 40.87, N = 394, SD = 10.34) is significantly higher than that of those

who had low Supervisory Instruction (Mean = 38.91, $N = 391$, $SD = 11.38$) [$t = 2.52$, $p \leq .05$, $d = 0.18$].

iii. The mean score of Domain Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' (Mean = 38.47, $N = 159$, $SD = 10.80$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 40.25, $N = 626$, $SD = 10.92$) [$t = 1.84$, $p > .05$].

iv. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' (Mean = 7.19, $N = 291$, $SD = 2.80$) is significantly higher than that of those who had low Student Participatory Individual Instruction (Mean = 6.54, $N = 171$, $SD = 2.73$) [$t = 2.43$, $p \leq .05$, $d = 0.24$].

v. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' (Mean = 5.81, $N = 284$, $SD = 2.27$) is significantly higher than that of those who had low Student Participatory Individual Instruction (Mean = 5.30, $N = 167$, $SD = 2.50$) [$t = 2.24$, $p \leq .05$, $d = 0.21$].

vi. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' (Mean = 7.48, $N = 181$, $SD = 2.62$) is significantly higher than

that of those who had low Supervisory Instruction (Mean = 6.62, $N = 281$, $SD = 2.85$) [$t = 3.27$, $p \leq .01$, $d = 0.31$].

vii. The mean score of Domain Interest in Gravitation of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' (Mean = 5.54, $N = 168$, $SD = 2.38$) does not significantly differ from that of those who had low Supervisory Instruction even (Mean = 5.67, $N = 283$, $SD = 2.36$) [$t = 0.60$, $p > .05$].

viii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' (Mean = 6.83, $N = 76$, $SD = 2.79$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 6.98, $N = 386$, $SD = 2.79$) [$t = 0.42$, $p > .05$].

ix. The mean score of Domain Interest in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' (Mean = 5.68, $N = 41$, $SD = 2.14$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 5.62, $N = 410$, $SD = 2.39$) [$t = 0.17$, $p > .05$].

x. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' (Mean = 26.70, $N = 409$, $SD = 6.54$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 26.02, $N = 376$, $SD = 7.29$) [$t = 1.37$, $p > .05$].

xi. The mean score of Situational Interest in Physics of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' (Mean = 27.00, $N = 394$, $SD = 6.85$) is significantly higher than that of those who had low Supervisory Instruction (Mean = 25.74, $N = 391$, $SD = 6.92$) [$t = 2.55$, $p \leq .05$, $d = 0.18$].

xii. The mean score of Situational Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' (Mean = 26.13, $N = 159$, $SD = 6.52$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 26.44, $N = 626$, $SD = 7.01$) [$t = 0.51$, $p > .05$].

xiii. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' (Mean = 44.09, $N = 409$, $SD = 13.92$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 42.30, $N = 376$, $SD = 13.15$) [$t = 1.85$, $p > .05$].

xiv. The mean score of Individual Interest in Physics of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' (Mean = 45.08, $N = 394$, $SD = 13.54$) is significantly higher than that of those who had low Supervisory Instruction (Mean = 41.37, $N = 391$, $SD = 13.38$) [$t = 3.86$, $p \leq .01$, $d = 0.28$].

xv. The mean score of Individual Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-

up Activity' (Mean = 43.47, $N = 159$, $SD = 12.92$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 43.17, $N = 626$, $SD = 13.75$) [$t = 0.24$, $p > .05$].

Influence of Instructional Practices for 'Enriching Learning Experiences' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high 'Directing to take part in Science Club Activities' for 'Enriching Learning Experiences' (Mean = 37.77, $N = 334$, $SD = 11.30$) is significantly higher than that of those who had low 'Directing to take part in Science Club Activities' (Mean = 41.47, $N = 451$, $SD = 10.34$) [$t = 4.76$, $p \leq .01$, $d = 0.34$].

ii. The mean score of Domain Interest in Physics of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' (Mean = 39.56, $N = 515$, $SD = 11.48$) does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' (Mean = 40.53, $N = 270$, $SD = 9.71$) [$t = 1.26$, $p > .05$].

iii. The mean score of Domain Interest in Physics of secondary school students who had high 'Directing to Exhibit Works on Public Platforms' for 'Enriching Learning Experiences' (Mean = 39.90, $N = 656$, $SD = 11.06$) does not significantly differ from that of those who had low 'Directing to Exhibit Works on Public Platforms' (Mean = 39.87, $N = 129$, $SD = 10.16$) [$t = 0.03$, $p > .05$].

iv. The mean score of Domain Interest in Physics of secondary school students who had high 'Organizing Field Trips' for 'Enriching Learning Experiences' (Mean = 39.92, $N = 732$, $SD = 10.91$) does not significantly differ from that of those who had low 'Organizing Field Trips' (Mean = 39.55, $N = 53$, $SD = 10.99$) [$t = 0.24$, $p > .05$].

v. The mean score of Domain Interest in Equations of Motion of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' (Mean = 6.84, $N = 350$, $SD = 2.79$) does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' (Mean = 7.29, $N = 112$, $SD = 2.76$) [$t = 1.49$, $p > .05$].

vi. The mean score of Domain Interest in Gravitation of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' (Mean = 5.60, $N = 359$, $SD = 2.40$) does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' (Mean = 5.70, $N = 92$, $SD = 2.23$) [$t = 0.33$, $p > .05$].

vii. The mean score of Situational Interest in Physics of secondary school students who had high 'Directing to take part in Science Club Activities' for 'Enriching Learning Experiences' (Mean = 25.84, $N = 334$, $SD = 7.33$) does not significantly differ from that of those who had low 'Directing to take part in Science Club Activities' (Mean = 26.77, $N = 451$, $SD = 6.57$) [$t = 1.86$, $p > .05$].

viii. The mean score of Situational Interest in Physics of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' (Mean = 26.12, N = 515, SD = 7.21) does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' (Mean = 26.85, N = 270, SD = 6.28) [t = 1.46, $p > .05$].

ix. The mean score of Situational Interest in Physics of secondary school students who had high 'Directing to Exhibit Works on Public Platforms' for 'Enriching Learning Experiences' (Mean = 26.31, N = 656, SD = 6.93) does not significantly differ from that of those who had low 'Directing to Exhibit Works on Public Platforms' (Mean = 26.71, N = 129, SD = 6.84) [t = 0.61, $p > .05$].

x. The mean score of Situational Interest in Physics of secondary school students who had high 'Organizing Field Trips' for 'Enriching Learning Experiences' (Mean = 26.26, N = 732, SD = 6.92) does not significantly differ from that of those who had low 'Organizing Field Trips' (Mean = 27.92, N = 53, SD = 6.62) [t = 1.69, $p > .05$].

xi. The mean score of Individual Interest in Physics of secondary school students who had high 'Directing to take part in Science Club Activities' for 'Enriching Learning Experiences' (Mean = 40.71, N = 334, SD = 13.32) is significantly higher than that of those who had low 'Directing to take part in Science Club Activities' (Mean = 45.10, N = 451, SD = 13.47) [t = 4.54, $p \leq .01$, d = 0.33].

xii. The mean score of Individual Interest in Physics of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' (Mean = 42.44, N = 515, SD = 14.22) is significantly higher than that of those who had low 'Suggesting Extra Reference Materials/Web Resources' (Mean = 44.75, N = 270, SD = 12.14) [t = 2.39, $p \leq .05$, d = 0.17].

xiii. The mean score of Individual Interest in Physics of secondary school students who had high 'Directing to Exhibit Works on Public Platforms' for 'Enriching Learning Experiences' (Mean = 42.84, N = 656, SD = 13.64) does not significantly differ from that of those who had low 'Directing to Exhibit Works on Public Platforms' (Mean = 45.22, N = 129, SD = 13.12) [t = 1.83, $p > .05$].

xiv. The mean score of Individual Interest in Physics of secondary school students who had high 'Organizing Field Trips' for 'Enriching Learning Experiences' (Mean = 43.11, N = 732, SD = 13.70) does not significantly differ from that of those who had low 'Organizing Field Trips' (Mean = 44.94, N = 53, SD = 11.81) [t = 0.95, $p > .05$].

Influence of Instructional Practices for 'Examination Preparedness' on Student Interests in Physics

i. The mean score of Domain Interest in Physics of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' (Mean = 37.95, N = 344, SD = 10.51) is significantly higher than that of those

who had low Test Previewing Strategy (Mean = 41.41, $N = 441$, $SD = 10.98$) [$t = 4.47$, $p \leq .01$, $d = 0.32$].

ii. The mean score of Domain Interest in Physics of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' (Mean = 38.66, $N = 396$, $SD = 10.86$) is significantly higher than that of those who had low Test Reviewing Strategy (Mean = 41.15, $N = 389$, $SD = 10.83$) [$t = 3.22$, $p \leq .01$, $d = 0.23$].

iii. The mean score of Domain Interest in Physics of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' (Mean = 39.42, $N = 426$, $SD = 11.04$) does not significantly differ from that of those who had low Differentiated Strategy (Mean = 40.45, $N = 359$, $SD = 10.74$) [$t = 1.32$, $p > .05$].

iv. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' (Mean = 6.17, $N = 125$, $SD = 2.52$) is significantly higher than that of those who had low Test Previewing Strategy (Mean = 7.24, $N = 337$, $SD = 2.83$) [$t = 3.93$, $p \leq .01$, $d = 0.40$].

v. The mean score of Domain Interest in Gravitation of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' (Mean = 5.54, $N = 111$, $SD = 2.62$) does not significantly differ from that of those who had low Test Previewing Strategy (Mean = 5.65, $N = 340$, $SD = 2.28$) [$t = 0.39$, $p > .05$].

vi. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' (Mean = 6.85, $N = 253$, $SD = 2.75$) does not significantly differ from that of those who had low Test Reviewing Strategy (Mean = 7.08, $N = 209$, $SD = 2.84$) [$t = 0.87$, $p > .05$].

vii. The mean score of Domain Interest in Gravitation of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' (Mean = 5.57, $N = 274$, $SD = 2.40$) does not significantly differ from that of those who had low Test Reviewing Strategy (Mean = 5.70, $N = 177$, $SD = 2.31$) [$t = 0.56$, $p > .05$].

viii. The mean score of Domain Interest in Equations of Motion of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' (Mean = 6.92, $N = 312$, $SD = 2.74$) does not significantly differ from that of those who had low Differentiated Strategy (Mean = 7.02, $N = 150$, $SD = 2.90$) [$t = 0.36$, $p > .05$].

ix. The mean score of Domain Interest in Gravitation of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' (Mean = 5.57, $N = 301$, $SD = 2.39$) does not significantly differ from that of those who had low Differentiated Strategy (Mean = 5.73, $N = 150$, $SD = 2.32$) [$t = 0.70$, $p > .05$].

x. The mean score of Situational Interest in Physics of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness'

(Mean = 25.60, N = 344, SD = 7.58) is significantly higher than that of those who had low Test Previewing Strategy (Mean = 26.98, N = 441, SD = 6.29) [t = 2.73, $p \leq .01$, d = 0.20].

xi. The mean score of Situational Interest in Physics of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' (Mean = 25.48, N = 396, SD = 7.08) is significantly higher than that of those who had low Test Reviewing Strategy (Mean = 27.29, N = 389, SD = 6.62) [t = 3.69, $p \leq .01$, d = 0.26].

xii. The mean score of Situational Interest in Physics of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' (Mean = 26.02, N = 426, SD = 7.38) does not significantly differ from that of those who had low Differentiated Strategy (Mean = 26.79, N = 359, SD = 6.30) [t = 1.58, $p > .05$].

xiii. The mean score of Individual Interest in Physics of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' (Mean = 42.74, N = 344, SD = 13.72) does not significantly differ from that of those who had low Test Previewing Strategy (Mean = 43.61, N = 441, SD = 13.47) [t = 0.89, $p > .05$].

xiv. The mean score of Individual Interest in Physics of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' (Mean = 41.68, N = 396, SD = 13.10) is significantly higher than that of those who

had low Test Reviewing Strategy (Mean = 44.82, N = 389, SD = 13.88) [t = 3.26, $p \leq .01$, d = 0.23].

xv. The mean score of Individual Interest in Physics of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' (Mean = 41.90, N = 426, SD = 13.71) is significantly higher than that of those who had low Differentiated Strategy (Mean = 44.82, N = 359, SD = 13.26) [t = 3.01, $p \leq .01$, d = 0.22].

Influence of Instructional Practices on Achievement in Physics Among Secondary School Students

Influence of Instructional Practices for 'Introducing New Concepts' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' (Mean = 14.65, N = 322, SD = 8.72) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 17.06, N = 463, SD = 8.31) [t = 3.93, $p \leq .01$, d = 0.28].

ii. The mean score of Achievement Interest in Physics of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' (Mean = 15.61, N = 357, SD = 8.39) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 16.45, N = 428, SD = 8.69) [t = 1.37, $p > .05$].

iii. The mean score of Achievement Interest in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' (Mean = 16.39, N = 350, SD = 8.87) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 15.81, N = 435, SD = 8.30) [t = 0.94, $p > .05$].

iv. The mean score of Achievement Interest in Physics of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' (Mean = 16.16, N = 453, SD = 8.35) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 15.95, N = 332, SD = 8.85) [t = 0.33, $p > .05$].

v. The mean score of Achievement in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' (Mean = 8.72, N = 244, SD = 3.25) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 9.15, N = 218, SD = 3.50) [t = 1.37, $p > .05$].

vi. The mean score of Achievement in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Introducing New Concepts' (Mean = 8.66, N = 235, SD = 3.81) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 9.00, N = 216, SD = 3.58) [t = 0.99, $p > .05$].

vii. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for

'Introducing New Concepts' (Mean = 9.05, N = 304, SD = 3.22) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 8.67, N = 158, SD = 3.65) [t = 1.14, $p > .05$].

viii. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Introducing New Concepts' (Mean = 8.70, N = 308, SD = 3.69) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 9.07, N = 143, SD = 3.72) [t = 0.98, $p > .05$].

ix. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' (Mean = 9.06, N = 285, SD = 3.54) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 8.69, N = 177, SD = 3.09) [t = 1.16, $p > .05$].

x. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Introducing New Concepts' (Mean = 9.00, N = 268, SD = 3.84) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 8.55, N = 183, SD = 3.47) [t = 1.27, $p > .05$].

xi. The mean score of Achievement in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' (Mean = 9.16, N = 334, SD = 3.44) is significantly less than that of

those who had low ICT-mediated Instruction (Mean = 8.28, N = 128, SD = 3.11) [t = 2.53, $p \leq .01$, d = 0.27].

xii. The mean score of Achievement in Gravitation of secondary school students who had high ICT-mediated Instruction for 'Introducing New Concepts' (Mean = 9.06, N = 340, SD = 3.78) is significantly less than that of those who had low ICT-mediated Instruction (Mean = 8.10, N = 111, SD = 3.35) [t = 2.38, $p \leq .01$, d = 0.27].

Influence of Instructional Practices for 'Performing Experiments and Activities' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Performing Experiments and Activities' (Mean = 15.47, N = 424, SD = 8.21) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 16.78, N = 361, SD = 8.92) [t = 2.12, $p \leq .05$, d = 0.15].

ii. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Performing Experiments and Activities' (Mean = 16.24, N = 410, SD = 8.44) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 15.89, N = 375, SD = 8.69) [t = 0.58, $p > .05$].

iii. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Group Instruction for 'Performing Experiments and Activities' (Mean = 16.34, N = 447, SD = 8.47) does not significantly

differ from that of those who had low Student Participatory Group Instruction (Mean = 15.71, $N = 338$, $SD = 8.68$) [$t = 1.03$, $p > .05$].

iv. The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for 'Performing Experiments and Activities' (Mean = 16.14, $N = 444$, $SD = 8.47$) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 15.98, $N = 341$, $SD = 8.68$) [$t = 0.27$, $p > .05$].

v. The mean score of Achievement in Physics of secondary school students who had high ICT-mediated Instruction for 'Performing Experiments and Activities' (Mean = 16.43, $N = 568$, $SD = 8.64$) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 15.12, $N = 217$, $SD = 8.28$) [$t = 1.93$, $p > .05$].

Influence of Instructional Practices for 'Working-out Mathematical Problems' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' (Mean = 15.31, $N = 349$, $SD = 8.48$) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 16.68, $N = 436$, $SD = 8.58$) [$t = 2.23$, $p \leq .05$, $d = 0.16$].

ii. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Working-out

Mathematical Problems' (Mean = 16.76, N = 297, SD = 8.59) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 15.65, N = 488, SD = 8.52) [t = 1.76, $p > .05$].

iii. The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' (Mean = 16.39, N = 395, SD = 8.82) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 15.75, N = 390, SD = 8.29) [t = 1.04, $p > .05$].

iv. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' (Mean = 17.01, N = 409, SD = 8.52) is significantly less than that of those who had low Student Participatory Group Instruction (Mean = 15.05, N = 376, SD = 8.50) [t = 3.23, $p \leq .01$, d = 0.23].

v. The mean score of Achievement in Physics of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' (Mean = 16.57, N = 597, SD = 8.55) is significantly less than that of those who had low ICT-mediated Instruction (Mean = 14.47, N = 188, SD = 8.43) [t = 2.95, $p \leq .01$, d = 0.25].

vi. The mean score of Achievement in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' (Mean = 8.79, N = 169, SD = 3.08) does not

significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 9.00, $N = 293$, $SD = 3.54$) [$t = 0.64$, $p > .05$].

vii. The mean score of Achievement in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Working-out Mathematical Problems' (Mean = 8.70, $N = 184$, $SD = 3.96$) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 8.91, $N = 267$, $SD = 3.52$) [$t = 0.59$, $p > .05$].

viii. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' (Mean = 8.61, $N = 158$, $SD = 3.27$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 9.08, $N = 304$, $SD = 3.42$) [$t = 1.44$, $p > .05$].

ix. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Working-out Mathematical Problems' (Mean = 9.15, $N = 154$, $SD = 3.76$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 8.65, $N = 297$, $SD = 3.67$) [$t = 1.36$, $p > .05$].

x. The mean score of Achievement in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' (Mean = 9.29, $N = 211$, $SD = 3.61$) is significantly

less than that of those who had low Supervisory Instruction (Mean = 8.61, N = 251, SD = 3.13) [t = 2.14, $p \leq .05$, d = 0.20].

xi. The mean score of Achievement in Gravitation of secondary school students who had high Supervisory Instruction for 'Working-out Mathematical Problems' (Mean = 8.80, N = 213, SD = 3.87) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 8.84, N = 238, SD = 3.56) [t = 0.10, $p > .05$].

xii. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' (Mean = 9.40, N = 216, SD = 3.52) is significantly less than that of those who had low Student Participatory Group Instruction (Mean = 8.50, N = 246, SD = 3.19) [t = 2.91, $p \leq .01$, d = 0.27].

xiii. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Working-out Mathematical Problems' (Mean = 9.16, N = 229, SD = 3.77) is significantly less than that of those who had low Student Participatory Group Instruction (Mean = 8.47, N = 222, SD = 3.61) [t = 1.97, $p \leq .05$, d = 0.19].

xiv. The mean score of Achievement in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' (Mean = 9.06, N = 398, SD = 3.41) is significantly

less than that of those who had low ICT-mediated Instruction (Mean = 8.03, $N = 64$, $SD = 3.00$) [$t = 2.28$, $p \leq .05$, $d = 0.32$].

xv. The mean score of Achievement in Gravitation of secondary school students who had high ICT-mediated Instruction for 'Working-out Mathematical Problems' (Mean = 8.91, $N = 394$, $SD = 3.70$) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 8.19, $N = 57$, $SD = 3.70$) [$t = 1.37$, $p > .05$].

Influence of 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Working-out Related Problems' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 14.10, $N = 387$, $SD = 8.27$) is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 17.99, $N = 398$, $SD = 8.41$) [$t = 6.55$, $p \leq .01$, $d = 0.47$].

ii. The mean score of Achievement in Equations of Motion of secondary school students who had high level usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 8.41, $N = 261$, $SD = 3.06$) is significantly higher than that of those who had low level of usage of

'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 9.59, $N = 201$, $SD = 3.65$) [$t = 3.70$, $p \leq .01$, $d = 0.35$].

iii. The mean score of Achievement in Gravitation of secondary school students who had high level usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 8.17, $N = 244$, $SD = 3.71$) is significantly higher than that of those who had low level of usage of 'Transacting Methodical Tactics of Mathematical Problem-solving' (Mean = 9.59, $N = 207$, $SD = 3.55$) [$t = 4.14$, $p \leq .01$, $d = 0.39$].

iv. The mean score of Achievement in Physics of secondary school students who had high level of usage of 'Introducing Graph and Working out Related Problems' (Mean = 14.68, $N = 342$, $SD = 8.53$) is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' (Mean = 17.15, $N = 443$, $SD = 8.43$) [$t = 4.05$, $p \leq .01$, $d = 0.29$].

v. The mean score of Achievement in Equations of Motion of secondary school students who had high level usage of 'Introducing Graph and Working out Related Problems' (Mean = 8.21, $N = 203$, $SD = 3.00$) is significantly higher than that of those who had low level of usage of 'Introducing Graph and Working out Related Problems' (Mean = 9.48, $N = 259$, $SD = 3.56$) [$t = 4.18$, $p \leq .01$, $d = 0.39$].

Influence of Instructional Practices for 'Facilitating Note-making Process' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' (Mean = 16.73, $N = 321$, $SD = 9.09$) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 15.62, $N = 464$, $SD = 8.15$) [$t = 1.76$, $p > .05$].

ii. The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' (Mean = 15.80, $N = 405$, $SD = 8.65$) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 16.37, $N = 380$, $SD = 8.46$) [$t = 0.93$, $p > .05$].

iii. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' (Mean = 16.25, $N = 386$, $SD = 8.43$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 15.89, $N = 399$, $SD = 8.69$) [$t = 0.59$, $p > .05$].

iv. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' (Mean = 16.22, $N = 716$, $SD = 8.54$) does not significantly

differ from that of those who had low Student Participatory Group Instruction (Mean = 14.55, $N = 69$, $SD = 8.63$) [$t = 1.55$, $p > .05$].

v. The mean score of Achievement in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' (Mean = 9.13, $N = 99$, $SD = 3.59$) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 8.86, $N = 363$, $SD = 3.32$) [$t = 0.70$, $p > .05$].

vi. The mean score of Achievement in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Facilitating Note-making Process' (Mean = 8.60, $N = 100$, $SD = 3.83$) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 8.88, $N = 351$, $SD = 3.67$) [$t = 0.68$, $p > .05$].

vii. The mean score of Achievement in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' (Mean = 8.94, $N = 282$, $SD = 3.30$) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 8.88, $N = 180$, $SD = 3.50$) [$t = 0.19$, $p > .05$].

viii. The mean score of Achievement in Gravitation of secondary school students who had high Supervisory Instruction for 'Facilitating Note-making Process' (Mean = 9.09, $N = 277$, $SD = 3.87$) does not significantly differ from that of

those who had low Supervisory Instruction (Mean = 8.40, $N = 174$, $SD = 3.38$) [$t = 1.93$, $p > .05$].

ix. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' (Mean = 9.05, $N = 262$, $SD = 3.37$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 8.75, $N = 200$, $SD = 3.38$) [$t = 0.95$, $p > .05$].

x. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Facilitating Note-making Process' (Mean = 8.67, $N = 269$, $SD = 3.48$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 9.05, $N = 182$, $SD = 4.00$) [$t = 1.08$, $p > .05$].

xi. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' (Mean = 8.98, $N = 435$, $SD = 3.39$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 7.89, $N = 27$, $SD = 2.93$) [$t = 1.64$, $p > .05$].

xii. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Facilitating Note-making Process' (Mean = 8.86, $N = 435$, $SD = 3.71$) does not significantly

differ from that of those who had low Student Participatory Group Instruction (Mean = 7.63, $N = 16$, $SD = 3.26$) [$t = 1.32$, $p > .05$].

Influence of Instructional Practices under 'Miscellaneous Ways of Teaching' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high 'Addressing Misconceptions' (Mean = 14.84, $N = 297$, $SD = 8.66$) is significantly higher than that of those who had low 'Addressing Misconceptions' (Mean = 16.82, $N = 488$, $SD = 8.42$) [$t = 3.18$, $p \leq .01$, $d = 0.23$].

ii. The mean score of Achievement in Physics of secondary school students who had high 'Using Mnemonics/Concept Mapping' (Mean = 15.65, $N = 350$, $SD = 8.82$) does not significantly differ from that of those who had low 'Using Mnemonics/Concept Mapping' (Mean = 16.41, $N = 435$, $SD = 8.34$) [$t = 1.24$, $p > .05$].

iii. The mean score of Achievement in Physics of secondary school students who had high 'Peer Teaching' (Mean = 16.19, $N = 660$, $SD = 8.66$) does not significantly differ from that of those who had low 'Peer Teaching' (Mean = 15.45, $N = 125$, $SD = 7.99$) [$t = 0.89$, $p > .05$].

iv. The mean score of Achievement in Physics of secondary school students who had high 'Conducting Debate' (Mean = 16.44, $N = 650$, $SD = 8.59$) is

significantly less than that of those who had low 'Conducting Debate' (Mean = 14.32, $N = 135$, $SD = 8.24$) [$t = 2.62$, $p \leq .01$, $d = 0.25$].

v. The mean score of Achievement in Equations of Motion of secondary school students who had high 'Addressing Misconceptions' (Mean = 8.58, $N = 149$, $SD = 3.21$) does not significantly differ from that of those who had low 'Addressing Misconceptions' (Mean = 9.08, $N = 313$, $SD = 3.45$) [$t = 1.48$, $p > .05$].

vi. The mean score of Achievement in Gravitation of secondary school students who had high 'Addressing Misconceptions' (Mean = 8.27, $N = 131$, $SD = 3.33$) is significantly higher than that of those who had low 'Addressing Misconceptions' (Mean = 9.04, $N = 320$, $SD = 3.83$) [$t = 2.01$, $p \leq .05$, $d = 0.21$].

vii. The mean score of Achievement in Equations of Motion of secondary school students who had high 'Using Mnemonics/Concept Mapping' (Mean = 8.79, $N = 180$, $SD = 3.40$) does not significantly differ from that of those who had low 'Using Mnemonics/Concept Mapping' (Mean = 9.00, $N = 282$, $SD = 3.36$) [$t = 0.67$, $p > .05$].

viii. The mean score of Achievement in Gravitation of secondary school students who had high 'Using Mnemonics/Concept Mapping' (Mean = 8.46, $N = 162$, $SD = 3.65$) does not significantly differ from that of those who had low 'Using

Mnemonics/Concept Mapping' (Mean = 9.02, N = 289, SD = 3.72) [t = 1.54, $p > .05$].

ix. The mean score of Achievement in Equations of Motion of secondary school students who had high 'Peer Teaching' (Mean = 8.83, N = 409, SD = 3.28) does not significantly differ from that of those who had low 'Peer Teaching' (Mean = 9.64, N = 53, SD = 3.99) [t = 1.66, $p > .05$].

x. The mean score of Achievement in Gravitation of secondary school students who had high 'Peer Teaching' (Mean = 8.78, N = 410, SD = 3.66) does not significantly differ from that of those who had low 'Peer Teaching' (Mean = 9.27, N = 41, SD = 4.07) [t = 0.81, $p > .05$].

Influence of Instructional Practices for 'Conducting Assessment' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high Formative Assessment while 'Conducting Assessment' (Mean = 14.84, N = 345, SD = 8.50) is significantly higher than that of those who had low Formative Assessment (Mean = 17.04, N = 440, SD = 8.49) [t = 3.60, $p \leq .01$, d = 0.26].

ii. The mean score of Achievement in Physics of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' (Mean = 15.33, N = 376, SD = 8.83) is significantly higher than that of those

who had low Mastery Oriented Assessment (Mean = 16.76, N = 409, SD = 8.25) [t = 2.34, $p \leq .05$, d = 0.17].

iii. The mean score of Achievement in Physics of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' (Mean = 16.37, N = 660, SD = 8.67) is significantly less than that of those who had low Facilitated Assessment (Mean = 14.51, N = 125, SD = 7.79) [t = 2.23, $p \leq .05$, d = 0.23].

iv. The mean score of Achievement in Physics of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' (Mean = 16.26, N = 661, SD = 8.50) does not significantly differ from that of those who had low Question Generation Strategy (Mean = 15.41, N = 174, SD = 8.78) [t = 1.15, $p > .05$].

v. The mean score of Achievement in Physics of secondary school students who had high ICT-mediated Assessment for 'Conducting Assessment' (Mean = 16.26, N = 721, SD = 8.58) is significantly less than that of those who had low ICT-mediated Assessment (Mean = 13.92, N = 64, SD = 8.04) [t = 2.10, $p \leq .05$, d = 0.28].

vi. The mean score of Achievement in Equations of Motion of secondary school students who had high Formative Assessment while 'Conducting Assessment' (Mean = 8.57, N = 163, SD = 3.48) does not significantly differ from that of

those who had low Formative Assessment (Mean = 9.11, $N = 299$, $SD = 3.31$) [$t = 1.65$, $p > .05$].

vii. The mean score of Achievement in Gravitation of secondary school students who had high Formative Assessment while 'Conducting Assessment' (Mean = 8.65, $N = 146$, $SD = 3.47$) does not significantly differ from that of those who had low Formative Assessment (Mean = 8.90, $N = 305$, $SD = 3.81$) [$t = 0.67$, $p > .05$].

viii. The mean score of Achievement in Equations of Motion of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' (Mean = 8.70, $N = 243$, $SD = 3.28$) does not significantly differ from that of those who had low Mastery Oriented Assessment (Mean = 9.16, $N = 219$, $SD = 3.47$) [$t = 1.45$, $p > .05$].

ix. The mean score of Achievement in Gravitation of secondary school students who had high Mastery Oriented Assessment while 'Conducting Assessment' (Mean = 9.05, $N = 236$, $SD = 3.76$) does not significantly differ from that of those who had low Mastery Oriented Assessment (Mean = 8.57, $N = 215$, $SD = 3.62$) [$t = 1.39$, $p > .05$].

x. The mean score of Achievement in Equations of Motion of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' (Mean = 9.02, $N = 416$, $SD = 3.39$) is significantly less than that of those who

had low Facilitated Assessment (Mean = 7.98, $N = 46$, $SD = 3.13$) [$t = 2.00$, $p \leq .05$, $d = 0.32$].

xi. The mean score of Achievement in Gravitation of secondary school students who had high Facilitated Assessment for 'Conducting Assessment' (Mean = 8.95, $N = 419$, $SD = 3.73$) is significantly less than that of those who had low Facilitated Assessment (Mean = 7.19, $N = 32$, $SD = 2.80$) [$t = 2.61$, $p \leq .01$, $d = 0.53$].

xii. The mean score of Achievement in Equations of Motion of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' (Mean = 9.00, $N = 400$, $SD = 3.31$) does not significantly differ from that of those who had low Question Generation Strategy (Mean = 8.39, $N = 62$, $SD = 3.78$) [$t = 1.34$, $p > .05$].

xiii. The mean score of Achievement in Gravitation of secondary school students who had high Question Generation Strategy while 'Conducting Assessment' (Mean = 8.95, $N = 384$, $SD = 3.74$) does not significantly differ from that of those who had low Question Generation Strategy (Mean = 8.07, $N = 67$, $SD = 3.41$) [$t = 1.79$, $p > .05$].

xiv. The mean score of Achievement in Equations of Motion of secondary school students who had high ICT-mediated Assessment while 'Conducting Assessment' (Mean = 8.99, $N = 433$, $SD = 3.39$) does not significantly differ

from that of those who had low ICT-mediated Assessment (Mean = 7.90, N = 29, SD = 2.94) [t = 1.69, $p > .05$].

xv. The mean score of Achievement in Gravitation of secondary school students who had high ICT-mediated Assessment while 'Conducting Assessment' (Mean = 8.86, N = 435, SD = 3.71) does not significantly differ from that of those who had low ICT-mediated Assessment (Mean = 7.75, N = 16, SD = 3.26) [t = 1.18, $p > .05$].

Influence of Instructional Practices for 'Consolidation of Concepts' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' (Mean = 14.53, N = 376, SD = 8.24) is significantly higher than that of those who had low Teacher Dominant Instruction (Mean = 17.49, N = 409, SD = 8.61) [t = 4.92, $p \leq .01$, d = 0.35].

ii. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' (Mean = 16.11, N = 489, SD = 8.40) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 16.00, N = 296, SD = 8.83) [t = 0.18, $p > .05$].

iii. The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' (Mean =

16.69, $N = 579$, $SD = 8.77$) is significantly less than that of those who had low Supervisory Instruction (Mean = 14.33, $N = 206$, $SD = 7.70$) [$t = 3.65$, $p \leq .01$, $d = 0.29$].

iv. The mean score of Achievement in Physics of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' (Mean = 16.16, $N = 625$, $SD = 8.69$) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 15.73, $N = 160$, $SD = 8.06$) [$t = 0.56$, $p > .05$].

v. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' (Mean = 16.37, $N = 708$, $SD = 8.51$) is significantly less than that of those who had low Student Participatory Group Instruction (Mean = 13.30, $N = 77$, $SD = 8.56$) [$t = 3.01$, $p \leq .01$, $d = 0.36$].

vi. The mean score of Achievement in Equations of Motion of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' (Mean = 8.83, $N = 102$, $SD = 3.63$) does not significantly differ from that of those who had low Teacher Dominant Instruction (Mean = 8.94, $N = 360$, $SD = 3.30$) [$t = 0.29$, $p > .05$].

vii. The mean score of Achievement in Gravitation of secondary school students who had high Teacher Dominant Instruction for 'Consolidation of Concepts' (Mean = 8.87, $N = 97$, $SD = 3.62$) does not significantly differ from that of

those who had low Teacher Dominant Instruction (Mean = 8.81, $N = 354$, $SD = 3.73$) [$t = 0.14$, $p > .05$].

viii. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' (Mean = 9.04, $N = 340$, $SD = 3.20$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 8.59, $N = 122$, $SD = 3.83$) [$t = 1.16$, $p > .05$].

ix. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Consolidation of Concepts' (Mean = 8.85, $N = 330$, $SD = 3.70$) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 8.74, $N = 121$, $SD = 3.71$) [$t = 0.30$, $p > .05$].

x. The mean scor of Achievement in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' (Mean = 9.20, $N = 374$, $SD = 3.33$) is significantly less than that of those who had low Supervisory Instruction (Mean = 7.75, $N = 88$, $SD = 3.31$) [$t = 3.66$, $p \leq .01$, $d = 0.44$].

xi. The mean score of Achievement in Gravitation of secondary school students who had high Supervisory Instruction for 'Consolidation of Concepts' (Mean = 8.99, $N = 368$, $SD = 3.81$) is significantly less than that of those who had

low Supervisory Instruction (Mean = 8.08, $N = 83$, $SD = 3.07$) [$t = 2.01$, $p \leq .05$, $d = 0.26$].

xii. The mean score of Achievement in Equations of Motion of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' (Mean = 9.03, $N = 409$, $SD = 3.38$) does not significantly differ from that of those who had low ICT-mediated Instruction (Mean = 8.08, $N = 53$, $SD = 3.24$) [$t = 1.94$, $p > .05$].

xiii. The mean score of Achievement in Gravitation of secondary school students who had high ICT-mediated Instruction for 'Consolidation of Concepts' (Mean = 8.95, $N = 391$, $SD = 3.72$) is significantly less than that of those who had low ICT-mediated Instruction (Mean = 7.95, $N = 60$, $SD = 3.49$) [$t = 1.96$, $p \leq .05$, $d = 0.28$].

xiv. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' (Mean = 9.06, $N = 421$, $SD = 3.32$) is significantly less than that of those who had low Student Participatory Group Instruction (Mean = 7.46, $N = 41$, $SD = 3.59$) [$t = 2.92$, $p \leq .01$, $d = 0.46$].

xv. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Consolidation of Concepts' (Mean = 8.87, $N = 426$, $SD = 3.74$) does not significantly differ

from that of those who had low Student Participatory Group Instruction (Mean = 8.00, $N = 25$, $SD = 2.86$) [$t = 1.14$, $p > .05$].

Influence of Instructional Practices for 'Providing Follow-up Activity' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' (Mean = 14.53, $N = 376$, $SD = 8.24$) is significantly higher than that of those who had low Student Participatory Individual Instruction (Mean = 17.49, $N = 409$, $SD = 8.61$) [$t = 4.92$, $p \leq .01$, $d = 0.35$].

ii. The mean score of Achievement in Physics of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' (Mean = 15.69, $N = 391$, $SD = 8.35$) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 16.45, $N = 394$, $SD = 8.76$) [$t = 1.24$, $p > .05$].

iii. The mean score of Achievement in Physics of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' (Mean = 16.66, $N = 626$, $SD = 8.65$) is significantly less than that of those who had low Student Participatory Group Instruction (Mean = 13.77, $N = 159$, $SD = 7.81$) [$t = 4.07$, $p \leq .01$, $d = 0.35$].

iv. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Individual Instruction for

'Providing Follow-up Activity' (Mean = 8.54, N = 171, SD = 3.24) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 9.14, N = 291, SD = 3.44) [t = 1.87, $p > .05$].

v. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Individual Instruction for 'Providing Follow-up Activity' (Mean = 8.98, N = 167, SD = 3.93) does not significantly differ from that of those who had low Student Participatory Individual Instruction (Mean = 8.73, N = 284, SD = 3.56) [t = 0.71, $p > .05$].

vi. The mean score of Achievement in Equations of Motion of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' (Mean = 8.89, N = 281, SD = 3.29) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 8.96, N = 181, SD = 3.51) [t = 0.21, $p > .05$].

vii. The mean score of Achievement in Gravitation of secondary school students who had high Supervisory Instruction for 'Providing Follow-up Activity' (Mean = 8.75, N = 283, SD = 3.69) does not significantly differ from that of those who had low Supervisory Instruction (Mean = 8.94, N = 168, SD = 3.73) [t = 0.53, $p > .05$].

viii. The mean score of Achievement in Equations of Motion of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' (Mean = 9.06, N = 386, SD = 3.46) is significantly less

than that of those who had low Student Participatory Group Instruction (Mean = 8.20, $N = 76$, $SD = 2.81$) [$t = 2.36$, $p \leq .05$, $d = 0.27$].

ix. The mean score of Achievement in Gravitation of secondary school students who had high Student Participatory Group Instruction for 'Providing Follow-up Activity' (Mean = 8.90, $N = 410$, $SD = 3.79$) does not significantly differ from that of those who had low Student Participatory Group Instruction (Mean = 8.05, $N = 41$, $SD = 2.63$) [$t = 1.40$, $p > .05$].

Influence of Instructional Practices for 'Enriching Learning Experiences' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high 'Directing to take part in Science Club Activities' for 'Enriching Learning Experiences' (Mean = 14.56, $N = 334$, $SD = 8.41$) is significantly higher than that of those who had low 'Directing to take part in Science Club Activities' (Mean = 17.19, $N = 451$, $SD = 8.51$) [$t = 4.30$, $p \leq .01$, $d = 0.31$].

ii. The mean score of Achievement in Physics of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' (Mean = 15.99, $N = 515$, $SD = 8.50$) does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' (Mean = 16.23, $N = 270$, $SD = 8.68$) [$t = 0.37$, $p > .05$].

iii. The mean score of Achievement in Physics of secondary school students who had high 'Directing to Exhibit Works on Public Platforms' for 'Enriching Learning Experiences' (Mean = 16.21, N = 656, SD = 8.26) does not significantly differ from that of those who had low 'Directing to Exhibit Works on Public Platforms' (Mean = 15.37, N = 129, SD = 9.96) [t = 0.90, $p > .05$].

iv. The mean score of Achievement in Physics of secondary school students who had high 'Organizing Field Trips' for 'Enriching Learning Experiences' (Mean = 16.28, N = 732, SD = 8.64) is significantly less than that of those who had low 'Organizing Field Trips' (Mean = 13.13, N = 53, SD = 6.72) [t = 3.23, $p \leq .01$, d = 0.41].

v. The mean score of Achievement in Equations of Motion of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' (Mean = 9.04, N = 350, SD = 3.31) does not significantly differ from that of those who had low 'Suggesting Extra Reference Materials/Web Resources' (Mean = 8.54, N = 112, SD = 3.55) [t = 1.39, $p > .05$].

vi. The mean score of Achievement in Gravitation of secondary school students who had high 'Suggesting Extra Reference Materials/Web Resources' for 'Enriching Learning Experiences' (Mean = 8.92, N = 359, SD = 3.75) does not significantly differ from that of those who had low 'Suggesting Extra

Reference Materials/Web Resources' (Mean = 8.41, N = 92, SD = 3.51) [t = 1.18, $p > .05$].

Influence of Instructional Practices for 'Examination Preparedness' on Student Achievement in Physics

i. The mean score of Achievement in Physics of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' (Mean = 14.51, N = 344, SD = 8.66) is significantly higher than that of those who had low Test Previewing Strategy (Mean = 17.29, N = 441, SD = 8.29) [t = 4.58, $p \leq .01$, d = 0.33].

ii. The mean score of Achievement in Physics of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' (Mean = 14.96, N = 396, SD = 8.42) is significantly higher than that of those who had low Test Reviewing Strategy (Mean = 17.21, N = 389, SD = 8.56) [t = 3.71, $p \leq .01$, d = 0.27].

iii. The mean score of Achievement in Physics of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' (Mean = 16.24, N = 426, SD = 8.55) does not significantly differ from that of those who had low Differentiated Strategy (Mean = 15.87, N = 359, SD = 8.58) [t = 0.61, $p > .05$].

iv. The mean score of Achievement in Equations of Motion of secondary school students who had high Test Previewing Strategy for 'Examination

Preparedness' (Mean = 8.78, N = 125, SD = 3.15) does not significantly differ from that of those who had low Test Previewing Strategy (Mean = 8.97, N = 337, SD = 3.46) [t = 0.56, $p > .05$].

v. The mean score of Achievement in Gravitation of secondary school students who had high Test Previewing Strategy for 'Examination Preparedness' (Mean = 8.86, N = 111, SD = 3.86) does not significantly differ from that of those who had low Test Previewing Strategy (Mean = 8.81, N = 340, SD = 3.65) [t = 0.12, $p > .05$].

vi. The mean score of Achievement in Equations of Motion of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' (Mean = 8.92, N = 253, SD = 3.34) does not significantly differ from that of those who had low Test Reviewing Strategy (Mean = 8.92, N = 209, SD = 3.42) [t = 0.01, $p > .05$].

vii. The mean score of Achievement in Gravitation of secondary school students who had high Test Reviewing Strategy for 'Examination Preparedness' (Mean = 8.76, N = 274, SD = 3.79) does not significantly differ from that of those who had low Test Reviewing Strategy (Mean = 8.91, N = 177, SD = 3.57) [t = 0.41, $p > .05$].

viii. The mean score of Achievement in Equations of Motion of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' (Mean = 9.19, N = 312, SD = 3.33) is significantly less than that of those who

had low Differentiated Strategy (Mean = 8.36, N = 150, SD = 3.41) [t = 2.49, $p \leq .05$, d = 0.25].

ix. The mean score of Achievement in Gravitation of secondary school students who had high Differentiated Strategy for 'Examination Preparedness' (Mean = 8.93, N = 301, SD = 3.55) does not significantly differ from that of those who had low Differentiated Strategy (Mean = 8.59, N = 150, SD = 3.98) [t = 0.92, $p > .05$].

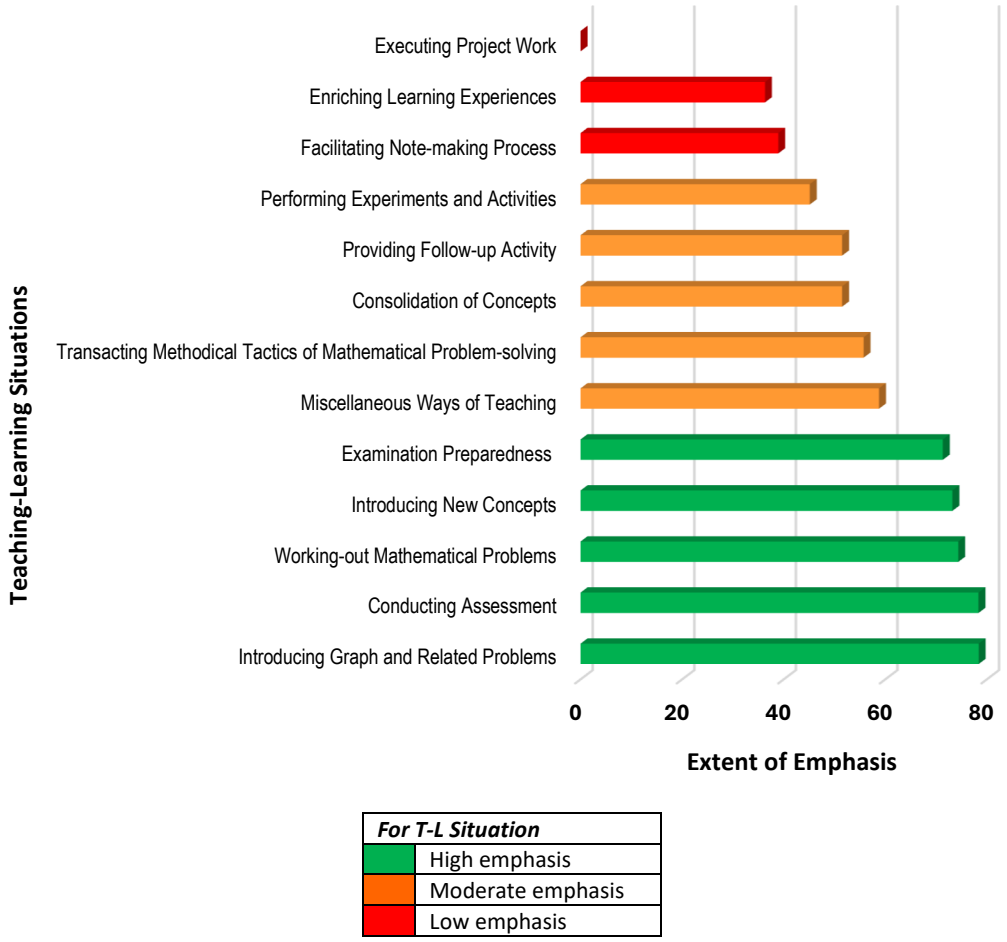
Findings in Brief and Tenability of Hypotheses

In secondary school physics teaching, irrespective of the difficulty level of the concepts the same pattern of instructions is practiced by teachers within each of the identified teaching-learning situations of physics.

At secondary level, physics teachers put more emphasis on teaching-learning situations namely, 'Introducing New Concepts', 'Working out Mathematical Problems', 'Introducing Graph and Working out Related Problems', 'Conducting Assessment' and 'Examination Preparedness'. Moderate emphasis of teaching is observed in 'Miscellaneous Ways of Teaching' (Addressing Misconceptions), 'Performing Experiments or Activities', 'Transacting Methodical Tactics of Mathematical Problem-solving', 'Using Mnemonics / Concept Mapping', 'Consolidation of Concepts' and 'Providing Follow-up Activity'. Less emphasis is observed in, 'Enriching Learning Experiences' and 'Facilitating Note-making Process'. The overview of the teaching-learning situations and the emphasis given by the physics teachers is depicted in Figure 3.

Figure 3

Extent of Emphasis of Physics Teachers on Various Teaching-Learning Situations / Instructional Practices



The extent of usage of various Instructional Practices within each teaching-learning situation is summarized as follows.

For 'Introducing New Concepts' in Physics at secondary level, Teacher Dominant Instruction is used frequently, Student Participatory Group Instruction and Student Participatory Individual Instruction is practiced rarely and ICT-mediated Instruction is used almost never. While 'Performing Experiments or Activities', Teacher Dominant Instruction is employed occasionally, Student Participatory

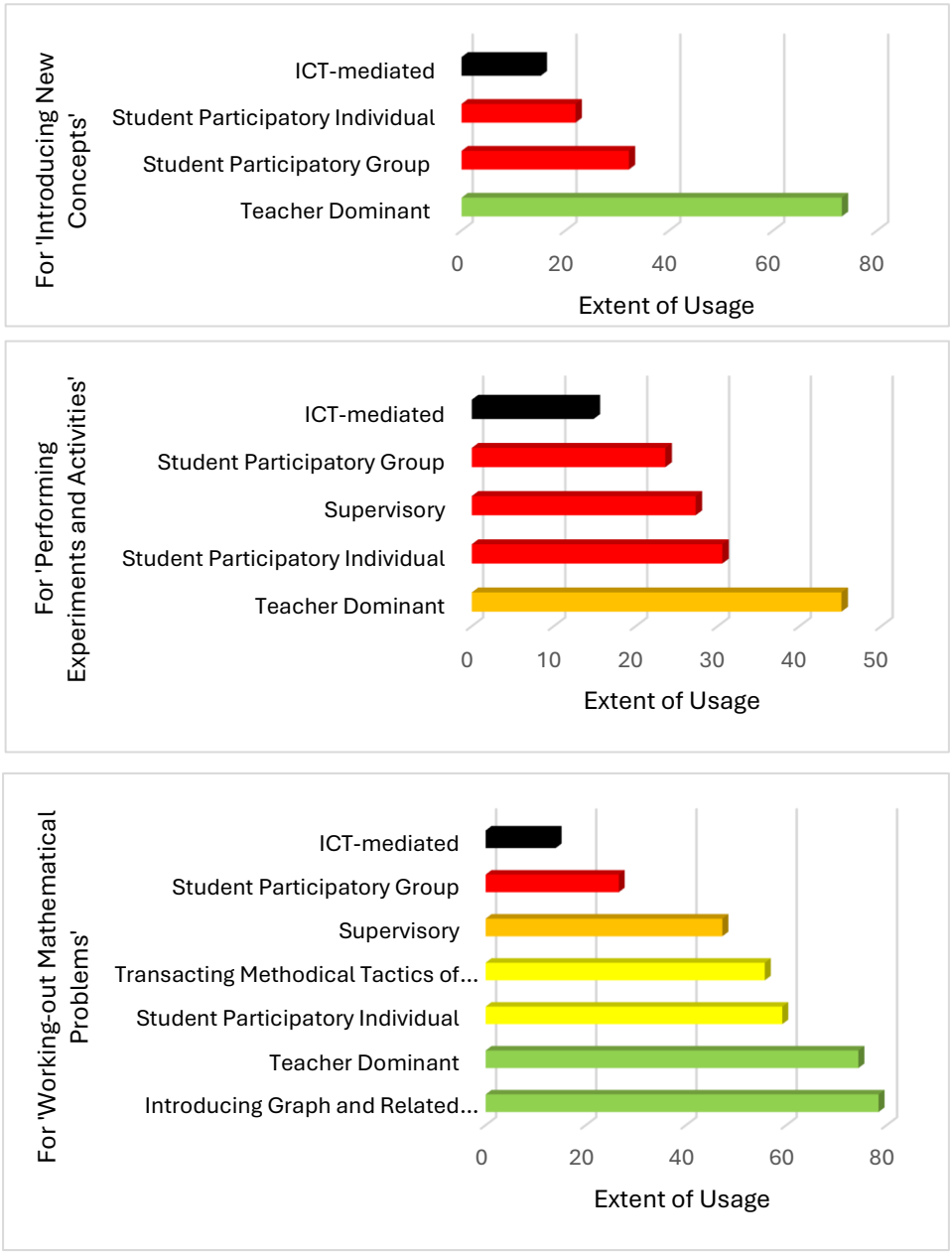
Individual Instruction, Student Participatory Group Instruction and Supervisory Instruction are used rarely and ICT-mediated Instruction is used almost never. For 'Working out Mathematical Problems', Teacher Dominant Instruction is employed frequently, Student Participatory Individual Instruction is used sometimes, Supervisory Instruction is used occasionally, Student Participatory Group Instruction is employed rarely and ICT-mediated Instruction is practiced almost never. 'Transacting Methodical Tactics of Mathematical Problem-solving' is practiced sometimes and 'Introducing Graph and Working out Related Problems' are practiced frequently. For 'Facilitating Note-making Process', Teacher Dominant Instruction and Supervisory Instruction are used occasionally, Student Participatory Individual Instruction is employed rarely and Student Participatory Group Instruction is practiced almost never. Under 'Miscellaneous Ways of Teaching', 'Addressing Misconceptions' and 'Using Mnemonics/ Concept Mapping' are done sometimes, 'Peer Teaching' and 'Conducting Debate' is performed almost never and 'Team Teaching' is never employed. While 'Conducting Assessment', Formative Assessment is used frequently, Mastery-oriented Assessment is practiced sometimes, Facilitated Assessment, Question Generation Strategy and ICT-mediated Assessment are employed almost never. For 'Consolidation of Concepts', Teacher Dominant Instruction is practiced sometimes, Student Participatory Individual Instruction is used rarely, Supervisory Instruction, ICT-mediated Instruction and Student Participatory Group Instruction are practiced almost never. While 'Providing Follow-up Activity', Student Participatory Individual Instruction is used sometimes, Supervisory Instruction is employed rarely and Student Participatory Group

Instruction is practiced almost never. For 'Enriching Learning Experiences', 'Directing to take part in Science Club Activities' is done occasionally, 'Suggesting Extra Reference Materials/Web Resources' is done rarely, 'Directing to Exhibit Works on Public Platforms' and 'Organizing Field Trips' are performed almost never. For performing 'Examination Preparedness', both Test Previewing Strategy and Test Reviewing Strategy are employed frequently and Differentiated Strategy is used rarely.

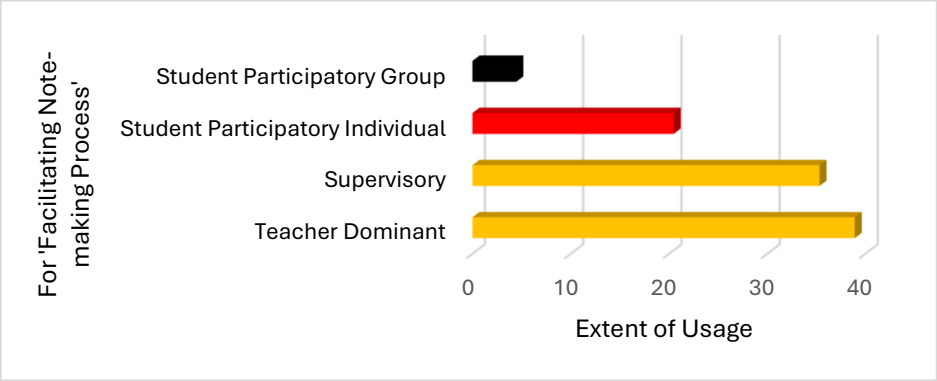
The overview of the extent of usage of various Instructional Practices within each teaching-learning situation is given in Figure 4.

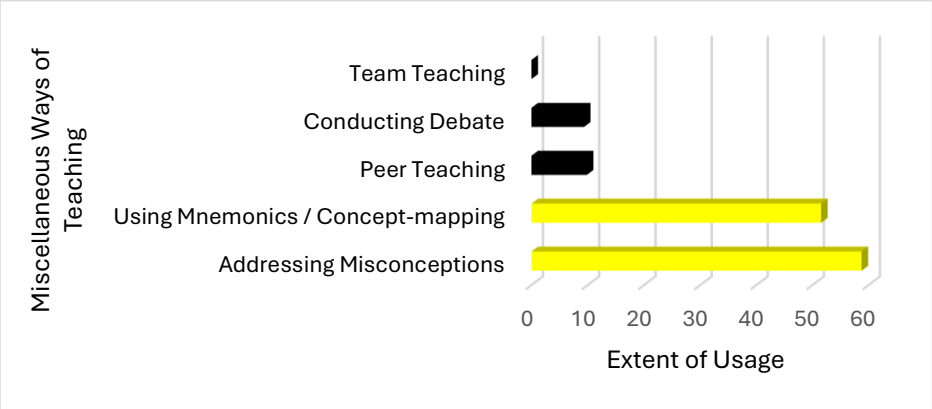
Figure 4

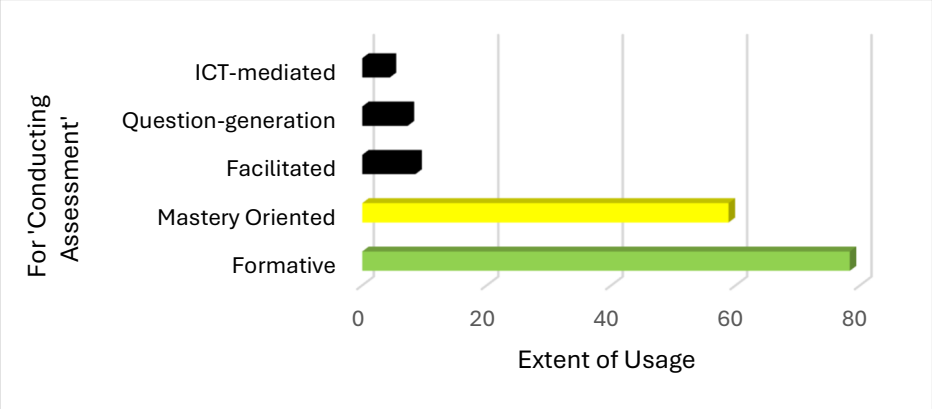
Extent of Usage of Various Instructional Practices in Each Teaching-Learning Situation



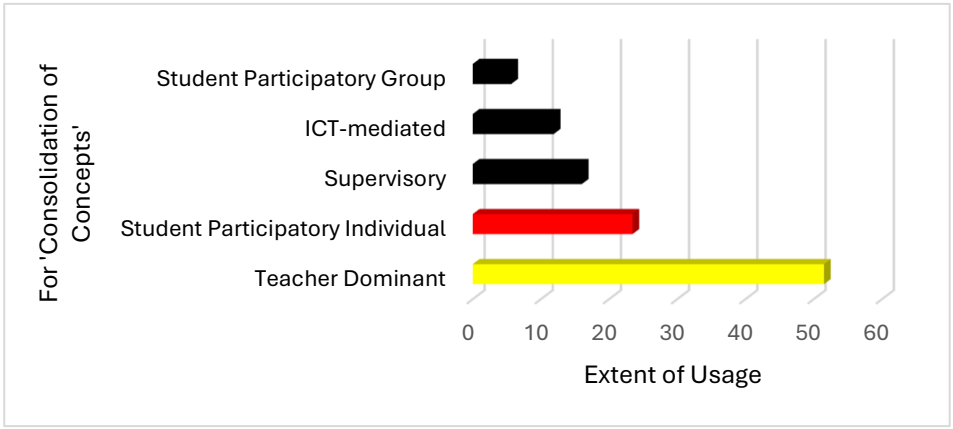
For Instructional Practices	
	Very often
	Frequently
	Sometimes
	Occasionally
	Rarely
	Almost never

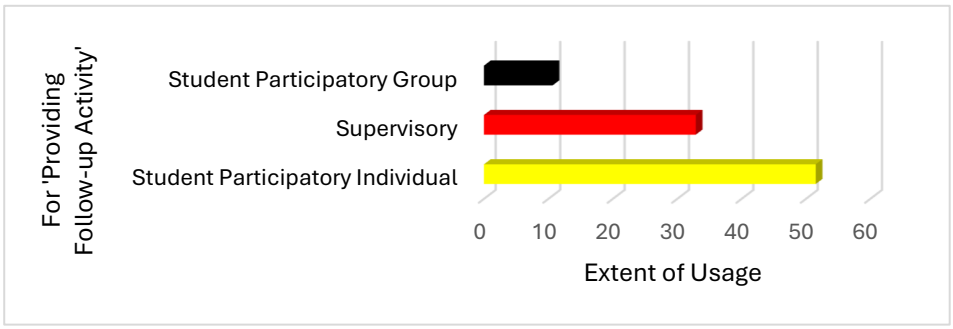


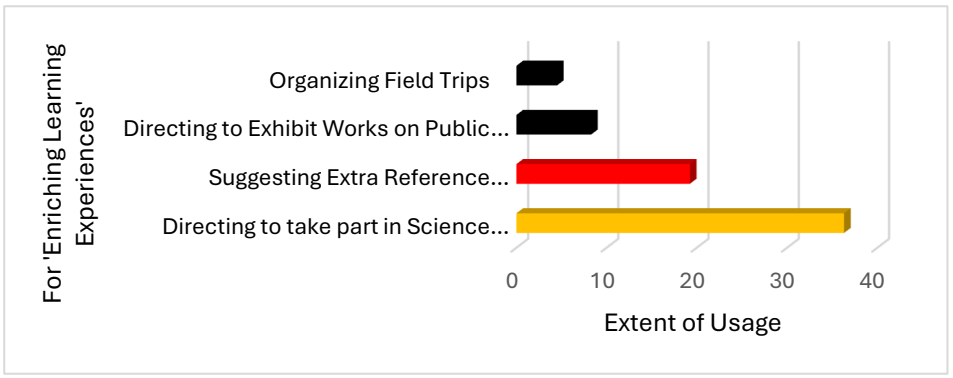


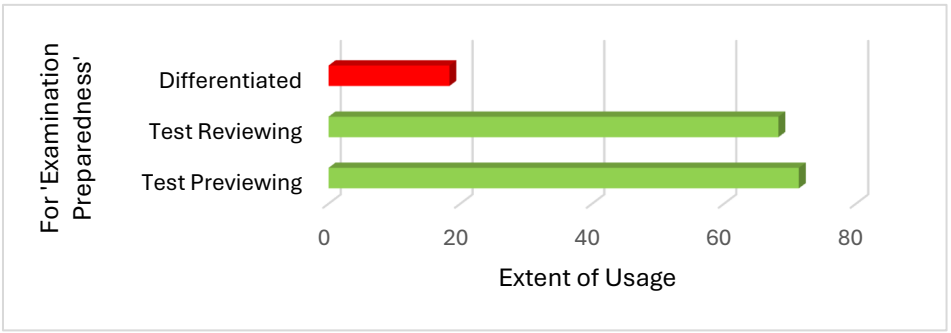


For Instructional Practices	
	Very often
	Frequently
	Sometimes
	Occasionally
	Rarely
	Almost never









For Instructional Practices	
	Very often
	Frequently
	Sometimes
	Occasionally
	Rarely
	Almost never

The Instructional Practices that influence Interests and Achievement in Physics and in difficult concepts within each teaching-learning situation is summarized as follows.

Domain Interest in Physics is found favoured only by the Instructional Practices, viz., Teacher Dominant Instruction while 'Introducing New Concepts'; Teacher Dominant Instruction, Student Participatory Individual Instruction and Supervisory Instruction while 'Performing Experiments / Activities'; Teacher Dominant Instruction and Supervisory Instruction while 'Working-out Mathematical Problems'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; 'Addressing Misconceptions', 'Using Mnemonics/ Concept Mapping' and 'Peer Teaching'; Formative Assessment and Mastery Oriented Assessment while 'Conducting Assessment; Teacher Dominant Instruction while 'Consolidation of Concepts'; Student Participatory Individual Instruction and Supervisory Instruction while 'Providing Follow-up Activity'; Directing to take part in Science Club Activities for 'Enriching Learning Experiences'; Test Previewing and Test Reviewing Strategies while performing 'Examination Preparedness'.

Hence, the first hypothesis that "the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in Physics among secondary school students" is only partially substantiated.

Situational Interest in Physics is found favoured only by the Instructional Practices, viz., Teacher Dominant Instruction and ICT-mediated Instruction while 'Introducing New Concepts'; Student Participatory Group Instruction while

Performing Experiments and Activities; Teacher Dominant Instruction while 'Working-out Mathematical Problems'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; Teacher Dominant Instruction and Supervisory Instruction while 'Facilitating Note-making Process'; 'Addressing Misconceptions', 'Using Mnemonics/ Concept Mapping' and 'Peer Teaching'; Formative Assessment while 'Conducting Assessment; Student Participatory Individual Instruction and Supervisory Instruction while 'Consolidation of Concepts'; Supervisory Instruction while 'Providing Follow-up Activity'; Test Previewing and Test Reviewing Strategies while performing 'Examination Preparedness'.

Hence, the third hypothesis that "the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Situational Interest in Physics among secondary school students" is only partially substantiated.

Individual Interest in Physics is found favoured only by the Instructional Practices, viz., Teacher Dominant Instruction and ICT-mediated Instruction while 'Introducing New Concepts'; Student Participatory Individual Instruction and Supervisory Instruction while 'Performing Experiments / Activities'; Teacher Dominant Instruction and Supervisory Instruction while 'Working-out Mathematical Problems'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; Teacher Dominant Instruction and Supervisory Instruction while 'Facilitating Note-making Process'; 'Addressing Misconceptions', 'Using Mnemonics/ Concept Mapping' and 'Conducting Debate'; Formative Assessment and Mastery Oriented Assessment while 'Conducting

Assessment; Student Participatory Individual Instruction and Supervisory Instruction while 'Consolidation of Concepts'; Supervisory Instruction while 'Providing Follow-up Activity'; Directing to take part in science club activities and Suggesting extra references and web resources for 'Enriching Learning Experiences'; Test Reviewing Strategies and Differentiated Strategy while performing 'Examination Preparedness'.

Hence, the fourth hypothesis that "the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Individual Interest in Physics among secondary school students" is only partially substantiated.

Achievement in Physics is found favoured only by the Instructional Practices, viz., Teacher Dominant Instruction while 'Introducing New Concepts', 'Performing Experiments / Activities', 'Working-out Mathematical Problems' and 'Consolidation of Concepts'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; 'Addressing Misconceptions'; Formative and Mastery Oriented Assessment; Student Participatory Individual Instruction while 'Providing Follow-up Activity' ; 'Directing to take part in Science Club Activities'; Test Previewing and Test Reviewing Strategies while performing 'Examination Preparedness'. ***Achievement in Physics is found disfavoured*** only by the Instructional Practices, viz., Student Participatory Group Instruction and ICT-mediated Instruction while 'Working-out Mathematical Problems'; 'Conducting Debate'; Facilitated and ICT-mediated Assessment; Student Participatory Group Instruction and Supervisory Instruction while 'Consolidation of Concepts'; Student Participatory Group Instruction while 'Providing Follow -up Activity'; Organizing field trip.

Hence, the fifth hypothesis that "the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in Physics among secondary school students" is only partially substantiated.

Domain Interest in difficult concepts is found favoured only by the Instructional Practices, viz., Teacher Dominant Instruction while 'Introducing New Concepts' and 'Working-out Mathematical Problems'; 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems'; Teacher Dominant Instruction while 'Facilitating Note-making Process'; 'Addressing Misconceptions', 'Using Mnemonics/ Concept Mapping' and 'Peer Teaching'; Student Participatory Individual Instruction and Supervisory Instruction while 'Providing Follow-up Activity'; Test Previewing Strategy while performing 'Examination Preparedness'. ***Domain Interest in difficult concepts is found disfavoured*** only by the Instructional Practices, viz., ICT-mediated instruction while 'Introducing New Concepts' and Supervisory Instruction while 'Consolidation of Concepts'.

Hence, the second hypothesis that "the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Domain Interest in difficult concepts in physics among secondary school students" is only partially substantiated.

Achievement in difficult concepts is found favoured only by the Instructional Practices, viz., 'Transacting Methodical Tactics of Mathematical Problem-solving' and 'Introducing Graph and Related Problems' and 'Addressing Misconceptions'. ***Achievement in difficult concepts is found disfavoured*** only by the Instructional

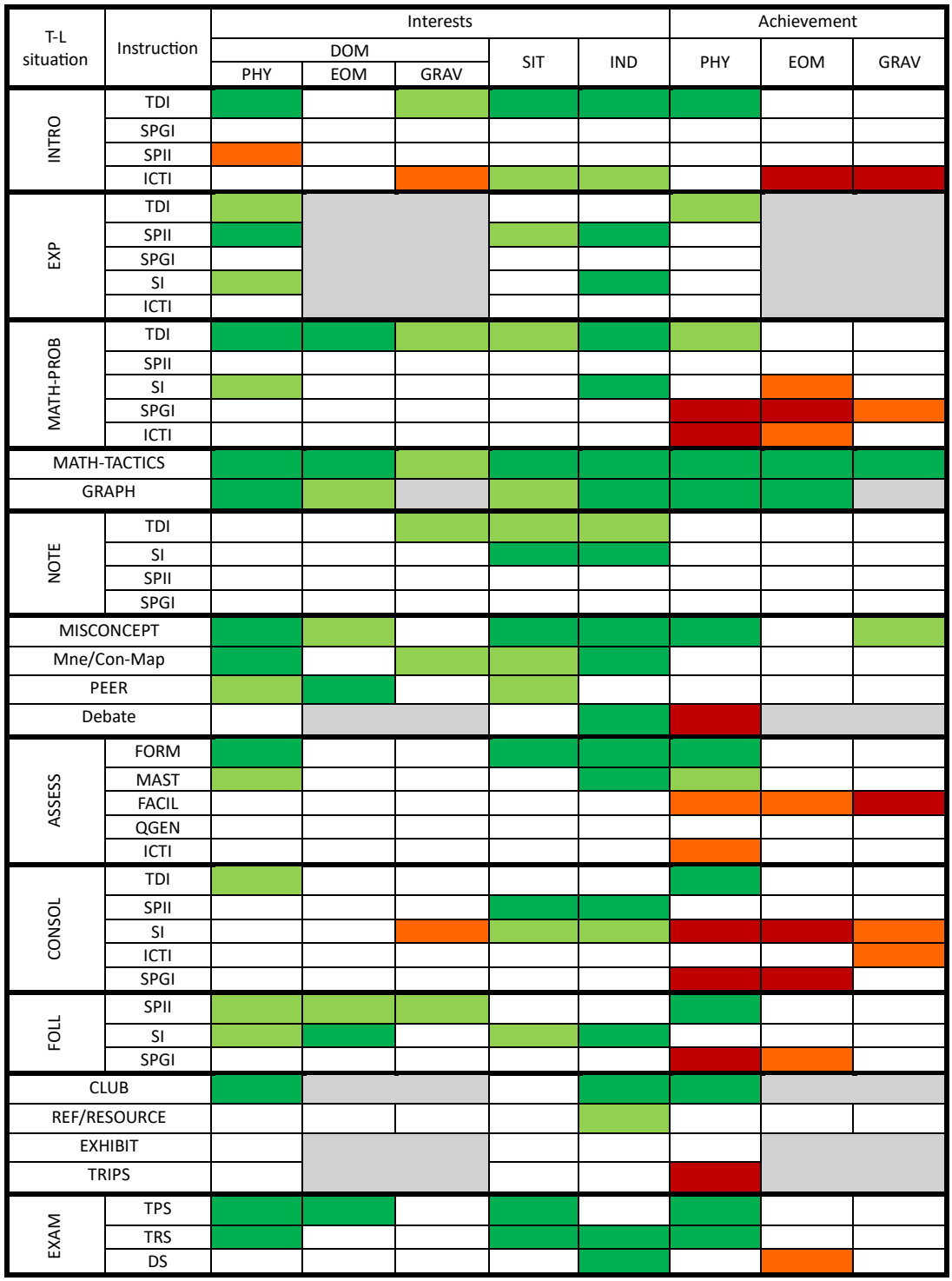
Practices, viz., ICT-mediated Instruction while 'Introducing New Concepts'; Student Participatory Group Instruction, Supervisory Instruction and ICT-mediated Instruction while 'Working-out Mathematical Problems' and 'Consolidation of Concepts'; Facilitated Assessment; Student Participatory Group Instruction while 'Providing Follow-up Activity'; Differentiated Instruction while 'Examination Preparedness'.

Hence, the sixth hypothesis that "the extent of each type of Instructional Practice in select teaching-learning situations has a significant influence on Achievement in difficult concepts in physics among secondary school students" is only partially substantiated.

For a better visualization, the influence of Instructional Practices on Domain Interest in Physics, Domain Interest in difficult concepts, Situational Interest in Physics, Individual Interest in Physics, Achievement in Physics and Achievement in difficult concepts are provided in Figure 5.

Figure 5

Overview of Influence of Instructional Practices in Physics on Interests and Achievement in Physics and in Difficult Concepts



Note: Favouring at .01 level (Dark Green); Favouring at .05 level (Light Green); Disfavouring at .05 level (Orange); Disfavouring at .01 level (Maroon); Not applicable (Grey)

Conclusion

In secondary school physics teaching, irrespective of the difficulty level of the concepts the same pattern of instructions is practiced by teachers within each of the identified teaching-learning situations of physics. This result contradicts the recommendation put forward by Omeodu (2019) that physics teachers should vary the instructional practices in accordance with the nature of concepts and learning attitude of the students towards the concepts.

Physics teachers put high emphasis on situations of introducing the concept, solving mathematical problems, assessment and examination, and comparatively less emphasis on other aspects such as performing experiments, transacting methodical tactics of mathematical problem-solving, addressing misconceptions, using mnemonics/concept mapping, consolidation of concepts, providing follow-up activity, enriching learning experiences and facilitating note-making process.

For physics teaching at secondary level, frequently used instructional practices are Teacher Dominant Instruction (while introducing a concept and its consolidation, mathematical problem-solving), working-out problems related to graph, Formative Assessment, Test Previewing and Reviewing Strategies.

Student Participatory Instruction (both Individual and Group) and ICT-mediated Instructions are practiced limitedly. ICT-mediated Instruction is almost never used, Student Participatory Group Instruction is slightly more used and Student Participatory Individual Instruction is even more slightly used in secondary physics classrooms.

Facilitated Assessment and Question Generation Strategy (while conducting assessment), Peer Teaching, Conducting Debate, Directing to Exhibit Works on Public Platforms and Organizing Field Trips is almost never used in secondary physics classrooms. 'Executing Project Works' and 'Team Teaching' are not even attempted by the physics teachers at secondary level.

The Instructional Practices, which are almost never in use by the physics teachers, are not considered for further interpretation of results of influence of Instructional Practices on Interests and Achievement in Physics.

The Instructional Practices and their influence on Interests and Achievement in Physics among students in each teaching-learning situation is summed up and provided in Figure 6.

Figure 6

Summary of Research Outcomes

T-L Situation	Interest in Physics	Achievement in Physics
Introducing New Concepts	Teacher Dominant ↑ Student Participatory (Individual & Group) →	Teacher Dominant ↑ Student Participatory (Individual & Group) →
Performing Experiments/Activities	Student Participatory Individual ↑ Supervisory ↑ Teacher Dominant ↑ (Domain only) Student Participatory Group →	Student Participatory Individual → Supervisory → Teacher Dominant ↑ Student Participatory Group →
Working-out Mathematical Problems	Teacher Dominant* ↑ Supervisory ↑ Student Participatory Group → Tactics of PS* ↑ Graphs* ↑ Student Participatory Individual →	Teacher Dominant ↑ Supervisory → Student Participatory Group* ↓ Tactics of PS* ↑ Graphs* ↑ Student Participatory Individual →
Facilitating Note-making Process	Teacher Dominant* ↑ Supervisory ↑ Student Participatory Individual →	Teacher Dominant → Supervisory → Student Participatory Individual →
Miscellaneous Ways of Teaching	Addressing Misconceptions* ↑ Using Mnemonics/C-mapping* ↑	Addressing Misconceptions* ↑ Using Mnemonics/C-mapping →
Conducting Assessment	Formative ↑ Mastery Oriented ↑	Formative ↑ Mastery Oriented ↑
Consolidation of Concepts	Student Participatory Individual ↑ Teacher Dominant ↑ (Domain only)	Student Participatory Individual → Teacher Dominant ↑
Providing Follow-up Activity	Student Participatory Individual* (Domain only) ↑ Supervisory* ↑	Student Participatory Individual ↑ Supervisory →
Enriching Learning Experience	Directing to take part in Science Club Activities ↑ Reference / Resources ↑	Directing to take part in Science Club Activities ↑ Reference / Resources →
Examination Preparedness	Preview*↑ Review↑	Preview ↑ Review↑

*Applicable to difficult concepts also; Favours (↑), Disfavours (↓), No influence (→)

Figure 6 implies the following generalizations.

1. While Introducing New Concepts, Teacher Dominant Instruction favours both Interest and Achievement in Physics. Student Participatory Instructions (Individual or Group) has no influence on Interest and Achievement in Physics.

2. While Performing Experiments and Activities, Student Participatory Individual Instruction and Supervisory Instruction favours Interest in Physics. Teacher Dominant Instruction favours Domain Interest and Achievement in Physics. Student Participatory Group Instruction has no influence on Interest and Achievement in Physics.

3. While Working-out Mathematical Problems, Teacher Dominant Instruction, Transacting of Methodical Tactics of Problem-solving and Introducing Graph and Related Problems favour both Interest and Achievement in Physics. Supervisory Instruction favours Interest in Physics. Student Participatory Group disfavours Achievement in Physics. Student Participatory Individual Instruction has no influence on Interest and Achievement in Physics.

4. While Facilitating Note-making Process, Teacher Dominant Instruction and Supervisory Instruction favour Interest in Physics; but have no influence on Achievement. Student Participatory Individual Instruction has no influence on Interest and Achievement in Physics.

5. Addressing Misconceptions favours both Interest and Achievement in Physics. Using Mnemonics/ Concept Mapping favours Interest; but have no influence on Achievement in Physics.

6. While Conducting Assessment, Formative and Mastery Oriented strategies favour both Interest and Achievement in Physics.

7. While Consolidation of Concepts, Student Participatory Individual Instruction favours Interest in Physics. Teacher Dominant Instruction favours Domain Interest and Achievement.

8. While Providing Follow-up Activity, Student Participatory Individual Instruction favours both Interest and Achievement in Physics. Supervisory Instruction favours Interest; but has no influence on Achievement.

9. Directing to take part in science club activities favours both Interest and Achievement. Suggesting extra reference materials/web resources favours Individual Interest only; but has no influence on Achievement.

10. While Examination Preparedness, both Test Previewing and Reviewing strategies favour Interest and Achievement in Physics.

Summing up, the Instructional Practices that favour both Interest and Achievement in Physics are Teacher Dominant Instruction while Introducing New Concepts and Working-out Mathematical Problems, Transacting Methodical Tactics of Mathematical Problem-solving, Introducing Graph and Related problems, Addressing Misconceptions, Formative and Mastery Oriented Assessment, Student

Participatory Individual Instruction while Providing Follow-up Activities, Directing to take part in Science Club Activities, Test Previewing and Reviewing Strategies for Examination Preparedness.

The Instructional Practices that favour Interest in Physics are Student Participatory Individual and Supervisory Instruction while Performing Experiments and Activities, Supervisory Instruction while Working-out Mathematical Problems, Teacher Dominant Instruction and Supervisory Instruction while Facilitating Note-making Process, Using Mnemonics / Concept Mapping, Student Participatory Individual Instruction while Consolidation of Concepts, Student Participatory Individual Instruction and Supervisory Instruction while Providing Follow-up Activity and Suggesting Extra References/ Web Resources.

The Instructional Practices that favour Achievement in Physics are Teacher Dominant Instructions while Performing Experiments and Activities, Working-out Mathematical Problems and Consolidation of Concepts.

The Instructional Practices that favour both Interest and Achievement in difficult concepts are Transacting Methodical Tactics of Mathematical Problem-solving and Introducing Graph and Related Problems. The practices that favour Interest in difficult concepts are Teacher Dominant Instruction while Working-out Mathematical Problems and Facilitating Note-making Process, Using Mnemonics/Concept-mapping, Student Participatory Individual Instruction and Supervisory Instruction while Providing Follow-up Activity and Test Previewing Strategy for Examination Preparedness.

Chapter Six

RECOMMENDATIONS

- Educational Implications
- Limitations of the Study
- Recommendations for Further Research

To reinforce the contributions and significance of the study, this chapter consolidates the study in terms of objectives, methodology, statistical techniques, findings and its implication in educational setting. The chapter also throws light upon the gaps that were not addressed in the current study, suggesting new angles and suggestions for further research.

This study identified the extant Instructional Practices of physics teachers at secondary level and their influence on Interests and Achievement in Physics among secondary school students. Above objectives were also substantiated in the case of transaction of major concepts in physics that students perceive to be difficult while learning.

Educational Implications

In secondary level physics teaching, the transaction of a concept takes place through many teaching-learning contexts starting from introduction of the concept to evaluating the level of understanding among students. This study reveals that the Instructional Practices employed by the teachers vary from context to context. These practices have influence on interest and achievement of students in the subject. This influence also varies across the concepts based on its perceived difficulty by the students. So, it becomes important to highlight the identified practices within each

context that strengthen the interest and achievement of the learners. The implications for the educational settings that arise from this study are briefed as follows.

Activating Prior Knowledge: A Teacher's Strategy to Begin Lessons in Physics

The study showed that the teachers prefer and frequently use teacher dominant strategies in the beginning of a lesson and the students who reported this had high domain interest, situational interest, individual interest and achievement in physics. Rather than opting for student-led or student-participatory approaches in physics that showed no influence on interest and achievement, the dominance of teachers is relevant in the beginning of lessons in physics. While planning for a lesson, teachers must know the age, level of experience and prior knowledge of the students regarding the concept to be introduced. Teachers may give due consideration to the prior knowledge of learners and bridge the new concept with already known, by citing instances from their daily life routine. The examples and illustrations provided in the textbooks and handbooks will be useful for the teachers in this context. Teachers can also demonstrate simple examples that students can easily connect with.

These are consistent with the observations of Lavonen et al. (2005), Keller (2017) and Haussler et al. (1998). Connecting the physics concepts or phenomena to the real-life contexts and to the instances concerning the students directly can enhance their interest towards the subject (Lavonen et al., 2005). Such 'Authentic Learning' (Keller, 2017) makes students more interested in physics as they find the concepts learnt in their classes applicable to the situations outside the school. Haussler et al. (1998) also supported linking the new concepts to prior knowledge and experience of the learners to encourage student interest.

Individual Student-led Experimentation for Building Interest and Observational Learning for Achievement

The physics teachers' moderate emphasis on experimentation and related activities is one of the highlights of the study. Even though, student's individual participation and teacher supervision are rare practices in this context, this usage is found supporting the Domain, Situational and Individual Interest in physics. So, this implies the importance of active and interesting learning experience through incorporation of experimentation performed by students, that bridge the learnt concept with its practical aspect. Students performing experiments individually, exploring and presenting their findings, along with sufficient teacher supervision can support not just short-term student engagement and interest in the subject matter, but one that sustains for a longer period.

This result is in line with the explanation by Nugroho and Waslam (2020) that the experimental activity in physics with challenging questions enhances interest among students towards the subject and makes learning a fun-filled experience. There is immediate positive impact upon the interest of the learners who perform experiments by themselves (Dohn et al., 2009; Palmer, 2009; Zahorik, 1996).

Teacher dominated instruction is occasionally practised in the context of experimentation and this is found backing Achievement and Domain Interest among learners. So, the teacher demonstrating experiments in front of the students and explaining the findings is seen influencing the conceptual understanding of the pupils and their interest towards the specific concept upon which the experiment is based.

The studies of Abraham and Millar (2008), Lazarowitz and Tamir (1994), Wood et al. (1976), Ogborn et al. (1996) and Lunetta (1998) supported that doing experiments alone would not contribute to conceptual understanding of the students in science. The involvement of the authority, i.e., the teacher, is essential to help students see and imbibe the scientific phenomena in the proper way as the teacher wants them to imbibe it and thus catering to better understanding of the concept.

So, the teachers can begin with class demonstrations to build the conceptual understanding among the students, later providing opportunities to conduct experiments individually under teacher supervision to enhance student interest towards the underlying concept.

Teacher- Controlled Instruction for Unlocking Challenges in Mathematical Problem Solving

Mathematical problem-solving is the crux of physics teaching and learning process. Teachers lay high emphasis to this context and employ teacher led strategies frequently while dealing with mathematical problems in physics. Occasionally, teacher supervision is provided while students work on problems.

Teacher dominance during working-out mathematical problems supports Domain, Situational and Individual Interest in Physics. In this context, teacher can demonstrate solving process by working-out problems on the blackboard and can also ask the students to follow the step-by-step instruction provided. Teacher guidance and timely assistance while students try to tackle problems by themselves is also found favouring the interest in the subject.

Students must be transacted with the methodical tactics of solving mathematical problems in physics, which is found backing Domain Interest, Situational Interest, Individual Interest and Achievement in Physics. The study reveals that teachers sometimes practice it in their physics classrooms. While solving a problem, students should be taught initially to identify what is being given in the question and what is to be found. For better understanding of the question, the students should then convert it into symbolic or diagrammatic form. The next task is to plan to solve the question by locating the most appropriate equation and then making substitutions of the knowns and rearranging the equation to reach the solution. Finally, the students must be directed to cross check and review the answer obtained. Biswal (2023) explained that the minimal use of explicit teaching strategies hinders the student learning.

It is through the IX standard physics syllabus that students from Kerala State Board schools, acquaint with the concept of graph for the first time. So, the physics teachers are liable to introduce the concept of graph and frequently practice graph related problems to the students systematically, which supports Domain Interest, Situational Interest, Individual Interest and Achievement in physics. Along with explaining what a graph is, its use in real life has to be transacted, so that students can realize its relevance. The different parts/elements and axes of the graph, assigning scales to the axes and plotting points are the basics of graph that initially have to be transacted by teachers. The students have to become well-versed in performing table data to graph conversion and vice-versa. The major concepts in physics such as

Equations of Motion and Laws of Motion involves applications of graphs. Hence, most of the mathematical problems based on these concepts have graphs from which the students are meant to identify the nature of motion of the object, find displacement, velocity, acceleration etc. So, adopting the step-by-step approach in effectively transacting graph is a necessity in physics classrooms.

These are found in line with the explanations by Stein et al. (2004) that it is the teacher-directed practices of explicit teaching of concept and skill, and demonstration of the procedure of problem-solving, later followed by repeated practice on solving mathematical problems (using drills or worksheets), that help students gain the procedural fluency, higher order thinking skills and problem-solving skills. Teacher directed strategies are helpful for students especially with math difficulty and the teacher while demonstrating the sequential steps in problem solving in a well-organized and orderly manner cater to better understanding among students (Kroesbergen et al., 2004; Morgan et al., 2015). The demonstration in the logical manner lays down the procedures and principles to be followed for the spectators, thus enhancing their problem-solving skills and makes them capable to solve any complicated problems (Akinbobola, 2015).

This study pinpointed that, even if the teachers rarely direct the students to work-out mathematical problems in groups, this practice can disfavour achievement of students in the subject. Teacher may also ask one of the students randomly to work out problem on the blackboard and later ask rest of the students to check its correctness.

Similarly, Le et al. (2006) had proposed that the practice of problem-solving involving group-works of the students, be it mixed-ability grouping or not, had negative impact on learning. Students involved in collaborative mathematical problem-solving face a range of struggles such as cognitive (difficulty to understand the problem and to solve it), socio-cognitive (difficulty to explain to peer, to accept others explanation or to reach an agreement), social (difficulty to have one's own views and ideas to take up) and materials struggles (difficulty in access to learning materials), out of which socio-cognitive and social struggles were major (Jarry-Shore & Anantharajan, 2021). The existence of socio-cognitive and social difficulties during mathematical problem-solving in groups is also supported by Langer-Osuna (2011) and Franke et al. (2015).

Providing Teacher-curated Learning Notes to Spark Interest

Learning note aids the learning process. But the teachers put only less emphasis in facilitating note-making process in physics classrooms. Occasionally, teacher provides structured notes, and this usage is seen supporting the Situational and Individual Interest in physics. Especially for a school subject like physics, these learning notes simplifies the complex content and helps students to pinpoint on the key points. The logical flow of well-organized notes prepared by the teacher can provide the students the comprehensive view of the whole content. The study of Kiewra (1985) and Kiewra et al. (1988) had explained similar findings that the notes provided by the instructor, in any form (complete text, linear, matrix), are considered

to be complete and organized, which serves as a reliable external storage of information that can be reviewed any time by the students.

Also, physics teachers occasionally practice the note reviewing and content refinement process of note-making and this is found favouring both Situational and Individual Interest in the subject. Whether the teacher structures and dictates or distributes the learning notes, or the students prepare it by themselves, checking them and providing suggestions timely is also the inevitable part of the process. In short, identifying errors and ensuring the accurate recording of the key concepts holds significance and has to be practiced even more frequently.

Debugging Misconceptions by Teachers Through Targeted Interventions

Findings of the study revealed that students' misconceptions in physics are addressed only sometimes by the teachers. As far it is being practiced, it is found favouring Domain Interest, Situational Interest, Individual Interest and Achievement in the subject. Misconceptions hinder the level of interest, achievement and learning of advanced concepts in physics. Misconceptions hinder the perceiving of accurate body of knowledge and thus inhibiting conceptual understanding, the ability of problem-solving and achievement among students (Ozmen, 2024). They are also the source of frustration and cognitive conflict, which makes students lazy to learn the subject (Chen et al., 2019; Labobar et al., 2017; Verkade et al., 2017).

It is important to identify misconceptions, to address and prevent it, as the effective learning will not occur if misconceptions are overlooked (Garnett &

Treagust, 1992; Huddle et al., 2000; Sanger & Greenbowe, 1997). It is the duty of the teacher to address misconceptions in the science classrooms (Assem et al., 2023). This conveys that rectification of misconceptions in physics, by providing ample examples, should be made frequent and timely, as it is relevant to build a strong foundation of conceptual understanding, especially among secondary school students. Early identification using diagnostic assessment and by incorporating practices like inquiry-based learning, concept mapping, experiential learning, virtual labs, peer instruction, worksheets etc., can minimize misconceptions to a large extent.

Utilizing Memory Aids and Visual Frameworks in Enhancing Higher Order Thinking Ability, and hence Interest

Mnemonics is a beneficial memory aid as far as physics is concerned, as it helps students link complex concepts to familiar words or patterns, which in turn makes recalling easy. Similarly, concept maps are for visualizing relationships between concepts and for making abstractness in the subject more concrete. Findings highlight the fact that both these simplifying techniques are used only sometimes by physics teachers. Since, this usage is found backing Domain, Situational and Individual Interest, it becomes relevant to implement them more frequently in the teaching-learning context.

These findings align with the study of Usman and Mankilik (2019) which showed that concept mapping as a graphical tool for logically organized information, enhances students understanding and achievement in physics. The students' attributes such as positive attitude, achievement and retention, reasoning and higher order-

thinking ability, comprehension etc. in various subjects are boosted with the usage of concept maps (Ahmed et al., 2021; Awofala, 2011; Cheema & Mirza, 2013). Experimental studies also show that along with achievement, student interest can also be elevated with this strategy (Chiou, 2008; Youssef & Mansour, 2012). The use of mnemonic strategy in physics improves learning and achievement among high school students (Ntibi et al., 2018; Sugiarti, 2017). The strategy involving mnemonics could not only enhance the vocabulary skill in physics, but also made the learning process enjoyable, motivating and highly satisfying for the learners (Pilit et al., 2024). Contribution to interest and understanding among students by the mnemonic strategy is also proved in the study by Colak and Aydin (2022).

Formative and Mastery Oriented Teacher-led Questioning on a Daily Basis

Physics teachers highly emphasize the process of performing assessment. For monitoring the learning process, it is formative assessment that teachers frequently practice, and this is found supporting Domain Interest, Situational Interest, Individual Interest and Achievement in physics. After transacting a concept, the students must be enquired whether they have understood it or not, teachers can provide explanation and clarification in case of doubts raised by students. Apart from getting immediate feedback on students' level of understanding, the practice of asking questions among the students randomly in between the class is very useful in ensuring the learner alertness and interest throughout the session, which further favours their achievement in the subject.

The findings are in line with the studies of Bulunuz et al. (2014), Hattie (2009), McManus (2008) and Ozan and Kincal (2018). Among the 138 influential factors for achievement of students, the third position is for formative assessment (Hattie, 2009). Apart from organizing the teaching-learning process, formative assessment can also enhance student achievement (McManus, 2008). This assessment significantly enhances the level of understanding of students in physics (Bulunuz et al., 2014). Formative assessment practices brought better student achievement and attitude in social science among students, and the progress in uninterested students were evident as a result of this practice (Ozan & Kincal, 2018). Similar influence of formative assessment on the attitude of the students is also explained by Tekin (2010), King (2003), Hwang and Chang (2011), McKenna (2011), Irons (2008), Johnson (2016) and Kingston and Nash (2011). Asking questions in between the instruction is one of the significant elements of formative assessment (Hodgson & Pyle, 2010), and the teacher can spend one-third of the teaching session by asking questions among the students (Moss & Brookhart, 2009).

Mastery Oriented Assessment which is sometimes used as a strategy for keeping track of learning, is also found supporting Domain Interest, Individual Interest and Achievement among learners. Apart from supplementing the teacher in the process of ensuring the level of mastery attained by the students, the practice of asking questions among the students based on the concepts taught in the previous day, at the beginning of each class, works on the engagement and activeness of the students towards the subject. So, teachers can adopt this strategy in their daily routine for

accomplishing the immediate need of feedback on the student understanding along with their engagement.

Student Reflection on their Conceptual Understanding for Boosting Interest and Teacher-led Consolidation to Elevate both Interest and Achievement

Physics teachers give moderate importance for consolidation of concepts. Students are rarely asked to consolidate the key concept individually at the end of the lesson. Even then, this practice is seen favouring Situational and Individual Interest in physics. Organizing ideas on their own and presenting them, help internalize the depth of the concept rather than memorizing it. So, this elucidates that consolidation when done individually becomes productive in terms of interest.

This trend is comparable to the explanations by Magnaye (2023), Wolf and Supon (1994) and Ganske (2017). The proper consolidation of the lessons enhances achievement of the learners, as the practice would help them understand and summarize the key points learnt, and motivate further to learn the advanced level concepts, making learning joyful (Magnaye, 2023). Teachers may take effort to set aside 5-8 minutes at the end of the lesson for students to recollect and actively assemble the important ideas and reflect on their thoughts (Ganske, 2017; Wolf & Supon, 1994).

At the end of the physics lesson, teachers sometimes consolidate the concept taught. As far as the student interest is concerned, such teacher dominant consolidation favours interest towards that particular concept only, which is denoted

as the domain interest in that concept. Meanwhile, this strategy enhances achievement of the students. So, this teacher led strategy is found productive in enhancing the achievement and the domain specific interest among the learners. This is in line with the explanation of Biswal (2023) that the teacher's failure to consolidate the taught concept in the last minutes of the class may hinder the learning among the students.

Independent Practice with Personalized Feedback from Teachers Leading to Learner Interest and Achievement

Providing follow-up activities is given moderate importance by physics teachers. Follow-up tasks and exercises are sometimes assigned in such a way that the students are meant to work individually on it, and this is found significantly backing Domain Interest in physics. Also, even if, the supervision of the teacher is provided rarely, it is also found supporting Domain, Situational and Individual Interest. This sums up the need for frequent practice of providing follow-up activities in the form of homework, assignments and worksheets to the students based on the physics concept learnt, which they have to individually work on. And more relevant is the teacher's evaluation of the students' completed tasks and suggestions for improvement.

This echoes the findings of Ozan and Kincal (2018) and Biswal (2023). Feedback, especially for homework and activities which are not meant for grading or marking, is a significant factor in learning (Ozan & Kincal, 2018). Proper feedback from teachers caters to student understanding of one's own strengths and weaknesses, which can bring overall improvement in the work done (Biswal, 2023).

Ensuring Student Participation in Science Club Activities for Imbibing Curiosity

Science club activities provide learning experiences beyond classrooms. Teachers occasionally direct students to take part in club-initiated programmes and activities and this encouragement is found favouring Domain and Individual Interest and achievement in physics. So, the teacher's role is to inspire, support and guide students to become a part of science club activities, thus developing curiosity and love for scientific exploration, which will lead them to become better achievers in the subject. This is in line with the results of the study by Nwankwo and Okoye (2015) which showed that the students' participation in science club activities had positive influence on both their achievement, immediate interest and long-term interest. Similar results are also obtained in the studies by Anderson (2008), Bozdogan and Yalcin (2009), and Vartiainen and Aksela (2013).

Promoting Reading Beyond Textbook for Enriching Learning Experience

Another way that teachers rarely practice for enriching learning experience is suggesting extra reference materials and web resources related to the learnt concept. This helps students to acquaint with the concept beyond what is described in their textbook. This widens the horizon of perception of the students, which cater to their better interest towards the concept. So, physics teachers can recommend supplementary resources and extended learning materials.

Initiation of Strategic Examination Preparation Including Previewing, Reviewing and Re-teaching

Preparing students to face the examination is highly emphasized by the physics teachers. In this context, both test previewing and reviewing strategies are frequently used by the teachers that significantly favour Domain, Situational and Individual Interest and Achievement in physics. This implies that teachers can continue adopting the pre-examination practice of discussing previous years' question papers prior to examination for students to acquaint with the form of questions asked. These results corroborate that of Biswal (2023), Fakcharoenphol and Stelzer (2014) and Balch (1998). Biswal (2023) also explained that failure in communicating the question patterns and expected answer patterns in assessment with the pupils hinder their learning. The practice of model question papers is needed to improve the performance of students in the examination. After the real examination, it can be reviewed, by discussing the answers in the class or by asking students to answer the question paper, so that students will be aware of the mistakes they made. Teaching the common tough topic again after the exam will tackle the cases of misconceptions and misunderstandings (Balch, 1998; Fakcharoenphol & Stelzer, 2014).

Explicit Instruction on Step-by-step Procedure for Mathematical Problem Solving

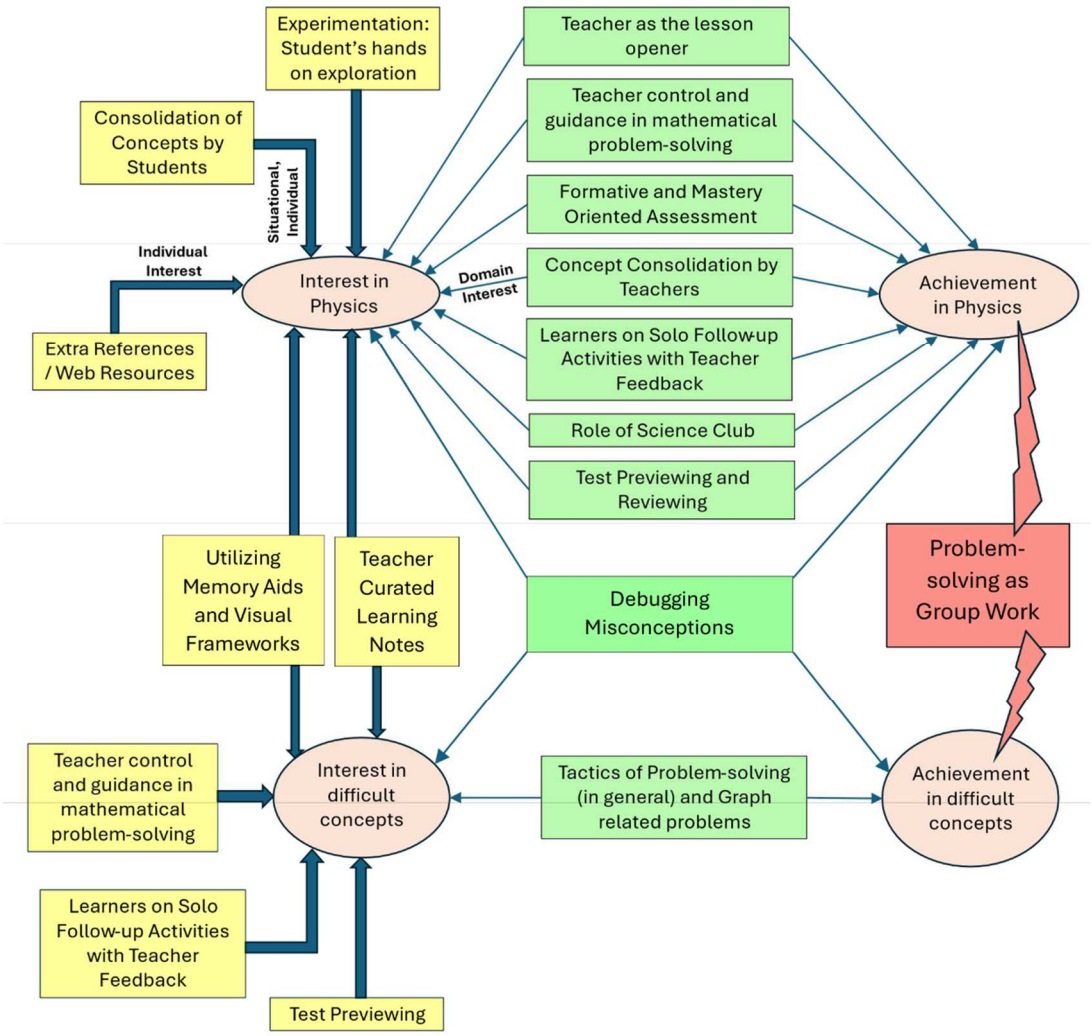
While transacting difficult concepts such as Equations of Motion and Gravitation, the teachers must give prime importance in transacting the methodical tactics of mathematical problem solving. Students should know the technique of dealing with physics mathematical problem. Since the concept of Equations of Motion

involves the usage of graph, students must be transacted with the basics of graph and how to solve related problems. Moreover, teacher can work-out and demonstrate problem solving to the students. Students can also be provided with step-by-step instruction while they indulge in problem solving by themselves. After transacting a concept, the teachers must frequently provide follow-up activities based on it, so that students can individually work on it and produce their findings. It is important that these findings can be checked, and the suggestions can be recommended accordingly by the teacher, so that students can make improvements. Students must be made prepared for mathematical problem solving, by discussing and practicing worksheets.

The visual summary of the implications of this study is given as Figure 7.

Figure 7

Visual Summary of the Influence of Instructional Practices on Interest and Achievement in Physics and in Difficult Concepts



Based on the findings and implications of this study, following are the key considerations for the teachers and other stakeholders in improving the physics teaching-learning process at secondary level.

- Pre-service and in-service training can be provided for teachers to design and execute strategies in accordance with the demand and nature of the physics concept to be transacted. Curriculum designers can avoid one-size fit all

approach. The curriculum must be flexible, allowing the teachers to adapt the methods that suits the content and the learners they are teaching. The schools can also ensure the availability of resources that supplement the varied teaching strategies employed by the teachers.

- Teachers should receive training how to bring conceptual understanding in students prior to introducing formulas while transacting physics. The formula-first approach may lead to students' vagueness in understanding and rote learning habits. Only after they imbibe the concept, the mathematical problems are needed to be introduced.

- Misconceptions in physics have to be identified by the teachers as early as possible, so as to adopt the curbing strategies accordingly. Teachers must receive training on how to identify them with the help of formative and mastery-oriented assessment practices and also on how to correct them.

- The teachers should know how to guide students through the process of inquiry and experimentation. Teachers through proper training can learn how to facilitate learning by implementing guided approaches with incorporation of artificial intelligence while experimenting rather than delivering the content in the textbook.

- The policy makers and administrators must think of setting timetable with periods allotted for team teaching for mathematics and physics teachers. Such collaborative practice can help integrate mathematics with the subject without overwhelming the students. Mathematics teachers have to teach the students

the basic mathematical skills of how to use equations and carry out their rearrangements and transformations to find the unknowns.

- Graph is being introduced for the school students in their nineth standard physics curriculum, not in mathematics. So, it is better to introduce mathematical concepts in mathematics syllabus, rather than in physics.

- Practice worksheets can be made a daily routine in both mathematics and physics subjects, so that students get enough exposure to the problem-solving process. Students can be asked to prepare formula sheets and unit conversion chart by themselves which makes them organise the ideas and get a wholistic view of the math-in-physics.

Limitations of the Study

This study was carried out with utmost care in planning, development of valid tools, data collection and analysis of results. Despite the rigorous methodology employed, this research has the limitations listed as follows.

- The extant instructional practices are identified from the perception of students only. The teachers are not approached for collecting data regarding the strategies and techniques they use during physics teaching.

- The higher order objective in Revised Bloom's Taxonomy, 'Creating', is not considered for the preparation of Conceptual Understanding Test in Physics, Achievement Test on Equations of Motion and Achievement Test on Gravitation.

- In the Conceptual Understanding Test in Physics, the items are arranged in such a way that, they are aligned with each of the physics concepts as they appear sequentially in the SCERT textbook of nineth standard. This might have contributed to slight variations in students' achievement scores in the test.

- In this study, five major concepts were ranked based on the difficulty as perceived by students. Only the 'two' most difficult physics concepts are used for meeting the specific objectives of the study.

Recommendations for Further Research

This study analysed the existing Instructional Practices of Physics teachers and their influence on interests and achievement among secondary school students. Some recommendations for further research are given below.

- A qualitative study on the root causes of perceived difficulty of students in secondary school physics is suggested. The results can help the teachers plan strategically to work on specific areas of difficulty.

- Mathematical applications in physics is the primary aspect that makes the subject difficult for the students. Studies for analysing the underlying reasons for these mathematical difficulties and distinguishing between (i) lack of foundational mathematical proficiency, (ii) challenges in translating physics concepts into mathematical expressions and (iii) difficulty in interpreting mathematical results in physics context are needed.

- The usage of ICT-mediation in the current physics classroom teaching is found limited. Further research is needed to study the reasons for the teachers' preference of other strategies over ICT integration and analyse how the integration of ICT-mediated instruction influences interest and achievement in physics, which is inconclusive from this study.

- In the case of facilitating note-taking process, none of the types of instructional practices in physics which is taken into consideration for this study is found influencing the achievement among students. So, extensive research is needed to find the various note-taking strategies and styles and to analyse how they influence the student retention and achievement.

- Project method is not attempted by teachers for teaching physics at secondary level. Inquiry is needed to gain clearer insights regarding the perceived barriers that prevent teachers in implementing project method at secondary level and the impact of the absence of project-based learning on students' conceptual understanding and engagement.

- Students have persistent misconceptions when it comes to physics. Longitudinal study can be carried out to understand the effect of formative assessment strategies on conceptual understanding, problem-solving and motivation across high school classes. Their influence can be tracked across gender and ability level of the students.

- Metacognitive awareness is important for students to monitor their conceptual understanding. An intervention can be designed to explicitly teach

metacognitive assessment while performing consolidation after physics instruction and explore their impact on the consolidation done by students across achievement levels.

- Based on the findings of this study, a physics teaching model focussing on interest and achievement of the students can be developed depicting the complete sequence of a typical physics instructional process. Later its effectiveness can be studied experimentally, based on subsamples of gender and age.

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APPENDICES

APPENDIX 1

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-A)
(DRAFT – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Maximum Marks: 25

Time: 60 minutes

നിർദ്ദേശങ്ങൾ:

ഈ ടെസ്റ്റിന് മൂന്ന് ഭാഗങ്ങളാണുള്ളത്. Section A കുട്ടികളുടെ പൊതുവിവരങ്ങളുമായി ബന്ധപ്പെട്ടതാണ്. Section B യിൽ ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട ചില ആശയങ്ങളെ അവയുടെ കാഠിന്യമനുസരിച്ച് റാങ്ക് രേഖപ്പെടുത്തണം. ഏറ്റവും ബുദ്ധിമുട്ടുള്ള ആശയത്തിന് നേരെ റാങ്ക് '1' എന്നും അതിനേക്കാൾ കാഠിന്യം കുറഞ്ഞ ആശയത്തിന് നേരെ '2', എന്നിങ്ങനെ കാഠിന്യ നിലവാരം കുറയുന്നതിനനുസരിച്ച രീതിയിലാണ് റാങ്ക് രേഖപ്പെടുത്തേണ്ടത്. ഒമ്പതാം ക്ലാസിലെ വിദ്യാർത്ഥികളുടെ ആശയധാരണകളെ അളക്കാനുള്ള 25 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് Section C യിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. എല്ലാ ചോദ്യത്തിനും ഉത്തരം തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d) എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കുറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

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SECTION A

വിദ്യാർത്ഥിയുടെ പേര് :

ലിംഗം : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂളിന്റെ പേര് :

ഒമ്പതാം ക്ലാസ്സിൽ ഭൗതികശാസ്ത്രത്തിൽ ഒന്നാം പാദവാർഷിക പരീക്ഷക്കും രണ്ടാം പാദവാർഷിക പരീക്ഷക്കും ലഭിച്ച മാർക്ക് :

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SECTION B

No.	ഭൗതികശാസ്ത്രത്തിലെ ആശയങ്ങൾ	റാങ്ക്
1.	ദ്രവബലങ്ങൾ	
2.	ചലനസമവാക്യങ്ങൾ	
3.	ചലനവും ചലനനിയമങ്ങളും	
4.	ഗുരുത്വാകർഷണം	
5.	പ്രവൃത്തി, ഊർജം, പവർ	

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SECTION C

1. പ്ലവക്ഷമബലത്തെ വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

a) ഒരു വസ്തു ദ്രവത്തിൽ പൂർണമായി മുങ്ങിയിരിക്കുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ താഴേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് പ്ലവക്ഷമബലം.

b) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ മുകളിലേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് പ്ലവക്ഷമബലം.

c) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായി മുങ്ങിയിരിക്കുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ മുകളിലേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് പ്ലവക്ഷമബലം.

d) ഒരു വസ്തു ദ്രവത്തിൽ താഴോട്ട് മുങ്ങുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ താഴേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് പ്ലവക്ഷമബലം.

2. താഴെ കൊടുത്തിരിക്കുന്നവയിൽ ആർക്കമെഡീസ് തത്ത്വം ആസ്പദമാക്കി പ്രവർത്തിക്കുന്ന ഉപകരണം ഏത് ?

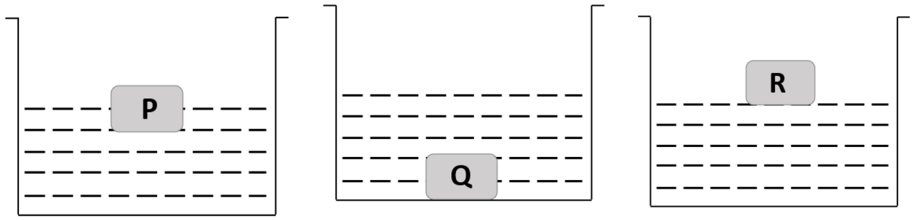
a) ഹൈഡ്രോളിക് ലിഫ്റ്റ്
c) കേശികക്കുഴൽ

b) ഹൈഡ്രോളിക് പമ്പ്
d) ഹൈഡ്രോമീറ്റർ

3. ഒരു ഹൈഡ്രോളിക് ജാക്കിന്റെ പിസ്റ്റണുകളുടെ വ്യാസം 1.5 cm ഉം 15 cm ഉം ആണ്. എങ്കിലതുപയോഗിച്ച് 1000 kg ഉയർത്താൻ ആവശ്യമായ ബലമെത്ര?

a) 1000 N
b) 100 N
c) 10 N
d) 50 N

4. ഒരേ ദ്രാവകത്തിൽ മുങ്ങിക്കിടക്കുന്ന വ്യത്യസ്ത സാന്ദ്രതയുള്ള മൂന്ന് വസ്തുക്കളാണ് P ഉം Q ഉം R ഉം (ചിത്രം കാണുക). വസ്തുക്കളുടെ സാന്ദ്രതയുടെ അവരോഹണ ക്രമീകരണം ഏത്?



a) Q, P, R
b) P, Q, R
c) R, P, Q
d) Q, R, P

5. പ്ലവനത്തെ ആസ്പദമാക്കി ശരിയായ പ്രസ്താവന ഏത് ?

i. 500 N ഭാരമുള്ള ഒരു വസ്തു വെള്ളത്തിൽ മുങ്ങിക്കിടക്കുന്നു. ആ വസ്തു ആദേശം ചെയ്ത വെള്ളത്തിന്റെ ഭാരം 50 N ആണെങ്കിൽ, വെള്ളത്തിൽ വസ്തുവിന്റെ ഭാരം 400 N ആണ്.

ii. 500 N ഭാരമുള്ള ഒരു വസ്തു വെള്ളത്തിൽ പൊങ്ങിക്കിടക്കുകയാണെങ്കിൽ, ആ വസ്തുവിന്റെ വെള്ളത്തിലുള്ള ഭാരം 0 N ഉം ആ വസ്തു ആദേശം ചെയ്യുന്ന വെള്ളത്തിന്റെ ഭാരം 500 N ഉം ആണ്.

iii. 750 N ഭാരമുള്ള ഒരു വസ്തു വെള്ളത്തിൽ മുങ്ങിക്കിടക്കുന്നു. ആ വസ്തു ആദേശം ചെയ്ത വെള്ളത്തിന്റെ ഭാരം 150 N ആണെങ്കിൽ, വെള്ളത്തിൽ വസ്തുവിന്റെ ഭാരം 600 N ആണ്.

iv. 750 N ഭാരമുള്ള ഒരു വസ്തു വെള്ളത്തിൽ പൊങ്ങിക്കിടക്കുകയാണെങ്കിൽ, ആ വസ്തുവിന്റെ വെള്ളത്തിലുള്ള ഭാരം 550 N ഉം ആ വസ്തു ആദേശം ചെയ്യുന്ന വെള്ളത്തിന്റെ ഭാരം 200 N ഉം ആണ്.

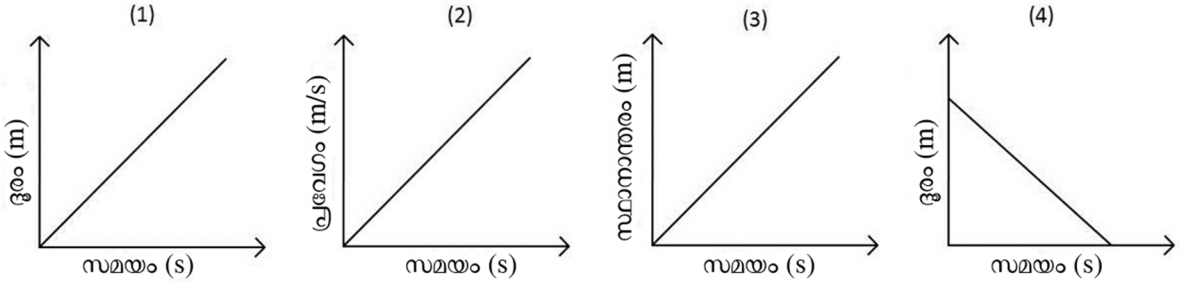
a) (i) ഉം (ii) ഉം ശരിയാണ്.
b) (iii) ഉം (iv) ഉം ശരിയാണ്.
c) (i) ഉം (iv) ഉം ശരിയാണ്.
d) (ii) ഉം (iii) ഉം ശരിയാണ്.

6. ശരിയായ ചലനസമവാക്യം ഏത്?

a) $v^2 = u^2 + 2as^2$ c) $u^2 = v^2 + 2as$

b) $v^2 = u^2 - 2as^2$ d) $v^2 = u^2 + 2as$

7. സമത്വരണം സൂചിപ്പിക്കുന്ന ചിത്രം കണ്ടെത്തുക.



a) (1) മാത്രം c) (2) ഉം (3) ഉം

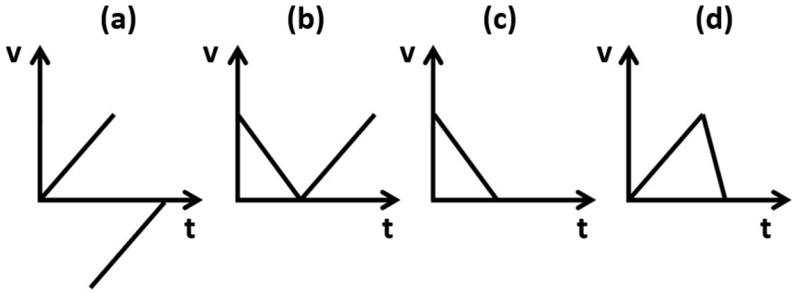
b) (2) മാത്രം d) (1) ഉം (4) ഉം

8. 10 മിനിറ്റിൽ തീവണ്ടിയുടെ പ്രവേഗം 80 m/s ഇൽ നിന്നും 20 m/s ആയി മാറുന്നുവെങ്കിൽ അതിന്റെ മന്ദീകരണം എത്ര?

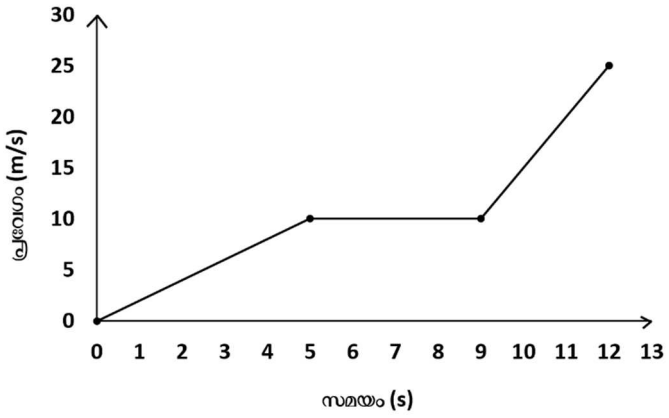
a) $0.1\ m/s^2$ c) $6\ m/s^2$

b) $1\ m/s^2$ d) $10\ m/s^2$

9. നിർബാധം പതിക്കുന്ന വസ്തു ഒരു പ്രതലത്തിൽ തട്ടി മുകളിലേക്ക് പൊന്തുന്നു. താഴോട്ട് വീഴുമ്പോഴും മുകളിലേക്ക് പൊന്തുമ്പോഴും വസ്തുവിന്റെ സമയാനുസൃതമായ പ്രവേഗം ശരിയായി കാണിച്ചിരിക്കുന്നത് ഏത് ഗ്രാഫിലാണ് ?



10. ഒരു കളിപ്പാട്ടക്കാർ ഒരു സ്ഥലത്ത് നിന്നും മറ്റൊരു സ്ഥലത്തേക്ക് 12 s കൊണ്ട് ചലിക്കുന്നു. ഈ ചലനത്തിന്റെ പ്രവേഗ-സമയ ഗ്രാഫ് ആണ് തന്നിരിക്കുന്നത്. ഗ്രാഫിനെ കുറിച്ച് തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത് ?



i. കാറിന്റെ ചലനത്തിലെ ഏറ്റവും ഉയർന്ന ത്വരണം 5 m/s^2 ആണ്.

ii. 9 s ഇനും 12 s നും ഇടയിൽ സഞ്ചരിച്ച ദൂരം 52.5 m ആണ്.

iii. കാറിന്റെ ചലനത്തിലെ ഏറ്റവും കുറഞ്ഞ ത്വരണം 2 m/s^2 ആണ്.

a) (i) മാത്രം ശരിയാണ്. c) (i) ഉം (ii) ഉം ശരിയാണ്.

b) (ii) മാത്രം ശരിയാണ്. d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

11. 'ന്യൂട്ടന്റെ മൂന്നാം ചലന നിയമം വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത്?

a) ഒരു വസ്തുവിനുണ്ടാകുന്ന ആക്കവ്യത്യാസത്തിന്റെ നിരക്ക് ആ വസ്തുവിൽ പ്രയോഗിക്കുന്ന അസന്തുലിത ബാഹ്യബലത്തിന് നേർ അനുപാതത്തിലായിരിക്കും.

b) അസന്തുലിതമായ ബാഹ്യബലം അനുഭവപ്പെടുന്നത് വരെ ഓരോ വസ്തുവും അതിന്റെ നിശ്ചലാവസ്ഥയിലോ നേർരേഖാ സമചലനത്തിലോ തുടരുന്നതാണ്.

c) ഏതൊരു പ്രവർത്തനത്തിനും തുല്യവും വിപരീതവുമായ ഒരു പ്രതി പ്രവർത്തനമുണ്ടായിരിക്കും.

d) ഒരു വസ്തുവിൽ അനുഭവപ്പെടുന്ന പരിണതബലം പൂജ്യമെങ്കിൽ പ്രയോഗിക്കപ്പെട്ട ബലങ്ങളെ സന്തുലിത ബലങ്ങൾ എന്ന് പറയുന്നു. ഇത്തരം ബലങ്ങൾക്ക് നിശ്ചലാവസ്ഥയിലുള്ള വസ്തുക്കളെ ചലിപ്പിക്കാനോ ചലിക്കുന്ന വസ്തുക്കളെ നിശ്ചലമാക്കാനോ കഴിയില്ല.

12. ന്യൂട്ടന്റെ രണ്ടാം ചലനനിയമം പ്രയോജനപ്പെടുത്തുന്ന സന്ദർഭം താഴെ കൊടുത്തിരിക്കുന്നവയിൽ ഏത് ?

a) ഒരു വിരിപ്പിന് മേൽ വടി കൊണ്ട് അടിക്കുമ്പോൾ അതിലെ പൊടിപടലങ്ങൾ പുറത്തേക്ക് തെറിക്കുന്നു.

b) വെടിയുതിർക്കുമ്പോൾ ബുള്ളറ്റ് പോകുന്ന ദിശക്ക് എതിരെ തോക്ക് ചലിക്കുന്നു.

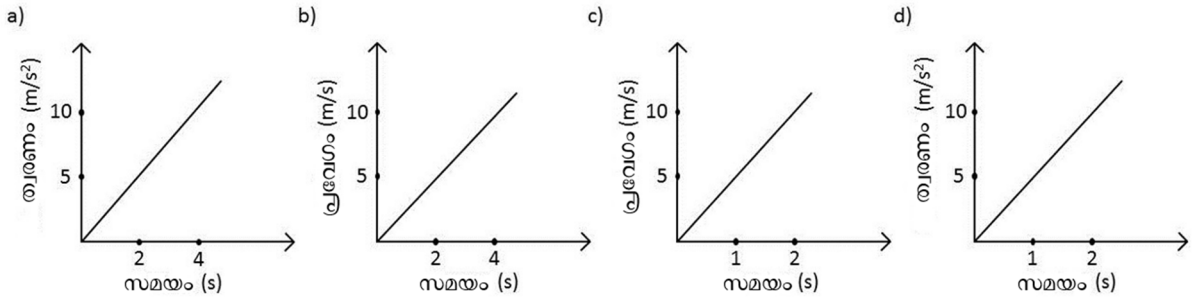
c) കാറ്റഴിച്ചു വിടുമ്പോൾ ബലൂണിന്റെ ചലനം.

d) ഗ്ലാസ് പാത്രങ്ങൾ അടുക്കിവെച്ച പാക്കറ്റുകളിൽ സ്പോഞ്ച്, വൈക്കോൽ എന്നിവ നിറക്കുന്നത് പാത്രങ്ങൾ തമ്മിൽ കൂട്ടിമുട്ടി പൊട്ടുന്നത് ഒഴിവാക്കാൻ സഹായിക്കുന്നു.

13. ഒരു ഘർഷണരഹിതമായ മേശയുടെ മുകളിൽ സ്പർശിച്ചുകൊണ്ട് 4 m/s സമപ്രവേഗത്തിൽ 2 kg മാസുള്ള ഒരു വസ്തു നിരങ്ങി നീങ്ങുന്നു. അതേ പ്രവേഗത്തിൽ വസ്തു ചലനം തുടരാൻ ആവശ്യമായ ബലമെത്ര ?

a) 0 N
b) 2 N
c) 6 N
d) 8 N

14. 4 kg മാസുള്ള വസ്തുവിന്റെ മേൽ പ്രവർത്തിക്കുന്ന ബലം 10 N ആണെങ്കിൽ, അതിന്റെ ചലനം കാണിക്കുന്ന ഗ്രാഫ് ഏത്?



15. ചലിച്ചുകൊണ്ടിരിക്കുന്ന ഒരു വസ്തുവിന്റെ ദൂര-സമയ പട്ടികയാണ് താഴെ തന്നിരിക്കുന്നത്.

സമയം (സെക്കൻഡ്)	ദൂരം (മീറ്റർ)
0	0
1	1
2	8
3	27
4	64
5	125

വസ്തുവിന് അനുഭവപ്പെടുന്ന ബലങ്ങളെ കുറിച്ച് നിങ്ങളുടെ അനുമാനമെന്ത്?

a) ബലത്തിന്റെ അളവിൽ മാറ്റമില്ല.

b) സമയാനുസൃതമായി ബലം സമമായി വർധിച്ചു കൊണ്ടിരിക്കുന്നു.

c) സമയാനുസൃതമായി ബലം സമമായി കുറഞ്ഞു കൊണ്ടിരിക്കുന്നു.

d) ബലം പൂജ്യമാണ്.

16. താഴെ തന്നിരിക്കുന്നവയിൽ സാർവികഗുരുത്വാകർഷണനിയമം ഏത് ?

a) ഭൂമി എല്ലാ വസ്തുക്കളെയും അതിന്റെ കേന്ദ്രത്തിലേക്കാകർഷിക്കുന്നു. ഭൂമിയിലുള്ള വസ്തുക്കളെ സംബന്ധിച്ചിടത്തോളം അതിന്റെ നില നിവർന്നതോ തലകീഴായതോ എന്ന് തീരുമാനിക്കുന്നത് ഭൂഗുരുത്വബലത്തിന്റെ ദിശയെ അടിസ്ഥാനമാക്കിയാണ്.

b) പ്രപഞ്ചത്തിലുള്ള എല്ലാ വസ്തുക്കളും പരസ്പരം ആകർഷിക്കുന്നു. രണ്ട് വസ്തുക്കൾ തമ്മിലുള്ള പരസ്പരാകർഷണബലം അവയുടെ മാസുകളുടെ ഗുണനഫലത്തിന് നേർ അനുപാതത്തിലും അവ തമ്മിലുള്ള അകലത്തിന്റെ വർഗത്തിന് വിപരീതാനുപാതത്തിലുമായിരിക്കും.

c) രണ്ട് ഗ്രഹങ്ങൾ തമ്മിലുള്ള പരസ്പരാകർഷണബലം അവക്കിടയിലുള്ള ശരാശരി ദൂരത്തിന്റെ കൃബിന് നേർ അനുപാതത്തിലും അവയുടെ പരിക്രമണപ്രവേഗങ്ങളുടെ ഗുണനഫലത്തിന് വിപരീതാനുപാതത്തിലുമായിരിക്കും.

d) ഒരു യൂണിറ്റ് ദൂരത്തിൽ അകൽച്ചയിലിരിക്കുന്ന രണ്ട് യൂണിറ്റ് മാസുകൾക്കിടയിലുള്ള പരസ്പരാകർഷണബലം അവയെ ത്വരിതപ്പെടുത്തുന്നു. ഈ ത്വരണത്തെ ഭൂഗുരുത്വത്വരണം എന്ന് പറയുന്നു.

17. 1 kg മാസുള്ള ഒരു വസ്തു ഭൂമിയിലേക്ക് ആകർഷിക്കപ്പെടുമ്പോൾ ഉണ്ടാകുന്ന ബലം

a) 6.67×10^{11} N
c) 9.8 N
b) 100 N
d) 1 N

18. ഒരു വസ്തുവിന്റെ മാസ് 88 kg ആണെങ്കിൽ ചന്ദ്രനിൽ അതിന്റെ ഭാരമെത്ര?

a) 88 N
c) 143.73 N
b) 132.33 N
d) 212.33 N

19. ഭൂഗുരുത്വത്വരണം 'g' യെ കുറിച്ച് താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത് ?

a) ഭൂമിയുടെ ഉപരിതലത്തിൽ നിന്ന് ഭൂമിയുടെ കേന്ദ്രത്തിലേക്ക് നീങ്ങുമ്പോൾ g യുടെ മൂല്യം കുറയുന്നു.

b) ഭൂമിയുടെ ഉപരിതലത്തിൽ നിന്ന് മുകളിലേക്ക് പോകുമ്പോൾ g യുടെ മൂല്യം കൂടുന്നു.

c) 'g' യുടെ മൂല്യം ധ്രുവ പ്രദേശത്ത് നിന്ന് ഭൂമധ്യരേഖ പ്രദേശത്തേക്ക് പോകുമ്പോൾ കൂടുന്നു.

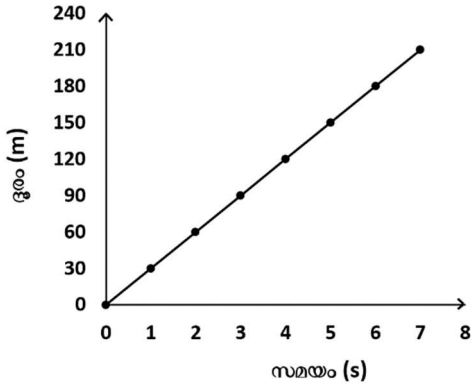
d) ഭൂമിയിൽ 'g' യുടെ മൂല്യം വസ്തുവിന്റെ മാസിനെ ആശ്രയിക്കുന്നു.

20. 245 m പൊക്കമുള്ള ഒരു ടവറിന് മുകളിൽ മനു ഒരു സ്റ്റോപ്പ് വാച്ചും പിടിച്ച് നിൽക്കുന്നു. അവൻ മുകളിൽ നിന്ന് ഒരു കല്ല് താഴോട്ടിടുന്നു. താഴെ തന്നിരിക്കുന്നവയിൽ ശരിയായ പ്രസ്താവന ഏത്?

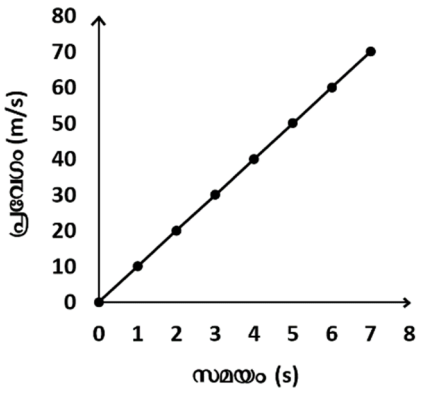
i. കല്ല് നിലത്ത് തൊടുമ്പോൾ സ്റ്റോപ്പ് വാച്ചിലെ റീഡിങ് 6 s ആയിരിക്കും.

ii. കല്ല് നിലത്ത് തൊടുമ്പോൾ അതിന്റെ അന്ത്യപ്രവേഗം 70 m/s ആയിരിക്കും.

iii. കല്ലിന്റെ ദൂര-സമയ ഗ്രാഫ്



iv. കല്ലിന്റെ പ്രവേഗ-സമയ ഗ്രാഫ്



a) (i) ഉം (ii) ഉം ശരിയാണ്.
c) (ii) ഉം (iii) ഉം ശരിയാണ്.
b) (i) ഉം (iv) ഉം ശരിയാണ്.
d) (ii) ഉം (iv) ഉം ശരിയാണ്.

21. ശരിയായ പ്രസ്താവന ഏത്?

a) ഒരു വസ്തുവിന്മേൽ പ്രയോഗിച്ച ബലത്തിന്റെ ദിശക്ക് ലംബമായി സ്ഥാനാന്തരം ഉണ്ടാകുമ്പോൾ മാത്രമാണ് പ്രവൃത്തി ചെയ്തതായി കണക്കാക്കുകയുള്ളൂ.
b) സ്ഥിതികോർജത്തിൽ ഉണ്ടായ മാറ്റത്തിന് തുല്യമാണ് പ്രവൃത്തി എന്നതാണ് പ്രവൃത്തി-ഊർജതത്ത്വം.
c) ഒരു വസ്തുവിൽ സ്ഥാനം കൊണ്ട് ലഭ്യമാകുന്ന ഊർജമാണ് സ്ഥിതികോർജം.
d) പ്രവൃത്തിയുടെയും സ്ഥാനാന്തരത്തിന്റെയും ഹരണഫലമാണ് പവർ.

22. ഭൂമിയിലേക്ക് വീണുകൊണ്ടിരിക്കെ ഒരു വസ്തുവിന്റെ മൊത്തം ഊർജം

a) കൂടുന്നു
c) ആദ്യം കൂടുന്നു, പിന്നെ കുറയുന്നു
b) കുറയുന്നു
d) മാറ്റമില്ല

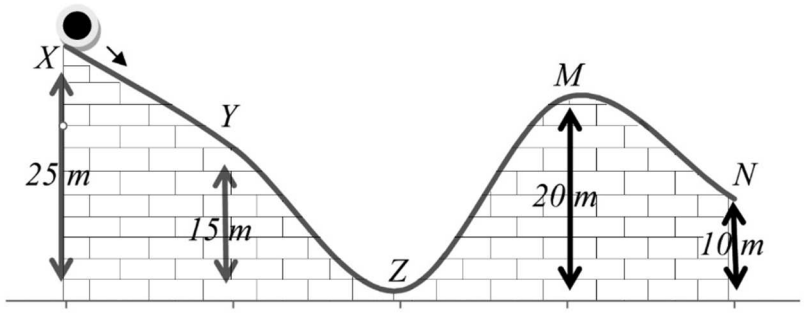
23. ഒരു പെൺകുട്ടി 3 kg മാസ്സുള്ള സ്കൂൾ ബാഗ് ചുമലിലിട്ടു ഒരു നിരപ്പായിട്ടുള്ള റോഡിലൂടെ 200 m നടന്നുനീങ്ങി. ഗുരുത്വാകർഷണബലത്തിനെതിരായി ചെയ്ത പ്രവൃത്തിയുടെ അളവെത്ര? ($g = 10\ m\ /\ s^2$)

a) 6×10^3 J
c) 0.6 J
b) 6 J
d) 0 J

24. നെഗറ്റീവ് പ്രവൃത്തിയുള്ള സന്ദർഭമേത്?

a) ചരിഞ്ഞ പ്രതലത്തിലൂടെ ഒരു വസ്തു താഴോട്ട് നിരങ്ങി വീഴുമ്പോൾ ഘർഷണബലം ചെയ്ത പ്രവൃത്തി.
b) കപ്പി ഇല്ലാതെ കയർ മാത്രം ഉപയോഗിച്ച് കിണറ്റിൽ നിന്നും വെള്ളം കോരുന്നയാൾ ചെയ്ത പ്രവൃത്തി.
c) ഒരു റബ്ബർ ബാൻഡ് നീട്ടി വലിക്കുമ്പോൾ ബലം ചെയ്ത പ്രവൃത്തി.
d) ഒരു മാവിൽ തൂങ്ങിക്കിടക്കുന്ന മാങ്ങയുടെ മേൽ ഗുരുത്വാകർഷണബലം ചെയ്ത പ്രവൃത്തി.

25. ഒരു ഘർഷണരഹിത ട്രാക്കിന്റെ ചിത്രമാണ് താഴെ തന്നിരിക്കുന്നത്. ഭാരമുള്ള ഒരു പന്ത് X എന്ന ബിന്ദുവിൽ നിന്ന് മോചിപ്പിച്ചാൽ, താഴെ തന്ന പ്രസ്താവനകളിൽ ശരിയേത് ?



i. Y എന്ന ബിന്ദുവിൽ പന്ത് കൂടുതൽ വേഗതയിൽ സഞ്ചരിക്കും.

ii. M എന്ന ബിന്ദുവിൽ പന്തിന്റെ വേഗത 10 m / s ആയിരിക്കും.

iii. X എന്ന ബിന്ദുവിനും Y എന്ന ബിന്ദുവിനും ഇടക്ക് സ്ഥിതികോർജ്ജത്തിലുള്ള വ്യത്യാസം 5 J ആയിരിക്കും.

a) (i) മാത്രം ശരിയാണ്.
b) (ii) മാത്രം ശരിയാണ്.
c) (i) ഉം (ii)ഉം ശരിയാണ്.
d) (ii) ഉം (iii)ഉം ശരിയാണ്.

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APPENDIX 2

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-B)
(DRAFT – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Maximum Marks: 25

നിർദ്ദേശങ്ങൾ: Time: 60 minutes

ഈ ടെസ്റ്റിന് മൂന്ന് ഭാഗങ്ങളാണുള്ളത്. Section A കുട്ടികളുടെ പൊതുവിവരങ്ങളുമായി ബന്ധപ്പെട്ടതാണ്. Section B യിൽ ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട ചില ആശയങ്ങളെ അവയുടെ കാഠിന്യമനുസരിച്ച് റാങ്ക് രേഖപ്പെടുത്തണം. ഏറ്റവും ബുദ്ധിമുട്ടുള്ള ആശയത്തിന് നേരെ റാങ്ക് '1' എന്നും അതിനേക്കാൾ കാഠിന്യം കുറഞ്ഞ ആശയത്തിന് നേരെ '2', എന്നിങ്ങനെ കാഠിന്യ നിലവാരം കുറയുന്നതിനനുസരിച്ച രീതിയിലാണ് റാങ്ക് രേഖപ്പെടുത്തേണ്ടത്. ഒമ്പതാം ക്ലാസിലെ വിദ്യാർത്ഥികളുടെ ആശയധാരണകളെ അളക്കാനുള്ള 25 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് Section C യിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. എല്ലാ ചോദ്യത്തിനും ഉത്തരം തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d) എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കുറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

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SECTION A

വിദ്യാർത്ഥിയുടെ പേര് :

ലിംഗം : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂളിന്റെ പേര് :

ഒമ്പതാം ക്ലാസ്സിൽ ഭൗതികശാസ്ത്രത്തിൽ ഒന്നാം പാദവാർഷിക പരീക്ഷക്കും രണ്ടാം പാദവാർഷിക പരീക്ഷക്കും ലഭിച്ച മാർക്ക് :

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SECTION B

No.	ഭൗതികശാസ്ത്രത്തിലെ ആശയങ്ങൾ	റാങ്ക്
1.	ദ്രവബലങ്ങൾ	
2.	ചലനസമവാക്യങ്ങൾ	
3.	ചലനവും ചലനനിയമങ്ങളും	
4.	ഗുരുത്വാകർഷണം	
5.	പ്രവൃത്തി, ഊർജം, പവർ	

.....

SECTION C

1. ആർക്കമെഡീസ് തത്ത്വത്തെ വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

   a) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ അതിൽ അനുഭവപ്പെടുന്ന പ്ലവക്ഷമബലം വസ്തു ആദേശം ചെയ്യുന്ന ദ്രവത്തിന്റെ ഭാരത്തിന് തുല്യമായിരിക്കും.

   b) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ അതിൽ അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം വസ്തു ആദേശം ചെയ്യുന്ന ദ്രവത്തിന്റെ ഭാരത്തിന് തുല്യമായിരിക്കും.

   c) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ അതിൽ അനുഭവപ്പെടുന്ന പ്ലവക്ഷമബലം വസ്തു ആദേശം ചെയ്യുന്ന ദ്രവത്തിന്റെ ആപേക്ഷികസാന്ദ്രതക്ക് തുല്യമായിരിക്കും.

d) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ അതിൽ അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം വസ്തു ആദേശം ചെയ്യുന്ന ദ്രവത്തിന്റെ ആപേക്ഷികസാന്ദ്രതക്ക് തുല്യമായിരിക്കും.

2. മണ്ണുമാന്തിയന്ത്രത്തിൽ ഉപയോഗിക്കപ്പെടുന്ന തത്ത്വമേത് ?

a) പ്ലവക്ഷമബലതത്ത്വം
b) ആർക്കമെഡീസ് തത്ത്വം
c) പാസ്കൽ നിയമം
d) പ്ലവന നിയമം

3. 1000 N ഭാരമുള്ള വസ്തു വെള്ളത്തിൽ മുങ്ങിക്കിടക്കുന്നു. ആ വസ്തു ആദേശം ചെയ്ത വെള്ളത്തിന്റെ ഭാരം 250 N ആണെങ്കിൽ, വെള്ളത്തിൽ ആ വസ്തുവിന്റെ ഭാരമെത്ര?

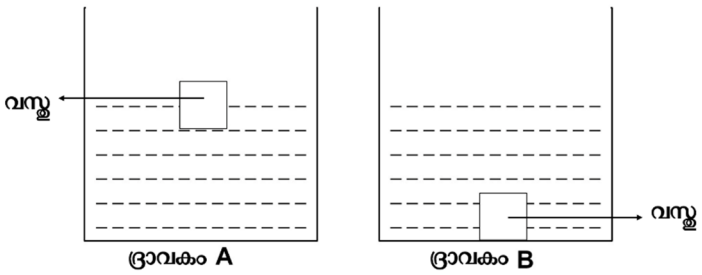
a) 250 N
b) 750 N
c) 1000 N
d) 1250 N

4. നാല് വ്യത്യസ്ത ദ്രാവകങ്ങൾ നിറച്ച ടെസ്റ്റ് ട്യൂബാണ് താഴെ കാണിച്ചിരിക്കുന്നത്. ദ്രാവകങ്ങളുടെ സാന്ദ്രതയുടെ അവരോഹണ ക്രമമേത്?



a) തേൻ, വെള്ളം, എണ്ണ, മണ്ണെണ്ണ
b) മണ്ണെണ്ണ, എണ്ണ, വെള്ളം, തേൻ
c) മണ്ണെണ്ണ, തേൻ, എണ്ണ, വെള്ളം
d) വെള്ളം, തേൻ, എണ്ണ, മണ്ണെണ്ണ

5. ചിത്രത്തെ അടിസ്ഥാനമാക്കി ശരിയായ പ്രസ്താവനയേത് ?



i. A എന്ന ദ്രാവകത്തിൽ വസ്തുവിൽ അനുഭവപ്പെടുന്ന പ്ലവക്ഷമ ബലം B എന്ന ദ്രാവകത്തിലേക്കാൾ കൂടുതലാണ്. എന്നാൽ B എന്ന ദ്രാവകത്തിൽ വസ്തുവിന് അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം A എന്ന ദ്രാവകത്തിലേക്കാൾ കൂടുതലാണ്.

ii. A എന്ന ദ്രാവകത്തിൽ വസ്തുവിൽ അനുഭവപ്പെടുന്ന പ്ലവക്ഷമബലം ഗുരുത്വാകർഷണബലത്തേക്കാൾ കുറവാണ്. എന്നാൽ B എന്ന ദ്രാവകത്തിൽ വസ്തുവിൽ അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം പ്ലവക്ഷമബലത്തേക്കാൾ കുറവാണ്.

iii. B എന്ന ദ്രാവകത്തിന്റെ സാന്ദ്രത വസ്തുവിന്റെയും A എന്ന ദ്രാവകത്തിന്റെയും സാന്ദ്രതയെക്കാൾ കുറവാണ്.

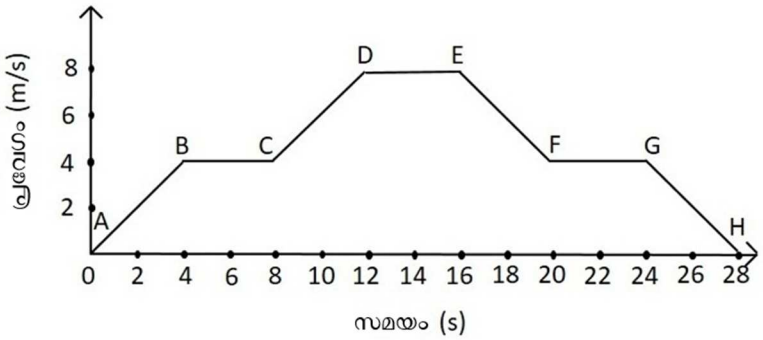
iv. വസ്തുവിന്റെ ആപേക്ഷിക സാന്ദ്രത A എന്ന ദ്രാവകത്തിന്റെയും B എന്ന ദ്രാവകത്തിന്റെയും സാന്ദ്രതയെക്കാൾ കൂടുതലാണ്.

a) (i) മാത്രം ശരിയാണ്.
c) (ii) ഉം (iv) ഉം ശരിയാണ്.
b) (iv) മാത്രം ശരിയാണ്.
d) (i) ഉം (iii) ഉം ശരിയാണ്.

6. ശരിയായ ചലനസമവാക്യം ഏത്?

a) $s = ut - \frac{1}{2}\, at^2$
c) $s = ut + \frac{1}{2}\, at^2$
b) $s = ut + \frac{1}{2}\, a^2t^2$
d) $s = ut - \frac{1}{2}\, a^2t^2$

7. താഴെ കൊടുത്തിരിക്കുന്നവയിൽ ത്വരണം സംഭവിക്കുന്ന സന്ദർഭങ്ങൾ തിരഞ്ഞെടുക്കുക.

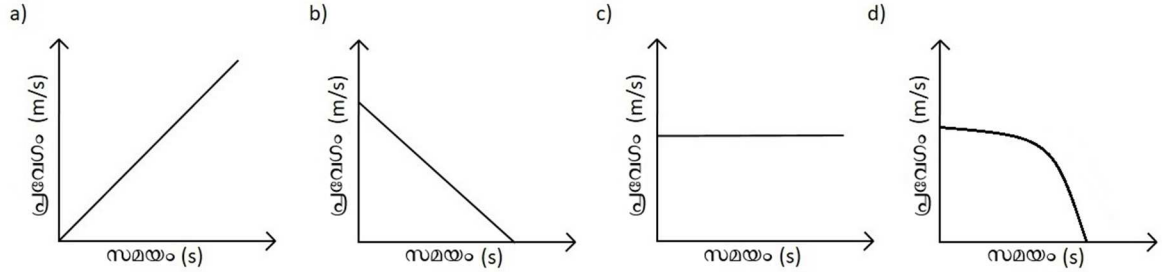


a) CD യും EF ഉം
c) EF ഉം GH ഉം
b) AB യും CD യും
d) BC ഉം DE ഉം FG ഉം

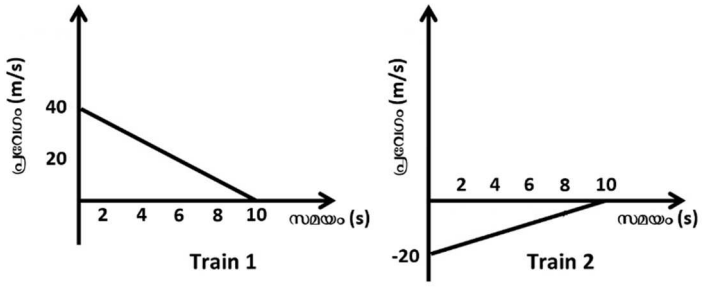
8. 40 m/s ആദ്യ പ്രവേഗത്തിൽ ഒരു കല്ല് കുത്തനെ മുകളിലേക്ക് എറിയുന്നു. ആ കല്ലിന് എത്തിച്ചേരാൻ പറ്റുന്ന ഉയരം എത്ര ?

a) 40 m
b) 60 m
c) 80 m
d) 100 m

9. നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗമാറ്റം സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത് ?



10. എതിർദിശയിൽ വ്യത്യസ്ത ട്രാക്കുകളിൽ സഞ്ചരിക്കുന്ന തീവണ്ടികളെ അബദ്ധവശാൽ ഒരേ ട്രാക്കിൽ കൂടി കടത്തി വിട്ടു. അബദ്ധം തിരിച്ചറിഞ്ഞ ഡ്രൈവർമാർ ട്രെയിനുകൾ തമ്മിൽ 300 m അകലത്തിലായിരിക്കെ രണ്ട് ട്രെയ്നിന്റെയും വേഗത കുറക്കാൻ തുടങ്ങി. വേഗത കുറഞ്ഞു വരുന്ന രണ്ട് ട്രെയിനുകളുടെ പ്രവേഗ-സമയ ഗ്രാഫുകളാണ് താഴെ തന്നിരിക്കുന്നത്. ട്രെയിനുകളുടെ ഈ ചലനത്തെ കുറിച്ചുള്ള ശരിയായ പ്രസ്താവന ഏത്?



i. ബ്രേക്ക് പ്രയോഗിക്കുമ്പോൾ, നിശ്ചലാവസ്ഥയിൽ എത്തുന്നതിന് മുൻപ് ട്രെയിൻ 2 ട്രെയിൻ 1 നേക്കാൾ കൂടുതൽ ദൂരം സഞ്ചരിക്കും.

ii. ട്രെയിനുകൾ നിശ്ചലാവസ്ഥയിൽ എത്തുമ്പോൾ അവ തമ്മിലുള്ള അകലം 20 m ആണ്.

iii. ബ്രേക്ക് പ്രയോഗിക്കുമ്പോൾ, ട്രെയിൻ 1 ന്റെയും ട്രെയിൻ 2 ന്റെയും പ്രവേഗ-സമയ ഗ്രാഫ് ഒരുപോലെയായിരുന്നെങ്കിൽ, അവ തമ്മിൽ കൂട്ടിയിടിക്കുമായിരുന്നു.

a) (i) മാത്രം ശരിയാണ്.
b) (ii) മാത്രം ശരിയാണ്.
c) (i) ഉം (ii) ഉം ശരിയാണ്.
d) (ii) ഉം (iii) ഉം ശരിയാണ്.

11. ന്യൂട്ടന്റെ ഒന്നാം ചലന നിയമം വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

a) അസന്തുലിത ബാഹ്യബലത്തിന്റെ അഭാവത്തിൽ രണ്ട് വസ്തുക്കൾ തമ്മിൽ കൂട്ടിയിടിക്കുന്നതിന് മുൻപുള്ള ആകെ ആക്കവും ഇടിച്ചതിന് ശേഷമുള്ള ആകെ ആക്കവും തുല്യമായിരിക്കും.

b) ഒരു വസ്തുവിനുണ്ടാകുന്ന ആക്കവ്യത്യാസത്തിന്റെ നിരക്ക് ആ വസ്തുവിൽ പ്രയോഗിക്കുന്ന അസന്തുലിത ബാഹ്യബലത്തിന് നേർ അനുപാതത്തിലായിരിക്കും.

c) അസന്തുലിതമായ ബാഹ്യബലം അനുഭവപ്പെടുന്നത് വരെ ഓരോ വസ്തുവും അതിന്റെ നിശ്ചലാവസ്ഥയിലോ നേർരേഖാ സമചലനത്തിലോ തുടരുന്നതാണ്.

d) ഒരു വസ്തുവിൽ അനുഭവപ്പെടുന്ന പരിണതബലം പൂജ്യമെങ്കിൽ പ്രയോഗിക്കപ്പെട്ട ബലങ്ങളെ സന്തുലിത ബലങ്ങൾ എന്ന് പറയുന്നു. ഇത്തരം ബലങ്ങൾക്ക് നിശ്ചലാവസ്ഥയിലുള്ള വസ്തുക്കളെ ചലിപ്പിക്കാനോ ചലിക്കുന്ന വസ്തുക്കളെ നിശ്ചലമാക്കാനോ കഴിയില്ല.

12. ആക്കസംരക്ഷണനിയമം പ്രയോജനപ്പെടുത്തുന്ന സന്ദർഭം താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

a) ഹൈ ജമ്പ് മത്സരത്തിൽ, മത്സരാർത്ഥിയെ ഒരു കുഷ്യനുള്ള ബെഡിലേക്ക് വീഴാൻ അനുവദിക്കുന്നു.

b) ഒരു വിരിപ്പിന് മേൽ വടി കൊണ്ട് അടിക്കുമ്പോൾ അതിലെ പൊടിപടലങ്ങൾ പുറത്തേക്ക് തെറിക്കുന്നു.

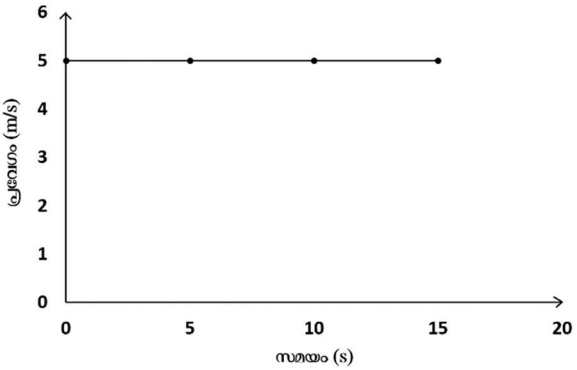
c) കരാട്ടെ അഭ്യാസി വളരെ വേഗത്തിൽ കൈ വീശി കട്ടപ്പുമുള്ള ഇഷ്ടികകൾ തകർക്കുന്നു.

d) ലിഫ്റ്റ് മുകളിലേക്ക് നീങ്ങുമ്പോൾ അതിനകത്ത് സ്പ്രിങ് ത്രാസിന്റെ ഹുക്കിൽ തൂക്കിയ വസ്തുവിന്മേൽ ത്വരണം താഴോട്ട് അനുഭവപ്പെടുന്നു.

13. ഒരു ചലിക്കുന്ന വസ്തുവിന്മേൽ അനുഭവപ്പെടുന്ന ബലത്തിന് മാറ്റമില്ലാതെ വസ്തുവിന്റെ മാസ് ഇരട്ടിയാക്കിയാൽ അതിന്റെ ത്വരണം എത്ര ?

a) ത്വരണത്തിൽ മാറ്റമില്ല.
b) ത്വരണം ഇരട്ടിയാകും.
c) ത്വരണം പൂജ്യമാകും.
d) ത്വരണം പകുതിയാകും.

14. 2 kg മാസുള്ള ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗ-സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്. വസ്തുവിന് മേൽ അനുഭവപ്പെടുന്ന ബലം എത്ര ?



a) 0 N
b) 2.5 N
c) 10 N
d) 20 N

15. ഒരു വലിയ ബസും ഒരു വാനും v എന്ന പ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു. അവ തമ്മിൽ കൂട്ടിയിടിച്ചതിന് ശേഷം രണ്ട് വാഹനങ്ങളും നിശ്ചലാവസ്ഥയിൽ എത്തുന്നു. കൂട്ടിയിടിക്കാൻ എടുത്ത സമയം 1 s ആണെങ്കിൽ

i. ബസ്സിനാണ് കൂട്ടിമുട്ടലിന്റെ ആഘാതം കുറഞ്ഞ രീതിയിൽ അനുഭവപ്പെടുന്നത്.
ii. വാനിനാണ് കുറഞ്ഞ ആക്കവ്യത്യാസം അനുഭവപ്പെടുന്നത്.
iii. വാനിനാണ് കൂടുതൽ ത്വരണം അനുഭവപ്പെടുന്നത്.

a) (i) ഉം (ii) ഉം ശരിയാണ്.
b) (ii) ഉം (iii) ഉം ശരിയാണ്.
c) (i) ഉം (iii) ഉം ശരിയാണ്.
d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

16. സാർവികഗുരുത്വാകർഷണനിയമത്തിന്റെ ഗണിതരൂപത്തിൽ

a) G യുടെ മൂല്യം നിരീക്ഷിക്കുന്നിടത്തെ g യുടെ മൂല്യവുമായി ബന്ധപ്പെട്ടിരിക്കുന്നു.
b) G എന്നത് ഗുരുത്വാകർഷണസ്ഥിരാങ്കമാണ്.
c) രണ്ട് മാസുകളിൽ ഒരെണ്ണം ഭൂമിയായി സങ്കല്പിക്കുന്ന സന്ദർഭത്തിലാണ് G ഉപയോഗിക്കപ്പെടുന്നത്.
d) G യുടെ മൂല്യം ഏറ്റവും ഉയർന്നത് ഭൂമിയുടെ ഉപരിതലത്തിലാണ്.

17. ഒരു മാവിൽ നിന്ന് മാങ്ങ താഴോട്ട് വീഴുമ്പോൾ

a) ഭൂമി മാത്രമാണ് മാങ്ങയെ ആകർഷിക്കുന്നത്.
b) മാങ്ങ മാത്രമാണ് ഭൂമിയെ ആകർഷിക്കുന്നത്.

c) മാങ്ങയും ഭൂമിയും പരസ്പരം ആകർഷിക്കുന്നു.

d) മാവ് മാങ്ങയെ വികർഷിക്കുകയും ഭൂമി അതിനെ ആകർഷിക്കുകയും ചെയ്യുന്നു.

18. രണ്ട് കണികകൾ ഒരു നിശ്ചിത അകലത്തിൽ സ്ഥിതി ചെയ്യുന്നു. കണികകൾ തമ്മിലുള്ള അകലം വ്യത്യാസപ്പെടുത്താതെ ഓരോ കണികയുടെയും മാസുകൾ ഇരട്ടിപ്പിച്ചാൽ അവക്കിടയിലുള്ള ഗുരുത്വാകർഷണബലത്തിന്റെ മൂല്യം

a) $\frac{1}{4}$ മടങ്ങായിരിക്കും

b) 4 മടങ്ങായിരിക്കും

c) $\frac{1}{2}$ മടങ്ങായിരിക്കും

d) 2 മടങ്ങായിരിക്കും

19. ഭൂമിയുടെ ഗുരുത്വാകർഷണം പെട്ടെന്ന് അപ്രത്യക്ഷമായാൽ, താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത്?

a) വസ്തുവിന്റെ ഭാരം പൂജ്യമാവുകയും മാസ് മാറ്റമില്ലാതെ തുടരുകയും ചെയ്യും.

b) വസ്തുവിന്റെ ഭാരം മാറ്റമില്ലാതെ തുടരുകയും മാസ് പൂജ്യമാവുകയും ചെയ്യും.

c) മാസും ഭാരവും പൂജ്യമാകും.

d) മാസും ഭാരവും പൂജ്യമാകില്ല.

20. ഒരു സ്വിമ്മിങ് പൂളിന്റെ 45 m ഉയരത്തിലുള്ള ജമ്പിങ് ബോർഡിൽ നിന്നു കൊണ്ട് സുനിൽ ഒരു പന്ത് താഴോട്ട് എറിയുന്നു. ഒരു സെക്കന്ഡിന് ശേഷം അതെ ബോർഡിൽ നിന്ന് കൊണ്ട് u ആദ്യപ്രവേഗത്തിൽ മറ്റൊരു പന്ത് അവൻ താഴേക്കെറിഞ്ഞു. രണ്ട് പന്തുകളും ഒരേ സമയത്ത് വെള്ളത്തിന്റെ ഉപരിതലത്തിൽ തട്ടുന്നു. എങ്കിൽ ശരിയായ പ്രസ്താവന ഏത് ?

i. ആദ്യത്തെ പന്ത് വെള്ളത്തിന്റെ ഉപരിതലത്തിലെത്താൻ 3 s എടുക്കുന്നു.

ii. രണ്ടാമത്തെ പന്തിന്റെ ആദ്യ പ്രവേഗം 12.5 m/s ആണ്.

iii. രണ്ട് പന്തുകളും വെള്ളത്തിന്റെ ഉപരിതലത്തിൽ തട്ടുന്നത് തുല്യപ്രവേഗത്തിലായിരിക്കും.

iv. രണ്ടാമത്തെ പന്ത് വെള്ളത്തിന്റെ ഉപരിതലത്തിൽ തട്ടുന്നത് ഉയർന്ന പ്രവേഗത്തിലായിരിക്കും.

a) (i) ഉം (iii) ഉം ശരിയാണ്.

b) (ii) ഉം (iii) ഉം ശരിയാണ്.

c) (i) ഉം (ii) ഉം (iii) ഉം ശരിയാണ്.

d) (i) ഉം (ii) ഉം (iv) ഉം ശരിയാണ്.

21. ശരിയായ പ്രസ്താവന ഏത്?

a) ഒരു വസ്തുവിന്മേൽ പ്രയോഗിച്ച ബലത്തിന്റെ ദിശക്ക് ലംബമായി സ്ഥാനാന്തരം ഉണ്ടാകുമ്പോൾ മാത്രമാണ് പ്രവൃത്തി ചെയ്തതായി കണക്കാക്കുകയുള്ളൂ.

b) ഒരു വസ്തുവിന് അതിന്റെ ചലനം കൊണ്ട് ലഭ്യമാകുന്ന ഊർജമാണ് ഗതികോർജം.

c) സ്ഥിതികോർജത്തിൽ ഉണ്ടായ മാറ്റത്തിന് തുല്യമാണ് പ്രവൃത്തി എന്നതാണ് പ്രവൃത്തി-ഊർജതത്ത്വം.

d) പ്രവൃത്തിയുടെയും സ്ഥാനാന്തരത്തിന്റെയും ഹരണഫലമാണ് പവർ.

22. സ്ഥാനാന്തരം ബലത്തിന് ലംബമാണെങ്കിൽ പ്രവൃത്തി

a) നെഗറ്റീവ് c) പൂജ്യം

b) പോസിറ്റീവ് d) അനന്തം

23. ഒരു വസ്തു ഉയരം h ഇൽ നിന്ന് താഴോട്ട് വീഴുന്നു. ഉയരം $\frac{h}{2}$ സഞ്ചരിച്ചു കഴിയുമ്പോൾ ആ വസ്തു അനുഭവപ്പെടുന്നത്

a) സ്ഥിതികോർജം മാത്രമായിരിക്കും

b) ഗതികോർജം മാത്രമായിരിക്കും

c) പകുതി സ്ഥിതികോർജവും ബാക്കി പകുതി ഗതികോർജവുമായിരിക്കും

d) കൂടുതൽ ഗതികോർജവും കുറച്ച് സ്ഥിതികോർജവുമായിരിക്കും

24. A എന്ന ആൾ ഒരു ആശുപത്രിയുടെ രണ്ടാം നിലയിലേക്ക് ലിഫ്റ്റിൽ എത്തി. എന്നാൽ B എന്ന മറ്റൊരാൾ അതെ നിലയിലേക്ക് കോണികയറിയെത്തി. രണ്ടുപേരുടെയും മാസ്സുകൾ തുല്യമാണെങ്കിൽ

a) ഗുരുത്വാകർഷണബലത്തിനെതിരെ രണ്ടു പേരും ചെയ്ത പ്രവൃത്തി തുല്യമാണ്.

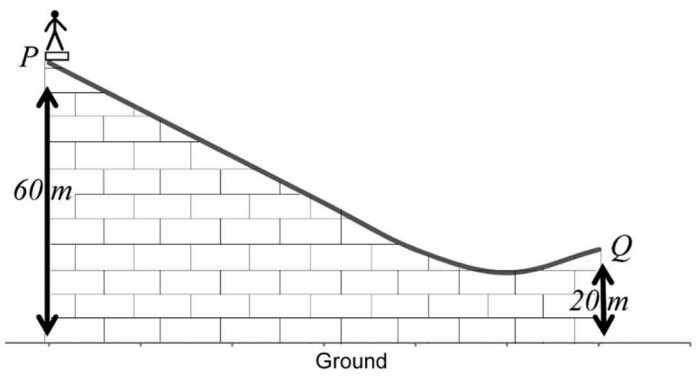
b) ഗുരുത്വാകർഷണബലത്തിനെതിരെ A ചെയ്ത പ്രവൃത്തിയേക്കാൾ കൂടുതലാണ് B ചെയ്തത്.

c) ഗുരുത്വാകർഷണബലത്തിനെതിരെ B ചെയ്ത പ്രവൃത്തിയേക്കാൾ കൂടുതലാണ് A ചെയ്തത്.

d) രണ്ടുപേരുടെയും പവർ തുല്യമാണ്.

25. 50 kg മാസുള്ള ഒരു സ്കീയർ (മഞ്ഞിന്റെ ഉപരിതലത്തിൽ തെന്നി നീങ്ങുന്ന ആൾ) ഒരു സ്കി ജമ്പിന്റെ ഉയർന്ന ബിന്ദു P യിൽ നില്ക്കുന്നു. ചിത്രത്തിൽ കാണിച്ചിരിക്കുന്നത്

പോലെ അയാൾ P യിൽ നിന്ന് Q എന്ന ബിന്ദുവിലേക്ക് തെന്നി നീങ്ങുകയും Q വിലെത്തിയപ്പോൾ ഉയർന്നു പൊങ്ങുകയും ചെയ്തു. Q വിലുള്ള ഗതികോർജത്തിന്റെ അളവ് P യിനും Q വിനും ഇടയിലുള്ള സ്ഥിതികോർജ്ജത്തിലുള്ള മാറ്റത്തിന്റെ 50 % ആകുമ്പോൾ, താഴെ കൊടുത്തിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത്?



i. സ്കീയറിന്റെ സ്ഥിതികോർജ്ജത്തിലുള്ള മാറ്റം 10000 J ആണ്.

ii. സ്കീയറിന്റെ ഗതികോർജം 5000 J ആണ്.

iii. Q വിൽ എത്തുമ്പോൾ സ്കീയറിന്റെ വേഗത 20 m/s ആണ്.

a) (i) മാത്രം ശരിയാണ്.
b) (i) ഉം (ii)ഉം ശരിയാണ്.
c) (ii) ഉം (iii)ഉം ശരിയാണ്.
d) (iii) മാത്രം ശരിയാണ്.

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APPENDIX 3

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-C)
(DRAFT – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Maximum Marks: 25

Time: 60 minutes

നിർദ്ദേശങ്ങൾ:

ഈ ടെസ്റ്റിന് മൂന്ന് ഭാഗങ്ങളാണുള്ളത്. Section A കുട്ടികളുടെ പൊതുവിവരങ്ങളുമായി ബന്ധപ്പെട്ടതാണ്. Section B യിൽ ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട ചില ആശയങ്ങളെ അവയുടെ കാഠിന്യമനുസരിച്ച് റാങ്ക് രേഖപ്പെടുത്തണം. ഏറ്റവും ബുദ്ധിമുട്ടുള്ള ആശയത്തിന് നേരെ റാങ്ക് '1' എന്നും അതിനേക്കാൾ കാഠിന്യം കുറഞ്ഞ ആശയത്തിന് നേരെ '2', എന്നിങ്ങനെ കാഠിന്യ നിലവാരം കുറയുന്നതിനനുസരിച്ച രീതിയിലാണ് റാങ്ക് രേഖപ്പെടുത്തേണ്ടത്. ഒമ്പതാം ക്ലാസിലെ വിദ്യാർത്ഥികളുടെ ആശയധാരണകളെ അളക്കാനുള്ള 25 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് Section C യിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. എല്ലാ ചോദ്യത്തിനും ഉത്തരം തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d) എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കുറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

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SECTION A

വിദ്യാർത്ഥിയുടെ പേര് :

ലിംഗം : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂളിന്റെ പേര് :

ഒമ്പതാം ക്ലാസ്സിൽ ഭൗതികശാസ്ത്രത്തിൽ ഒന്നാം പാദവാർഷിക പരീക്ഷക്കും രണ്ടാം പാദവാർഷിക പരീക്ഷക്കും ലഭിച്ച മാർക്ക് :

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SECTION B

No.	ഭൗതികശാസ്ത്രത്തിലെ ആശയങ്ങൾ	റാങ്ക്
1.	ദ്രവബലങ്ങൾ	
2.	ചലനസമവാക്യങ്ങൾ	
3.	ചലനവും ചലനനിയമങ്ങളും	
4.	ഗുരുത്വാകർഷണം	
5.	പ്രവൃത്തി, ഊർജം, പവർ	

.....

SECTION C

1. വിസ്കസ് ബലത്തെ വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?
   a) ഒരു വസ്തു ദ്രവത്തിൽ പൂർണമായി മുങ്ങിയിരിക്കുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ താഴേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് വിസ്കസ് ബലം.
   b) ഒരു സംവൃതവ്യൂഹത്തിൽ അടങ്ങിയിരിക്കുന്ന ദ്രാവകത്തിന്റെ ഏതെങ്കിലും ഒരു ഭാഗത്ത് പ്രയോഗിക്കുന്ന മർദ്ദം ദ്രാവകത്തിന്റെ എല്ലാ ഭാഗത്തും ഒരു പോലെ അനുഭവപ്പെടും. ഈ ബലമാണ് വിസ്കസ് ബലം.
   c) ജലോപരിതലത്തിലെ കണികകൾ പരസ്പരം ആകർഷിക്കുന്നതുമൂലം ജലോപരിതലം ഒരു പാടപോലെ വലിഞ്ഞുനിൽക്കുന്നു. ഇതിനു കാരണമായ ബലമാണ് വിസ്കസ് ബലം.
   d) ചലിച്ചുകൊണ്ടിരിക്കുന്ന ദ്രാവകപടലങ്ങൾക്കിടയിൽ അവയുടെ ആപേക്ഷിക ചലനത്തെ തടസ്സപ്പെടുത്തുന്ന വിധത്തിൽ പടലങ്ങൾക്ക് സമാന്തരമായി പ്രവർത്തിക്കുന്ന ഘർഷണബലമാണ് വിസ്കസ് ബലം.
2. പ്ലവക്ഷമബലത്തിന് ഉദാഹരണം താഴെ കൊടുത്തിരിക്കുന്നവയിലേത് ?

a) ഹൈഡ്രജൻ നിറച്ച ബലൂൺ വായുവിൽ പൊങ്ങുന്നു.

b) ഒരു ചരിഞ്ഞ ഗ്ലാസ് പ്ലേറ്റിന് മേൽ വെള്ളത്തുള്ളി താഴോട്ട് നീങ്ങുന്നു.

c) ഒരു റോക്കറ്റ് വിക്ഷേപിച്ചതിന് ശേഷം വായുവിൽ മുൻപോട്ട് ഉയരുന്നു.

d) ഫൗണ്ടൻ പേനയിൽ മഷി മുനയിലേക്ക് എത്തുന്നു.

3. W ഭാരമുള്ള ഒരു വസ്തു ദ്രവത്തിൽ മുങ്ങിക്കിടക്കുന്നു. പ്ലവക്ഷമ ബലം വസ്തുവിന്റെ ഭാരത്തിന്റെ $\frac{1}{4}$ ഭാഗത്തിന് തുല്യമാണെങ്കിൽ ദ്രവത്തിൽ വസ്തുവിന്റെ ഭാരമെത്ര ?

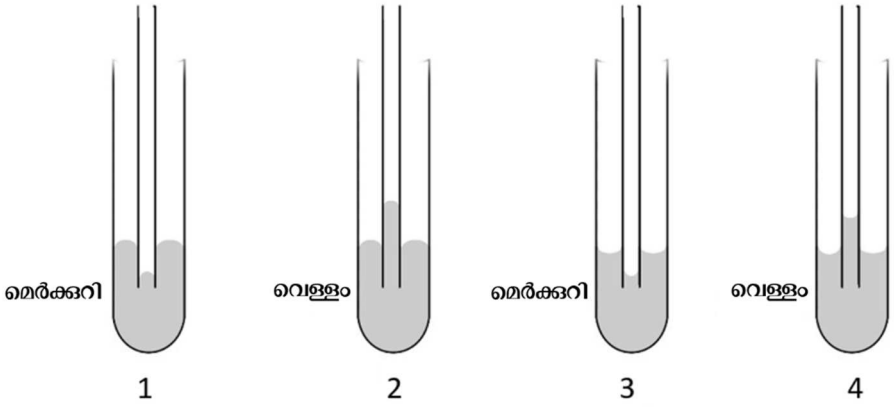
a) $2\,W$

b) $\frac{1}{4}\,W$

c) $\frac{3}{4}\,W$

d) $\frac{1}{2}\,W$

4. കേശികത്വം അടിസ്ഥാനപ്പെടുത്തി താഴെ തന്നിരിക്കുന്ന ചിത്രത്തിൽ ശരിയേത് ?



a) 4 മാത്രം ശരിയാണ്.

b) 1 ഉം 4 ഉം ശരിയാണ്.

c) 2 ഉം 4 ഉം ശരിയാണ്.

d) 2 ഉം 3 ഉം ശരിയാണ്.

5. A, B എന്നീ രണ്ട് ദ്രാവകങ്ങളുടെ ആപേക്ഷികസാന്ദ്രത യഥാക്രമം 0.75 ഉം 1.0 ഉം ആണ്. ആപേക്ഷികസാന്ദ്രത യഥാക്രമം 0.6 ഉം 0.9 ഉം ആയ P, Q എന്ന രണ്ട് പൊള്ളയല്ലാത്ത വസ്തുക്കൾ ഈ ദ്രാവകങ്ങളിലിട്ടാൽ

a) P എന്ന വസ്തു A യിൽ പൊങ്ങിക്കിടക്കുകയും Q എന്ന വസ്തു B യിൽ മുങ്ങുകയും ചെയ്യും.

b) P എന്ന വസ്തു A യിൽ മുങ്ങുകയും Q എന്ന വസ്തു B യിൽ പൊങ്ങിക്കിടക്കുകയും ചെയ്യും.

c) P എന്ന വസ്തു B യിൽ പൊങ്ങിക്കിടക്കുകയും Q എന്ന വസ്തു A യിൽ മുങ്ങുകയും ചെയ്യും.

d) P എന്ന വസ്തു B യിൽ മുങ്ങുകയും Q എന്ന വസ്തു A യിൽ പൊങ്ങിക്കിടക്കുകയും ചെയ്യും.

6. ശരിയായ ചലനസമവാക്യം ഏത്?

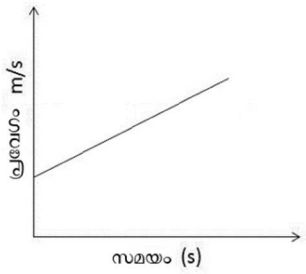
a) $v = u + at^2$

b) $v = u + at$

c) $v = ut + at^2$

d) $v = u - at$

7. തന്നിരിക്കുന്ന പ്രവേഗ-സമയ ഗ്രാഫ് അനുസരിച്ച്



a) വസ്തുവിന് ഒരു നിശ്ചിത ആദ്യ പ്രവേഗമുണ്ട്.

b) വസ്തു സമപ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു.

c) വസ്തു തുടക്കത്തിൽ ഒരു നിശ്ചിത പ്രവേഗത്തിൽ സഞ്ചരിക്കുകയും പിന്നീട് സമപ്രവേഗത്തിലേക്ക് മാറുകയും ചെയ്യുന്നു.

d) വസ്തു നിശ്ചലാവസ്ഥയിലാണ്.

8. നിശ്ചലാവസ്ഥയിൽ നിന്ന് ചലിച്ചു തുടങ്ങിയ ഒരു ട്രെയിൻ 2 മിനിട്ടിനുള്ളിൽ $0.1\ m/s^2$ സമത്വരണത്തിൽ സഞ്ചരിക്കുന്നു. ട്രെയിൻ സഞ്ചരിച്ച ദൂരം എത്ര ?

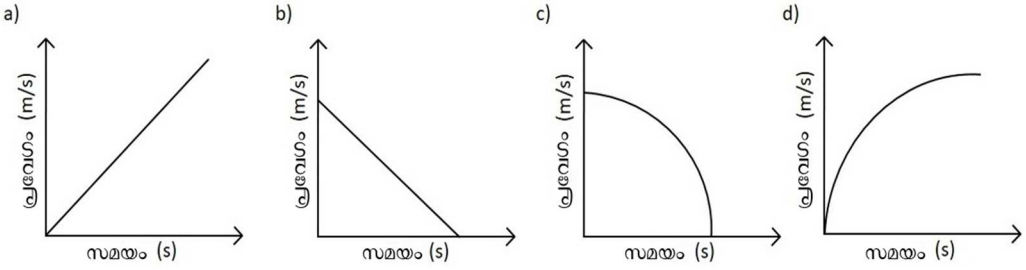
a) 0.05 m

b) 20 m

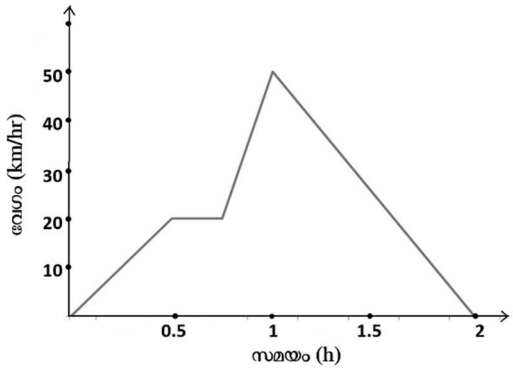
c) 360 m

d) 720 m

9. ഒരു വസ്തുവിനെ കുത്തനെ മുകളിലോട്ടു എറിയുമ്പോൾ അനുഭവപ്പെടുന്ന ത്വരണം സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത് ?



10. ഒരു ട്രെയിൻ ഒരു സ്റ്റേഷനിൽ നിന്ന് മറ്റൊരു സ്റ്റേഷനിലേക്ക് 2 മണിക്കൂർ കൊണ്ട് എത്തിച്ചേരുന്നു. ആ ചലനത്തിന്റെ വേഗ-സമയ ഗ്രാഫാണ് തന്നിരിക്കുന്നത്. ഗ്രാഫിനെ കുറിച്ചുള്ള പ്രസ്താവനകളിൽ ശരിയേത് ?



i. യാത്രയിൽ ട്രെയിനിന്റെ പരമാവധി ത്വരണം 120 km/hr^2 ആണ്.

ii. 0.75 hr തൊട്ട് 1 hr വരെയുള്ള ഇടവേളയിൽ ട്രെയിൻ സഞ്ചരിക്കുന്ന ദൂരം 8.75 km ആണ്.

iii. യാത്രയുടെ തുടക്കം മുതൽ 0.5 hrs വരെയുള്ള ഇടവേളയിൽ ട്രെയിൻ സമപ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു.

a) മാത്രം ശരിയാണ്. c) (i) ഉം (ii) ഉം ശരിയാണ്.

b) (ii) മാത്രം ശരിയാണ് d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

11. ന്യൂട്ടന്റെ രണ്ടാം ചലന നിയമം വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

a) ഒരു വസ്തുവിനുണ്ടാകുന്ന ആക്കവ്യത്യാസത്തിന്റെ നിരക്ക് ആ വസ്തുവിൽ പ്രയോഗിക്കുന്ന അസന്തുലിത ബാഹ്യബലത്തിന് നേർ അനുപാതത്തിലായിരിക്കും.

b) അസന്തുലിത ബാഹ്യബലത്തിന്റെ അഭാവത്തിൽ രണ്ട് വസ്തുക്കൾ തമ്മിൽ കൂട്ടിയിടിക്കുന്നതിന് മുൻപുള്ള ആകെ ആക്കവും ഇടിച്ചതിന് ശേഷമുള്ള ആകെ ആക്കവും തുല്യമായിരിക്കും.

c) അസന്തുലിതമായ ബാഹ്യബലം അനുഭവപ്പെടുന്നത് വരെ ഓരോ വസ്തുവും അതിന്റെ നിശ്ചലാവസ്ഥയിലോ നേർരേഖാ സമചലനത്തിലോ തുടരുന്നതാണ്.

d) ഒരു വസ്തുവിൽ അനുഭവപ്പെടുന്ന പരിണതബലം പൂജ്യമെങ്കിൽ പ്രയോഗിക്കപ്പെട്ട ബലങ്ങളെ സന്തുലിത ബലങ്ങൾ എന്ന് പറയുന്നു. ഇത്തരം ബലങ്ങൾക്ക്

നിശ്ചലാവസ്ഥയിലുള്ള വസ്തുക്കളെ ചലിപ്പിക്കാനോ ചലിക്കുന്ന വസ്തുക്കളെ നിശ്ചലമാക്കാനോ കഴിയില്ല.

12. ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമം പ്രയോജനപ്പെടുത്തുന്ന സന്ദർഭം താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

a) ഒരു വിരിപ്പിന് മേൽ വടി കൊണ്ട് അടിക്കുമ്പോൾ അതിലെ പൊടിപടലങ്ങൾ പുറത്തേക്ക് തെറിക്കുന്നു.

b) വെടിയുതിർക്കുമ്പോൾ ബുള്ളറ്റ് പോകുന്ന ദിശക്ക് എതിരെ തോക്ക് ചലിക്കുന്നു.

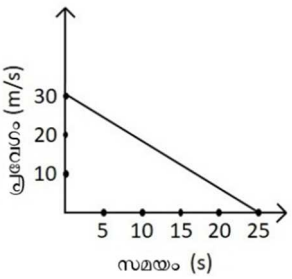
c) കാറ്റഴിച്ചു വിടുമ്പോൾ ബലൂണിന്റെ ചലനം.

d) ഗ്ലാസ് പാത്രങ്ങൾ അടുക്കിവെച്ച പാക്കറ്റുകളിൽ സ്പോഞ്ച്, വൈക്കോൽ എന്നിവ നിറക്കുന്നത് പാത്രങ്ങൾ തമ്മിൽ കൂട്ടിമുട്ടി പൊട്ടുന്നത് ഒഴിവാക്കാൻ സഹായിക്കുന്നു.

13. 1500 kg ഭാരമുള്ള ഒരു കാറിന്റെ വേഗത സമമായി 32 km/hr ൽ നിന്ന് 72 km/hr ലേക്ക് ഉയരുന്നു. കാറിന്റെ ആക്കവ്യത്യാസം എത്ര ?

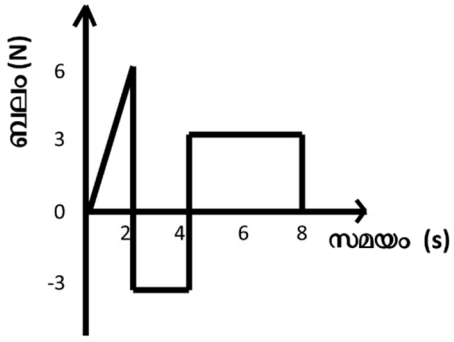
a) 15000 kg km/hr
b) 15000 kg m/s
c) 54000 kg m/s
d) 54000 g m/s

14. 50 kg മാസുള്ള ഒരു വസ്തു നിലത്ത് ഉരുളുമ്പോഴുള്ള പ്രവേഗ-സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്. വസ്തുവിന് മേൽ അനുഭവപ്പെടുന്ന ബലം എത്ര ?



a) 5 N
b) 25 N
c) 30 N
d) 60 N

15. m മാസുള്ള ഒരു വസ്തുവിന് മേലുള്ള F എന്ന ബലം സൂചിപ്പിക്കുന്ന ബല-സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്. ശരിയായ പ്രസ്താവന കണ്ടെത്തുക.



i. 0 സെക്കന്റ് മുതൽ 4 s വരെ ഉള്ള ഇടവേളയിൽ വസ്തുവിനുണ്ടായ ആക്കവ്യത്യാസം 4 s തൊട്ട് 8 s വരെയുള്ള ഇടവേളയിലേതിന് തുല്യമാണ്.

ii. 0 സെക്കന്റ് മുതൽ 2 s വരെ ഉള്ള ഇടവേളയിൽ വസ്തുവിനുണ്ടായ ആക്കവ്യത്യാസത്തിന്റെ അളവ് 2 s തൊട്ട് 4 s വരെയുള്ള ഇടവേളയിലേതിന് തുല്യമാണ്.

iii. 0 സെക്കന്റ് മുതൽ 8 s വരെ ഉള്ള ഇടവേളയിൽ വസ്തുവിനുണ്ടായ ആക്കവ്യത്യാസം 12 N ആണ്.

a) ഉം (ii) ഉം ശരിയാണ്.
c) (ii) ഉം (iii) ഉം ശരിയാണ്.
b) (i) ഉം (iii) ഉം ശരിയാണ്.
d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

16. ഏത് തമ്മിലുള്ള ഗുരുത്വാകർഷണബലമാണ് സാർവികഗുരുത്വാകർഷണനിയമത്തിൽ പ്രതിപാദിക്കുന്നത് ?

a) ഭൂമിയും ഏതെങ്കിലുമൊരു മാസും മാത്രം
b) ഭൂമിയും സൂര്യനും മാത്രം
c) ചാർജുള്ള ഏതെങ്കിലും രണ്ട് വസ്തുക്കൾ
d) മാസുള്ള ഏതെങ്കിലും രണ്ട് വസ്തുക്കൾ

17. തുല്യവലുപ്പമുള്ള രണ്ട് റബ്ബർ പന്തുകൾ ആദ്യം ഭൂമിയിലും പിന്നീട് ചന്ദ്രനിലും നിർബാധം പതിക്കുന്നു. ഒരു പന്ത് പൊള്ളയായതും മറ്റേത് പൊള്ളയല്ലാത്തതും ആണ്. ഭൂമിയിലുള്ള ഗുരുത്വാകർഷണത്വരണം $10\ m/s^2$ ഉം ചന്ദ്രനിലേത് $1.7\ m/s^2$ ഉം ആണ്. എങ്കിൽ കൂടുതൽ ഗുരുത്വാകർഷണബലം അനുഭവപ്പെടുന്ന പന്ത് ഏത്?

	പന്തിന്റെ തരം	നിർബാധപതന സ്ഥാനം
a)	പൊള്ളയായ പന്ത്	ചന്ദ്രൻ
b)	പൊള്ളയായ പന്ത്	ഭൂമി
c)	പൊള്ളയല്ലാത്ത പന്ത്	ചന്ദ്രൻ
d)	പൊള്ളയല്ലാത്ത പന്ത്	ഭൂമി

18. ഒരു വസ്തുവിന്റെ മാസ് 135 kg ആണെങ്കിൽ ഭൂമിയിൽ അതിന്റെ ഭാരമെത്ര?

a) 135 N
b) 1224 N
c) 1323 N
d) 1413 N

19. ഭൂമധ്യരേഖയിൽ വെച്ച് മാസും ഭാരവും തിട്ടപ്പെടുത്തിയ വസ്തു ഇപ്പോൾ ധ്രുവപ്രദേശത്ത് സ്ഥാപിക്കപ്പെടുന്നു. എങ്കിൽ താഴെ തന്നിരിക്കുന്നവയിൽ ശരിയായ പ്രസ്താവന ഏത് ?

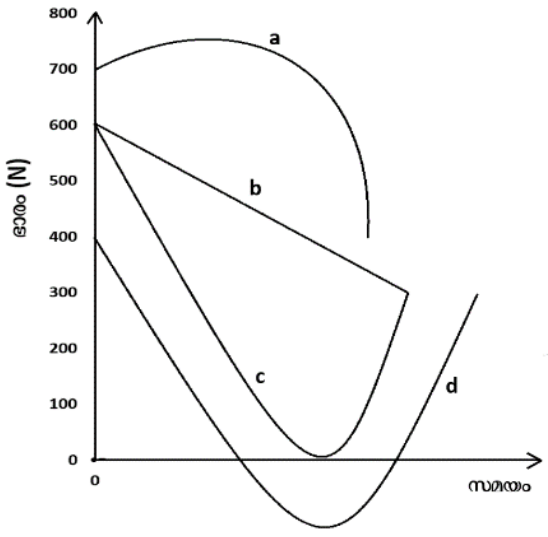
a) മാസ് വ്യത്യാസമില്ലാതിരിക്കുകയും ഭാരം ഏറ്റവും ഉയർന്ന മൂല്യത്തിലെത്തുകയും ചെയ്യുന്നു.

b) മാസ് വ്യത്യാസമില്ലാതിരിക്കുകയും ഭാരം ഏറ്റവും താഴ്ന്ന മൂല്യത്തിലെത്തുകയും ചെയ്യുന്നു.

c) മാസും ഭാരവും ഏറ്റവും ഉയർന്ന മൂല്യത്തിലെത്തുന്നു.

d) മാസും ഭാരവും ഏറ്റവും കുറഞ്ഞ മൂല്യത്തിലെത്തുന്നു.

20. ഭൂമിയുടെ ഉപരിതലത്തിൽ ഗുരുത്വാകർഷണത്വരണം $10\ m/s^2$ ഉം ചൊവ്വയുടെ ഉപരിതലത്തിൽ $4\ m/s^2$ഉം ആണെന്ന് സങ്കല്പിക്കുക. സ്ഥിരപ്രവേഗത്തിലുള്ള ഒരു ബഹിരാകാശവാഹനത്തിൽ ഭൂമിയിൽ നിന്ന് ചൊവ്വയിലേക്ക് 60 kg ഭാരമുള്ള ഒരു യാത്രികൻ സഞ്ചരിക്കുന്നു. ബഹിരാകാശത്തുള്ള മറ്റെല്ലാ വസ്തുക്കളെയും അവഗണിക്കുക. എങ്കിൽ താഴെ തന്നിരിക്കുന്ന ചിത്രത്തിൽ സമയാനുസൃതമായി യാത്രികന്റെ ഭാരം ശരിയായി സൂചിപ്പിക്കുന്ന ഭാഗമേത്?



21. ശരിയായ പ്രസ്താവന ഏത്?

a) യൂണിറ്റ് സമയത്തിൽ ഉണ്ടാവുന്ന ഊർജത്തിന്റെ അളവാണ് പ്രവൃത്തിയുടെ അളവ്.

b) സ്ഥിതികോർജത്തിൽ ഉണ്ടായ മാറ്റത്തിന് തുല്യമാണ് പ്രവൃത്തി എന്നതാണ് പ്രവൃത്തി-ഊർതത്ത്വം.

c) ഒരു വസ്തുവിന്മേൽ പ്രയോഗിച്ച ബലത്തിന്റെ ദിശയിൽ സ്ഥാനാന്തരം ഉണ്ടാകുമ്പോൾ മാത്രമാണ് പ്രവൃത്തി ചെയ്തതായി കണക്കാക്കുകയുള്ളൂ.

d) പ്രവൃത്തിയുടെയും സ്ഥാനാന്തരത്തിന്റെയും ഹരണഫലമാണ് പവർ.

22. പ്രവർത്തി നെഗറ്റീവ് ആകുന്ന സാഹചര്യത്തിൽ ബലത്തിനും സ്ഥാനാന്തരത്തിനുമിടക്കുള്ള കോണളവെത്ര ?

a) 180^0 c) 45^0

b) 90^0 d) 0^0

23. ഒരു നിരപ്പായ റോഡിൽ സഞ്ചരിക്കുന്ന കാറിന്റെ വേഗത കൂടി, അതിന്റെ പ്രവേഗം നാലിരട്ടിയായി വർധിക്കുന്നു. അപ്പോൾ കാറിന്റെ

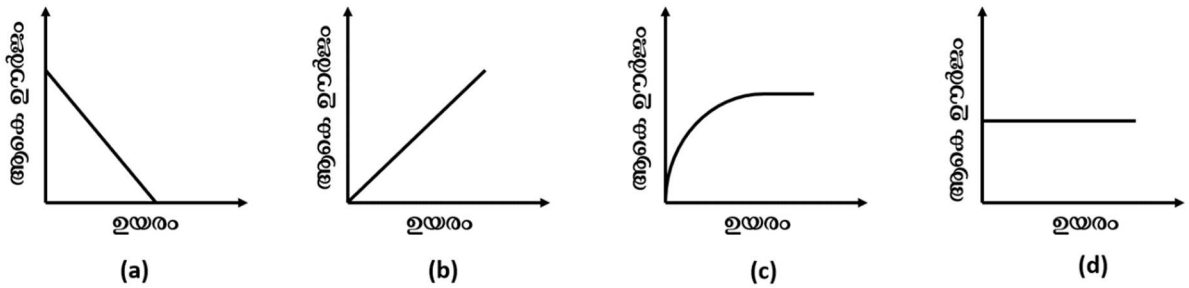
a) സ്ഥിതികോർജത്തിൽ മാറ്റമുണ്ടാവില്ല

b) സ്ഥിതികോർജം രണ്ടിരട്ടിയാകും

c) സ്ഥിതികോർജം നാലിരട്ടിയാകും

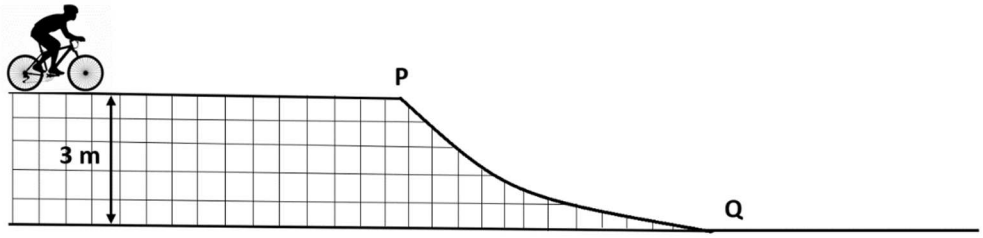
d) സ്ഥിതികോർജം പതിനാറിരട്ടിയാകും

24. ഒരു നിശ്ചിത ഉയരത്തിൽ നിന്ന് നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ ആകെ ഊർജം കാണിക്കുന്ന ഗ്രാഫ് ഏത് ?



25. ഒരു സൈക്കിൾ യാത്രികൻ ഒരു ചെറിയ കുന്നിലെ P എന്ന ബിന്ദുവിൽ നിന്നും താഴോട്ട് ഇറങ്ങി, Q എന്ന ബിന്ദുവിലൂടെ കടന്ന്, ശേഷം നിരപ്പായ റോഡിലൂടെ സഞ്ചരിക്കുന്നതാണ് ചിത്രത്തിൽ കാണിച്ചിരിക്കുന്നത്. യാത്രികന്റെയും

സൈക്കിളിന്റെയും ആകെ മാസ് 60 kg ആണ്. P എന്ന ബിന്ദുവിൽ യാത്രികന്റെ പ്രവേഗം 10 m/s ആണ്. എങ്കിൽ താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത്?



i. P എന്ന ബിന്ദുവിൽ ഗതികോർജം 3000 J ആണ്.

ii. P ഇനും Q ഇനുമിടക്ക് സ്ഥിതികോർജത്തിലുള്ള നഷ്ടം 3000 J ആണ്.

iii. മൊത്തം ഊർജം 6000 J ആണ്.

iv. ഉയർന്ന സ്ഥിരവേഗതയിൽ സഞ്ചരിക്കാൻ യാത്രികന് കൂടുതൽ പവർ ആവശ്യമാണ്.

a) ഉം (ii)ഉം ശരിയാണ്.
b) (i) ഉം (iv)ഉം ശരിയാണ്.
c) (ii) ഉം (iii)ഉം ശരിയാണ്.
d) (i) മാത്രം ശരിയാണ്.

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APPENDIX 4

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-A)
(DRAFT – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Maximum Marks: 25

Instructions: Time: 60 minutes

This test consists of three sections. Section A is meant for collecting general information regarding the student. In Section B, the student must rank the physics concepts based on the difficulty. The ranking must be done in such a way that rank '1' should be written against the most difficult concept and rank '2' for the next difficult concept, etc. Section C consists of twenty-five (25) multiple choice type questions which are meant to measure the conceptual understanding of IX standard students in physics. The candidate would be required to answer all the questions. Separate response sheet is provided to mark the answers of Section C. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The candidate must mark the response by darkening the circle as indicated below on the correct response against each item. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response. The responses will be only used for research purpose.

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SECTION A

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term and second term examination of IX standard:

……

SECTION B

No.	Concepts in physics	Rank
1.	Forces in Fluids	
2.	Equations of Motion	
3.	Motion and Laws of Motion	
4.	Gravitation	
5.	Work, Energy, Power	

……

SECTION C

1. Select the statement that explains the concept of Buoyancy.

a) When a body is immersed completely in a fluid, the fluid exerts a downward force on the body. This force is known as buoyancy.

b) When a body is immersed completely or partially in a fluid, the fluid exerts an upward force on the body. This force is known as buoyancy.

c) When a body is immersed partially in a fluid, the fluid exerts an upward force on the body. This force is known as buoyancy.

d) When a body sinks to the bottom of the fluid, the fluid exerts a downward force on the body. This force is known as buoyancy.

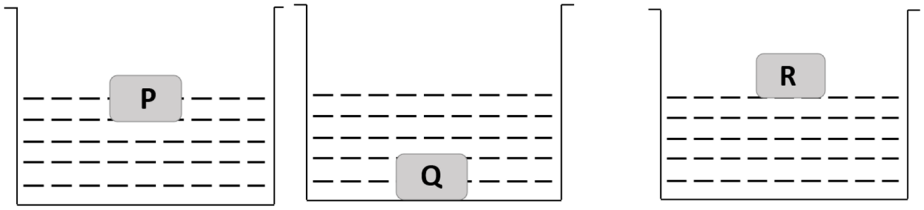
2. The instrument based on Archimedes principle is

a) Hydraulic lift
b) Hydraulic pump
c) Capillary tube
d) Hydrometer

3. The diameters of the pistons of a hydraulic jack are 1.5 cm and 15 cm. The force required to lift 1000 kg using it is

a) 1000 N
b) 100 N
c) 10 N
d) 50 N

4. P, Q and R are objects having different densities immersed in same liquid as shown below. Select the correct option showing their densities in descending order.



a) Q, P, R
b) P, Q, R
c) R, P, Q
d) Q, R, P

5. Select the correct statement based on floatation.

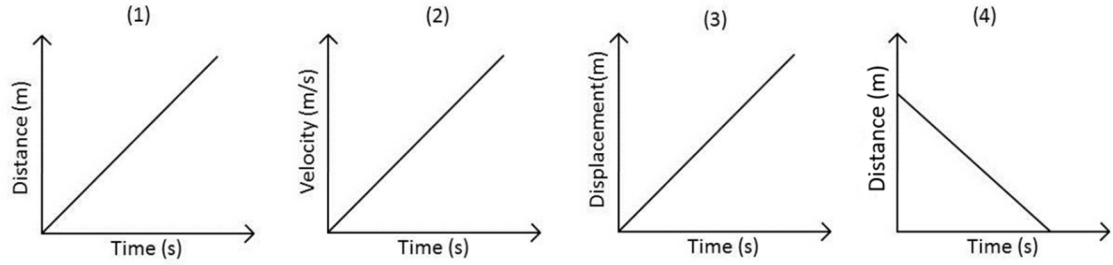
i. A body of weight 500 N sinks in water. If the weight of the liquid overflowed is 50 N, then the weight of the body in water is 400 N.
ii. If a body of weight 500 N floats in water, then its weight in water is 0 N and the weight of the water displaced is 500 N.
iii. A body of weight 750 N sinks in water. If the weight of the liquid overflowed is 150 N, then the weight of the body in water is 600 N.
iv. If a body of weight 750 N floats in water, then its weight in water is 550 N and the weight of the water displaced is 200 N.

a) Both (i) and (ii) are correct.
b) Both (iii) and (iv) are correct.
c) Both (i) and (iv) are correct.
d) Both (ii) and (iii) are correct.

6. Correct equation of motion is

a) $v^2 = u^2 + 2as^2$
b) $v^2 = u^2 - 2as^2$
c) $u^2 = v^2 + 2as$
d) $v^2 = u^2 + 2as$

7. Select the diagram showing uniform acceleration.

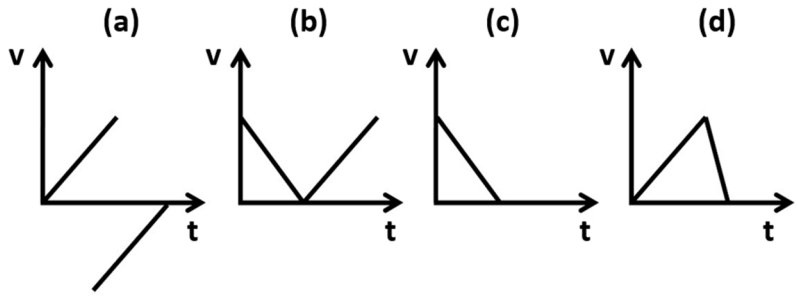


a) Only (1)
b) Only (2)
c) Both (2) and (3)
d) Both (1) and (4)

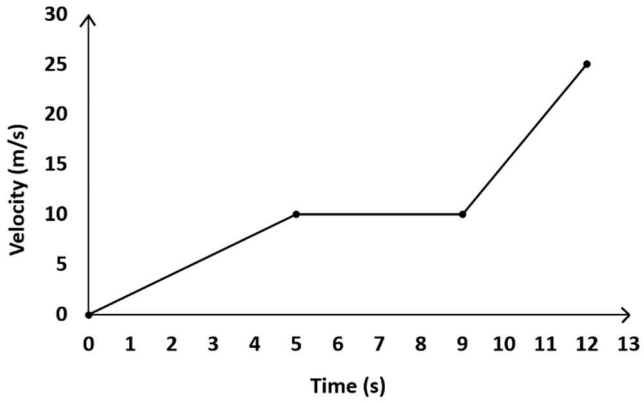
8. The retardation of the train which changes its velocity from 80 m/s to 20 m/s in 10 minutes will be

a) $0.1\ m/s^2$
b) $1\ m/s^2$
c) $6\ m/s^2$
d) $10\ m/s^2$

9. A freely falling body strikes the surface and rebounds. The velocity of the body with respect to time during its fall and rebound is represented by



10. A toy car moves from one place to another in 12 s time. Its velocity-time graph during the motion is shown in figure. Select the correct statement regarding the graph.



i. The maximum acceleration during the journey is 5 m/s^2.

ii. The distance covered during the time interval from 9 s to 12 s is 52.5 m.

iii. The minimum acceleration during the journey is 2 m/s^2.

a) Only (i) is correct.
b) Only (ii) is correct.
c) Both (i) and (ii) are correct.
d) All statements are correct.

11. Select the statement that explains 'Newton's Third Law of Motion'.

a) The rate of change of momentum of a body is directly proportional to the unbalanced external force acting upon it.

b) Every object continues in its state of rest or of uniform motion along a straight line unless an unbalanced external force acts on it.

c) To every action, there is an equal and opposite reaction.

d) The applied forces are said to be balanced forces, if the resultant force on the body is zero and such forces can neither move a body at rest nor stop a body in motion.

12. Which one of the following is an example for application of 'Newton's Second Law of Motion'?

a) When a carpet is beaten with a stick, dust particle comes out.

b) While firing a bullet, the gun moves in the direction opposite to that of the bullet.

c) Motion of the inflated balloon when it gets deflated and released suddenly.

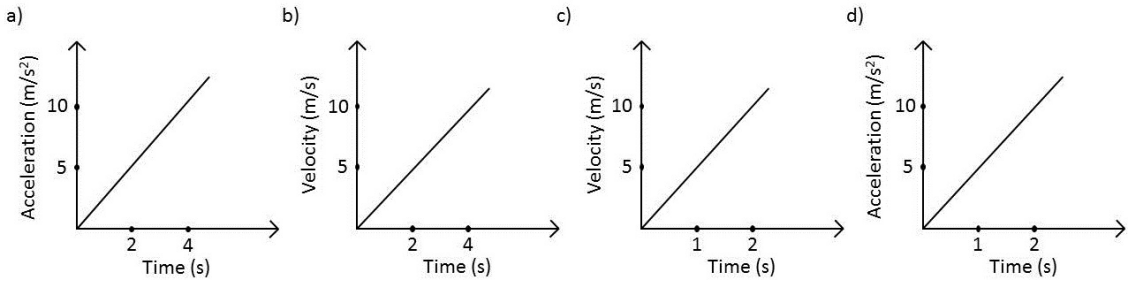
d) Hay or sponges are used while packing glass wares to avoid breakage.

13. An object of mass 2 kg is sliding with a constant velocity of 4 m/s on a frictionless horizontal table. The force required to keep the object moving with the same velocity is

a) 0 N c) 6 N

b) 2 N d) 8 N

14. Select the graph that represents the motion of a body of mass 4 kg, if the force acting on it is 10 N.



15. The table given below shows the distance-time relation of an object in motion.

Time (in seconds)	Distance (in metres)
0	0
1	1
2	8
3	27
4	64
5	125

What do you infer about the forces acting on the object?

a) Force is constant.
b) Force is increasing uniformly with time.
c) Force is decreasing uniformly with time.
d) Force is zero.

16. Identify 'Universal Law of Gravitation' from the following.

a) The earth attracts all objects towards its centre and whether an object on earth stands erect or upside down is decided on the basis of the direction of gravity.
b) All bodies in the universe attract each other. The force of mutual attraction between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.
c) The force of mutual attraction between two planets is directly proportional to the cube of the mean distance between them and inversely proportional to the product of orbital velocities of the planets.
d) The force of attraction between two unit masses separated by a unit distance results in acceleration of the masses known as acceleration due to gravity.

17. A body of mass 1 kg is attracted by the earth with a force which is equal to

a) 6.67×10^{11} N
b) 100 N
c) 9.8 N
d) 1 N

18. If the mass of object is 88 kg, then its weight on moon will be

a) 88 N
b) 132.33 N
c) 143.73 N
d) 212.33 N

19. Select the correct statement about acceleration due to gravity 'g'.

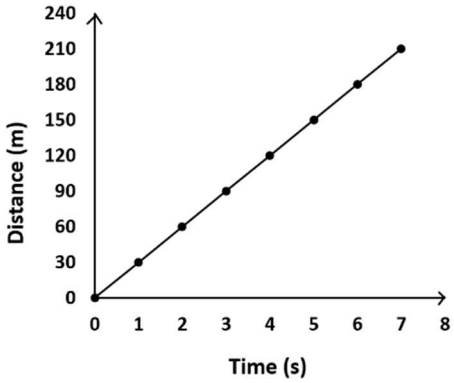
a) The value of 'g' decreases as we go towards the centre of the earth from its surface.
b) The value of 'g' increases as we go above the earth's surface.
c) The value of 'g' increases from pole to equator.
d) The value of 'g' on the Earth depends upon the mass of the body.

20. Manu was standing on a 245 m high tower with a stopwatch. He dropped a stone from the tower. Select the correct statement from the following.

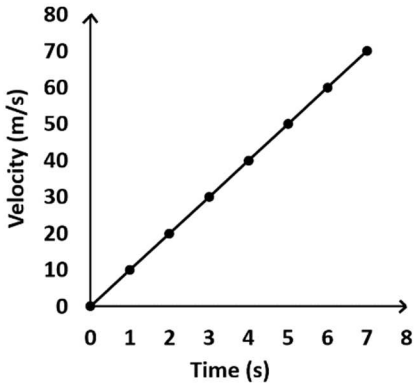
i. The reading in the stopwatch when the stone reaches the ground is 6 s.

ii. The final velocity when the stone touched the ground is 70 m/s.

iii. The distance-time graph of the stone is



iv. The velocity-time graph of the stone is



a) Both (i) and (ii) are correct.
b) Both (i) and (iv) are correct.
c) Both (ii) and (iii) are correct.
d) Both (ii) and (iv) are correct.

21. Select the correct statement.

a) Work is said to be done only when a body undergoes displacement perpendicular to the applied force.
b) Work-energy principle states that work done is equal to change in potential energy.
c) The energy possessed by a body by virtue of its position is the potential energy.
d) Power is the ratio of work done to the displacement.

22. When a body falls freely towards the earth, then, its total energy

a) Increases
c) First increases, then decreases
b) Decreases
d) Remains constant

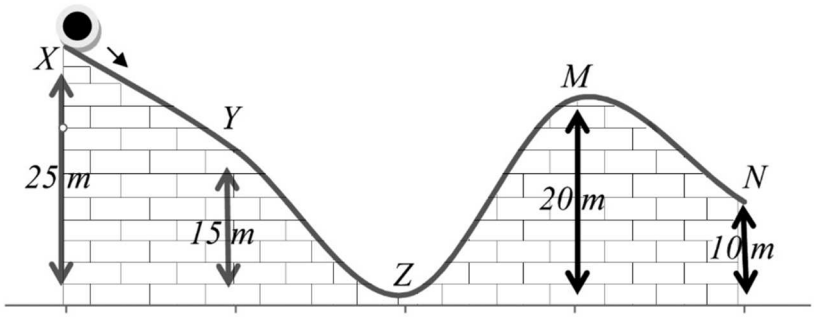
23. A girl is carrying a school bag of 3 kg mass on her back and moves 200m on a levelled road. The work done against the gravitational force will be (g=10 m / s^2)

a) 6×10^3 J
c) 0.6 J
b) 6 J
d) 0 J

24. Select the instance of negative work.

a) Work done by the frictional force while an object is sliding down along an inclined plane.
b) Work done by a person drawing water from a well using a rope without a pulley.
c) Work done by the force to stretch a rubber band.
d) Work done by gravitational force on a mango hanging on a tree.

25. The diagram shows a frictionless track. If a heavier ball is released from point X, then, which of the given statement is true?



i. The ball will move with a greater speed at Y.
ii. The speed of the ball at M is 10 m / s.
iii. The loss of potential energy between X and Y is 5 J.

a) Only (i) is true.
c) Both (i) and (ii) are true.
b) Only (ii) is true.
d) Both (ii) and (iii) are true.

****

APPENDIX 5

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-B)

(DRAFT – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Maximum Marks: 25

Instructions: Time: 60 minutes

This test consists of three sections. Section A is meant for collecting general information regarding the student. In Section B, the student must rank the physics concepts based on the difficulty. The ranking must be done in such a way that rank '1' should be written against the most difficult concept and rank '2' for the next difficult concept, etc. Section C consists of twenty-five (25) multiple choice type questions which are meant to measure the conceptual understanding of IX standard students in physics. The candidate would be required to answer all the questions. Separate response sheet is provided to mark the answers of Section C. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The candidate must mark the response by darkening the circle as indicated below on the correct response against each item. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response. The responses will be only used for research purpose.

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SECTION A

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term and second term examination of IX standard:

……

SECTION B

No.	Concepts in physics	Rank
1.	Forces in Fluids	
2.	Equations of Motion	
3.	Motion and Laws of Motion	
4.	Gravitation	
5.	Work, Energy, Power	

……

SECTION C

1. Select the statement that explains Archimedes' principle.

a) When an object is immersed partially or completely in a fluid, the buoyancy experienced by it will be equal to the weight of the fluid displaced by it.

b) When an object is immersed partially or completely in a fluid, the gravitational force experienced by it will be equal to the weight of the fluid displaced by it.

c) When an object is immersed partially or completely in a fluid, the buoyancy experienced by it will be equal to the relative density of the fluid displaced by it.

d) When an object is immersed partially or completely in a fluid, the gravitational force experienced by it will be equal to the relative density of the fluid displaced by it.

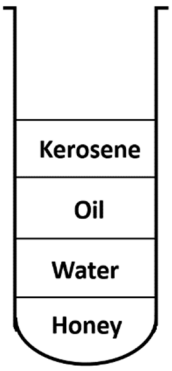
2. The principle in the functioning of excavators is

a) Buoyancy principle
c) Pascal's Law
b) Archimedes' principle
d) Law of floatation

3. A body of weight 1000 N sinks in water. If the weight of the liquid overflowed is 250 N, the weight of the body in water is

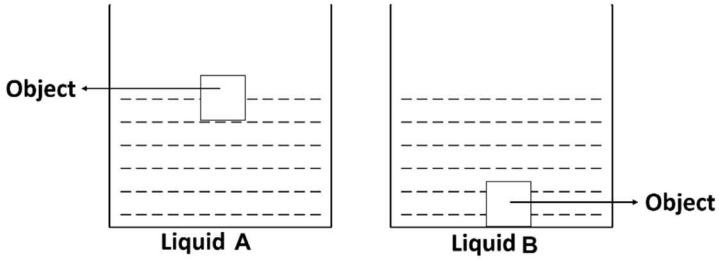
a) 250 N
c) 1000 N
b) 750 N
d) 1250 N

4. Following is the figure of a test tube that contains four different liquids. Arrange the liquids in the order of decreasing density.



a) Honey, Water, Oil, Kerosene
b) Kerosene, Oil, Water, Honey
c) Kerosene, Honey, Oil, Water
d) Water, Honey, Oil, Kerosene

5. Select the correct statement based on the figures.



i. In liquid A, the buoyant force acting on the object is greater than that in liquid B. But the gravitational force on object is greater in liquid B than in Liquid A.
ii. In Liquid A, buoyant force is less than the gravitational force on the object. While in liquid B, gravitational force on the object is less than the buoyant force.
iii. The density of the liquid B is less than that of the density of the object and liquid A.
iv. The relative density of the object is greater than that of liquid A and liquid B.

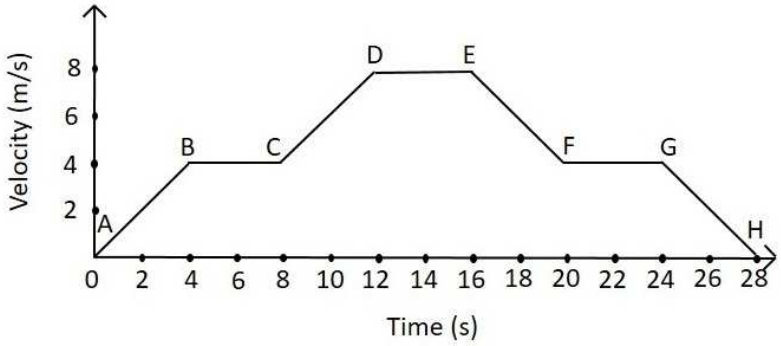
a) Only (i) is correct.
b) Only (iv) is correct.
c) Both (ii) and (iv) are correct.
d) Both (i) and (iii) are correct.

6. Correct equation of motion is

a) $s = ut - \frac{1}{2}\, at^2$ c) $s = ut + \frac{1}{2}\, at^2$

b) $s = ut + \frac{1}{2}\, a^2t^2$ d) $s = ut - \frac{1}{2}\, a^2t^2$

7. Select the option that represents accelerated motion.



a) CD and EF c) EF and GH

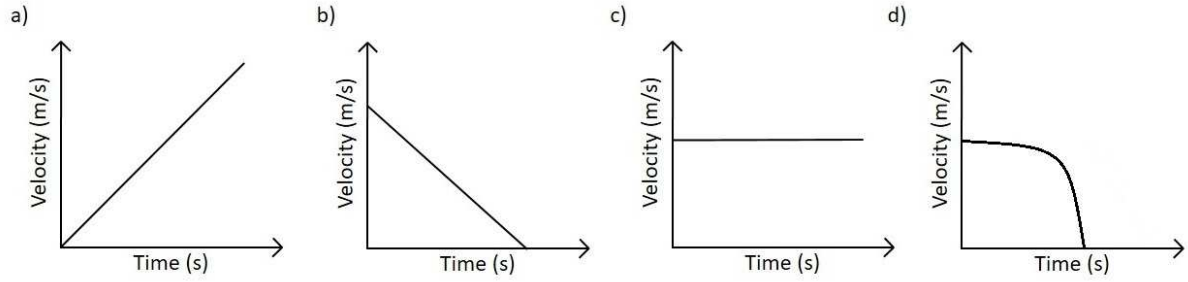
b) AB and CD d) BC, DE and FG

8. A stone is thrown vertically upward with an initial velocity of 40 m/s. The maximum height reached by the stone is

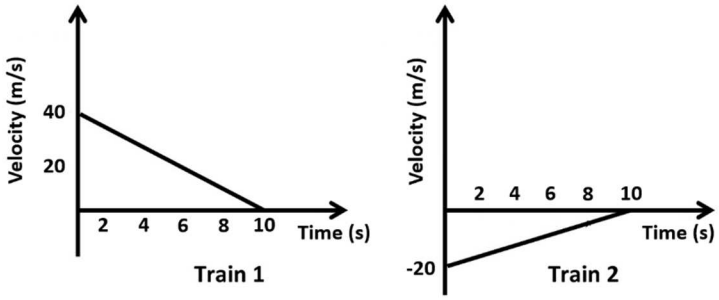
a) 40 m c) 80 m

b) 60 m d) 100 m

9. Select the graph showing the change in velocity of a freely falling body.



10. Two trains, which are moving along different tracks in opposite directions are put on the same track due to mistake. Their drivers on noticing the mistake, start slowing down the trains when the trains are 300 m apart. Given below are the velocity-time graphs of the two trains as they slow down. Identify the correct statement regarding the journey of the trains.



i. On applying brakes, Train 2 travels more distance than Train 1 before coming to rest.

ii. The separation between the trains when both have stopped is 20 m.

iii. On applying brakes, if the velocity-time graph of Train 2 was same as that of Train 1, then the two trains would have collided.

a) Only (i) is correct.
b) Only (ii) is correct.
c) Both (i) and (ii) are correct.
d) Both (ii) and (iii) are correct.

11. Identify the statement of 'Newton's First Law of Motion'.

a) The sum of momentum of the two objects before collision is equal to the sum of momentum after the collision provided there is no external unbalanced force acting on them.

b) The rate of change of momentum of a body is directly proportional to the unbalanced external force acting on it.

c) Every object continues in its state of rest or of uniform motion along a straight line unless an unbalanced external force acts on it.

d) The applied forces are said to be balanced forces, if the resultant force on the body is zero and such forces can neither move a body at rest nor stop a body in motion.

12. Which one of the following is an example for application of the 'Law of Conservation of Momentum'?

a) In high jump competition, the athlete is made to fall on a cushioned bed.

b) When a carpet is beaten with a stick, dust particle comes out.

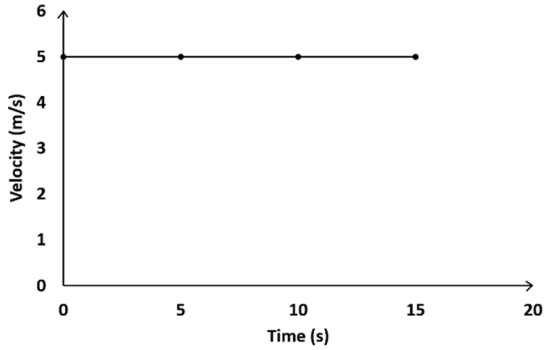
c) Karate experts move their hands with great speed to chop strong bricks.

d) A body suspended from the hook of a spring balance in a lift is accelerated downwards as the lift moves up.

13. If the mass of a moving body were doubled, keeping the force acting upon it the same, then the acceleration of the body

a) Will remain the same
b) Will be doubled
c) Will become zero
d) Will be halved

14. Velocity-time graph of a moving particle of mass 2 kg is shown below. The force acting on the body is



a) 0 N
b) 2.5 N
c) 10 N
d) 20 N

15. A large bus and a van, both moving with a velocity v, have a head-on-collision and both the vehicles stop after the collision. If the time of the collision is 1 second, then,

i. Bus experiences smaller force of impact.
ii. Van experiences smaller momentum change.
iii. Van experiences greater acceleration.

a) Statements (i) and (ii) are correct.
b) Statements (ii) and (iii) are correct.
c) Statements (i) and (iii) are correct.
d) All statements are correct.

16. The 'G' in the mathematical expression of Universal Law of Gravitation

a) Depends on the value of 'g' at the place of observation
b) Is universal gravitational constant
c) Is used only when the Earth is one of the two masses
d) Is greatest at the surface of the Earth

17. When a mango falls from a mango tree,

a) Only the Earth attracts the mango.

b) Only the mango attracts the Earth.

c) Both the mango and the Earth attract each other.

d) The tree repels and the Earth attracts the mango.

18. Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, then, the value of gravitational force between them will be

a) $\frac{1}{4}$ times

b) 4 times

c) $\frac{1}{2}$ times

d) 2 times

19. If the gravitational force of attraction of the Earth suddenly disappears, which one of the following will be true?

a) The weight of the body will become zero, but the mass will remain same.

b) The weight of the body will remain same, but the mass will become zero

c) Both mass and weight become zero

d) Neither mass nor weight becomes zero

20. Sunil threw a ball while standing on the jumping board of a swimming pool, which is at a height of 45 m. After one second, he threw another ball from the same board with initial velocity u. Both the balls hit the water together. Select the correct statement.

i. The first ball takes 3 s to reach the water surface.

ii. The initial velocity of the second ball is 12.5 m/s.

iii. The two balls hit the water with same velocity.

iv. The second ball hits the water with higher velocity.

a) Both (i) and (iii) are correct.

b) Both (ii) and (iii) are correct.

c) (i), (ii) and (iii) are correct.

d) (i), (ii) and (iv) are correct.

21. Select the correct statement.

a) Work is said to be done only when a body undergoes displacement perpendicular to the applied force.

b) The energy possessed by a body by virtue of its motion is the kinetic energy.

c) Work-energy principle states that work done is equal to change in potential energy.

d) Power is the ratio of work done to the displacement.

22. If the displacement is perpendicular to the force, then the work done is said to be

a) Negative
c) Zero
b) Positive
d) Infinity

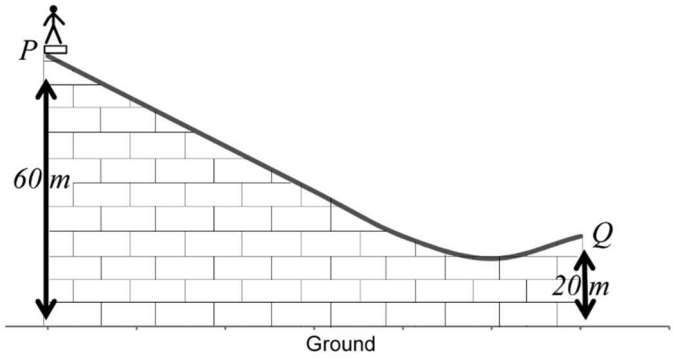
23. A body is falling from a height h. After it has fallen a height $\frac{h}{2}$, it will possess

a) Only potential energy
b) Only kinetic energy
c) Half potential energy and half kinetic energy
d) More kinetic energy and less potential energy

24. Person A reached the second floor of a hospital by lift and person B reached the same floor by stairs. If both their masses are the same, then the

a) Work done by them against the gravitational force is the same.
b) Work done by A against the gravitational force is greater than that done by B.
c) Work done by B against the gravitational force is greater than that done by A.
d) Power expended by both A and B is the same.

25. A skier of mass 50 kg stands at point P at the top of the ski jump. He moves from P to Q and takes off his jump at Q as shown in figure. If 50 % of the change in the potential energy of the skier between points P and Q becomes the kinetic energy at Q, select the correct statement.



i. The change in gravitational potential energy of the skier is 10000 J.

ii. The kinetic energy of the skier is 5000 J.

iii. Speed with which the skier arrives at Q is 20 m/s.

a) Only (i) is correct.
b) Both (i) and (ii) are correct.
c) Both (ii) and (iii) are correct.
d) Only (iii) is correct.

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APPENDIX 6

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-C)
(DRAFT – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Maximum Marks: 25

Instructions: Time: 60 minutes

This test consists of three sections. Section A is meant for collecting general information regarding the student. In Section B, the student must rank the physics concepts based on the difficulty. The ranking must be done in such a way that rank '1' should be written against the most difficult concept and rank '2' for the next difficult concept, etc. Section C consists of twenty-five (25) multiple choice type questions which are meant to measure the conceptual understanding of IX standard students in physics. The candidate would be required to answer all the questions. Separate response sheet is provided to mark the answers of Section C. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The candidate must mark the response by darkening the circle as indicated below on the correct response against each item. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response. The responses will be only used for research purpose.

……

SECTION A

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term and second term examination of IX standard:

……

SECTION B

No.	Concepts in physics	Rank
1.	Forces in Fluids	
2.	Equations of Motion	
3.	Motion and Laws of Motion	
4.	Gravitation	
5.	Work, Energy, Power	

……

SECTION C

1. Select the statement that explains Viscous force.

a) When a body is immersed completely or partially in a fluid, the fluid exerts an upward force on the body. This force is known as viscous force.

b) The force applied at any point of a liquid at rest in a closed system will be experienced equally at all parts of the liquid and the force is known as viscous force.

c) Due to the mutual attraction of the molecules on the surface of water, the surface is stretched like a membrane. The force responsible for this is called viscous force.

d) Between the layers of a liquid in motion, there is a frictional force parallel to the layers which try to prevent the relative motion between the layers. This force is the viscous force.

2. Which among the following is an example for buoyant force?

a) A hydrogen filled balloon rising in the air.

b) Water flows when placed on a tilted glass plate.

c) Rocket after propulsion moves upward in the air.

d) Ink in the fountain pen reaches the nib.

3. An object of weight W is immersed in a liquid. If the upthrust is equal to $\frac{1}{4}$ th the weight of the object immersed in the liquid, then its weight in the liquid is

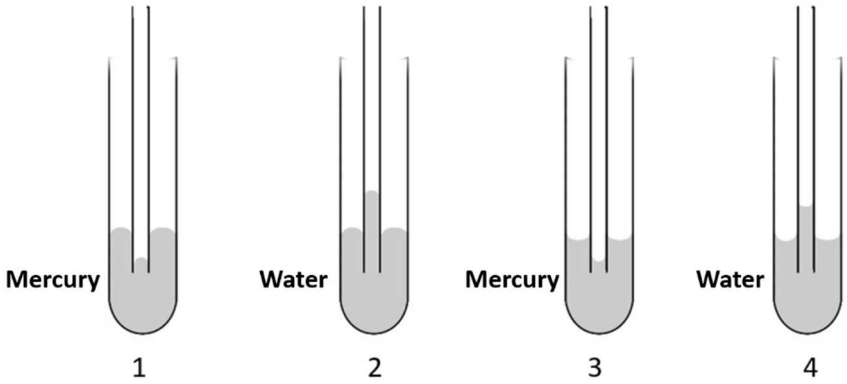
a) $2\,W$

b) $\frac{1}{4}\,W$

c) $\frac{3}{4}\,W$

d) $\frac{1}{2}\,W$

4. Based on the principle of capillarity, select the correct diagram from the following.



a) Only 4 is correct.
b) Both 1 and 4 are correct.
c) Both 2 and 4 are correct.
d) Both 2 and 3 are correct.

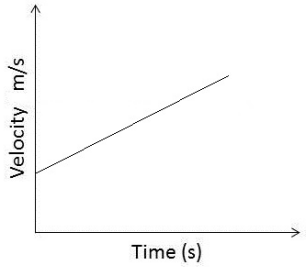
5. There are two liquids A and B whose relative densities are 0.75 and 1.0 respectively. If we dip solid objects P and Q having relative densities 0.6 and 0.9 respectively, in these liquids, then,

a) P floats in A and Q sinks in B.
b) P sinks in A and Q floats in B.
c) P floats in B and Q sinks in A.
d) P sinks in B and Q floats in A.

6. Correct equation of motion is

a) $v = u + at^2$
b) $v = u + at$
c) $v = ut + at^2$
d) $v = u - at$

7. According to the given velocity-time graph, the object



a) Has initial velocity which is not zero
b) Is moving with uniform velocity

c) Has initial velocity which is not zero and later is moving with uniform velocity

d) Is at rest

8. A train starts from rest and moves with uniform acceleration $0.1\,m/s^2$ for 2 minutes. The distance travelled by the train is

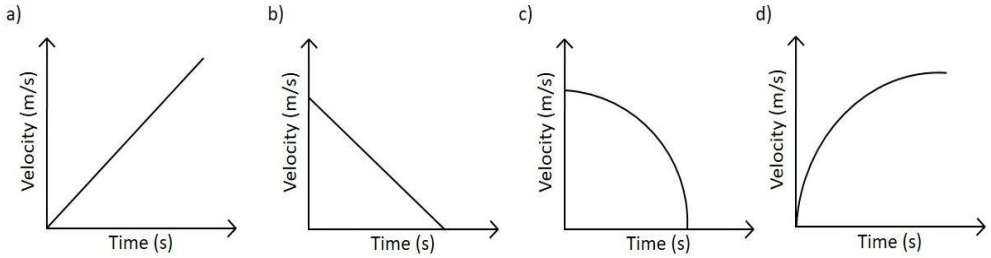
a) 0.05 m

b) 20 m

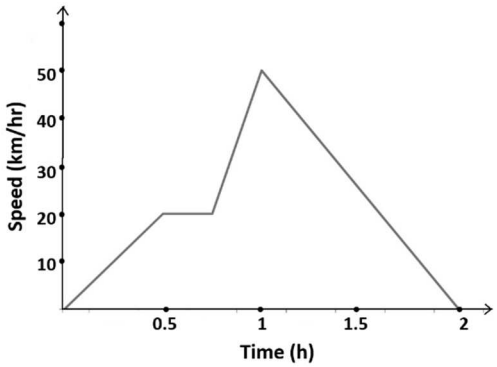
c) 360 m

d) 720 m

9. Select the graph showing the acceleration of a body when thrown vertically upward.



10. A train moves from one station to another in 2 hrs time. Its speed-time graph during the motion is shown in figure. Identify the correct statement regarding the graph.



i. The maximum acceleration during the journey is $120\ km/hr^2$.

ii. The distance covered during the time interval from 0.75 hr to 1 hr is 8.75 km.

iii. From the beginning of the journey to 0.5 hrs, the train moves with constant velocity.

a) Only (i) is correct.
c) Both (i) and (ii) are correct.
b) Only (ii) is correct.
d) All statements are correct.

11. Identify the statement of 'Newton's Second Law of Motion'.

a) The rate of change of momentum of a body is directly proportional to the unbalanced external force acting on it.
b) The sum of momentum of the two objects before collision is equal to the sum of momentum after the collision provided there is no external unbalanced force acting on them.
c) Every object continues in its state of rest or of uniform motion along a straight line unless an unbalanced external force acts on it.
d) The applied forces are said to be balanced forces, if the resultant force on the body is zero and such forces can neither move a body at rest nor stop a body in motion.

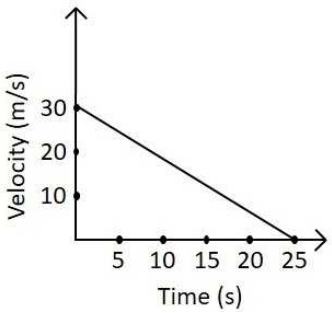
12. Which one of the following is an example for application of 'Newton's First Law of Motion'?

a) When a carpet is beaten with a stick, dust particle comes out.
b) Recoiling of a gun while firing a bullet.
c) Motion of the inflated balloon when it gets deflated and released suddenly.
d) Hay or sponges are used while packing glass wares to avoid breakage.

13. The speed of a car weighing 1500 kg increases from 32 km/hr to 72 km/hr uniformly. The change in momentum of the car is

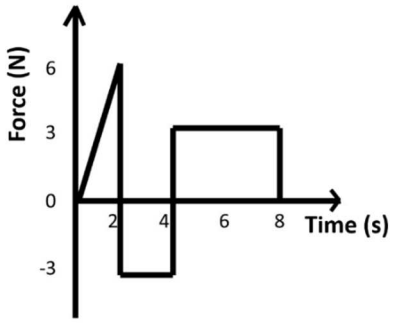
a) 15000 kg km/hr
c) 54000 kg m/s
b) 15000 kg m/s
d) 54000 g m/s

14. Velocity-time graph of a body of 50 kg rolling on a floor is given below. The force acting on the body is



a) 5 N
b) 25 N
c) 30 N
d) 60 N

15. The force F acting on a particle of mass m is indicated by the force-time graph shown below. Identify the correct statement.



i. Change in momentum of the particle over the time interval from 0 to 4s is same as that between 4s to 8s.
ii. Change in momentum of the particle over the time-interval from 0 to 2s and that between 2s to 4s is same in magnitude.
iii. Change in momentum of the particle over the time interval from zero to 8s is 12 N.

a) Statements (i) and (ii) are correct.
b) Statements (i) and (iii) are correct.
c) Statements (ii) and (iii) are correct.
d) All statements are correct.

16. The Universal Law of Gravitation gives the gravitational force between

a) The earth and any mass only
b) The earth and sun only
c) Any two charged bodies
d) Any two bodies having mass

17. Two rubber balls of the same size are dropped on the earth and on the moon. One ball is solid and other is hollow. The gravitational acceleration on the earth is 10 m/s^2 and on the moon is 1.7 m/s^2. Which ball has greater force acting on it?

	Type of ball	**Where it is dropped**
a)	Hollow	On the moon
b)	Hollow	On the earth
c)	Solid	On the moon
d)	Solid	On the earth

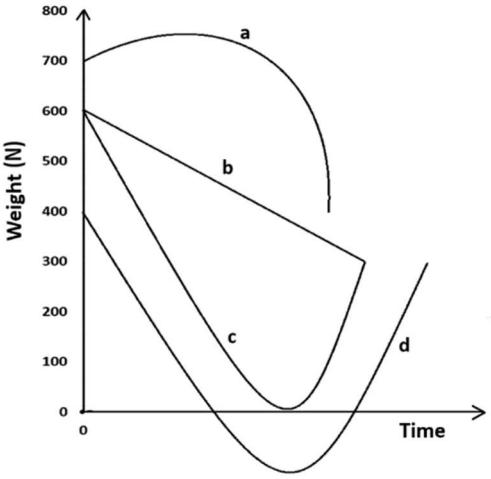
18. The mass of an object is 135 kg, then its weight on earth will be

a) 135 N
b) 1224 N
c) 1323 N
d) 1413 N

19. A body, the mass and the weight of which were already determined at the equator, is now placed at the pole. Choose the correct statement from the following.

a) Mass does not change, weight is maximum.
b) Mass does not change, weight is minimum.
c) Both mass and weight are maximum.
d) Both mass and weight are minimum.

20. Suppose the acceleration due to gravity at the earth's surface is 10 $m/s^2$and at the surface of Mars is 4 m/s^2. A passenger having weight 60 kg goes from the Earth to the Mars in a spaceship moving with a constant velocity. Neglect all other objects in the sky. Which part of the figure represents the weight of the passenger with respect to time?



21. Select the correct statement.

a) Amount of energy per unit time is the amount of work.
b) Work-energy principle states that work done is equal to change in potential energy.
c) Work is said to be done only when a body undergoes displacement in the direction of applied force.
d) Power is the ratio of work done to the displacement.

22. In the case of negative work, the angle between the force and displacement is

a) 180^0 c) 45^0

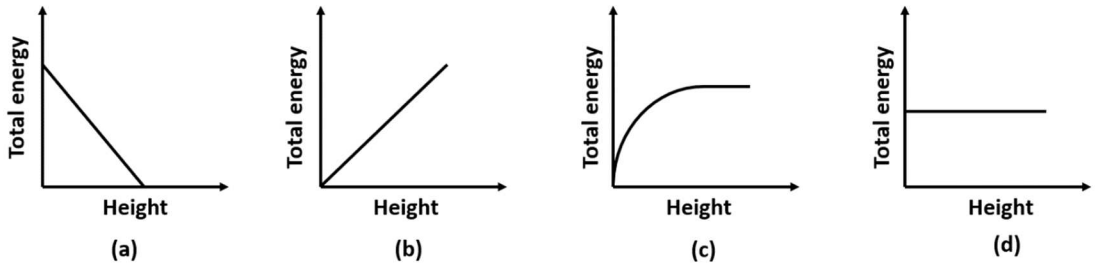
b) 90^0 d) 0^0

23. A car is accelerated on a levelled road and attains a velocity of four times of its initial velocity, In this process, the potential energy of the car

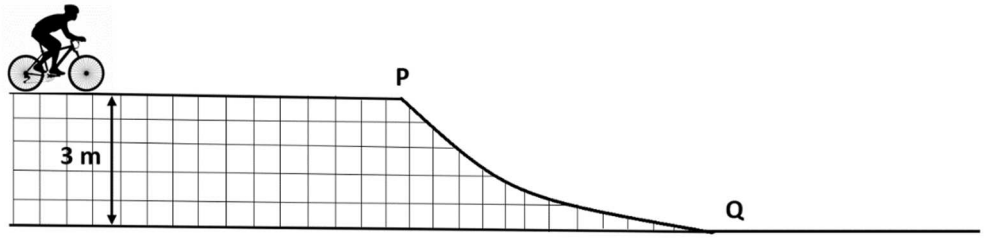
a) Does not change c) Becomes four times that of initial

b) Becomes twice to that of initial d) Becomes 16 times that of initial

24. The graph of the total energy of a freely falling body from a height is



25. The diagram shows a cyclist moving down a small hill at P before travelling on a flat road after point Q. The total mass of the cyclist and his bicycle is 60 kg and the speed of the cyclist at P is 10 m/s. Select the correct statement. (Take g=10 m / s^2)



i. The kinetic energy at P is 3000 J

ii. The loss of potential energy between P and Q is 3000 J.

iii. The total energy is 6000 J.

iv. The cyclist requires a greater power when he travels at a higher constant speed.

a) Both (i) and (ii) are correct. c) Both (ii) and (iii) are correct.

b) Both (i) and (iv) are correct. d) Only (i) is correct.

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APPENDIX 7

RESPONSE SHEET(DRAFT)
CONCEPTUAL UNDERSTANDING TEST IN PHYSICS

GENERAL DATA

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term and second term examination of IX standard:

ANSWERS

1. ⓐ ⓑ ⓒ ⓓ	11. ⓐ ⓑ ⓒ ⓓ	21. ⓐ ⓑ ⓒ ⓓ
2. ⓐ ⓑ ⓒ ⓓ	12. ⓐ ⓑ ⓒ ⓓ	22. ⓐ ⓑ ⓒ ⓓ
3. ⓐ ⓑ ⓒ ⓓ	13. ⓐ ⓑ ⓒ ⓓ	23. ⓐ ⓑ ⓒ ⓓ
4. ⓐ ⓑ ⓒ ⓓ	14. ⓐ ⓑ ⓒ ⓓ	24. ⓐ ⓑ ⓒ ⓓ
5. ⓐ ⓑ ⓒ ⓓ	15. ⓐ ⓑ ⓒ ⓓ	25. ⓐ ⓑ ⓒ ⓓ
6. ⓐ ⓑ ⓒ ⓓ	16. ⓐ ⓑ ⓒ ⓓ	
7. ⓐ ⓑ ⓒ ⓓ	17. ⓐ ⓑ ⓒ ⓓ	
8. ⓐ ⓑ ⓒ ⓓ	18. ⓐ ⓑ ⓒ ⓓ	
9. ⓐ ⓑ ⓒ ⓓ	19. ⓐ ⓑ ⓒ ⓓ	
10. ⓐ ⓑ ⓒ ⓓ	20. ⓐ ⓑ ⓒ ⓓ	

APPENDIX 8

SCORING KEY (DRAFT)
CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-A)

No.	a	b	c	d
1.		✓		
2.				✓
3.			✓	
4.	✓			
5.				✓
6.				✓
7.		✓		
8.	✓			
9.	✓			
10.			✓	
11.			✓	
12.				✓
13.	✓			
14.		✓		
15.		✓		
16.		✓		
17.			✓	
18.			✓	
19.	✓			
20.				✓
21.			✓	
22.				✓
23.				✓
24.	✓			
25.		✓		

APPENDIX 9

SCORING KEY (DRAFT)
CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-B)

No.	a	b	c	d
1.	✓			
2.			✓	
3.		✓		
4.	✓			
5.				✓
6.			✓	
7.		✓		
8.			✓	
9.	✓			
10.				✓
11.			✓	
12.				✓
13.				✓
14.	✓			
15.		✓		
16.		✓		
17.			✓	
18.		✓		
19.	✓			
20.				✓
21.		✓		
22.			✓	
23.			✓	
24.	✓			
25.				✓

APPENDIX 10

SCORING KEY (DRAFT)
CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-C)

No.	a	b	c	d
1.				✓
2.	✓			
3.			✓	
4.		✓		
5.			✓	
6.		✓		
7.	✓			
8.				✓
9.		✓		
10.			✓	
11.	✓			
12.	✓			
13.		✓		
14.				✓
15.			✓	
16.				✓
17.				✓
18.		✓		
19.	✓			
20.			✓	
21.			✓	
22.	✓			
23.	✓			
24.				✓
25.		✓		

APPENDIX 11

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-A)
(FINAL – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

പൊതുവായ നിർദ്ദേശങ്ങൾ :

ഈ ടെസ്റ്റിന് മൂന്ന് ഭാഗങ്ങളാണുള്ളത്: Section A (കുട്ടികളുടെ പൊതുവിവരങ്ങൾ), Section B (ഭൗതികശാസ്ത്രത്തിലെ ആശയങ്ങളുടെ റാങ്കിങ്), Section C (ആശയധാരണ മനസ്സിലാക്കുന്നതിനുള്ള ടെസ്റ്റ്). ഓരോ ഭാഗങ്ങൾക്ക് താഴെ അതത് നിർദ്ദേശങ്ങൾ നൽകിയിട്ടുണ്ട്. നിങ്ങളുടെ പ്രതികരണങ്ങൾ ഗവേഷണാവശ്യത്തിന് മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

……

SECTION A

നിർദ്ദേശങ്ങൾ : വ്യക്തിപരമായ വിവരങ്ങൾ താഴെ എഴുതുക.

വിദ്യാർത്ഥിയുടെ പേര് :

ലിംഗം : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂളിന്റെ പേര് :

ഒമ്പതാം ക്ലാസ്സിൽ ഭൗതികശാസ്ത്രത്തിൽ ഒന്നാം പാദവാർഷിക പരീക്ഷക്ക് ലഭിച്ച മാർക്ക് :

ഒമ്പതാം ക്ലാസ്സിൽ ഭൗതികശാസ്ത്രത്തിൽ രണ്ടാം പാദവാർഷിക പരീക്ഷക്ക് ലഭിച്ച മാർക്ക് :

……

SECTION B

നിർദ്ദേശങ്ങൾ: ഒമ്പതാം ക്ലാസ്സിലെ പാഠപുസ്തകത്തിലെ ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട ചില ആശയങ്ങളാണ് താഴെ തന്നിരിക്കുന്നത്. അവയുടെ കാഠിന്യമനുസരിച്ച് റാങ്ക് രേഖപ്പെടുത്തണം. ഏറ്റവും ബുദ്ധിമുട്ടുള്ള ആശയത്തിന് നേരെ റാങ്ക് '1' എന്നും അതിനേക്കാൾ കാഠിന്യം കുറഞ്ഞ ആശയത്തിന് നേരെ '2', എന്നിങ്ങനെ കാഠിന്യ നിലവാരം കുറയുന്നതിനനുസരിച്ച രീതിയിലാണ് റാങ്ക് രേഖപ്പെടുത്തേണ്ടത്.

No.	ഭൗതികശാസ്ത്രത്തിലെ ആശയങ്ങൾ	റാങ്ക്
1.	ദ്രവബലങ്ങൾ	
2.	ചലനസമവാക്യങ്ങൾ	
3.	ചലനവും ചലനനിയമങ്ങളും	
4.	ഗുരുത്വാകർഷണം	
5.	പ്രവൃത്തി, ഊർജം, പവർ	

.....

SECTION C

ഒമ്പതാം ക്ലാസിലെ വിദ്യാർത്ഥികളുടെ ആശയധാരണകളെ അളക്കാനുള്ള 25 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് ഈ Section നിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. എല്ലാ ചോദ്യത്തിനും ഉത്തരം തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d) എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

Maximum Marks: 25

Time: 60 minutes

1. പ്ലവക്ഷമബലത്തെ വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

a) ഒരു വസ്തു ദ്രവത്തിൽ പൂർണമായി മുങ്ങിയിരിക്കുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ താഴേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് പ്ലവക്ഷമബലം.

b) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ മുകളിലേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് പ്ലവക്ഷമബലം.

c) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായി മുങ്ങിയിരിക്കുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ മുകളിലേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് പ്ലവക്ഷമബലം.

d) ഒരു വസ്തു ദ്രവത്തിൽ താഴോട്ട് മുങ്ങുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ താഴേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് പ്ലവക്ഷമബലം.

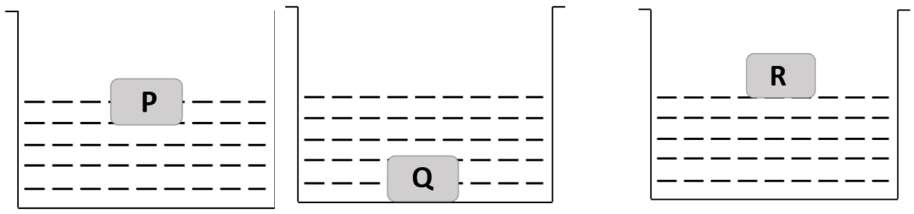
2. താഴെ കൊടുത്തിരിക്കുന്നവയിൽ ആർക്കമെഡീസ് തത്ത്വം ആസ്പദമാക്കി പ്രവർത്തിക്കുന്ന ഉപകരണം ഏത് ?

a) ഹൈഡ്രോളിക് ലിഫ്റ്റ്
b) ഹൈഡ്രോളിക് പമ്പ്
c) കേശികക്കുഴൽ
d) ഹൈഡ്രോമീറ്റർ

3. ഒരു ഹൈഡ്രോളിക് ജാക്കിന്റെ പിസ്റ്റണുകളുടെ വ്യാസം 1.5 cm ഉം 15 cm ഉം ആണ്. എങ്കിലുപയോഗിച്ച് 1000 kg ഉയർത്താൻ ആവശ്യമായ ബലമെത്ര?

a) 1000 N
b) 100 N
c) 10 N
d) 50 N

4. ഒരേ ദ്രാവകത്തിൽ മുങ്ങിക്കിടക്കുന്ന വ്യത്യസ്ത സാന്ദ്രതയുള്ള മൂന്ന് വസ്തുക്കളാണ് P ഉം Q ഉം R ഉം (ചിത്രം കാണുക). വസ്തുക്കളുടെ സാന്ദ്രതയുടെ അവരോഹണ ക്രമീകരണം ഏത്?



a) Q, P, R
b) P, Q, R
c) R, P, Q
d) Q, R, P

5. പ്ലവനത്തെ ആസ്പദമാക്കി ശരിയായ പ്രസ്താവന ഏത് ?

i. 500 N ഭാരമുള്ള ഒരു വസ്തു വെള്ളത്തിൽ മുങ്ങിക്കിടക്കുന്നു. ആ വസ്തു ആദേശം ചെയ്ത വെള്ളത്തിന്റെ ഭാരം 50 N ആണെങ്കിൽ, വെള്ളത്തിൽ വസ്തുവിന്റെ ഭാരം 400 N ആണ്.

ii. 500 N ഭാരമുള്ള ഒരു വസ്തു വെള്ളത്തിൽ പൊങ്ങിക്കിടക്കുകയാണെങ്കിൽ, ആ വസ്തുവിന്റെ വെള്ളത്തിലുള്ള ഭാരം 0 N ഉം ആ വസ്തു ആദേശം ചെയ്യുന്ന വെള്ളത്തിന്റെ ഭാരം 500 N ഉം ആണ്.

iii. 750 N ഭാരമുള്ള ഒരു വസ്തു വെള്ളത്തിൽ മുങ്ങിക്കിടക്കുന്നു. ആ വസ്തു ആദേശം ചെയ്ത വെള്ളത്തിന്റെ ഭാരം 150 N ആണെങ്കിൽ, വെള്ളത്തിൽ വസ്തുവിന്റെ ഭാരം 600 N ആണ്.

iv. 750 N ഭാരമുള്ള ഒരു വസ്തു വെള്ളത്തിൽ പൊങ്ങിക്കിടക്കുകയാണെങ്കിൽ, ആ വസ്തുവിന്റെ വെള്ളത്തിലുള്ള ഭാരം 550 N ഉം ആ വസ്തു ആദേശം ചെയ്യുന്ന വെള്ളത്തിന്റെ ഭാരം 200 N ഉം ആണ്.

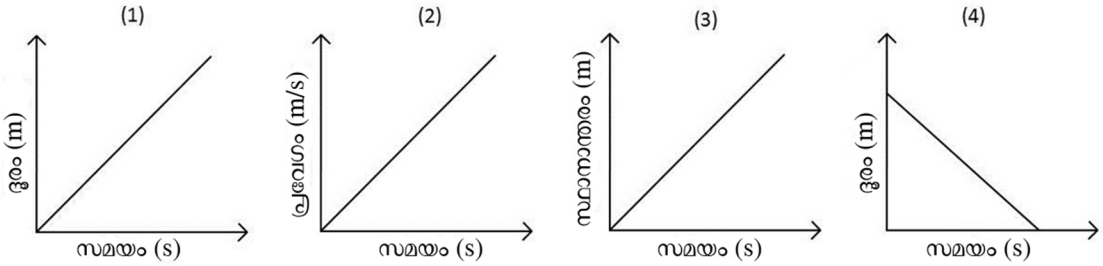
a) (i) ഉം (ii) ഉം ശരിയാണ്.
b) (iii) ഉം (iv) ഉം ശരിയാണ്.
c) (i) ഉം (iv) ഉം ശരിയാണ്.
d) (ii) ഉം (iii) ഉം ശരിയാണ്.

6. ശരിയായ ചലനസമവാക്യം ഏത്?

a) $v^2 = u^2 + 2as^2$ c) $u^2 = v^2 + 2as$

b) $v^2 = u^2 - 2as^2$ d) $v^2 = u^2 + 2as$

7. സമത്വരണം സൂചിപ്പിക്കുന്ന ചിത്രം കണ്ടെത്തുക.



a) (1) മാത്രം c) (2) ഉം (3) ഉം

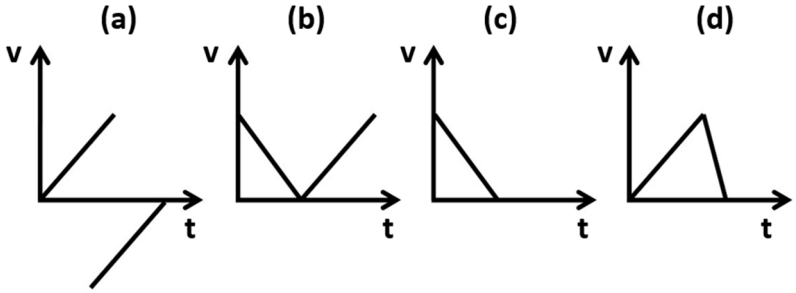
b) (2) മാത്രം d) (1) ഉം (4) ഉം

8. 10 മിനിറ്റിൽ തീവണ്ടിയുടെ പ്രവേഗം 80 m/s ഇൽ നിന്നും 20 m/s ആയി മാറുന്നുവെങ്കിൽ അതിന്റെ മന്ദീകരണം എത്ര?

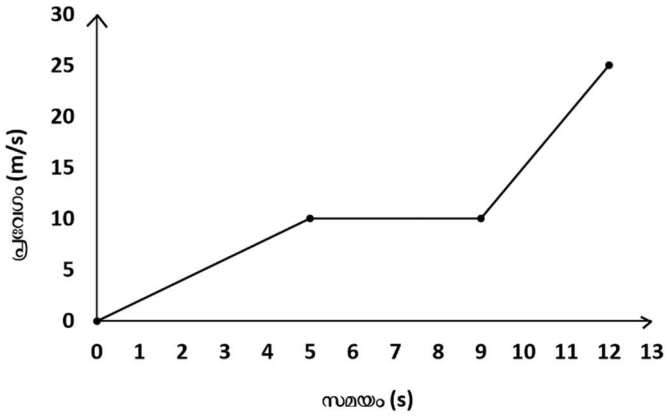
a) $0.1\ m/s^2$ c) $6\ m/s^2$

b) $1\ m/s^2$ d) $10\ m/s^2$

9. നിർബാധം പതിക്കുന്ന വസ്തു ഒരു പ്രതലത്തിൽ തട്ടി മുകളിലേക്ക് പൊങ്ങുന്നു. താഴോട്ട് വീഴുമ്പോഴും മുകളിലേക്ക് പൊങ്ങുമ്പോഴും വസ്തുവിന്റെ സമയാനുസൃതമായ പ്രവേഗം ശരിയായി കാണിച്ചിരിക്കുന്നത് ഏത് ഗ്രാഫിലാണ് ?



10. ഒരു കളിപ്പാട്ടക്കാർ ഒരു സ്ഥലത്ത് നിന്നും മറ്റൊരു സ്ഥലത്തേക്ക് 12 s കൊണ്ട് ചലിക്കുന്നു. ഈ ചലനത്തിന്റെ പ്രവേഗ-സമയ ഗ്രാഫ് ആണ് തന്നിരിക്കുന്നത്. ഗ്രാഫിനെ കുറിച്ച് തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത് ?



i. കാറിന്റെ ചലനത്തിലെ ഏറ്റവും ഉയർന്ന ത്വരണം 5 m/s^2 ആണ്.

ii. 9 s ഇനും 12 s നും ഇടയിൽ സഞ്ചരിച്ച ദൂരം 52.5 m ആണ്.

iii. കാറിന്റെ ചലനത്തിലെ ഏറ്റവും കുറഞ്ഞ ത്വരണം 2 m/s^2 ആണ്.

a) (i) മാത്രം ശരിയാണ്.
b) (ii) മാത്രം ശരിയാണ്.
c) (i) ഉം (ii) ഉം ശരിയാണ്.
d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

11. 'ന്യൂട്ടന്റെ മൂന്നാം ചലന നിയമം വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത്?

a) ഒരു വസ്തുവിനുണ്ടാകുന്ന ആക്കവ്യത്യാസത്തിന്റെ നിരക്ക് ആ വസ്തുവിൽ പ്രയോഗിക്കുന്ന അസന്തുലിത ബാഹ്യബലത്തിന് നേർ അനുപാതത്തിലായിരിക്കും.

b) അസന്തുലിതമായ ബാഹ്യബലം അനുഭവപ്പെടുന്നത് വരെ ഓരോ വസ്തുവും അതിന്റെ നിശ്ചലാവസ്ഥയിലോ നേർരേഖാ സമചലനത്തിലോ തുടരുന്നതാണ്.

c) ഏതൊരു പ്രവർത്തനത്തിനും തുല്യവും വിപരീതവുമായ ഒരു പ്രതി പ്രവർത്തനമുണ്ടായിരിക്കും.

d) ഒരു വസ്തുവിൽ അനുഭവപ്പെടുന്ന പരിണതബലം പൂജ്യമെങ്കിൽ പ്രയോഗിക്കപ്പെട്ട ബലങ്ങളെ സന്തുലിത ബലങ്ങൾ എന്ന് പറയുന്നു. ഇത്തരം ബലങ്ങൾക്ക്

നിശ്ചലാവസ്ഥയിലുള്ള വസ്തുക്കളെ ചലിപ്പിക്കാനോ ചലിക്കുന്ന വസ്തുക്കളെ നിശ്ചലമാക്കാനോ കഴിയില്ല.

12. ന്യൂട്ടന്റെ രണ്ടാം ചലനനിയമം പ്രയോജനപ്പെടുത്തുന്ന സന്ദർഭം താഴെ കൊടുത്തിരിക്കുന്നവയിൽ ഏത് ?

a) ഒരു വിരിപ്പിന് മേൽ വടി കൊണ്ട് അടിക്കുമ്പോൾ അതിലെ പൊടിപടലങ്ങൾ പുറത്തേക്ക് തെറിക്കുന്നു.

b) വെടിയുതിർക്കുമ്പോൾ ബുള്ളറ്റ് പോകുന്ന ദിശക്ക് എതിരെ തോക്ക് ചലിക്കുന്നു.

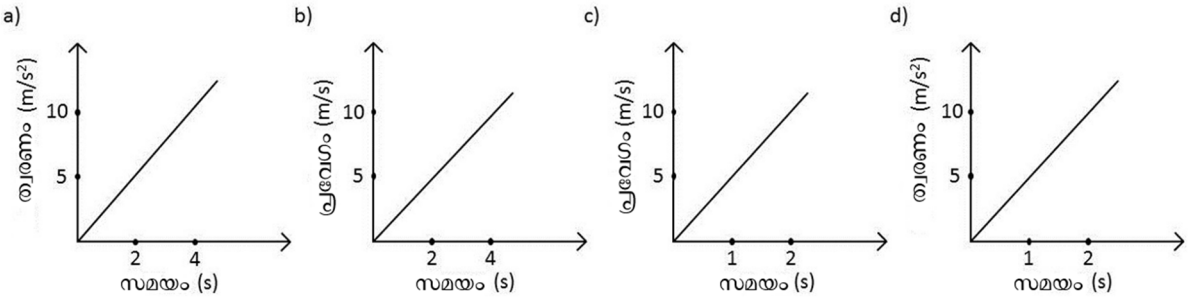
c) കാറ്റഴിച്ചു വിടുമ്പോൾ ബലൂണിന്റെ ചലനം.

d) ഗ്ലാസ് പാത്രങ്ങൾ അടുക്കിവെച്ച പാക്കറ്റുകളിൽ സ്പോഞ്ച്, വൈക്കോൽ എന്നിവ നിറക്കുന്നത് പാത്രങ്ങൾ തമ്മിൽ കൂട്ടിമുട്ടി പൊട്ടുന്നത് ഒഴിവാക്കാൻ സഹായിക്കുന്നു.

13. ഒരു ഘർഷണരഹിതമായ മേശയുടെ മുകളിൽ സ്പർശിച്ചുകൊണ്ട് 4 m/s സമപ്രവേഗത്തിൽ 2 kg മാസുള്ള ഒരു വസ്തു നിരങ്ങി നീങ്ങുന്നു. അതേ പ്രവേഗത്തിൽ വസ്തു ചലനം തുടരാൻ ആവശ്യമായ ബലമെത്ര ?

a) 0 N
b) 2 N
c) 6 N
d) 8 N

14. 4 kg മാസുള്ള വസ്തുവിന്റെ മേൽ പ്രവർത്തിക്കുന്ന ബലം 10 N ആണെങ്കിൽ, അതിന്റെ ചലനം കാണിക്കുന്ന ഗ്രാഫ് ഏത്?



15. ചലിച്ചുകൊണ്ടിരിക്കുന്ന ഒരു വസ്തുവിന്റെ ദൂര-സമയ പട്ടികയാണ് താഴെ തന്നിരിക്കുന്നത്.

സമയം (സെക്കൻഡ്)	ദൂരം (മീറ്റർ)
0	0
1	1
2	8
3	27
4	64
5	125

വസ്തുവിന് അനുഭവപ്പെടുന്ന ബലങ്ങളെ കുറിച്ച് നിങ്ങളുടെ അനുമാനമെന്ത്?

a) ബലത്തിന്റെ അളവിൽ മാറ്റമില്ല.

b) സമയാനുസൃതമായി ബലം സമമായി വർധിച്ചു കൊണ്ടിരിക്കുന്നു.

c) സമയാനുസൃതമായി ബലം സമമായി കുറഞ്ഞു കൊണ്ടിരിക്കുന്നു.

d) ബലം പൂജ്യമാണ്.

16. താഴെ തന്നിരിക്കുന്നവയിൽ സാർവികഗുരുത്വാകർഷണനിയമം ഏത് ?

a) ഭൂമി എല്ലാ വസ്തുക്കളെയും അതിന്റെ കേന്ദ്രത്തിലേക്കാകർഷിക്കുന്നു. ഭൂമിയിലുള്ള വസ്തുക്കളെ സംബന്ധിച്ചിടത്തോളം അതിന്റെ നില നിവർന്നതോ തലകീഴായതോ എന്ന് തീരുമാനിക്കുന്നത് ഭൂഗുരുത്വബലത്തിന്റെ ദിശയെ അടിസ്ഥാനമാക്കിയാണ്.

b) പ്രപഞ്ചത്തിലുള്ള എല്ലാ വസ്തുക്കളും പരസ്പരം ആകർഷിക്കുന്നു. രണ്ട് വസ്തുക്കൾ തമ്മിലുള്ള പരസ്പരാകർഷണബലം അവയുടെ മാസുകളുടെ ഗുണനഫലത്തിന് നേർ അനുപാതത്തിലും അവ തമ്മിലുള്ള അകലത്തിന്റെ വർഗത്തിന് വിപരീതാനുപാതത്തിലുമായിരിക്കും.

c) രണ്ട് ഗ്രഹങ്ങൾ തമ്മിലുള്ള പരസ്പരാകർഷണബലം അവക്കിടയിലുള്ള ശരാശരി ദൂരത്തിന്റെ കൃബിന് നേർ അനുപാതത്തിലും അവയുടെ പരിക്രമണപ്രവേഗങ്ങളുടെ ഗുണനഫലത്തിന് വിപരീതാനുപാതത്തിലുമായിരിക്കും.

d) ഒരു യൂണിറ്റ് ദൂരത്തിൽ അകൽച്ചയിലിരിക്കുന്ന രണ്ട് യൂണിറ്റ് മാസുകൾക്കിടയിലുള്ള പരസ്പരാകർഷണബലം അവയെ ത്വരിതപ്പെടുത്തുന്നു. ഈ ത്വരണത്തെ ഭൂഗുരുത്വത്വരണം എന്ന് പറയുന്നു.

17. 1 kg മാസുള്ള ഒരു വസ്തു ഭൂമിയിലേക്ക് ആകർഷിക്കപ്പെടുമ്പോൾ ഉണ്ടാകുന്ന ബലം

a) 6.67×10^{11} N
b) 100 N
c) 9.8 N
d) 1 N

18. ഒരു വസ്തുവിന്റെ മാസ് 88 kg ആണെങ്കിൽ ചന്ദ്രനിൽ അതിന്റെ ഭാരമെത്ര?

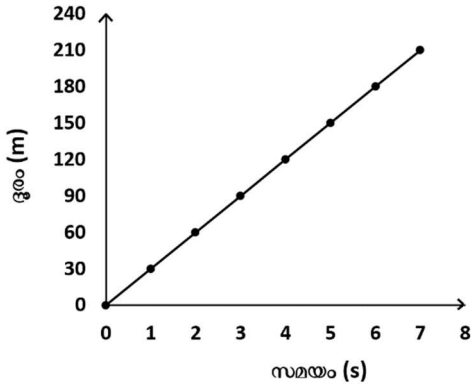
a) 88 N
b) 132.33 N
c) 143.73 N
d) 212.33 N

19. ഭൂഗുരുത്വത്വരണം 'g' യെ കുറിച്ച് താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത് ?

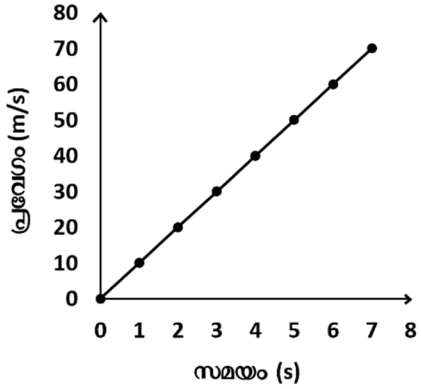
a) ഭൂമിയുടെ ഉപരിതലത്തിൽ നിന്ന് ഭൂമിയുടെ കേന്ദ്രത്തിലേക്ക് നീങ്ങുമ്പോൾ g യുടെ മൂല്യം കുറയുന്നു.
b) ഭൂമിയുടെ ഉപരിതലത്തിൽ നിന്ന് മുകളിലേക്ക് പോകുമ്പോൾ g യുടെ മൂല്യം കൂടുന്നു.
c) 'g' യുടെ മൂല്യം ധ്രുവ പ്രദേശത്ത് നിന്ന് ഭൂമധ്യരേഖ പ്രദേശത്തേക്ക് പോകുമ്പോൾ കൂടുന്നു.
d) ഭൂമിയിൽ 'g' യുടെ മൂല്യം വസ്തുവിന്റെ മാസിനെ ആശ്രയിക്കുന്നു.

20. 245 m പൊക്കമുള്ള ഒരു ടവറിന് മുകളിൽ മനു ഒരു സ്റ്റോപ്പ് വാച്ചും പിടിച്ച് നിൽക്കുന്നു. അവൻ മുകളിൽ നിന്ന് ഒരു കല്ല് താഴോട്ടിടുന്നു. താഴെ തന്നിരിക്കുന്നവയിൽ ശരിയായ പ്രസ്താവന ഏത്?

i. കല്ല് നിലത്ത് തൊടുമ്പോൾ സ്റ്റോപ്പ് വാച്ചിലെ റീഡിങ് 6 s ആയിരിക്കും.
ii. കല്ല് നിലത്ത് തൊടുമ്പോൾ അതിന്റെ അന്ത്യപ്രവേഗം 70 m/s ആയിരിക്കും.
iii. കല്ലിന്റെ ദൂര-സമയ ഗ്രാഫ്



iv. കല്ലിന്റെ പ്രവേഗ-സമയ ഗ്രാഫ്



a) (i) ഉം (ii) ഉം ശരിയാണ്.
b) (i) ഉം (iv) ഉം ശരിയാണ്.
c) (ii) ഉം (iii) ഉം ശരിയാണ്.
d) (ii) ഉം (iv) ഉം ശരിയാണ്.

21. ശരിയായ പ്രസ്താവന ഏത്?

a) ഒരു വസ്തുവിന്മേൽ പ്രയോഗിച്ച ബലത്തിന്റെ ദിശക്ക് ലംബമായി സ്ഥാനാന്തരം ഉണ്ടാകുമ്പോൾ മാത്രമാണ് പ്രവൃത്തി ചെയ്തതായി കണക്കാക്കുകയുള്ളൂ.
b) സ്ഥിതികോർജത്തിൽ ഉണ്ടായ മാറ്റത്തിന് തുല്യമാണ് പ്രവൃത്തി എന്നതാണ് പ്രവൃത്തി-ഊർജതത്ത്വം.
c) ഒരു വസ്തുവിൽ സ്ഥാനം കൊണ്ട് ലഭ്യമാകുന്ന ഊർജമാണ് സ്ഥിതികോർജം.
d) പ്രവൃത്തിയുടെയും സ്ഥാനാന്തരത്തിന്റെയും ഹരണഫലമാണ് പവർ.

22. ഭൂമിയിലേക്ക് വീണുകൊണ്ടിരിക്കെ ഒരു വസ്തുവിന്റെ മൊത്തം ഊർജം

a) കൂടുന്നു
b) കുറയുന്നു
c) ആദ്യം കൂടുന്നു, പിന്നെ കുറയുന്നു
d) മാറ്റമില്ല

23. ഒരു പെൺകുട്ടി 3 kg മാസ്സുള്ള സ്കൂൾ ബാഗ് ചുമലിലിട്ടു ഒരു നിരപ്പായിട്ടുള്ള റോഡിലൂടെ 200 m നടന്നുനീങ്ങി. ഗുരുത്വാകർഷണബലത്തിനെതിരായി ചെയ്ത പ്രവൃത്തിയുടെ അളവെത്ര? ($g = 10\ m\ /\ s^2$)

a) 6×10^3 J
b) 6 J
c) 0.6 J
d) 0 J

24. നെഗറ്റീവ് പ്രവൃത്തിയുള്ള സന്ദർഭമേത്?

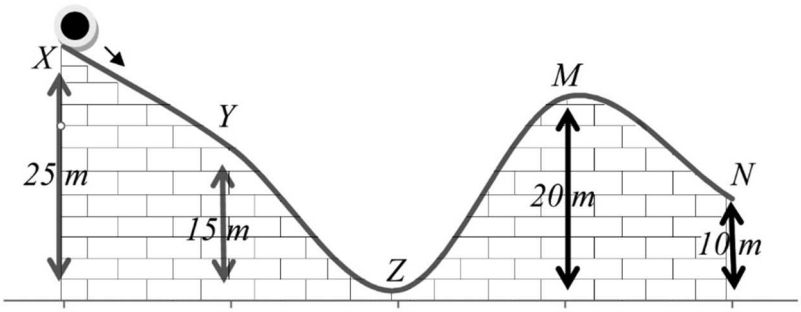
a) ചരിഞ്ഞ പ്രതലത്തിലൂടെ ഒരു വസ്തു താഴോട്ട് നിരങ്ങി വീഴുമ്പോൾ ഘർഷണബലം ചെയ്ത പ്രവൃത്തി.

b) കപ്പി ഇല്ലാതെ കയർ മാത്രം ഉപയോഗിച്ച് കിണറ്റിൽ നിന്നും വെള്ളം കോരുന്നയാൾ ചെയ്ത പ്രവൃത്തി.

c) ഒരു റബ്ബർ ബാൻഡ് നീട്ടി വലിക്കുമ്പോൾ ബലം ചെയ്ത പ്രവൃത്തി.

d) ഒരു മാവിൽ തൂങ്ങിക്കിടക്കുന്ന മാങ്ങയുടെ മേൽ ഗുരുത്വാകർഷണബലം ചെയ്ത പ്രവൃത്തി.

25. ഒരു ഘർഷണരഹിത ട്രാക്കിന്റെ ചിത്രമാണ് താഴെ തന്നിരിക്കുന്നത്. ഭാരമുള്ള ഒരു പന്ത് X എന്ന ബിന്ദുവിൽ നിന്ന് മോചിപ്പിച്ചാൽ, താഴെ തന്ന പ്രസ്താവനകളിൽ ശരിയേത് ?



i. Y എന്ന ബിന്ദുവിൽ പന്ത് കൂടുതൽ വേഗതയിൽ സഞ്ചരിക്കും.

ii. M എന്ന ബിന്ദുവിൽ പന്തിന്റെ വേഗത $10\ m\ /\ s$ ആയിരിക്കും.

iii. X എന്ന ബിന്ദുവിനും Y എന്ന ബിന്ദുവിനും ഇടക്ക് സ്ഥിതികോർജത്തിലുള്ള വ്യത്യാസം 5 J ആയിരിക്കും.

a) (i) മാത്രം ശരിയാണ്.
b) (ii) മാത്രം ശരിയാണ്.
c) (i) ഉം (ii)ഉം ശരിയാണ്.
d) (ii) ഉം (iii)ഉം ശരിയാണ്.

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APPENDIX 12

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-B)
(FINAL – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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പൊതുവായ നിർദ്ദേശങ്ങൾ :

ഈ ടെസ്റ്റിന് മൂന്ന് ഭാഗങ്ങളാണുള്ളത്: Section A (കുട്ടികളുടെ പൊതുവിവരങ്ങൾ), Section B (ഭൗതികശാസ്ത്രത്തിലെ ആശയങ്ങളുടെ റാങ്കിങ്), Section C (ആശയധാരണ മനസ്സിലാക്കുന്നതിനുള്ള ടെസ്റ്റ്). ഓരോ ഭാഗങ്ങൾക്ക് താഴെ അതത് നിർദ്ദേശങ്ങൾ നൽകിയിട്ടുണ്ട്. നിങ്ങളുടെ പ്രതികരണങ്ങൾ ഗവേഷണാവശ്യത്തിന് മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

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SECTION A

നിർദ്ദേശങ്ങൾ : വ്യക്തിപരമായ വിവരങ്ങൾ താഴെ എഴുതുക.

വിദ്യാർത്ഥിയുടെ പേര് :

ലിംഗം : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂളിന്റെ പേര് :

ഒമ്പതാം ക്ലാസ്സിൽ ഭൗതികശാസ്ത്രത്തിൽ ഒന്നാം പാദവാർഷിക പരീക്ഷക്ക് ലഭിച്ച മാർക്ക് :

ഒമ്പതാം ക്ലാസ്സിൽ ഭൗതികശാസ്ത്രത്തിൽ രണ്ടാം പാദവാർഷിക പരീക്ഷക്ക് ലഭിച്ച മാർക്ക് :

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SECTION B

നിർദ്ദേശങ്ങൾ: ഒമ്പതാം ക്ലാസ്സിലെ പാഠപുസ്തകത്തിലെ ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട ചില ആശയങ്ങളാണ് താഴെ തന്നിരിക്കുന്നത്. അവയുടെ കാഠിന്യമനുസരിച്ച് റാങ്ക് രേഖപ്പെടുത്തണം. ഏറ്റവും ബുദ്ധിമുട്ടുള്ള ആശയത്തിന് നേരെ റാങ്ക് '1' എന്നും അതിനേക്കാൾ കാഠിന്യം കുറഞ്ഞ ആശയത്തിന് നേരെ '2', എന്നിങ്ങനെ കാഠിന്യ നിലവാരം കുറയുന്നതിനനുസരിച്ച രീതിയിലാണ് റാങ്ക് രേഖപ്പെടുത്തേണ്ടത്.

No.	ഭൗതികശാസ്ത്രത്തിലെ ആശയങ്ങൾ	റാങ്ക്
1.	ദ്രവബലങ്ങൾ	
2.	ചലനസമവാക്യങ്ങൾ	
3.	ചലനവും ചലനനിയമങ്ങളും	
4.	ഗുരുത്വാകർഷണം	
5.	പ്രവൃത്തി, ഊർജം, പവർ	

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SECTION C

ഒമ്പതാം ക്ലാസിലെ വിദ്യാർത്ഥികളുടെ ആശയധാരണകളെ അളക്കാനുള്ള 25 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് ഈ Section നിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. എല്ലാ ചോദ്യത്തിനും ഉത്തരം തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d) എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

Maximum Marks: 25

Time: 60 minutes

1. ആർക്കമെഡീസ് തത്ത്വത്തെ വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

   a) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ അതിൽ അനുഭവപ്പെടുന്ന പ്ലവക്ഷമബലം വസ്തു ആദേശം ചെയ്യുന്ന ദ്രവത്തിന്റെ ഭാരത്തിന് തുല്യമായിരിക്കും.

   b) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ അതിൽ അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം വസ്തു ആദേശം ചെയ്യുന്ന ദ്രവത്തിന്റെ ഭാരത്തിന് തുല്യമായിരിക്കും.

   c) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ അതിൽ അനുഭവപ്പെടുന്ന പ്ലവക്ഷമബലം വസ്തു ആദേശം ചെയ്യുന്ന ദ്രവത്തിന്റെ ആപേക്ഷികസാന്ദ്രതക്ക് തുല്യമായിരിക്കും.

   d) ഒരു വസ്തു ദ്രവത്തിൽ ഭാഗികമായോ പൂർണമായോ മുങ്ങിയിരിക്കുമ്പോൾ അതിൽ അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം വസ്തു ആദേശം ചെയ്യുന്ന ദ്രവത്തിന്റെ ആപേക്ഷികസാന്ദ്രതക്ക് തുല്യമായിരിക്കും.

2. മണ്ണുമാന്തിയന്ത്രത്തിൽ ഉപയോഗിക്കപ്പെടുന്ന തത്ത്വമേത് ?

a) പ്ലവക്ഷമബലതത്ത്വം
b) ആർക്കമെഡീസ് തത്ത്വം
c) പാസ്കൽ നിയമം
d) പ്ലവന നിയമം

3. 1000 N ഭാരമുള്ള വസ്തു വെള്ളത്തിൽ മുങ്ങിക്കിടക്കുന്നു. ആ വസ്തു ആദേശം ചെയ്ത വെള്ളത്തിന്റെ ഭാരം 250 N ആണെങ്കിൽ, വെള്ളത്തിൽ ആ വസ്തുവിന്റെ ഭാരമെത്ര?

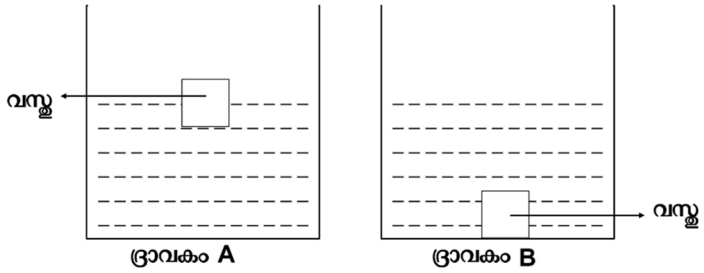
a) 250 N
b) 750 N
c) 1000 N
d) 1250 N

4. നാല് വ്യത്യസ്ത ദ്രാവകങ്ങൾ നിറച്ച ടെസ്റ്റ് ട്യൂബാണ് താഴെ കാണിച്ചിരിക്കുന്നത്. ദ്രാവകങ്ങളുടെ സാന്ദ്രതയുടെ അവരോഹണ ക്രമമേത്?



a) തേൻ, വെള്ളം, എണ്ണ, മണ്ണെണ്ണ
b) മണ്ണെണ്ണ, എണ്ണ, വെള്ളം, തേൻ
c) മണ്ണെണ്ണ, തേൻ, എണ്ണ, വെള്ളം
d) വെള്ളം, തേൻ, എണ്ണ, മണ്ണെണ്ണ

5. ചിത്രത്തെ അടിസ്ഥാനമാക്കി ശരിയായ പ്രസ്താവനയേത് ?



i. A എന്ന ദ്രാവകത്തിൽ വസ്തുവിൽ അനുഭവപ്പെടുന്ന പ്ലവക്ഷമ ബലം B എന്ന ദ്രാവകത്തിലേക്കാൾ കൂടുതലാണ്. എന്നാൽ B എന്ന ദ്രാവകത്തിൽ വസ്തുവിന്

അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം A എന്ന ദ്രാവകത്തിലേക്കാൾ കൂടുതലാണ്.

ii. A എന്ന ദ്രാവകത്തിൽ വസ്തുവിൽ അനുഭവപ്പെടുന്ന പ്ലവക്ഷമബലം ഗുരുത്വാകർഷണബലത്തേക്കാൾ കുറവാണ്. എന്നാൽ B എന്ന ദ്രാവകത്തിൽ വസ്തുവിൽ അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം പ്ലവക്ഷമബലത്തേക്കാൾ കുറവാണ്.

iii. B എന്ന ദ്രാവകത്തിന്റെ സാന്ദ്രത വസ്തുവിന്റെയും A എന്ന ദ്രാവകത്തിന്റെയും സാന്ദ്രതയെക്കാൾ കുറവാണ്.

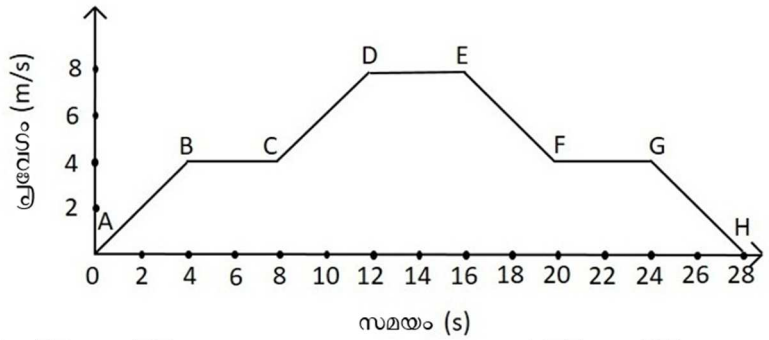
iv. വസ്തുവിന്റെ ആപേക്ഷിക സാന്ദ്രത A എന്ന ദ്രാവകത്തിന്റെയും B എന്ന ദ്രാവകത്തിന്റെയും സാന്ദ്രതയെക്കാൾ കൂടുതലാണ്.

a) (i) മാത്രം ശരിയാണ്.
c) (ii) ഉം (iv) ഉം ശരിയാണ്.
b) (iv) മാത്രം ശരിയാണ്.
d) (i) ഉം (iii) ഉം ശരിയാണ്.

6. ശരിയായ ചലനസമവാക്യം ഏത്?

a) $s = ut - \frac{1}{2}\, at^2$
c) $s = ut + \frac{1}{2}\, at^2$
b) $s = ut + \frac{1}{2}\, a^2t^2$
d) $s = ut - \frac{1}{2}\, a^2t^2$

7. താഴെ കൊടുത്തിരിക്കുന്നവയിൽ ത്വരണം സംഭവിക്കുന്ന സന്ദർഭങ്ങൾ തിരഞ്ഞെടുക്കുക.

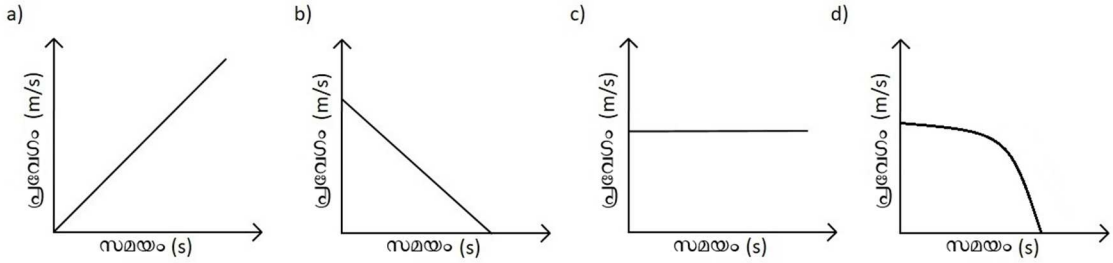


a) CD യും EF ഉം
c) EF ഉം GH ഉം
b) AB യും CD യും
d) BC ഉം DE ഉം FG ഉം

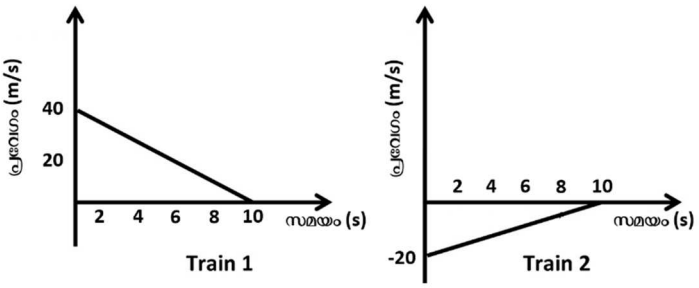
8. 40 m/s ആദ്യ പ്രവേഗത്തിൽ ഒരു കല്ല് കുത്തനെ മുകളിലേക്ക് എറിയുന്നു. ആ കല്ലിന് എത്തിച്ചേരാൻ പറ്റുന്ന ഉയരം എത്ര ?

a) 40 m
b) 60 m
c) 80 m
d) 100 m

9. നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗമാറ്റം സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത് ?



10. എതിർദിശയിൽ വ്യത്യസ്ത ട്രാക്കുകളിൽ സഞ്ചരിക്കുന്ന തീവണ്ടികളെ അബദ്ധവശാൽ ഒരേ ട്രാക്കിൽ കൂടി കടത്തി വിട്ടു. അബദ്ധം തിരിച്ചറിഞ്ഞ ഡ്രൈവർമാർ ട്രെയിനുകൾ തമ്മിൽ 300 m അകലത്തിലായിരിക്കെ രണ്ട് ട്രെയ്നിന്റെയും വേഗത കുറക്കാൻ തുടങ്ങി. വേഗത കുറഞ്ഞു വരുന്ന രണ്ട് ട്രെയിനുകളുടെ പ്രവേഗ-സമയ ഗ്രാഫുകളാണ് താഴെ തന്നിരിക്കുന്നത്. ട്രെയിനുകളുടെ ഈ ചലനത്തെ കുറിച്ചുള്ള ശരിയായ പ്രസ്താവന ഏത്?



i. ബ്രേക്ക് പ്രയോഗിക്കുമ്പോൾ, നിശ്ചലാവസ്ഥയിൽ എത്തുന്നതിന് മുൻപ് ട്രെയിൻ 2 ട്രെയിൻ 1 ഇനേക്കാൾ കൂടുതൽ ദൂരം സഞ്ചരിക്കും.

ii. ട്രെയിനുകൾ നിശ്ചലാവസ്ഥയിൽ എത്തുമ്പോൾ അവ തമ്മിലുള്ള അകലം 20 m ആണ്.

iii. ബ്രേക്ക് പ്രയോഗിക്കുമ്പോൾ, ട്രെയിൻ 1 ന്റെയും ട്രെയിൻ 2 ന്റെയും പ്രവേഗ-സമയ ഗ്രാഫ് ഒരുപോലെയായിരുന്നെങ്കിൽ, അവ തമ്മിൽ കൂട്ടിയിടിക്കുമായിരുന്നു.

a) (i) മാത്രം ശരിയാണ്.
b) (ii) മാത്രം ശരിയാണ്.
c) (i) ഉം (ii) ഉം ശരിയാണ്.
d) (ii) ഉം (iii) ഉം ശരിയാണ്.

11. ന്യൂട്ടന്റെ ഒന്നാം ചലന നിയമം വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

    a) അസന്തുലിത ബാഹ്യബലത്തിന്റെ അഭാവത്തിൽ രണ്ട് വസ്തുക്കൾ തമ്മിൽ കൂട്ടിയിടിക്കുന്നതിന് മുൻപുള്ള ആകെ ആക്കവും ഇടിച്ചതിന് ശേഷമുള്ള ആകെ ആക്കവും തുല്യമായിരിക്കും.

    b) ഒരു വസ്തുവിനുണ്ടാകുന്ന ആക്കവ്യത്യാസത്തിന്റെ നിരക്ക് ആ വസ്തുവിൽ പ്രയോഗിക്കുന്ന അസന്തുലിത ബാഹ്യബലത്തിന് നേർ അനുപാതത്തിലായിരിക്കും.

    c) അസന്തുലിതമായ ബാഹ്യബലം അനുഭവപ്പെടുന്നത് വരെ ഓരോ വസ്തുവും അതിന്റെ നിശ്ചലാവസ്ഥയിലോ നേർരേഖാ സമചലനത്തിലോ തുടരുന്നതാണ്.

    d) ഒരു വസ്തുവിൽ അനുഭവപ്പെടുന്ന പരിണതബലം പൂജ്യമെങ്കിൽ പ്രയോഗിക്കപ്പെട്ട ബലങ്ങളെ സന്തുലിത ബലങ്ങൾ എന്ന് പറയുന്നു. ഇത്തരം ബലങ്ങൾക്ക് നിശ്ചലാവസ്ഥയിലുള്ള വസ്തുക്കളെ ചലിപ്പിക്കാനോ ചലിക്കുന്ന വസ്തുക്കളെ നിശ്ചലമാക്കാനോ കഴിയില്ല.

12. ആക്കസംരക്ഷണനിയമം പ്രയോജനപ്പെടുത്തുന്ന സന്ദർഭം താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

    a) ഹൈ ജമ്പ് മത്സരത്തിൽ, മത്സരാർത്ഥിയെ ഒരു കുഷ്യനുള്ള ബെഡിലേക്ക് വീഴാൻ അനുവദിക്കുന്നു.

    b) ഒരു വിരിപ്പിന് മേൽ വടി കൊണ്ട് അടിക്കുമ്പോൾ അതിലെ പൊടിപടലങ്ങൾ പുറത്തേക്ക് തെറിക്കുന്നു.

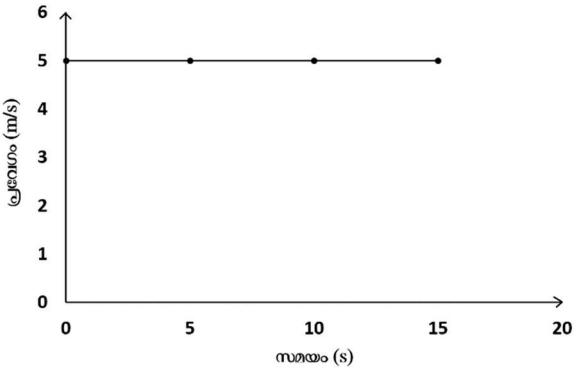
    c) കരാട്ടെ അഭ്യാസി വളരെ വേഗത്തിൽ കൈ വീശി കട്ടുപ്പുമുള്ള ഇഷ്ടികകൾ തകർക്കുന്നു.

    d) ലിഫ്റ്റ് മുകളിലേക്ക് നീങ്ങുമ്പോൾ അതിനകത്ത് സ്പ്രിങ് ത്രാസിന്റെ ഹുക്കിൽ തൂക്കിയ വസ്തുവിന്മേൽ ത്വരണം താഴോട്ട് അനുഭവപ്പെടുന്നു.

13. ഒരു ചലിക്കുന്ന വസ്തുവിന്മേൽ അനുഭവപ്പെടുന്ന ബലത്തിന് മാറ്റമില്ലാതെ വസ്തുവിന്റെ മാസ് ഇരട്ടിയാക്കിയാൽ അതിന്റെ ത്വരണം എത്ര ?

    a) ത്വരണത്തിൽ മാറ്റമില്ല.
    b) ത്വരണം ഇരട്ടിയാകും.
    c) ത്വരണം പൂജ്യമാകും.
    d) ത്വരണം പകുതിയാകും.

14. 2 kg മാസുള്ള ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗ-സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്. വസ്തുവിന് മേൽ അനുഭവപ്പെടുന്ന ബലം എത്ര ?



a) 0 N
b) 2.5 N
c) 10 N
d) 20 N

15. ഒരു വലിയ ബസും ഒരു വാനും v എന്ന പ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു. അവ തമ്മിൽ കൂട്ടിയിടിച്ചതിന് ശേഷം രണ്ട് വാഹനങ്ങളും നിശ്ചലാവസ്ഥയിൽ എത്തുന്നു. കൂട്ടിയിടിക്കാൻ എടുത്ത സമയം 1 s ആണെങ്കിൽ

i. ബസ്സിനാണ് കൂട്ടിമുട്ടലിന്റെ ആഘാതം കുറഞ്ഞ രീതിയിൽ അനുഭവപ്പെടുന്നത്.
ii. വാനിനാണ് കുറഞ്ഞ ആക്കവ്യത്യാസം അനുഭവപ്പെടുന്നത്.
iii. വാനിനാണ് കൂടുതൽ ത്വരണം അനുഭവപ്പെടുന്നത്.

a) (i) ഉം (ii) ഉം ശരിയാണ്.
b) (ii) ഉം (iii) ഉം ശരിയാണ്.
c) (i) ഉം (iii) ഉം ശരിയാണ്.
d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

16. സാർവികഗുരുത്വാകർഷണനിയമത്തിന്റെ ഗണിതരൂപത്തിൽ

a) G യുടെ മൂല്യം നിരീക്ഷിക്കുന്നിടത്തെ g യുടെ മൂല്യവുമായി ബന്ധപ്പെട്ടിരിക്കുന്നു.
b) G എന്നത് ഗുരുത്വാകർഷണസ്ഥിരാങ്കമാണ്.
c) രണ്ട് മാസുകളിൽ ഒരെണ്ണം ഭൂമിയായി സങ്കല്പിക്കുന്ന സന്ദർഭത്തിലാണ് G ഉപയോഗിക്കപ്പെടുന്നത്.
d) G യുടെ മൂല്യം ഏറ്റവും ഉയർന്നത് ഭൂമിയുടെ ഉപരിതലത്തിലാണ്.

17. ഒരു മാവിൽ നിന്ന് മാങ്ങ താഴോട്ട് വീഴുമ്പോൾ

a) ഭൂമി മാത്രമാണ് മാങ്ങയെ ആകർഷിക്കുന്നത്.
b) മാങ്ങ മാത്രമാണ് ഭൂമിയെ ആകർഷിക്കുന്നത്.

c) മാങ്ങയും ഭൂമിയും പരസ്പരം ആകർഷിക്കുന്നു.

d) മാവ് മാങ്ങയെ വികർഷിക്കുകയും ഭൂമി അതിനെ ആകർഷിക്കുകയും ചെയ്യുന്നു.

18. രണ്ട് കണികകൾ ഒരു നിശ്ചിത അകലത്തിൽ സ്ഥിതി ചെയ്യുന്നു. കണികകൾ തമ്മിലുള്ള അകലം വ്യത്യാസപ്പെടുത്താതെ ഓരോ കണികയുടെയും മാസുകൾ ഇരട്ടിപ്പിച്ചാൽ അവക്കിടയിലുള്ള ഗുരുത്വാകർഷണബലത്തിന്റെ മൂല്യം

a) $\frac{1}{4}$ മടങ്ങായിരിക്കും

b) 4 മടങ്ങായിരിക്കും

c) $\frac{1}{2}$ മടങ്ങായിരിക്കും

d) 2 മടങ്ങായിരിക്കും

19. ഭൂമിയുടെ ഗുരുത്വാകർഷണം പെട്ടെന്ന് അപ്രത്യക്ഷമായാൽ, താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത്?

a) വസ്തുവിന്റെ ഭാരം പൂജ്യമാവുകയും മാസ് മാറ്റമില്ലാതെ തുടരുകയും ചെയ്യും.

b) വസ്തുവിന്റെ ഭാരം മാറ്റമില്ലാതെ തുടരുകയും മാസ് പൂജ്യമാവുകയും ചെയ്യും.

c) മാസും ഭാരവും പൂജ്യമാകും.

d) മാസും ഭാരവും പൂജ്യമാകില്ല.

20. ഒരു സ്വിമ്മിങ് പൂളിന്റെ 45 m ഉയരത്തിലുള്ള ജമ്പിങ് ബോർഡിൽ നിന്നു കൊണ്ട് സുനിൽ ഒരു പന്ത് താഴോട്ട് എറിയുന്നു. ഒരു സെക്കന്ഡിന് ശേഷം അതെ ബോർഡിൽ നിന്ന് കൊണ്ട് u ആദ്യപ്രവേഗത്തിൽ മറ്റൊരു പന്ത് അവൻ താഴേക്കെറിഞ്ഞു. രണ്ട് പന്തുകളും ഒരേ സമയത്ത് വെള്ളത്തിന്റെ ഉപരിതലത്തിൽ തട്ടുന്നു. എങ്കിൽ ശരിയായ പ്രസ്താവന ഏത് ?

i. ആദ്യത്തെ പന്ത് വെള്ളത്തിന്റെ ഉപരിതലത്തിലെത്താൻ 3 s എടുക്കുന്നു.

ii. രണ്ടാമത്തെ പന്തിന്റെ ആദ്യ പ്രവേഗം 12.5 m/s ആണ്.

iii. രണ്ട് പന്തുകളും വെള്ളത്തിന്റെ ഉപരിതലത്തിൽ തട്ടുന്നത് തുല്യപ്രവേഗത്തിലായിരിക്കും.

iv. രണ്ടാമത്തെ പന്ത് വെള്ളത്തിന്റെ ഉപരിതലത്തിൽ തട്ടുന്നത് ഉയർന്ന പ്രവേഗത്തിലായിരിക്കും.

a) (i) ഉം (iii) ഉം ശരിയാണ്.

b) (ii) ഉം (iii) ഉം ശരിയാണ്.

c) (i) ഉം (ii) ഉം (iii) ഉം ശരിയാണ്.

d) (i) ഉം (ii) ഉം (iv) ഉം ശരിയാണ്.

21. ശരിയായ പ്രസ്താവന ഏത്?

a) ഒരു വസ്തുവിന്മേൽ പ്രയോഗിച്ച ബലത്തിന്റെ ദിശക്ക് ലംബമായി സ്ഥാനാന്തരം ഉണ്ടാകുമ്പോൾ മാത്രമാണ് പ്രവൃത്തി ചെയ്തതായി കണക്കാക്കുകയുള്ളൂ.

b) ഒരു വസ്തുവിന് അതിന്റെ ചലനം കൊണ്ട് ലഭ്യമാകുന്ന ഊർജമാണ് ഗതികോർജം.

c) സ്ഥിതികോർജത്തിൽ ഉണ്ടായ മാറ്റത്തിന് തുല്യമാണ് പ്രവൃത്തി എന്നതാണ് പ്രവൃത്തി-ഊർജതത്ത്വം.

d) പ്രവൃത്തിയുടെയും സ്ഥാനാന്തരത്തിന്റെയും ഹരണഫലമാണ് പവർ.

22. സ്ഥാനാന്തരം ബലത്തിന് ലംബമാണെങ്കിൽ പ്രവൃത്തി

a) നെഗറ്റീവ്
b) പോസിറ്റീവ്
c) പൂജ്യം
d) അനന്തം

23. ഒരു വസ്തു ഉയരം h ഇൽ നിന്ന് താഴോട്ട് വീഴുന്നു. ഉയരം $\frac{h}{2}$ സഞ്ചരിച്ചു കഴിയുമ്പോൾ ആ വസ്തു അനുഭവപ്പെടുന്നത്

a) സ്ഥിതികോർജം മാത്രമായിരിക്കും
b) ഗതികോർജം മാത്രമായിരിക്കും
c) പകുതി സ്ഥിതികോർജവും ബാക്കി പകുതി ഗതികോർജവുമായിരിക്കും
d) കൂടുതൽ ഗതികോർജവും കുറച്ച് സ്ഥിതികോർജവുമായിരിക്കും

24. A എന്ന ആൾ ഒരു ആശുപത്രിയുടെ രണ്ടാം നിലയിലേക്ക് ലിഫ്റ്റിൽ എത്തി. എന്നാൽ B എന്ന മറ്റൊരാൾ അതെ നിലയിലേക്ക് കോണികയറിയെത്തി. രണ്ടുപേരുടെയും മാസ്സുകൾ തുല്യമാണെങ്കിൽ

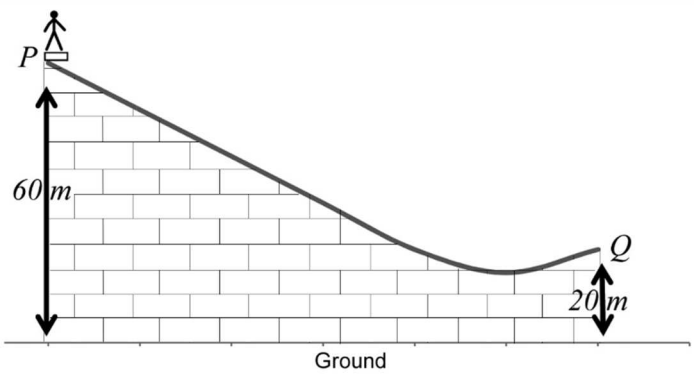
a) ഗുരുത്വാകർഷണബലത്തിനെതിരെ രണ്ടു പേരും ചെയ്ത പ്രവൃത്തി തുല്യമാണ്.

b) ഗുരുത്വാകർഷണബലത്തിനെതിരെ A ചെയ്ത പ്രവൃത്തിയേക്കാൾ കൂടുതലാണ് B ചെയ്തത്.

c) ഗുരുത്വാകർഷണബലത്തിനെതിരെ B ചെയ്ത പ്രവൃത്തിയേക്കാൾ കൂടുതലാണ് A ചെയ്തത്.

d) രണ്ടുപേരുടെയും പവർ തുല്യമാണ്.

25. 50 kg മാസുള്ള ഒരു സ്കീയർ (മഞ്ഞിന്റെ ഉപരിതലത്തിൽ തെന്നി നീങ്ങുന്ന ആൾ) ഒരു സ്കി ജമ്പിന്റെ ഉയർന്ന ബിന്ദു P യിൽ നില്ക്കുന്നു. ചിത്രത്തിൽ കാണിച്ചിരിക്കുന്നത് പോലെ അയാൾ P യിൽ നിന്ന് Q എന്ന ബിന്ദുവിലേക്ക് തെന്നി നീങ്ങുകയും Q വിലെത്തിയപ്പോൾ ഉയർന്നു പൊങ്ങുകയും ചെയ്തു. Q വിലുള്ള ഗതികോർജ്ജത്തിന്റെ അളവ് P യിനും Q വിനും ഇടയിലുള്ള സ്ഥിതികോർജ്ജത്തിലുള്ള മാറ്റത്തിന്റെ 50 % ആകുമ്പോൾ, താഴെ കൊടുത്തിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത്?



i. സ്കീയറിന്റെ സ്ഥിതികോർജ്ജത്തിലുള്ള മാറ്റം 10000 J ആണ്.

ii. സ്കീയറിന്റെ ഗതികോർജം 5000 J ആണ്.

iii. Q വിൽ എത്തുമ്പോൾ സ്കീയറിന്റെ വേഗത 20 m/s ആണ്.

a) (i) മാത്രം ശരിയാണ്.
b) (i) ഉം (ii)ഉം ശരിയാണ്.
c) (ii) ഉം (iii)ഉം ശരിയാണ്.
d) (iii) മാത്രം ശരിയാണ്.

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APPENDIX 13

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-C)
(FINAL – MALAYALAM)

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Research Scholar
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Dr. Mumthas N. S.
Professor
Farook Training College

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പൊതുവായ നിർദ്ദേശങ്ങൾ :

ഈ ടെസ്റ്റിന് മൂന്ന് ഭാഗങ്ങളാണുള്ളത്: Section A (കുട്ടികളുടെ പൊതുവിവരങ്ങൾ), Section B (ഭൗതികശാസ്ത്രത്തിലെ ആശയങ്ങളുടെ റാങ്കിങ്), Section C (ആശയധാരണ മനസ്സിലാക്കുന്നതിനുള്ള ടെസ്റ്റ്). ഓരോ ഭാഗങ്ങൾക്ക് താഴെ അതത് നിർദ്ദേശങ്ങൾ നൽകിയിട്ടുണ്ട്. നിങ്ങളുടെ പ്രതികരണങ്ങൾ ഗവേഷണാവശ്യത്തിന് മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

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SECTION A

നിർദ്ദേശങ്ങൾ : വ്യക്തിപരമായ വിവരങ്ങൾ താഴെ എഴുതുക.

വിദ്യാർത്ഥിയുടെ പേര് :

ലിംഗം : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂളിന്റെ പേര് :

ഒമ്പതാം ക്ലാസ്സിൽ ഭൗതികശാസ്ത്രത്തിൽ ഒന്നാം പാദവാർഷിക പരീക്ഷക്ക് ലഭിച്ച മാർക്ക് :

ഒമ്പതാം ക്ലാസ്സിൽ ഭൗതികശാസ്ത്രത്തിൽ രണ്ടാം പാദവാർഷിക പരീക്ഷക്ക് ലഭിച്ച മാർക്ക് :

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SECTION B

നിർദ്ദേശങ്ങൾ: ഒമ്പതാം ക്ലാസ്സിലെ പാഠപുസ്തകത്തിലെ ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട ചില ആശയങ്ങളാണ് താഴെ തന്നിരിക്കുന്നത്. അവയുടെ കാഠിന്യമനുസരിച്ച് റാങ്ക് രേഖപ്പെടുത്തണം. ഏറ്റവും ബുദ്ധിമുട്ടുള്ള ആശയത്തിന് നേരെ റാങ്ക് '1' എന്നും അതിനേക്കാൾ കാഠിന്യം കുറഞ്ഞ ആശയത്തിന് നേരെ '2', എന്നിങ്ങനെ കാഠിന്യ നിലവാരം കുറയുന്നതിനനുസരിച്ച രീതിയിലാണ് റാങ്ക് രേഖപ്പെടുത്തേണ്ടത്.

No.	ഭൗതികശാസ്ത്രത്തിലെ ആശയങ്ങൾ	റാങ്ക്
1.	ദ്രവബലങ്ങൾ	
2.	ചലനസമവാക്യങ്ങൾ	
3.	ചലനവും ചലനനിയമങ്ങളും	
4.	ഗുരുത്വാകർഷണം	
5.	പ്രവൃത്തി, ഊർജം, പവർ	

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SECTION C

ഒമ്പതാം ക്ലാസിലെ വിദ്യാർത്ഥികളുടെ ആശയധാരണകളെ അളക്കാനുള്ള 25 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് ഈ Section നിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. എല്ലാ ചോദ്യത്തിനും ഉത്തരം തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d) എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

Maximum Marks: 25

Time: 60 minutes

1. വിസ്കസ് ബലത്തെ വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

   a) ഒരു വസ്തു ദ്രവത്തിൽ പൂർണമായി മുങ്ങിയിരിക്കുമ്പോൾ ആ ദ്രവം വസ്തുവിൽ താഴേക്ക് ഒരു ബലം പ്രയോഗിക്കുന്നു. ഈ ബലമാണ് വിസ്കസ് ബലം.

   b) ഒരു സംവൃതവ്യൂഹത്തിൽ അടങ്ങിയിരിക്കുന്ന ദ്രാവകത്തിന്റെ ഏതെങ്കിലും ഒരു ഭാഗത്ത് പ്രയോഗിക്കുന്ന മർദ്ദം ദ്രാവകത്തിന്റെ എല്ലാ ഭാഗത്തും ഒരു പോലെ അനുഭവപ്പെടും. ഈ ബലമാണ് വിസ്കസ് ബലം.

   c) ജലോപരിതലത്തിലെ കണികകൾ പരസ്പരം ആകർഷിക്കുന്നതുമൂലം ജലോപരിതലം ഒരു പാടപോലെ വലിഞ്ഞുനിൽക്കുന്നു. ഇതിനു കാരണമായ ബലമാണ് വിസ്കസ് ബലം.

   d) ചലിച്ചുകൊണ്ടിരിക്കുന്ന ദ്രാവകപടലങ്ങൾക്കിടയിൽ അവയുടെ ആപേക്ഷിക ചലനത്തെ തടസ്സപ്പെടുത്തുന്ന വിധത്തിൽ പടലങ്ങൾക്ക് സമാന്തരമായി പ്രവർത്തിക്കുന്ന ഘർഷണബലമാണ് വിസ്കസ് ബലം.

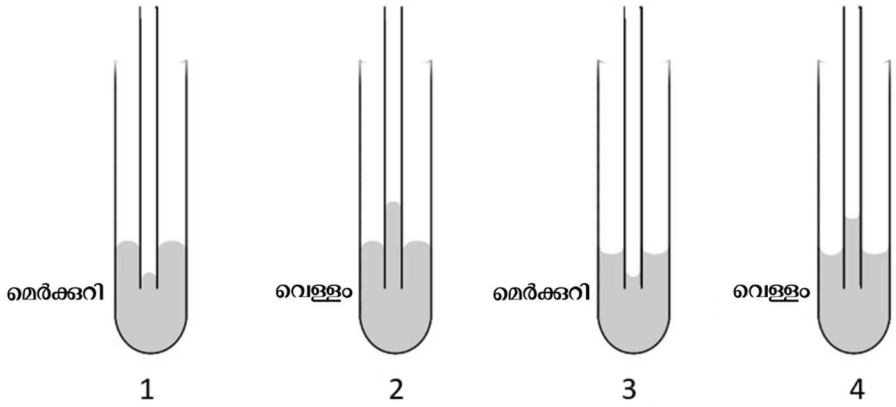
2. പ്ലവക്ഷമബലത്തിന് ഉദാഹരണം താഴെ കൊടുത്തിരിക്കുന്നവയിലേത് ?

   a) ഹൈഡ്രജൻ നിറച്ച ബലൂൺ വായുവിൽ പൊങ്ങുന്നു.
   b) ഒരു ചരിഞ്ഞ ഗ്ലാസ് പ്ലേറ്റിന് മേൽ വെള്ളത്തുള്ളി താഴോട്ട് നീങ്ങുന്നു.
   c) ഒരു റോക്കറ്റ് വിക്ഷേപിച്ചതിന് ശേഷം വായുവിൽ മുൻപോട്ട് ഉയരുന്നു.
   d) ഫൗണ്ടൻ പേനയിൽ മഷി മുനയിലേക്ക് എത്തുന്നു.

3. W ഭാരമുള്ള ഒരു വസ്തു ദ്രവത്തിൽ മുങ്ങിക്കിടക്കുന്നു. പ്ലവക്ഷമ ബലം വസ്തുവിന്റെ ഭാരത്തിന്റെ $\frac{1}{4}$ ഭാഗത്തിന് തുല്യമാണെങ്കിൽ ദ്രവത്തിൽ വസ്തുവിന്റെ ഭാരമെത്ര ?

   a) $2\,W$
   b) $\frac{1}{4}\,W$
   c) $\frac{3}{4}\,W$
   d) $\frac{1}{2}\,W$

4. കേശികത്വം അടിസ്ഥാനപ്പെടുത്തി താഴെ തന്നിരിക്കുന്ന ചിത്രത്തിൽ ശരിയേത് ?



   a) 4 മാത്രം ശരിയാണ്.
   b) 1 ഉം 4 ഉം ശരിയാണ്.
   c) 2 ഉം 4 ഉം ശരിയാണ്.
   d) 2 ഉം 3 ഉം ശരിയാണ്.

5. A, B എന്നീ രണ്ട് ദ്രാവകങ്ങളുടെ ആപേക്ഷികസാന്ദ്രത യഥാക്രമം 0.75 ഉം 1.0 ഉം ആണ്. ആപേക്ഷികസാന്ദ്രത യഥാക്രമം 0.6 ഉം 0.9 ഉം ആയ P, Q എന്ന രണ്ട് പൊള്ളയല്ലാത്ത വസ്തുക്കൾ ഈ ദ്രാവകങ്ങളിലിട്ടാൽ

   a) P എന്ന വസ്തു A യിൽ പൊങ്ങിക്കിടക്കുകയും Q എന്ന വസ്തു B യിൽ മുങ്ങുകയും ചെയ്യും.
   b) P എന്ന വസ്തു A യിൽ മുങ്ങുകയും Q എന്ന വസ്തു B യിൽ പൊങ്ങിക്കിടക്കുകയും ചെയ്യും.

c) P എന്ന വസ്തു B യിൽ പൊങ്ങിക്കിടക്കുകയും Q എന്ന വസ്തു A യിൽ മുങ്ങുകയും ചെയ്യും.

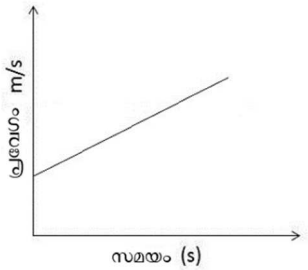
d) P എന്ന വസ്തു B യിൽ മുങ്ങുകയും Q എന്ന വസ്തു A യിൽ പൊങ്ങിക്കിടക്കുകയും ചെയ്യും.

6. ശരിയായ ചലനസമവാക്യം ഏത്?

a) $v = u + at^2$ c) $v = ut + at^2$

b) $v = u + at$ d) $v = u - at$

7. തന്നിരിക്കുന്ന പ്രവേഗ-സമയ ഗ്രാഫ് അനുസരിച്ച്



a) വസ്തുവിന് ഒരു നിശ്ചിത ആദ്യ പ്രവേഗമുണ്ട്.

b) വസ്തു സമപ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു.

c) വസ്തു തുടക്കത്തിൽ ഒരു നിശ്ചിത പ്രവേഗത്തിൽ സഞ്ചരിക്കുകയും പിന്നീട് സമപ്രവേഗത്തിലേക്ക് മാറുകയും ചെയ്യുന്നു.

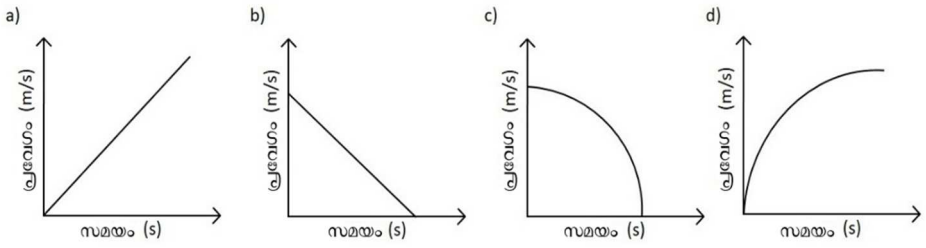
d) വസ്തു നിശ്ചലാവസ്ഥയിലാണ്.

8. നിശ്ചലാവസ്ഥയിൽ നിന്ന് ചലിച്ചു തുടങ്ങിയ ഒരു ട്രെയിൻ 2 മിനിട്ടിനുള്ളിൽ $0.1\ m/s^2$ സമത്വരണത്തിൽ സഞ്ചരിക്കുന്നു. ട്രെയിൻ സഞ്ചരിച്ച ദൂരം എത്ര ?

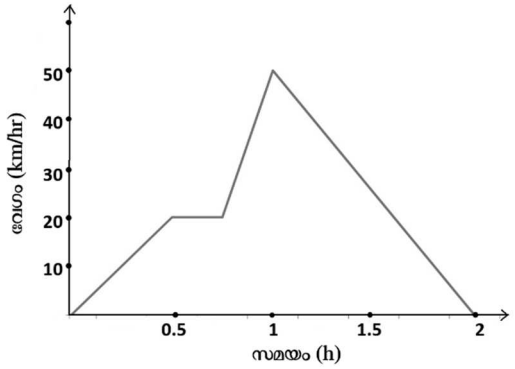
a) 0.05 m c) 360 m

b) 20 m d) 720 m

9. ഒരു വസ്തുവിനെ കുത്തനെ മുകളിലോട്ടു എറിയുമ്പോൾ അനുഭവപ്പെടുന്ന ത്വരണം സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത് ?



10. ഒരു ട്രെയിൻ ഒരു സ്റ്റേഷനിൽ നിന്ന് മറ്റൊരു സ്റ്റേഷനിലേക്ക് 2 മണിക്കൂർ കൊണ്ട് എത്തിച്ചേരുന്നു. ആ ചലനത്തിന്റെ വേഗ-സമയ ഗ്രാഫാണ് തന്നിരിക്കുന്നത്. ഗ്രാഫിനെ കുറിച്ചുള്ള പ്രസ്താവനകളിൽ ശരിയേത് ?



i. യാത്രയിൽ ട്രെയിനിന്റെ പരമാവധി ത്വരണം $120\ km/hr^2$ ആണ്.

ii. 0.75 hr തൊട്ട് 1 hr വരെയുള്ള ഇടവേളയിൽ ട്രെയിൻ സഞ്ചരിക്കുന്ന ദൂരം 8.75 km ആണ്.

iii. യാത്രയുടെ തുടക്കം മുതൽ 0.5 hrs വരെയുള്ള ഇടവേളയിൽ ട്രെയിൻ സമപ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു.

a) മാത്രം ശരിയാണ്.
b) (ii) മാത്രം ശരിയാണ്
c) (i) ഉം (ii) ഉം ശരിയാണ്.
d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

11. ന്യൂട്ടന്റെ രണ്ടാം ചലന നിയമം വിശദീകരിക്കുന്ന പ്രസ്താവന താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

a) ഒരു വസ്തുവിനുണ്ടാകുന്ന ആക്കവ്യത്യാസത്തിന്റെ നിരക്ക് ആ വസ്തുവിൽ പ്രയോഗിക്കുന്ന അസന്തുലിത ബാഹ്യബലത്തിന് നേർ അനുപാതത്തിലായിരിക്കും.

b) അസന്തുലിത ബാഹ്യബലത്തിന്റെ അഭാവത്തിൽ രണ്ട് വസ്തുക്കൾ തമ്മിൽ കൂട്ടിയിടിക്കുന്നതിന് മുൻപുള്ള ആകെ ആക്കവും ഇടിച്ചതിന് ശേഷമുള്ള ആകെ ആക്കവും തുല്യമായിരിക്കും.

c) അസന്തുലിതമായ ബാഹ്യബലം അനുഭവപ്പെടുന്നത് വരെ ഓരോ വസ്തുവും അതിന്റെ നിശ്ചലാവസ്ഥയിലോ നേർരേഖാ സമചലനത്തിലോ തുടരുന്നതാണ്.

d) ഒരു വസ്തുവിൽ അനുഭവപ്പെടുന്ന പരിണതബലം പൂജ്യമെങ്കിൽ പ്രയോഗിക്കപ്പെട്ട ബലങ്ങളെ സന്തുലിത ബലങ്ങൾ എന്ന് പറയുന്നു. ഇത്തരം ബലങ്ങൾക്ക്

നിശ്ചലാവസ്ഥയിലുള്ള വസ്തുക്കളെ ചലിപ്പിക്കാനോ ചലിക്കുന്ന വസ്തുക്കളെ നിശ്ചലമാക്കാനോ കഴിയില്ല.

12. ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമം പ്രയോജനപ്പെടുത്തുന്ന സന്ദർഭം താഴെ തന്നിരിക്കുന്നവയിൽ ഏത് ?

a) ഒരു വിരിപ്പിന് മേൽ വടി കൊണ്ട് അടിക്കുമ്പോൾ അതിലെ പൊടിപടലങ്ങൾ പുറത്തേക്ക് തെറിക്കുന്നു.

b) വെടിയുതിർക്കുമ്പോൾ ബുള്ളറ്റ് പോകുന്ന ദിശക്ക് എതിരെ തോക്ക് ചലിക്കുന്നു.

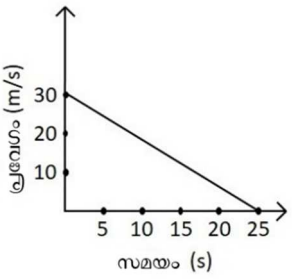
c) കാറ്റഴിച്ചു വിടുമ്പോൾ ബലൂണിന്റെ ചലനം.

d) ഗ്ലാസ് പാത്രങ്ങൾ അടുക്കിവെച്ച പാക്കറ്റുകളിൽ സ്പോഞ്ച്, വൈക്കോൽ എന്നിവ നിറക്കുന്നത് പാത്രങ്ങൾ തമ്മിൽ കൂട്ടിമുട്ടി പൊട്ടുന്നത് ഒഴിവാക്കാൻ സഹായിക്കുന്നു.

13. 1500 kg ഭാരമുള്ള ഒരു കാറിന്റെ വേഗത സമമായി 32 km/hr ൽ നിന്ന് 72 km/hr ലേക്ക് ഉയരുന്നു. കാറിന്റെ ആക്കവ്യത്യാസം എത്ര ?

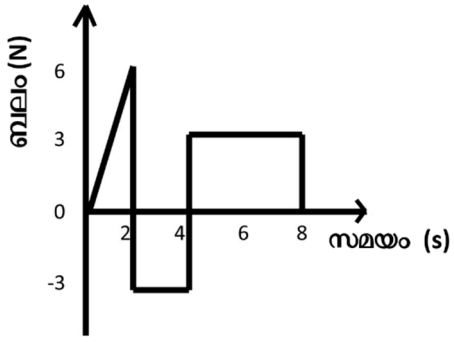
a) 15000 kg km/hr
b) 15000 kg m/s
c) 54000 kg m/s
d) 54000 g m/s

14. 50 kg മാസുള്ള ഒരു വസ്തു നിലത്ത് ഉരുളുമ്പോഴുള്ള പ്രവേഗ-സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്. വസ്തുവിന് മേൽ അനുഭവപ്പെടുന്ന ബലം എത്ര ?



a) 5 N
b) 25 N
c) 30 N
d) 60 N

15. m മാസുള്ള ഒരു വസ്തുവിന് മേലുള്ള F എന്ന ബലം സൂചിപ്പിക്കുന്ന ബല-സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്. ശരിയായ പ്രസ്താവന കണ്ടെത്തുക.



i. 0 സെക്കന്റ് മുതൽ 4 s വരെ ഉള്ള ഇടവേളയിൽ വസ്തുവിനുണ്ടായ ആക്കവ്യത്യാസം 4 s തൊട്ട് 8 s വരെയുള്ള ഇടവേളയിലേതിന് തുല്യമാണ്.

ii. 0 സെക്കന്റ് മുതൽ 2 s വരെ ഉള്ള ഇടവേളയിൽ വസ്തുവിനുണ്ടായ ആക്കവ്യത്യാസത്തിന്റെ അളവ് 2 s തൊട്ട് 4 s വരെയുള്ള ഇടവേളയിലേതിന് തുല്യമാണ്.

iii. 0 സെക്കന്റ് മുതൽ 8 s വരെ ഉള്ള ഇടവേളയിൽ വസ്തുവിനുണ്ടായ ആക്കവ്യത്യാസം 12 N ആണ്.

a) ഉം (ii) ഉം ശരിയാണ്.
c) (ii) ഉം (iii) ഉം ശരിയാണ്.
b) (i) ഉം (iii) ഉം ശരിയാണ്.
d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

16. ഏത് തമ്മിലുള്ള ഗുരുത്വാകർഷണബലമാണ് സാർവികഗുരുത്വാകർഷണനിയമത്തിൽ പ്രതിപാദിക്കുന്നത് ?

a) ഭൂമിയും ഏതെങ്കിലുമൊരു മാസും മാത്രം
b) ഭൂമിയും സൂര്യനും മാത്രം
c) ചാർജുള്ള ഏതെങ്കിലും രണ്ട് വസ്തുക്കൾ
d) മാസുള്ള ഏതെങ്കിലും രണ്ട് വസ്തുക്കൾ

17. തുല്യവലുപ്പമുള്ള രണ്ട് റബ്ബർ പന്തുകൾ ആദ്യം ഭൂമിയിലും പിന്നീട് ചന്ദ്രനിലും നിർബാധം പതിക്കുന്നു. ഒരു പന്ത് പൊള്ളയായതും മറ്റേത് പൊള്ളയല്ലാത്തതും ആണ്. ഭൂമിയിലുള്ള ഗുരുത്വാകർഷണത്വരണം $10\ m/s^2$ ഉം ചന്ദ്രനിലേത് $1.7\ m/s^2$ ഉം ആണ്. എങ്കിൽ കൂടുതൽ ഗുരുത്വാകർഷണബലം അനുഭവപ്പെടുന്ന പന്ത് ഏത്?

	പന്തിന്റെ തരം	നിർബാധപതന സ്ഥാനം
a)	പൊള്ളയായ പന്ത്	ചന്ദ്രൻ
b)	പൊള്ളയായ പന്ത്	ഭൂമി
c)	പൊള്ളയല്ലാത്ത പന്ത്	ചന്ദ്രൻ
d)	പൊള്ളയല്ലാത്ത പന്ത്	ഭൂമി

18. ഒരു വസ്തുവിന്റെ മാസ് 135 kg ആണെങ്കിൽ ഭൂമിയിൽ അതിന്റെ ഭാരമെത്ര?

c) 135 N c) 1323 N

d) 1224 N d) 1413 N

19. ഭൂമധ്യരേഖയിൽ വെച്ച് മാസും ഭാരവും തിട്ടപ്പെടുത്തിയ വസ്തു ഇപ്പോൾ ധ്രുവപ്രദേശത്ത് സ്ഥാപിക്കപ്പെടുന്നു. എങ്കിൽ താഴെ തന്നിരിക്കുന്നവയിൽ ശരിയായ പ്രസ്താവന ഏത് ?

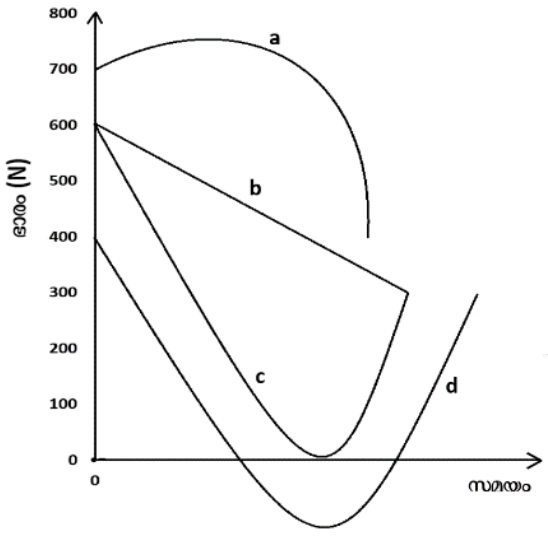
e) മാസ് വ്യത്യാസമില്ലാതിരിക്കുകയും ഭാരം ഏറ്റവും ഉയർന്ന മൂല്യത്തിലെത്തുകയും ചെയ്യുന്നു.

f) മാസ് വ്യത്യാസമില്ലാതിരിക്കുകയും ഭാരം ഏറ്റവും താഴ്ന്ന മൂല്യത്തിലെത്തുകയും ചെയ്യുന്നു.

g) മാസും ഭാരവും ഏറ്റവും ഉയർന്ന മൂല്യത്തിലെത്തുന്നു.

h) മാസും ഭാരവും ഏറ്റവും കുറഞ്ഞ മൂല്യത്തിലെത്തുന്നു.

20. ഭൂമിയുടെ ഉപരിതലത്തിൽ ഗുരുത്വാകർഷണത്വരണം $10\ m/s^2$ ഉം ചൊവ്വയുടെ ഉപരിതലത്തിൽ $4\ m/s^2$ഉം ആണെന്ന് സങ്കല്പിക്കുക. സ്ഥിരപ്രവേഗത്തിലുള്ള ഒരു ബഹിരാകാശവാഹനത്തിൽ ഭൂമിയിൽ നിന്ന് ചൊവ്വയിലേക്ക് 60 kg ഭാരമുള്ള ഒരു യാത്രികൻ സഞ്ചരിക്കുന്നു. ബഹിരാകാശത്തുള്ള മറ്റെല്ലാ വസ്തുക്കളെയും അവഗണിക്കുക. എങ്കിൽ താഴെ തന്നിരിക്കുന്ന ചിത്രത്തിൽ സമയാനുസൃതമായി യാത്രികന്റെ ഭാരം ശരിയായി സൂചിപ്പിക്കുന്ന ഭാഗമേത്?



21. ശരിയായ പ്രസ്താവന ഏത്?

a) യൂണിറ്റ് സമയത്തിൽ ഉണ്ടാവുന്ന ഊർജത്തിന്റെ അളവാണ് പ്രവൃത്തിയുടെ അളവ്.

b) സ്ഥിതികോർജത്തിൽ ഉണ്ടായ മാറ്റത്തിന് തുല്യമാണ് പ്രവൃത്തി എന്നതാണ് പ്രവൃത്തി-ഊർതത്ത്വം.

c) ഒരു വസ്തുവിന്മേൽ പ്രയോഗിച്ച ബലത്തിന്റെ ദിശയിൽ സ്ഥാനാന്തരം ഉണ്ടാകുമ്പോൾ മാത്രമാണ് പ്രവൃത്തി ചെയ്തതായി കണക്കാക്കുകയുള്ളൂ.

d) പ്രവൃത്തിയുടെയും സ്ഥാനാന്തരത്തിന്റെയും ഹരണഫലമാണ് പവർ.

22. പ്രവർത്തി നെഗറ്റീവ് ആകുന്ന സാഹചര്യത്തിൽ ബലത്തിനും സ്ഥാനാന്തരത്തിനുമിടക്കുള്ള കോണളവെത്ര ?

a) 180^0 c) 45^0

b) 90^0 d) 0^0

23. ഒരു നിരപ്പായ റോഡിൽ സഞ്ചരിക്കുന്ന കാറിന്റെ വേഗത കൂടി, അതിന്റെ പ്രവേഗം നാലിരട്ടിയായി വർധിക്കുന്നു. അപ്പോൾ കാറിന്റെ

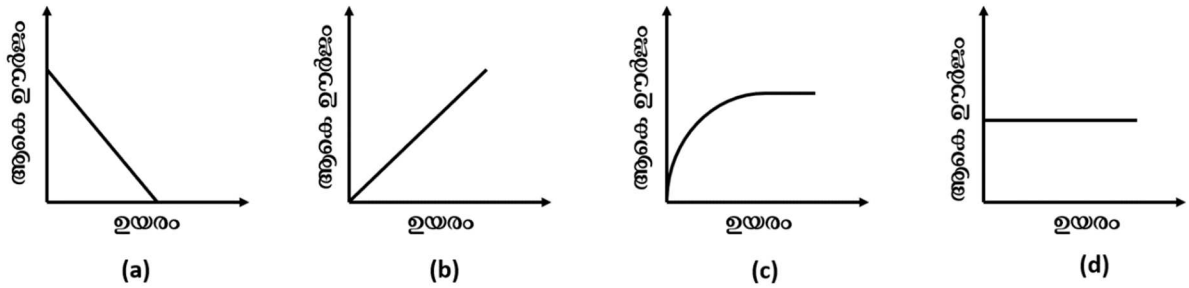
a) സ്ഥിതികോർജത്തിൽ മാറ്റമുണ്ടാവില്ല

b) സ്ഥിതികോർജം രണ്ടിരട്ടിയാകും

c) സ്ഥിതികോർജം നാലിരട്ടിയാകും

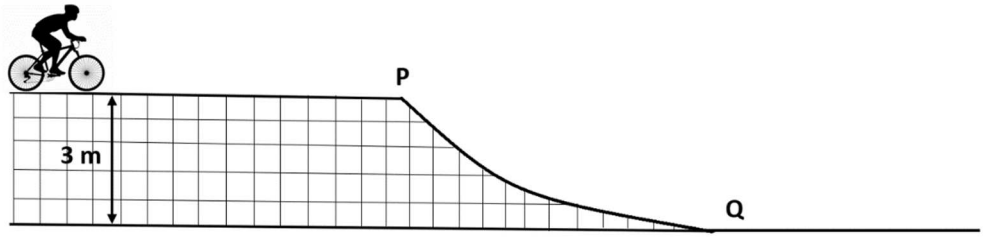
d) സ്ഥിതികോർജം പതിനാറിരട്ടിയാകും

24. ഒരു നിശ്ചിത ഉയരത്തിൽ നിന്ന് നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ ആകെ ഊർജം കാണിക്കുന്ന ഗ്രാഫ് ഏത് ?



25. ഒരു സൈക്കിൾ യാത്രികൻ ഒരു ചെറിയ കുന്നിലെ P എന്ന ബിന്ദുവിൽ നിന്നും താഴോട്ട് ഇറങ്ങി, Q എന്ന ബിന്ദുവിലൂടെ കടന്ന്, ശേഷം നിരപ്പായ റോഡിലൂടെ സഞ്ചരിക്കുന്നതാണ് ചിത്രത്തിൽ കാണിച്ചിരിക്കുന്നത്. യാത്രികന്റെയും

സൈക്കിളിന്റെയും ആകെ മാസ് 60 kg ആണ്. P എന്ന ബിന്ദുവിൽ യാത്രികന്റെ പ്രവേഗം 10 m/s ആണ്. എങ്കിൽ താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത്?



i. P എന്ന ബിന്ദുവിൽ ഗതികോർജം 3000 J ആണ്.

ii. P ഇനും Q ഇനുമിടക്ക് സ്ഥിതികോർജത്തിലുള്ള നഷ്ടം 3000 J ആണ്.

iii. മൊത്തം ഊർജം 6000 J ആണ്.

iv. ഉയർന്ന സ്ഥിരവേഗതയിൽ സഞ്ചരിക്കാൻ യാത്രികന് കൂടുതൽ പവർ ആവശ്യമാണ്.

a) ഉം (ii)ഉം ശരിയാണ്.
b) (i) ഉം (iv)ഉം ശരിയാണ്.
c) (ii) ഉം (iii)ഉം ശരിയാണ്.
d) (i) മാത്രം ശരിയാണ്.

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APPENDIX 14

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-A)
(FINAL – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

General Instructions:

This test consists of three sections: Section A (General Information), Section B (Ranking of Physics Concepts) and Section C (Conceptual Understanding Test). Separate instructions are provided under each section. Your responses will be only used for research purpose.

……

SECTION A

Instructions: Fill your basic information below.

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term examination of IX standard:

Marks scored in Physics in second term examination of IX standard:

……

SECTION B

Instructions: Following is the list of major concepts in IX standard physics textbook. You have to rank the given physics concepts based on the difficulty in learning them. The ranking is to be done in such a way that rank '1' should be written against the most difficult concept and rank '2' for the next difficult concept and so on.

No.	Concepts in physics	Rank
1.	Forces in Fluids	
2.	Equations of Motion	
3.	Motion and Laws of Motion	
4.	Gravitation	
5.	Work, Energy, Power	

……

SECTION C

Instructions: This section consists of 25 multiple choice type questions which are meant to measure the conceptual understanding in physics among IX standard students. The student would be required to answer all the questions. Separate response sheet is provided to mark the answers. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The responses can be marked by darkening the circle on the correct response. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response.

Maximum Marks: 25

Time: 60 minutes

1. Select the statement that explains the concept of Buoyancy.

a) When a body is immersed completely in a fluid, the fluid exerts a downward force on the body. This force is known as buoyancy.

b) When a body is immersed completely or partially in a fluid, the fluid exerts an upward force on the body. This force is known as buoyancy.

c) When a body is immersed partially in a fluid, the fluid exerts an upward force on the body. This force is known as buoyancy.

d) When a body sinks to the bottom of the fluid, the fluid exerts a downward force on the body. This force is known as buoyancy.

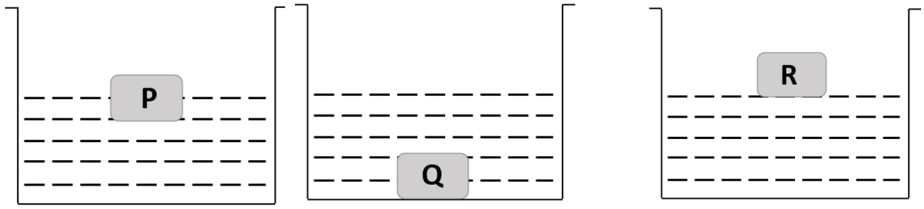
2. The instrument based on Archimedes principle is

a) Hydraulic lift
b) Hydraulic pump
c) Capillary tube
d) Hydrometer

3. The diameters of the pistons of a hydraulic jack are 1.5 cm and 15 cm. The force required to lift 1000 kg using it is

a) 1000 N
b) 100 N
c) 10 N
d) 50 N

4. P, Q and R are objects having different densities immersed in same liquid as shown below. Select the correct option showing their densities in descending order.



a) Q, P, R
b) P, Q, R
c) R, P, Q
d) Q, R, P

5. Select the correct statement based on floatation.

i. A body of weight 500 N sinks in water. If the weight of the liquid overflowed is 50 N, then the weight of the body in water is 400 N.

ii. If a body of weight 500 N floats in water, then its weight in water is 0 N and the weight of the water displaced is 500 N.

iii. A body of weight 750 N sinks in water. If the weight of the liquid overflowed is 150 N, then the weight of the body in water is 600 N.

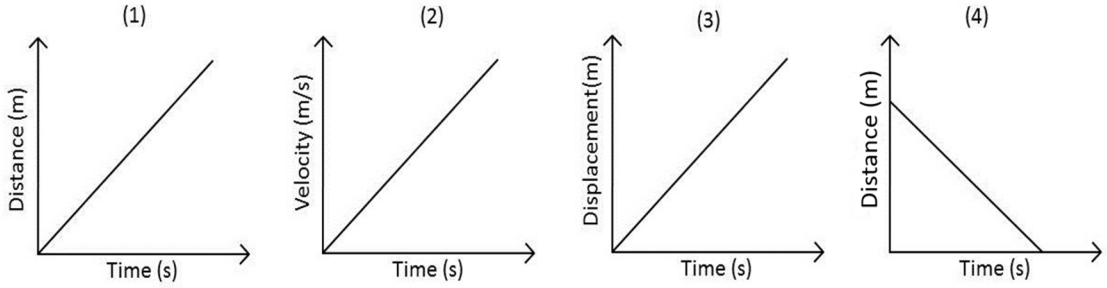
iv. If a body of weight 750 N floats in water, then its weight in water is 550 N and the weight of the water displaced is 200 N.

a) Both (i) and (ii) are correct.
b) Both (iii) and (iv) are correct.
c) Both (i) and (iv) are correct.
d) Both (ii) and (iii) are correct.

6. Correct equation of motion is

a) $v^2 = u^2 + 2as^2$
b) $v^2 = u^2 - 2as^2$
c) $u^2 = v^2 + 2as$
d) $v^2 = u^2 + 2as$

7. Select the diagram showing uniform acceleration.

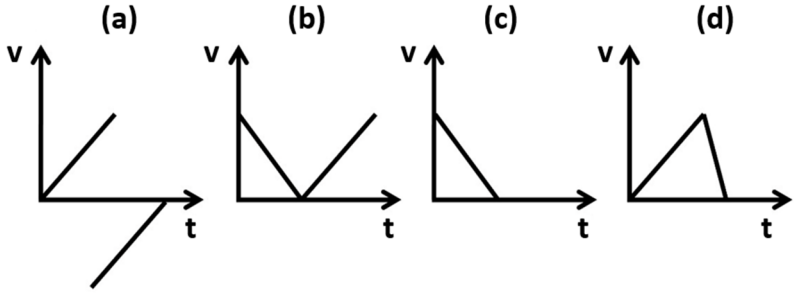


a) Only (1)
b) Only (2)
c) Both (2) and (3)
d) Both (1) and (4)

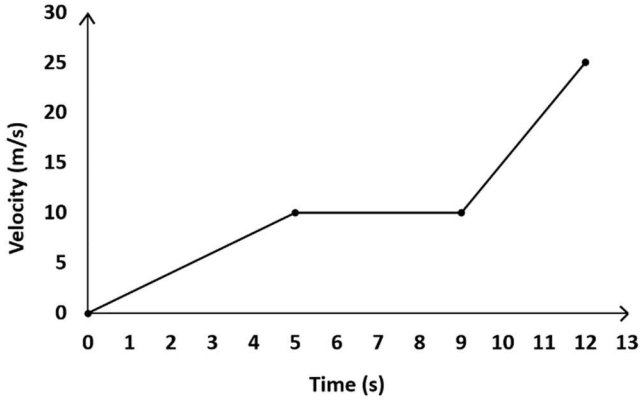
8. The retardation of the train which changes its velocity from 80 m/s to 20 m/s in 10 minutes will be

a) $0.1\ m|s^2$
b) $1\ m|s^2$
c) $6\ m|s^2$
d) $10\ m|s^2$

9. A freely falling body strikes the surface and rebounds. The velocity of the body with respect to time during its fall and rebound is represented by



10. A toy car moves from one place to another in 12 s time. Its velocity-time graph during the motion is shown in figure. Select the correct statement regarding the graph.



i. The maximum acceleration during the journey is $5\ m|s^2$.

ii. The distance covered during the time interval from 9 s to 12 s is 52.5 m.

iii. The minimum acceleration during the journey is $2\ m|s^2$.

a) Only (i) is correct.
b) Only (ii) is correct.
c) Both (i) and (ii) are correct.
d) All statements are correct.

11. Select the statement that explains 'Newton's Third Law of Motion'.

a) The rate of change of momentum of a body is directly proportional to the unbalanced external force acting upon it.
b) Every object continues in its state of rest or of uniform motion along a straight line unless an unbalanced external force acts on it.
c) To every action, there is an equal and opposite reaction.
d) The applied forces are said to be balanced forces, if the resultant force on the body is zero and such forces can neither move a body at rest nor stop a body in motion.

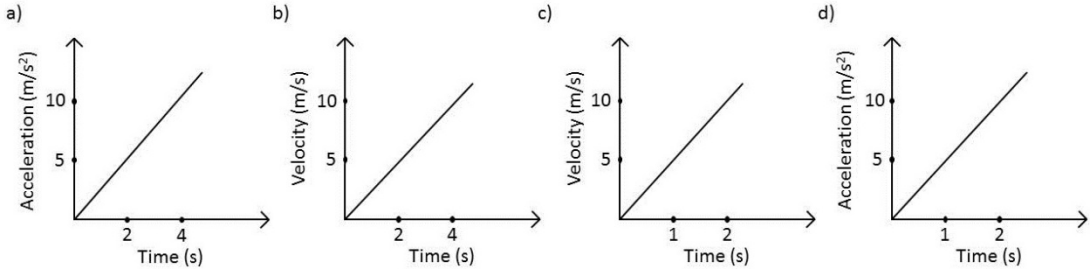
12. Which one of the following is an example for application of 'Newton's Second Law of Motion'?

a) When a carpet is beaten with a stick, dust particle comes out.
b) While firing a bullet, the gun moves in the direction opposite to that of the bullet.
c) Motion of the inflated balloon when it gets deflated and released suddenly.
d) Hay or sponges are used while packing glass wares to avoid breakage.

13. An object of mass 2 kg is sliding with a constant velocity of 4 m/s on a frictionless horizontal table. The force required to keep the object moving with the same velocity is

a) 0 N
b) 2 N
c) 6 N
d) 8 N

14. Select the graph that represents the motion of a body of mass 4 kg, if the force acting on it is 10 N.



15. The table given below shows the distance-time relation of an object in motion.

Time (in seconds)	Distance (in metres)
0	0
1	1
2	8
3	27
4	64
5	125

What do you infer about the forces acting on the object?

a) Force is constant.
b) Force is increasing uniformly with time.
c) Force is decreasing uniformly with time.
d) Force is zero.

16. Identify 'Universal Law of Gravitation' from the following.

a) The earth attracts all objects towards its centre and whether an object on earth stands erect or upside down is decided on the basis of the direction of gravity.
b) All bodies in the universe attract each other. The force of mutual attraction between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.
c) The force of mutual attraction between two planets is directly proportional to the cube of the mean distance between them and inversely proportional to the product of orbital velocities of the planets.

d) The force of attraction between two unit masses separated by a unit distance results in acceleration of the masses known as acceleration due to gravity.

17. A body of mass 1 kg is attracted by the earth with a force which is equal to

a) 6.67×10^{11} N
c) 9.8 N
b) 100 N
d) 1 N

18. If the mass of object is 88 kg, then its weight on moon will be

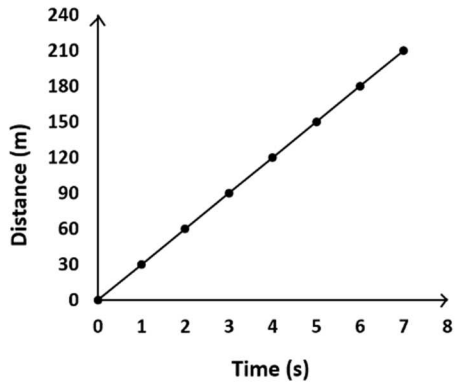
a) 88 N
c) 143.73 N
b) 132.33 N
d) 212.33 N

19. Select the correct statement about acceleration due to gravity 'g'.

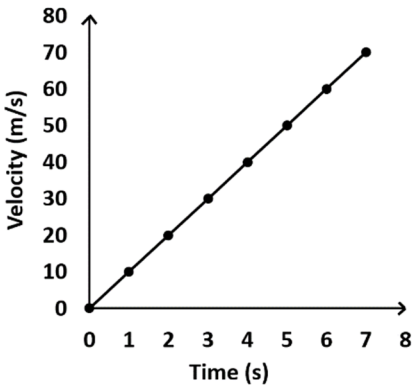
a) The value of 'g' decreases as we go towards the centre of the earth from its surface.
b) The value of 'g' increases as we go above the earth's surface.
c) The value of 'g' increases from pole to equator.
d) The value of 'g' on the Earth depends upon the mass of the body.

20. Manu was standing on a 245 m high tower with a stopwatch. He dropped a stone from the tower. Select the correct statement from the following.

i. The reading in the stopwatch when the stone reaches the ground is 6 s.
ii. The final velocity when the stone touched the ground is 70 m/s.
iii. The distance-time graph of the stone is



iv. The velocity-time graph of the stone is



c) Both (i) and (ii) are correct.
c) Both (ii) and (iii) are correct.
d) Both (i) and (iv) are correct.
d) Both (ii) and (iv) are correct.

21. Select the correct statement.

a) Work is said to be done only when a body undergoes displacement perpendicular to the applied force.
b) Work-energy principle states that work done is equal to change in potential energy.
c) The energy possessed by a body by virtue of its position is the potential energy.
d) Power is the ratio of work done to the displacement.

22. When a body falls freely towards the earth, then, its total energy

a) Increases
c) First increases, then decreases
b) Decreases
d) Remains constant

23. A girl is carrying a school bag of 3 kg mass on her back and moves 200m on a levelled road. The work done against the gravitational force will be (g=10 m / s^2)

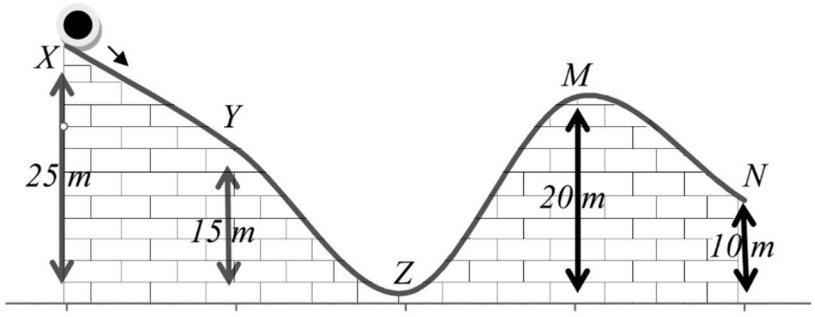
a) 6×10^3 J
c) 0.6 J
b) 6 J
d) 0 J

24. Select the instance of negative work.

a) Work done by the frictional force while an object is sliding down along an inclined plane.
b) Work done by a person drawing water from a well using a rope without a pulley.
c) Work done by the force to stretch a rubber band.

d) Work done by gravitational force on a mango hanging on a tree.

25. The diagram shows a frictionless track. If a heavier ball is released from point X, then, which of the given statement is true?



i. The ball will move with a greater speed at Y.

ii. The speed of the ball at M is 10 m / s.

iii. The loss of potential energy between X and Y is 5 J.

a) Only (i) is true.

b) Only (ii) is true.

c) Both (i) and (ii) are true.

d) Both (ii) and (iii) are true.

****

APPENDIX 15

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-B)
(FINAL – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

General Instructions:

This test consists of three sections: Section A (General Information), Section B (Ranking of Physics Concepts) and Section C (Conceptual Understanding Test). Separate instructions are provided under each section. Your responses will be only used for research purpose.

……

SECTION A

Instructions: Fill your basic information below.

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term examination of IX standard:

Marks scored in Physics in second term examination of IX standard:

……

SECTION B

Instructions: Following is the list of major concepts in IX standard physics textbook. You have to rank the given physics concepts based on the difficulty in learning them. The ranking is to be done in such a way that rank '1' should be written against the most difficult concept and rank '2' for the next difficult concept and so on.

No.	Concepts in physics	Rank
1.	Forces in Fluids	
2.	Equations of Motion	
3.	Motion and Laws of Motion	
4.	Gravitation	
5.	Work, Energy, Power	

……

SECTION C

Instructions: This section consists of 25 multiple choice type questions which are meant to measure the conceptual understanding in physics among IX standard students. The student would be required to answer all the questions. Separate response sheet is provided to mark the answers. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The responses can be marked by darkening the circle on the correct response. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response.

Maximum Marks: 25

Time: 60 minutes

1. Select the statement that explains Archimedes' principle.

a) When an object is immersed partially or completely in a fluid, the buoyancy experienced by it will be equal to the weight of the fluid displaced by it.

b) When an object is immersed partially or completely in a fluid, the gravitational force experienced by it will be equal to the weight of the fluid displaced by it.

c) When an object is immersed partially or completely in a fluid, the buoyancy experienced by it will be equal to the relative density of the fluid displaced by it.

d) When an object is immersed partially or completely in a fluid, the gravitational force experienced by it will be equal to the relative density of the fluid displaced by it.

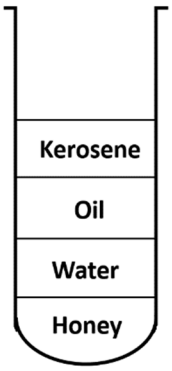
2. The principle in the functioning of excavators is

a) Buoyancy principle
b) Archimedes' principle
c) Pascal's Law
d) Law of floatation

3. A body of weight 1000 N sinks in water. If the weight of the liquid overflowed is 250 N, the weight of the body in water is

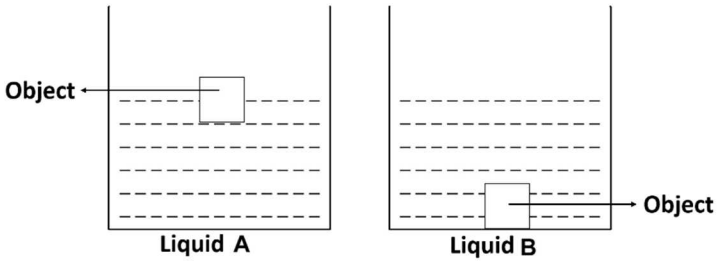
a) 250 N
b) 750 N
c) 1000 N
d) 1250 N

4. Following is the figure of a test tube that contains four different liquids. Arrange the liquids in the order of decreasing density.



a) Honey, Water, Oil, Kerosene
b) Kerosene, Oil, Water, Honey
c) Kerosene, Honey, Oil, Water
d) Water, Honey, Oil, Kerosene

5. Select the correct statement based on the figures.



i. In liquid A, the buoyant force acting on the object is greater than that in liquid B. But the gravitational force on object is greater in liquid B than in Liquid A.
ii. In Liquid A, buoyant force is less than the gravitational force on the object. While in liquid B, gravitational force on the object is less than the buoyant force.
iii. The density of the liquid B is less than that of the density of the object and liquid A.
iv. The relative density of the object is greater than that of liquid A and liquid B.

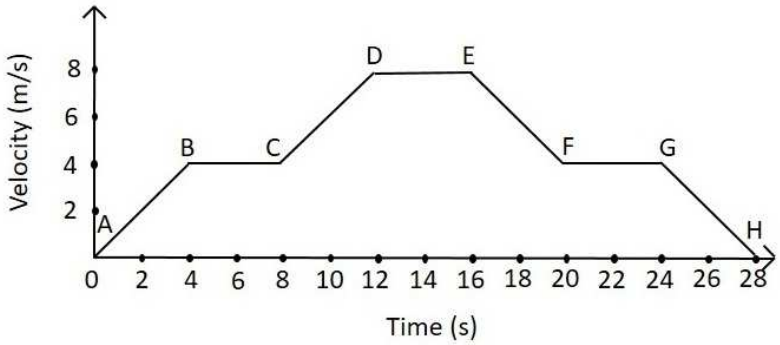
a) Only (i) is correct.
b) Only (iv) is correct.
c) Both (ii) and (iv) are correct.
d) Both (i) and (iii) are correct.

6. Correct equation of motion is

a) $s = ut - \frac{1}{2}\, at^2$ c) $s = ut + \frac{1}{2}\, at^2$

b) $s = ut + \frac{1}{2}\, a^2t^2$ d) $s = ut - \frac{1}{2}\, a^2t^2$

7. Select the option that represents accelerated motion.



a) CD and EF c) EF and GH

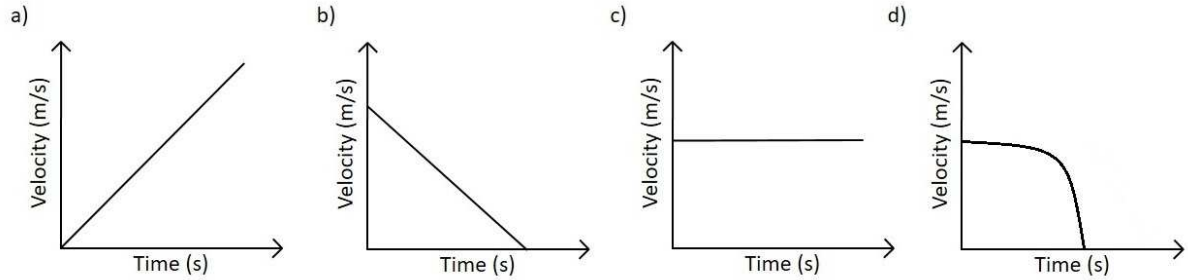
b) AB and CD d) BC, DE and FG

8. A stone is thrown vertically upward with an initial velocity of 40 m/s. The maximum height reached by the stone is

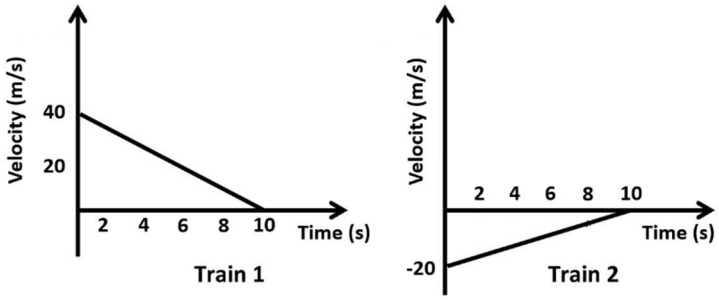
a) 40 m c) 80 m

b) 60 m d) 100 m

9. Select the graph showing the change in velocity of a freely falling body.



10. Two trains, which are moving along different tracks in opposite directions are put on the same track due to mistake. Their drivers on noticing the mistake, start slowing down the trains when the trains are 300 m apart. Given below are the velocity-time graphs of the two trains as they slow down. Identify the correct statement regarding the journey of the trains.



i. On applying brakes, Train 2 travels more distance than Train 1 before coming to rest.

ii. The separation between the trains when both have stopped is 20 m.

iii. On applying brakes, if the velocity-time graph of Train 2 was same as that of Train 1, then the two trains would have collided.

a) Only (i) is correct.
b) Only (ii) is correct.
c) Both (i) and (ii) are correct.
d) Both (ii) and (iii) are correct.

11. Identify the statement of 'Newton's First Law of Motion'.

a) The sum of momentum of the two objects before collision is equal to the sum of momentum after the collision provided there is no external unbalanced force acting on them.

b) The rate of change of momentum of a body is directly proportional to the unbalanced external force acting on it.

c) Every object continues in its state of rest or of uniform motion along a straight line unless an unbalanced external force acts on it.

d) The applied forces are said to be balanced forces, if the resultant force on the body is zero and such forces can neither move a body at rest nor stop a body in motion.

12. Which one of the following is an example for application of the 'Law of Conservation of Momentum'?

a) In high jump competition, the athlete is made to fall on a cushioned bed.

b) When a carpet is beaten with a stick, dust particle comes out.

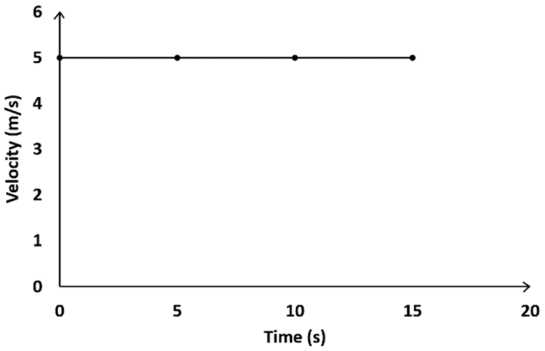
c) Karate experts move their hands with great speed to chop strong bricks.

d) A body suspended from the hook of a spring balance in a lift is accelerated downwards as the lift moves up.

13. If the mass of a moving body were doubled, keeping the force acting upon it the same, then the acceleration of the body

a) Will remain the same
b) Will be doubled
c) Will become zero
d) Will be halved

14. Velocity-time graph of a moving particle of mass 2 kg is shown below. The force acting on the body is



a) 0 N
b) 2.5 N
c) 10 N
d) 20 N

15. A large bus and a van, both moving with a velocity v, have a head-on-collision and both the vehicles stop after the collision. If the time of the collision is 1 second, then,

i. Bus experiences smaller force of impact.
ii. Van experiences smaller momentum change.
iii. Van experiences greater acceleration.

a) Statements (i) and (ii) are correct.
b) Statements (ii) and (iii) are correct.
c) Statements (i) and (iii) are correct.
d) All statements are correct.

16. The 'G' in the mathematical expression of Universal Law of Gravitation

a) Depends on the value of 'g' at the place of observation
b) Is universal gravitational constant
c) Is used only when the Earth is one of the two masses
d) Is greatest at the surface of the Earth

17. When a mango falls from a mango tree,

a) Only the Earth attracts the mango.
b) Only the mango attracts the Earth.

c) Both the mango and the Earth attract each other.

d) The tree repels and the Earth attracts the mango.

18. Two particles are placed at some distance. If the mass of each of the two particles is doubled, keeping the distance between them unchanged, then, the value of gravitational force between them will be

a) $\frac{1}{4}$ times

c) $\frac{1}{2}$ times

b) 4 times

d) 2 times

19. If the gravitational force of attraction of the Earth suddenly disappears, which one of the following will be true?

a) The weight of the body will become zero, but the mass will remain same.

b) The weight of the body will remain same, but the mass will become zero

c) Both mass and weight become zero

d) Neither mass nor weight becomes zero

20. Sunil threw a ball while standing on the jumping board of a swimming pool, which is at a height of 45 m. After one second, he threw another ball from the same board with initial velocity u. Both the balls hit the water together. Select the correct statement.

i. The first ball takes 3 s to reach the water surface.

ii. The initial velocity of the second ball is 12.5 m/s.

iii. The two balls hit the water with same velocity.

iv. The second ball hits the water with higher velocity.

a) Both (i) and (iii) are correct.

c) (i), (ii) and (iii) are correct.

b) Both (ii) and (iii) are correct.

d) (i), (ii) and (iv) are correct.

21. Select the correct statement.

a) Work is said to be done only when a body undergoes displacement perpendicular to the applied force.

b) The energy possessed by a body by virtue of its motion is the kinetic energy.

c) Work-energy principle states that work done is equal to change in potential energy.

d) Power is the ratio of work done to the displacement.

22. If the displacement is perpendicular to the force, then the work done is said to be

a) Negative
b) Positive
c) Zero
d) Infinity

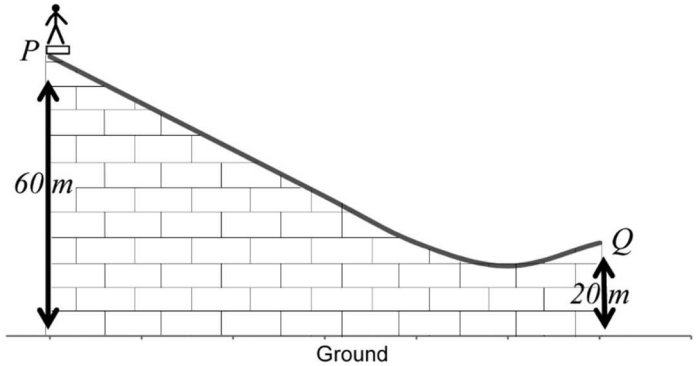
23. A body is falling from a height h. After it has fallen a height $\frac{h}{2}$, it will possess

a) Only potential energy
b) Only kinetic energy
c) Half potential energy and half kinetic energy
d) More kinetic energy and less potential energy

24. Person A reached the second floor of a hospital by lift and person B reached the same floor by stairs. If both their masses are the same, then the

a) Work done by them against the gravitational force is the same.
b) Work done by A against the gravitational force is greater than that done by B.
c) Work done by B against the gravitational force is greater than that done by A.
d) Power expended by both A and B is the same.

25. A skier of mass 50 kg stands at point P at the top of the ski jump. He moves from P to Q and takes off his jump at Q as shown in figure. If 50 % of the change in the potential energy of the skier between points P and Q becomes the kinetic energy at Q, select the correct statement.



i. The change in gravitational potential energy of the skier is 10000 J.
ii. The kinetic energy of the skier is 5000 J.

iii. Speed with which the skier arrives at Q is 20 m/s.

a) Only (i) is correct.
b) Both (i) and (ii) are correct.
c) Both (ii) and (iii) are correct.
d) Only (iii) is correct.

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APPENDIX 16

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-C)
(FINAL – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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General Instructions:

This test consists of three sections: Section A (General Information), Section B (Ranking of Physics Concepts) and Section C (Conceptual Understanding Test). Separate instructions are provided under each section. Your responses will be only used for research purpose.

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SECTION A

Instructions: Fill your basic information below.

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term examination of IX standard:

Marks scored in Physics in second term examination of IX standard:

……

SECTION B

Instructions: Following is the list of major concepts in IX standard physics textbook. The student is have to rank the given physics concepts based on the difficulty in learning them. The ranking is to be done in such a way that rank '1' should be written against the most difficult concept and rank '2' for the next difficult concept and so on.

No.	Concepts in physics	Rank
1.	Forces in Fluids	
2.	Equations of Motion	
3.	Motion and Laws of Motion	
4.	Gravitation	
5.	Work, Energy, Power	

……

SECTION C

Instructions: This section consists of 25 multiple choice type questions which are meant to measure the conceptual understanding in physics among IX standard students. The student would be required to answer all the questions. Separate response sheet is provided to mark the answers. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The responses can be marked by darkening the circle on the correct response. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response.

Maximum Marks: 25

Time: 60 minutes

1. Select the statement that explains Viscous force.

a) When a body is immersed completely or partially in a fluid, the fluid exerts an upward force on the body. This force is known as viscous force.

b) The force applied at any point of a liquid at rest in a closed system will be experienced equally at all parts of the liquid and the force is known as viscous force.

c) Due to the mutual attraction of the molecules on the surface of water, the surface is stretched like a membrane. The force responsible for this is called viscous force.

d) Between the layers of a liquid in motion, there is a frictional force parallel to the layers which try to prevent the relative motion between the layers. This force is the viscous force.

2. Which among the following is an example for buoyant force?

a) A hydrogen filled balloon rising in the air.

b) Water flows when placed on a tilted glass plate.

c) Rocket after propulsion moves upward in the air.

d) Ink in the fountain pen reaches the nib.

3. An object of weight W is immersed in a liquid. If the upthrust is equal to $\frac{1}{4}$ th the weight of the object immersed in the liquid, then its weight in the liquid is

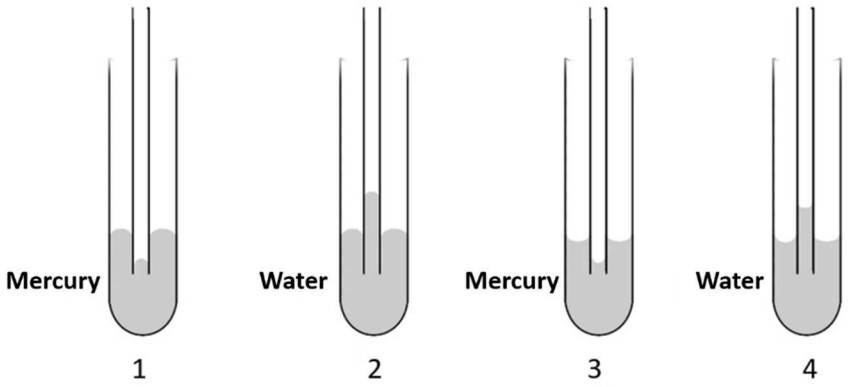
a) $2\,W$

b) $\frac{1}{4}\,W$

c) $\frac{3}{4}\,W$

d) $\frac{1}{2}\,W$

4. Based on the principle of capillarity, select the correct diagram from the following.



a) Only 4 is correct.

b) Both 1 and 4 are correct.

c) Both 2 and 4 are correct.

d) Both 2 and 3 are correct.

5. There are two liquids A and B whose relative densities are 0.75 and 1.0 respectively. If we dip solid objects P and Q having relative densities 0.6 and 0.9 respectively, in these liquids, then,

a) P floats in A and Q sinks in B.

b) P sinks in A and Q floats in B.

c) P floats in B and Q sinks in A.

d) P sinks in B and Q floats in A.

6. Correct equation of motion is

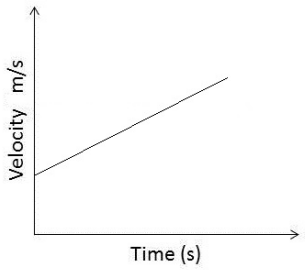
a) $v = u + at^2$

b) $v = u + at$

c) $v = ut + at^2$

d) $v = u - at$

7. According to the given velocity-time graph, the object

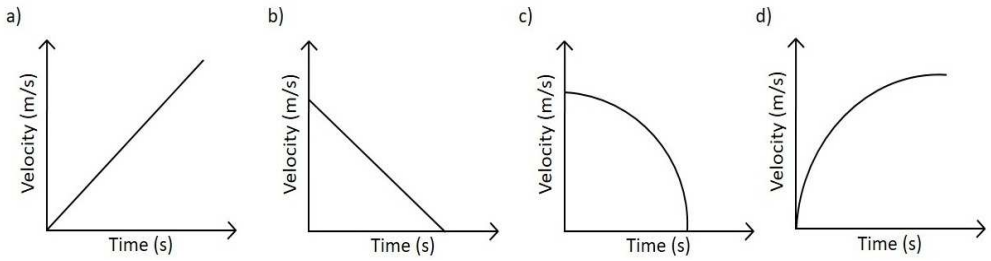


a) Has initial velocity which is not zero
b) Is moving with uniform velocity
c) Has initial velocity which is not zero and later is moving with uniform velocity
d) Is at rest

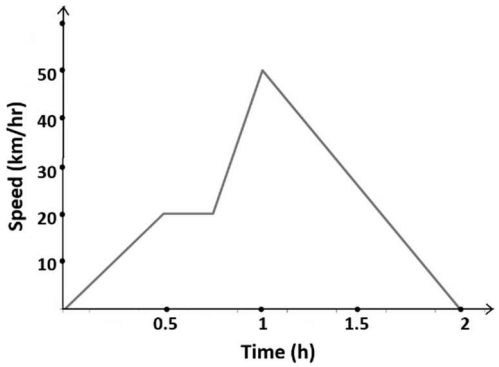
8. A train starts from rest and moves with uniform acceleration $0.1\,m/s^2$ for 2 minutes. The distance travelled by the train is

a) 0.05 m
b) 20 m
c) 360 m
d) 720 m

9. Select the graph showing the acceleration of a body when thrown vertically upward.



10. A train moves from one station to another in 2 hrs time. Its speed-time graph during the motion is shown in figure. Identify the correct statement regarding the graph.



i. The maximum acceleration during the journey is $120\ km/hr^2$.

ii. The distance covered during the time interval from 0.75 hr to 1 hr is 8.75 km.

iii. From the beginning of the journey to 0.5 hrs, the train moves with constant velocity.

a) Only (i) is correct.
b) Only (ii) is correct.
c) Both (i) and (ii) are correct.
d) All statements are correct.

11. Identify the statement of 'Newton's Second Law of Motion'.

a) The rate of change of momentum of a body is directly proportional to the unbalanced external force acting on it.
b) The sum of momentum of the two objects before collision is equal to the sum of momentum after the collision provided there is no external unbalanced force acting on them.
c) Every object continues in its state of rest or of uniform motion along a straight line unless an unbalanced external force acts on it.
d) The applied forces are said to be balanced forces, if the resultant force on the body is zero and such forces can neither move a body at rest nor stop a body in motion.

12. Which one of the following is an example for application of 'Newton's First Law of Motion'?

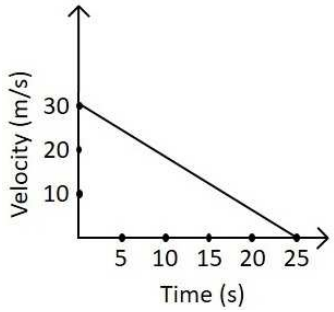
a) When a carpet is beaten with a stick, dust particle comes out.
b) Recoiling of a gun while firing a bullet.
c) Motion of the inflated balloon when it gets deflated and released suddenly.

d) Hay or sponges are used while packing glass wares to avoid breakage.

13. The speed of a car weighing 1500 kg increases from 32 km/hr to 72 km/hr uniformly. The change in momentum of the car is

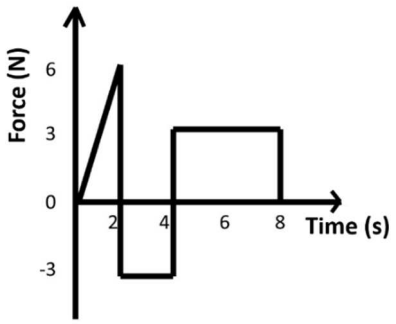
a) 15000 kg km/hr
b) 15000 kg m/s
c) 54000 kg m/s
d) 54000 g m/s

14. Velocity-time graph of a body of 50 kg rolling on a floor is given below. The force acting on the body is



a) 5 N
b) 25 N
c) 30 N
d) 60 N

15. The force F acting on a particle of mass m is indicated by the force-time graph shown below. Identify the correct statement.



i. Change in momentum of the particle over the time interval from 0 to 4s is same as that between 4s to 8s.

ii. Change in momentum of the particle over the time-interval from 0 to 2s and that between 2s to 4s is same in magnitude.

iii. Change in momentum of the particle over the time interval from zero to 8s is 12 N.

a) Statements (i) and (ii) are correct. c) Statements (ii) and (iii) are correct.

b) Statements (i) and (iii) are correct. d) All statements are correct.

16. The Universal Law of Gravitation gives the gravitational force between

a) The earth and any mass only

b) The earth and sun only

c) Any two charged bodies

d) Any two bodies having mass

17. Two rubber balls of the same size are dropped on the earth and on the moon. One ball is solid and other is hollow. The gravitational acceleration on the earth is 10 m/s^2 and on the moon is 1.7 m/s^2. Which ball has greater force acting on it?

	Type of ball	**Where it is dropped**
a)	Hollow	On the moon
b)	Hollow	On the earth
c)	Solid	On the moon
d)	Solid	On the earth

18. The mass of an object is 135 kg, then its weight on earth will be

a) 135 N

b) 1224 N

c) 1323 N

d) 1413 N

19. A body, the mass and the weight of which were already determined at the equator, is now placed at the pole. Choose the correct statement from the following.

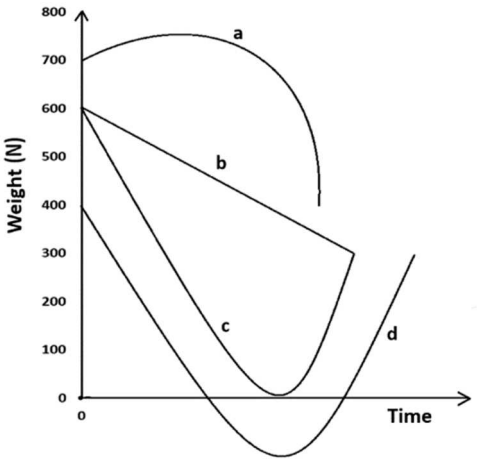
a) Mass does not change, weight is maximum.

b) Mass does not change, weight is minimum.

c) Both mass and weight are maximum.

d) Both mass and weight are minimum.

20. Suppose the acceleration due to gravity at the earth's surface is 10 $m/s^2$and at the surface of Mars is 4 m/s^2. A passenger having weight 60 kg goes from the Earth to the Mars in a spaceship moving with a constant velocity. Neglect all other objects in the sky. Which part of the figure represents the weight of the passenger with respect to time?



21. Select the correct statement.

a) Amount of energy per unit time is the amount of work.

b) Work-energy principle states that work done is equal to change in potential energy.

c) Work is said to be done only when a body undergoes displacement in the direction of applied force.

d) Power is the ratio of work done to the displacement.

22. In the case of negative work, the angle between the force and displacement is

a) 180^0 c) 45^0

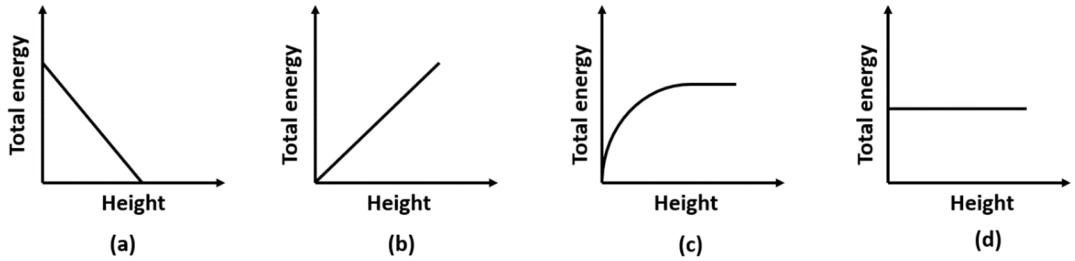
b) 90^0 d) 0^0

23. A car is accelerated on a levelled road and attains a velocity of four times of its initial velocity, In this process, the potential energy of the car

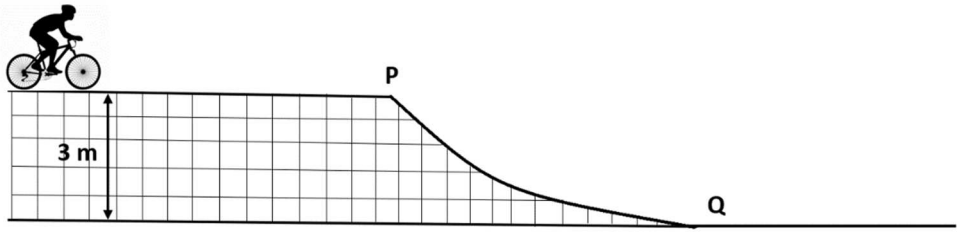
a) Does not change c) Becomes four times that of initial

b) Becomes twice to that of initial d) Becomes 16 times that of initial

24. The graph of the total energy of a freely falling body from a height is



25. The diagram shows a cyclist moving down a small hill at P before travelling on a flat road after point Q. The total mass of the cyclist and his bicycle is 60 kg and the speed of the cyclist at P is 10 m/s. Select the correct statement. (Take g=10 m / s^2)



i. The kinetic energy at P is 3000 J

ii. The loss of potential energy between P and Q is 3000 J.

iii. The total energy is 6000 J.

iv. The cyclist requires a greater power when he travels at a higher constant speed.

a) Both (i) and (ii) are correct.

b) Both (i) and (iv) are correct.

c) Both (ii) and (iii) are correct.

d) Only (i) is correct.

****

APPENDIX 17

RESPONSE SHEET(DRAFT)
CONCEPTUAL UNDERSTANDING TEST IN PHYSICS

GENERAL DATA

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term examination of IX standard:

Marks scored in Physics in second term examination of IX standard:

ANSWERS

1. ⓐ ⓑ ⓒ ⓓ	11. ⓐ ⓑ ⓒ ⓓ	21. ⓐ ⓑ ⓒ ⓓ
2. ⓐ ⓑ ⓒ ⓓ	12. ⓐ ⓑ ⓒ ⓓ	22. ⓐ ⓑ ⓒ ⓓ
3. ⓐ ⓑ ⓒ ⓓ	13. ⓐ ⓑ ⓒ ⓓ	23. ⓐ ⓑ ⓒ ⓓ
4. ⓐ ⓑ ⓒ ⓓ	14. ⓐ ⓑ ⓒ ⓓ	24. ⓐ ⓑ ⓒ ⓓ
5. ⓐ ⓑ ⓒ ⓓ	15. ⓐ ⓑ ⓒ ⓓ	25. ⓐ ⓑ ⓒ ⓓ
6. ⓐ ⓑ ⓒ ⓓ	16. ⓐ ⓑ ⓒ ⓓ	
7. ⓐ ⓑ ⓒ ⓓ	17. ⓐ ⓑ ⓒ ⓓ	
8. ⓐ ⓑ ⓒ ⓓ	18. ⓐ ⓑ ⓒ ⓓ	
9. ⓐ ⓑ ⓒ ⓓ	19. ⓐ ⓑ ⓒ ⓓ	
10. ⓐ ⓑ ⓒ ⓓ	20. ⓐ ⓑ ⓒ ⓓ	

APPENDIX 18

SCORING KEY (FINAL)
CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-A)

No.	a	b	c	d
1.		✓		
2.				✓
3.			✓	
4.	✓			
5.				✓
6.				✓
7.		✓		
8.	✓			
9.	✓			
10.			✓	
11.			✓	
12.				✓
13.	✓			
14.		✓		
15.		✓		
16.		✓		
17.			✓	
18.			✓	
19.	✓			
20.				✓
21.			✓	
22.				✓
23.				✓
24.	✓			
25.		✓		

APPENDIX 19

SCORING KEY (FINAL)
CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-B)

No.	a	b	c	d
1.	✓			
2.			✓	
3.		✓		
4.	✓			
5.				✓
6.			✓	
7.		✓		
8.			✓	
9.	✓			
10.				✓
11.			✓	
12.				✓
13.				✓
14.	✓			
15.		✓		
16.		✓		
17.			✓	
18.		✓		
19.	✓			
20.				✓
21.		✓		
22.			✓	
23.			✓	
24.	✓			
25.				✓

APPENDIX 20

SCORING KEY (FINAL)
CONCEPTUAL UNDERSTANDING TEST IN PHYSICS (SET-C)

No.	a	b	c	d
1.				✓
2.	✓			
3.			✓	
4.		✓		
5.			✓	
6.		✓		
7.	✓			
8.				✓
9.		✓		
10.			✓	
11.	✓			
12.	✓			
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19.	✓			
20.			✓	
21.			✓	
22.	✓			
23.	✓			
24.				✓
25.		✓		

APPENDIX 21

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

SCALE ON INSTRUCTIONAL PRACTICES IN PHYSICS
(DRAFT – MALAYALAM)

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Professor
Farook Training College

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നിർദ്ദേശങ്ങൾ:

ഒമ്പതാം ക്ലാസ്സിലെ കുട്ടികളെ ഭൗതികശാസ്ത്രം പഠിപ്പിക്കുമ്പോൾ, വ്യത്യസ്ത പഠന-ബോധന സന്ദർഭങ്ങളിൽ അധ്യാപകരുടെ ബോധന രീതികളുടെ ഉപയോഗം എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്തുകയാണ് ഈ സ്കെയ്ലിന്റെ ലക്ഷ്യം. ഒരോ പ്രസ്താവനയ്ക്കും 'മിക്കപ്പോഴും', 'ചിലപ്പോഴൊക്കെ', 'അപൂർവമായി', 'ഒരിക്കലുമില്ല' എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. നിങ്ങൾക്ക് ഉചിതമെന്ന് തോന്നുന്നതിന് നേരെ ✓ രേഖപ്പെടുത്തുക. ശരിയുത്തരം തെറ്റുത്തരം എന്നിങ്ങനെ ഇല്ല എന്നത് ശ്രദ്ധിക്കണം. എല്ലാ ചോദ്യങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്തണം എന്നത് നിർബന്ധമാണ്. നിങ്ങളിൽ നിന്നും സ്വീകരിക്കുന്ന പ്രതികരണങ്ങൾ ഗവേഷണത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ. അത് തികച്ചും രഹസ്യമായി സൂക്ഷിക്കുകയും ചെയ്യും.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	അപൂർവമായി	ഒരിക്കലുമില്ല
പുതിയ ആശയം അവതരിപ്പിക്കാൻ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (1-8)?					
1.	വാമൊഴിയായി പറഞ്ഞു കൊണ്ട്				
2.	പാഠപുസ്തകത്തിലെ ഉദാഹരണങ്ങൾ നൽകിക്കൊണ്ട്				

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	ഒരിക്കലുമില്ല	അപൂർവ്വമായി	ചിലപ്പോൾ	പലപ്പോഴും
3.	ഞങ്ങൾക്ക് അറിയുന്ന ആശയങ്ങളോട് ബന്ധപ്പെടുത്തിക്കൊണ്ട്				
4.	ദൈനംദിന ഉദാഹരണങ്ങളോട് ബന്ധപ്പെടുത്തിക്കൊണ്ട്				
5.	എളുപ്പമുള്ള ഉദാഹരങ്ങൾ ചെയ്ത് കാണിച്ച് കൊണ്ട്				
6.	ചോദ്യങ്ങൾ ചോദിച്ച് ഞങ്ങളിൽ നിന്ന് ശരിയായ പ്രതികരണം (ആശയങ്ങൾ/ നിർദ്ദേശങ്ങൾ) കൊണ്ടുവരുന്നതിലൂടെ				
7.	വീഡിയോസ്/ ആനിമേഷൻസിലൂടെ				
8.	സ്ലൈഡ്/ ലഘുലേഖയിലൂടെ				
കണക്ക് ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (9-15)?					
9.	ബ്ലാക്ക് ബോർഡിൽ ചെയ്ത് കാണിച്ച് കൊണ്ട്				
10.	സ്ലൈഡ്/ വീഡിയോസ് എന്നിവ പ്രദർശിപ്പിച്ചുകൊണ്ട്				
11.	പടിപടിയായ നൽകുന്ന നിർദ്ദേശങ്ങൾ പിന്തുടരാൻ പറഞ്ഞു കൊണ്ട്				
12.	ഞങ്ങളിൽ ഏതെങ്കിലും ഒരാളോട് ബ്ലാക്ക് ബോർഡിൽ കണക്ക് ചെയ്യാനും പിന്നീട് മറ്റുള്ളവരോട് അത് ശെരിയാണോ എന്ന് പരിശോധിക്കാനും ആവശ്യപ്പെട്ട് കൊണ്ട്				
13.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
14.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് ചർച്ച ചെയ്ത് ഉത്തരങ്ങൾ കണ്ടെത്തി അവതരിപ്പിക്കുവാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
15.	ഞങ്ങൾ കണക്ക് ചെയുമ്പോൾ മേൽനോട്ടം വഹിക്കുകയും സഹായിക്കുകയും ചെയ്യ കൊണ്ട്				
പരീക്ഷണം/പ്രവർത്തനം ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (16-22)?					
16.	വാമൊഴിയായി പറഞ്ഞു കൊണ്ട്				
17.	വീഡിയോയിലൂടെ				
18.	കണ്ടെത്തലുകൾ ചെയ്ത് കാണിച്ചും വിശദീകരിക്കുകയും				

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	ഒരിക്കലുമില്ല	അപൂർവ്വമായി	ചിലപ്പോൾ	പലപ്പോഴും
	ചെയ്യ കൊണ്ട്				
19.	ചെയ്ത് കാണിച്ചതിന് ശേഷം അത് വിശകലനം ചെയ്ത് നിഗമനത്തിലെത്താൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
20.	ഞങ്ങൾ ഓരോരുത്തരോടും ഒറ്റയ്ക്ക് അവ ചെയ്ത് കണ്ടെത്തലുകൾ വിശകലനം ചെയ്ത് നിഗമനങ്ങൾ അവതരിപ്പിക്കുവാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
21.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് അവ ചെയ്ത് കണ്ടെത്തലുകൾ വിശകലനം ചെയ്ത് നിഗമനങ്ങൾ അവതരിപ്പിക്കുവാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
22.	അവ ശരിയായ രീതിയിൽ ചെയ്യാനുള്ള നിർദ്ദേശങ്ങൾ നൽകി കൊണ്ട്				
പ്രൊജക്ട് ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (23-30)?					
23.	വിഷയം നേരിട്ട് പറഞ്ഞ് കൊടുത്ത് കൊണ്ട്				
24.	ക്ലാസ്സിലെ ചർച്ചയ്ക്കിടെ വെല്ലുവിളി നിറഞ്ഞ ഒരു സാഹചര്യത്തിലൂടെ വിഷയം അവതരിപ്പിച്ചു കൊണ്ടും ഒരു പ്രശ്നത്തിലേക്ക് കടന്നുകൊണ്ടും				
25.	ഞങ്ങൾ ഓരോരുത്തരോടും ഒറ്റയ്ക്ക് അവ ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
26.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് അവ ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
27.	അവ സംബന്ധിച്ച വിവരങ്ങളും വിഭവങ്ങളും നൽകി കൊണ്ട്				
28.	അവ സംബന്ധിച്ച വിവരങ്ങളും വിഭവങ്ങളും സ്വയം കണ്ടെത്താൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
29.	പഠന നേട്ടങ്ങൾ ആർജ്ജിച്ചോ എന്ന് ഉറപ്പ് വരുത്തുന്നതിനായി, എല്ലാവരുടെയും അവതരണങ്ങൾക്ക് ശേഷം സാരാംശം ക്രോഡീകരിച്ച് കൊണ്ട്				
30.	ഞങ്ങളുടെ അവതരണങ്ങൾക്ക് ശേഷം കൂടുതൽ നിർദ്ദേശങ്ങൾ നൽകി കൊണ്ട്				
മൂല്യനിർണ്ണയം നടത്തുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (31-38)?					

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	ഒരിക്കലുമില്ല	അപൂർവ്വമായി	ചിലപ്പോൾ	എപ്പോഴും
31.	മനസ്സിലായോ എന്ന് അന്വേഷിച്ച് കൊണ്ട്				
32.	ഞങ്ങൾക്ക് മനസ്സിലാകാത്ത സന്ദർഭങ്ങളിൽ വീണ്ടും വിവരിച്ചും സംശയങ്ങൾ വിശദീകരിച്ചും കൊണ്ട്				
33.	ക്ലാസ്സിനിടയിൽ ചോദ്യങ്ങൾ ചോദിച്ച് കൊണ്ട്				
34.	ക്ലാസ്സ് തുടങ്ങുന്നതിന് മുമ്പ് തലേ ദിവസം പഠിപ്പിച്ച ആശയത്തെ ആസ്പദമാക്കി ഞങ്ങൾക്കിടയിൽ ചോദ്യങ്ങൾ ചോദിച്ച് കൊണ്ട്				
35.	സ്വയം ചോദ്യങ്ങൾ ഉണ്ടാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
36.	ഗ്രൂപ്പുകളായി തിരിഞ്ഞു ചർച്ച ചെയ്ത് ചോദ്യങ്ങൾ ഉണ്ടാക്കുകയും ഗ്രൂപ്പുകൾക്കിടയിൽ ക്വിസ്സ് നടത്താനും നിർദ്ദേശിച്ച് കൊണ്ട്				
37.	ഞങ്ങൾ നടത്തുന്ന ക്വിസ്സിന് മേൽനോട്ടവും മദ്ധ്യസ്ഥതയും വഹിച്ച കൊണ്ട്				
38.	മൂല്യനിർണ്ണയത്തിനുള്ള ഓൺലൈൻ ഉപകരണങ്ങൾ ഉപയോഗിച്ച് കൊണ്ട് (eg: Kahoot, Socrative, Google forms, Quizizz)				
ക്രോഡീകരണത്തിനായി അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (39-43)?					
39.	വാമൊഴിയായി പറഞ്ഞു കൊണ്ട്				
40.	സ്ലൈഡ്/ വീഡിയോസ് എന്നിവ പ്രദർശിപ്പിച്ചുകൊണ്ട്				
41.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
42.	ഗ്രൂപ്പ് ചർച്ച ചെയ്യാൻ നിർദ്ദേശിച്ചുകൊണ്ട്				
43.	ഞങ്ങളുടെ അവതരണത്തിന് ശേഷം അവ വിലയിരുത്തിയും തിരുത്തലുകൾ നിർദ്ദേശിക്കുകയും ചെയ്തുകൊണ്ട്				
നോട്ട് തയ്യാറാക്കുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (44-48)?					
44.	നോട്ട് പറഞ്ഞെഴുതിച്ച് കൊണ്ട്				
45.	അച്ചടിച്ച രൂപം / പി.ഡി എഫ് / സ്ലൈഡ് എന്നിവ നൽകിക്കൊണ്ട്				

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	ഒരിക്കലുമില്ല	അപൂർവ്വമായി	ചിലപ്പോൾ	പലപ്പോഴും
46.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് തയ്യാറാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
47.	ഗ്രൂപ്പ് ചർച്ചയിലൂടെ തയ്യാറാക്കാൻ പറഞ്ഞു കൊണ്ട്				
48.	ഞങ്ങൾ തയ്യാറാക്കിയ നോട്ട് പരിശോധിച്ചും ആവശ്യാനുസരണം നിർദ്ദേശങ്ങൾ നൽകിക്കൊണ്ടും				
തുടർപ്രവർത്തനങ്ങൾ (ഹോംവർക്ക്/വർക്ക്ഷീറ്റ്/അസൈൻമെൻറ്) ചെയ്യിപ്പിക്കാൻ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (49-51)?					
49.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് തയ്യാറാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
50.	ഗ്രൂപ്പ് ചർച്ചകൾക്ക് ശേഷം ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
51.	ഞങ്ങൾ കണ്ടെത്തിയ ഉത്തരങ്ങൾ പരിശോധിക്കുകയും ആവശ്യമെങ്കിൽ നിർദ്ദേശങ്ങൾ നൽകുകയും ചെയ്തുകൊണ്ട്				
മറ്റു ബോധന രീതികൾ അധ്യാപകർ എങ്ങിനെയാണ് ഉപയോഗിക്കാറുള്ളത് (52-57)?					
52.	നമുക്കിടയിൽ പിയർ ടീച്ചിംഗ് നടത്തിക്കൊണ്ട്				
53.	പ്രയാസമേറിയ ആശയങ്ങൾ പഠിപ്പിക്കാൻ നിമ്മോണിക്സ് / കൺസെപ്റ്റ് മാപ്പിംഗ് ഉപയോഗിച്ച് കൊണ്ട്				
54.	തെറ്റിദ്ധാരണകൾ ഒഴിവാക്കാൻ ധാരാളം ഉദാഹരണങ്ങൾ പറഞ്ഞ് കൊണ്ട്				
55.	സാമൂഹിക പ്രസക്തിയുള്ള ആശയങ്ങളിൽ സംവാദം നടത്തിക്കൊണ്ട്				
56.	ഗണിത അധ്യാപകരും ഭൗതികശാസ്ത്ര അധ്യാപകരും ഒരുമിച്ച് ക്ലാസുകൾ കൈകാര്യം ചെയ്ത് കൊണ്ട്				
57.	ഒന്നിലധികം ഭൗതികശാസ്ത്ര അധ്യാപകർ ഒരുമിച്ച് ക്ലാസുകൾ കൈകാര്യം ചെയ്ത് കൊണ്ട്				
പരീക്ഷയ്ക്കുള്ള തയ്യാറെടുപ്പിന് അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (58-62)?					
58.	പരീക്ഷയ്ക്ക് മുമ്പ് പഴയ ചോദ്യപേപ്പറുകൾ ചർച്ചചെയ്യുന്നതിലൂടെ				

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	ഒരിക്കലുമില്ല	അപൂർവമായി	ചിലപ്പോൾ	പലപ്പോഴും
59.	മിഡ്-ടേം / പാദവാർഷിക പരീക്ഷയ്ക്ക് ശേഷം ക്ലാസിൽ ഉത്തരങ്ങൾ ചർച്ച ചെയ്ത് കൊണ്ട്				
60.	എല്ലാവർക്കും പ്രയാസമായി തോന്നിയ ആശയം പരീക്ഷയ്ക്ക് ശേഷം വീണ്ടും പഠിപ്പിച്ചുകൊണ്ട്				
61.	പഠനത്തിൽ മിടുക്കരായ കുട്ടികൾക്ക് കൂടുതൽ പഠന സാമഗ്രികൾ നൽകിക്കൊണ്ട്				
62.	പഠനത്തിൽ പിന്നാക്കം ഉള്ള കുട്ടികൾക്ക് പരിഹാരബോധനം നൽകിക്കൊണ്ട്				
പഠനാനുഭവങ്ങളെ പോഷിപ്പിക്കുന്നതിന് അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (63-66)?					
63.	ഫീൽഡ് ട്രിപ്പുകൾ സംഘടിപ്പിച്ച് കൊണ്ട്				
64.	പൊതു പ്ലാറ്റ്ഫോമുകളിൽ ഞങ്ങളുടെ സൃഷ്ടികൾ പ്രദർശിപ്പിക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
65.	സയൻസ് ക്ലബ്ബ് പ്രവർത്തനങ്ങളിൽ പങ്കാളികളാകാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
66.	കൂടുതൽ റഫറൻസ് മെറ്റീരിയലുകളും വെബ് അധിഷ്ഠിത ഉപാധികളും നിർദ്ദേശിച്ച് കൊണ്ട്				
ഭൗതികശാസ്ത്രത്തിലെ കണക്കുകൾ ചെയ്യാൻ അധ്യാപകർ പഠിപ്പിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (67-72)?					
67.	ചോദ്യത്തിൽ എന്താണ് തന്നിരിക്കുന്നത് എന്ന് തിരിച്ചറിയാൻ				
68.	ചോദ്യത്തിൽ എന്താണ് ചോദിച്ചിരിക്കുന്നത് എന്ന് തിരിച്ചറിയാൻ				
69.	ചോദ്യത്തെക്കുറിച്ച് കൂടുതൽ ധാരണയുണ്ടാക്കാൻ വേണ്ടി അതിനെ സൂചകങ്ങളായും ചിത്രങ്ങളായും രൂപഭേദം വരുത്താൻ				
70.	ഏറ്റവും ഉചിതമായ സമവാക്യം കണ്ടെത്തി ഉത്തരത്തിൽ എങ്ങിനെയെത്താം എന്നത് പ്ലാൻ ചെയ്യാൻ				
71.	ഉത്തരത്തിലെത്താൻ സമവാക്യത്തിൽ വേണ്ട സബ്സ്റ്റിട്യൂഷൻസ് ചെയ്ത് അതിനെ പുനഃക്രമീകരിക്കാൻ				
72.	കിട്ടിയ ഉത്തരം ശരി തന്നെയാണോ എന്ന് പല തരത്തിൽ സൂക്ഷ്മമായി പരിശോധിക്കാൻ				

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	ഒരിക്കലുമില്ല	ചിലപ്പോൾ	പലപ്പോഴും	എപ്പോഴും
ഗ്രാഫും അതിനോട് ബന്ധപ്പെട്ട കണക്കുകളും ചെയ്യാൻ അധ്യാപകർ പഠിപ്പിച്ച രീതികൾ താഴെ തന്നവയിലേത് (73-80) ?					
73.	ഒരു ഗ്രാഫ് എന്താണെന്നും യഥാർത്ഥ ജീവിതത്തിൽ അതിന്റെ ഉപയോഗത്തെക്കുറിച്ചും				
74.	x-അക്ഷം, y-അക്ഷം, മൂലബിന്ദു തുടങ്ങിയ ഗ്രാഫിന്റെ ഭാഗങ്ങൾ പഠിപ്പിച്ചു കൊണ്ട്				
75.	അക്ഷങ്ങൾക്ക് സ്കെയിൽ എങ്ങനെ നൽകാം				
76.	നമുക്ക് അനുയോജ്യമായ x, y മൂല്യങ്ങൾ ഉണ്ടെങ്കിൽ ഗ്രാഫിൽ പോയിന്റുകൾ എങ്ങനെ രേഖപ്പെടുത്താം				
77.	പട്ടികയിൽ തന്ന വിവരങ്ങൾ എങ്ങനെ ഗ്രാഫാക്കി മാറ്റാം				
78.	ഗ്രാഫ് എങ്ങനെ പട്ടിക രൂപത്തിലേക്ക് പരിവർത്തനം ചെയ്യാം				
79.	സ്ഥാനം-സമയം/വേഗത-സമയ ഗ്രാഫ് കണ്ട് വസ്തുവിന്റെ ചലനത്തിന്റെ സ്വഭാവം തിരിച്ചറിയാൻ				
80.	ഗ്രാഫിൽ നിന്ന് സ്ഥാനചലനം, വേഗത, ത്വരണം മുതലായവ കണ്ടെത്തുന്നതിനുള്ള ഘട്ടം ഘട്ടമായുള്ള പ്രക്രിയ				

81. മുകളിൽ സൂചിപ്പിച്ച ബോധനരീതികൾക്കുപുറമേ മറ്റേതെങ്കിലും ഉണ്ടെങ്കിൽ എഴുതുക.

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APPENDIX 22

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

SCALE ON INSTRUCTIONAL PRACTICES IN PHYSICS
(DRAFT – ENGLISH)

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Dr. Mumthas N. S.
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Instructions:

This scale aims to find out the extent to which teachers use various instructional practices in various teaching-learning contexts while teaching physics to IX standard students. Under each item, four options are available as 'Often', 'Sometimes', 'Rarely' and 'Never'. Students have to put a tick mark (✓) against whichever practice is applicable in the columns provided. Please remember that there is no right and wrong answer. Responding to all items is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

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Name: Male / Female

School:

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
How often does your teacher use the following ways (items 1-8) while 'Introducing new concepts'?					
1.	By conveying orally				
2.	By providing the examples given in the textbook				
3.	By connecting with the concepts that are already known to us				
4.	By relating to examples from daily life				
5.	By demonstrating simple examples				

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
6.	By eliciting response (may be ideas or suggestions) from us for the questions asked by the teacher				
7.	By using videos /animations				
8.	By using slides/handouts				
How often does your teacher use the following ways (items 9-15) while 'Working-out Mathematical Problems'?					
9.	By working out on the blackboard				
10.	By demonstrating using slides/ videos				
11.	By asking us to follow the step-by-step instruction provided				
12.	By asking one of us randomly to work out problem on the blackboard and later asking rest of us to check its correctness				
13.	By asking us individually to work out problems				
14.	By directing us to carry out group discussions and present the findings				
15.	By supervising and assisting while we work on problems				
How often does your teacher use the following ways (items 16-22) while 'Performing experiments/activities'?					
16.	By conveying orally				
17.	By using videos				
18.	By demonstrating and explaining the findings				
19.	By demonstrating and then asking us to analyse and reach conclusions				
20.	By asking us individually to perform, explore the findings and to present the conclusion				
21.	By asking us to perform in groups, explore the findings and to present the conclusion				
22.	By providing proper directions to perform it				
How often does your teacher use the following ways (items 23-30) while 'Executing project works'?					
23.	By providing the topic directly				

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
24.	By introducing the topic through a challenging situation and further into a problem during class discussion				
25.	By asking us individually to do it				
26.	By asking us to do it in groups				
27.	By providing related information and resources				
28.	By asking us to find related information and resources by ourselves				
29.	By summarizing the key theme to ensure the attainment of learning outcome, at the end of all our presentations				
30.	By providing suggestions after our presentations				
How often does your teacher use the following ways (items 31-38) while 'Conducting Assessment'?					
31.	By enquiring whether we have understood or not				
32.	By explaining again and clarifying the doubts in case we didn't understand				
33.	By asking us questions in between the class				
34.	By asking us questions randomly based on the concepts taught the previous day at the beginning of each class				
35.	By directing us to prepare questions on our own				
36.	By asking us in groups to prepare questions and to conduct quiz in between groups				
37.	By supervising and mediating the quiz session initiated by us				
38.	By using online assessment tools (eg: Kahoot, Socrative, Google forms, Quizizz)				
How often does your teacher use the following ways (items 39-43) for 'Consolidation of concepts'?					
39.	By conveying orally				
40.	By using slide/video presentations				
41.	By directing us individually to do it				
42.	By directing us to do it after group discussion				

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
43.	By commenting and suggesting corrections after our presentations				
How often does your teacher use the following ways (items 44-48) while 'Facilitating note-making process'?					
44.	By dictating				
45.	By providing in printed form/pdf/slides				
46.	By asking us to prepare it individually				
47.	By asking us to prepare it after group discussion				
48.	By checking and by providing suggestions, if needed				
How often does your teacher use the following ways (items 49-51) while 'Providing follow up activity (homework/ worksheets/ assignments)'?					
49.	By directing us to do it individually				
50.	By directing us to do it after group discussion				
51.	By checking our answers and by providing suggestions, if needed				
How often does your teacher use 'Miscellaneous ways of teaching' (items 52-57)?					
52.	Initiating peer teaching among us				
53.	Using Mnemonics/concept mapping to transact tough concepts				
54.	Providing ample examples to eliminate misconceptions				
55.	Conducting debate on socially relevant concepts				
56.	Maths and physics teachers handling sessions together				
57.	More than one physics teachers handling sessions together				
How often does your teacher use the following ways (items 58-62) for 'Examination preparedness and follow-up'?					
58.	Discussing old question papers prior to examination				
59.	Discussing the answers in the class after mid-term/terminal exam				
60.	Teaching the common tough topic again after exam				
61.	Providing extra learning materials for high performers				
62.	Providing remedial teaching for the slow learners				

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
How often does your teacher 'Enrich learning experiences' in the following ways (items 63-66)?					
63.	Organizing field trips				
64.	Directing us to exhibit our work on public platforms				
65.	Directing us to take part in science club activities				
66.	Suggesting extra reference materials and web-based resources.				
While solving mathematical problems in physics, the teacher teaches me					
67.	to identify what is being given in the question				
68.	to identify what is being asked in the question				
69.	how to convert the question into symbolic/diagrammatic form for better understanding of the question				
70.	how to plan to solve the question by locating the most appropriate equation				
71.	how to make substitutions and rearranging the equations to reach the solution				
72.	how to cross check and review the answer				
While teaching 'graph and mathematical problems related to it', the teacher taught me					
73.	what a graph is and about its use in real life				
74.	the parts of the graph such as x-axis, y-axis, origin				
75.	how to assign scale to the axes				
76.	how to plot points in the graph if we have the corresponding x and y values				
77.	how to convert tabular data into graphs				
78.	how to convert graph into tabular form				
79.	to identify the nature of motion of the object by seeing the position-time/velocity-time graph				
80.	the step-by-step process to find displacement, velocity, acceleration etc from the graph				

81. Please suggest other instructional practices other than that mentioned above.

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APPENDIX 23

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

SCALE ON INSTRUCTIONAL PRACTICES IN PHYSICS
(FINAL – MALAYALAM)

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നിർദ്ദേശങ്ങൾ:

ഒമ്പതാം ക്ലാസ്സിലെ കുട്ടികളെ ഭൗതികശാസ്ത്രം പഠിപ്പിക്കുമ്പോൾ, വ്യത്യസ്ത പഠന-ബോധന സന്ദർഭങ്ങളിൽ അധ്യാപകരുടെ ബോധന രീതികളുടെ ഉപയോഗം എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്തുകയാണ് ഈ സ്കെയ്ലിന്റെ ലക്ഷ്യം. ഒരോ പ്രസ്താവനയ്ക്കും 'മിക്കപ്പോഴും', 'ചിലപ്പോഴൊക്കെ', 'അപൂർവമായി', 'ഒരിക്കലുമില്ല' എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. നിങ്ങൾക്ക് ഉചിതമെന്ന് തോന്നുന്നതിന് നേരെ ✓ രേഖപ്പെടുത്തുക. ശരിയുത്തരം തെറ്റുത്തരം എന്നിങ്ങനെ ഇല്ല എന്നത് ശ്രദ്ധിക്കണം. എല്ലാ ചോദ്യങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്തണം എന്നത് നിർബന്ധമാണ്. നിങ്ങളിൽ നിന്നും സ്വീകരിക്കുന്ന പ്രതികരണങ്ങൾ ഗവേഷണത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ. അത് തികച്ചും രഹസ്യമായി സൂക്ഷിക്കുകയും ചെയ്യും.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	അപൂർവമായി	ഒരിക്കലുമില്ല
പുതിയ ആശയം അവതരിപ്പിക്കാൻ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (1-9)?					
1.	പാഠപുസ്തകത്തിലെ ഉദാഹരണങ്ങൾ നൽകിക്കൊണ്ട്				
2.	ഞങ്ങൾക്ക് അറിയുന്ന ആശയങ്ങളോട് ബന്ധപ്പെടുത്തിക്കൊണ്ട്				

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	അപൂർവമായി	ഒരിക്കലുമില്ല
3.	ദൈനംദിന ഉദാഹരണങ്ങളോട് ബന്ധപ്പെടുത്തിക്കൊണ്ട്				
4.	എളുപ്പമുള്ള ഉദാഹരങ്ങൾ ചെയ്ത് കാണിച്ച് കൊണ്ട്				
5.	ചോദ്യങ്ങൾ ചോദിച്ച് ഞങ്ങളിൽ നിന്ന് ശരിയായ പ്രതികരണം (ആശയങ്ങൾ/ നിർദ്ദേശങ്ങൾ) കൊണ്ടുവരുന്നതിലൂടെ				
6.	വീഡിയോസ്/ ആനിമേഷൻസിലൂടെ				
7.	സ്ലൈഡ്/ ലഘുലേഖയിലൂടെ				
8.	ക്ലാസ്സിൽ പഠിപ്പിക്കുന്നതിന് മുമ്പായി സ്വയം വായിച്ചും മനസ്സിലാക്കിയും വരാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
9.	ക്ലാസ്സിൽ പഠിപ്പിക്കുന്നത് മുമ്പായി പഠന സാമഗ്രികൾ നൽകി സ്വയം വായിച്ചും മനസ്സിലാക്കിയും വരാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
കണക്ക് ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (10-16)?					
10.	ബ്ലാക്ക് ബോർഡിൽ ചെയ്ത് കാണിച്ച് കൊണ്ട്				
11.	സ്ലൈഡ്/ വീഡിയോസ് എന്നിവ പ്രദർശിപ്പിച്ചുകൊണ്ട്				
12.	പടിപടിയായ നൽകുന്ന നിർദ്ദേശങ്ങൾ പിന്തുടരാൻ പറഞ്ഞു കൊണ്ട്				
13.	ഞങ്ങളിൽ ഏതെങ്കിലും ഒരാളോട് ബ്ലാക്ക് ബോർഡിൽ കണക്ക് ചെയ്യാനും പിന്നീട് മറ്റുള്ളവരോട് അത് ശെരിയാണോ എന്ന് പരിശോധിക്കാനും ആവശ്യപ്പെട്ട് കൊണ്ട്				
14.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
15.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് ചർച്ച ചെയ്ത് ഉത്തരങ്ങൾ കണ്ടെത്തി അവതരിപ്പിക്കുവാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
16.	ഞങ്ങൾ കണക്ക് ചെയുമ്പോൾ മേൽനോട്ടം വഹിക്കുകയും സഹായിക്കുകയും ചെയ്ത കൊണ്ട്				
പരീക്ഷണം/പ്രവർത്തനം ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (17-22)?					

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	അപൂർവമായി	ഒരിക്കലുമില്ല
17.	വീഡിയോയിലൂടെ				
18.	കണ്ടെത്തലുകൾ ചെയ്ത് കാണിച്ചും വിശദീകരിക്കുകയും ചെയ്ത കൊണ്ട്				
19.	ചെയ്ത് കാണിച്ചതിന് ശേഷം അത് വിശകലനം ചെയ്ത് നിഗമനത്തിലെത്താൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
20.	ഞങ്ങൾ ഓരോരുത്തരോടും ഒറ്റയ്ക്ക് അവ ചെയ്ത് കണ്ടെത്തലുകൾ വിശകലനം ചെയ്ത് നിഗമനങ്ങൾ അവതരിപ്പിക്കുവാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
21.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് അവ ചെയ്ത് കണ്ടെത്തലുകൾ വിശകലനം ചെയ്ത് നിഗമനങ്ങൾ അവതരിപ്പിക്കുവാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
22.	അവ ശരിയായ രീതിയിൽ ചെയ്യാനുള്ള നിർദ്ദേശങ്ങൾ നൽകി കൊണ്ട്				
പ്രൊജക്ട് ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (23-30)?					
23.	വിഷയം നേരിട്ട് പറഞ്ഞ് കൊടുത്ത് കൊണ്ട്				
24.	ക്ലാസ്സിലെ ചർച്ചയ്ക്കിടെ വെല്ലുവിളി നിറഞ്ഞ ഒരു സാഹചര്യത്തിലൂടെ വിഷയം അവതരിപ്പിച്ച കൊണ്ടും ഒരു പ്രശ്നത്തിലേക്ക് കടന്നുകൊണ്ടും				
25.	ഞങ്ങൾ ഓരോരുത്തരോടും ഒറ്റയ്ക്ക് അവ ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
26.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് അവ ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
27.	അവ സംബന്ധിച്ച വിവരങ്ങളും വിഭവങ്ങളും സ്വയം കണ്ടെത്താൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
28.	അവ സംബന്ധിച്ച വിവരങ്ങളും വിഭവങ്ങളും സ്വയം കണ്ടെത്താൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
29.	പഠന നേട്ടങ്ങൾ ആർജ്ജിച്ചോ എന്ന് ഉറപ്പ് വരുത്തുന്നതിനായി, എല്ലാവരുടെയും അവതരണങ്ങൾക്ക് ശേഷം സാരാംശം ക്രോഡീകരിച്ച് കൊണ്ട്				
30.	ഞങ്ങളുടെ അവതരണങ്ങൾക്ക് ശേഷം കൂടുതൽ നിർദ്ദേശങ്ങൾ നൽകി കൊണ്ട്				

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	അപൂർവമായി	ഒരിക്കലുമില്ല
മൂല്യനിർണ്ണയം നടത്തുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (31-39)?					
31.	മനസ്സിലായോ എന്ന് അന്വേഷിച്ച് കൊണ്ട്				
32.	ഞങ്ങൾക്ക് മനസ്സിലാകാത്ത സന്ദർഭങ്ങളിൽ വീണ്ടും വിവരിച്ചും സംശയങ്ങൾ വിശദീകരിച്ചും കൊണ്ട്				
33.	ക്ലാസ്സിനിടയിൽ ചോദ്യങ്ങൾ ചോദിച്ച് കൊണ്ട്				
34.	ക്ലാസ്സ് തുടങ്ങുന്നതിന് മുമ്പ് തലേ ദിവസം പഠിപ്പിച്ച ആശയത്തെ ആസ്പദമാക്കി ഞങ്ങൾക്കിടയിൽ ചോദ്യങ്ങൾ ചോദിച്ച് കൊണ്ട്				
35.	സ്വയം ചോദ്യങ്ങൾ ഉണ്ടാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
36.	ഗ്രൂപ്പുകളായി തിരിഞ്ഞു ചർച്ച ചെയ്ത് ചോദ്യങ്ങൾ ഉണ്ടാക്കുകയും ഗ്രൂപ്പുകൾക്കിടയിൽ ക്വിസ്സ് നടത്താനും നിർദ്ദേശിച്ച് കൊണ്ട്				
37.	ഞങ്ങൾ നടത്തുന്ന ക്വിസ്സിന് മേൽനോട്ടവും മദ്ധ്യസ്ഥതയും വഹിച്ചു കൊണ്ട്				
38.	മൂല്യനിർണ്ണയത്തിനുള്ള ഓൺലൈൻ ഉപകരണങ്ങൾ ഉപയോഗിച്ച് കൊണ്ട് (eg: Kahoot, Socrative, Google forms, Quizizz)				
39.	അർദ്ധ വാർഷിക പരീക്ഷകൾക്ക് പുറമെ ക്ലാസ്സ് പരീക്ഷകൾ നടത്തിക്കൊണ്ട്				
ക്രോഡീകരണത്തിനായി അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (40-44)?					
40.	വാമൊഴിയായി പറഞ്ഞു കൊണ്ട്				
41.	സ്ലൈഡ്/ വീഡിയോസ് എന്നിവ പ്രദർശിപ്പിച്ചുകൊണ്ട്				
42.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
43.	ഗ്രൂപ്പ് ചർച്ച ചെയ്യാൻ നിർദ്ദേശിച്ചുകൊണ്ട്				
44.	ഞങ്ങളുടെ അവതരണത്തിന് ശേഷം അവ വിലയിരുത്തിയും തിരുത്തലുകൾ നിർദ്ദേശിക്കുകയും ചെയ്തുകൊണ്ട്				
നോട്ട് തയ്യാറാക്കുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (45-50)?					

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	അപൂർവമായി	ഒരിക്കലുമില്ല
45.	ലെക്ചർ നോട്ട് എഴുതിയെടുക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
46.	നോട്ട് പറഞ്ഞെഴുതിച്ച് കൊണ്ട്				
47.	അച്ചടിച്ച രൂപം / പി.ഡി എഫ് / സ്ലൈഡ് എന്നിവ നൽകിക്കൊണ്ട്				
48.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് തയ്യാറാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
49.	ഗ്രൂപ്പ് ചർച്ചയിലൂടെ തയ്യാറാക്കാൻ പറഞ്ഞു കൊണ്ട്				
50.	ഞങ്ങൾ തയ്യാറാക്കിയ നോട്ട് പരിശോധിച്ചും ആവശ്യാനുസരണം നിർദ്ദേശങ്ങൾ നൽകിക്കൊണ്ടും				
തുടർപ്രവർത്തനങ്ങൾ (ഹോംവർക്ക്/വർക്ക്ഷീറ്റ്/അസൈൻമെൻറ്) ചെയ്യിപ്പിക്കാൻ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (51-53)?					
51.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് തയ്യാറാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
52.	ഗ്രൂപ്പ് ചർച്ചകൾക്ക് ശേഷം ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
53.	ഞങ്ങൾ കണ്ടെത്തിയ ഉത്തരങ്ങൾ പരിശോധിക്കുകയും ആവശ്യമെങ്കിൽ നിർദ്ദേശങ്ങൾ നൽകുകയും ചെയ്തുകൊണ്ട്				
മറ്റു ബോധന രീതികൾ അധ്യാപകർ എങ്ങിനെയാണ് ഉപയോഗിക്കാറുള്ളത് (54-59)?					
54.	നമുക്കിടയിൽ പിയർ ടീച്ചിംഗ് നടത്തിക്കൊണ്ട്				
55.	പ്രയാസമേറിയ ആശയങ്ങൾ പഠിപ്പിക്കാൻ നിമ്മോണിക്സ് / കൺസെപ്റ്റ് മാപ്പിംഗ് ഉപയോഗിച്ച് കൊണ്ട്				
56.	തെറ്റിദ്ധാരണകൾ ഒഴിവാക്കാൻ ധാരാളം ഉദാഹരണങ്ങൾ പറഞ്ഞ് കൊണ്ട്				
57.	സാമൂഹിക പ്രസക്തിയുള്ള ആശയങ്ങളിൽ സംവാദം നടത്തിക്കൊണ്ട്				
58.	ഗണിത അധ്യാപകരും ഭൗതികശാസ്ത്ര അധ്യാപകരും ഒരുമിച്ച് ക്ലാസുകൾ കൈകാര്യം ചെയ്ത് കൊണ്ട്				
59.	ഒന്നിലധികം ഭൗതികശാസ്ത്ര അധ്യാപകർ ഒരുമിച്ച് ക്ലാസുകൾ കൈകാര്യം ചെയ്ത് കൊണ്ട്				

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	അപൂർവമായി	ഒരിക്കലുമില്ല
പരീക്ഷയ്ക്കുള്ള തയ്യാറെടുപ്പിന് അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (60-65)?					
60.	പരീക്ഷയ്ക്ക് മുമ്പ് പഴയ ചോദ്യപേപ്പറുകൾ ചർച്ചചെയ്യുന്നതിലൂടെ				
61.	മിഡ്-ടേം / പാദവാർഷിക പരീക്ഷയ്ക്ക് ശേഷം ക്ലാസിൽ ഉത്തരങ്ങൾ ചർച്ച ചെയ്ത് കൊണ്ട്				
62.	മിഡ്-ടേം / പാദവാർഷിക പരീക്ഷയ്ക്ക് ശേഷം ചോദ്യപേപ്പറിന് ഉത്തരം കണ്ടെത്തി എഴുതിവരാൻ ഞങ്ങളോട് ആവശ്യപ്പെട്ട് കൊണ്ട്				
63.	എല്ലാവർക്കും പ്രയാസമായി തോന്നിയ ആശയം പരീക്ഷയ്ക്ക് ശേഷം വീണ്ടും പഠിപ്പിച്ചുകൊണ്ട്				
64.	പഠനത്തിൽ മിടുക്കരായ കുട്ടികൾക്ക് കൂടുതൽ പഠന സാമഗ്രികൾ നൽകിക്കൊണ്ട്				
65.	പഠനത്തിൽ പിന്നാക്കം ഉള്ള കുട്ടികൾക്ക് പരിഹാരബോധനം നൽകിക്കൊണ്ട്				
പഠനാനുഭവങ്ങളെ പോഷിപ്പിക്കുന്നതിന് അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (66-69)?					
66.	ഫീൽഡ് ട്രിപ്പുകൾ സംഘടിപ്പിച്ച് കൊണ്ട്				
67.	പൊതു പ്ലാറ്റ്ഫോമുകളിൽ ഞങ്ങളുടെ സൃഷ്ടികൾ പ്രദർശിപ്പിക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
68.	സയൻസ് ക്ലബ്ബ് പ്രവർത്തനങ്ങളിൽ പങ്കാളികളാകാൻ നിർദ്ദേശിച്ച് കൊണ്ട്				
69.	കൂടുതൽ റഫറൻസ് മെറ്റീരിയലുകളും വെബ് അധിഷ്ഠിത ഉപാധികളും നിർദ്ദേശിച്ച് കൊണ്ട്				
ഭൗതികശാസ്ത്രത്തിലെ കണക്കുകൾ ചെയ്യാൻ അധ്യാപകർ പഠിപ്പിക്കുന്ന രീതി താഴെ തന്നവയിലേത് (70-75)?					
70.	ചോദ്യത്തിൽ എന്താണ് തന്നിരിക്കുന്നത് എന്ന് തിരിച്ചറിയാൻ				
71.	ചോദ്യത്തിൽ എന്താണ് ചോദിച്ചിരിക്കുന്നത് എന്ന് തിരിച്ചറിയാൻ				

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	മിക്കപ്പോഴും	ചിലപ്പോഴൊക്കെ	അപൂർവമായി	ഒരിക്കലുമില്ല
72.	ചോദ്യത്തെക്കുറിച്ച് കൂടുതൽ ധാരണയുണ്ടാക്കാൻ വേണ്ടി അതിനെ സൂചകങ്ങളായും ചിത്രങ്ങളായും രൂപഭേദം വരുത്താൻ				
73.	ഏറ്റവും ഉചിതമായ സമവാക്യം കണ്ടെത്തി ഉത്തരത്തിൽ എങ്ങിനെയെത്താം എന്നത് പ്ലാൻ ചെയ്യാൻ				
74.	ഉത്തരത്തിലെത്താൻ സമവാക്യത്തിൽ വേണ്ട സബ്സ്റ്റിട്യൂഷൻസ് ചെയ്ത് അതിനെ പുനഃക്രമീകരിക്കാൻ				
75.	കിട്ടിയ ഉത്തരം ശരി തന്നെയാണോ എന്ന് പല തരത്തിൽ സൂക്ഷ്മമായി പരിശോധിക്കാൻ				
ഗ്രാഫും അതിനോട് ബന്ധപ്പെട്ട കണക്കുകളും ചെയ്യാൻ അധ്യാപകർ പഠിപ്പിച്ച രീതി താഴെ തന്നവയിലേത് (76-83)?					
76.	ഒരു ഗ്രാഫ് എന്താണെന്നും യഥാർത്ഥ ജീവിതത്തിൽ അതിന്റെ ഉപയോഗത്തെക്കുറിച്ചും				
77.	x-അക്ഷം, y-അക്ഷം, മൂലബിന്ദു തുടങ്ങിയ ഗ്രാഫിന്റെ ഭാഗങ്ങൾ പഠിപ്പിച്ചു കൊണ്ട്				
78.	അക്ഷങ്ങൾക്ക് സ്കെയിൽ എങ്ങനെ നൽകാം				
79.	നമുക്ക് അനുയോജ്യമായ x, y മൂല്യങ്ങൾ ഉണ്ടെങ്കിൽ ഗ്രാഫിൽ പോയിന്റുകൾ എങ്ങനെ രേഖപ്പെടുത്താം				
80.	പട്ടികയിൽ തന്ന വിവരങ്ങൾ എങ്ങനെ ഗ്രാഫാക്കി മാറ്റാം				
81.	ഗ്രാഫ് എങ്ങനെ പട്ടിക രൂപത്തിലേക്ക് പരിവർത്തനം ചെയ്യാം				
82.	സ്ഥാനം-സമയം/വേഗത-സമയ ഗ്രാഫ് കണ്ട് വസ്തുവിന്റെ ചലനത്തിന്റെ സ്വഭാവം തിരിച്ചറിയാൻ				
83.	ഗ്രാഫിൽ നിന്ന് സ്ഥാനചലനം, വേഗത, ത്വരണം മുതലായവ കണ്ടെത്തുന്നതിനുള്ള ഘട്ടം ഘട്ടമായുള്ള പ്രക്രിയ				

APPENDIX 24

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

SCALE ON INSTRUCTIONAL PRACTICES IN PHYSICS
(FINAL – ENGLISH)

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Instructions:

This scale aims to find out the extent to which teachers use various instructional practices in various teaching-learning contexts while teaching physics to IX standard students. Under each item, four options are available as 'Often', 'Sometimes', 'Rarely' and 'Never'. Students have to put a tick mark (✓) against whichever practice is applicable in the columns provided. Please remember that there is no right and wrong answer. Responding to all items is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

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Name: Male / Female

School:

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
How often does your teacher use the following ways (items 1-9) while 'Introducing new concepts'?					
1.	By providing the examples given in the textbook				
2.	By connecting with the concepts that are already known to us				
3.	By relating to examples from daily life				
4.	By demonstrating simple examples				
5.	By eliciting response (may be ideas or suggestions) from us for the questions asked by the teacher				

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
6.	By using videos /animations				
7.	By using slides/handouts				
8.	By directing us to self-learn and make an understanding prior to the class				
9.	By providing us with learning materials for self-learning and by directing to make an understanding on it, prior to the class				
How often does your teacher use the following ways (items 10-16) while 'Working-out Mathematical Problems'?					
10.	By working out on the blackboard				
11.	By demonstrating using slides/ videos				
12.	By asking us to follow the step-by-step instruction provided				
13.	By asking one of us randomly to work out problem on the blackboard and later asking rest of us to check its correctness				
14.	By asking us individually to work out problems				
15.	By directing us to carry out group discussions and present the findings				
16.	By supervising and assisting while we work on problems				
How often does your teacher use the following ways (items 17-22) while 'Performing experiments/activities'?					
17.	By using videos				
18.	By demonstrating and explaining the findings				
19.	By demonstrating and then asking us to analyse and reach conclusions				
20.	By asking us individually to perform, explore the findings and to present the conclusion				
21.	By asking us to perform in groups, explore the findings and to present the conclusion				
22.	By providing proper directions and timely supervision to perform it.				
How often does your teacher use the following ways (items 23-30) while 'Executing project works'?					

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
23.	By providing the topic directly				
24.	By introducing the topic through a challenging situation and further into a problem during class discussion				
25.	By asking us individually to do it				
26.	By asking us to do it in groups				
27.	By providing related information and resources				
28.	By asking us to find related information and resources by ourselves				
29.	By summarizing the key theme to ensure the attainment of learning outcome, at the end of all our presentations				
30.	By providing suggestions after our presentations				
How often does your teacher use the following ways (items 31-39) while 'Conducting Assessment'?					
31.	By enquiring whether we have understood or not				
32.	By explaining again and clarifying the doubts in case we didn't understand				
33.	By asking us questions in between the class				
34.	By asking us questions randomly based on the concepts taught the previous day at the beginning of each class				
35.	By directing us to prepare questions on our own				
36.	By asking us in groups to prepare questions and to conduct quiz in between groups				
37.	By supervising and mediating the quiz session initiated by us				
38.	By using online assessment tools (eg: Kahoot, Socrative, Google forms, Quizizz)				
39.	By conducting class tests apart from mid-term test				
How often does your teacher use the following ways (items 40-44) for 'Consolidation of concepts'?					
40.	By conveying orally				

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
41.	By using slide/video presentations				
42.	By directing us individually to do it				
43.	By directing us to do it after group discussion				
44.	By commenting and suggesting corrections after our presentations				
How often does your teacher use the following ways (items 45-50) while 'Facilitating note-making process'?					
45.	By asking us to take down lecture notes				
46.	By dictating				
47.	By providing in printed form/pdf/slides				
48.	By asking us to prepare it individually				
49.	By asking us to prepare it after group discussion				
50.	By checking it and by providing suggestions, if needed.				
How often does your teacher use the following ways (items 51-53) while 'Providing follow up activity (homework/ worksheets/ assignments)'?					
51.	By directing us to do it individually				
52.	By directing us to do it after group discussion				
53.	By checking our answers and by providing suggestions, if needed				
How often does your teacher use 'Miscellaneous ways of teaching' (items 54-59)?					
54.	Initiating peer teaching among us				
55.	Using Mnemonics/concept mapping to transact tough concepts				
56.	Providing ample examples to eliminate misconceptions				
57.	Conducting debate on socially relevant concepts				
58.	Maths and physics teachers handling sessions together				
59.	More than one physics teachers handling sessions together				

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
How often does your teacher use the following ways (items 60-65) for 'Examination preparedness'?					
60.	Discussing old question papers prior to examination				
61.	Discussing the answers in the class after mid-term/terminal exam				
62.	Asking us to answer the question paper after mid-term/terminal exam				
63.	Teaching the common tough topic again after exam				
64.	Providing extra learning materials for high performers				
65.	Providing remedial teaching for the slow learners				
How often does your teacher 'Enrich learning experiences' in the following ways (items 66-69)?					
66.	Organizing field trips				
67.	Directing us to exhibit our work on public platforms				
68.	Directing us to take part in science club activities				
69.	Suggesting extra reference materials and web-based resources.				
While solving mathematical problems in physics, the teacher teaches me					
70.	to identify what is being given in the question				
71.	to identify what is being asked in the question				
72.	how to convert the question into symbolic/diagrammatic form for better understanding of the question				
73.	how to plan to solve the question by locating the most appropriate equation				
74.	how to make substitutions and rearranging the equations to reach the solution				
75.	how to cross check and review the answer				
While teaching 'graph and mathematical problems related to it', the teacher taught me					
76.	what a graph is and about its use in real life				

No.	Instructional Practices of Physics Teachers	Often	Sometimes	Rarely	Never
77.	the parts of the graph such as x-axis, y-axis, origin				
78.	how to assign scale to the axes				
79.	how to plot points in the graph if we have the corresponding x and y values				
80.	how to convert tabular data into graphs				
81.	how to convert graph into tabular form				
82.	to identify the nature of motion of the object by seeing the position-time/velocity-time graph				
83.	the step-by-step process to find displacement, velocity, acceleration etc from the graph				

APPENDIX 25

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CHECKLIST ON INSTRUCTIONAL PRACTICES FOR EQUATIONS OF MOTION / GRAVITATION
(DRAFT – MALAYALAM)

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നിർദ്ദേശങ്ങൾ:

ഒമ്പതാം ക്ലാസ്സിലെ കുട്ടികളെ ഭൗതികശാസ്ത്രത്തിലെ 'ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം' എന്നീ ആശയങ്ങൾ പഠിപ്പിക്കുമ്പോൾ, വ്യത്യസ്ത പഠന-ബോധന സന്ദർഭങ്ങളിൽ അധ്യാപകരുടെ ബോധന രീതികളുടെ ഉപയോഗം എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്തുകയാണ് ഈ സ്കെയ്ലിന്റെ ലക്ഷ്യം. തന്നിരിക്കുന്ന പ്രതികരണപട്ടികയിൽ നിങ്ങൾക്ക് ഉചിതമെന്ന് തോന്നുന്നതിന് നേരെ ✓ രേഖപ്പെടുത്തുക. ശരിയുത്തരം തെറ്റുത്തരം എന്നിങ്ങനെ ഇല്ല എന്നത് ശ്രദ്ധിക്കണം. എല്ലാ ചോദ്യങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്തണം എന്നത് നിർബന്ധമാണ്. നിങ്ങളിൽ നിന്നും സ്വീകരിക്കുന്ന പ്രതികരണങ്ങൾ ഗവേഷണത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ. അത് തികച്ചും രഹസ്യമായി സൂക്ഷിക്കുകയും ചെയ്യും.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	പ്രതികരണം
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവ പഠിപ്പിക്കുമ്പോൾ പുതിയ ആശയം അവതരിപ്പിക്കാൻ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (1-8)?		
1.	വാമൊഴിയായി പറഞ്ഞു കൊണ്ട്	
2.	പാഠപുസ്തകത്തിലെ ഉദാഹരണങ്ങൾ നൽകിക്കൊണ്ട്	

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	പ്രതികരണം
3.	ഞങ്ങൾക്ക് അറിയുന്ന ആശയങ്ങളോട് ബന്ധപ്പെടുത്തിക്കൊണ്ട്	
4.	ദൈനംദിന ഉദാഹരണങ്ങളോട് ബന്ധപ്പെടുത്തിക്കൊണ്ട്	
5.	എളുപ്പമുള്ള ഉദാഹരങ്ങൾ ചെയ്ത് കാണിച്ച് കൊണ്ട്	
6.	ചോദ്യങ്ങൾ ചോദിച്ച് ഞങ്ങളിൽ നിന്ന് ശരിയായ പ്രതികരണം (ആശയങ്ങൾ/ നിർദ്ദേശങ്ങൾ) കൊണ്ടുവരുന്നതിലൂടെ	
7.	വീഡിയോസ്/ ആനിമേഷൻസിലൂടെ	
8.	സ്ലൈഡ്/ ലഘുലേഖയിലൂടെ	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിലെ കണക്ക് ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (9-15)?		
9.	ബ്ലാക്ക് ബോർഡിൽ ചെയ്ത് കാണിച്ച് കൊണ്ട്	
10.	സ്ലൈഡ്/ വീഡിയോസ് എന്നിവ പ്രദർശിപ്പിച്ചുകൊണ്ട്	
11.	പടിപടിയായ നൽകുന്ന നിർദ്ദേശങ്ങൾ പിന്തുടരാൻ പറഞ്ഞു കൊണ്ട്	
12.	ഞങ്ങളിൽ ഏതെങ്കിലും ഒരാളോട് ബ്ലാക്ക് ബോർഡിൽ കണക്ക് ചെയ്യാനും പിന്നീട് മറ്റുള്ളവരോട് അത് ശെരിയാണോ എന്ന് പരിശോധിക്കാനും ആവശ്യപ്പെട്ട് കൊണ്ട്	
13.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
14.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് ചർച്ച ചെയ്ത് ഉത്തരങ്ങൾ കണ്ടെത്തി അവതരിപ്പിക്കുവാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
15.	ഞങ്ങൾ കണക്ക് ചെയുമ്പോൾ മേൽനോട്ടം വഹിക്കുകയും സഹായിക്കുകയും ചെയ്ത കൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിലെ പ്രൊജക്ട് ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (16-23)?		
16.	വിഷയം നേരിട്ട് പറഞ്ഞ് കൊടുത്ത് കൊണ്ട്	
17.	ക്ലാസ്സിലെ ചർച്ചയ്ക്കിടെ വെല്ലുവിളി നിറഞ്ഞ ഒരു സാഹചര്യത്തിലൂടെ വിഷയം അവതരിപ്പിച്ചു കൊണ്ടും ഒരു പ്രശ്നത്തിലേക്ക് കടന്നുകൊണ്ടും	
18.	ഞങ്ങൾ ഓരോരുത്തരോടും ഒറ്റയ്ക്ക് അവ ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
19.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് അവ ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
20.	അവ സംബന്ധിച്ച വിവരങ്ങളും വിഭവങ്ങളും നൽകി കൊണ്ട്	
21.	അവ സംബന്ധിച്ച വിവരങ്ങളും വിഭവങ്ങളും സ്വയം കണ്ടെത്താൻ നിർദ്ദേശിച്ച് കൊണ്ട്	

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	പ്രതികരണം
22.	പഠന നേട്ടങ്ങൾ ആർജ്ജിച്ചോ എന്ന് ഉറപ്പ് വരുത്തുന്നതിനായി, എല്ലാവരുടെയും അവതരണങ്ങൾക്ക് ശേഷം സാരാംശം ക്രോഡീകരിച്ച് കൊണ്ട്	
23.	ഞങ്ങളുടെ അവതരണങ്ങൾക്ക് ശേഷം കൂടുതൽ നിർദ്ദേശങ്ങൾ നൽകി കൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയുടെ മൂല്യനിർണ്ണയം നടത്തുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (24-31)?		
24.	മനസ്സിലായോ എന്ന് അന്വേഷിച്ച് കൊണ്ട്	
25.	ഞങ്ങൾക്ക് മനസ്സിലാകാത്ത സന്ദർഭങ്ങളിൽ വീണ്ടും വിവരിച്ചും സംശയങ്ങൾ വിശദീകരിച്ചും കൊണ്ട്	
26.	ക്ലാസ്സിനിടയിൽ ചോദ്യങ്ങൾ ചോദിച്ച് കൊണ്ട്	
27.	ക്ലാസ്സ് തുടങ്ങുന്നതിന് മുമ്പ് തലേ ദിവസം പഠിപ്പിച്ച ആശയത്തെ ആസ്പദമാക്കി ഞങ്ങൾക്കിടയിൽ ചോദ്യങ്ങൾ ചോദിച്ച് കൊണ്ട്	
28.	സ്വയം ചോദ്യങ്ങൾ ഉണ്ടാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
29.	ഗ്രൂപ്പുകളായി തിരിഞ്ഞു ചർച്ച ചെയ്ത് ചോദ്യങ്ങൾ ഉണ്ടാക്കുകയും ഗ്രൂപ്പുകൾക്കിടയിൽ ക്വിസ്സ് നടത്താനും നിർദ്ദേശിച്ച് കൊണ്ട്	
30.	ഞങ്ങൾ നടത്തുന്ന ക്വിസ്സിന് മേൽനോട്ടവും മദ്ധ്യസ്ഥതയും വഹിച്ചു കൊണ്ട്	
31.	മൂല്യനിർണ്ണയത്തിനുള്ള ഓൺലൈൻ ഉപകരണങ്ങൾ ഉപയോഗിച്ച് കൊണ്ട് (eg: Kahoot, Socrative, Google forms, Quizizz)	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയുടെ ക്രോഡീകരണത്തിനായി അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (32-36)?		
32.	വാമൊഴിയായി പറഞ്ഞു കൊണ്ട്	
33.	സ്ലൈഡ്/ വീഡിയോസ് എന്നിവ പ്രദർശിപ്പിച്ചുകൊണ്ട്	
34.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
35.	ഗ്രൂപ്പ് ചർച്ച ചെയ്യാൻ നിർദ്ദേശിച്ചുകൊണ്ട്	
36.	ഞങ്ങളുടെ അവതരണത്തിന് ശേഷം അവ വിലയിരുത്തിയും തിരുത്തലുകൾ നിർദ്ദേശിക്കുകയും ചെയ്തുകൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിൽ നോട്ട് തയ്യാറാക്കുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (37-41)?		
37.	നോട്ട് പറഞ്ഞെഴുതിച്ച് കൊണ്ട്	
38.	അച്ചടിച്ച രൂപം / പി.ഡി എഫ് / സ്ലൈഡ് എന്നിവ നൽകിക്കൊണ്ട്	

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	പ്രതികരണം
39.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് തയ്യാറാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
40.	ഗ്രൂപ്പ് ചർച്ചയിലൂടെ തയ്യാറാക്കാൻ പറഞ്ഞു കൊണ്ട്	
41.	ഞങ്ങൾ തയ്യാറാക്കിയ നോട്ട് പരിശോധിച്ചും ആവശ്യാനുസരണം നിർദ്ദേശങ്ങൾ നൽകിക്കൊണ്ടും	
ചലനസമവാക്യങ്ങൾ / ഉരുത്വാകർഷണം എന്നിവയിൽ തുടർപ്രവർത്തനങ്ങൾ (ഹോംവർക്ക് /വർക്ക്ഷീറ്റ് /അസൈൻമെൻറ്) ചെയ്യിപ്പിക്കാൻ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (42-44)?		
42.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് തയ്യാറാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
43.	ഗ്രൂപ്പ് ചർച്ചകൾക്ക് ശേഷം ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
44.	ഞങ്ങൾ കണ്ടെത്തിയ ഉത്തരങ്ങൾ പരിശോധിക്കുകയും ആവശ്യമെങ്കിൽ നിർദ്ദേശങ്ങൾ നൽകുകയും ചെയ്തുകൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഉരുത്വാകർഷണം എന്നിവക്ക് അധ്യാപകർ ഉപയോഗിക്കുന്ന മറ്റു ബോധന രീതികൾ ഏതൊക്കെയാണ് (45-49)?		
45.	നമുക്കിടയിൽ പിയർ ടീച്ചിംഗ് നടത്തിക്കൊണ്ട്	
46.	പ്രയാസമേറിയ ആശയങ്ങൾ പഠിപ്പിക്കാൻ നിമ്മോണിക്സ് / കൺസെപ്റ്റ് മാപ്പിംഗ് ഉപയോഗിച്ച് കൊണ്ട്	
47.	തെറ്റിദ്ധാരണകൾ ഒഴിവാക്കാൻ ധാരാളം ഉദാഹരണങ്ങൾ പറഞ്ഞ് കൊണ്ട്	
48.	ഗണിത അധ്യാപകരും ഭൗതികശാസ്ത്ര അധ്യാപകരും ഒരുമിച്ച് ക്ലാസുകൾ കൈകാര്യം ചെയ്ത് കൊണ്ട്	
49.	ഒന്നിലധികം ഭൗതികശാസ്ത്ര അധ്യാപകർ ഒരുമിച്ച് ക്ലാസുകൾ കൈകാര്യം ചെയ്ത് കൊണ്ട്	
പരീക്ഷയ്ക്കുള്ള തയ്യാറെടുപ്പിന് ചലനസമവാക്യങ്ങൾ / ഉരുത്വാകർഷണം എന്നിവക്ക് അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (50-54)?		
50.	പരീക്ഷയ്ക്ക് മുമ്പ് പഴയ ചോദ്യപേപ്പറുകൾ ചർച്ചചെയ്യുന്നതിലൂടെ	
51.	മിഡ്-ടേം / പാദവാർഷിക പരീക്ഷയ്ക്ക് ശേഷം ക്ലാസിൽ ഉത്തരങ്ങൾ ചർച്ച ചെയ്ത് കൊണ്ട്	
52.	എല്ലാവർക്കും പ്രയാസമായി തോന്നിയ ആശയം പരീക്ഷയ്ക്ക് ശേഷം വീണ്ടും പഠിപ്പിച്ചുകൊണ്ട്	
53.	പഠനത്തിൽ മിടുക്കരായ കുട്ടികൾക്ക് കൂടുതൽ പഠന സാമഗ്രികൾ നൽകിക്കൊണ്ട്	
54.	പഠനത്തിൽ പിന്നാക്കം ഉള്ള കുട്ടികൾക്ക് പരിഹാരബോധനം നൽകിക്കൊണ്ട്	

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	പ്രതികരണം
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിൽ പഠനാനുഭവങ്ങളെ പോഷിപ്പിക്കുന്നതിന് അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (55)?		
55.	കൂടുതൽ റഫറൻസ് മെറ്റീരിയലുകളും വെബ് അധിഷ്ഠിത ഉപാധികളും നിർദ്ദേശിച്ച് കൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിലെ കണക്കുകൾ ചെയ്യാൻ അധ്യാപകർ പഠിപ്പിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (56-61)?		
56.	ചോദ്യത്തിൽ എന്താണ് തന്നിരിക്കുന്നത് എന്ന് തിരിച്ചറിയാൻ	
57.	ചോദ്യത്തിൽ എന്താണ് ചോദിച്ചിരിക്കുന്നത് എന്ന് തിരിച്ചറിയാൻ	
58.	ചോദ്യത്തെക്കുറിച്ച് കൂടുതൽ ധാരണയുണ്ടാക്കാൻ വേണ്ടി അതിനെ സൂചകങ്ങളായും ചിത്രങ്ങളായും രൂപഭേദം വരുത്താൻ	
59.	ഏറ്റവും ഉചിതമായ സമവാക്യം കണ്ടെത്തി ഉത്തരത്തിൽ എങ്ങിനെയെത്താം എന്നത് പ്ലാൻ ചെയ്യാൻ	
60.	ഉത്തരത്തിലെത്താൻ സമവാക്യത്തിൽ വേണ്ട സബ്സ്റ്റിട്യൂഷൻസ് ചെയ്ത് അതിനെ പുനഃക്രമീകരിക്കാൻ	
61.	കിട്ടിയ ഉത്തരം ശരി തന്നെയാണോ എന്ന് പല തരത്തിൽ സൂക്ഷ്മമായി പരിശോധിക്കാൻ	
ചലനസമവാക്യങ്ങളിലെ ഗ്രാഫും അതിനോട് ബന്ധപ്പെട്ട കണക്കുകളും ചെയ്യാൻ അധ്യാപകർ പഠിപ്പിച്ച രീതികൾ താഴെ തന്നവയിലേത് (62-69) ?		
62.	ഒരു ഗ്രാഫ് എന്താണെന്നും യഥാർത്ഥ ജീവിതത്തിൽ അതിന്റെ ഉപയോഗത്തെക്കുറിച്ചും	
63.	x-അക്ഷം, y-അക്ഷം, മൂലബിന്ദു തുടങ്ങിയ ഗ്രാഫിന്റെ ഭാഗങ്ങൾ പഠിപ്പിച്ചു കൊണ്ട്	
64.	അക്ഷങ്ങൾക്ക് സ്കെയിൽ എങ്ങനെ നൽകാം	
65.	നമുക്ക് അനുയോജ്യമായ x, y മൂല്യങ്ങൾ ഉണ്ടെങ്കിൽ ഗ്രാഫിൽ പോയിന്റുകൾ എങ്ങനെ രേഖപ്പെടുത്താം	
66.	പട്ടികയിൽ തന്ന വിവരങ്ങൾ എങ്ങനെ ഗ്രാഫാക്കി മാറ്റാം	
67.	ഗ്രാഫ് എങ്ങനെ പട്ടിക രൂപത്തിലേക്ക് പരിവർത്തനം ചെയ്യാം	
68.	സ്ഥാനം-സമയം/വേഗത-സമയ ഗ്രാഫ് കണ്ട് വസ്തുവിന്റെ ചലനത്തിന്റെ സ്വഭാവം തിരിച്ചറിയാൻ	
69.	ഗ്രാഫിൽ നിന്ന് സ്ഥാനചലനം, വേഗത, ത്വരണം മുതലായവ കണ്ടെത്തുന്നതിനുള്ള ഘട്ടം ഘട്ടമായുള്ള പ്രക്രിയ	

70. ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നീ ആശയങ്ങൾ പഠിപ്പിക്കുമ്പോൾ, മുകളിൽ സൂചിപ്പിച്ച ബോധനരീതികൾക്കുപുറമേ മറ്റേതെങ്കിലും ഉപയോഗിക്കുന്നുണ്ടെങ്കിൽ എഴുതുക.

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APPENDIX 26

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CHECKLIST ON INSTRUCTIONAL PRACTICES FOR EQUATIONS OF MOTION / GRAVITATION

(DRAFT – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Instructions:

This checklist aims to find out whether the teachers use various instructional strategies during various teaching-learning contexts in transacting the concepts of 'Equations of Motion/ Gravitation' to IX standard students. Against each item students have to put a tick mark (✓) whichever is applicable in response column provided. Please remember that there is no right and wrong answer. Responding to all items is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

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Name: Male / Female

School:

No.	Instructional Practices of Physics Teachers	Response
Does your teacher use the following ways (items 1-8) while 'Introducing new concepts' in Equations of Motion / Gravitation?		
1.	By conveying orally	
2.	By providing the examples given in the textbook	
3.	By connecting with the concepts that are already known to us	
4.	By relating to examples from daily life	
5.	By demonstrating simple examples	

No.	Instructional Practices of Physics Teachers	Response
6.	By eliciting response (may be ideas or suggestions) from us for the questions asked by the teacher	
7.	By using videos /animations	
8.	By using slides/handouts	
Does your teacher use the following ways (items 9-15) while 'Working-out Mathematical Problems' in Equations of Motion / Gravitation?		
9.	By working out on the blackboard	
10.	By demonstrating using slides/ videos	
11.	By asking us to follow the step-by-step instruction provided	
12.	By asking one of us randomly to work out problem on the blackboard and later asking rest of us to check its correctness	
13.	By asking us individually to work out problems	
14.	By directing us to carry out group discussions and present the findings	
15.	By supervising and assisting while we work on problems	
Does your teacher use the following ways (16-23) while 'Executing project works' in Equations of Motion / Gravitation?		
16.	By providing the topic directly	
17.	By introducing the topic through a challenging situation and further into a problem during class discussion	
18.	By asking us individually to do it	
19.	By asking us to do it in groups	
20.	By providing related information and resources	
21.	By asking us to find related information and resources by ourselves	
22.	By summarizing the key theme to ensure the attainment of learning outcome, at the end of all our presentations	
23.	By providing suggestions after our presentations	
Does your teacher use the following ways (24-31) while 'Conducting Assessment' in Equations of Motion / Gravitation?		
24.	By enquiring whether we have understood or not	
25.	By explaining again and clarifying the doubts in case we didn't understand	

No.	Instructional Practices of Physics Teachers	Response
26.	By asking us questions in between the class	
27.	By asking us questions randomly based on the concepts taught the previous day at the beginning of each class	
28.	By directing us to prepare questions on our own	
29.	By asking us in groups to prepare questions and to conduct quiz in between groups	
30.	By supervising and mediating the quiz session initiated by us	
31.	By using online assessment tools (eg: Kahoot, Socrative, Google forms, Quizizz)	
Does your teacher use the following ways (32-36) for 'Consolidation of concepts' in Equations of Motion / Gravitation?		
32.	By conveying orally	
33.	By using slide/video presentations	
34.	By directing us individually to do it	
35.	By directing us to do it after group discussion	
36.	By commenting and suggesting corrections after our presentations	
Does your teacher use the following ways (37-41) while 'Facilitating note-making process' in Equations of Motion / Gravitation?		
37.	By dictating	
38.	By providing in printed form/pdf/slides	
39.	By asking us to prepare it individually	
40.	By asking us to prepare it after group discussion	
41.	By checking and by providing suggestions, if needed	
Does your teacher use the following ways (items 42-44) while 'Providing follow up activity (homework/ worksheets/ assignments)' in Equations of Motion / Gravitation?		
42.	By directing us to do it individually	
43.	By directing us to do it after group discussion	
44.	By checking our answers and by providing suggestions, if needed	

No.	Instructional Practices of Physics Teachers	Response
Does your teacher use 'Miscellaneous ways of teaching' (items 45-49) in Equations of Motion / Gravitation?		
45.	Initiating peer teaching among us	
46.	Using Mnemonics/concept mapping to transact tough concepts	
47.	Providing ample examples to eliminate misconceptions	
48.	Maths and physics teachers handling sessions together	
49.	More than one physics teachers handling sessions together	
Does your teacher use the following ways (items 50-54) for 'Examination preparedness' in Equations of Motion / Gravitation?		
50.	Discussing old question papers prior to examination	
51.	Discussing the answers in the class after mid-term/terminal exam	
52.	Teaching the common tough topic again after exam	
53.	Providing extra learning materials for high performers	
54.	Providing remedial teaching for the slow learners	
Does your teacher 'Enrich learning experiences' in the following ways (item 55) while transacting Equations of Motion / Gravitation?		
55.	Suggesting extra reference materials and web-based resources.	
While solving mathematical problems in in Equations of Motion / Gravitation, the teacher teaches me		
56.	to identify what is being given in the question	
57.	to identify what is being asked in the question	
58.	how to convert the question into symbolic/diagrammatic form for better understanding of the question	
59.	how to plan to solve the question by locating the most appropriate equation	
60.	how to make substitutions and rearranging the equations to reach the solution	
61.	how to cross check and review the answer	
While teaching graph and mathematical problems related to it in Equations of Motion, the teacher taught me		
62.	what a graph is and about its use in real life	
63.	the parts of the graph such as x-axis, y-axis, origin	
64.	how to assign scale to the axes	

No.	Instructional Practices of Physics Teachers	Response
65.	how to plot points in the graph if we have the corresponding x and y values	
66.	how to convert tabular data into graphs	
67.	how to convert graph into tabular form	
68.	to identify the nature of motion of the object by seeing the position-time/velocity-time graph	
69.	the step-by-step process to find displacement, velocity, acceleration etc. from the graph	

70. Please suggest other instructional practices for transacting Equations of Motion / Gravitation, other than that mentioned above.

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APPENDIX 27

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CHECKLIST ON INSTRUCTIONAL PRACTICES FOR EQUATIONS OF MOTION / GRAVITATION
(FINAL – MALAYALAM)

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നിർദ്ദേശങ്ങൾ:

ഒമ്പതാം ക്ലാസ്സിലെ കുട്ടികളെ ഭൗതികശാസ്ത്രത്തിലെ 'ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം' എന്നീ ആശയങ്ങൾ പഠിപ്പിക്കുമ്പോൾ, വ്യത്യസ്ത പഠന-ബോധന സന്ദർഭങ്ങളിൽ അധ്യാപകരുടെ ബോധന രീതികളുടെ ഉപയോഗം എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്തുകയാണ് ഈ സ്കെയ്ലിന്റെ ലക്ഷ്യം. തന്നിരിക്കുന്ന പ്രതികരണപട്ടികയിൽ നിങ്ങൾക്ക് ഉചിതമെന്ന് തോന്നുന്നതിന് നേരെ ✓ രേഖപ്പെടുത്തുക. ശരിയുത്തരം തെറ്റുത്തരം എന്നിങ്ങനെ ഇല്ല എന്നത് ശ്രദ്ധിക്കണം. എല്ലാ ചോദ്യങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്തണം എന്നത് നിർബന്ധമാണ്. നിങ്ങളിൽ നിന്നും സ്വീകരിക്കുന്ന പ്രതികരണങ്ങൾ ഗവേഷണത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ. അത് തികച്ചും രഹസ്യമായി സൂക്ഷിക്കുകയും ചെയ്യും.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	പ്രതികരണം
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവ പഠിപ്പിക്കുമ്പോൾ പുതിയ ആശയം അവതരിപ്പിക്കാൻ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (1-9)?		
1.	പാഠപുസ്തകത്തിലെ ഉദാഹരണങ്ങൾ നൽകിക്കൊണ്ട്	
2.	ഞങ്ങൾക്ക് അറിയുന്ന ആശയങ്ങളോട് ബന്ധപ്പെടുത്തിക്കൊണ്ട്	

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	പ്രതികരണം
3.	ദൈനംദിന ഉദാഹരണങ്ങളോട് ബന്ധപ്പെടുത്തിക്കൊണ്ട്	
4.	എളുപ്പമുള്ള ഉദാഹരങ്ങൾ ചെയ്ത് കാണിച്ച് കൊണ്ട്	
5.	ചോദ്യങ്ങൾ ചോദിച്ച് ഞങ്ങളിൽ നിന്ന് ശരിയായ പ്രതികരണം (ആശയങ്ങൾ/ നിർദ്ദേശങ്ങൾ) കൊണ്ടുവരുന്നതിലൂടെ	
6.	വീഡിയോസ്/ ആനിമേഷൻസിലൂടെ	
7.	സ്ലൈഡ്/ ലഘുലേഖയിലൂടെ	
8.	ക്ലാസ്സിൽ പഠിപ്പിക്കുന്നതിന് മുമ്പായി സ്വയം വായിച്ചും മനസ്സിലാക്കിയും വരാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
9.	ക്ലാസ്സിൽ പഠിപ്പിക്കുന്നത് മുമ്പായി പഠന സാമഗ്രികൾ നൽകി സ്വയം വായിച്ചും മനസ്സിലാക്കിയും വരാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിലെ കണക്ക് ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (10-16)?		
10.	ബ്ലാക്ക് ബോർഡിൽ ചെയ്ത് കാണിച്ച് കൊണ്ട്	
11.	സ്ലൈഡ്/ വീഡിയോസ് എന്നിവ പ്രദർശിപ്പിച്ചുകൊണ്ട്	
12.	പടിപടിയായ നൽകുന്ന നിർദ്ദേശങ്ങൾ പിന്തുടരാൻ പറഞ്ഞു കൊണ്ട്	
13.	ഞങ്ങളിൽ ഏതെങ്കിലും ഒരാളോട് ബ്ലാക്ക് ബോർഡിൽ കണക്ക് ചെയ്യാനും പിന്നീട് മറ്റുള്ളവരോട് അത് ശെരിയാണോ എന്ന് പരിശോധിക്കാനും ആവശ്യപ്പെട്ട് കൊണ്ട്	
14.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
15.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് ചർച്ച ചെയ്ത് ഉത്തരങ്ങൾ കണ്ടെത്തി അവതരിപ്പിക്കുവാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
16.	ഞങ്ങൾ കണക്ക് ചെയുമ്പോൾ മേൽനോട്ടം വഹിക്കുകയും സഹായിക്കുകയും ചെയ്ത കൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിലെ പ്രൊജക്ട് ചെയ്യുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (17-24)?		
17.	വിഷയം നേരിട്ട് പറഞ്ഞ് കൊടുത്ത് കൊണ്ട്	
18.	ക്ലാസ്സിലെ ചർച്ചയ്ക്കിടെ വെല്ലുവിളി നിറഞ്ഞ ഒരു സാഹചര്യത്തിലൂടെ വിഷയം അവതരിപ്പിച്ച കൊണ്ടും ഒരു പ്രശ്നത്തിലേക്ക് കടന്നുകൊണ്ടും	
19.	ഞങ്ങൾ ഓരോരുത്തരോടും ഒറ്റയ്ക്ക് അവ ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
20.	ഞങ്ങളോട് ഗ്രൂപ്പുകളായി തിരിഞ്ഞ് അവ ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
21.	അവ സംബന്ധിച്ച വിവരങ്ങളും വിഭവങ്ങളും നൽകി കൊണ്ട്	

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22.	അവ സംബന്ധിച്ച വിവരങ്ങളും വിഭവങ്ങളും സ്വയം കണ്ടെത്താൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
23.	പഠന നേട്ടങ്ങൾ ആർജ്ജിച്ചോ എന്ന് ഉറപ്പ് വരുത്തുന്നതിനായി, എല്ലാവരുടെയും അവതരണങ്ങൾക്ക് ശേഷം സാരാംശം ക്രോഡീകരിച്ച് കൊണ്ട്	
24.	ഞങ്ങളുടെ അവതരണങ്ങൾക്ക് ശേഷം കൂടുതൽ നിർദ്ദേശങ്ങൾ നൽകി കൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഉരുത്വാകർഷണം എന്നിവയുടെ മൂല്യനിർണ്ണയം നടത്തുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (25-33)?		
25.	മനസ്സിലായോ എന്ന് അന്വേഷിച്ച് കൊണ്ട്	
26.	ഞങ്ങൾക്ക് മനസ്സിലാകാത്ത സന്ദർഭങ്ങളിൽ വീണ്ടും വിവരിച്ചും സംശയങ്ങൾ വിശദീകരിച്ചും കൊണ്ട്	
27.	ക്ലാസ്സിനിടയിൽ ചോദ്യങ്ങൾ ചോദിച്ച് കൊണ്ട്	
28.	ക്ലാസ്സ് തുടങ്ങുന്നതിന് മുമ്പ് തലേ ദിവസം പഠിപ്പിച്ച ആശയത്തെ ആസ്പദമാക്കി ഞങ്ങൾക്കിടയിൽ ചോദ്യങ്ങൾ ചോദിച്ച് കൊണ്ട്	
29.	സ്വയം ചോദ്യങ്ങൾ ഉണ്ടാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
30.	ഗ്രൂപ്പുകളായി തിരിഞ്ഞു ചർച്ച ചെയ്ത് ചോദ്യങ്ങൾ ഉണ്ടാക്കുകയും ഗ്രൂപ്പുകൾക്കിടയിൽ ക്വിസ്സ് നടത്താനും നിർദ്ദേശിച്ച് കൊണ്ട്	
31.	ഞങ്ങൾ നടത്തുന്ന ക്വിസ്സിന് മേൽനോട്ടവും മദ്ധ്യസ്ഥതയും വഹിച്ചു കൊണ്ട്	
32.	മൂല്യനിർണ്ണയത്തിനുള്ള ഓൺലൈൻ ഉപകരണങ്ങൾ ഉപയോഗിച്ച് കൊണ്ട് (eg: Kahoot, Socrative, Google forms, Quizizz)	
33.	അർദ്ധ വാർഷിക പരീക്ഷകൾക്ക് പുറമെ ക്ലാസ്സ് പരീക്ഷകൾ നടത്തിക്കൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഉരുത്വാകർഷണം എന്നിവയുടെ ക്രോഡീകരണത്തിനായി അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (34-38)?		
34.	വാമൊഴിയായി പറഞ്ഞു കൊണ്ട്	
35.	സ്ലൈഡ്/ വീഡിയോസ് എന്നിവ പ്രദർശിപ്പിച്ചുകൊണ്ട്	
36.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
37.	ഗ്രൂപ്പ് ചർച്ച ചെയ്യാൻ നിർദ്ദേശിച്ചുകൊണ്ട്	
38.	ഞങ്ങളുടെ അവതരണത്തിന് ശേഷം അവ വിലയിരുത്തിയും തിരുത്തലുകൾ നിർദ്ദേശിക്കുകയും ചെയ്തുകൊണ്ട്	

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ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിൽ നോട്ട് തയ്യാറാക്കുമ്പോൾ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (39-44)?		
39.	ലെക്ചർ നോട്ട് എഴുതിയെടുക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
40.	നോട്ട് പറഞ്ഞെഴുതിച്ച് കൊണ്ട്	
41.	അച്ചടിച്ച രൂപം / പി.ഡി എഫ് / സ്ലൈഡ് എന്നിവ നൽകിക്കൊണ്ട്	
42.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് തയ്യാറാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
43.	ഗ്രൂപ്പ് ചർച്ചയിലൂടെ തയ്യാറാക്കാൻ പറഞ്ഞു കൊണ്ട്	
44.	ഞങ്ങൾ തയ്യാറാക്കിയ നോട്ട് പരിശോധിച്ചും ആവശ്യാനുസരണം നിർദ്ദേശങ്ങൾ നൽകിക്കൊണ്ടും	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിൽ തുടർപ്രവർത്തനങ്ങൾ (ഹോംവർക്ക് /വർക്ക്ഷീറ്റ് /അസൈൻമെൻറ്) ചെയ്യിപ്പിക്കാൻ അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (45-47)?		
45.	ഞങ്ങൾ ഓരോരുത്തരോടും അത് ഒറ്റയ്ക്ക് തയ്യാറാക്കാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
46.	ഗ്രൂപ്പ് ചർച്ചകൾക്ക് ശേഷം ചെയ്യാൻ നിർദ്ദേശിച്ച് കൊണ്ട്	
47.	ഞങ്ങൾ കണ്ടെത്തിയ ഉത്തരങ്ങൾ പരിശോധിക്കുകയും ആവശ്യമെങ്കിൽ നിർദ്ദേശങ്ങൾ നൽകുകയും ചെയ്തുകൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവക്ക് അധ്യാപകർ ഉപയോഗിക്കുന്ന മറ്റു ബോധന രീതികൾ ഏതൊക്കെയാണ് (48-52)?		
48.	നമുക്കിടയിൽ പിയർ ടീച്ചിംഗ് നടത്തിക്കൊണ്ട്	
49.	പ്രയാസമേറിയ ആശയങ്ങൾ പഠിപ്പിക്കാൻ നിമ്മോണിക്സ് / കൺസെപ്റ്റ് മാപ്പിംഗ് ഉപയോഗിച്ച് കൊണ്ട്	
50.	തെറ്റിദ്ധാരണകൾ ഒഴിവാക്കാൻ ധാരാളം ഉദാഹരണങ്ങൾ പറഞ്ഞ് കൊണ്ട്	
51.	ഗണിത അധ്യാപകരും ഭൗതികശാസ്ത്ര അധ്യാപകരും ഒരുമിച്ച് ക്ലാസുകൾ കൈകാര്യം ചെയ്ത് കൊണ്ട്	
52.	ഒന്നിലധികം ഭൗതികശാസ്ത്ര അധ്യാപകർ ഒരുമിച്ച് ക്ലാസുകൾ കൈകാര്യം ചെയ്ത് കൊണ്ട്	
പരീക്ഷയ്ക്കുള്ള തയ്യാറെടുപ്പിന് ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവക്ക് അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (53-58)?		
53.	പരീക്ഷയ്ക്ക് മുമ്പ് പഴയ ചോദ്യപേപ്പറുകൾ ചർച്ചചെയ്യുന്നതിലൂടെ	
54.	മിഡ്-ടേം / പാദവാർഷിക പരീക്ഷയ്ക്ക് ശേഷം ക്ലാസിൽ ഉത്തരങ്ങൾ ചർച്ച ചെയ്ത് കൊണ്ട്	

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55.	മിഡ്-ടേം / പാദവാർഷിക പരീക്ഷയ്ക്ക് ശേഷം ചോദ്യപേപ്പറിന് ഉത്തരം കണ്ടെത്തി എഴുതിവരാൻ ഞങ്ങളോട് ആവശ്യപ്പെട്ട് കൊണ്ട്	
56.	എല്ലാവർക്കും പ്രയാസമായി തോന്നിയ ആശയം പരീക്ഷയ്ക്ക് ശേഷം വീണ്ടും പഠിപ്പിച്ചുകൊണ്ട്	
57.	പഠനത്തിൽ മിടുക്കരായ കുട്ടികൾക്ക് കൂടുതൽ പഠന സാമഗ്രികൾ നൽകിക്കൊണ്ട്	
58.	പഠനത്തിൽ പിന്നാക്കം ഉള്ള കുട്ടികൾക്ക് പരിഹാരബോധനം നൽകിക്കൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിൽ പഠനാനുഭവങ്ങളെ പോഷിപ്പിക്കുന്നതിന് അധ്യാപകർ ഉപയോഗിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (59)?		
59.	കൂടുതൽ റഫറൻസ് മെറ്റീരിയലുകളും വെബ് അധിഷ്ഠിത ഉപാധികളും നിർദ്ദേശിച്ച് കൊണ്ട്	
ചലനസമവാക്യങ്ങൾ / ഗുരുത്വാകർഷണം എന്നിവയിലെ കണക്കുകൾ ചെയ്യാൻ അധ്യാപകർ പഠിപ്പിക്കുന്ന രീതികൾ താഴെ തന്നവയിലേത് (60-65)?		
60.	ചോദ്യത്തിൽ എന്താണ് തന്നിരിക്കുന്നത് എന്ന് തിരിച്ചറിയാൻ	
61.	ചോദ്യത്തിൽ എന്താണ് ചോദിച്ചിരിക്കുന്നത് എന്ന് തിരിച്ചറിയാൻ	
62.	ചോദ്യത്തെക്കുറിച്ച് കൂടുതൽ ധാരണയുണ്ടാക്കാൻ വേണ്ടി അതിനെ സൂചകങ്ങളായും ചിത്രങ്ങളായും രൂപഭേദം വരുത്താൻ	
63.	ഏറ്റവും ഉചിതമായ സമവാക്യം കണ്ടെത്തി ഉത്തരത്തിൽ എങ്ങിനെയെത്താം എന്നത് പ്ലാൻ ചെയ്യാൻ	
64.	ഉത്തരത്തിലെത്താൻ സമവാക്യത്തിൽ വേണ്ട സബ്സ്റ്റിട്യൂഷൻസ് ചെയ്ത് അതിനെ പുനഃക്രമീകരിക്കാൻ	
65.	കിട്ടിയ ഉത്തരം ശരി തന്നെയാണോ എന്ന് പല തരത്തിൽ സൂക്ഷ്മമായി പരിശോധിക്കാൻ	
ചലനസമവാക്യങ്ങളിലെ ഗ്രാഫും അതിനോട് ബന്ധപ്പെട്ട കണക്കുകളും ചെയ്യാൻ അധ്യാപകർ പഠിപ്പിച്ച രീതികൾ താഴെ തന്നവയിലേത് (66-73) ?		
66.	ഒരു ഗ്രാഫ് എന്താണെന്നും യഥാർത്ഥ ജീവിതത്തിൽ അതിന്റെ ഉപയോഗത്തെക്കുറിച്ചും	
67.	x-അക്ഷം, y-അക്ഷം, മൂലബിന്ദു തുടങ്ങിയ ഗ്രാഫിന്റെ ഭാഗങ്ങൾ പഠിപ്പിച്ചു കൊണ്ട്	
68.	അക്ഷങ്ങൾക്ക് സ്കെയിൽ എങ്ങനെ നൽകാം	

No.	ഭൗതികശാസ്ത്ര അധ്യാപകരുടെ ബോധനരീതികൾ	പ്രതികരണം
69.	നമുക്ക് അനുയോജ്യമായ x, y മൂല്യങ്ങൾ ഉണ്ടെങ്കിൽ ഗ്രാഫിൽ പോയിന്റുകൾ എങ്ങനെ രേഖപ്പെടുത്താം	
70.	പട്ടികയിൽ തന്ന വിവരങ്ങൾ എങ്ങനെ ഗ്രാഫാക്കി മാറ്റാം	
71.	ഗ്രാഫ് എങ്ങനെ പട്ടിക രൂപത്തിലേക്ക് പരിവർത്തനം ചെയ്യാം	
72.	സ്ഥാനം-സമയം/വേഗത-സമയ ഗ്രാഫ് കണ്ട് വസ്തുവിന്റെ ചലനത്തിന്റെ സ്വഭാവം തിരിച്ചറിയാൻ	
73.	ഗ്രാഫിൽ നിന്ന് സ്ഥാനചലനം, വേഗത, ത്വരണം മുതലായവ കണ്ടെത്തുന്നതിനുള്ള ഘട്ടം ഘട്ടമായുള്ള പ്രക്രിയ	

APPENDIX 28

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

CHECKLIST ON INSTRUCTIONAL PRACTICES FOR EQUATIONS OF MOTION / GRAVITATION

(FINAL – ENGLISH)

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Dr. Mumthas N. S.
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Instructions:

This checklist aims to find out whether the teachers use various instructional strategies during various teaching-learning contexts in transacting the concepts of 'Equations of Motion/ Gravitation' to IX standard students. Against each item students have to put a tick mark (✓) whichever is applicable in response column provided. Please remember that there is no right and wrong answer. Responding to all items is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

……

Name: Male / Female

School:

No.	Instructional Practices of Physics Teachers	Response
Does your teacher use the following ways (items 1-9) while 'Introducing new concepts' in Equations of Motion / Gravitation?		
1.	By providing the examples given in the textbook	
2.	By connecting with the concepts that are already known to us	
3.	By relating to examples from daily life	
4.	By demonstrating simple examples	
5.	By eliciting response (may be ideas or suggestions) from us for the questions asked by the teacher	

No.	Instructional Practices of Physics Teachers	Response
6.	By using videos /animations	
7.	By using slides/handouts	
8.	By directing us to self-learn and make an understanding prior to the class	
9.	By providing us with learning materials for self-learning and by directing to make an understanding on it, prior to the class	
Does your teacher use the following ways (items 10-16) while 'Working-out Mathematical Problems' in Equations of Motion / Gravitation?		
10.	By working out on the blackboard	
11.	By demonstrating using slides/ videos	
12.	By asking us to follow the step-by-step instruction provided	
13.	By asking one of us randomly to work out problem on the blackboard and later asking rest of us to check its correctness	
14.	By asking us individually to work out problems	
15.	By directing us to carry out group discussions and present the findings	
16.	By supervising and assisting while we work on problems	
Does your teacher use the following ways (items 17-24) while 'Executing project works' in Equations of Motion / Gravitation?		
17.	By providing the topic directly	
18.	By introducing the topic through a challenging situation and further into a problem during class discussion	
19.	By asking us individually to do it	
20.	By asking us to do it in groups	
21.	By providing related information and resources	
22.	By asking us to find related information and resources by ourselves	
23.	By summarizing the key theme to ensure the attainment of learning outcome, at the end of all our presentations	
24.	By providing suggestions after our presentations	
Does your teacher use the following ways (items 25-33) while 'Conducting Assessment' in Equations of Motion / Gravitation?		
25.	By enquiring whether we have understood or not	

No.	Instructional Practices of Physics Teachers	Response
26.	By explaining again and clarifying the doubts in case we didn't understand	
27.	By asking us questions in between the class	
28.	By asking us questions randomly based on the concepts taught the previous day at the beginning of each class	
29.	By directing us to prepare questions on our own	
30.	By asking us in groups to prepare questions and to conduct quiz in between groups	
31.	By supervising and mediating the quiz session initiated by us	
32.	By using online assessment tools (eg: Kahoot, Socrative, Google forms, Quizizz)	
33.	By conducting class tests apart from mid-term test	
Does your teacher use the following ways (items 34-38) for 'Consolidation of concepts' in Equations of Motion / Gravitation?		
34.	By conveying orally	
35.	By using slide/video presentations	
36.	By directing us individually to do it	
37.	By directing us to do it after group discussion	
38.	By commenting and suggesting corrections after our presentations	
Does your teacher use the following ways (items 39-44) while 'Facilitating note-making process' in Equations of Motion / Gravitation?		
39.	By asking us to take down lecture notes	
40.	By dictating	
41.	By providing in printed form/pdf/slides	
42.	By asking us to prepare it individually	
43.	By asking us to prepare it after group discussion	
44.	By checking and by providing suggestions, if needed	
Does your teacher use the following ways (items 45-47) while 'Providing follow up activity (homework/ worksheets/ assignments)' in Equations of Motion / Gravitation?		
45.	By directing us to do it individually	

No.	Instructional Practices of Physics Teachers	Response
46.	By directing us to do it after group discussion	
47.	By checking it and by providing suggestions, if needed	
Does your teacher use 'Miscellaneous ways of teaching' (items 48-52) in Equations of Motion / Gravitation?		
48.	Initiating peer teaching among us	
49.	Using Mnemonics/concept mapping to transact tough concepts	
50.	Providing ample examples to eliminate misconceptions	
51.	Maths and physics teachers handling sessions together	
52.	More than one physics teachers handling sessions together	
Does your teacher use the following ways (items 53-58) for 'Examination preparedness' in Equations of Motion / Gravitation?		
53.	Discussing old question papers prior to examination	
54.	Discussing the answers in the class after mid-term/terminal exam	
55.	Asking us to answer the question paper after mid-term/terminal exam	
56.	Teaching the common tough topic again after exam	
57.	Providing extra learning materials for high performers	
58.	Providing remedial teaching for the slow learners	
Does your teacher 'Enrich learning experiences' in the following ways (item 59) while transacting Equations of Motion / Gravitation?		
59.	Suggesting extra reference materials and web-based resources.	
While solving mathematical problems in Equations of Motion / Gravitation, the teacher teaches me		
60.	to identify what is being given in the question	
61.	to identify what is being asked in the question	
62.	how to convert the question into symbolic/diagrammatic form for better understanding of the question	
63.	how to plan to solve the question by locating the most appropriate equation	
64.	how to make substitutions and rearranging the equations to reach the solution	

No.	Instructional Practices of Physics Teachers	Response
65.	how to cross check and review the answer	
While 'Introducing the Basics of Graph and Related Problems' in Equations of Motion, the teacher taught me		
66.	what a graph is and about its use in real life	
67.	the parts of the graph such as x-axis, y-axis, origin	
68.	how to assign scale to the axes	
69.	how to plot points in the graph if we have the corresponding x and y values	
70.	how to convert tabular data into graphs	
71.	how to convert graph into tabular form	
72.	to identify the nature of motion of the object by seeing the position-time/velocity-time graph	
73.	the step-by-step process to find displacement, velocity, acceleration etc from the graph	

APPENDIX 29

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

DOMAIN INTEREST SCALE IN PHYSICS
(DRAFT – MALAYALAM)

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നിർദ്ദേശങ്ങൾ:

ഈ സ്കെയിൽ സെക്കൻഡറി സ്കൂൾ വിദ്യാർത്ഥികൾക്ക് ഭൗതികശാസ്ത്രത്തിലുള്ള താല്പര്യം (Domain Interest) എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്താനുള്ളതാണ്. 35 ആശയങ്ങളാണ് ഈ സ്കെയിലിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. തന്നിട്ടുള്ള ആശയങ്ങൾക്ക് ഉചിതമാണെന്ന് നിങ്ങൾക്ക് തോന്നുന്നുന്ന പ്രതികരണം കണ്ടെത്തി 'തീരെ താല്പര്യമില്ല', 'കുറച്ചു താല്പര്യമുണ്ട്', 'വളരെ അധികം താല്പര്യമുണ്ട്' എന്നിങ്ങനെ എഴുതിയതിന് താഴെയുള്ള കോളത്തിൽ ✓ രേഖപ്പെടുത്തണം. ശരിയുത്തരം തെറ്റുത്തരം എന്നിങ്ങനെ ഇല്ല എന്നത് ശ്രദ്ധിക്കണം.എല്ലാ ആശയങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്തണം എന്നത് നിർബന്ധമാണ്. നിങ്ങളിൽ നിന്നും സ്വീകരിക്കുന്ന പ്രതികരണങ്ങൾ ഗവേഷണത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ. അത് തികച്ചും രഹസ്യമായി സൂക്ഷിക്കുകയും ചെയ്യും.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	ആശയങ്ങൾ	തീരെ താല്പര്യമില്ല	കുറച്ച് താല്പര്യമുണ്ട്	വളരെ അധികം താല്പര്യമുണ്ട്
1.	പ്ലവക്ഷമബലം			
2.	ആർക്കമെഡീസ് തത്ത്വം			
3.	പ്ലവനം, പ്ലവനതത്ത്വം			

Appendices

No.	ആശയങ്ങൾ	തീരെ താല്പര്യമില്ല	കേട്ട് താല്പര്യമുണ്ട്	വളരെ അധികം താല്പര്യമുണ്ട്
4.	ആപേക്ഷികസാന്ദ്രത			
5.	പാസ്കൽ നിയമം			
6.	കേശികത്വം			
7.	വിസ്കസ് ബലം			
8.	ഗ്രാഫും അതിന്റെ ഘടകങ്ങളും			
9.	സ്ഥാന-സമയ ഗ്രാഫ്			
10.	പ്രവേഗ-സമയ ഗ്രാഫ്			
11.	ഒന്നാം ചലനസമവാക്യം			
12.	രണ്ടാം ചലനസമവാക്യം			
13.	മൂന്നാം ചലനസമവാക്യം			
14.	സന്തുലിത / അസന്തുലിത ബലം			
15.	ഗലീലിയോയുടെ നിരീക്ഷണങ്ങൾ			
16.	ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമം			
17.	ജഡത്വം			
18.	ആക്കം			
19.	ന്യൂട്ടന്റെ രണ്ടാം ചലനനിയമം			
20.	ആവേഗം			
21.	ന്യൂട്ടന്റെ മൂന്നാം ചലനനിയമം			
22.	ആക്കസംരക്ഷണനിയമം			
23.	സമവർത്തുളചലനം			
24.	സാർവികഗുരുത്വാകർഷണനിയമം			
25.	ഭൂഗുരുത്വാകർഷണബലം			
26.	ഭൂഗുരുത്വത്വരണം			
27.	മാസും ഭാരവും			
28.	നിർബാധപതനം			
29.	പ്രവൃത്തി			

No.	ആശയങ്ങൾ	തീരെ താല്പര്യമില്ല	കേട്ട് താല്പര്യമുണ്ട്	വളരെ അധികം താല്പര്യമുണ്ട്
30.	ഊർജം			
31.	ഗതികോർജം, സമവാക്യം			
32.	പ്രവൃത്തി -ഊർജതത്ത്വം			
33.	സ്ഥിതികോർജം			
34.	ഊർജസംരക്ഷണനിയമം			
35.	പവർ, സമവാക്യം			

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APPENDIX 30

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

DOMAIN INTEREST SCALE IN PHYSICS
(DRAFT – ENGLISH)

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Instructions:

This scale is meant to find out the extent of domain interest in physics among secondary school students. In this scale, there are 35 concepts listed. Students have to mark their response for each concept which they find appropriate, using tick mark (✓) under the column heading 'Not Interested', 'Somewhat Interested', 'Very Interested'. Please remember that there is no right and wrong answer. Responding to all the concepts is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

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Name: Male / Female

School:

No.	Concepts	Not Interested	Somewhat Interested	Very Interested
1.	Buoyant force			
2.	Archimedes' Principle			
3.	Floatation, Principle of floatation			
4.	Relative density			
5.	Pascal's law			
6.	Capillarity			
7.	Viscous force			
8.	Graph and its components			

No.	Concepts	Not Interested	Somewhat Interested	Very Interested
9.	Position-time graph			
10.	Velocity-time graph			
11.	First equation of motion			
12.	Second equation of motion			
13.	Third equation of motion			
14.	Balanced / unbalanced force			
15.	Observations of Galileo			
16.	Newton's first law of motion			
17.	Inertia			
18.	Momentum			
19.	Newton's second law of motion			
20.	Impulse			
21.	Newton's third law of motion			
22.	Law of conservation of momentum			
23.	Uniform circular motion			
24.	Universal law of gravitation			
25.	Force of gravity			
26.	Acceleration due to gravity			
27.	Mass and Weight			
28.	Freefall			
29.	Work			
30.	Energy			
31.	Kinetic energy, Equation			
32.	Work- energy principle			
33.	Potential energy			
34.	Law of conservation of energy			
35.	Power, Equation			

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APPENDIX 31

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

DOMAIN INTEREST SCALE IN PHYSICS
(FINAL – MALAYALAM)

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നിർദ്ദേശങ്ങൾ:

ഈ സ്കെയിൽ IX ആം ക്ലാസ് വിദ്യാർത്ഥികൾക്ക് ഭൗതികശാസ്ത്രത്തിലുള്ള താല്പര്യം (Domain Interest) എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്താനുള്ളതാണ്. 35 ആശയങ്ങളാണ് ഈ സ്കെയിലിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. തന്നിട്ടുള്ള ആശയങ്ങൾക്ക് ഉചിതമാണെന്ന് നിങ്ങൾക്ക് തോന്നുന്നുന്ന പ്രതികരണം കണ്ടെത്തി, 'തീരെ താല്പര്യമില്ല', 'കുറച്ചു താല്പര്യമുണ്ട്', 'വളരെ അധികം താല്പര്യമുണ്ട്' എന്നിങ്ങനെ എഴുതിയതിന് താഴെയുള്ള കോളത്തിൽ ✓ രേഖപ്പെടുത്തണം. ശരിയുത്തരം തെറ്റുത്തരം എന്നിങ്ങനെ ഇല്ല എന്നത് ശ്രദ്ധിക്കണം. എല്ലാ ആശയങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്തണം എന്നത് നിർബന്ധമാണ്. നിങ്ങളിൽ നിന്നും സ്വീകരിക്കുന്ന പ്രതികരണങ്ങൾ ഗവേഷണത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ. അത് തികച്ചും രഹസ്യമായി സൂക്ഷിക്കുകയും ചെയ്യും.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	ആശയങ്ങൾ	തീരെ താല്പര്യമില്ല	കുറച്ച് താല്പര്യമുണ്ട്	വളരെ അധികം താല്പര്യമുണ്ട്
1.	പ്ലവക്ഷമബലം (അളവ്, സ്വാധീനിക്കുന്ന ഘടകങ്ങൾ)			
2.	ആർക്കമെഡീസ് തത്ത്വം			

No.	ആശയങ്ങൾ	തീരെ തൃപ്തിയില്ല	കുറച്ച് തൃപ്തിയുണ്ട്	വളരെ അധികം തൃപ്തിയുണ്ട്
3.	പ്ലവനം, പ്ലവനതത്ത്വം			
4.	ആപേക്ഷികസാന്ദ്രത (ഹൈഡ്രോമീറ്റർ, ലാക്ടോമീറ്റർ)			
5.	പാസ്കൽ നിയമം (ഉപകരണങ്ങൾ)			
6.	കേശികത്വം (കേശിക ഉയർച്ച / താഴ്ച്ച, അഡ്ഹിഷൻ / കൊഹിഷൻ ബലം)			
7.	വിസ്കസ് ബലം (വിസ്കോസിറ്റിയും താപനിലയും)			
8.	ഗ്രാഫും അതിന്റെ ഘടകങ്ങളും			
9.	സ്ഥാന-സമയ ഗ്രാഫ്			
10.	പ്രവേഗ-സമയ ഗ്രാഫ്			
11.	ഒന്നാം ചലനസമവാക്യം			
12.	രണ്ടാം ചലനസമവാക്യം			
13.	മൂന്നാം ചലനസമവാക്യം			
14.	സന്തുലിത/ അസന്തുലിത ബലം (ആന്തരിക/ബാഹ്യബലം)			
15.	ഗലീലിയോയുടെ നിരീക്ഷണങ്ങൾ			
16.	ന്യൂട്ടന്റെ ഒന്നാം ചലനനിയമം			
17.	ജഡത്വം (നിശ്ചല /ചലന ജഡത്വം, മാസും ജഡത്വവും)			
18.	ആക്കം			
19.	ന്യൂട്ടന്റെ രണ്ടാം ചലനനിയമം			
20.	ആവേഗം			
21.	ന്യൂട്ടന്റെ മൂന്നാം ചലനനിയമം			
22.	ആക്കസംരക്ഷണനിയമം			
23.	സമവർത്തുളചലനം			
24.	സാർവികഗുരുത്വാകർഷണനിയമം			
25.	ഭൂഗുരുത്വാകർഷണബലം			
26.	ഭൂഗുരുത്വത്വരണം			
27.	മാസും ഭാരവും			

Appendices

No.	ആശയങ്ങൾ	തീരെ താല്പര്യമില്ല	കുറച്ച് താല്പര്യമുണ്ട്	വളരെ അധികം താല്പര്യമുണ്ട്
28.	നിർബാധപതനം			
29.	പ്രവൃത്തി (സൂത്രവാക്യം, പോസിറ്റീവ് /നെഗറ്റീവ് പ്രവൃത്തി)			
30.	ഊർജം			
31.	ഗതികോർജം, സമവാക്യം			
32.	പ്രവൃത്തി -ഊർജതത്ത്വം			
33.	സ്ഥിതികോർജം (സമവാക്യം, സ്ട്രെയിൻ മൂലമുള്ള സ്ഥിതികോർജം)			
34.	ഊർജസംരക്ഷണനിയമം			
35.	പവർ, സമവാക്യം			

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APPENDIX 32

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

DOMAIN INTEREST SCALE IN PHYSICS
(FINAL – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Instructions:

This scale is meant to find out the extent of domain interest in physics among IX standard students. In this scale, there are 35 concepts listed. For each concept, students should mark their level of interest which they find appropriate using tick mark (✓) under the column heading 'Not Interested', 'Somewhat Interested' and 'Very Interested'. Please remember that there is no right and wrong answer. Responding to all the concepts is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

……

Name: Male / Female

School:

No	Concepts	Not Interested	Somewhat Interested	Very Interested
1.	Buoyant force (Measurement, Influencing factors)			
2.	Archimedes' Principle			
3.	Floatation, Principle of floatation			
4.	Relative density (Hydrometer, Lactometer)			
5.	Pascal's law (Instruments)			
6.	Capillarity (Capillary rise / fall, Adhesive/cohesive force)			
7.	Viscous force (Viscosity and temperature)			

No	Concepts	Not Interested	Somewhat Interested	Very Interested
8.	Graph and its components			
9.	Position-time graph			
10.	Velocity-time graph			
11.	First equation of motion			
12.	Second equation of motion			
13.	Third equation of motion			
14.	Balanced / unbalanced force (Internal / external force)			
15.	Observations of Galileo			
16.	Newton's first law of motion			
17.	Inertia (Inertia of rest / motion, mass and inertia)			
18.	Momentum			
19.	Newton's second law of motion			
20.	Impulse			
21.	Newton's third law of motion			
22.	Law of conservation of momentum			
23.	Uniform circular motion			
24.	Universal law of gravitation			
25.	Force of gravity			
26.	Acceleration due to gravity			
27.	Mass and Weight			
28.	Freefall			
29.	Work (Formula, positive / negative work)			
30.	Energy			
31.	Kinetic energy, Equation			
32.	Work- energy principle			
33.	Potential energy (Equation, Potential energy due to strain)			
34.	Law of conservation of energy			
35.	Power, Equation			

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APPENDIX 33

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

SITUATIONAL INTEREST SCALE IN PHYSICS
(DRAFT – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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നിർദ്ദേശങ്ങൾ:

ഈ സ്കെയിൽ സെക്കൻഡറി സ്കൂൾ വിദ്യാർത്ഥികൾക്ക് ഭൗതികശാസ്ത്രത്തിലുള്ള താല്പര്യം (Situational Interest) എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്താനുള്ളതാണ്. 25 സന്ദർഭങ്ങളാണ് ഈ സ്കെയിലിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. തന്നിട്ടുള്ള സന്ദർഭങ്ങൾക്ക് ഉചിതമാണെന്ന് നിങ്ങൾക്ക് തോന്നുന്ന പ്രതികരണം കണ്ടെത്തി, 'നിസ്സംഗതയോടെ', 'കൗതുകത്തോടെ', 'അത്യുത്സാഹത്തോടെ' എന്നിങ്ങനെ എഴുതിയതിന് താഴെയുള്ള കോളത്തിൽ ✓ രേഖപ്പെടുത്തണം. ഉത്തരങ്ങളിൽ ശരിയും തെറ്റും ഇല്ലെന്ന് പ്രത്യേകം ഓർക്കുക. എല്ലാ ആശയങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക. ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണാവശ്യങ്ങൾക്കു മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	പ്രസ്താവനകൾ	നിസ്സംഗത	കൗതുകം	അത്യുത്സാഹം
1.	വ്യത്യസ്തതരം മണ്ണുകളുടെ ജല ആഗിരണശേഷിയെപ്പറ്റി ഒരു ലഘു പ്രൊജക്ട് തയ്യാറാക്കി ക്ലാസ്സിൽ അവതരിപ്പിക്കാൻ അധ്യാപകർ ആവശ്യപ്പെട്ടാൽ, ഞാൻ അത് ചെയ്യുന്നത് _____.			

No.	പ്രസ്താവനകൾ	നിസ്സംഗതയോടെ	ദേഷ്യത്തോടെ	ദേഷ്യത്തോടെയല്ല
2.	തൃശ്ശൂരിലെ മണ്ണുത്തി കാർഷിക സർവകലാശാലയിൽ സംഘടിപ്പിച്ച ഒരു ശില്പശാലയിൽ പങ്കെടുത്ത് അവിടത്തെ ഉദ്യോഗസ്ഥരുമായി 'വേനൽകാലം ആരംഭിക്കുന്നതിനു മുമ്പ് പറമ്പു കിളക്കുന്നത് പറമ്പിലെ ജലാംശം നിലനിർത്താൻ സഹായിക്കുന്നതെങ്ങിനെ ?' എന്നതിനെക്കുറിച്ച് ചർച്ച ചെയ്യാൻ എനിക്ക് അവസരം ലഭിച്ചാൽ, ഞാൻ അത് ചെയ്യുന്നത് _____.			
3.	സ്കൂൾ ശാസ്ത്രമേളയിൽ 'ഹൈഡ്രോളിക് ലിഫ്റ്റിന്റെ വർക്കിംഗ് മോഡൽ' പ്രദർശിപ്പിക്കാൻ എന്റെ അധ്യാപകർ എന്നോട് ആവശ്യപ്പെട്ടാൽ ഞാൻ അത് ചെയ്യുന്നത് _____.			
4.	'മണ്ണുമാന്തിയന്ത്രങ്ങൾക്ക് പരിസ്ഥിതി നാശത്തിലുള്ള പങ്കിനെക്കുറിച്ച്' ഞാൻ താമസിക്കുന്ന പ്രദേശത്ത് ഒരു സർവ്വേ നടത്താൻ എനിക്ക് അവസരം ലഭിച്ചാൽ, ഞാൻ അത് ചെയ്യുന്നത് _____.			
5.	ചോക്ക് ഉപയോഗിച്ചുണ്ടാക്കുന്ന മണ്ണെണ്ണ വിളക്കിന്റെ പ്രവർത്തനത്തെക്കുറിച്ച് അനിയനെയോ അനിയത്തിയെയോ വീട്ടിൽ എനിക്ക് പഠിപ്പിക്കേണ്ടി വന്നാൽ ഞാൻ അത് ചെയ്യുന്നത് _____.			
6.	സ്റ്റീഫൻ ഹോക്കിങ്സ് എഴുതിയ 'എ ബ്രീഫ് ഹിസ്റ്ററി ഓഫ് ടൈം' എന്ന പുസ്തകം അമ്മ എനിക്ക് സമ്മാനിച്ചാൽ ഞാൻ അത് വായിക്കുന്നത് _____.			
7.	ടൈം മെഷീൻ ഉപയോഗിച്ച് കാലത്തെ പിറകോട്ടു സഞ്ചരിപ്പിച്ച് ഐസാക്ക് ന്യൂട്ടനെ കാണാൻ എനിക്ക് അവസരം ലഭിച്ചാൽ ഞാൻ അത് ചെയ്യുന്നത് _____.			
8.	'ആഗോളതാപനം മൂലം താപനിലയിലുണ്ടാകുന്ന ഉയർച്ച' എന്ന വിഷയത്തിൽ ഒരു ചെറുഖണ്ഡിക തയ്യാറാക്കാൻ ആവശ്യപ്പെട്ടാൽ, ഞാൻ അത് എഴുതുന്നത് _____.			
9.	ലാബ് ദിനാഘോഷത്തോടനുബന്ധിച്ച് ഓം നിയമത്തിന്റെ പരീക്ഷണം ചെയ്യാൻ എന്നോട് ആവശ്യപ്പെട്ടാൽ, ഞാൻ അത് ചെയ്യുന്നത് _____.			
10.	'ലാക്ടോമീറ്റർ ഉപയോഗിച്ച് പാലിൽ മായം ചേർക്കുന്നത് എങ്ങിനെ കണ്ടുപിടിക്കാം?' എന്നതിനെക്കുറിച്ച് എന്റെ മുത്തശ്ശിക്ക് ഞാൻ പറഞ്ഞ് കൊടുക്കുന്നത് _____.			

No.	പ്രസ്താവനകൾ	നിസ്സംശയമായും	ഒരുപക്ഷേ	ഒരുപക്ഷേയല്ല
11.	കേരള ഹൈവേ വികസന പദ്ധതിയുടെ ഭാഗമായി 'ആറുവരിപ്പാതയും അതിനോട് അനുബന്ധിച്ച് സ്ഥാപിക്കുന്ന സ്പീഡ് ലിമിറ്റ് ബോർഡുകളും റോഡ് അപകടങ്ങളെ കുറയ്ക്കും' എന്നതിനെക്കുറിച്ച് ഞാൻ ആലോചിക്കുന്നത് _____.			
12.	'സൂര്യൻ മറ്റു നക്ഷത്രങ്ങളെയും ഗ്രഹങ്ങളെയും അതതിന്റെ സ്ഥാനത്തു പിടിച്ചു നിർത്തുന്നത് എങ്ങനെയായിരിക്കും?' എന്നതിനെക്കുറിച്ച് ഞാനാലോചിക്കുന്നത് _____.			
13.	അടുത്ത ദിവസം ഭൗതികശാസ്ത്രം സ്പെഷ്യൽ ക്ലാസ് ഉണ്ടാകുമെന്ന് ഹെഡ്മാസ്റ്റർ അറിയിച്ചാൽ, ഞാനതിൽ ഹാജരാകുന്നത് _____.			
14.	സ്കൂൾ വാർഷികാഘോഷവുമായി ബന്ധപ്പെട്ട് ഒരു ഭൗതികശാസ്ത്രജ്ഞനുമായി അഭിമുഖം നടത്താൻ എനിക്ക് അവസരം ലഭിച്ചാൽ, ഞാനത് ചെയ്യുന്നത് _____.			
15.	മൊബൈൽ ഫോൺ ടവറുകൾ പുറപ്പെടുവിക്കുന്ന 600 മില്ലിവാട്ട് / മീറ്റർ ൽ അധികം വരുന്ന വൈദ്യുതകാന്തികതരംഗങ്ങളുടെ ദോഷവശങ്ങളെക്കുറിച്ച് 3 മിനിറ്റിൽ കവിയാതെ പ്രസംഗിക്കാൻ അവസരം ലഭിക്കുകയാണെങ്കിൽ, ഞാൻ സംസാരിക്കുന്നത് _____.			
16.	മഴയോടനുബന്ധിച്ച് ഇടിയും മിന്നലും എങ്ങിനെ ഉണ്ടാകുന്നു എന്ന് ഞാനാലോചിക്കുന്നത് _____.			
17.	വൈദ്യുത ടോർച്ചിന്റെ നിർമ്മാണം ഞാൻ യൂട്യൂബിൽ കാണുന്നത് _____.			
18.	വൈദ്യുത ഉപകരണങ്ങളും അവയുടെ സൂചകങ്ങളും ഒരു ചാർട്ട് രൂപത്തിലാക്കി ക്ലാസ്സ്മുറിയിൽ പ്രദർശിപ്പിക്കാൻ എന്നോട് ആവശ്യപ്പെടുകയാണെങ്കിൽ, ഞാനത് തയ്യാറാക്കുന്നത് _____.			
19.	ഉപരിപഠനത്തിന് ഭൗതികശാസ്ത്രം തെരഞ്ഞെടുക്കുന്നതിനെപ്പറ്റി ഞാൻ ആലോചിക്കുന്നത് _____.			
20.	സ്കൂൾ സയൻസ് ക്ലബിന്റെ ലീഡർ എന്ന നിലയിൽ അന്താരാഷ്ട്ര ചാന്ദ്രദിനാഘോഷം ഞാൻ സംഘടിപ്പിക്കുന്നത് _____.			

No.	പ്രസ്താവനകൾ	നിസ്സംശയമായും ശരി	ശരിയാകാൻ സാധ്യത	ശരിയാകാൻ സാധ്യതയില്ല
21.	''മണിക്കൂറിൽ 60 മൈൽസ് ദൂരം എന്ന വേഗതയിലോ അതിൽ കൂടുതലോ പറക്കാനും അൾട്രാസോണിക് ശബ്ദം പ്രയോജനപ്പെടുത്തി ഇരയെ പിടിക്കാനും കഴിവുള്ള ജീവിയാണ് വവ്വാൽ'' എന്ന വസ്തുത ഞാൻ മനസ്സിലാക്കുന്നത് _____.			
22.	സ്കൂളിൽ നിന്നും പ്രയദർശിനി സ്പേസ് പ്ലാനറ്റേറിയത്തിലേക്ക് വിനോദയാത്ര സംഘടിപ്പിച്ചാൽ ഞാനതിന്റെ ഭാഗമാകുന്നത് _____.			
23.	പ്രകാശത്തിന്റെ അപവർത്തനം ഉപയോഗിച്ച് മാജിക് ചിത്രങ്ങൾ വരയ്ക്കാൻ അവസരം ലഭിച്ചാൽ ഞാനത് ചെയ്യുന്നത് _____.			
24.	സ്കൂളിലെ ഫ്രൂട്സ് ഡേ ആഘോഷത്തിന്റെ ഭാഗമായി നാലാം ക്ലാസ്സിൽ 'ഒരു ആപ്പിൾ എങ്ങിനെയാണ് ഭൗതികശാസ്ത്രത്തിലെ ചരിത്രപ്രധാനമായ ഗുരുത്വാകർഷണ നിയമങ്ങൾ രൂപപ്പെടുന്നതിന് കാരണമായത്?' എന്നതിനെക്കുറിച്ച് ഒരു പരിപാടി സംഘടിപ്പിക്കാൻ ആവശ്യപ്പെട്ടാൽ ഞാനത് ചെയ്യുന്നത് _____.			
25.	ബാലരമയിലെ ഇലക്ട്രോണിക് യന്ത്രോപകരണങ്ങളെ പറ്റിയുള്ള പദപ്രശ്നം ഞാൻ ചെയ്യുന്നത് _____.			

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APPENDIX 34

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

SITUATIONAL INTEREST SCALE IN PHYSICS
(DRAFT – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Instructions:

This scale is meant to find out the extent of situational interest in physics among secondary school students. In this scale, there are 25 statements. Students must mark their response for each statement which they find appropriate, using tick mark (✓) under the column heading 'Indifferent, Curious, Thrilled'. Please remember that there is no right and wrong answer. Responding to all the statements is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

……

Name: Male/ Female

School:

No.	Statements	Indifferent	Curious	Thrilled
1.	If my teacher asked me to find the water holding capacity of different types of soil and to present it as a mini-project, I will feel _____.			
2.	While participating in an agricultural workshop conducted at Mannuthy Agricultural University, Thrissur, if I get a chance to discuss with the officials present on 'how ploughing of land before summer helps to retain moisture in the soil', I will feel _____.			
3.	If my teacher asked me to exhibit 'working model of hydraulic lift' in the school science exhibition, I will feel _____.			

No.	Statements	Indifferent	Curious	Thrilled
4.	If my teacher asked me to exhibit 'working model of hydraulic lift' in the school science exhibition, I will feel _____.			
5.	If I get an opportunity to teach my younger sister or brother at home about 'the working of kerosene lamp using chalk', I will feel _____.			
6.	If my mom gifts me the book 'A Brief History of Time' written by Stephen Hawking, I will feel _____.			
7.	If I am given a chance to travel through time machine and meet Isaac Newton, I will feel _____.			
8.	If I have to write a short paragraph on the topic, 'Increase in temperature due to global warming', I will feel _____.			
9.	If I had to perform experiment on Ohm's Law as a part of Lab Day Celebration at school, I will feel _____.			
10.	If I had to explain 'the working of lactometer to detect adulteration in milk' to my grandmother, I will feel _____.			
11.	The thought that 'the speed limit boards will be installed' along with Kerala highway expansion of NH-66 to 6 lanes to reduce road accidents makes me feel _____.			
12.	The thought regarding how the stars and planets are held in position by the Sun makes me feel _____.			
13.	If the headmaster informs that there will be physics special class on the next day, I will feel _____.			
14.	In relation to school annual day celebration, if I get a chance to interview a physicist, I will feel _____.			
15.	If I had to give a 3 minutes talk on the issue, 'Mobile phone towers emit electromagnetic rays above 600 milliwatts per metre limit which is harmful', I will feel _____.			
16.	The thought of 'how lightning and thunder accompanies rain?' makes me feel _____.			

No.	Statements	Indifferent	Curious	Thrilled
17.	While watching 'the making of electric torch' in You Tube, I feel _____.			
18.	If I was asked to prepare a chart on electronic devices and its symbols to exhibit in the classroom, I will feel _____.			
19.	The thought of opting physics for higher studies makes me feel _____.			
20.	As the leader of school science club, if I had to organize the celebration on International Moon Day, I will feel _____.			
21.	The fact that 'Bats can fly at speeds of 60 miles per hour or more and make use of ultrasonic sounds for catching prey' makes me feel _____.			
22.	If a school tour was organized to Priyadarsini Space Planetarium, I will feel _____.			
23.	If I had to do 'magic drawing with refraction of light', I will feel _____.			
24.	For the 'Fruits Day' celebration at school, if I was asked to engage the students of 4th standard by narrating the history of how an apple led to the landmark in physics laws related to gravity, I will feel _____.			
25.	Doing a cross word related to electronic gadgets in Balarama makes me feel _____.			

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APPENDIX 35

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

SITUATIONAL INTEREST SCALE IN PHYSICS
(FINAL – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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നിർദ്ദേശങ്ങൾ:

ഈ സ്കെയിൽ IX, X ക്ലാസ്സുകളിലെ വിദ്യാർത്ഥികൾക്ക് ഭൗതികശാസ്ത്രത്തിലുള്ള താല്പര്യം (Situational Interest) എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്താനുള്ളതാണ്. 25 സന്ദർഭങ്ങളാണ് ഈ സ്കെയിലിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. തന്നിട്ടുള്ള സന്ദർഭങ്ങൾക്ക് ഉചിതമാണെന്ന് നിങ്ങൾക്ക് തോന്നുന്നുന്ന പ്രതികരണം കണ്ടെത്തി, 'നിസ്സംഗതയോടെ', 'കൗതുകത്തോടെ', 'അത്യുത്സാഹത്തോടെ' എന്നിങ്ങനെ എഴുതിയതിന് താഴെയുള്ള കോളത്തിൽ ✓ രേഖപ്പെടുത്തണം. ഉത്തരങ്ങളിൽ ശരിയും തെറ്റും ഇല്ലെന്ന് പ്രത്യേകം ഓർക്കുക. എല്ലാ ആശയങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക. ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണാവശ്യങ്ങൾക്കു മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	**സന്ദർഭങ്ങൾ**	**നിസ്സംഗതയോടെ**	**കൗതുകത്തോടെ**	**അത്യുത്സാഹത്തോടെ**
1.	വ്യത്യസ്തതരം മണ്ണുകളുടെ ജല ആഗിരണശേഷിയെപ്പറ്റി ഒരു ലഘു പ്രൊജക്ട് തയ്യാറാക്കി ക്ലാസ്സിൽ അവതരിപ്പിക്കാൻ അധ്യാപകർ ആവശ്യപ്പെട്ടാൽ, ഞാൻ അത് ചെയ്യുന്നത്			

No.	സന്ദർഭങ്ങൾ	ടാഗ്യാഗ്യാംഗ്ഗ്യ	ടാഗ്യാഷ്ടാള്ടാഷ	ടാഗ്യാഷ്ടാഗ്യാഗ്ഗ്യാ
2.	തൃശ്ശൂരിലെ മണ്ണുത്തി കാർഷിക സർവകലാശാലയിൽ സംഘടിപ്പിച്ച ഒരു ശില്പശാലയിൽ പങ്കെടുത്ത് അവിടത്തെ ഉദ്യോഗസ്ഥരുമായി 'വേനൽകാലം ആരംഭിക്കുന്നതിനു മുമ്പ് പറമ്പു കിളക്കുന്നത് പറമ്പിലെ ജലാംശം നിലനിർത്താൻ സഹായിക്കുന്നതെങ്ങിനെ ?' എന്നതിനെക്കുറിച്ച് ചർച്ച ചെയ്യാൻ എനിക്ക് അവസരം ലഭിച്ചാൽ, ഞാൻ അത് ചെയ്യുന്നത്			
3.	സ്കൂൾ ശാസ്ത്രമേളയിൽ 'ഹൈഡ്രോളിക് ലിഫ്റ്റിന്റെ വർക്കിംഗ് മോഡൽ' പ്രദർശിപ്പിക്കാൻ എന്റെ അധ്യാപകർ എന്നോട് ആവശ്യപ്പെട്ടാൽ ഞാൻ അത് ചെയ്യുന്നത്			
4.	'മണ്ണുമാന്തിയന്ത്രങ്ങൾക്ക് പരിസ്ഥിതി നാശത്തിലുള്ള പങ്കിനെക്കുറിച്ച്' ഞാൻ താമസിക്കുന്ന പ്രദേശത്ത് ഒരു സർവ്വേ നടത്താൻ എനിക്ക് അവസരം ലഭിച്ചാൽ, ഞാൻ അത് ചെയ്യുന്നത്			
5.	ചോക്ക് ഉപയോഗിച്ചുണ്ടാക്കുന്ന മണ്ണെണ്ണ വിളക്കിന്റെ പ്രവർത്തനത്തെക്കുറിച്ച് അനിയനെയോ അനിയത്തിയെയോ വീട്ടിൽ എനിക്ക് പഠിപ്പിക്കേണ്ടി വന്നാൽ ഞാൻ അത് ചെയ്യുന്നത്			
6.	സ്റ്റീഫൻ ഹോക്കിങ്സ് എഴുതിയ 'എ ബ്രീഫ് ഹിസ്റ്ററി ഓഫ് ടൈം' എന്ന പുസ്തകം അമ്മ എനിക്ക് സമ്മാനിച്ചാൽ ഞാൻ അത് വായിക്കുന്നത്			
7.	ടൈം മെഷീൻ ഉപയോഗിച്ച് കാലത്തെ പിറകോട്ടു സഞ്ചരിപ്പിച്ച് ഐസാക്ക് ന്യൂട്ടനെ കാണാൻ എനിക്ക് അവസരം ലഭിച്ചാൽ ഞാൻ അത് ചെയ്യുന്നത്			
8.	'ആഗോളതാപനം മൂലം താപനിലയിലുണ്ടാകുന്ന ഉയർച്ച' എന്ന വിഷയത്തിൽ ഒരു ചെറുഖണ്ഡിക തയ്യാറാക്കാൻ ആവശ്യപ്പെട്ടാൽ, ഞാൻ അത് എഴുന്നത്			
9.	ലാബ് ദിനാഘോഷത്തോടനുബന്ധിച്ച് ഓം നിയമത്തിന്റെ പരീക്ഷണം ചെയ്യാൻ എന്നോട് ആവശ്യപ്പെട്ടാൽ, ഞാൻ അത് ചെയ്യുന്നത്			
10.	'ലാക്ടോമീറ്റർ ഉപയോഗിച്ച് പാലിൽ മായം ചേർക്കുന്നത് എങ്ങിനെ കണ്ടുപിടിക്കാം?' എന്നതിനെക്കുറിച്ച് എന്റെ മുത്തശ്ശിക്ക് ഞാൻ പറഞ്ഞ് കൊടുക്കുന്നത്			

Appendices

| No. | സന്ദർഭങ്ങൾ | ടടട

| No. | സന്ദർഭങ്ങൾ | ടടട

APPENDIX 36

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

SITUATIONAL INTEREST SCALE IN PHYSICS

(FINAL – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Instructions:

This scale is meant to find out the extent of situational interest in physics among IX and X standard students. In this scale, there are 25 situations explained. For each situation, students must mark their level of excitement which they find appropriate using tick mark (✓) under the column heading 'Indifferent', 'Curious' and 'Thrilled'. Please remember that there is no right and wrong answer. Responding to all the statements is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

……

Name: Male / Female

School:

No.	Situations	Indifferent	Curious	Thrilled
1.	If my teacher asked me to find the water holding capacity of different types of soil and to present it as a mini-project, I will feel			
2.	While participating in an agricultural workshop conducted at Mannuthy Agricultural University, Thrissur, if I get a chance to discuss with the officials present on 'how ploughing of land before summer helps to retain moisture in the soil', I will feel			

No.	Situations	Indifferent	Curious	Thrilled
3.	If my teacher asked me to exhibit 'working model of hydraulic lift' in the school science exhibition, I will feel			
4.	If I get an opportunity to conduct a survey in my locality on 'the role of excavators in ruining the environment', I will feel			
5.	If I get an opportunity to teach my younger sister or brother at home about 'the working of kerosene lamp using chalk', I will feel			
6.	If my mom gifts me the book 'A Brief History of Time' written by Stephen Hawking, I will feel			
7.	If I am given a chance to travel through time machine and meet Isaac Newton, I will feel			
8.	If I have to write a short paragraph on the topic, 'Increase in temperature due to global warming', I will feel			
9.	If I had to perform experiment on Ohm's Law as a part of Lab Day Celebration at school, I would feel			
10.	If I had to explain 'the working of lactometer to detect adulteration in milk' to my grandmother, I would feel			
11.	The thought that 'the speed limit boards will be installed' along with Kerala highway expansion of NH-66 to 6 lanes to reduce road accidents makes me feel			
12.	The thought regarding how the stars and planets are held in position by the Sun makes me feel			
13.	If the headmaster informs that there will be physics special class on the next day, I will feel			
14.	In relation to school annual day celebration, if I get a chance to interview a physicist, I will feel			
15.	If I had to give a 3-minute talk on the issue, 'Mobile phone towers emit electromagnetic rays above 600 milliwatts per metre limit which is harmful', I will feel			
16.	The thought of 'how lightning and thunder accompanies rain?' makes me feel			
17.	While watching 'the making of electric torch' in You Tube, I feel			

No.	Situations	Indifferent	Curious	Thrilled
18.	If I was asked to prepare a chart on electronic devices and its symbols to exhibit in the classroom, I will feel			
19.	The thought of opting physics for higher studies makes me feel			
20.	As the leader of school science club, if I had to organize the celebration on International Moon Day, I would feel			
21.	The fact that 'Bats can fly at speeds of 60 miles per hour or more and make use of ultrasonic sounds for catching prey' makes me feel			
22.	If a school tour was organized to Priyadarsini Space Planetarium, I will feel			
23.	If I had to do 'magic drawing with refraction of light', I would feel			
24.	For the 'Fruits Day' celebration at school, if I was asked to engage the students of 4th standard by narrating the history of how an apple led to the landmark in physics laws related to gravity, I will feel			
25.	Doing a cross word related to electronic gadgets in Balarama makes me feel			

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APPENDIX 37

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

INDIVIDUAL INTEREST SCALE IN PHYSICS

(DRAFT – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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നിർദ്ദേശങ്ങൾ:

ഈ സ്കെയിൽ സെക്കൻഡറി സ്കൂൾ വിദ്യാർത്ഥികൾക്ക് ഭൗതികശാസ്ത്രത്തിലുള്ള താല്പര്യം (Individual Interest) എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്താനുള്ളതാണ്. 42 പ്രസ്താവനകളാണ് ഈ സ്കെയിലിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. തന്നിട്ടുള്ള പ്രസ്താവനകൾക്ക് ഉചിതമാണെന്ന് നിങ്ങൾക്ക് തോന്നുന്ന പ്രതികരണം കണ്ടെത്തി, 'ശരി', 'ഏറെക്കുറേ ശരി', 'തെറ്റ്' എന്നിങ്ങനെ എഴുതിയതിന് താഴെയുള്ള കോളത്തിൽ ✓ രേഖപ്പെടുത്തണം. ഉത്തരങ്ങളിൽ ശരിയും തെറ്റും ഇല്ലെന്ന് പ്രത്യേകം ഓർക്കുക. എല്ലാ ആശയങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക. ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണാവശ്യങ്ങൾക്കു മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	പ്രസ്താവനകൾ	ശരി	ഏറെക്കുറെ ശരി	തെറ്റ്
1.	എനിക്ക് ഭൗതികശാസ്ത്രം പഠിക്കാൻ ഇഷ്ടമാണ്.			
2.	ഭൗതികശാസ്ത്രം വിരസതയുണ്ടാക്കുന്ന ശാസ്ത്രവിഷയമായാണ് എനിക്ക് തോന്നുന്നത്.			

Appendices

No.	പ്രസ്താവനകൾ	ശരി	തെറ്റ്	ശരിയുമല്ല തെറ്റുമല്ല
3.	ശാസ്ത്രത്തിന്റെ വളരെ പ്രധാനപ്പെട്ട ഒരു ശാഖയാണ് ഭൗതികശാസ്ത്രം.			
4.	ഉപരിപഠനത്തിന് ഭൗതികശാസ്ത്രം ഒരു നല്ല ഓപ്ഷനല്ല.			
5.	എനിക്ക് ഭൗതികശാസ്ത്രത്തിൽ നല്ല അറിവുണ്ട്.			
6.	വിവിധ ഭൗതികശാസ്ത്രജ്ഞരുടെ കണ്ടുപിടുത്തങ്ങൾ എന്നെ വിസ്മയിപ്പിക്കുന്നു.			
7.	ഭൗതികശാസ്ത്രത്തിലെ പരീക്ഷണങ്ങൾ നടത്താനും നിഗമനങ്ങളിൽ എത്തിച്ചേരാനുമുള്ള കഴിവ് എനിക്കില്ല.			
8.	എന്റെ ഒഴിവുസമയങ്ങളിൽ കൂടുതലും ഭൗതികശാസ്ത്ര മെറ്റീരിയലുകൾ വായിക്കാനാണ് ഞാൻ ഇഷ്ടപ്പെടുന്നത്.			
9.	ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട സെമിനാറുകളിലും ചർച്ചകളിലും പങ്കെടുക്കാൻ ഞാൻ ഇഷ്ടപ്പെടുന്നില്ല.			
10.	ഞാൻ ഭൗതികശാസ്ത്രം ആസ്വദിച്ചാണ് പഠിക്കുന്നത്.			
11.	ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട പാഠ്യേതര പ്രവർത്തനങ്ങളിൽ പങ്കെടുക്കുന്നത് ഞാൻ ആസ്വദിക്കുന്നു.			
12.	ഭൗതികശാസ്ത്രപഠനം എന്നെ അലോസരപ്പെടുത്തുന്നു.			
13.	മെച്ചപ്പെട്ട മനുഷ്യജീവിതത്തിന് ഭൗതികശാസ്ത്രത്തിലെ അറിവ് അത്യന്താപേക്ഷിതമാണ്.			
14.	ഭൗതികശാസ്ത്രം ഒരു സ്കൂൾ വിഷയമായി ഉൾപ്പെടുത്തുന്നത് എനിക്ക് തിരിച്ചടികളും പരാജയങ്ങളും മാത്രമേ നൽകിയിട്ടുള്ളൂ.			
15.	ഭൗതികശാസ്ത്രത്തിലെ ഗ്രേഡുകൾ മെച്ചപ്പെടുത്താൻ പഠനത്തിൽ പിന്നാക്കമുള്ള സഹപാഠികളെ സഹായിക്കാൻ എനിക്ക് കഴിയും.			
16.	ഭൗതികശാസ്ത്രപഠനം എന്നെ മികച്ച വ്യക്തിയാക്കും.			
17.	സ്കൂളുകളിൽ നിന്ന് ഭൗതികശാസ്ത്രം നീക്കം ചെയ്തിരുന്നെങ്കിൽ, നല്ല ഗ്രേഡുകൾ നേടുന്നതിന് ഞാൻ മികച്ച പ്രകടനം കാഴ്ചവെക്കുമായിരുന്നു.			
18.	ഭൗതികശാസ്ത്രമേഖലയിലെ പുതിയ കണ്ടുപിടുത്തങ്ങളെക്കുറിച്ച് കൂടുതൽ അറിയാൻ എനിക്ക് താല്പര്യമുണ്ട് .			
19.	ഭൗതികശാസ്ത്രം പഠിക്കുന്നത് മാറ്റിവെക്കുന്ന പ്രവണത എനിക്കുണ്ട്.			

No.	പ്രസ്താവനകൾ	ശരി	തെറ്റ്	ശരിയുത്തരമില്ല
20.	ഭൗതികശാസ്ത്രപഠനം എനിക്ക് ആവേശം പകരുന്നു.			
21.	സ്കൂൾ വിഷയങ്ങളിൽ നിന്ന് ഭൗതികശാസ്ത്രം ഒഴിവാക്കിയാൽ എനിക്ക് സന്തോഷമാണ്.			
22.	ജീവനുള്ളതും അല്ലാത്തതുമായ എല്ലാ ജീവജാലങ്ങൾക്കും അനുയോജ്യമായ ഇടമാക്കി ലോകത്തെ മാറ്റുന്നതിൽ ഭൗതികശാസ്ത്രജ്ഞർ വളരെ പ്രധാനപ്പെട്ട പങ്ക് വഹിക്കുന്നു.			
23.	ഭൗതികശാസ്ത്രത്തിൽ പഠിക്കേണ്ട എല്ലാ പാഠഭാഗങ്ങളെക്കുറിച്ചും എനിക്ക് നല്ല അറിവുണ്ട്.			
24.	ഭാവിയിൽ ഒരു മികച്ച തൊഴിൽ ലഭിക്കാൻ ഭൗതികശാസ്ത്രപഠനം കൊണ്ട് സാധിക്കില്ല..			
25.	ക്ലാസ്സിൽ ഭൗതികശാസ്ത്ര അധ്യാപകർ ചോദിക്കുന്ന ചോദ്യങ്ങൾക്ക് എനിക്ക് ഉത്തരം നല്കാൻ കഴിയും.			
26.	ഭൗതികശാസ്ത്രപഠനത്തിൽ സ്കൂളിൽ എനിക്ക് മികച്ച പ്രകടനം കാഴ്ചവെക്കാൻ കഴിയാറില്ല.			
27.	ക്ലാസ്സിൽ പഠിക്കുന്നതിനപ്പുറം ഭൗതികശാസ്ത്രത്തിൽ എനിക്ക് കൂടുതൽ അറിവ് നേടേണ്ടതുണ്ട്.			
28.	ഭൗതികശാസ്ത്രത്തിലെ ഹോംവർക്കുകളോ അസൈൻമെന്റുകളോ ചെയ്യാതെ മാറ്റിവെക്കാൻ നിരവധി ഒഴികഴിവുകൾ ഞാൻ കണ്ടെത്താറുണ്ട്.			
29.	ഭൗതികശാസ്ത്രത്തിൽ നല്ല ഗ്രേഡുകൾ നേടുന്നത് എന്നെ സംബന്ധിച്ചിടത്തോളം പ്രധാനമാണ്.			
30.	ഭൗതികശാസ്ത്രത്തിലെ പരീക്ഷണങ്ങൾ ചെയ്യുന്നത് എനിക്ക് ആവേശം പകരുന്നു.			
31.	ഭൗതികശാസ്ത്രപഠനം ഒരു പേടിസ്വപ്നമാണ്.			
32.	ഭൗതികശാസ്ത്രത്തിലെ കണക്കുകൾക്ക് ഉത്തരങ്ങൾ കണ്ടെത്താൻ എനിക്കറിയാം.			
33.	ഭൗതികശാസ്ത്രത്തിൽ നല്ല മാർക്ക് നേടുക എന്നത് ഭാഗ്യശാലികളായ വിദ്യാർത്ഥികൾക്ക് മാത്രം സാധ്യമായ കാര്യമാണ്.			
34.	ഭൗതികശാസ്ത്രത്തിലെ കണക്കുകൾ ചെയ്യുന്നത് ഞാൻ ആസ്വദിക്കുന്നു.			
35.	ചില വിദ്യാർത്ഥികൾ ഭൗതികശാസ്ത്രം ഇഷ്ടപ്പെടുന്നതിൽ എനിക്ക് അത്ഭുതം തോന്നുന്നു.			

No.	പ്രസ്താവനകൾ	ശരി	തെറ്റാകാൻ സാധ്യത	തെറ്റ്
36.	ഭൗതികശാസ്ത്ര ക്ലാസുകൾ എനിക്ക് ആവേശം പകരുന്നു.			
37.	എനിക്ക് അവസരം ലഭിച്ചാൽ ഞാൻ ഭൗതികശാസ്ത്ര ക്ലാസുകൾ പങ്കെടുക്കാതെ മുങ്ങും.			
38.	ഭൗതികശാസ്ത്ര ക്ലാസുകൾ നന്നായി ശ്രദ്ധിക്കേണ്ടത് അത്യാവശ്യമാണ്.			
39.	ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട പ്രവർത്തനങ്ങളിൽ ഏർപ്പെടുന്നോറും ഞാൻ കൂടുതൽ പ്രകോപിതനാകും.			
40.	വീട്ടിലിരുന്ന് സ്വന്തമായി ഭൗതികശാസ്ത്രത്തിലെ പരീക്ഷണങ്ങൾ നടത്താൻ എനിക്ക് താൽപ്പര്യമുണ്ട്.			
41.	ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട പ്രവർത്തനങ്ങൾ ബുദ്ധിമുട്ടാണെങ്കിലും അവ പരിഹരിക്കുന്നത് ഞാൻ ആസ്വദിക്കുന്നു.			
42.	ഭൗതികശാസ്ത്രം പഠിക്കുന്നത് സമയം പാഴാക്കലാണ്.			

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APPENDIX 38

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

INDIVIDUAL INTEREST SCALE IN PHYSICS
(DRAFT – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Instructions:

This scale is meant to find out the extent of individual interest in physics among secondary school students. In this scale, there are 42 statements. Students have to mark their response for each statement which they find appropriate, using tick mark (✓) under the column heading 'Correct', 'Partially correct', 'Incorrect'. Please remember that there is no right and wrong answer. Responding to all the statements is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

……

Name: Male / Female

School:

No.	Statements	Correct	Partially correct	Incorrect
1.	I like studying physics.			
2.	I feel physics is a boring science subject.			
3.	Physics is a very important branch of science.			
4.	Physics is not a good option for higher studies.			
5.	I have good knowledge in physics.			

No.	Statements	Correct	Partially correct	Incorrect
6.	I admire the inventions and discoveries of various physicists.			
7.	I do not have the skill to perform physics experiments and to draw conclusions.			
8.	I prefer spending more time reading physics materials during my leisure time.			
9.	I don't like to attend seminars and talks related to physics.			
10.	I enjoy studying physics.			
11.	I enjoy participating in extracurricular activities related to physics.			
12.	Learning physics irritates me.			
13.	Knowledge in physics is essential for a better human life.			
14.	Including physics as a school discipline has only given me setbacks and failures.			
15.	I can guide poor performers among my classmates to improve their grades in physics.			
16.	Learning physics will make me a better person.			
17.	If physics was removed from schools, I would have performed well to bring good grades.			
18.	I would like to know more about new inventions and discoveries in the field of physics.			
19.	I have a tendency to postpone learning physics.			
20.	Learning physics makes me excited.			
21.	I would be happy if physics was removed from school subjects.			
22.	Physicists play a very important role in making the world a better place for all living and non-living organisms.			
23.	I am thorough with all the topics that I have to study in physics.			

No.	Statements	Correct	Partially correct	Incorrect
24.	Learning physics will never give a better career in future.			
25.	I can answer the questions that physics teacher asks in the classroom.			
26.	At school, I am a poor performer when it comes to physics.			
27.	I need to acquire more knowledge in physics beyond what I learn in class.			
28.	I find many excuses for keeping aside homework or assignments in physics.			
29.	Getting good grades in physics is important for me.			
30.	Performing experiments in physics is fascinating.			
31.	Learning physics is a nightmare.			
32.	I know how to solve physics problems.			
33.	Scoring good marks in physics is meant for lucky students.			
34.	I enjoy working out physics problems.			
35.	I wonder why some students like physics.			
36.	Physics classes excite me.			
37.	I will bunk physics classes if I get a chance.			
38.	It is important to listen to the physics classes properly.			
39.	The more I engage in physics related activities, the more I get irritated.			
40.	I am interested in performing experiments in physics on my own at home.			
41.	I enjoy solving physics related tasks even if it is difficult.			
42.	Learning physics is a waste of time.			

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APPENDIX 39

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

INDIVIDUAL INTEREST SCALE IN PHYSICS
(FINAL – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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നിർദ്ദേശങ്ങൾ:

ഈ സ്കെയിൽ സെക്കൻഡറി സ്കൂൾ വിദ്യാർത്ഥികൾക്ക് ഭൗതികശാസ്ത്രത്തിലുള്ള താല്പര്യം (Individual Interest) എത്രത്തോളം ഉണ്ടെന്ന് കണ്ടെത്താനുള്ളതാണ്. 42 പ്രസ്താവനകളാണ് ഈ സ്കെയിലിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്. തന്നിട്ടുള്ള പ്രസ്താവനകൾക്ക് ഉചിതമാണെന്ന് നിങ്ങൾക്ക് തോന്നുന്ന പ്രതികരണം കണ്ടെത്തി, 'ശരി', 'ഏറെക്കുറേ ശരി', 'തെറ്റ്' എന്നിങ്ങനെ എഴുതിയതിന് താഴെയുള്ള കോളത്തിൽ ✓ രേഖപ്പെടുത്തണം. ഉത്തരങ്ങളിൽ ശരിയും തെറ്റും ഇല്ലെന്ന് പ്രത്യേകം ഓർക്കുക. എല്ലാ ആശയങ്ങൾക്കും പ്രതികരണം രേഖപ്പെടുത്താൻ പ്രത്യേകം ശ്രദ്ധിക്കുക. ഇവിടെ തരുന്ന പ്രതികരണങ്ങൾ ഗവേഷണാവശ്യങ്ങൾക്കു മാത്രമേ ഉപയോഗിക്കുകയുള്ളൂ.

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പേര് : ആൺകുട്ടി / പെൺകുട്ടി

സ്കൂൾ :

No.	പ്രസ്താവനകൾ	ശരി	ഏറെക്കുറേ ശരി	തെറ്റ്
1.	എനിക്ക് ഭൗതികശാസ്ത്രം പഠിക്കാൻ ഇഷ്ടമാണ്.			
2.	ഭൗതികശാസ്ത്രം വിരസതയുണ്ടാക്കുന്ന ശാസ്ത്രവിഷയമാണ്.			
3.	ശാസ്ത്രത്തിന്റെ വളരെ പ്രധാനപ്പെട്ട ഒരു ശാഖയാണ് ഭൗതികശാസ്ത്രം.			

4.	ഉപരിപഠനത്തിന് ഭൗതികശാസ്ത്രം ഒരു നല്ല ഓപ്ഷനല്ല.			
5.	എനിക്ക് ഭൗതികശാസ്ത്രത്തിൽ നല്ല അറിവുണ്ട്.			
6.	വിവിധ ഭൗതികശാസ്ത്രജ്ഞരുടെ കണ്ടുപിടുത്തങ്ങൾ എന്നെ വിസ്മയിപ്പിക്കുന്നു.			
7.	ഭൗതികശാസ്ത്രത്തിലെ പരീക്ഷണങ്ങൾ നടത്താനും നിഗമനങ്ങളിൽ എത്തിച്ചേരാനുമുള്ള കഴിവ് എനിക്കില്ല.			
8.	എന്റെ ഒഴിവുസമയങ്ങളിൽ കൂടുതലും ഭൗതികശാസ്ത്ര മെറ്റീരിയലുകൾ വായിക്കാനാണ് ഞാൻ ഇഷ്ടപ്പെടുന്നത്.			
9.	ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട സെമിനാറുകളിലും ചർച്ചകളിലും പങ്കെടുക്കാൻ ഞാൻ ഇഷ്ടപ്പെടുന്നില്ല.			
10.	ഞാൻ ഭൗതികശാസ്ത്രം ആസ്വദിച്ചാണ് പഠിക്കുന്നത്.			
11.	ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട പാഠ്യേതര പ്രവർത്തനങ്ങളിൽ പങ്കെടുക്കുന്നത് ഞാൻ ആസ്വദിക്കുന്നു.			
12.	ഭൗതികശാസ്ത്രപഠനം എന്നെ അലോസരപ്പെടുത്തുന്നു.			
13.	മെച്ചപ്പെട്ട മനുഷ്യജീവിതത്തിന് ഭൗതികശാസ്ത്രത്തിലെ അറിവ് അത്യന്താപേക്ഷിതമാണ്.			
14.	ഭൗതികശാസ്ത്രം ഒരു സ്കൂൾ വിഷയമായി ഉൾപ്പെടുത്തുന്നത് എനിക്ക് തിരിച്ചടികളും പരാജയങ്ങളും മാത്രമേ നൽകിയിട്ടുള്ളൂ.			
15.	ഭൗതികശാസ്ത്രത്തിലെ ഗ്രേഡുകൾ മെച്ചപ്പെടുത്താൻ പഠനത്തിൽ പിന്നാക്കമുള്ള സഹപാഠികളെ സഹായിക്കാൻ എനിക്ക് കഴിയും.			
16.	ഭൗതികശാസ്ത്രപഠനം എന്നെ മികച്ച വ്യക്തിയാക്കും.			
17.	സ്കൂളുകളിൽ നിന്ന് ഭൗതികശാസ്ത്രം നീക്കം ചെയ്തിരുന്നെങ്കിൽ, നല്ല ഗ്രേഡുകൾ നേടുന്നതിന് ഞാൻ മികച്ച പ്രകടനം കാഴ്ചവെക്കുമായിരുന്നു.			
18.	ഭൗതികശാസ്ത്രമേഖലയിലെ പുതിയ കണ്ടുപിടുത്തങ്ങളെക്കുറിച്ച് കൂടുതൽ അറിയാൻ എനിക്ക് താല്പര്യമുണ്ട് .			
19.	ഭൗതികശാസ്ത്രം പഠിക്കുന്നത് മാറ്റിവെക്കുന്ന പ്രവണത എനിക്കുണ്ട്.			
20.	ഭൗതികശാസ്ത്രപഠനം എനിക്ക് ആവേശം പകരുന്നു.			
21.	സ്കൂൾ വിഷയങ്ങളിൽ നിന്ന് ഭൗതികശാസ്ത്രം ഒഴിവാക്കിയാൽ എനിക്ക് സന്തോഷമാണ്.			
22.	ജീവനുള്ളതും അല്ലാത്തതുമായ എല്ലാ ജീവജാലങ്ങൾക്കും അനുയോജ്യമായ ഇടമാക്കി ലോകത്തെ മാറ്റുന്നതിൽ ഭൗതികശാസ്ത്രജ്ഞർ വളരെ പ്രധാനപ്പെട്ട പങ്ക് വഹിക്കുന്നു.			
23.	ഭൗതികശാസ്ത്രത്തിൽ പഠിക്കേണ്ട എല്ലാ പാഠഭാഗങ്ങളെക്കുറിച്ചും എനിക്ക് നല്ല അറിവുണ്ട്.			

24.	ഭാവിയിൽ ഒരു മികച്ച തൊഴിൽ ലഭിക്കാൻ ഭൗതികശാസ്ത്രപഠനം കൊണ്ട് സാധിക്കില്ല..			
25.	ക്ലാസ്സിൽ ഭൗതികശാസ്ത്ര അധ്യാപകർ ചോദിക്കുന്ന ചോദ്യങ്ങൾക്ക് എനിക്ക് ഉത്തരം നല്കാൻ കഴിയും.			
26.	ഭൗതികശാസ്ത്രപഠനത്തിൽ സ്കൂളിൽ എനിക്ക് മികച്ച പ്രകടനം കാഴ്ചവെക്കാൻ കഴിയാറില്ല.			
27.	ക്ലാസ്സിൽ പഠിക്കുന്നതിനപ്പുറം ഭൗതികശാസ്ത്രത്തിൽ എനിക്ക് കൂടുതൽ അറിവ് നേടേണ്ടതുണ്ട്.			
28.	ഭൗതികശാസ്ത്രത്തിലെ ഹോംവർക്കുകളോ അസൈൻമെന്റുകളോ ചെയ്യാതെ മാറ്റിവെക്കാൻ നിരവധി ഒഴികഴിവുകൾ ഞാൻ കണ്ടെത്താറുണ്ട്.			
29.	ഭൗതികശാസ്ത്രത്തിൽ നല്ല ഗ്രേഡുകൾ നേടുന്നത് എന്നെ സംബന്ധിച്ചിടത്തോളം പ്രധാനമാണ്.			
30.	ഭൗതികശാസ്ത്രത്തിലെ പരീക്ഷണങ്ങൾ ചെയ്യുന്നത് എനിക്ക് ആവേശം പകരുന്നു.			
31.	ഭൗതികശാസ്ത്രപഠനം ഒരു പേടിസ്വപ്നമാണ്.			
32.	ഭൗതികശാസ്ത്രത്തിലെ കണക്കുകൾക്ക് ഉത്തരങ്ങൾ കണ്ടെത്താൻ എനിക്കറിയാം.			
33.	ഭൗതികശാസ്ത്രത്തിൽ നല്ല മാർക്ക് നേടുക എന്നത് ഭാഗ്യശാലികളായ വിദ്യാർത്ഥികൾക്ക് മാത്രം സാധ്യമായ കാര്യമാണ്.			
34.	ഭൗതികശാസ്ത്രത്തിലെ കണക്കുകൾ ചെയ്യുന്നത് ഞാൻ ആസ്വദിക്കുന്നു.			
35.	ചില വിദ്യാർത്ഥികൾ ഭൗതികശാസ്ത്രം ഇഷ്ടപ്പെടുന്നതിൽ എനിക്ക് അത്ഭുതം തോന്നുന്നു.			
36.	ഭൗതികശാസ്ത്രക്ലാസുകൾ എനിക്ക് ആവേശം പകരുന്നു.			
37.	എനിക്ക് അവസരം ലഭിച്ചാൽ ഞാൻ ഭൗതികശാസ്ത്രക്ലാസുകൾ പങ്കെടുക്കാതെ മുങ്ങും.			
38.	ഭൗതികശാസ്ത്ര ക്ലാസുകൾ നന്നായി ശ്രദ്ധിക്കേണ്ടത് അത്യാവശ്യമാണ്.			
39.	ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട പ്രവർത്തനങ്ങളിൽ ഏർപ്പെടുന്നോറും ഞാൻ കൂടുതൽ പ്രകോപിതനാകും.			
40.	വീട്ടിലിരുന്ന് സ്വന്തമായി ഭൗതികശാസ്ത്രത്തിലെ പരീക്ഷണങ്ങൾ നടത്താൻ എനിക്ക് താൽപ്പര്യമുണ്ട്.			
41.	ഭൗതികശാസ്ത്രവുമായി ബന്ധപ്പെട്ട പ്രവർത്തനങ്ങൾ ബുദ്ധിമുട്ടാണെങ്കിലും അവ പരിഹരിക്കുന്നത് ഞാൻ ആസ്വദിക്കുന്നു.			
42.	ഭൗതികശാസ്ത്രം പഠിക്കുന്നത് സമയം പാഴാക്കലാണ്.			

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APPENDIX 40

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

INDIVIDUAL INTEREST SCALE IN PHYSICS

(FINAL – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Instructions:

This scale is meant to find out the extent of individual interest in physics among secondary school students. In this scale, there are 42 statements. For each statement, students have to mark their response which they find appropriate, using tick mark (✓) under the column heading 'Correct', 'Partially correct' and 'Incorrect'. Please remember that there is no right and wrong answer. Responding to all the statements is mandatory. The responses collected will be kept highly confidential and will be used only for research purposes.

……

Name: Male / Female

School:

No.	Statements	Correct	Partially correct	Incorrect
1.	I like studying physics.			
2.	Physics is a boring science subject.			
3.	Physics is a very important branch of science.			
4.	Physics is not a good option for higher studies.			
5.	I have good knowledge in physics.			

No.	Statements	Correct	Partially correct	Incorrect
6.	I admire the inventions and discoveries of various physicists.			
7.	I do not have the skill to perform physics experiments and to draw conclusions.			
8.	I prefer spending more time reading physics materials during my leisure time.			
9.	I don't like to attend seminars and talks related to physics.			
10.	I enjoy studying physics.			
11.	I enjoy participating in extracurricular activities related to physics.			
12.	Learning physics irritates me.			
13.	Knowledge in physics is essential for a better human life.			
14.	Including physics as a school subject has only given me setbacks and failures.			
15.	I can guide poor performers among my classmates to improve their grades in physics.			
16.	Learning physics will make me a better person.			
17.	If physics was removed from schools, I would have performed well to bring good grades.			
18.	I would like to know more about new inventions and discoveries in the field of physics.			
19.	I have a tendency to postpone learning physics.			
20.	Learning physics makes me excited.			
21.	I would be happy if physics was removed from school subjects.			
22.	Physicists play a very important role in making the world a better place for all living and non-living organisms.			
23.	I am thorough with all the topics that I have to study in physics.			
24.	Learning physics will never give a better career in future.			

No.	Statements	Correct	Partially correct	Incorrect
25.	I can answer the questions that physics teacher asks in the classroom.			
26.	At school, I am a poor performer when it comes to physics.			
27.	I need to acquire more knowledge in physics beyond what I learn in class.			
28.	I find many excuses for keeping aside homework or assignments in physics.			
29.	Getting good grades in physics is important for me.			
30.	Performing experiments in physics is fascinating.			
31.	Learning physics is a nightmare.			
32.	I know how to solve physics problems.			
33.	Scoring good marks in physics is meant for lucky students.			
34.	I enjoy working out physics problems.			
35.	I wonder why some students like physics.			
36.	Physics classes excite me.			
37.	I will bunk physics classes if I get a chance.			
38.	It is important to listen to physics classes properly.			
39.	The more I engage in physics related activities, the more I get irritated.			
40.	I am interested in performing experiments in physics on my own at home.			
41.	I enjoy solving physics related tasks even if it is difficult.			
42.	Learning physics is a waste of time.			

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APPENDIX 41

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

ACHIEVEMENT TEST ON 'EQUATIONS OF MOTION'
(DRAFT – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

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Maximum Marks: 32

നിർദ്ദേശങ്ങൾ: Time: 60 minutes

ഭൗതികശാസ്ത്രത്തിലെ 'ചലനസമവാക്യങ്ങൾ' എന്ന ആശയത്തിൽ ഒമ്പതാം ക്ലാസ്സിലെ കുട്ടികളുടെ പഠനേട്ടം അളക്കുന്നതിനുള്ള ടെസ്റ്റാണിത്. ഇതിൽ 32 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് ഇതിൽ ഉൾപ്പെടുത്തിയിട്ടുള്ളത്, എല്ലാ ചോദ്യത്തിനും ഉത്തരം തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d) എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കുറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

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1. ശരിയായ ചലനസമവാക്യങ്ങൾ ഏത്?

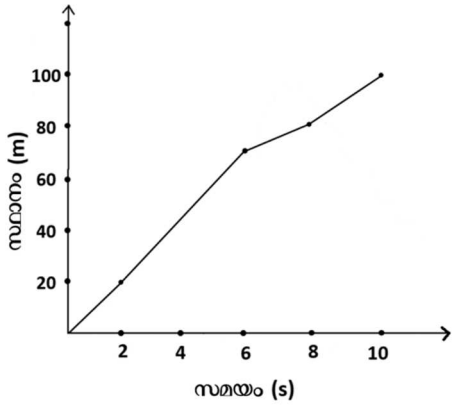
a) $v = u + at^2, s = ut - \frac{1}{2}\, at^2, v^2 = u^2 - 2as^2$

b) $v = u - \ at, s = ut - \frac{1}{2}\, a^2t^2, v^2 = u^2 + 2as^2$

c) $v = ut + at^2, s = ut + \frac{1}{2}\, a^2t^2, u^2 = v^2 + 2as$

d) $v = u + at, s = ut + \frac{1}{2}\, at^2, v^2 = u^2 + 2as$

2. ഒരു കാറിന്റെ ചലനം സൂചിപ്പിക്കുന്ന ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്. 8 സെക്കന്റിൽ കാർ സഞ്ചരിച്ച ദൂരം

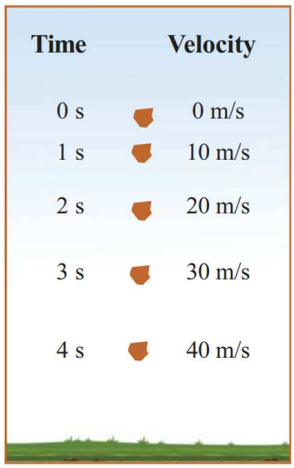


a) 200 m
c) 80 m
b) 100 m
d) 60 m

3. നിശ്ചലാവസ്ഥയിൽ നിന്ന് ഒരു കാർ സമത്വരണത്തോടെ സഞ്ചരിക്കുന്നു. ചലനം ആരംഭിച്ച് 10 സെക്കന്റിനുള്ളിൽ അതിന്റെ പ്രവേഗം $30\ m/s$ ആകുന്നുവെങ്കിൽ കാറിന്റെ ത്വരണം എത്ര ?

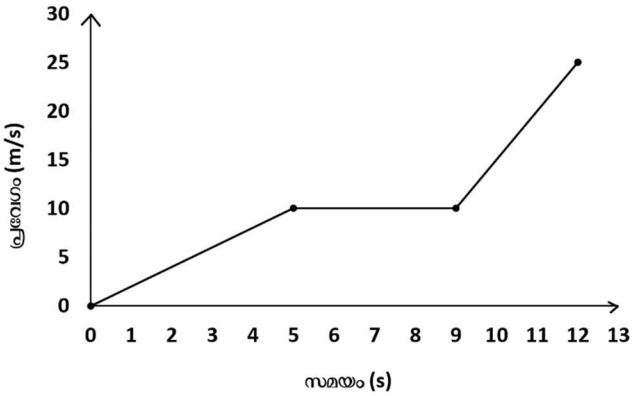
a) $2\ m/s^2$
c) $10\ m/s^2$
b) $3\ m/s^2$
d) $30\ m/s^2$

4. നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ ചിത്രം ആണ് താഴെ തന്നിരിക്കുന്നത്. 4 സെക്കന്റിൽ വസ്തുവിന്റെ ത്വരണം കണക്കാക്കുക.



a) $160\ m/s^2$
c) $10\ m/s^2$
b) $40\ m/s^2$
d) $4\ m/s^2$

5. ഒരു കളിപ്പാട്ടക്കാർ ഒരു സ്ഥലത്ത് നിന്നും മറ്റൊരു സ്ഥലത്തേക്ക് 12 s കൊണ്ട് ചലിക്കുന്നു. ഈ ചലനത്തിന്റെ പ്രവേഗ-സമയ ഗ്രാഫ് ആണ് തന്നിരിക്കുന്നത്. ഗ്രാഫിനെ കുറിച്ച് തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത്?



i. കാറിന്റെ ചലനത്തിലെ ഏറ്റവും ഉയർന്ന ത്വരണം 9 s ഉം 12 s ും ഇടയിലാണ്.

ii. 9 s ഉം 12 s ും ഇടയിൽ സഞ്ചരിച്ച ദൂരം $[\frac{1}{2}$ x 3 x 15] + [3 x 10] m ആണ്.

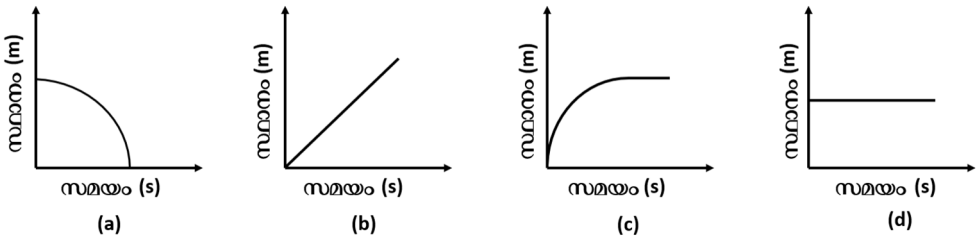
iii. കാറിന്റെ ചലനത്തിലെ ഏറ്റവും കുറഞ്ഞ ത്വരണം 0 s ഉം 5 s ും ഇടയിലാണ്.

a) (i) മാത്രം ശരിയാണ്.
b) (ii) മാത്രം ശരിയാണ്.
c) (i) ഉം (ii) ഉം ശരിയാണ്.
d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

6. ഒരു പ്രവേഗ-സമയ ഗ്രാഫിൽ നിശ്ചിത സമയഇടവേളകൾക്കിടയിൽ വസ്തുവിനുണ്ടാകുന്ന _____ഗ്രാഫിന് ചുവടെയുള്ള ഭാഗത്തിന്റെ പരപ്പളവിന് തുല്യമായിരിക്കും.

a) സ്ഥാനാന്തരം
b) ദൂരം
c) പ്രവേഗം
d) ചലനസമയം

7. സമവേഗത സൂചിപ്പിക്കുന്ന ഗ്രാഫ് താഴെ തന്നവയിലേത് ?



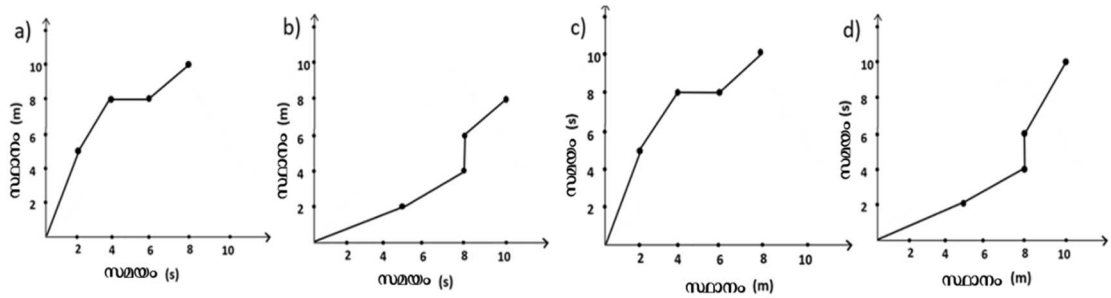
8. 10 സെക്കന്റിൽ തീവണ്ടിയുടെ പ്രവേഗം $80\,m/s$ ഇൽ നിന്നും $20\,m/s$ ആയി മാറുന്നുവെങ്കിൽ അതിന്റെ മന്ദീകരണം എത്ര?

a) $0.1\,m/s^2$ c) $6\,m/s^2$

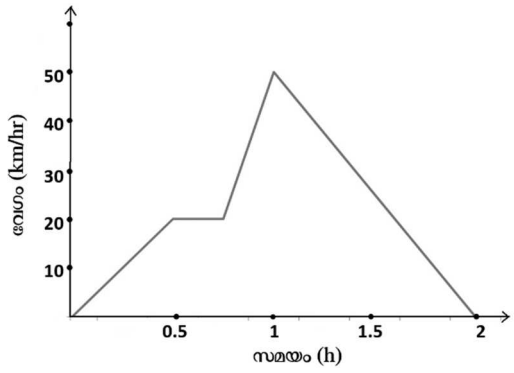
b) $1\,m/s^2$ d) $10\,m/s^2$

9. ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ സ്ഥാനവും സമയവും ആണ് താഴെ പട്ടികയിൽ തന്നിട്ടുള്ളത്. ആ ചലനത്തെ സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത് ?

സമയം (s)	0	2	4	6	8
സ്ഥാനം (m)	0	5	8	8	10



10. ഒരു ട്രെയിൻ ഒരു സ്റ്റേഷനിൽ നിന്ന് മറ്റൊരു സ്റ്റേഷനിലേക്ക് 2 മണിക്കൂർ കൊണ്ട് എത്തിച്ചേരുന്നു. ആ ചലനത്തിന്റെ വേഗ-സമയ ഗ്രാഫാണ് തന്നിരിക്കുന്നത്. ഗ്രാഫിനെ കുറിച്ചുള്ള പ്രസ്താവനകളിൽ ശരിയേത് ?



i. യാത്രയിൽ ട്രെയിനിന്റെ പരമാവധി ത്വരണം 0.75 hr ഇനും 1 hr നും ഇടയിലാണ്

ii. 0.5 hr തൊട്ട് 0.75 hr വരെയുള്ള ഇടവേളയിൽ ട്രെയിൻ സഞ്ചരിക്കുന്ന ദൂരം (0.25 x 20) km ആണ്.

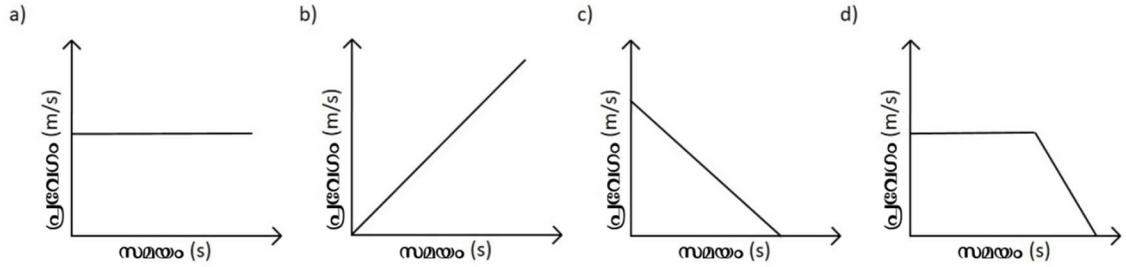
iii. യാത്രയുടെ തുടക്കം മുതൽ 0.5 hrs വരെയുള്ള ഇടവേളയിൽ ട്രെയിൻ സമപ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു.

a) (i) മാത്രം ശരിയാണ്.
b) (ii) മാത്രം ശരിയാണ്.
c) (i) ഉം (ii) ഉം ശരിയാണ്.
d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

11. താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ **തെറ്റേത്**?

a) ഗ്രാഫ് രണ്ട് അക്ഷങ്ങളുള്ള ഒരു ദ്വിമാനചിത്രമാണ്.
b) ലംബ അക്ഷത്തെ x അക്ഷമെന്നും തിരശ്ചീന അക്ഷത്തെ y അക്ഷമെന്നും വിളിക്കുന്നു.
c) x, y അക്ഷങ്ങൾ സന്ധിക്കുന്നത് മൂലബിന്ദുവിലാണ്.
d) ഗ്രാഫിന് പേര് നൽകുമ്പോൾ, y അക്ഷത്തിലെ അളവ് ആദ്യം ഉപയോഗിക്കും.

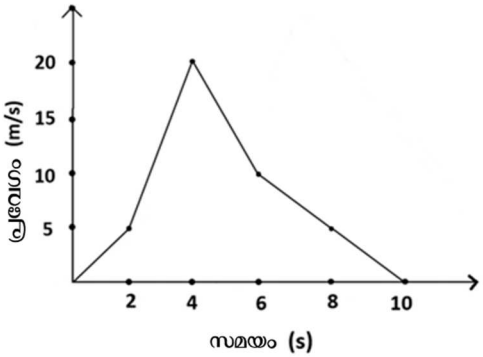
12. സമയത്തിനനുസരിച്ച് കൂടുന്ന പ്രവേഗം വിശേഷിപ്പിക്കുന്ന ഗ്രാഫ് ഏത്?



13. നിശ്ചലാവസ്ഥയിൽ നിന്ന് ചലിച്ചു തുടങ്ങിയ ഒരു കളിപ്പാട്ട ട്രെയിൻ 2 സെക്കന്റിനുള്ളിൽ $0.1\ m/s^2$ സമത്വരണത്തിൽ സഞ്ചരിക്കുന്നു. ട്രെയിൻ സഞ്ചരിച്ച ദൂരം എത്ര ?

a) 1 m
b) 0.4 m
c) 0.2 m
d) 0.05 m

14. ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ ഗ്രാഫ് ആണ് താഴെ തന്നിരിക്കുന്നത്. ഗ്രാഫിന് അനുയോജ്യമായ പട്ടിക ഏതെന്ന് കണ്ടെത്തുക.



a)

സമയം (s)	0	2	4	6	8	10
പ്രവേഗം (m/s)	0	5	20	10	5	0

b)

സമയം (s)	0	2	4	6	8	10
പ്രവേഗം (m/s)	0	5	10	15	20	25

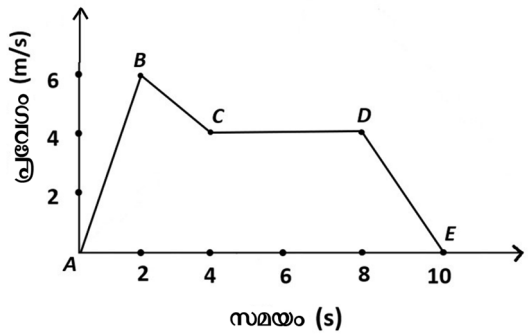
c)

സമയം (s)	0	10	20	10	5	0
പ്രവേഗം (m/s)	0	2	4	6	8	10

d)

സമയം (s)	2	4	6	8	10
പ്രവേഗം (m/s)	5	10	20	15	5

ചോദ്യം 15-16: ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗ സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്.



15. C എന്ന ബിന്ദുവിനും D എന്ന ബിന്ദുവിനും ഇടയിൽ വസ്തുവിനുണ്ടാകുന്ന ത്വരണമെത്ര?

a) പൂജ്യം
c) $8\ m/s^2$
b) $4\ m/s^2$
d) $16\ m/s^2$

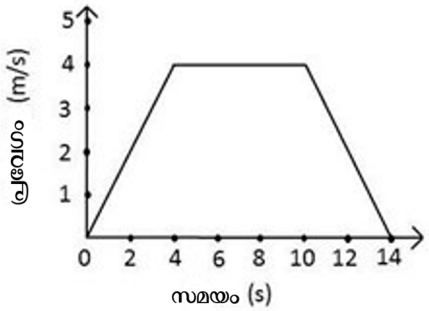
16. വസ്തുവിന് മന്ദീകരണം സംഭവിക്കുന്ന സന്ദർഭങ്ങൾ ഏത് ?

a) CD മാത്രം
c) AB യും BC യും
b) AB യും DE യും
d) BC യും DE യും

17. നിശ്ചലാവസ്ഥയിൽ നിന്ന് ഒരു കാർ സമത്വരണത്തോടെ സഞ്ചരിക്കുന്നു. ചലനം ആരംഭിച്ച് 5 s കൊണ്ട് 50 m ദൂരം എത്തിയെങ്കിൽ കാറിന്റെ ത്വരണം കണക്കാക്കുക.

a) $[\frac{5\ X\ 50}{2}]\ m/s^2$
c) $[\frac{2\ X\ 50}{5}]\ m/s^2$
b) $[\frac{50}{5^2}]\ m/s^2$
d) $[\frac{2\ X\ 50}{5^2}]\ m/s^2$

18. താഴെ കൊടുത്ത ഗ്രാഫ് വിശകലനം ചെയ്ത വസ്തു 4 സെക്കന്റിനും 8 സെക്കന്റിനുമിടയിൽ സഞ്ചരിച്ച ദൂരം കണ്ടെത്തുക.



a) 4 m
c) 16 m
b) 12 m
d) 32 m

19. $40\ m/s$ ആദ്യ പ്രവേഗത്തിൽ ഒരു കല്ല് കുത്തനെ മുകളിലേക്ക് എറിയുന്നു. ആ കല്ലിന് എത്തിച്ചേരാൻ പറ്റുന്ന ഉയരം എത്ര ? (g = $10\ m/s^2$, ഏറ്റവും ഉയരത്തിൽ കല്ലിന്റെ പ്രവേഗം $0\ m/s$ ആണ്)

a) 40 m
c) $[\frac{40}{2\ X\ 10}]$ m
b) $[\frac{40\ X\ 40}{10}]$ m
d) $\left[\frac{40\ X\ 40}{2\ X\ 10}\right]$ m

20. വ്യത്യസ്ത സമയങ്ങളിൽ ഒരു കളിപ്പാട്ട കാറിന്റെ സ്ഥാനം ആണ് താഴെ പട്ടികയിൽ തന്നിരിക്കുന്നത്.

സമയം (s)	0	2	4	6	8	10
സ്ഥാനം (m)	5	10	15	20	25	30

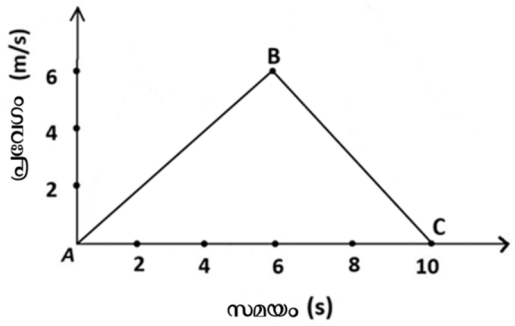
8 സെക്കന്റിൽ ആ കാർ സഞ്ചരിച്ച ദൂരം എത്ര?

a) 25 m
b) 20 m
c) 8 m
d) 5 m

21. ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗം $0\ m/s$ ഇൽ നിന്നും $30\ m/s$ ആകുമ്പോൾ അതിന്റെ ത്വരണം $5\ m/s^2$ ആണ്. എങ്കിൽ ആ വസ്തു സഞ്ചരിച്ച ദൂരം എത്ര ?

a) $[\frac{30-0}{2\ X\ 5}]\ m$
b) $[\frac{30^2-0^2}{5}]\ m$
c) $[\frac{30^2-0^2}{2}]\ m$
d) $[\frac{30^2-0^2}{2\ X\ 5}]\ m$

ചോദ്യം (22-23): ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്.



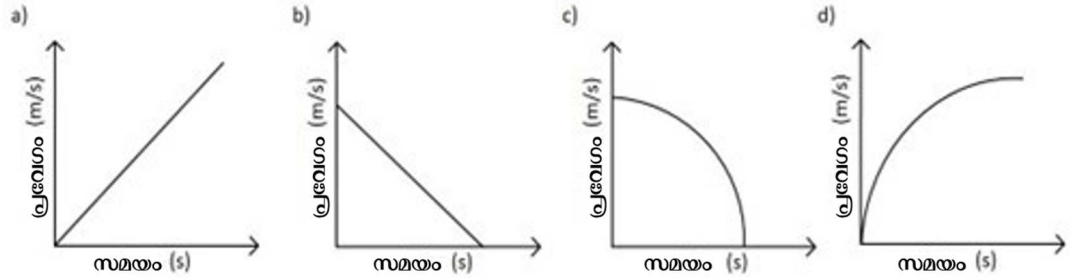
22. താഴെ തന്നവയിൽ നിന്ന് ശരിയായ പ്രസ്താവന കണ്ടെത്തുക.

a) AB യിൽ വസ്തുവിന് സമചലനവും BC യിൽ അസമചലനവുമാണ്.
b) BC യിൽ വസ്തുവിന് സമചലനവും AB യിൽ അസമചലനവുമാണ്.
c) A യിൽ നിന്ന് C യിലേക്ക് പോകുമ്പോൾ വസ്തു സമചലനത്തിലാണ്.
d) A യിൽ നിന്ന് C യിലേക്ക് പോകുമ്പോൾ വസ്തു അസമചലനത്തിലാണ്.

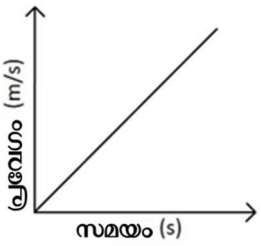
23. B യിൽ നിന്ന് C യിലേക്ക് ചലിക്കുമ്പോൾ വസ്തുവിന്റെ ത്വരണം എത്ര?

a) Zero
b) $1\ m/s^2$
c) $\frac{1}{2} m/s^2$
d) $\frac{3}{2}\ m/s^2$

24. ഒരു വസ്തുവിനെ കുത്തനെ മുകളിലോട്ടു എറിയുമ്പോൾ അനുഭവപ്പെടുന്ന ത്വരണം സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത്?



25. തന്നിരിക്കുന്ന പ്രവേഗ–സമയ ഗ്രാഫ് വിശേഷിപ്പിക്കുന്നത്



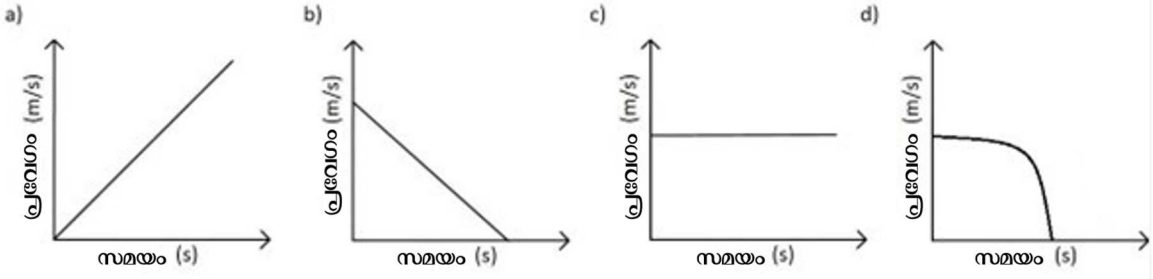
a) ഭൂമിയിൽ നിന്ന് ഒരു നിശ്ചിത ഉയരത്തിൽ നിന്നും താഴേക്കു വീഴുന്ന ഒരു കല്ലിൻറെ പ്രവേഗമാറ്റത്തെയാണ്.

b) ലംബമായി മുകളിലേക്ക് എറിയപ്പെട്ട വസ്തുവിൻറെ പ്രവേഗമാറ്റത്തെയാണ്.

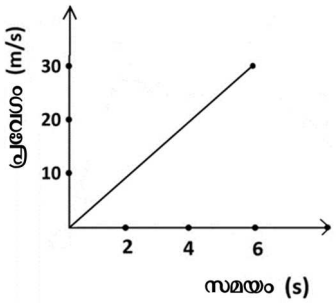
c) സമയത്തിനനുസരിച്ചു കൂടുന്ന പ്രവേഗത്തെയാണ്.

d) സ്ഥിരപ്രവേഗത്തെയാണ്.

26. നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗമാറ്റം സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത്?



ചോദ്യം (27-28): ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗ-സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്.



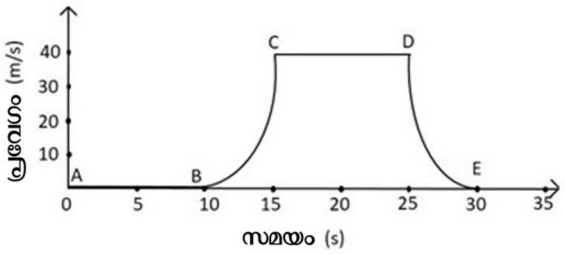
27. വസ്തുവിന്റെ ആദ്യപ്രവേഗവും അന്ത്യപ്രവേഗവും യഥാക്രമം _____ഉം _____ഉമാണ്.

a) $0\ m/s$ and $30\ m/s$
b) $30\ m/s$ and $0\ m/s$
c) $6\ m/s$ and $30\ m/s$
d) $30\ m/s$ and $6\ m/s$

28. 6 സെക്കന്റിൽ വസ്തുവിനുണ്ടാകുന്ന സ്ഥാനാന്തരം എത്ര?

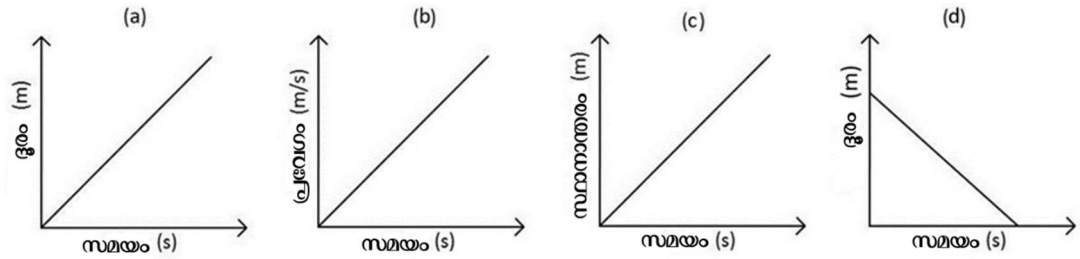
a) 6 m
b) 30 m
c) 90 m
d) 160 m

29. താഴെ കൊടുത്തിരിക്കുന്ന ഗ്രാഫിൽ ഏതു ഭാഗമാണ് വസ്തുവിൻറെ ത്വരണം പൂജ്യമായി കാണിച്ചിട്ടുള്ളത്?

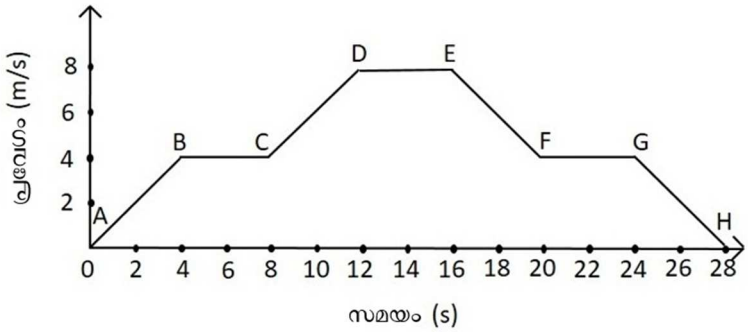


a) CD
b) DE
c) BC യും DE യും
d) AB യും CD യും

30. സമത്വരണം സൂചിപ്പിക്കുന്ന ചിത്രം കണ്ടെത്തുക.

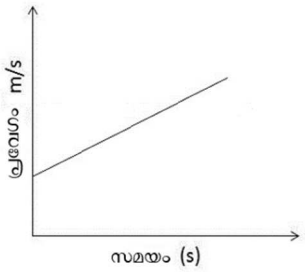


31. താഴെ കൊടുത്തിരിക്കുന്നവയിൽ പോസിറ്റീവായി ത്വരണം സംഭവിക്കുന്ന സന്ദർഭങ്ങൾ തിരഞ്ഞെടുക്കുക.



a) CD യും EF ഉം
b) AB യും CD യും
c) EF ഉം GH ഉം
d) BC ഉം DE ഉം FG ഉം

32. തന്നിരിക്കുന്ന പ്രവേഗ-സമയ ഗ്രാഫ് അനുസരിച്ച്



a) വസ്തുവിന് ഒരു നിശ്ചിത ആദ്യ പ്രവേഗമുണ്ട്.
b) വസ്തു സമപ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു.
c) വസ്തു തുടക്കത്തിൽ ഒരു നിശ്ചിത പ്രവേഗത്തിൽ സഞ്ചരിക്കുകയും പിന്നീട് സമപ്രവേഗത്തിലേക്ക് മാറുകയും ചെയ്യുന്നു.
d) വസ്തു നിശ്ചലാവസ്ഥയിലാണ്.

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APPENDIX 42

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

ACHIEVEMENT TEST ON 'EQUATIONS OF MOTION'
(DRAFT – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

Maximum Marks: 32

Instructions: Time: 60 minutes

This test is meant to measure achievement of IX standard students in the physics concept, 'Equations of Motion'. This test consists of thirty-two (32) multiple choice type questions out of which the candidate would be required to answer all the questions. Separate response sheet is provided to mark the answers. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The candidate must mark the response by darkening the circle as indicated below on the correct response against each item. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response. The results of this test will be only used for research purpose.

……

1. The correct equations of motion

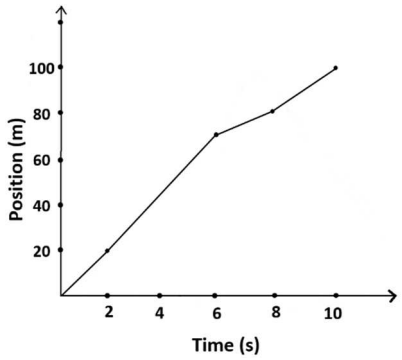
a) $v = u + at^2, s = ut - \frac{1}{2}\, at^2, v^2 = u^2 - 2as^2$

b) $v = u - \ at, s = ut - \frac{1}{2}\, a^2t^2, v^2 = u^2 + 2as^2$

c) $v = ut + at^2, s = ut + \frac{1}{2}\, a^2t^2, u^2 = v^2 + 2as$

d) $v = u + at, s = ut + \frac{1}{2}\, at^2, v^2 = u^2 + 2as$

2. Given below is the graph that shows motion of a car. The distance travelled by it in 8 secs is _____

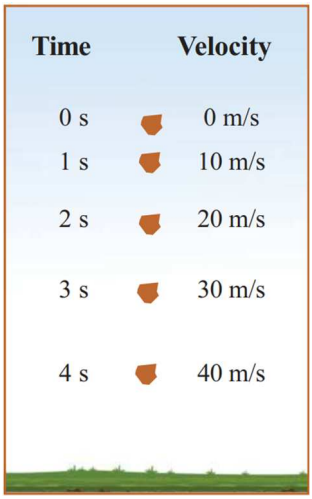


a) 200 m
c) 80 m
b) 100 m
d) 60 m

3. A car accelerates uniformly from rest to a velocity of 30 m/s in 10 seconds. What is the acceleration of the car?

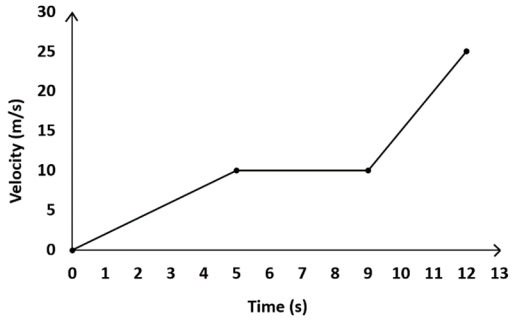
a) 2 m/s^2
c) 10 m/s^2
b) 3 m/s^2
d) 30 m/s^2

4. Given below is the figure of a freely falling object. The acceleration of the object at 4s will be



a) 160 m/s^2
c) 10 m/s^2
b) 40 m/s^2
d) 4 m/s^2

5. A toy car moves from one place to another in 12 s time. Its velocity-time graph during the motion is shown in figure. Select the correct statement regarding the graph.



i. The maximum acceleration during the journey is in between 9 s and 12 s.

ii. The distance covered during the time interval from 9 s to 12 s is $[\frac{1}{2}$ x 3 x 15] + [3 x 10] metres.

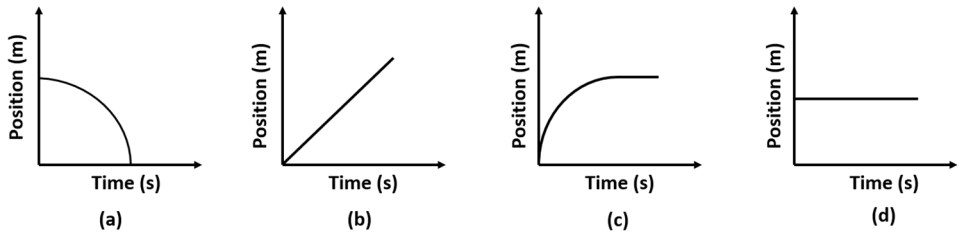
iii. The minimum acceleration during the journey is in between 0 s and 5 s.

a) Only (i) is correct.
b) Only (ii) is correct.
c) Both (i) and (ii) are correct.
d) All statements are correct.

6. _____ of a body within a definite interval of time is equal to the area of the portion under velocity-time graph.

a) Displacement
b) Distance
c) Velocity
d) Time of motion

7. Which of the following graphs represents uniform speed?

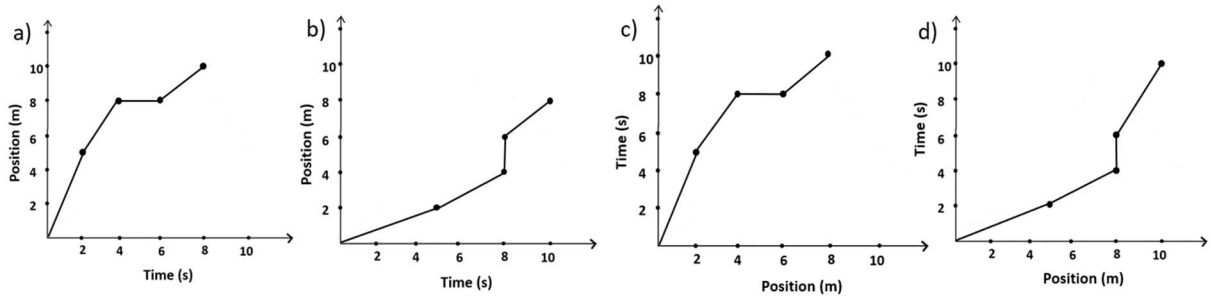


8. The retardation of the train which changes its velocity from $80\ m/s$ to $20\ m/s$ in 10 seconds will be

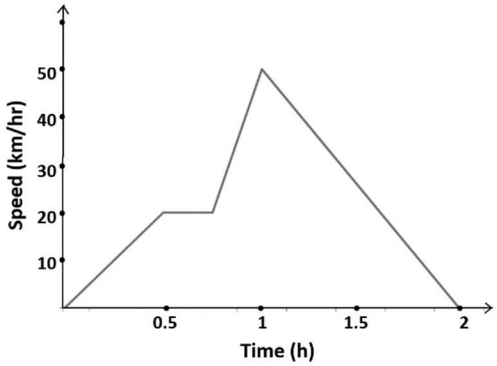
a) $0.1\ m/s^2$
b) $1\ m/s^2$
c) $6\ m/s^2$
d) $10\ m/s^2$

9. Given below is the table that shows the position and time of a moving object. The graph that shows its motion is

Time (s)	0	2	4	6	8
Position (m)	0	5	8	8	10



10. A train moves from one station to another in 2 hrs time. Its speed-time graph during the motion is shown in figure. Identify the correct statement regarding the graph.



i. The maximum acceleration during the journey is in between 0.75 hr to 1 hr.

ii. The distance covered during the time interval from 0.5 hr to 0.75 hr is (0.25 x 20) kms.

iii. From the beginning of the journey to 0.5 hrs, the train moves with constant velocity.

a) Only (i) is correct.
b) Only (ii) is correct.
c) Both (i) and (ii) are correct.
d) All statements are correct.

11. Which one of the following statements is **false**?

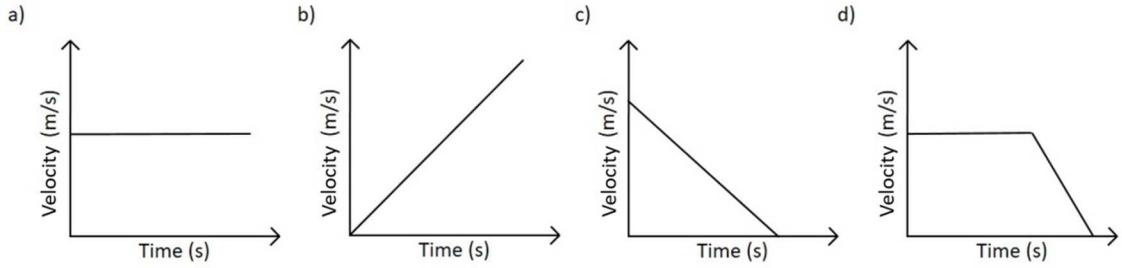
a) Graph is a two-dimensional diagram with two axes.

b) The vertical axis is the x-axis and the horizontal axis is the y-axis.

c) The point where x and y axes meet is the origin.

d) While naming a graph, value on the y-axis will be given first.

12. Which of the following graphs show increasing velocity with time?



13. A toy train starts from rest and moves with uniform acceleration $0.1\ m/s^2$ for 2 seconds. The distance travelled by the train is

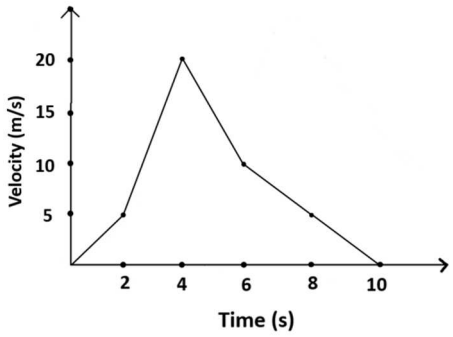
a) 1 m

b) 0.4 m

c) 0.2 m

d) 0.05 m

14. The graph given below represents the motion of an object. Which of the tables given corresponds to the graph provided?



a)

Time (s)	0	2	4	6	8	10
Velocity (m/s)	0	5	20	10	5	0

b)

Time (s)	0	2	4	6	8	10
Velocity (m/s)	0	5	10	15	20	25

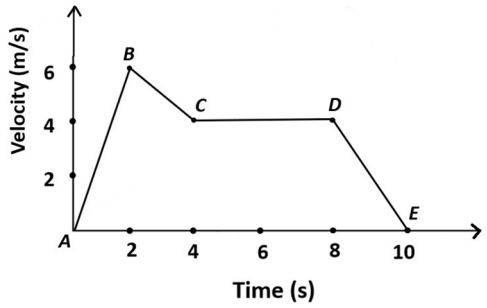
c)

Time (s)	0	10	20	10	5	0
Velocity (m/s)	0	2	4	6	8	10

d)

Time (s)	2	4	6	8	10
Velocity (m/s)	5	10	20	15	5

Question (15-16): The velocity-time graph of a moving body is given below.



15. What is the acceleration of the body between C and D?

a) Zero
b) $4\ m/s^2$
c) $8\ m/s^2$
d) $16\ m/s^2$

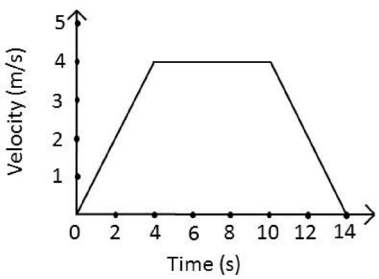
16. Which are the instances where the body experiences deceleration?

a) CD only
b) AB and DE
c) AB and BC
d) BC and DE

17. A car starting from rest travels 50 m in 5 s with uniform acceleration. The acceleration of the car is

a) $[\frac{5\ X\ 50}{2}]\ m/s^2$
b) $[\frac{50}{5^2}]\ m/s^2$
c) $[\frac{2\ X\ 50}{5}]\ m/s^2$
d) $[\frac{2\ X\ 50}{5^2}]\ m/s^2$

18. Study the given graph and calculate the displacement of the body in between 4 to 8 seconds.



a) 4 m

c) 16 m

b) 12 m

d) 32 m

19. A stone is thrown vertically upward with an initial velocity of 40 m/s. The maximum height reached by the stone is _____ (Take g = 10 m/s^2 and the velocity at the maximum height will be 0 m/s)

a) 40 m

c) $[\frac{40}{2\ X\ 10}]$ m

b) $[\frac{40\ X\ 40}{10}]$ m

d) $\left[\frac{40\ X\ 40}{2\ X\ 10}\right]$ m

20. The table below gives the position of a toy car at different time.

Time (s)	0	2	4	6	8	10
Position (m)	5	10	15	20	25	30

The distance travelled by the toy car in 8 seconds is _____

a) 25 m

c) 8 m

b) 20 m

d) 5 m

21. The acceleration of a moving body when its velocity changes from 0 m/s to 30 m/s is 5 m/s^2. The distance travelled by the body in its journey is ……..

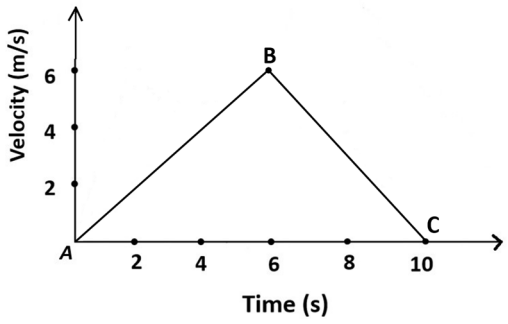
a) $[\frac{30-0}{2\ X\ 5}]\ m$

c) $[\frac{30^2-0^2}{2}]\ m$

b) $[\frac{30^2-0^2}{5}]\ m$

d) $[\frac{30^2-0^2}{2\ X\ 5}]\ m$

Question (22-23): Below given is the graph of a moving object.



22. Find the true statement from the following.

a) The object has uniform motion along AB and non-uniform motion along BC

b) The object has uniform motion along BC and non-uniform motion along AB

c) The object has uniform motion in its journey from A to C

d) The object has non-uniform motion in its journey from A to C

23. Find the acceleration of the object moving from B to C.

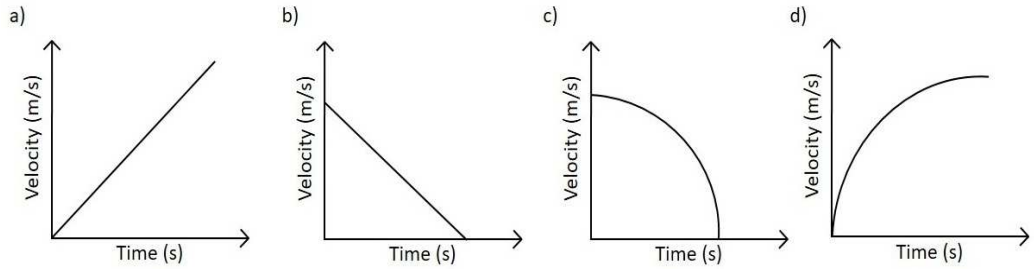
a) Zero

b) $1\ m/s^2$

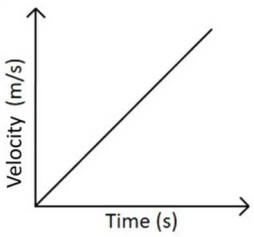
c) $\frac{1}{2} m/s^2$

d) $\frac{3}{2}\ m/s^2$

24. Select the graph showing the acceleration of a body when thrown vertically upward.



25. The given velocity- time graph represents



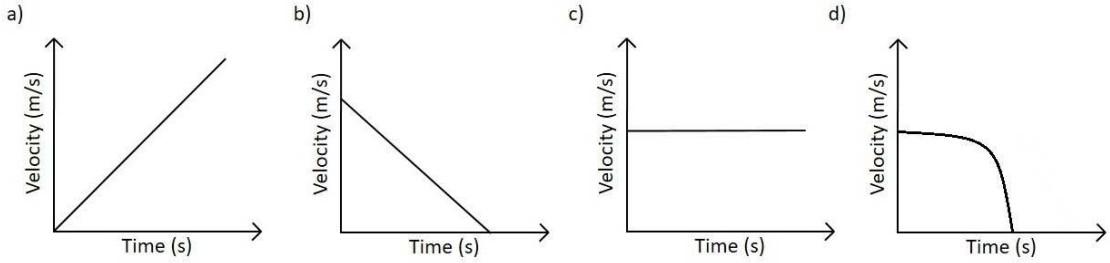
a) The change in velocity of a stone dropped from a height.

b) The change in velocity of a body thrown vertically upwards.

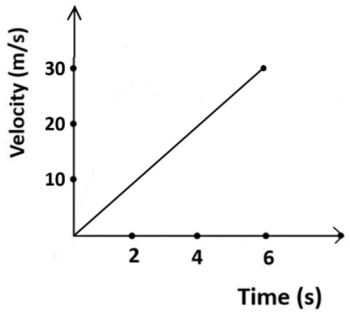
c) Increasing velocity with time.

d) Constant velocity.

26. Select the graph showing the change in velocity of a freely falling body.



Question **(27-28)**: The velocity-time graph of a moving body is given below.



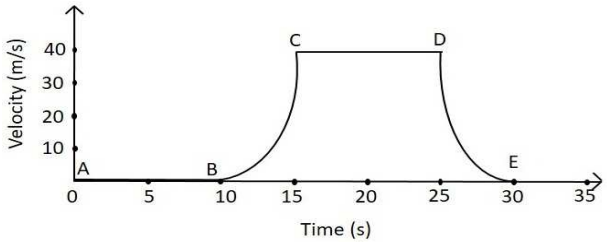
27. The initial velocity and final velocity of the body is _____ and _____ respectively.

a) 0 m/s and 30 m/s
b) 30 m/s and 0 m/s
c) 6 m/s and 30 m/s
d) 30 m/s and 6 m/s

28. The displacement of the body in 6 seconds is _____

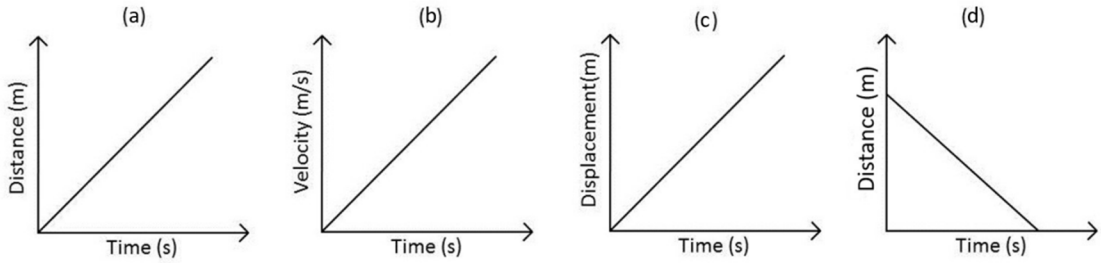
a) 6 m
b) 30 m
c) 90 m
d) 160 m

29. Identify the part of the graph where the object has zero acceleration.

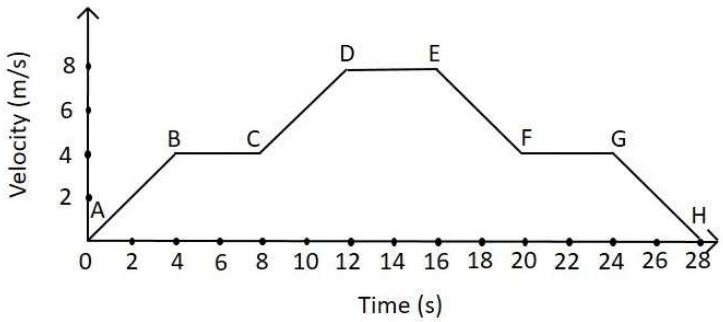


a) CD
b) DE
c) Both BC and DE
d) Both AB and CD

30. Select the diagram showing uniform acceleration.

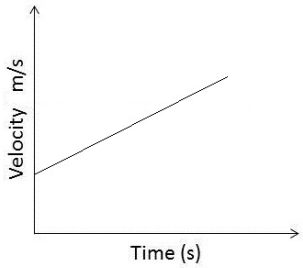


31. Select the option that represents positively accelerated motion.



a) CD and EF
b) AB and CD
c) EF and GH
d) BC, DE and FG

32. According to the given velocity-time graph, the object



a) Has initial velocity which is not zero
b) Is moving with uniform velocity
c) Has initial velocity which is not zero and later is moving with uniform velocity
d) Is at rest

****

APPENDIX 43

RESPONSE SHEET(DRAFT)
ACHIEVEMENT TEST ON 'EQUATIONS OF MOTION'

GENERAL DATA

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term and second term examination of IX standard:

ANSWERS

1. ⓐ ⓑ ⓒ ⓓ	12. ⓐ ⓑ ⓒ ⓓ	23. ⓐ ⓑ ⓒ ⓓ
2. ⓐ ⓑ ⓒ ⓓ	13. ⓐ ⓑ ⓒ ⓓ	24. ⓐ ⓑ ⓒ ⓓ
3. ⓐ ⓑ ⓒ ⓓ	14. ⓐ ⓑ ⓒ ⓓ	25. ⓐ ⓑ ⓒ ⓓ
4. ⓐ ⓑ ⓒ ⓓ	15. ⓐ ⓑ ⓒ ⓓ	26. ⓐ ⓑ ⓒ ⓓ
5. ⓐ ⓑ ⓒ ⓓ	16. ⓐ ⓑ ⓒ ⓓ	27. ⓐ ⓑ ⓒ ⓓ
6. ⓐ ⓑ ⓒ ⓓ	17. ⓐ ⓑ ⓒ ⓓ	28. ⓐ ⓑ ⓒ ⓓ
7. ⓐ ⓑ ⓒ ⓓ	18. ⓐ ⓑ ⓒ ⓓ	29. ⓐ ⓑ ⓒ ⓓ
8. ⓐ ⓑ ⓒ ⓓ	19. ⓐ ⓑ ⓒ ⓓ	30. ⓐ ⓑ ⓒ ⓓ
9. ⓐ ⓑ ⓒ ⓓ	20. ⓐ ⓑ ⓒ ⓓ	31. ⓐ ⓑ ⓒ ⓓ
10. ⓐ ⓑ ⓒ ⓓ	21. ⓐ ⓑ ⓒ ⓓ	32. ⓐ ⓑ ⓒ ⓓ
11. ⓐ ⓑ ⓒ ⓓ	22. ⓐ ⓑ ⓒ ⓓ	

APPENDIX 44

SCORING KEY (DRAFT)
ACHIEVEMENT TEST ON 'EQUATIONS OF MOTION'

No.	a	b	c	d
1.				✓
2.			✓	
3.		✓		
4.			✓	
5.			✓	
6.	✓			
7.		✓		
8.			✓	
9.	✓			
10.			✓	
11.		✓		
12.		✓		
13.			✓	
14.	✓			
15.	✓			
16.				✓
17.				✓
18.			✓	
19.				✓
20.		✓		
21.				✓
22.				✓
23.				✓
24.		✓		
25.	✓			
26.	✓			
27.	✓			
28.			✓	
29.				✓
30.		✓		
31.		✓		
32.	✓			

APPENDIX 45

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

ACHIEVEMENT TEST ON 'EQUATIONS OF MOTION'
(FINAL – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

Maximum Marks: 25

നിർദ്ദേശങ്ങൾ: Time: 60 minutes

ഭൗതികശാസ്ത്രത്തിലെ 'ചലനസമവാക്യങ്ങൾ' എന്ന ആശയത്തിൽ ഒമ്പതാം ക്ലാസ്സിലെ കുട്ടികളുടെ പഠനേട്ടം അളക്കുന്നതിനുള്ള ടെസ്റ്റാണിത്. ഇതിൽ 25 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് ഉൾപ്പെടുത്തിയിട്ടുള്ളത്, എല്ലാ ചോദ്യത്തിനും ഉത്തരം തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d)എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കുറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

……

1. ശരിയായ ചലനസമവാക്യങ്ങൾ ഏത്?

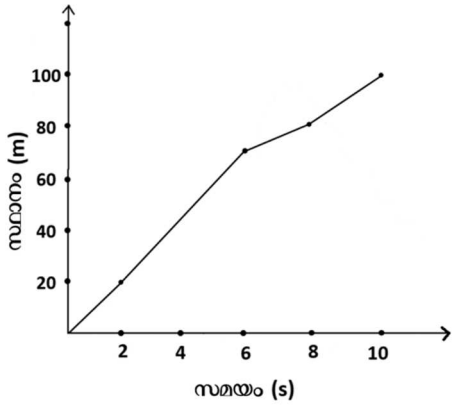
a) $v = u + at^2, s = ut - \frac{1}{2}\, at^2, v^2 = u^2 - 2as^2$

b) $v = u - \ at, s = ut - \frac{1}{2}\, a^2t^2, v^2 = u^2 + 2as^2$

c) $v = ut + at^2, s = ut + \frac{1}{2}\, a^2t^2, u^2 = v^2 + 2as$

d) $v = u + at, s = ut + \frac{1}{2}\, at^2, v^2 = u^2 + 2as$

2. ഒരു കാറിന്റെ ചലനം സൂചിപ്പിക്കുന്ന ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്. 8 സെക്കന്റിൽ കാർ സഞ്ചരിച്ച ദൂരം

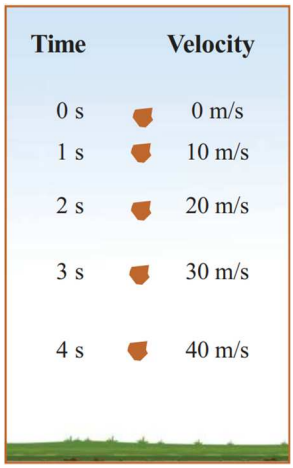


a) 200 m
c) 80 m
b) 100 m
d) 60 m

3. നിശ്ചലാവസ്ഥയിൽ നിന്ന് ഒരു കാർ സമത്വരണത്തോടെ സഞ്ചരിക്കുന്നു. ചലനം ആരംഭിച്ച് 10 സെക്കന്റിനുള്ളിൽ അതിന്റെ പ്രവേഗം $30\ m/s$ ആകുന്നുവെങ്കിൽ കാറിന്റെ ത്വരണം എത്ര ?

a) $2\ m/s^2$
c) $10\ m/s^2$
b) $3\ m/s^2$
d) $30\ m/s^2$

4. നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ ചിത്രം ആണ് താഴെ തന്നിരിക്കുന്നത്. 4 സെക്കന്റിൽ വസ്തുവിന്റെ ത്വരണം കണക്കാക്കുക.

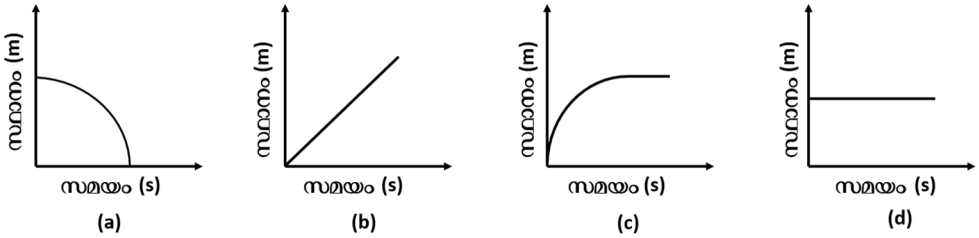


a) $160\ m/s^2$
c) $10\ m/s^2$
b) $40\ m/s^2$
d) $4\ m/s^2$

5. ഒരു പ്രവേഗ-സമയ ഗ്രാഫിൽ നിശ്ചിത സമയഇടവേളകൾക്കിടയിൽ വസ്തുവിനുണ്ടാകുന്ന _____ഗ്രാഫിന് ചുവടെയുള്ള ഭാഗത്തിന്റെ പരപ്പളവിന് തുല്യമായിരിക്കും.

a) സ്ഥാനാന്തരം
b) ദൂരം
c) പ്രവേഗം
d) ചലനസമയം

6. സമവേഗത സൂചിപ്പിക്കുന്ന ഗ്രാഫ് താഴെ തന്നവയിലേത് ?

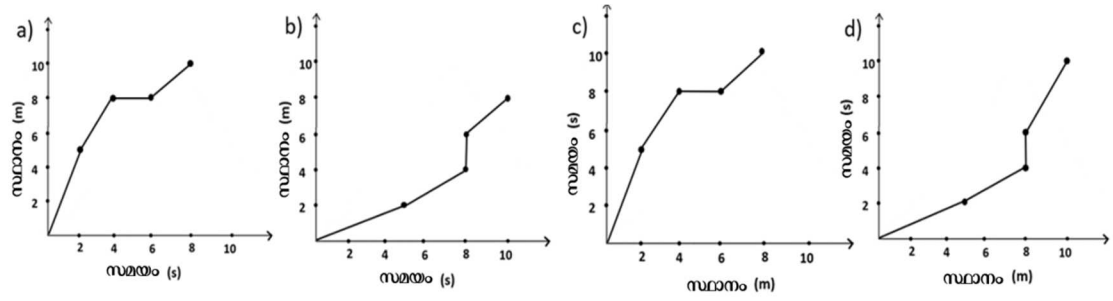


7. 10 സെക്കന്റിൽ തീവണ്ടിയുടെ പ്രവേഗം $80\ m/s$ ഇൽ നിന്നും $20\ m/s$ ആയി മാറുന്നുവെങ്കിൽ അതിന്റെ മന്ദീകരണം എത്ര?

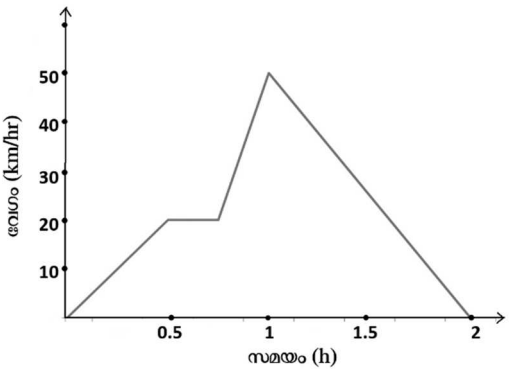
a) $0.1\ m/s^2$
b) $1\ m/s^2$
c) $6\ m/s^2$
d) $10\ m/s^2$

8. ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ സ്ഥാനവും സമയവും ആണ് താഴെ പട്ടികയിൽ തന്നിട്ടുള്ളത്. ആ ചലനത്തെ സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത് ?

സമയം (s)	0	2	4	6	8
സ്ഥാനം (m)	0	5	8	8	10



9. ഒരു ടെയിൻ ഒരു സ്റ്റേഷനിൽ നിന്ന് മറ്റൊരു സ്റ്റേഷനിലേക്ക് 2 മണിക്കൂർ കൊണ്ട് എത്തിച്ചേരുന്നു. ആ ചലനത്തിന്റെ വേഗ-സമയ ഗ്രാഫാണ് തന്നിരിക്കുന്നത്. ഗ്രാഫിനെ കുറിച്ചുള്ള പ്രസ്താവനകളിൽ ശരിയേത് ?



i. യാത്രയിൽ ട്രെയിനിന്റെ പരമാവധി ത്വരണം 0.75 hr ഇനും 1 hr നും ഇടയിലാണ്

ii. 0.5 hr തൊട്ട് 0.75 hr വരെയുള്ള ഇടവേളയിൽ ട്രെയിൻ സഞ്ചരിക്കുന്ന ദൂരം (0.25 x 20) km ആണ്.

iii. യാത്രയുടെ തുടക്കം മുതൽ 0.5 hrs വരെയുള്ള ഇടവേളയിൽ ട്രെയിൻ സമപ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു.

a) (i) മാത്രം ശരിയാണ്. c) (i) ഉം (ii) ഉം ശരിയാണ്.

b) (ii) മാത്രം ശരിയാണ്. d) എല്ലാ പ്രസ്താവനകളും ശരിയാണ്.

10. താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ **തെറ്റേത്**?

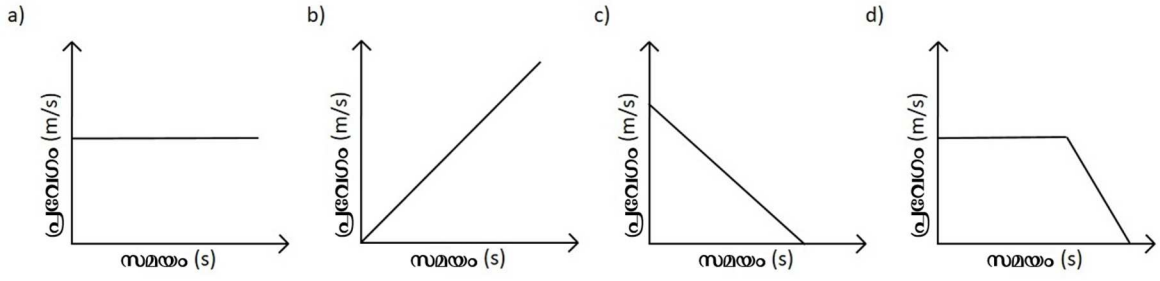
a) ഗ്രാഫ് രണ്ട് അക്ഷങ്ങളുള്ള ഒരു ദ്വിമാനചിത്രമാണ്.

b) ലംബ അക്ഷത്തെ x അക്ഷമെന്നും തിരശ്ചീന അക്ഷത്തെ y അക്ഷമെന്നും വിളിക്കുന്നു.

c) x, y അക്ഷങ്ങൾ സന്ധിക്കുന്നത് മൂലബിന്ദുവിലാണ്.

d) ഗ്രാഫിന് പേര് നൽകുമ്പോൾ, y അക്ഷത്തിലെ അളവ് ആദ്യം ഉപയോഗിക്കും.

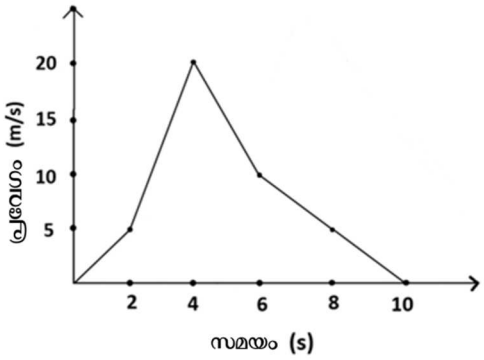
11. സമയത്തിനനുസരിച്ച് കൂടുന്ന പ്രവേഗം വിശേഷിപ്പിക്കുന്ന ഗ്രാഫ് ഏത്?



12. നിശ്ചലാവസ്ഥയിൽ നിന്ന് ചലിച്ചു തുടങ്ങിയ ഒരു കളിപ്പാട്ട ട്രെയിൻ 2 സെക്കന്റിനുള്ളിൽ $0.1\ m/s^2$ സമത്വരണത്തിൽ സഞ്ചരിക്കുന്നു. ട്രെയിൻ സഞ്ചരിച്ച ദൂരം എത്ര ?

a) 1 m
b) 0.4 m
c) 0.2 m
d) 0.05 m

13. ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ ഗ്രാഫ് ആണ് താഴെ തന്നിരിക്കുന്നത്. ഗ്രാഫിന് അനുയോജ്യമായ പട്ടിക ഏതെന്ന് കണ്ടെത്തുക.



a)

സമയം (s)	0	2	4	6	8	10
പ്രവേഗം (m/s)	0	5	20	10	5	0

b)

സമയം (s)	0	2	4	6	8	10
പ്രവേഗം (m/s)	0	5	10	15	20	25

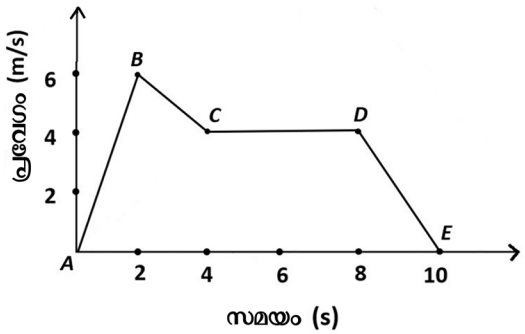
c)

സമയം (s)	0	10	20	10	5	0
പ്രവേഗം (m/s)	0	2	4	6	8	10

d)

സമയം (s)	2	4	6	8	10
പ്രവേഗം (m/s)	5	10	20	15	5

ചോദ്യം 14-15: ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗ സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്.



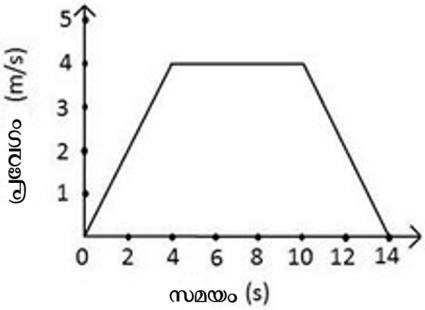
14. C എന്ന ബിന്ദുവിനും D എന്ന ബിന്ദുവിനും ഇടയിൽ വസ്തുവിനുണ്ടാകുന്ന ത്വരണമെത്ര?

a) പൂജ്യം
c) $8\ m/s^2$
b) $4\ m/s^2$
d) $16\ m/s^2$

15. വസ്തുവിന് മന്ദീകരണം സംഭവിക്കുന്ന സന്ദർഭങ്ങൾ ഏത് ?

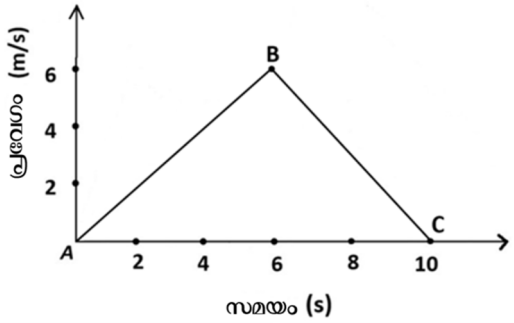
a) CD മാത്രം
c) AB യും BC യും
b) AB യും DE യും
d) BC യും DE യും

16. താഴെ കൊടുത്ത ഗ്രാഫ് വിശകലനം ചെയ്ത വസ്തു 4 സെക്കന്റിനും 8 സെക്കന്റിനുമിടയിൽ സഞ്ചരിച്ച ദൂരം കണ്ടെത്തുക.



a) 4 m
c) 16 m
b) 12 m
d) 32 m

ചോദ്യം (17-18): ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്.



17. താഴെ തന്നവയിൽ നിന്ന് ശരിയായ പ്രസ്താവന കണ്ടെത്തുക.

a) AB യിൽ വസ്തുവിന് സമചലനവും BC യിൽ അസമചലനവുമാണ്.

b) BC യിൽ വസ്തുവിന് സമചലനവും AB യിൽ അസമചലനവുമാണ്.

c) A യിൽ നിന്ന് C യിലേക്ക് പോകുമ്പോൾ വസ്തു സമചലനത്തിലാണ്.

d) A യിൽ നിന്ന് C യിലേക്ക് പോകുമ്പോൾ വസ്തു അസമചലനത്തിലാണ്.

18. B യിൽ നിന്ന് C യിലേക്ക് ചലിക്കുമ്പോൾ വസ്തുവിന്റെ ത്വരണം എത്ര?

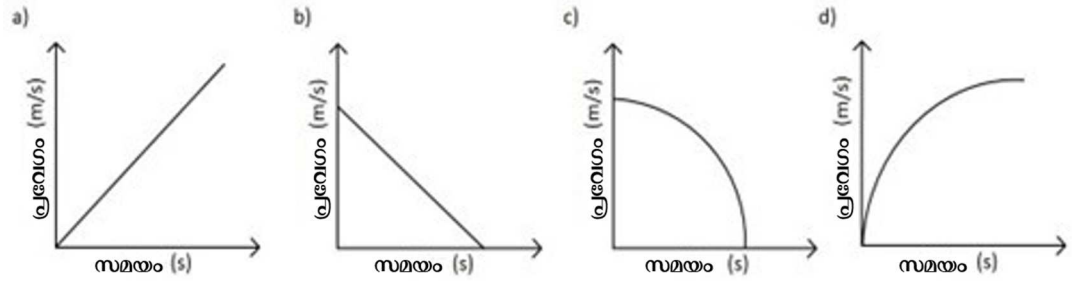
a) Zero

b) $1\ m/s^2$

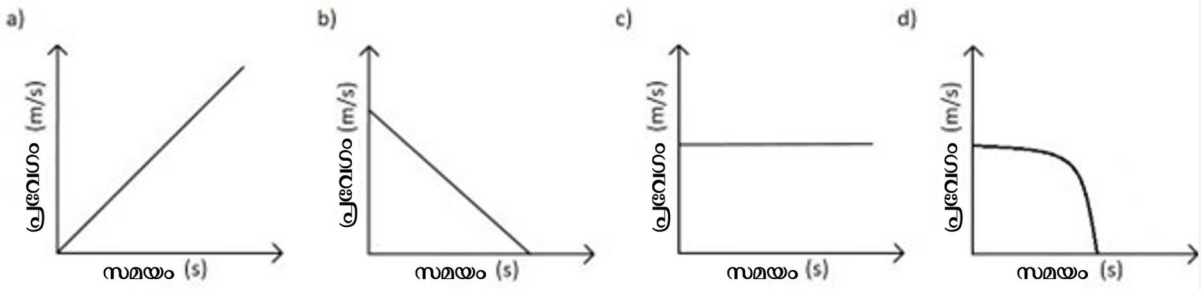
c) $\frac{1}{2} m/s^2$

d) $\frac{3}{2}\ m/s^2$

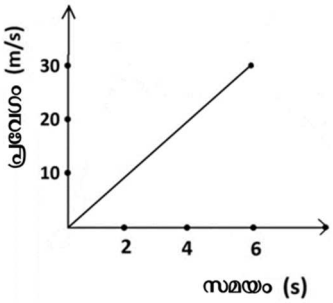
19. ഒരു വസ്തുവിനെ കുത്തനെ മുകളിലോട്ട് എറിയുമ്പോൾ അനുഭവപ്പെടുന്ന ത്വരണം സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത്?



20. നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗമാറ്റം സൂചിപ്പിക്കുന്ന ഗ്രാഫ് ഏത്?



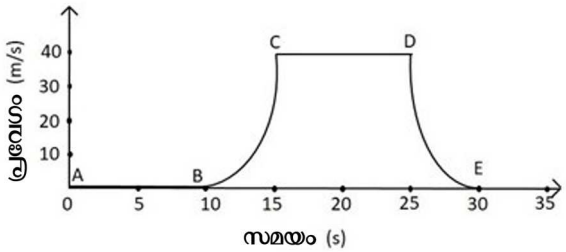
21. ചലിക്കുന്ന ഒരു വസ്തുവിന്റെ പ്രവേഗ-സമയ ഗ്രാഫാണ് താഴെ തന്നിരിക്കുന്നത്.



വസ്തുവിന്റെ ആദ്യപ്രവേഗവും അന്ത്യപ്രവേഗവും യഥാക്രമം _____ഉം _____ഉമാണ്.

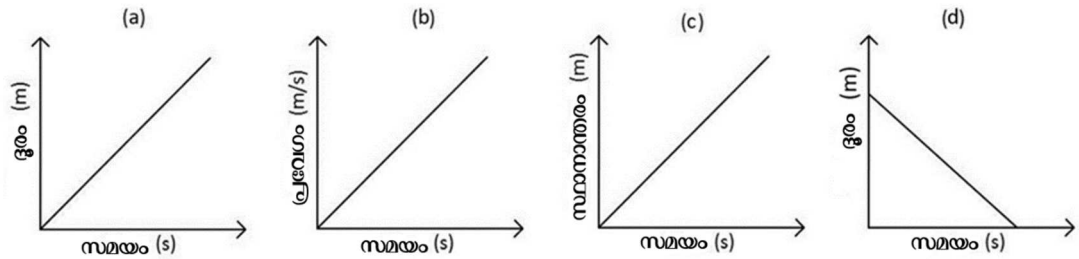
a) $0\ m/s$ and $30\ m/s$
b) $30\ m/s$ and $0\ m/s$
c) $6\ m/s$ and $30\ m/s$
d) $30\ m/s$ and $6\ m/s$

22. താഴെ കൊടുത്തിരിക്കുന്ന ഗ്രാഫിൽ ഏതു ഭാഗമാണ് വസ്തുവിൻറെ ത്വരണം പൂജ്യമായി കാണിച്ചിട്ടുള്ളത്?

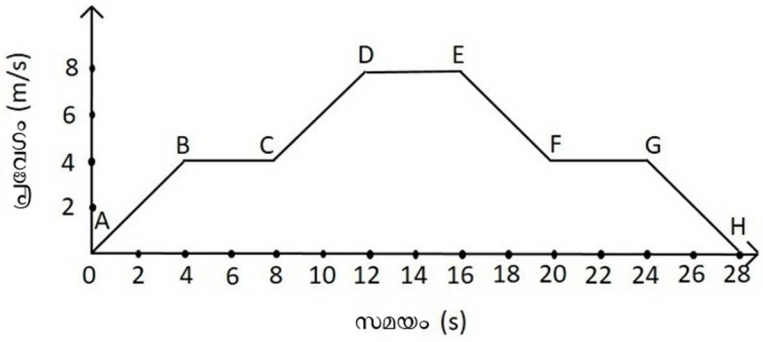


a) CD
b) DE
c) BC യും DE യും
d) AB യും CD യും

23. സമത്വരണം സൂചിപ്പിക്കുന്ന ചിത്രം കണ്ടെത്തുക.

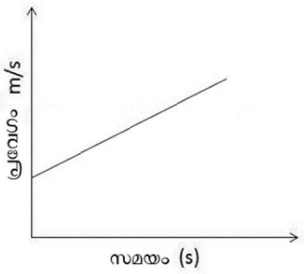


24. താഴെ കൊടുത്തിരിക്കുന്നവയിൽ പോസിറ്റീവായി ത്വരണം സംഭവിക്കുന്ന സന്ദർഭങ്ങൾ തിരഞ്ഞെടുക്കുക.



a) CD യും EF ഉം
b) AB യും CD യും
c) EF ഉം GH ഉം
d) BC ഉം DE ഉം FG ഉം

25. തന്നിരിക്കുന്ന പ്രവേഗ-സമയ ഗ്രാഫ് അനുസരിച്ച്



a) വസ്തുവിന് ഒരു നിശ്ചിത ആദ്യ പ്രവേഗമുണ്ട്.
b) വസ്തു സമപ്രവേഗത്തിൽ സഞ്ചരിക്കുന്നു.
c) വസ്തു തുടക്കത്തിൽ ഒരു നിശ്ചിത പ്രവേഗത്തിൽ സഞ്ചരിക്കുകയും പിന്നീട് സമപ്രവേഗത്തിലേക്ക് മാറുകയും ചെയ്യുന്നു.
d) വസ്തു നിശ്ചലാവസ്ഥയിലാണ്.

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APPENDIX 46

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

ACHIEVEMENT TEST ON 'EQUATIONS OF MOTION'
(FINAL – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

Maximum Marks: 25

Instructions: Time: 60 minutes

This test is meant to measure achievement of IX standard students in the physics concept, 'Equations of Motion'. This test consists of 25 multiple choice questions out of which the student would be required to answer all the questions. Separate response sheet is provided to mark the answers. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The candidate must mark the response by darkening the circle as indicated below on the correct response against each item. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response. The results of this test will be only used for research purpose.

……

1. The correct equations of motion

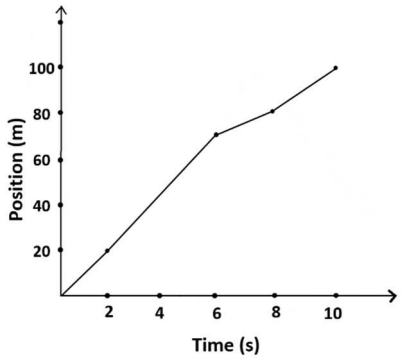
a) $v = u + at^2, s = ut - \frac{1}{2}\, at^2, v^2 = u^2 - 2as^2$

b) $v = u - \ at, s = ut - \frac{1}{2}\, a^2t^2, v^2 = u^2 + 2as^2$

c) $v = ut + at^2, s = ut + \frac{1}{2}\, a^2t^2, u^2 = v^2 + 2as$

d) $v = u + at, s = ut + \frac{1}{2}\, at^2, v^2 = u^2 + 2as$

2. Given below is the graph that shows motion of a car. The distance travelled by it in 8 secs is _____

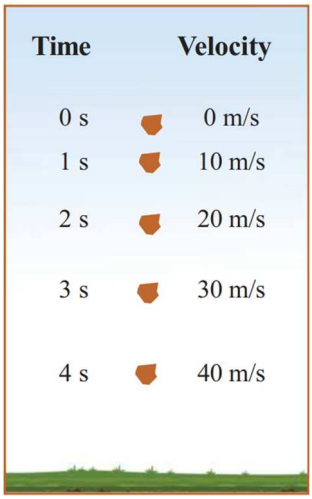


a) 200 m
c) 80 m
b) 100 m
d) 60 m

3. A car accelerates uniformly from rest to a velocity of 30 m/s in 10 seconds. What is the acceleration of the car?

a) 2 m/s^2
c) 10 m/s^2
b) 3 m/s^2
d) 30 m/s^2

4. Given below is the figure of a freely falling object. The acceleration of the object at 4s will be

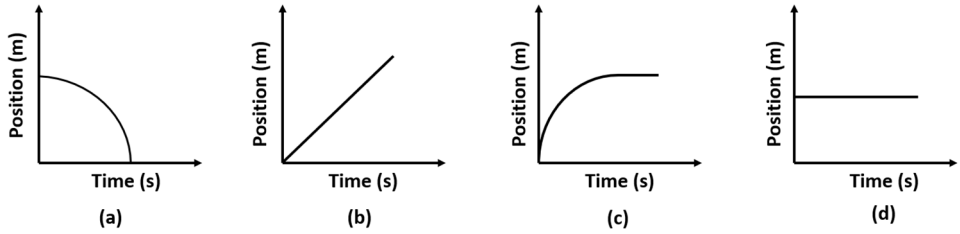


a) 160 m/s^2
c) 10 m/s^2
b) 40 m/s^2
d) 4 m/s^2

5. _____ of a body within a definite interval of time is equal to the area of the portion under velocity-time graph.

a) Displacement
c) Velocity
b) Distance
d) Time of motion

6. Which of the following graphs represents uniform speed?



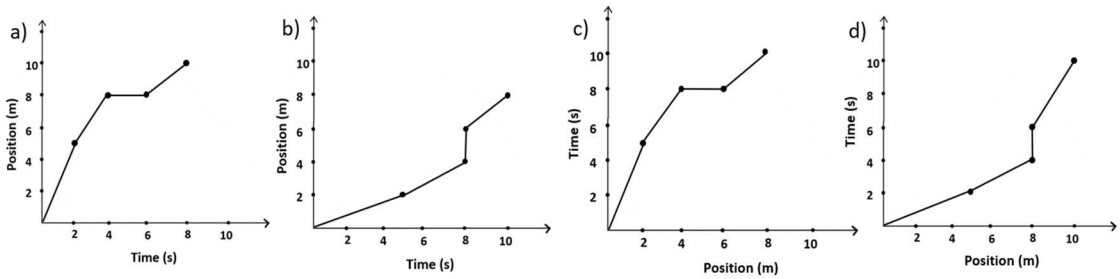
7. The retardation of the train which changes its velocity from $80\ m/s$ to $20\ m/s$ in 10 seconds will be

a) $0.1\ m/s^2$ c) $6\ m/s^2$

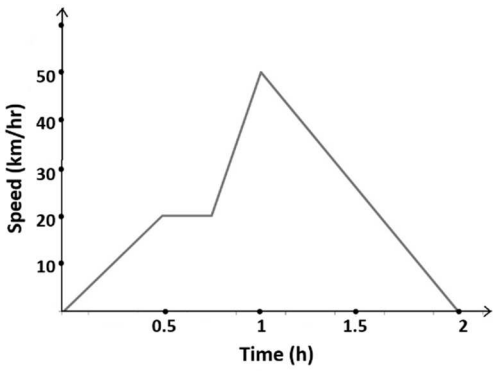
b) $1\ m/s^2$ d) $10\ m/s^2$

8. Given below is the table that shows the position and time of a moving object. The graph that shows its motion is

Time (s)	0	2	4	6	8
Position (m)	0	5	8	8	10



9. A train moves from one station to another in 2 hrs time. Its speed-time graph during the motion is shown in figure. Identify the correct statement regarding the graph.



i. The maximum acceleration during the journey is in between 0.75 hr to 1 hr.

ii. The distance covered during the time interval from 0.5 hr to 0.75 hr is (0.25 x 20) kms.

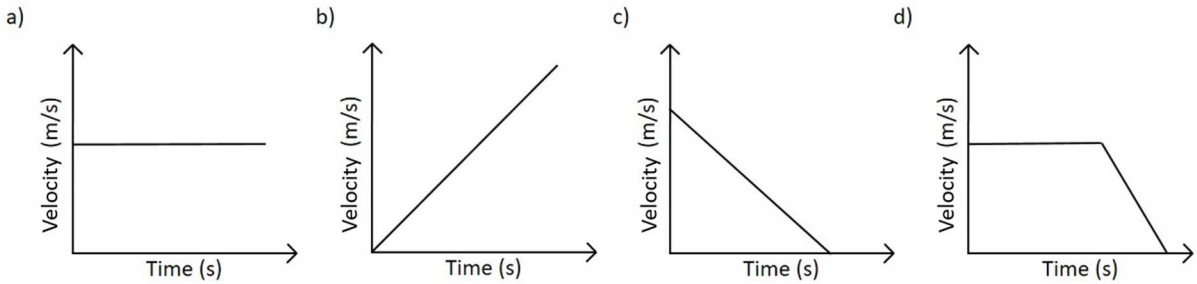
iii. From the beginning of the journey to 0.5 hrs, the train moves with constant velocity.

a) Only (i) is correct.
c) Both (i) and (ii) are correct.
b) Only (ii) is correct.
d) All statements are correct.

10. Which one of the following statements is **false**?

a) Graph is a two-dimensional diagram with two axes.
b) The vertical axis is the x-axis and the horizontal axis is the y-axis.
c) The point where x and y axes meet is the origin.
d) While naming a graph, value on the y-axis will be given first.

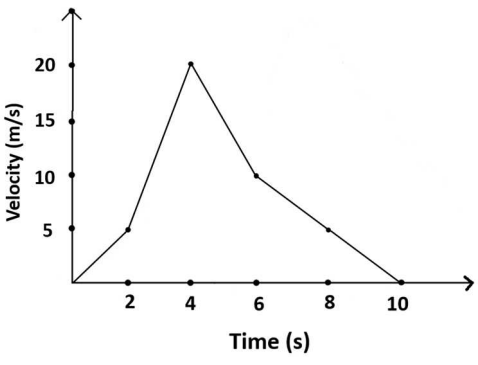
11. Which of the following graphs show increasing velocity with time?



12. A toy train starts from rest and moves with uniform acceleration $0.1\ m/s^2$ for 2 seconds. The distance travelled by the train is

a) 1 m
c) 0.2 m
b) 0.4 m
d) 0.05 m

13. The graph given below represents the motion of an object. Which of the tables given corresponds to the graph provided?



a)

Time (s)	0	2	4	6	8	10
Velocity (m/s)	0	5	20	10	5	0

b)

Time (s)	0	2	4	6	8	10
Velocity (m/s)	0	5	10	15	20	25

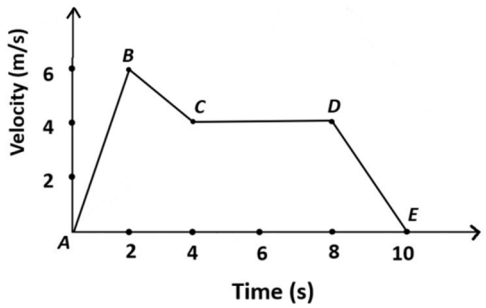
c)

Time (s)	0	10	20	10	5	0
Velocity (m/s)	0	2	4	6	8	10

d)

Time (s)	2	4	6	8	10
Velocity (m/s)	5	10	20	15	5

Question (14-15): The velocity-time graph of a moving body is given below.



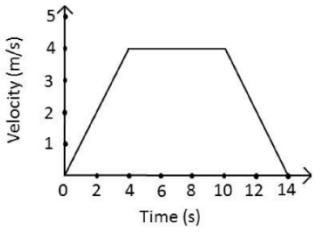
14. What is the acceleration of the body between C and D?

a) Zero
c) $8\ m/s^2$
b) $4\ m/s^2$
d) $16\ m/s^2$

15. Which are the instances where the body experiences deceleration?

a) CD only
c) AB and BC
b) AB and DE
d) BC and DE

16. Study the given graph and calculate the displacement of the body in between 4 to 8 seconds.



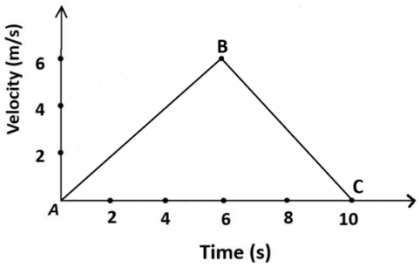
a) 4 m

c) 16 m

b) 12 m

d) 32 m

Question (17-18): Below given is the graph of a moving object.



17. Find the true statement from the following.

a) The object has uniform motion along AB and non-uniform motion along BC

b) The object has uniform motion along BC and non-uniform motion along AB

c) The object has uniform motion in its journey from A to C

d) The object has non-uniform motion in its journey from A to C

18. Find the acceleration of the object moving from B to C.

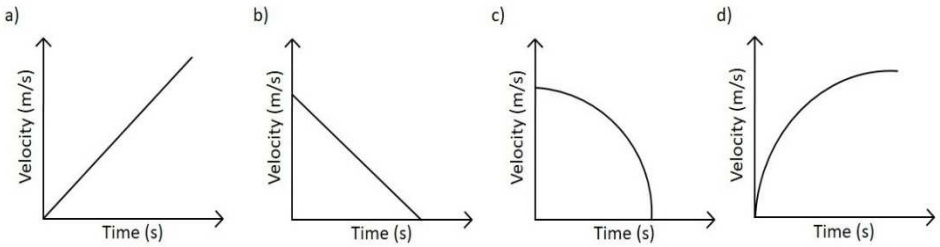
a) Zero

c) $\frac{1}{2} m/s^2$

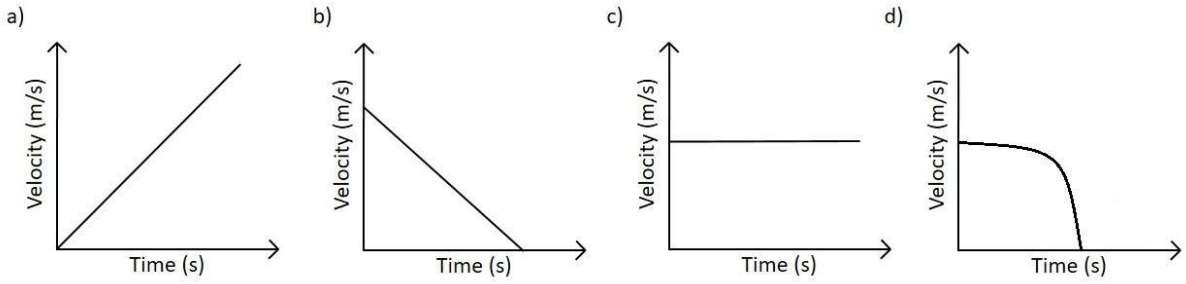
b) $1\ m/s^2$

d) $\frac{3}{2}\ m/s^2$

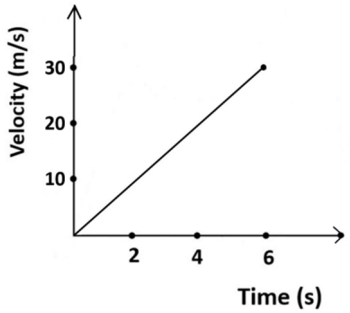
19. Select the graph showing the acceleration of a body when thrown vertically upward.



20. Select the graph showing the change in velocity of a freely falling body.



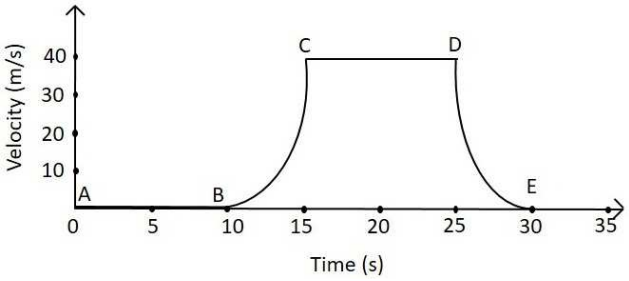
21. The velocity-time graph of a moving body is given below.



The initial velocity and final velocity of the body is _____ and _____ respectively.

a) $0\ m/s$ and $30\ m/s$
b) $30\ m/s$ and $0\ m/s$
c) $6\ m/s$ and $30\ m/s$
d) $30\ m/s$ and $6\ m/s$

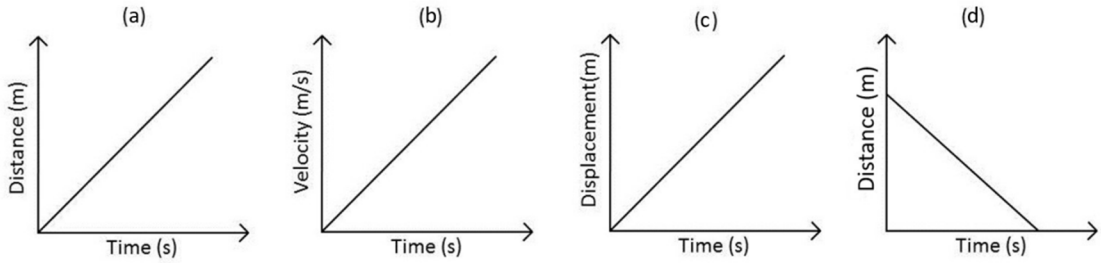
22. Identify the part of the graph where the object has zero acceleration.



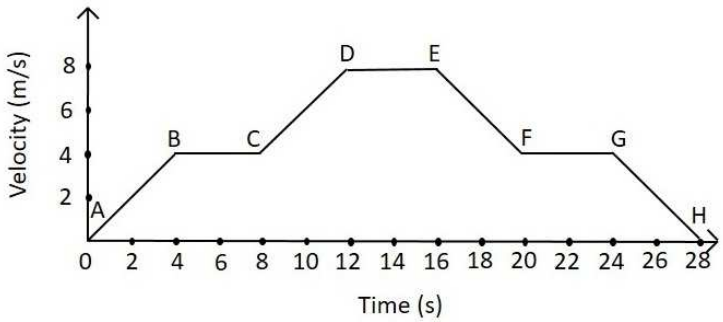
a) CD
b) DE
c) Both BC and DE
d) Both AB and CD

23.

24. Select the diagram showing uniform acceleration.

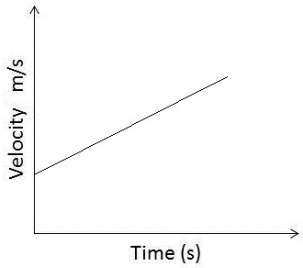


25. Select the option that represents positively accelerated motion.



a) CD and EF
b) AB and CD
c) EF and GH
d) BC, DE and FG

26. According to the given velocity-time graph, the object



a) Has initial velocity which is not zero
b) Is moving with uniform velocity
c) Has initial velocity which is not zero and later is moving with uniform velocity
d) Is at rest

****

APPENDIX 47

RESPONSE SHEET(FINAL)
ACHIEVEMENT TEST ON 'EQUATIONS OF MOTION'

GENERAL DATA

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term examination of IX standard:

Marks scored in Physics in first term examination of IX standard:

ANSWERS

1. ⓐ ⓑ ⓒ ⓓ	11. ⓐ ⓑ ⓒ ⓓ	21. ⓐ ⓑ ⓒ ⓓ
2. ⓐ ⓑ ⓒ ⓓ	12. ⓐ ⓑ ⓒ ⓓ	22. ⓐ ⓑ ⓒ ⓓ
3. ⓐ ⓑ ⓒ ⓓ	13. ⓐ ⓑ ⓒ ⓓ	23. ⓐ ⓑ ⓒ ⓓ
4. ⓐ ⓑ ⓒ ⓓ	14. ⓐ ⓑ ⓒ ⓓ	24. ⓐ ⓑ ⓒ ⓓ
5. ⓐ ⓑ ⓒ ⓓ	15. ⓐ ⓑ ⓒ ⓓ	25. ⓐ ⓑ ⓒ ⓓ
6. ⓐ ⓑ ⓒ ⓓ	16. ⓐ ⓑ ⓒ ⓓ	
7. ⓐ ⓑ ⓒ ⓓ	17. ⓐ ⓑ ⓒ ⓓ	
8. ⓐ ⓑ ⓒ ⓓ	18. ⓐ ⓑ ⓒ ⓓ	
9. ⓐ ⓑ ⓒ ⓓ	19. ⓐ ⓑ ⓒ ⓓ	
10. ⓐ ⓑ ⓒ ⓓ	20. ⓐ ⓑ ⓒ ⓓ	

APPENDIX 48

SCORING KEY (FINAL)
ACHIEVEMENT TEST ON 'EQUATIONS OF MOTION'

No.	a	b	c	d
1.				✓
2.			✓	
3.		✓		
4.			✓	
5.	✓			
6.		✓		
7.			✓	
8.	✓			
9.			✓	
10.		✓		
11.		✓		
12.			✓	
13.	✓			
14.	✓			
15.				✓
16.			✓	
17.				✓
18.				✓
19.		✓		
20.	✓			
21.	✓			
22.				✓
23.		✓		
24.		✓		
25.	✓			

APPENDIX 49

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

ACHIEVEMENT TEST ON 'GRAVITATION'
(DRAFT – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

Maximum Marks: 33

നിർദ്ദേശങ്ങൾ: Time: 60 minutes

ഭൗതികശാസ്ത്രത്തിലെ 'ഗുരുത്വാകർഷണം' എന്ന ആശയത്തിൽ ഒമ്പതാം ക്ലാസ്സിലെ കുട്ടികളുടെ പഠനേട്ടം അളക്കുന്നതിനുള്ള ടെസ്റ്റാണിത്. ഇതിൽ 33 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് ഉൾപ്പെടുത്തിയിട്ടുള്ളത്, എല്ലാ ചോദ്യത്തിനും ഉത്തരം, തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d)എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കുറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

……

1. x ഉം y യും മാസ്സുള്ള രണ്ട് വസ്തുക്കൾ n അകലത്തിലാണുള്ളത്. അവക്കിടയിലുള്ള ഗുരുത്വാകർഷണബലം എത്ര ?

a) $F = \frac{gxy}{n}$
c) $F = \frac{Gxy^2}{n^2}$
b) $F = \frac{Gxy}{n^2}$
d) $F = \frac{gxy}{n^2}$

2. 10 kg മാസ്സുള്ള ഒരു വസ്തു ഭൂകേന്ദ്രത്തിൽ ആയിരിക്കുമ്പോൾ അതിന്റെ ഭാരം എത്ര?

a) 0 N
c) 10 N
b) 9.8 N
d) 98 N

3. ഭൂമിയുടെ മാസിൻറെ ഇരട്ടി മാസുള്ളതും ഭൂമിയുടെ ആരത്തിന് തുല്യമായ ആരവുമുള്ള ഒരു ഗ്രഹത്തിൽ ഗുരുത്വത്വരണം g_p എത്ര ? (g = ഭൂഗുരുത്വത്വരണം)

a) $g_p = \frac{g}{2}$ c) $g_p = 2g$

b) $g_p = g$ d) $g_p = 4g$

4. ചന്ദ്രന്റെ പ്രതലത്തിനടുത്ത് വ്യത്യസ്ത മാസുകളുള്ള രണ്ട് വസ്തുക്കൾ ഒരേ ഉയരത്തിൽ നിന്ന് നിർബാധം പതിക്കുമ്പോൾ അവക്ക്

a) എല്ലായ്പ്പോഴും ഒരേ പ്രവേഗമായിരിക്കും

b) വ്യത്യസ്ത ത്വരണമായിരിക്കും

c) ഒരേ ബലമായിരിക്കും അനുഭവപ്പെടുന്നത്

d) വ്യത്യസ്തമായ പ്രകടമായ ഭാരമായിരിക്കും

5. പ്രസ്താവന 1 : ബഹിരാകാശ ഉപഗ്രഹത്തിനകത്ത് ബഹിരാകാശ സഞ്ചാരിക്ക് ഭാരവില്ലായ്മ അനുഭവപ്പെടുന്നു.

പ്രസ്താവന 2 : കാരണം ബഹിരാകാശത്ത് ആ സ്ഥാനത്ത് ഗുരുത്വാകർഷണബലം കുറവാണ്.

a) പ്രസ്താവന 1 ഉം 2 ഉം ശരിയാണ്. പ്രസ്താവന 2 പ്രസ്താവന 1 ന്റെ ശരിയായ വിശദീകരണമാണ്.

b) പ്രസ്താവന 1 ഉം 2 ഉം ശരിയാണ്. പ്രസ്താവന 2 പ്രസ്താവന 1 ന്റെ ശരിയായ വിശദീകരണമല്ല.

c) പ്രസ്താവന 1 ശരിയാണ്. എന്നാൽ പ്രസ്താവന 2 തെറ്റാണ്.

d) പ്രസ്താവന 1 തെറ്റാണ്. എന്നാൽ പ്രസ്താവന 2 ശരിയാണ്.

6. എന്തിനെയാണ് ഭൂഗുരുത്വത്വരണം ആശ്രയിച്ചിരിക്കുന്നത് ?

a) വസ്തുവിന്റെ മാസ്സ് c) വസ്തുവിന്റെ ആകൃതിയും വലുപ്പവും

b) ഭൂമിയുടെ മാസ്സ് d) വസ്തുവിന്റെ വ്യാപ്തം

7. ഒരു കല്ല് സ്പിങ് ത്രാസിൽ തൂക്കിയിട്ടാൽ അതിന്റെ പോയിന്റർ 5kg ഭാരം കാണിക്കുന്നു. ഇനി സ്പിങ് ത്രാസ്സ് മോചിപ്പിക്കുക. അപ്പോൾ പോയിന്ററിന്റെ റീഡിങ് എത്രയാകും?

a) 5kg ഭാരത്തിന് കുറവ് c) 5 kg ഭാരത്തിന് തുല്യം

b) 5kg ഭാരത്തിന് കൂടുതൽ d) പൂജ്യം

8. രണ്ട് കണികകൾ ഒരു നിശ്ചിത അകലത്തിൽ സ്ഥിതി ചെയ്യുന്നു. കണികകൾ തമ്മിലുള്ള അകലം വ്യത്യാസപ്പെടുത്താതെ ഒരു കാണികയുടെ മാസ് ഇരട്ടിപ്പിക്കുകയും മറ്റേതിന്റെ മാസ് വ്യത്യാസപ്പെടുത്താതെയും ഇരുന്നാൽ അവക്കിടയിലുള്ള ഗുരുത്വാകർഷണ ബലത്തിന്റെ മൂല്യം

a) $\frac{1}{4}$ മടങ്ങായിരിക്കും
c) $\frac{1}{2}$ മടങ്ങായിരിക്കും
b) 4 മടങ്ങായിരിക്കും
d) 2 മടങ്ങായിരിക്കും

9. ഒരു മനുഷ്യന് ഭൂമിയിൽ 1 m ഉയരത്തിൽ ചാടാൻ കഴിയും. എങ്കിൽ ചന്ദ്രനിൽ അയാൾക്ക് എത്ര ഉയരത്തിൽ ചാടാം?

a) 1 m ഉയരത്തിൽ ചാടാൻ കഴിയും, കാരണം ഭൂമിയിലും ചന്ദ്രനിലും ഗുരുത്വത്വരണം തുല്യമാണ്.
b) 6 ഇരട്ടി ഉയരത്തിൽ ചാടാൻ കഴിയും, കാരണം അയാളുടെ ഭാരം ചന്ദ്രനിൽ $\frac{1}{6}$ മടങ്ങായിരിക്കും.
c) ചന്ദ്രനിൽ അയാൾക്ക് ചാടാൻ കഴിയില്ല, കാരണം ചന്ദ്രനിൽ ഗുരുത്വാകർഷണബലം ഇല്ല .
d) 50 cms ഉയരത്തിൽ മാത്രമേ ചാടാൻ കഴിയൂള്ളൂ, കാരണം ചന്ദ്രന്റെ ഗുരുത്വാകർഷണബലം ഭൂമിയെക്കാൾ കൂടുതലാണ്.

10. ഒരു വസ്തുവിന്റെ മാസ് 8 kg ആണെങ്കിൽ ഭൂമിയിൽ അതിന്റെ ഭാരമെത്ര? (g= 10 m/s^2)

a) 2 N
c) 18 N
b) 8 N
d) 80 N

11. 10 kg മാസുള്ള ഒരു വസ്തു വ്യാഴഗ്രഹത്തിന്റെ ഉപരിതലത്തിൽ ആയിരിക്കുമ്പോഴുള്ള ഭാരം കണ്ടെത്തുക. (വ്യാഴത്തിലെ g = 23.1 m/s^2)

a) 2.31 N
c) 33.1 N
b) 10 N
d) 231 N

12. സൂര്യനും ഭൂമിക്കുമിടയിലുള്ള ദൂരം മൂന്നിരട്ടിയായി വർധിപ്പിച്ചാൽ , അവക്കിടയിലുള്ള ആകർഷണബലം എത്രയാകും?

a) 3 മടങ്ങായിരിക്കും
c) 9 മടങ്ങായിരിക്കും
b) $\frac{1}{3}$ മടങ്ങായിരിക്കും
d) $\frac{1}{9}$ മടങ്ങായിരിക്കും

13. ഭൂമിയുടെ ധ്രുവപ്രദേശത്തും ഭൂമധ്യരേഖാ പ്രദേശത്തും യുടെ മൂല്യം യഥാക്രമം

a) 0 m/s^2 and 9.8 m/s^2
b) 9.8 m/s^2 and 0 m/s^2
c) 9.78 m/s^2 and 9.83 m/s^2
d) 9.83 m/s^2 and 9.78 m/s^2

14. ഭൂമിയുടെ പ്രതലത്തിൽ ഒരു വസ്തുവിന്റെ മാസ്സ് 50 kg ആണെങ്കിൽ ചന്ദ്രൻറെ പ്രതലത്തിൽ അതിന്റെ മാസ്സ് എത്ര?

a) 50 kg
b) (50 x ചന്ദ്രനിലെ g) kg
c) ($\frac{50}{\text{ചന്ദ്രനിലെ g}}$) kg
d) ($\frac{G\ X\ 50^2}{\text{ചന്ദ്രന്റെ ആരം}^{\ 2}}$) kg

15. 5 kg മാസ്സുള്ള ഒരു വസ്തു ഭൂമിയുടെ മദ്ധ്യത്തിൽ വെച്ചാൽ അതനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം എത്ര?

a) 0 N
b) 5 N
c) 0 N നും 5 N നുമിടക്ക്
d) 5 N ന് കൂടുതൽ

16. ഒരു ലിഫ്റ്റ് 9.8 m/s^2 സമത്വരണത്തിൽ താഴോട്ട് നീങ്ങുമ്പോൾ അതിനകത്ത് നിൽക്കുന്ന മനുഷ്യന്റെ ഭാരത്തിന് എന്ത് സംഭവിക്കും ?

a) ഭാരം കൂടും
b) ഭാരം കുറയും
c) ഭാരം പൂജ്യമാകും
d) ഭാരത്തിന് മാറ്റമുണ്ടാവില്ല

17. മാസിനെയും ഭാരത്തെയും കുറിച്ചുള്ള ശരിയായ പ്രസ്താവനകൾ കണ്ടെത്തുക.

	മാസ്	**ഭാരം**
a)	അതിന്റെ മൂല്യം നെഗറ്റീവ് ആകാം	അതിന്റെ മൂല്യം ഒരിക്കലും പൂജ്യമാകില്ല
b)	അത് അദിശ അളവാണ്	അത് സദിശ അളവാണ്
c)	അതിന്റെ യൂണിറ്റ് ന്യൂട്ടൺ ആണ്	അതിന്റെ യൂണിറ്റ് kg ആണ്
d)	g യുടെ മൂല്യത്തിനനുസരിച്ച് അതിന്റെ മൂല്യം മാറും	g യുടെ മൂല്യത്തിനനുസരിച്ച് അതിന്റെ മൂല്യം മാറില്ല

18. ശൂന്യതയിൽ (വായുവിലെ പ്രതിരോധം പൂജ്യമാണ്) ഒരു വലിയ ഉയരത്തിൽ നിന്ന് ഭൂമിയിലേക്ക് വീഴുന്ന ഒരു വസ്തുവിന്റെ ചലനം എങ്ങിനെയായിരിക്കും?

a) ആദ്യം ത്വരിതപ്പെടുകയും പിന്നീട് സമവേഗതയിലും ചലിക്കും
b) തുടർച്ചയായി ത്വരിതപ്പെടും
c) മന്ദീകരണം സംഭവിച്ച് ഒടുവിൽ നിശ്ചലമാകും
d) സമവേഗതയിൽ ചലിക്കും

19. ഗുരുത്വാകർഷണസ്ഥിരാങ്കത്തിന്റെ മൂല്യം

a) ഉയർച്ചയിലേക്കു പോകുമ്പോൾ കൂടുന്നു.

b) ഉയർച്ചയിലേക്ക് പോകുമ്പോൾ കുറയുന്നു.

c) എല്ലായിടത്തും ഒരുപോലെയാണ്.

d) ഭൂകേന്ദ്രത്തിൽ പൂജ്യമാണ്.

20. ഒരു നിശ്ചിത അകലത്തിലുള്ള രണ്ട് വസ്തുക്കൾക്കിടയിലുള്ള ഗുരുത്വാകർഷണബലം X Newton ആണ്. അതേ അകലത്തിൽ ആ രണ്ട് വസ്തുക്കളെയും പിന്നീട് വെള്ളത്തിൽ സ്ഥാപിച്ചപ്പോൾ അവക്കിടയിലുള്ള ഗുരുത്വാകർഷണബലം Y Newton ആണ്. എങ്കിൽ,

a) $X = Y$ c) $X < Y$

b) $X > Y$ d) $X \neq Y$

21. നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ ഭാരത്തിന് എന്ത് സംഭവിക്കും ?

a) ഭാരം കുറയും c) ഭാരം പൂജ്യമാകും

b) ഭാരം കൂടും d) ഭാരത്തിന് മാറ്റമുണ്ടാവില്ല

22. ഒരു വസ്തുവിനെ ഭൂമിയുടെ പ്രതലത്തിൽ വെച്ചിരിക്കുന്നു. പിന്നീട് ഒരു നിശ്ചിത ഉയരത്തിലേക്ക് അതിനെ ഉയർത്തിയാൽ, അതനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം

a) കൂടുന്നു c) ആദ്യം കൂടുകയും, പിന്നീട് കുറയുകയും ചെയ്യുന്നു

b) കുറയുന്നു d) ആദ്യം കുറയുകയും, പിന്നീട് കൂടുകയും ചെയ്യുന്നു

23. ഒരു വസ്തു അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം ഏറ്റവും കൂടുതൽ ആകുന്നത് അതിനെ ഭൂമിയുടെ ഏത് ഭാഗത്ത് സ്ഥാപിക്കപ്പെടുമ്പോളാണ് ?

a) മദ്ധ്യത്തിൽ c) ഭൂമദ്ധ്യരേഖയിൽ

b) ധ്രുവത്തിൽ d) ധ്രുവത്തിനും ഭൂമധ്യരേഖക്കുമിടയിൽ ഭൂമിയുടെ പ്രതലത്തിൽ

24. ഭൂഗുരുത്വത്വരണം 'g' യെ കുറിച്ച് താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത് ?

a) ഭൂമിയുടെ ഉപരിതലത്തിൽ നിന്ന് ഭൂമിയുടെ കേന്ദ്രത്തിലേക്ക് നീങ്ങുമ്പോൾ g യുടെ മൂല്യം കുറയുന്നു.

b) ഭൂമിയുടെ ഉപരിതലത്തിൽ നിന്ന് മുകളിലേക്ക് പോകുമ്പോൾ g യുടെ മൂല്യം കൂടുന്നു.

c) 'g' യുടെ മൂല്യം ധ്രുവ പ്രദേശത്ത് നിന്ന് ഭൂമധ്യരേഖ പ്രദേശത്തേക്ക് പോകുമ്പോൾ കൂടുന്നു.

d) ഭൂമിയിൽ 'g' യുടെ മൂല്യം വസ്തുവിന്റെ മാസിനെ ആശ്രയിക്കുന്നു.

25. ഭൂമിയുടെ ഗുരുത്വാകർഷണം പെട്ടെന്ന് അപ്രത്യക്ഷമായാൽ, താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത്?

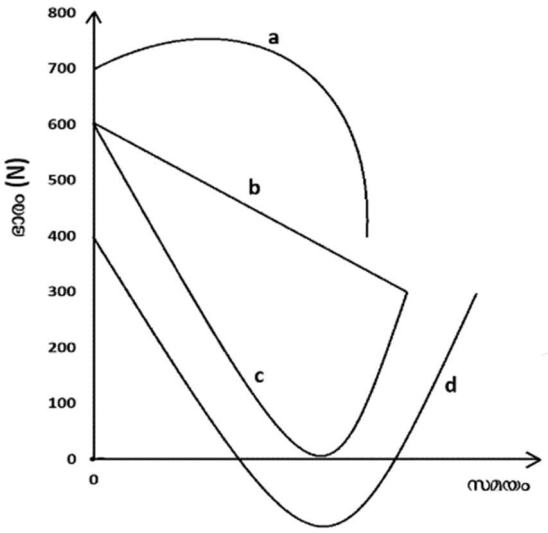
a) വസ്തുവിന്റെ ഭാരം പൂജ്യമാവുകയും മാസ് മാറ്റമില്ലാതെ തുടരുകയും ചെയ്യും.

b) വസ്തുവിന്റെ ഭാരം മാറ്റമില്ലാതെ തുടരുകയും മാസ് പൂജ്യമാവുകയും ചെയ്യും.

c) മാസും ഭാരവും പൂജ്യമാകും.

d) മാസും ഭാരവും പൂജ്യമാകില്ല.

26. ഭൂമിയുടെ ഉപരിതലത്തിൽ ഗുരുത്വാകർഷണത്വരണം $10\,m/s^2$ ഉം ചൊവ്വയുടെ ഉപരിതലത്തിൽ $4\,m/s^2$ഉം ആണെന്ന് സങ്കല്പിക്കുക. സ്ഥിരപ്രവേഗത്തിലുള്ള ഒരു ബഹിരാകാശവാഹനത്തിൽ ഭൂമിയിൽ നിന്ന് ചൊവ്വയിലേക്ക് 60 kg ഭാരമുള്ള ഒരു യാത്രികൻ സഞ്ചരിക്കുന്നു. ബഹിരാകാശത്തുള്ള മറ്റെല്ലാ വസ്തുക്കളെയും അവഗണിക്കുക. എങ്കിൽ താഴെ തന്നിരിക്കുന്ന ചിത്രത്തിൽ സമയാനുസൃതമായി യാത്രികന്റെ ഭാരം ശരിയായി സൂചിപ്പിക്കുന്ന ഭാഗമേത്?



27. ഭൂമധ്യരേഖയിൽ വെച്ച് മാസും ഭാരവും തിട്ടപ്പെടുത്തിയ വസ്തു ഇപ്പോൾ ധ്രുവപ്രദേശത്ത് സ്ഥാപിക്കപ്പെടുന്നു. എങ്കിൽ താഴെ തന്നിരിക്കുന്നവയിൽ ശരിയായ പ്രസ്താവന ഏത് ?

a) മാസ് വ്യത്യാസമില്ലാതിരിക്കുകയും ഭാരം ഏറ്റവും ഉയർന്ന മൂല്യത്തിലെത്തുകയും ചെയ്യുന്നു.

b) മാസ് വ്യത്യാസമില്ലാതിരിക്കുകയും ഭാരം ഏറ്റവും ഉയർന്ന മൂല്യത്തിലെത്തുകയും ചെയ്യുന്നു.

c) മാസും ഭാരവും ഏറ്റവും ഉയർന്ന മൂല്യത്തിലെത്തുന്നു.

d) മാസും ഭാരവും ഏറ്റവും കുറഞ്ഞ മൂല്യത്തിലെത്തുന്നു.

28. താഴെ തന്നിരിക്കുന്നവയിൽ സാർവികഗുരുത്വാകർഷണനിയമം ഏത് ?

a) ഭൂമി എല്ലാ വസ്തുക്കളെയും അതിന്റെ കേന്ദ്രത്തിലേക്കാകർഷിക്കുന്നു. ഭൂമിയിലുള്ള വസ്തുക്കളെ സംബന്ധിച്ചിടത്തോളം അതിന്റെ നില നിവർന്നതോ തലകീഴായതോ എന്ന് തീരുമാനിക്കുന്നത് ഭൂഗുരുത്വബലത്തിന്റെ ദിശയെ അടിസ്ഥാനമാക്കിയാണ്.

b) പ്രപഞ്ചത്തിലുള്ള എല്ലാ വസ്തുക്കളും പരസ്പരം ആകർഷിക്കുന്നു. രണ്ട് വസ്തുക്കൾ തമ്മിലുള്ള പരസ്പരാകർഷണബലം അവയുടെ മാസുകളുടെ ഗുണനഫലത്തിന് നേർ അനുപാതത്തിലും അവ തമ്മിലുള്ള അകലത്തിന്റെ വർഗത്തിന് വിപരീതാനുപാതത്തിലുമായിരിക്കും.

c) രണ്ട് ഗ്രഹങ്ങൾ തമ്മിലുള്ള പരസ്പരാകർഷണബലം അവക്കിടയിലുള്ള ശരാശരി ദൂരത്തിന്റെ ക്യൂബിന് നേർ അനുപാതത്തിലും അവയുടെ പരിക്രമണപ്രവേഗങ്ങളുടെ ഗുണനഫലത്തിന് വിപരീതാനുപാതത്തിലുമായിരിക്കും.

d) ഒരു യൂണിറ്റ് ദൂരത്തിൽ അകൽച്ചയിലിരിക്കുന്ന രണ്ട് യൂണിറ്റ് മാസുകൾക്കിടയിലുള്ള പരസ്പരാകർഷണബലം അവയെ ത്വരിതപ്പെടുത്തുന്നു. ഈ ത്വരണത്തെ ഭൂഗുരുത്വത്വരണം എന്ന് പറയുന്നു.

29. സാർവികഗുരുത്വാകർഷണനിയമത്തിന്റെ ഗണിതരൂപത്തിൽ

a) G യുടെ മൂല്യം നിരീക്ഷിക്കുന്നിടത്തെ g യുടെ മൂല്യവുമായി ബന്ധപ്പെട്ടിരിക്കുന്നു.

b) G എന്നത് ഗുരുത്വാകർഷണസ്ഥിരാങ്കമാണ്.

c) രണ്ട് മാസുകളിൽ ഒരെണ്ണം ഭൂമിയായി സങ്കല്പിക്കുന്ന സന്ദർഭത്തിലാണ് G ഉപയോഗിക്കപ്പെടുന്നത്.

d) G യുടെ മൂല്യം ഏറ്റവും ഉയർന്നത് ഭൂമിയുടെ ഉപരിതലത്തിലാണ്.

30. ഏത് തമ്മിലുള്ള ഗുരുത്വാകർഷണബലമാണ് സാർവികഗുരുത്വാകർഷണനിയമത്തിൽ പ്രതിപാദിക്കുന്നത് ?

a) ഭൂമിയും ഏതെങ്കിലുമൊരു മാസും മാത്രം

b) ഭൂമിയും സൂര്യനും മാത്രം

c) ചാർജുള്ള ഏതെങ്കിലും രണ്ട് വസ്തുക്കൾ

d) മാസുള്ള ഏതെങ്കിലും രണ്ട് വസ്തുക്കൾ

31. 1 kg മാസുള്ള ഒരു വസ്തു ഭൂമിയിലേക്ക് ആകർഷിക്കപ്പെടുമ്പോൾ ഉണ്ടാകുന്ന ബലം

a) 6.67×10^{11} N
b) 100 N
c) 9.8 N
d) 1 N

32. ഒരു മാവിൽ നിന്ന് മാങ്ങ താഴോട്ട് വീഴുമ്പോൾ

a) ഭൂമി മാത്രമാണ് മാങ്ങയെ ആകർഷിക്കുന്നത്.
b) മാങ്ങ മാത്രമാണ് ഭൂമിയെ ആകർഷിക്കുന്നത്.
c) മാങ്ങയും ഭൂമിയും പരസ്പരം ആകർഷിക്കുന്നു.
d) മാവ് മാങ്ങയെ വികർഷിക്കുകയും ഭൂമി അതിനെ ആകർഷിക്കുകയും ചെയ്യുന്നു.

33. തുല്യവലുപ്പമുള്ള രണ്ട് റബ്ബർ പന്തുകൾ ആദ്യം ഭൂമിയിലും പിന്നീട് ചന്ദ്രനിലും നിർബാധം പതിക്കുന്നു. ഒരു പന്ത് പൊള്ളയായതും മറ്റേത് പൊള്ളയല്ലാത്തതും ആണ്. ഭൂമിയിലുള്ള ഗുരുത്വാകർഷണത്വരണം $10\ m/s^2$ ഉം ചന്ദ്രനിലേത് $1.7\ m/s^2$ ഉം ആണ്. എങ്കിൽ കൂടുതൽ ഗുരുത്വാകർഷണബലം അനുഭവപ്പെടുന്ന പന്ത് ഏത്?

	പന്തിന്റെ തരം	**നിർബാധപതന സ്ഥാനം**
a)	പൊള്ളയായ പന്ത്	ചന്ദ്രൻ
b)	പൊള്ളയായ പന്ത്	ഭൂമി
c)	പൊള്ളയല്ലാത്ത പന്ത്	ചന്ദ്രൻ
d)	പൊള്ളയല്ലാത്ത പന്ത്	ഭൂമി

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APPENDIX 50

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

ACHIEVEMENT TEST ON 'GRAVITATION'
(DRAFT – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

Maximum Marks: 33

Instructions: Time: 60 minutes

This test is meant to measure achievement of IX standard students in the physics concept, 'Gravitation'. This test consists of thirty-three (33) multiple choice type questions out of which the candidate would be required to answer all the questions. Separate response sheet is provided to mark the answers. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The candidate must mark the response by darkening the circle as indicated below on the correct response against each item. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response. The results of this test will be only used for research purpose.

……

1. Two bodies having masses x and y are separated by a distance n. Then the gravitational force between them will be

a) $F = \frac{gxy}{n}$ c) $F = \frac{Gxy^2}{n^2}$

b) $F = \frac{Gxy}{n^2}$ d) $F = \frac{gxy}{n^2}$

2. How much would be the weight of an object of mass 10 kg when it is placed at the centre of the earth?

a) 0 N c) 10 N

b) 9.8 N d) 98 N

3. If a planet existed whose mass was twice that of Earth and whose radius was same as that of Earth, the acceleration due to gravity on the planet g_p will be…….

(g = acceleration due to gravity on earth)

a) $g_p = \frac{g}{2}$ c) $g_p = 2g$

b) $g_p = g$ d) $g_p = 4g$

4. Two objects of different masses falling freely near the surface of the moon from same height would

a) Have same velocities at any instant

b) Have different acceleration

c) Experience forces of same magnitude

d) Have different apparent weights

5. Statement 1: An astronaut experiences weightlessness in a space satellite.
Statement 2: This is because the gravitational force is small at that location in space.

a) Both statement 1 and statement 2 are correct and statement 2 is the correct explanation of the statement 1.

b) Both statement 1 and statement 2 are correct, but statement 2 is not the correct explanation of statement 1.

c) Statement 1 is correct, but statement 2 is incorrect.

d) Statement 1 is incorrect, but statement 2 is correct.

6. The acceleration due to gravity on the earth depends upon the

a) Mass of the body c) Shape and size of the body

b) Mass of the earth d) Volume of the body

7. When a stone is held at the end of a spring balance, the pointer shows 5kg weight. Now, release the spring balance. Then, the pointer will read

a) Less than 5kg weight c) Equal to 5kg weight

b) More than 5kg weight d) Zero

8. Two particles are placed at some distance. If the mass of one particle is doubled, keeping the mass of other particle and the distance between the particles unchanged, then, the value of gravitational force between them will become

a) $\frac{1}{4}$ times c) $\frac{1}{2}$ times

b) 4 times d) 2 times

9. A person can jump up to 1 m on the earth. How high can he jump on the moon?

a) He will jump up to 1 m, because acceleration due to gravity on earth and the moon is equal.

b) He will jump 6 times the height on the moon, because his weight becomes $\frac{1}{6}$ times on the moon.

c) He will not be able to jump on the moon, because of the zero gravity at moon

d) He will be able to jump up to 50 cms only, because the gravitational pull on the moon is greater than that on the earth.

10. If the mass of object is 8 kg, then its weight on earth will be_____
(Take g= 10 m/s^2)

a) 2 N
c) 18 N
b) 8 N
d) 80 N

11. An object of mass 10 kg is kept on the surface of Jupiter, where g at Jupiter = 23.1 m/s^2. Calculate the weight of the object.

a) 2.31 N
c) 33.1 N
b) 10 N
d) 231 N

12. If the distance between the sun and the earth is increased to three times, then the attraction between the two will become

a) 3 times
c) 9 times
b) $\frac{1}{3}$ times
d) $\frac{1}{9}$ times

13. The values of 'g' at the pole and the equator of earth respectively are…….

a) 0 m/s^2 and 9.8 m/s^2
c) 9.78 m/s^2 and 9.83 m/s^2
b) 9.8 m/s^2 and 0 m/s^2
d) 9.83 m/s^2 and 9.78 m/s^2

14. If the mass of a body is 50 kg on the surface of the earth, then its mass on the surface of the moon would be

a) 50 kg
c) ($\frac{50}{\text{g on moon}}$) kg
b) (50 x g on moon) kg
d) ($\frac{G\ X\ 50^2}{radius\ of\ moon^2}$) kg

15. When a body of mass 5 kg is placed at the centre of the earth, the gravitational force of attraction experienced by the body will be

a) 0 N
b) 5 N
c) In between 0 and 5 N
d) Greater than 5 N

16. When a lift moves down with uniform acceleration of 9.8 m/s^2, then what happens to the weight of the man inside the lift?

a) Weight increases
b) Weight decreases
c) Weight becomes zero
d) Weight remains unchanged

17. Analyse the correct statements regarding mass and weight.

	Mass	**Weight**
a)	Its value can be negative	Its value can never be zero
b)	It is a scalar quantity	It is a vector quantity
c)	Its SI unit is newton	Its SI unit is kg
d)	Its value changes with the value of g	Its value does not change with the value of g

18. If an object is dropped on earth from a high altitude in vacuum (no air resistance), what will its motion be like?

a) It will accelerate initially but then reach a constant speed
b) It will accelerate continuously
c) It will decelerate and eventually stop
d) It will move at a constant speed

19. The value of gravitational constant

a) Increases with height
b) Decreases with height
c) remains same everywhere
d) is zero at the centre of the earth

20. The gravitational force between two objects kept at a certain distance is X Newton. The same two objects are then kept in water with the same distance of separation. The gravitational force between the objects in water is Y Newton. Then,

a) X = Y
b) X > Y
c) X < Y
d) X ≠ Y

21. What happens to an object's weight when it is in freefall?

a) Its weight decreases
b) Its weight increases
c) Its weight becomes zero
d) Its weight remains unchanged

22. Consider a body placed on the surface of the earth. As the body is taken above the earth to certain height, the force of attraction due to gravity

a) Increases
b) Decreases
c) Initially increases, then decreases
d) Initially decreases, then increases

23. At which part of the earth is a body to be placed to experience the maximum force of attraction?

a) At the centre
b) At the pole
c) At the equator
d) On the earth surface in between pole and equator

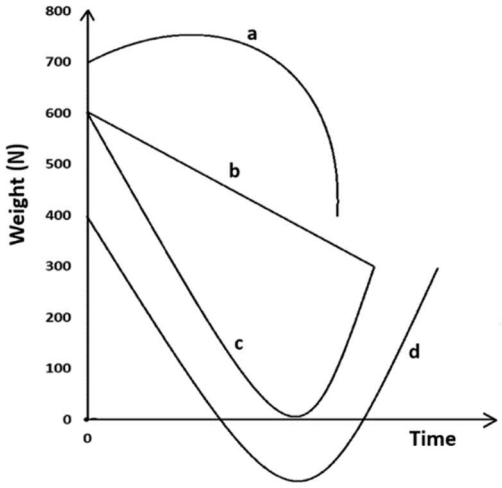
24. Select the correct statement about acceleration due to gravity 'g'.

a) The value of 'g' decreases as we go towards the centre of the earth from its surface.
b) The value of 'g' increases as we go above the earth's surface.
c) The value of 'g' increases from pole to equator.
d) The value of 'g' on the Earth depends upon the mass of the body.

25. If the gravitational force of attraction of the Earth suddenly disappears, which one of the following will be true?

a) The weight of the body will become zero, but the mass will remain same.
b) The weight of the body will remain same, but the mass will become zero
c) Both mass and weight become zero
d) Neither mass nor weight becomes zero

26. Suppose the acceleration due to gravity at the earth's surface is $10\ m/s^2$and at the surface of Mars is $4\ m/s^2$. A passenger having weight 60 kg goes from the Earth to the Mars in a spaceship moving with a constant velocity. Neglect all other objects in the sky. Which part of the figure represents the weight of the passenger with respect to time?



27. A body, the mass and the weight of which were already determined at the equator, is now placed at the pole. Choose the correct statement from the following.

a) Mass does not change, weight is maximum.
b) Mass does not change, weight is minimum.
c) Both mass and weight are maximum.
d) Both mass and weight are minimum.

28. Identify 'Universal Law of Gravitation' from the following.

a) The earth attracts all objects towards its centre and whether an object on earth stands erect or upside down is decided on the basis of the direction of gravity.
b) All bodies in the universe attract each other. The force of mutual attraction between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.
c) The force of mutual attraction between two planets is directly proportional to the cube of the mean distance between them and inversely proportional to the product of orbital velocities of the planets.
d) The force of attraction between two-unit masses separated by a unit distance results in acceleration of the masses known as acceleration due to gravity.

29. The 'G' in the mathematical expression of Universal Law of Gravitation

a) Depends on the value of 'g' at the place of observation
b) Is universal gravitational constant
c) Is used only when the Earth is one of the two masses
d) Is greatest at the surface of the Earth

30. The Universal Law of Gravitation gives the gravitational force between

a) The earth and any mass only
b) The earth and sun only
c) Any two charged bodies
d) Any two bodies having mass

31. A body of mass 1 kg is attracted by the earth with a force which is equal to

a) 6.67×10^{11} N
b) 100 N
c) 9.8 N
d) 1 N

32. When a mango falls from a mango tree,

a) Only the Earth attracts the mango.
b) Only the mango attracts the Earth.
c) Both the mango and the Earth attract each other.
d) The tree repels and the Earth attracts the mango.

33. Two rubber balls of the same size are dropped on the earth and on the moon. One ball is solid and other is hollow. The gravitational acceleration on the earth is $10\ m/s^2$ and on the moon is $1.7\ m/s^2$. Which ball has greater force acting on it?

	Type of ball	**Where it is dropped**
a)	Hollow	On the moon
b)	Hollow	On the earth
c)	Solid	On the moon
d)	Solid	On the earth

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APPENDIX 51

RESPONSE SHEET(DRAFT)
ACHIEVEMENT TEST ON 'GRAVITATION'

GENERAL DATA

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term and second term examination of IX standard:

ANSWERS

1. ⓐ ⓑ ⓒ ⓓ	12. ⓐ ⓑ ⓒ ⓓ	23. ⓐ ⓑ ⓒ ⓓ
2. ⓐ ⓑ ⓒ ⓓ	13. ⓐ ⓑ ⓒ ⓓ	24. ⓐ ⓑ ⓒ ⓓ
3. ⓐ ⓑ ⓒ ⓓ	14. ⓐ ⓑ ⓒ ⓓ	25. ⓐ ⓑ ⓒ ⓓ
4. ⓐ ⓑ ⓒ ⓓ	15. ⓐ ⓑ ⓒ ⓓ	26. ⓐ ⓑ ⓒ ⓓ
5. ⓐ ⓑ ⓒ ⓓ	16. ⓐ ⓑ ⓒ ⓓ	27. ⓐ ⓑ ⓒ ⓓ
6. ⓐ ⓑ ⓒ ⓓ	17. ⓐ ⓑ ⓒ ⓓ	28. ⓐ ⓑ ⓒ ⓓ
7. ⓐ ⓑ ⓒ ⓓ	18. ⓐ ⓑ ⓒ ⓓ	29. ⓐ ⓑ ⓒ ⓓ
8. ⓐ ⓑ ⓒ ⓓ	19. ⓐ ⓑ ⓒ ⓓ	30. ⓐ ⓑ ⓒ ⓓ
9. ⓐ ⓑ ⓒ ⓓ	20. ⓐ ⓑ ⓒ ⓓ	31. ⓐ ⓑ ⓒ ⓓ
10. ⓐ ⓑ ⓒ ⓓ	21. ⓐ ⓑ ⓒ ⓓ	32. ⓐ ⓑ ⓒ ⓓ
11. ⓐ ⓑ ⓒ ⓓ	22. ⓐ ⓑ ⓒ ⓓ	33. ⓐ ⓑ ⓒ ⓓ

APPENDIX 52

SCORING KEY (DRAFT)
ACHIEVEMENT TEST ON 'GRAVITATION'

No.	a	b	c	d
1.		✓		
2.	✓			
3.			✓	
4.	✓			
5.			✓	
6.		✓		
7.				✓
8.				✓
9.		✓		
10.				✓
11.				✓
12.				✓
13.				✓
14.	✓			
15.	✓			
16.			✓	
17.		✓		
18.		✓		
19.			✓	
20.	✓			
21.			✓	
22.		✓		
23.		✓		
24.	✓			
25.	✓			
26.			✓	
27.	✓			
28.		✓		
29.		✓		
30.				✓
31.			✓	
32.			✓	
33.				✓

APPENDIX 53

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

ACHIEVEMENT TEST ON 'GRAVITATION'
(FINAL – MALAYALAM)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

Maximum Marks: 25

നിർദ്ദേശങ്ങൾ: Time: 60 minutes

ഭൗതികശാസ്ത്രത്തിലെ 'ഗുരുത്വാകർഷണം' എന്ന ആശയത്തിൽ ഒമ്പതാം ക്ലാസ്സിലെ കുട്ടികളുടെ പഠനേട്ടം അളക്കുന്നതിനുള്ള ടെസ്റ്റാണിത്. ഇതിൽ 25 മൾട്ടിപ്പിൾ ചോയ്സ് ചോദ്യങ്ങളാണ് ഉൾപ്പെടുത്തിയിട്ടുള്ളത്, എല്ലാ ചോദ്യത്തിനും ഉത്തരം, തന്നിട്ടുള്ള ഉത്തരപേപ്പറിൽ രേഖപ്പെടുത്തണം. ഒരോ ചോദ്യത്തിനും (a), (b), (c), (d)എന്നിങ്ങനെ നാല് ഓപ്ഷനുകളാണ് നൽകിയിട്ടുള്ളത്. അതിൽ ഒരെണ്ണമായിരിക്കും ശരിയുത്തരം. അതേതെന്ന് കണ്ടെത്തി ആ ഓപ്ഷൻ കുറുപ്പിക്കണം. ഉദാഹരണത്തിന് (b) ആണ് ശരിയായ ഉത്തരമെങ്കിൽ, ⓐ ● ⓒ ⓓ. നിങ്ങളുടെ മാർക്ക് ഗവേഷണാവശ്യത്തിന് വേണ്ടി മാത്രമേ ഉപയോഗപ്പെടുത്തുകയുള്ളൂ.

……

1. x ഉം y യും മാസ്സുള്ള രണ്ട് വസ്തുക്കൾ n അകലത്തിലാണുള്ളത്. അവക്കിടയിലുള്ള ഗുരുത്വാകർഷണബലം എത്ര ?

a) $F = \frac{gxy}{n}$ c) $F = \frac{Gxy^2}{n^2}$

b) $F = \frac{Gxy}{n^2}$ d) $F = \frac{gxy}{n^2}$

2. 10 kg മാസ്സുള്ള ഒരു വസ്തു ഭൂകേന്ദ്രത്തിൽ ആയിരിക്കുമ്പോൾ അതിന്റെ ഭാരം എത്ര?

a) 0 N c) 10 N

b) 9.8 N d) 98 N

3. ഭൂമിയുടെ മാസിൻറെ ഇരട്ടി മാസുള്ളതും ഭൂമിയുടെ ആരത്തിന് തുല്യമായ ആരവുമുള്ള ഒരു ഗ്രഹത്തിൽ ഗുരുത്വത്വരണം g_p എത്ര ? (g = ഭൂഗുരുത്വത്വരണം)

a) $g_p = \frac{g}{2}$ c) $g_p = 2g$

b) $g_p = g$ d) $g_p = 4g$

4. ചന്ദ്രന്റെ പ്രതലത്തിനടുത്ത് വ്യത്യസ്ത മാസുകളുള്ള രണ്ട് വസ്തുക്കൾ ഒരേ ഉയരത്തിൽ നിന്ന് നിർബാധം പതിക്കുമ്പോൾ അവക്ക്

a) എല്ലായ്പ്പോഴും ഒരേ പ്രവേഗമായിരിക്കും

b) വ്യത്യസ്ത ത്വരണമായിരിക്കും

c) ഒരേ ബലമായിരിക്കും അനുഭവപ്പെടുന്നത്

d) വ്യത്യസ്തമായ പ്രകടമായ ഭാരമായിരിക്കും

5. എന്തിനെയാണ് ഭ്രഗുരുത്വത്വരണം ആശ്രയിച്ചിരിക്കുന്നത് ?

a) വസ്തുവിന്റെ മാസ്സ് c) വസ്തുവിന്റെ ആകൃതിയും വലുപ്പവും

b) ഭ്രമിയുടെ മാസ്സ് d) വസ്തുവിന്റെ വ്യാപ്തം

6. ഒരു കല്ല് സ്പിങ് ത്രാസിൽ തൂക്കിയിട്ടാൽ അതിന്റെ പോയിന്റർ 5kg ഭാരം കാണിക്കുന്നു. ഇനി സ്പിങ് ത്രാസ്സ് മോചിപ്പിക്കുക. അപ്പോൾ പോയിന്ററിന്റെ റീഡിങ് എത്രയാകും?

a) 5kg ഭാരത്തിന് കുറവ് c) 5 kg ഭാരത്തിന് തുല്യം

b) 5kg ഭാരത്തിന് കൂടുതൽ d) പൂജ്യം

7. രണ്ട് കണികകൾ ഒരു നിശ്ചിത അകലത്തിൽ സ്ഥിതി ചെയ്യുന്നു. കണികകൾ തമ്മിലുള്ള അകലം വ്യത്യാസപ്പെടുത്താതെ ഒരു കാണികയുടെ മാസ് ഇരട്ടിപ്പിക്കുകയും മറ്റേതിന്റെ മാസ് വ്യത്യാസപ്പെടുത്താതെയും ഇരുന്നാൽ അവക്കിടയിലുള്ള ഗുരുത്വാകർഷണബലത്തിന്റെ മൂല്യം

a) $\frac{1}{4}$ മടങ്ങായിരിക്കും c) $\frac{1}{2}$ മടങ്ങായിരിക്കും

b) 4 മടങ്ങായിരിക്കും d) 2 മടങ്ങായിരിക്കും

8. ഒരു മനുഷ്യന് ഭ്രമിയിൽ 1 m ഉയരത്തിൽ ചാടാൻ കഴിയും. എങ്കിൽ ചന്ദ്രനിൽ അയാൾക്ക് എത്ര ഉയരത്തിൽ ചാടാം?

a) 1 m ഉയരത്തിൽ ചാടാൻ കഴിയും, കാരണം ഭ്രമിയിലും ചന്ദ്രനിലും ഗുരുത്വത്വരണം തുല്യമാണ്.

b) 6 ഇരട്ടി ഉയരത്തിൽ ചാടാൻ കഴിയും, കാരണം അയാളുടെ ഭാരം ചന്ദ്രനിൽ $\frac{1}{6}$ മടങ്ങായിരിക്കും.

c) ചന്ദ്രനിൽ അയാൾക്ക് ചാടാൻ കഴിയില്ല, കാരണം ചന്ദ്രനിൽ ഗുരുത്വാകർഷണബലം ഇല്ല .

d) 50 cms ഉയരത്തിൽ മാത്രമേ ചാടാൻ കഴിയൂള്ളൂ, കാരണം ചന്ദ്രന്റെ ഗുരുത്വാകർഷണബലം ഭൂമിയെക്കാൾ കൂടുതലാണ്.

9. ഒരു വസ്തുവിന്റെ മാസ് 8 kg ആണെങ്കിൽ ഭൂമിയിൽ അതിന്റെ ഭാരമെത്ര? (g= 10 m/s^2)

a) 2 N
c) 18 N
b) 8 N
d) 80 N

10. 10 kg മാസുള്ള ഒരു വസ്തു വ്യാഴഗ്രഹത്തിന്റെ ഉപരിതലത്തിൽ ആയിരിക്കുമ്പോഴുള്ള ഭാരം കണ്ടെത്തുക. (വ്യാഴത്തിലെ g = 23.1 m/s^2)

a) 2.31 N
c) 33.1 N
b) 10 N
d) 231 N

11. ഭൂമിയുടെ ധ്രുവപ്രദേശത്തും ഭൂമധ്യരേഖാ പ്രദേശത്തും യുടെ മൂല്യം യഥാക്രമം

a) 0 m/s^2 and 9.8 m/s^2
c) 9.78 m/s^2 and 9.83 m/s^2
b) 9.8 m/s^2 and 0 m/s^2
d) 9.83 m/s^2 and 9.78 m/s^2

12. 5 kg മാസ്സുള്ള ഒരു വസ്തു ഭൂമിയുടെ മദ്ധ്യത്തിൽ വെച്ചാൽ അതനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം എത്ര?

a) 0 N
c) 0 N നും 5 N നുമിടക്ക്
b) 5 N
d) 5 N ന് കൂടുതൽ

13. ഒരു ലിഫ്റ്റ് 9.8 m/s^2 സമത്വരണത്തിൽ താഴോട്ട് നീങ്ങുമ്പോൾ അതിനകത്ത് നിൽക്കുന്ന മനുഷ്യന്റെ ഭാരത്തിന് എന്ത് സംഭവിക്കും ?

a) ഭാരം കൂടും
c) ഭാരം പൂജ്യമാകും
b) ഭാരം കുറയും
d) ഭാരത്തിന് മാറ്റമുണ്ടാവില്ല

14. മാസിനെയും ഭാരത്തെയും കുറിച്ചുള്ള ശരിയായ പ്രസ്താവനകൾ കണ്ടെത്തുക.

	മാസ്	**ഭാരം**
a)	അതിന്റെ മൂല്യം നെഗറ്റീവ് ആകാം	അതിന്റെ മൂല്യം ഒരിക്കലും പൂജ്യമാകില്ല
b)	അത് അദിശ അളവാണ്	അത് സദിശ അളവാണ്
c)	അതിന്റെ യൂണിറ്റ് ന്യൂട്ടൺ ആണ്	അതിന്റെ യൂണിറ്റ് kg ആണ്
d)	g യുടെ മൂല്യത്തിനനുസരിച്ച് അതിന്റെ മൂല്യം മാറും	g യുടെ മൂല്യത്തിനനുസരിച്ച് അതിന്റെ മൂല്യം മാറില്ല

15. നിർബാധം പതിക്കുന്ന ഒരു വസ്തുവിന്റെ ഭാരത്തിന് എന്ത് സംഭവിക്കും ?

a) ഭാരം കുറയും
b) ഭാരം കൂടും
c) ഭാരം പൂജ്യമാകും
d) ഭാരത്തിന് മാറ്റമുണ്ടാവില്ല

16. ഒരു വസ്തുവിനെ ഭൂമിയുടെ പ്രതലത്തിൽ വെച്ചിരിക്കുന്നു. പിന്നീട് ഒരു നിശ്ചിത ഉയരത്തിലേക്ക് അതിനെ ഉയർത്തിയാൽ, അതനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം

a) കൂടുന്നു
b) കുറയുന്നു
c) ആദ്യം കൂടുകയും, പിന്നീട് കുറയുകയും ചെയ്യുന്നു
d) ആദ്യം കുറയുകയും, പിന്നീട് കൂടുകയും ചെയ്യുന്നു

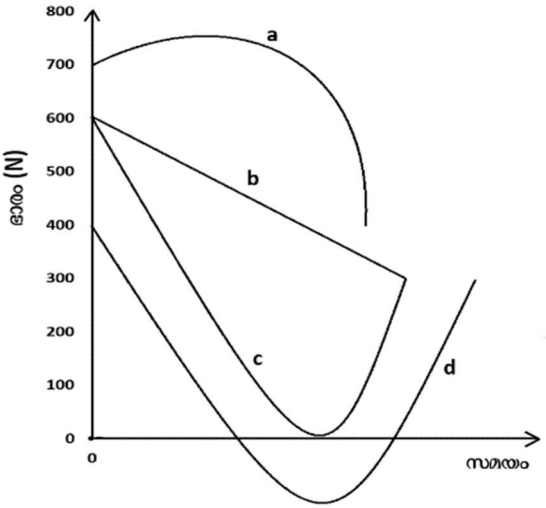
17. ഒരു വസ്തു അനുഭവപ്പെടുന്ന ഗുരുത്വാകർഷണബലം ഏറ്റവും കൂടുതൽ ആകുന്നത് അതിനെ ഭൂമിയുടെ ഏത് ഭാഗത്ത് സ്ഥാപിക്കപ്പെടുമ്പോളാണ് ?

a) മദ്ധ്യത്തിൽ
b) ധ്രുവത്തിൽ
c) ഭൂമദ്ധ്യരേഖയിൽ
d) ധ്രുവത്തിനും ഭൂമധ്യരേഖക്കുമിടയിൽ ഭൂമിയുടെ പ്രതലത്തിൽ

18. ഭൂമിയുടെ ഗുരുത്വാകർഷണം പെട്ടെന്ന് അപ്രത്യക്ഷമായാൽ, താഴെ തന്നിരിക്കുന്ന പ്രസ്താവനകളിൽ ശരിയേത്?

a) വസ്തുവിന്റെ ഭാരം പൂജ്യമാവുകയും മാസ് മാറ്റമില്ലാതെ തുടരുകയും ചെയ്യും.
b) വസ്തുവിന്റെ ഭാരം മാറ്റമില്ലാതെ തുടരുകയും മാസ് പൂജ്യമാവുകയും ചെയ്യും.
c) മാസും ഭാരവും പൂജ്യമാകും.
d) മാസും ഭാരവും പൂജ്യമാകില്ല.

19. ഭൂമിയുടെ ഉപരിതലത്തിൽ ഗുരുത്വാകർഷണത്വരണം $10\ m/s^2$ ഉം ചൊവ്വയുടെ ഉപരിതലത്തിൽ $4\ m/s^2$ഉം ആണെന്ന് സങ്കല്പിക്കുക. സ്ഥിരപ്രവേഗത്തിലുള്ള ഒരു ബഹിരാകാശവാഹനത്തിൽ ഭൂമിയിൽ നിന്ന് ചൊവ്വയിലേക്ക് $60\ kg$ ഭാരമുള്ള ഒരു യാത്രികൻ സഞ്ചരിക്കുന്നു. ബഹിരാകാശത്തുള്ള മറ്റെല്ലാ വസ്തുക്കളെയും അവഗണിക്കുക. എങ്കിൽ താഴെ തന്നിരിക്കുന്ന ചിത്രത്തിൽ സമയാനുസൃതമായി യാത്രികന്റെ ഭാരം ശരിയായി സൂചിപ്പിക്കുന്ന ഭാഗമേത്?



20. താഴെ തന്നിരിക്കുന്നവയിൽ സാർവികഗുരുത്വാകർഷണനിയമം ഏത് ?

a) ഭൂമി എല്ലാ വസ്തുക്കളെയും അതിന്റെ കേന്ദ്രത്തിലേക്കാകർഷിക്കുന്നു. ഭൂമിയിലുള്ള വസ്തുക്കളെ സംബന്ധിച്ചിടത്തോളം അതിന്റെ നില നിവർന്നതോ തലകീഴായതോ എന്ന് തീരുമാനിക്കുന്നത് ഭൂഗുരുത്വബലത്തിന്റെ ദിശയെ അടിസ്ഥാനമാക്കിയാണ്.

b) പ്രപഞ്ചത്തിലുള്ള എല്ലാ വസ്തുക്കളും പരസ്പരം ആകർഷിക്കുന്നു. രണ്ട് വസ്തുക്കൾ തമ്മിലുള്ള പരസ്പരാകർഷണബലം അവയുടെ മാസുകളുടെ ഗുണനഫലത്തിന് നേർ അനുപാതത്തിലും അവ തമ്മിലുള്ള അകലത്തിന്റെ വർഗത്തിന് വിപരീതാനുപാതത്തിലുമായിരിക്കും.

c) രണ്ട് ഗ്രഹങ്ങൾ തമ്മിലുള്ള പരസ്പരാകർഷണബലം അവക്കിടയിലുള്ള ശരാശരി ദൂരത്തിന്റെ ക്യൂബിന് നേർ അനുപാതത്തിലും അവയുടെ പരിക്രമണപ്രവേഗങ്ങളുടെ ഗുണനഫലത്തിന് വിപരീതാനുപാതത്തിലുമായിരിക്കും.

d) ഒരു യൂണിറ്റ് ദൂരത്തിൽ അകൽച്ചയിലിരിക്കുന്ന രണ്ട് യൂണിറ്റ് മാസുകൾക്കിടയിലുള്ള പരസ്പരാകർഷണബലം അവയെ ത്വരിതപ്പെടുത്തുന്നു. ഈ ത്വരണത്തെ ഭൂഗുരുത്വത്വരണം എന്ന് പറയുന്നു.

21. സാർവികഗുരുത്വാകർഷണനിയമത്തിന്റെ ഗണിതരൂപത്തിൽ

a) G യുടെ മൂല്യം നിരീക്ഷിക്കുന്നിടത്തെ g യുടെ മൂല്യവുമായി ബന്ധപ്പെട്ടിരിക്കുന്നു.

b) G എന്നത് ഗുരുത്വാകർഷണസ്ഥിരാങ്കമാണ്.

c) രണ്ട് മാസുകളിൽ ഒരെണ്ണം ഭ്രമിയായി സങ്കല്പിക്കുന്ന സന്ദർഭത്തിലാണ് G ഉപയോഗിക്കപ്പെടുന്നത്.

d) G യുടെ മൂല്യം ഏറ്റവും ഉയർന്നത് ഭ്രമിയുടെ ഉപരിതലത്തിലാണ്.

22. ഏത് തമ്മിലുള്ള ഗുരുത്വാകർഷണബലമാണ് സാർവികഗുരുത്വാകർഷണനിയമത്തിൽ പ്രതിപാദിക്കുന്നത് ?

a) ഭ്രമിയും ഏതെങ്കിലുമൊരു മാസും മാത്രം

b) ഭ്രമിയും സൂര്യനും മാത്രം

c) ചാർജുള്ള ഏതെങ്കിലും രണ്ട് വസ്തുക്കൾ

d) മാസുള്ള ഏതെങ്കിലും രണ്ട് വസ്തുക്കൾ

23. 1 kg മാസുള്ള ഒരു വസ്തു ഭ്രമിയിലേക്ക് ആകർഷിക്കപ്പെടുമ്പോൾ ഉണ്ടാകുന്ന ബലം

a) 6.67×10^{11} N
c) 9.8 N
b) 100 N
d) 1 N

24. ഒരു മാവിൽ നിന്ന് മാങ്ങ താഴോട്ട് വീഴുമ്പോൾ

a) ഭ്രമി മാത്രമാണ് മാങ്ങയെ ആകർഷിക്കുന്നത്.

b) മാങ്ങ മാത്രമാണ് ഭ്രമിയെ ആകർഷിക്കുന്നത്.

c) മാങ്ങയും ഭ്രമിയും പരസ്പരം ആകർഷിക്കുന്നു.

d) മാവ് മാങ്ങയെ വികർഷിക്കുകയും ഭ്രമി അതിനെ ആകർഷിക്കുകയും ചെയ്യുന്നു.

25. തുല്യവലുപ്പമുള്ള രണ്ട് റബ്ബർ പന്തുകൾ ആദ്യം ഭ്രമിയിലും പിന്നീട് ചന്ദ്രനിലും നിർബാധം പതിക്കുന്നു. ഒരു പന്ത് പൊള്ളയായതും മറ്റേത് പൊള്ളയല്ലാത്തതും ആണ്. ഭ്രമിയിലുള്ള ഗുരുത്വാകർഷണത്വരണം $10\ m/s^2$ ഉം ചന്ദ്രനിലേത് $1.7\ m/s^2$ ഉം ആണ്. എങ്കിൽ കൂടുതൽ ഗുരുത്വാകർഷണബലം അനുഭവപ്പെടുന്ന പന്ത് ഏത്?

	പന്തിന്റെ തരം	**നിർബാധപതന സ്ഥാനം**
a)	പൊള്ളയായ പന്ത്	ചന്ദ്രൻ
b)	പൊള്ളയായ പന്ത്	ഭ്രമി
c)	പൊള്ളയല്ലാത്ത പന്ത്	ചന്ദ്രൻ
d)	പൊള്ളയല്ലാത്ത പന്ത്	ഭ്രമി

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APPENDIX 54

FAROOK TRAINING COLLEGE

RESEARCH CENTRE IN EDUCATION

ACHIEVEMENT TEST ON 'GRAVITATION'
(FINAL – ENGLISH)

Shyma Usman Abdulla
Research Scholar
Farook Training College

Dr. Mumthas N. S.
Professor
Farook Training College

……

Maximum Marks: 25

Instructions: Time: 60 minutes

This test is meant to measure achievement of IX standard students in the physics concept, 'Gravitation'. This test consists of 25 multiple choice questions out of which the student would be required to answer all the questions. Separate response sheet is provided to mark the answers. Each question has four alternative responses: (a), (b), (c) and (d), out of which only one is correct. The candidate must mark the response by darkening the circle as indicated below on the correct response against each item. Example: ⓐ ● ⓒ ⓓ where (b) is the correct response. The results of this test will be only used for research purpose.

……

1. Two bodies having masses x and y are separated by a distance n. Then the gravitational force between them will be

a) $F = \frac{gxy}{n}$ c) $F = \frac{Gxy^2}{n^2}$

b) $F = \frac{Gxy}{n^2}$ d) $F = \frac{gxy}{n^2}$

2. How much would be the weight of an object of mass 10 kg when it is placed at the centre of the earth?

a) 0 N c) 10 N

b) 9.8 N d) 98 N

3. If a planet existed whose mass was twice that of Earth and whose radius was same as that of Earth, the acceleration due to gravity on the planet g_p will be…….

(g = acceleration due to gravity on earth)

a) $g_p = \frac{g}{2}$ c) $g_p = 2g$

b) $g_p = g$ d) $g_p = 4g$

4. Two objects of different masses falling freely near the surface of the moon from same height would

a) Have same velocities at any instant
b) Have different acceleration
c) Experience forces of same magnitude
d) Have different apparent weights

5. The acceleration due to gravity on the earth depends upon the

a) Mass of the body c) Shape and size of the body
b) Mass of the earth d) Volume of the body

6. When a stone is held at the end of a spring balance, the pointer shows 5kg weight. Now, release the spring balance. Then, the pointer will read

a) Less than 5kg weight c) Equal to 5kg weight
b) More than 5kg weight d) Zero

7. Two particles are placed at some distance. If the mass of one particle is doubled, keeping the mass of other particle and the distance between the particles unchanged, then, the value of gravitational force between them will become

a) $\frac{1}{4}$ times c) $\frac{1}{2}$ times
b) 4 times d) 2 times

8. A person can jump up to 1 m on the earth. How high can he jump on the moon?

a) He will jump up to 1 m, because acceleration due to gravity on earth and the moon is equal.
b) He will jump 6 times the height on the moon, because his weight becomes $\frac{1}{6}$ times on the moon.

c) He will not be able to jump on the moon, because of the zero gravity at moon

d) He will be able to jump up to 50 cms only, because the gravitational pull on the moon is greater than that on the earth

9. If the mass of object is 8 kg, then its weight on earth will be_____
(Take g= 10 m/s^2)

a) 2 N
c) 18 N
b) 8 N
d) 80 N

10. An object of mass 10 kg is kept on the surface of Jupiter, where g at Jupiter = 23.1 m/s^2. Calculate the weight of the object.

a) 2.31 N
c) 33.1 N
b) 10 N
d) 231 N

11. The values of 'g' at the pole and the equator of earth respectively are…….

a) 0 m/s^2 and 9.8 m/s^2
c) 9.78 m/s^2 and 9.83 m/s^2
b) 9.8 m/s^2 and 0 m/s^2
d) 9.83 m/s^2 and 9.78 m/s^2

12. When a body of mass 5 kg is placed at the centre of the earth, the gravitational force of attraction experienced by the body will be

a) 0 N
c) In between 0 and 5 N
b) 5 N
d) Greater than 5 N

13. When a lift moves down with uniform acceleration of 9.8 m/s^2, then what happens to the weight of the man inside the lift?

a) Weight increases
c) Weight becomes zero
b) Weight decreases
d) Weight remains unchanged

14. Analyse the correct statements regarding mass and weight.

	Mass	**Weight**
a)	Its value can be negative	Its value can never be zero
b)	It is a scalar quantity	It is a vector quantity
c)	Its SI unit is newton	Its SI unit is kg
d)	Its value changes with the value of g	Its value does not change with the value of g

15. What happens to an object's weight when it is in freefall?

a) Its weight decreases
b) Its weight increases
c) Its weight becomes zero
d) Its weight remains unchanged

16. Consider a body placed on the surface of the earth. As the body is taken above the earth to certain height, the force of attraction due to gravity

a) Increases
b) Decreases
c) Initially increases, then decreases
d) Initially decreases, then increases

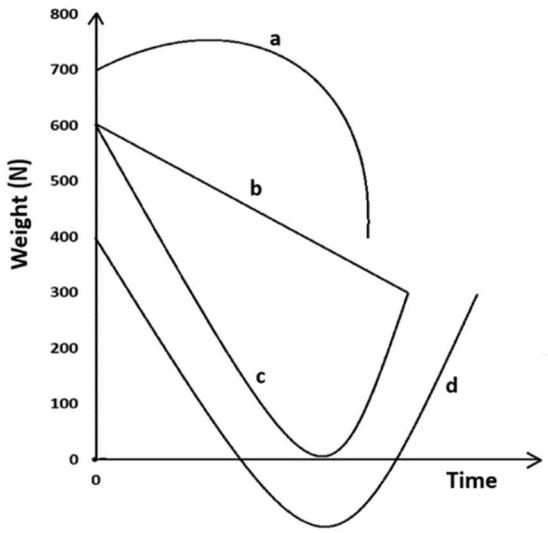
17. At which part of the earth is a body to be placed to experience the maximum force of attraction?

a) At the centre
b) At the pole
c) At the equator
d) On the earth surface in between pole and equator

18. If the gravitational force of attraction of the Earth suddenly disappears, which one of the following will be true?

a) The weight of the body will become zero, but the mass will remain same.
b) The weight of the body will remain same, but the mass will become zero
c) Both mass and weight become zero
d) Neither mass nor weight becomes zero

19. Suppose the acceleration due to gravity at the earth's surface is $10\ m/s^2$and at the surface of Mars is $4\ m/s^2$. A passenger having weight 60 kg goes from the Earth to the Mars in a spaceship moving with a constant velocity. Neglect all other objects in the sky. Which part of the figure represents the weight of the passenger with respect to time?



20. Identify 'Universal Law of Gravitation' from the following.

a) The earth attracts all objects towards its centre and whether an object on earth stands erect or upside down is decided on the basis of the direction of gravity.

b) All bodies in the universe attract each other. The force of mutual attraction between two bodies is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

c) The force of mutual attraction between two planets is directly proportional to the cube of the mean distance between them and inversely proportional to the product of orbital velocities of the planets.

d) The force of attraction between two-unit masses separated by a unit distance results in acceleration of the masses known as acceleration due to gravity.

21. The 'G' in the mathematical expression of Universal Law of Gravitation

a) Depends on the value of 'g' at the place of observation

b) Is universal gravitational constant

c) Is used only when the Earth is one of the two masses

d) Is greatest at the surface of the Earth

22. The Universal Law of Gravitation gives the gravitational force between

a) The earth and any mass only

b) The earth and sun only

c) Any two charged bodies

d) Any two bodies having mass

23. A body of mass 1 kg is attracted by the earth with a force which is equal to

a) 6.67×10^{11} N

b) 100 N

c) 9.8 N

d) 1 N

24. When a mango falls from a mango tree,

a) Only the Earth attracts the mango.

b) Only the mango attracts the Earth.

c) Both the mango and the Earth attract each other.

d) The tree repels and the Earth attracts the mango.

25. Two rubber balls of the same size are dropped on the earth and on the moon. One ball is solid and the other is hollow. The gravitational acceleration on the earth is $10\,m/s^2$ and on the moon is $1.7\,m/s^2$. Which ball has greater force acting on it?

	Type of ball	**Where it is dropped**
a)	Hollow	On the moon
b)	Hollow	On the earth
c)	Solid	On the moon
d)	Solid	On the earth

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APPENDIX 55

RESPONSE SHEET(FINAL)
ACHIEVEMENT TEST ON 'GRAVITATION'

GENERAL DATA

Name of the Student :

Gender : MALE / FEMALE

Name of the School :

Marks scored in Physics in first term and second term examination of IX standard:

ANSWERS

1. ⓐ ⓑ ⓒ ⓓ	11. ⓐ ⓑ ⓒ ⓓ	21. ⓐ ⓑ ⓒ ⓓ
2. ⓐ ⓑ ⓒ ⓓ	12. ⓐ ⓑ ⓒ ⓓ	22. ⓐ ⓑ ⓒ ⓓ
3. ⓐ ⓑ ⓒ ⓓ	13. ⓐ ⓑ ⓒ ⓓ	23. ⓐ ⓑ ⓒ ⓓ
4. ⓐ ⓑ ⓒ ⓓ	14. ⓐ ⓑ ⓒ ⓓ	24. ⓐ ⓑ ⓒ ⓓ
5. ⓐ ⓑ ⓒ ⓓ	15. ⓐ ⓑ ⓒ ⓓ	25. ⓐ ⓑ ⓒ ⓓ
6. ⓐ ⓑ ⓒ ⓓ	16. ⓐ ⓑ ⓒ ⓓ	
7. ⓐ ⓑ ⓒ ⓓ	17. ⓐ ⓑ ⓒ ⓓ	
8. ⓐ ⓑ ⓒ ⓓ	18. ⓐ ⓑ ⓒ ⓓ	
9. ⓐ ⓑ ⓒ ⓓ	19. ⓐ ⓑ ⓒ ⓓ	
10. ⓐ ⓑ ⓒ ⓓ	20. ⓐ ⓑ ⓒ ⓓ	

APPENDIX 56

SCORING KEY (FINAL)
ACHIEVEMENT TEST ON 'GRAVITATION'

No.	a	b	c	d
1.		✓		
2.	✓			
3.			✓	
4.	✓			
5.		✓		
6.				✓
7.				✓
8.		✓		
9.				✓
10.				✓
11.				✓
12.	✓			
13.			✓	
14.		✓		
15.			✓	
16.		✓		
17.		✓		
18.	✓			
19.			✓	
20.		✓		
21.		✓		
22.				✓
23.			✓	
24.			✓	
25.				✓

APPENDIX 57

DETAILS OF EXPERT VALIDATION OF TOOLS

Name of the experts	Tools validated	Seal & Signature
Dr. Manoj Praveen G., Associate Professor, Department of Education, University of Calicut.	Conceptual Understanding Test in Physics	Dr. Manoj Praveen G. Associate Professor Department of Education University of Calicut
Dr. Anees Mohammed C. Associate Professor, Farook Training College.	Conceptual Understanding Test in Physics Scale on Instructional Practices in Physics Checklist on Instructional Practices for Equations of Motion / Gravitation Domain Interest Scale in Physics Situational Interest Scale in Physics Individual Interest Scale in Physics Achievement Test on Equations of Motion Achievement Test on Gravitation	Dr. Anees Mohammed. C Associate Professor Farook Training College Farook College P.O., Kozhikode
Dr. Irshana Shahanaz Ulladan, Assistant Professor, Farook Training College.	Scale on Instructional Practices in Physics Checklist on Instructional Practices for Equations of Motion / Gravitation	IRSHANA SHAHNAZ ULLADAN Assistant Professor Farook Training College Farook College P.O Calicut - 673632
Dr. Mohammed Nasimudheen T., Assistant Professor, Farook Training College.	Achievement Test on Equations of Motion Achievement Test on Gravitation	Dr. MOHAMMED NASIMUDHEEN T. Assistant Professor Farook Training College Farook College P.O., Kozhikode - 673632

Dr. M. P. Ravishanker, Assistant Professor, N. S. S. Training College, Ottapalam.	Conceptual Understanding Test in Physics Scale on Instructional Practices in Physics Checklist on Instructional Practices for Equations of Motion / Gravitation Domain Interest Scale in Physics Situational Interest Scale in Physics Individual Interest Scale in Physics
Ms. Bindu A. P., High School Teacher (Physical Science), Farook Higher Secondary School.	Achievement Test on Equations of Motion Achievement Test on Gravitation
Mr. Abdul Samad P. K., H. S. S. T. (H. G.) Physics, G. V. H. S. S., Ambalavayal.	Domain Interest Scale in Physics Situational Interest Scale in Physics Individual Interest Scale in Physics
Ms. Deepthi E. P., H. S. S. T. Junior (Computer science) G. B. H. S. S., Parayanchery State Resource Group Member for HS Physics	Conceptual Understanding Test in Physics

Dr. M P RAVISHANKER
Assistant Professor in Education
NSS Training College, Ottapalam
Pin No: [illegible], Mob: [illegible]

FAROOK HIGHER SECONDARY SCHOOL
Pin: 673 632
AD FAROOK COLLEGE

ABDUL SAMAD P.K
HSST Physics
GVHSS Ambalavayal
Ambalavayal P.O
Wayanad, Pin-673 593

APPENDIX 58

List of Schools Selected for Phase I of the Survey

No.	Name of the school	District	Type of School	Locale	Boys	Girls
1.	P. M. Sayed Abdulkhader Pookkoya Thangal Higher Secondary School, Kakkove	Malappuram	Aided	Rural	25	18
2.	Ernad Muslim Educational Association Higher Secondary School, Kondotty	Malappuram	Aided	Rural	24	28
3.	Panakkad Pookkoyathangal Memorial Higher Secondary School, Kottukara	Malappuram	Aided	Urban	55	51
4.	Government Vocational Higher Secondary School, Cheruvannur	Kozhikode	Government	Urban	18	14
5.	Government Ganapath Vocational Higher Secondary School, Feroke	Kozhikode	Government	Urban	49	31
6.	Al Madrasathul Munavvara High School, Pulikkal	Malappuram	Aided	Rural	13	29
7.	Najath Higher Secondary School, Peruvallur	Malappuram	Unaided	Rural	6	28
8.	Al-Furqan English Higher Secondary School, Santhivayal	Malappuram	Unaided	Rural	11	7
9.	Government Higher Secondary School, Kottappuram	Malappuram	Government	Rural	21	18
10.	J. D. T. Islam Iqraa Higher Secondary School, Marykunnu	Kozhikode	Unaided	Urban	25	16

No.	Name of the school	District	Type of School	Locale	Boys	Girls
11.	Government Vocational Higher Secondary School for Girls, Nadakkav	Kozhikode	Government	Urban	0	99
12.	Calicut Islamic Higher Secondary School, Mathara	Kozhikode	Unaided	Rural	18	9
13.	Technical Higher Secondary School, Vazhakkad	Malappuram	Unaided	Rural	7	3

APPENDIX 59

List of Schools Selected for Phase II of the Survey

No.	Name of the school	District	Type of Management	Locale	Boys	Girls
1.	Government Ganapath Vocational Higher Secondary School, Feroke	Kozhikode	Government	Urban	12	18
2.	Government Higher Secondary School, Mezhathur	Palakkad	Government	Rural	19	23
3.	Government Higher Secondary School, Edappal	Malappuram	Government	Rural	7	19
4.	Peringode High School, Peringode	Palakkad	Government	Rural	19	15
5.	Government Higher Secondary School, Maranchery	Malappuram	Government	Rural	14	20
6.	Government Vocational Higher Secondary School for Boys, Kunnamkulam	Thrissur	Government	Urban	21	0
7.	Government Higher Secondary School, Beypore	Kozhikode	Government	Rural	11	18
8.	Government Higher Secondary School, Chathannur	Palakkad	Government	Rural	15	5
9.	Government Higher Secondary School, Kadikkad	Thrissur	Government	Rural	10	4
10.	Umbichy Hajee Higher Secondary School, Chaliyam	Kozhikode	Aided	Rural	12	23
11.	C. M. Higher Secondary School, Mannur	Malappuram	Aided	Rural	15	18
12.	M. I. C. Al-Ameen Higher Secondary School, Iringallur	Thrissur	Aided	Rural	11	12

No.	Name of the school	District	Type of Management	Locale	Boys	Girls
13.	Government Higher Secondary School, Thrikkav	Malappuram	Government	Urban	15	11
14.	Government Vocational Higher Secondary School, Vattenad	Palakkad	Government	Urban	14	15
15.	Ponnani Girls' High School, Ponnani	Malappuram	Government	Urban	0	29
16.	T. M. Vocational Higher Secondary School, Akkikav	Thrissur	Aided	Urban	10	10
17.	Government Higher Secondary School, Velliancode	Malappuram	Government	Rural	21	16
18.	MI Higher Secondary School, Ponnani	Malappuram	Aided	Urban	25	2
19.	Dr. K. B. Menon Memorial Higher Secondary School, Thrithala	Palakkad	Aided	Rural	5	9
20.	Gokhale Government Higher Secondary School, Kalladathur	Palakkad	Government	Rural	9	10
21.	M. E. S. Higher Secondary School, Ponnani	Malappuram	Aided	Urban	12	16
22.	M. I. Higher Secondary School for Girls, Puduponnani	Malappuram	Aided	Urban	0	32
23.	Government Higher Secondary School, Kumaranellur	Palakkad	Government	Rural	10	13
24.	Achutha Varrier Higher Secondary School, Ponnani	Malappuram	Aided	Urban	7	43

No.	Name of the school	District	Type of Management	Locale	Boys	Girls
25.	Darul Hidaya Orphanage Higher Secondary School, Pookarathara	Malappuram	Aided	Rural	11	6
26.	Government Higher Secondary School, Kochannur	Thrissur	Government	Rural	21	8
27.	Government Higher Secondary School, Anakkara	Palakkad	Government	Rural	17	23
28.	J. D. T. Islam Higher Secondary School, Vellimadukunnu	Kozhikode	Aided	Urban	12	17
29.	Government Higher Secondary School, Medical College Campus	Kozhikode	Government	Urban	17	19
30.	Government High School, Nallalam	Kozhikode	Government	Rural	16	11
31.	I. V. Higher Secondary School, Orumanayoor	Thrissur	Aided	Rural	16	0
32.	E. M. S. Government Higher Secondary School, Perumanna	Kozhikode	Government	Rural	10	8
33.	Seethi Sahib Memorial Vocational Higher Secondary School, Edakkazhiyoor	Thrissur	Aided	Rural	0	27

APPENDIX 60

P-P Plots of Dependent Variables

