

**EFFECT OF MASTERY LEARNING STRATEGY ON  
PROBLEM SOLVING ABILITY IN PHYSICS  
OF SECONDARY SCHOOL STUDENTS**

**MANOJ PRAVEEN G.**

**Thesis submitted for the degree of  
DOCTOR OF PHILOSOPHY. IN EDUCATION**

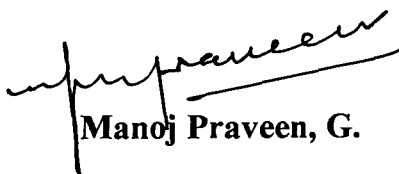
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**2006**

## DECLARATION

I, Manoj Praveen, G., do hereby declare that this thesis “Effect of Mastery Learning Strategy on Problem Solving Ability in Physics of Secondary School Students” has not been submitted by me for the award of a degree, diploma, title or recognition before.

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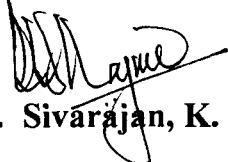


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**C E R T I F I C A T E**

I, Dr. Sivarajan, K., do hereby certify that this Ph. D. thesis on “Effect of Mastery Learning Strategy on Problem Solving Ability in Physics of Secondary School Students” is a record of bonafide study and research carried out by Mr. Manoj Praveen, G. under my supervision and guidance. The report has not been submitted by him for the award of a Degree, Diploma, Title or Recognition before.

  
**Dr. Sivarajan, K.**

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University of Calicut,

**Manoj Praveen, G.**

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## **INTRODUCTION**

- Setting of the Problem
- Need and Significance of the study
- Statement of the Problem
- Definition of Key Terms
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## INTRODUCTION

Education has been considered as the most important input and the most potent instrument for the development of an individual. It is the key to national prosperity and welfare and that no investment is too great for it. It is evident that education has a very important role to play in the economic and social development of the country, in the building up of the truly democratic society, in the promotion of national integration and unity, and above all for the transformation of individual in the endless pursuit of excellence and perfection.

The students in a classroom have different socio-economic status, aptitudes, interests, attitudes etc. and among them have different IQ levels. In a classroom situation where the students are varied in learning levels, (i.e., average, below average and above average) most of the time teachers teach for the average, neglecting the above average and below average in their hurry to finish the syllabus. In the classroom the above average feel bored and the slow-learners remain passive and day-by-day become poor in the subject.

According to the Secondary Education Commission (1952 - 53) "the present practice of mechanically applying the same methods to dull, average as well as bright children is responsible for much of the ineffectiveness of the instruction given in schools. If these various groups of children are allowed to proceed at their own appropriate pace and the method, approach as well as the curricular load are properly adjusted, it will be good for all of them. It will save the dull children

from discouragement and the bright children from a sense of frustration”.

The Education Commission (1964-66) says “suitable provision should, however be made for the education of the dull, who on account of their slower rate of mental development, cannot learn at the ordinary pace of normal children. In the ordinary classes where instruction is traditionally geared to the needs of the average child, the dull have to work under great hardship. They need individual attention, special remedial help and probably also a modified curriculum to suit their rate of learning”.

An individual differs from another individual in terms of interest, attitude, aptitude, achievement etc. As a result of the impact of educational technology a few ideas have gained currency in education in order to cater to these individual differences. As the number of pupils is very large, it is not practicable to prepare individualized instructional materials to suit everyone’s need. Mastery Learning Strategy can meet all these problems adequately. It is an individualized instruction within the context of group instruction. Recent researches conducted in advanced countries show that mastery learning is one of the most effective technique for teaching difficult and ability subjects.

## **1.1 THE SETTING OF THE PROBLEM**

"The present education system - consisting of examinations, syllabi, teaching methods and instructional materials - has formed a ground *conspiracy* to persuade everyone involved in it that learning is to be equated with rote memorization." This is how Benjamin S. Bloom

epitomizes pungently the current educational situation, as it strikes an intelligent and perceptive critic.

In the ordinary 'passive' school, untouched by the light of the new and the life giving ideas, the teacher talks most of the time, because he has somehow to 'cover' certain topics through his classroom lessons; he makes or tries to make, the curricular content as easy for the children as possible, and when the dreaded examination approaches, he enters into a more or less conscious battle of wits with the examiners and makes a guess at questions which are important from the examination point of view. The students on their part are naturally, almost inevitably, encouraged to memorize laboriously isolated facts and bits of information that can be disgorged in an examination, which is designed mainly to test these things.

But if you are out to test memory, only memory will be used and trained. If, however education is concerned with the thrill, the adventure and the joy of learning, of grappling with ideas, of realizing the essential purposes which are implicit in the different subjects of study, it puts an entirely new slant on the methods of work and learning. The examiner would then formulate questions, which call, for instance, for problem solving, for organization of ideas, for application of knowledge to practical problems and situations.

Critics of current educational practices say that present methods of instruction are not preparing students for the requirements of the work force. While able in textbook procedures, students lack the expertise to solve the 'ill-defined problems' they experience in the real world situations. Despite this, today's competitive world centers around

problem solving, requiring innovative thinking and technological expertise.

### **Importance of Physics**

“Science was not a pleasant diversion and abstraction but was the very texture of life, without which our modern world would vanish away. Politics led me to economics, and this led me inevitably to science and the scientific approach to all our problems and to life itself. It was science alone that could solve the problems of hunger and poverty, of insanitation and illiteracy, of superstition and deadening custom and tradition, of vast resources running to waste, of a rich country inhabited by starving people.”

This excerpt from Jawaharlal Nehru’s address at the Indian Science Congress, held at Calcutta in December 1937, ten years before independence, aptly sums up the vision that our political leaders and scientists had of Science for the up-liftment and progress of the Nation.

Physics is a major subject that has a great influence on the society in all spheres. None of the fronts, social, human, environmental or economic can be thought of as far as development is concerned, without Physics. Physics background plays a major indirect role in inducing rational thinking, youthful enthusiasm, self-control, inexhaustible curiosity, self-discipline and boldness – all basic elements for creativity. Physics, when taught in school, must be shown as a connected fabric of knowledge in which some thing learnt in one place proves useful somewhere else and something discovered later throws light back on something worked with earlier. But today the real pleasure of learning

Physics is missing in the classrooms. In today's educational system, though the syllabi are very rich in contents, the students' priority is to equip themselves with informational content alone and the real understanding of the subject becomes secondary.

### **A rationale for emphasizing Problem Solving**

The emphasis on problem solving accomplishes several key educational goals. It first makes learning more interesting by providing an optimal level of challenge. Students are motivated to learn when the learning task embodies an appropriate level of ambiguity and challenge. Second, problem solving makes knowledge come alive, thus increasing the likelihood that the information will be remembered. The inert knowledge that might otherwise lie dormant becomes translated to useful applied knowledge. Telling students that electricity will flow only if the circuit is complete is teaching inert knowledge; asking students to light up a bulb using cells and connection wires makes the inert knowledge come alive.

The problem solving approach, appropriately presented, helps students understand when to use certain processes; that is knowledge is 'contextualized'. Finally, an emphasis on problem solving is more likely to result in the mastery of processes that can be used again and again. Problem solving helps "knowing that" become transformed into "knowing how".

Anderson et al. (1971) are of the opinion that "science is the activity through which scientists solve problems by using scientific method." Emphasis should be given to the development of process-

oriented problem solving skills. This will enable the student to develop the ability in applying the processes and principles of science to a wide range of problems, social as well as scientific.

The assumption that underlies our entire educational system is that knowledge gained in school will not only be available in the future but will also be applied in some degree to the solution of new problems as they arise in future school and life situations. A predominant purpose of formal education in schools is to facilitate learning outside them. Nevertheless, often what is learned in school contributes very little to children and youths solving their future problems. This necessitates improvement in our teaching procedures so that transfer of formal learning to other situations will be enhanced to a much greater degree than at present.

### **The Conventional Strategy**

The term Conventional Strategy in this study is used to denote the classroom procedures for teaching-learning process associated with the changed new school curriculum of the state of Kerala. The new curriculum emphasizes Problem Solving approach in the mode of transaction of the curriculum as well as in the presentation of content in the textbook. Thus the Conventional Strategy denotes the strategy, as specified by SCERT, Kerala for teaching and learning science in the classroom, based on collaborative learning and problem solving approach.

## **Mastery Learning Strategy to foster Problem Solving Ability**

Bloom found that only about 20 percent of the students in a class generally learn excellently what the teacher set out to teach. Under these conditions, the distribution of achievement among students at the end of the instructional sequence looks much like a normal or bell shaped curve. Seeking a strategy that would produce better results, Bloom outlined the 'Mastery Learning Strategy', which makes use of the feed back and corrective procedure. Bloom believed that by using this strategy, nearly *all* could learn excellently and truly master the subject. (Bloom 1971).

Bloom emphasized the need to focus instruction in mastery learning classrooms on higher level learning outcomes, not simply basic abilities. He noted

I find great emphasis on problem solving, applications of principles, analytical abilities and creativity. Such higher mental processes are emphasized because this type of learning enables the individual to relate his or her learning to the many problems he or she encounters in day-to-day living. These abilities are stressed because they are retained and utilized long after the individual has forgotten the detailed specifics of the subject matter taught in the schools. These abilities are regarded as one set of essential characteristics needed to continue learning and to cope with a rapidly changing world. (Bloom, 1978 p.578)

Research studies show that mastery learning is highly effective when instruction focuses on higher-level outcomes such as problem solving, drawing inferences, deductive reasoning and creative expression (Arredondo and Block 1990, Mevarech 1985, Soled 1987).

## **1.2 NEED AND SIGNIFICANCE OF THE STUDY**

The education throughout the world has for many centuries emphasized a selective function. Much of the energy of the teachers and the administrators has been devoted to determining the students to be dropped at each major stage of the education programme. Quite in contrast to the notion of using schools for selection purposes is the view that education has as its primary function the development of the individual. Under this view, the central task of the schools is to develop those characteristics in students, which will enable them to live effectively in a complex society. (Bloom et al. 1971)

A major goal of education is to help students become more effective problem solvers, that is, people who can generate useful and original solutions when they are confronted with problems they have never seen before. Thus Education implicitly includes problem solving. Education is in fact training each child to cope with the problems of every day life situations.

Does it not need that each child be equipped to live successfully in the society? In other words does it not require all children to be successful problem solvers?

It is the sincere wish of every teacher to make '*all or almost all*' his students '*master*' the subject at a higher level of understanding. This

earnest desire instigates the search for a strategy, which would make almost all, if not all, the students good problem solvers.

Mastery Learning is a strategy, which can provide almost all students with the successful and rewarding learning experiences. It proposes that all or almost all students can master what they are taught in the classroom (Bloom, 1976). Research studies show that mastery learning is highly effective when instruction focuses on high-level outcomes such as problem solving, drawing inferences, deductive reasoning and creative expression (Arredondo and Block 1990, Mevarech 1985, Soled 1987). In this connection many questions spontaneously emerge in the minds of all concerned. 1. What is the real impact of Mastery Learning Strategy in Problem Solving Ability? 2. How does Mastery Learning Strategy effect Problem Solving Ability in the two sex groups; boys and girls? 3. Is this strategy more suitable to the average, above average or below average students with regard to their level of intelligence? 4. What steps should be taken by the teacher especially through Mastery Learning Strategy for the improvement of Problem Solving Ability of pupils. These and many such questions will find reliable answer only through serious sincere, systematic and scientific research. The present study is a humble attempt in this direction.

### **1.3 STATEMENT OF THE PROBLEM**

Present study is entitled as “EFFECT OF MASTERY LEARNING STRATEGY ON PROBLEM SOLVING ABILITY IN PHYSICS OF SECONDARY SCHOOL STUDENTS”.

## **1.4 DEFINITION OF KEY TERMS**

The key terms used in the study are defined operationally in the present context as follows.

### **1.4.1 MASTERY LEARNING STRATEGY**

Mastery Learning Strategy is an instructional strategy, which assumes that given sufficient time and appropriate instruction including alternative strategies, almost all of the students can master almost all of the content taught in the class. For the present study it implies that strategy, by which at least 80 % of students shall master at least 80% of the content of the first four chapters in Physics of IX standard.

### **1.4.2 PROBLEM SOLVING ABILITY**

Problem Solving Ability is the cognitive capability of the problem solver to perform physical or mental operations based upon his knowledge so as to achieve the goal of solving a problem. In the present study, Problem Solving Ability implies the cognitive capability to perform physical or mental operations based upon the content of the first four chapters in Physics of standard IX in order to solve conceptual problems. This is measured as the score of the Problem Solving Ability with three components namely, Comprehending the Problem, Clarifying the Problem and Finding Solution to the Problem. The subcomponents of Comprehending the Problem are 1. Sensing a Problem, 2. Defining the Problem and 3. Analysis of the Problem in to discrete elements. The subcomponents of Clarifying the Problem are 1. Ability to discriminate between the most relevant and closely related concepts, 2. Using

analogies for reasoning, 3. Using inductive/ deductive reasoning, 4. Hypothesizing and 5. Checking the testability of hypotheses. The subcomponents of Finding Solution to the Problem are 1. Controlling of variables, 2. Prediction of Happening, 3. Conceiving ideas using diagrammatic representation, 4. Conceiving a strategy to execute a plan of action to test the hypothesis, 5. Drawing inference from relevant observed data and 6. Generalizing.

## **1.5 OBJECTIVES**

The objectives of the present study are presented below as one general objective and a set of specific objectives.

### **General Objective**

To find out the effect of Mastery Learning Strategy on the Problem Solving Ability in Physics of secondary school students.

### **Specific Objectives**

1. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability in Physics of students of Standard IX.
2. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on the first component of Problem Solving Ability (Comprehending the Problem) in Physics of students of Standard IX.

3. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on the second component of Problem Solving Ability (Clarifying the problem) in Physics of students of Standard IX.
4. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on third component of Problem Solving Ability (Finding Solution to the Problem) in Physics of students of Standard IX.
5. To study the Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for the total sample.
6. To study the Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for girls of the total sample.
7. To study the Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for boys of the total sample.
8. To study the Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of

Instructional Strategy, on the Components of Problem Solving Ability for total sample.

9. To study the Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for girls of the total sample.
10. To study the Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for boys of the total sample.

## **1.6 HYPOTHESES**

1. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability in Physics of students of Standard IX.
2. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 1 viz; Comprehending the Problem, in Physics of students of Standard IX.
3. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as

covariates, on Problem Solving Ability component 2 viz; Clarifying the Problem, in Physics of students of Standard IX.

4. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 3 viz; Finding Solution to the Problem, in Physics of students of Standard IX.
5. There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for the total sample.
6. There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for girls of the total sample.
7. There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for boys of the total sample.
8. There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed

any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the total sample.

9. There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the girls of the total sample.
10. There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the boys of the total sample

## **1.7 METHODOLOGY**

The present study is an experimental one and the design applied here is pre-test post-test equivalent groups design. Two class divisions from the same school were taken for the experiment. The classes selected for the study were selected on a double blind priority basis. The two classes and the sex groups were tested using Multivariate ANOVA for Nonverbal Intelligence, Verbal Intelligence and Socio-Economic Status and were found to be matching so as to be considered as homogeneous groups. Out of the two study groups, one was assigned to be control group and other – the experimental group on a random basis.

### **1.7.1 SAMPLE**

The sample for the present study comprised of 74 students from two divisions, 9Q and 9G of Feroke Government Ganapet Vocational Higher Secondary School, Feroke.

### 1.7.2 DESIGN OF THE STUDY

The design of the study is summarised in the table 1.1. It shows the interventions made on the control group as well as the experimental group in the different stages of the study.

**TABLE 1.1**  
**Design of the study**

<b>STAGE</b>	<b>EXPERIMENTAL GROUP</b>	<b>CONTROL GROUP</b>
Pre - testing	Measurement of 1. Non-verbal Intelligence 2. Verbal Intelligence 3. Socio-economic status 4. Previous Achievement 5. Problem Solving Ability	Measurement of 1. Non-verbal Intelligence 2. Verbal Intelligence 3. Socio-economic status 4. Previous Achievement 5. Problem Solving Ability
Treatment	Teaching through Mastery Learning Strategy	Teaching in the Conventional Strategy
Post-testing	Measurement of 1. Problem Solving Ability 2. Achievement	Measurement of 1. Problem Solving Ability 2. Achievement

### 1.7.3 VARIABLES OF THE STUDY

Variables are the conditions or characteristics that the experimenter manipulates, controls or observes. The independent variables, dependent variables and the controlled variables of the present study are detailed below.

### **Dependent Variable**

The dependent variable in the present study was Problem Solving Ability in Physics of students of standard IX.

### **Independent Variable**

The independent variable for the present study was the Instructional Strategy (Mastery Learning Strategy / Conventional Strategy).

### **Controlled Variables**

The controlled variables were Non-verbal intelligence, Verbal Intelligence, Socio-Economic Status, Previous Achievement and Sex

## **1.7.4 TOOLS USED FOR MEASURING DIFFERENT VARIABLES**

### **1.7.4.1 Raven's Standard Progressive Matrices**

Non-verbal Intelligence of the subjects were measured by administering the Raven's Standard Progressive Matrices Test. This non-verbal test is intended to estimate the subjects' ability to discern and utilize a logical relationship presented by non-verbal materials.

### **1.7.4.2 Verbal Intelligence Test based on triarchic theory**

To test the Verbal Intelligence the Verbal Intelligence Test based on Triarchic Theory developed by Dr.V. Sumangala and Sholy Joseph (2005) of the Department of Education, University of Calicut was used.

#### **1.7.4.3 Socio-Economic Status Scale**

The scale developed by Kuppaswami was modified by K.S. Pillai in 1973. The criteria adopted for giving weightage to the level of income was further modified by Dr. Sivarajan and Subrahmaniadas (1998) with the consent of the experts in educational research and The Department of Economics and Statistics, Government of Kerala.

#### **1.7.4.4 Standardised Achievement Test developed by the investigator**

An achievement test for the first four chapters of Physics of the IX standard was developed and standardised by the investigator. The pretest scores of this test were used as the measure of Previous Achievement. The difference in the scores of the posttest and the pre test of this achievement test served as the measure of achievement in Physics of the students of standard IX.

#### **1.7.4.5 Problem Solving Ability Test in Physics developed by the investigator**

A Problem Solving Ability test was prepared for the first four chapters of Physics of the IX standard and was standardised by the investigator. The difference in the scores of the posttest and the pre test of this Problem Solving Ability Test served as the measure of Problem Solving Ability in Physics of the students of standard IX.

### **1.7.5 TOOLS USED FOR INSTRUCTION**

1. Lesson Plans in the conventional format. This would mean that the lesson plans were prepared in the new constructivist format as

illustrated in the Teachers' Hand Book in Physics for Standard IX of SCERT, Kerala.

2. Pre-conceived alternate learning experiences, including corrective measures and enrichment experiences. This would mean a repertoire of anecdotes, examples, illustrations and strategies relevant to the subject matter pertinent to this study which would be used in the event of re-teaching or enriching students during the Mastery Learning Cycle.

#### 1.7.6 STATISTICAL TECHNIQUES USED

The statistical techniques for the analysis of the data in the present study were:

1. Multivariate ANOVA for ascertaining the homogeneity of study groups.
2. ANCOVA to find out the effect of Instructional Strategy on Problem Solving Ability.
3. Three way ANOVA with 2X2X2 factorial design to find out the main and interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on Problem Solving Ability in the total sample and the sub samples based on sex.
4. Two way ANOVA with 2X2 factorial design to find out the main effects and interaction effect of Instructional Strategy and Previous Achievement on Problem Solving Ability in the total sample and the sub samples based on sex.

## **1.8 SCOPE AND LIMITATION OF THE STUDY**

The study focuses on the highest form of learning – the problem solving. Any form of instruction and any form of instructional system has the goal of manifesting problem solving behaviour in the pupil. As a method of teaching, it enjoys the highest prestige when compared to other methods of teaching, especially in science and mathematics (Vaidya, 1994). Even though studies on Mastery Learning Strategy are in plenty and generally suggest that it supports achievement, studies on measuring Problem Solving Ability are really scarce. The intangible area of cognition – thinking and problem solving- is a less explored one with more of assumptions and hypotheses with no solid proof. One has to tread with extreme caution and vigil while exploring this less-known zone. Considering the widely acknowledged relationship of Problem Solving Ability with the better-known aspects of cognition namely, Achievement, Nonverbal Intelligence and Verbal Intelligence the researcher has moulded the testable construct of Problem Solving Ability. Moreover all the aspects identified as the subcomponents of Problem Solving ability could not be taken into account while constructing the tool to test the Problem Solving Ability of the students. Considering all such restraints, the study had the following limitations.

1. The study would be confined to a single school, which would act as the sample for the entire population of the secondary schools.
2. The scope of the Problem Solving Ability is delimited to fourteen subcomponents of Problem Solving Ability, which are viable to be assessed through a paper pencil test.

3. The time span of the experiment would be three months, which may enable to cover only four units of Physics namely, Colours of Light, Motion, Force and Gravitation.

## **1.9 ORGANISATION OF THE REPORT**

There are five chapters included in this thesis. Chapter I details on the setting of the problem, need and significance of the study, statement of the problem, definition of the key terms, objectives of the study, hypotheses of the study, scope and limitation of the study and the organization of the report.

Chapter II presents the theoretical overview of Mastery Learning Strategy and Problem Solving Ability along with review of related studies in the field of Mastery Learning Strategy, Problem Solving Ability and the subject Physics.

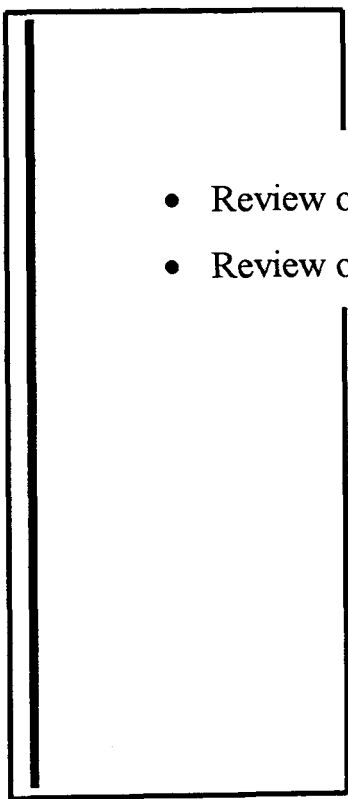
Chapter III describes the methodology, which details the variables of the study, design of the study sample, data collection procedure and statistical technique used in the study.

Chapter IV gives an analysis of the data along with its interpretation.

Chapter V elaborates upon the findings, conclusions, educational implications and recommendations based on the inferences.



**REVIEW OF RELATED LITERATURE**



- Review of Related Theory
- Review of Related Studies

## **REVIEW OF RELATED LITERATURE**

Any worthwhile study in any field of knowledge requires an adequate understanding and familiarity with the work that has been already done in the same area. The review of related literature forms an important aspect to a research study. It gives the researcher an understanding of the research methodology and also it helps him to be familiar with the current knowledge in the area of his study.

According to Borg “the literature in any field forms the foundation upon which all future work will be built. If we fail to build the foundation of knowledge provided by the review of literature, our work is likely to be shallow and naive and will often duplicate work that has already been done better by someone else”.

The investigator surveyed a number of books, journals, dissertations and research reports besides searching the internet. The investigator also made efforts to meet experts and discuss with them the various aspects of the study. Consolidating the theory and pertinent studies, the present chapter is divided into

1. Review of related theory.
2. Review of related studies.

## **2.1 REVIEW OF RELATED THEORY**

Since the present study is connected with Mastery Learning Strategy and Problem Solving Ability, the theoretical overviews of the two are to be given separately.

### **2.1.1 THEORETICAL OVERVIEW OF MASTERY LEARNING STRATEGY**

#### **2.1.1.1 Definition**

Mastery Learning Strategy is an instructional strategy, which assumes that given sufficient time and appropriate instruction including alternative strategies, almost all of the students can master almost all of the content taught in the class. According to Anderson (1995), Mastery Learning is a philosophy that asserts that any teacher can help virtually all students to learn excellently, quickly and self confidently. The teacher can help “dumb”, “slow”, “unmotivated” students to learn like “smart”, “fast” and “motivated” students.

#### **2.1.1.2 Origin of Mastery Learning**

Although the basic tenets of mastery learning can be traced to such early educators as Comenius, Pestalozzi and Herbart, most modern applications stem from the writings and research of Benjamin S. Bloom of the University of Chicago. Early attempts of using this concept can be traced to programmes developed by Washburne (1922) and Morrison (1926). Under Washburne’s Winnetka Plan student learning was self-paced. Each student was allowed, all the time, he needed to master a unit. Under Morrison’s method each student was allowed the learning

time his teacher required to bring all (or almost all) students to unit mastery. These characteristics are similar to the current scheme of mastery learning. While Morison's method was popular in the thirties, eventually the idea of mastery learning disappeared due to the lack of the technology required to sustain a successful strategy.

The idea of mastery learning resurfaces again in late fifties and early sixties as corollary of Programmed Instruction. A basic idea underlying Programmed Instruction was that the learning of any behaviour, no matter how complex, rested upon the learning of a sequence of less complex component behaviour (Skinner, 1954). Programmed Instruction worked very well for some students, but it was not effective for all (or almost all) students.

Recent discussion on mastery learning, however seem to go beyond these steps suggested by Washburne, Morrison and Skinner and refers to Carroll's *Model of School Learning*. Carroll's model was a conceptual paradigm, which outlined the major factors influencing student success in school learning and indicated how these factors interacted.

### **Carroll's Model of School Learning**

John B. Carroll formulated a model of 'learning for mastery' in 1963. His model was formulated on the following assumptions.

1. The model assumes that the work of school can be broken down to a series of discrete learning tasks.

2. Model applies to only one learning task at a time, but it should be possible to describe a student's success in learning a series of tasks (all the work of a certain school year) by summarizing the result of applying the model to each component task.
3. It is not intended (to be applied) to goals of schools that have to do with attitudes and dispositions (social and emotional goals of schooling). While Carroll acknowledges that learning tasks may play a role in support of attitude development. The acquisition of attitudes is postulated to follow a direct paradigm from that involved in learning task.
4. According to Carrol the model should not be confused with what is ordinarily called 'learning theory'. His model is intended a 'description of the economics of the school learning process', rather than as an exact scientific analysis of the essential conditions for process of learning itself.

The model proposed that under typical learning conditions, the time spent and the time needed were functions of certain features of the individual learner and the instruction he receives.

Carroll's model contains five elements. These elements act as variables that affect learning process in the classroom. The first three elements determine the time needed to learn a task, and the last two determine the time actually spent in learning.

(1) Aptitude, that is, the amount of time needed to learn the task under optimal instructional conditions, (2) ability to understand instruction related to his general intelligence and verbal ability, (3)

perseverance, that is, the amount of time the learner is willing to engage actively in learning, (4) opportunity, that is the time allowed for learning, and (5) quality of instruction judged by the degree to which it is optimal for every pupil.

Carroll's definition of aptitude as the amount of time needed to learn a task at a given criterion level was his most significant contribution. Prior to him aptitude was defined in terms of the level of performance. He stressed that a student's aptitude has traditionally been seen as an index of the level to which a child could learn in a given amount of time. From this perspective children tend to be viewed as either good or poor learners. The alternative perspective suggested by Carroll was to view aptitude as an index of amount of time required by a child to learn the subject to given level. Thus instead of being aptitude as a measure of ability to learn a particular subject, Carroll suggested that it could be viewed as a measure of learning rate. From this perspective children are seen as being fast or slow learners, rather than as good or poor learners.

In its simplest form his model proposed that if each student was allowed the time he needed to learn to some level and he spent the required learning time, then he could be expected to attain the level. However if the student was not allowed enough time, then the degree of which he could be expected to learn was a function of the ratio of the *time actually spent in learning* to the *time needed*.

This can be represented as

Degree of learning =  $f$  (*Time actually spent / Time needed* )

## **Carroll's model as the basis for Mastery Learning**

The concept of mastery, as explained theoretically by John B. Carroll, was transformed into a learning strategy by Benjamin S. Bloom. Building upon Carroll's work Bloom took up the job of transforming this conceptual method of school learning into working model for classroom instruction. If aptitudes were predictive of the rate at which, and not necessarily the level to which, a student could learn a given task, it should have been possible to fix the degree of learning expected of students at some mastery level and so systematically manipulate the relevant instructional variables in Carroll's model such that all (or almost all) students attain it.

### **Use of the instructional variables in Carroll's model**

Bloom focused on the major variables in the Carroll's model of school learning to suggest how these variables might be used in a strategy for mastery learning.

#### **1. Aptitude for particular kind of learning**

Carroll's view is that aptitude is the amount of time required by the learner to attain mastery of a learning task. Bloom believes that aptitudes for particular learning tasks are not completely stable and that they may be modified by appropriate environmental conditions or home and school learning experiences. In the opinion of Bloom the central task of educational programmes should be to produce positive changes in the student's basic aptitudes.

However, the key problem for Mastery Learning Strategy is to help students learn a subject to mastery whether or not changes are made in the aptitudes which are predictive of such learning.

## 2. Quality of Instruction

Carroll believes that individual student may need very different types and qualities of instruction to learn the same content and instructional objectives to mastery levels. He defines the quality of instruction in terms of the degree to which the presentation, explanation, and ordering of elements of the learning task approach the optimum for a given learner. Bloom observed that the quality of instruction must be developed with respect to the needs and characteristics of individual learners, rather than group of learners.

## 3. Ability to understand the instruction

This can be defined as the ability of the learner to understand the nature of the task, he is to learn, and the procedures he is to follow in its learning. In our school ability to understand instruction is determined by learner's verbal ability and reading comprehension. These two features are highly correlated with achievement. Therefore immediate modification needed is in dealing with ability to understand instruction. There are many instructional strategies, which teachers can use to fit their instruction to the differing needs of all their students. They are (i) small group study session; (two/three students) (ii) tutorial help; (iii) alternative textbook explanations, (iv) work book and programmed instruction on unit and (v) audio-visual methods and academic games.

#### 4. Perseverance

Carroll defines perseverance as the time the learner is willing to spend in learning. Bloom believes that perseverance is not fixed. It can be increased by increasing the frequency of reward and evidence of learning success. Further more, the need for perseverance can be decreased by high quality of instruction.

#### 5. Time allowed for learning

According to Carroll the time spent on learning is the key to mastery. His basic assumption is that aptitude determines rate of learning and that most, if not all students can achieve mastery, if they devote the amount of time needed to learn. This implies that the student must be allowed sufficient time for learning. According to Bloom it is not the sheer amount of time spent in learning that accounts for the level of students' learning. He believes that the students should be allowed the time they need to learn a particular subject. The learning time needed will be affected by his aptitudes, his ability to understand the instruction, and the quality of instruction. If students' use of time and instruction becomes more effective, it is likely that most students will need less time to master a subject, and the ratio of time required by the slower learners to that needed by the fast learners may be reduced.

##### **2.1.1.3 The Mastery Learning Strategy**

The Mastery Learning Strategy which Bloom proposed was designed to use in the class room where the time allowed for learning is relatively fixed and mastery was defined in terms of specific set of

major objectives, the student was expected to exhibit by a subject completion.

The teaching learning strategy Bloom outlined to include the feed back and corrective procedures was labeled 'learning for mastery' and later shortened to simply 'mastery learning'. As conceptualized by Bloom and others mastery learning entails the following.

- 1, Material to be learned over a time period is divided into smaller units and performance criteria is established.
- 2, Following instruction on each learning unit, a test is administered. The result of which is periodically fed back to teacher and students regarding mastery of units and necessary corrective strategies.
3. The teacher provides corrective feedback until the student achieves mastery on the learning units.
4. The student then progresses to the next ability in the learning hierarchy.

Through this process of formative testing, combined with the systematic correction of individual learning difficulties each student receives appropriate amount of allocated quality instructional time and proportion of engaged learning time. Bloom reasoned that under these conditions virtually all students could achieve mastery of the school curricula.

#### **2.1.1.4 Execution of Mastery Learning Strategy**

In describing the steps for Mastery Learning Strategy, Block (1980) has pointed out that this strategy is accomplished through two distinct sets of steps. First the preconditions, which occur outside the classroom and prior to the instruction. Second the operating procedures, which take place inside the classroom during the instruction. These

steps contain four basic tasks. Preconditions contain two namely defining for mastery and planning for mastery. In the same way, operating procedures have two basic tasks. Teaching for mastery and grading for mastery. Each of these tasks is divided into several sub tasks.

In this connection it is necessary to clear two points. First if mastery-learning programmes are to be as successful as they might be, all of the tasks and related subtasks must be accomplished. Second and somewhat related to the first point, how these tasks are accomplished is less important than that they are in fact accomplished. Each of the tasks and related subtasks serves as an important function with in the context of mastery learning.

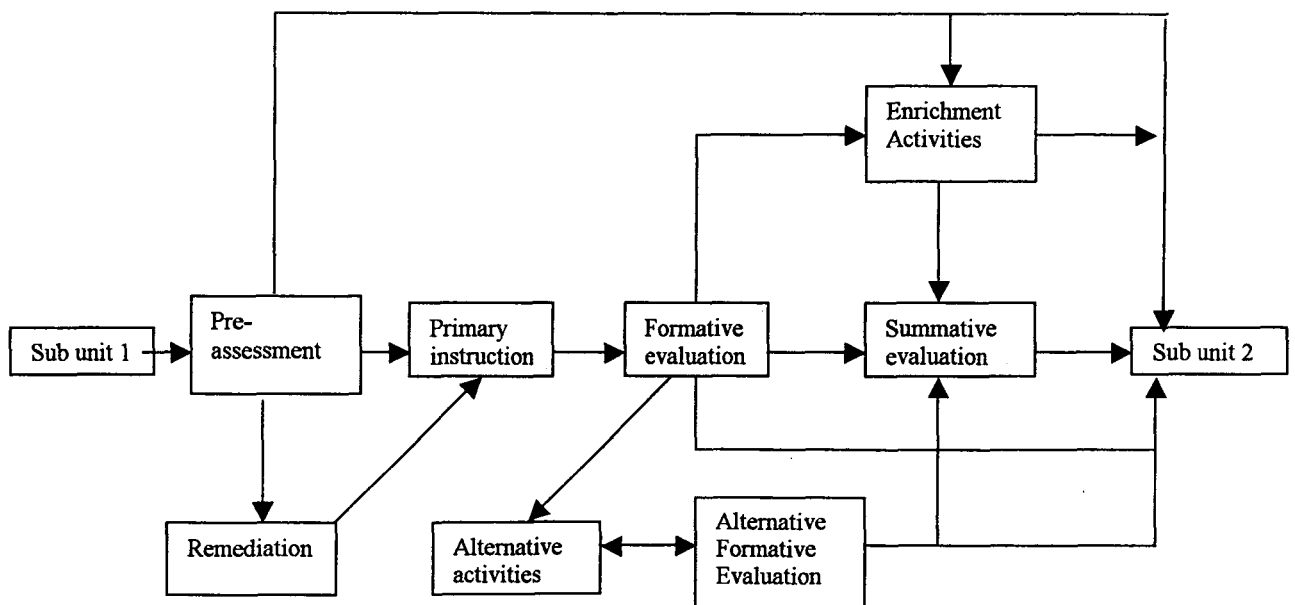


FIGURE 2-1 The Complete Mastery Model (Jacobsen, 1985)

In light of the above discussion the following section is focused on basic tasks and main steps involved in the development of successful mastery learning programme.

### **Basic Tasks**

Block and Anderson (1985) have suggested four basic tasks and their related subtasks. They are as under:

1. Defining mastery
2. Planning for mastery
3. Teaching for mastery
4. Grading for mastery

Each of these major tasks is divided in to several sub tasks. They are described below.

#### **Defining mastery**

Mastery learning programmes are out come based. Thus the first task is to define precisely what is meant by mastery. Defining mastery has the following related subtasks

1. Identification of course outcomes/objectives
2. Preparation of summative tests
3. Division of entire course into series of smaller units
4. Sequencing the units
5. Deciding what will constitute mastery of each learning unit

## **Planning for mastery**

After defining mastery the next task is to plan for mastery. This plan must be consistent with the way in which mastery has been defined. Specially, the plan must include activities, material related to the unit objectives and materials for those students failing to attain the performance-standard on the unit formative test. The function of planning for mastery is to permit teachers to be proactive in their classroom situation. Proactive teachers are ready to tackle classroom situation as they arise. They can anticipate likely problems and respond in one of a variety of appropriate pre-planned ways.

In essence, planning enables teachers to monitor student learning on a unit basis. If the evidence gathered from the formative tests suggest that learning is not proceeding as well as expected or desired, then steps can be taken to intervene, so that, ultimately the desired degree of learning is attained. Planning for mastery involves the following related subtasks.

1. To design a general plan for helping all students to master unit objectives.
2. Presentation of methods to interpret and use the information gathered from formative tests.
3. Planning for time.

## **Teaching for mastery**

Here the focus is on managing learning rather than managing learners. Inside the classroom, the function of the teacher is to specify what is to be learnt, to motivate pupils to learn it, to provide them with

instructional material, to administer these materials at a rate suitable for each pupil, to monitor students' progress, to diagnose difficulties and provide remediation for them, to give praise and encouragement for good performance, and to give review and practice that will maintain pupils' learning over long periods of time. Teaching for mastery has the following related subtasks:

1. Orientation of students
2. Teaching each learning unit in sequence using the original instruction plan
3. Administration of unit's formative test
4. Enrichment activities for masters and corrective procedures for non-masters.

### **Grading for mastery**

The final major task is grading for mastery. Grades are assigned to students based on their performance on the summative test relative to the predetermined performance standard, not based on their performance relative to the performance of other students. Such mastery grading is designed to engage students in competence motivation, that is the desire to compete against one self, and the objectives to be learned, and to disengage from competition motivation, that is the desire to compete against others. The sub task under grading for mastery is: administration of the summative test.

### **2.1.2 THEORETICAL OVERVIEW OF PROBLEM SOLVING**

“Problem solving is an exciting area in psychology because it is a basic, universal characteristic of all humans. What person does not face

a number of problems each day? To understand how people solve problems is, to a large degree, to understand basic human behaviour, the goal of every psychologist. The importance of problem solving strategies and obstacles lie at the foundation of understanding humankind.” (Magill, 1996)

A comprehensive theory on Problem Solving is not available as the concept has very abstract roots in Psychology and Physiology. The intangible area of cognition – thinking and Problem Solving- is a less explored one with more of assumptions and hypotheses with no solid proof. Much of the theory, models and hypotheses are available on the different aspects of the process associated with Problem Solving mainly highlighting the steps and general nature of Problem Solving. Vaidya (1968) remarks that educational research on Problem Solving itself has so far been very little.

#### **2.1.2.1 Definition for ‘problem’**

A Problem arises when one has a goal - 'a state of affairs that one want to achieve' - and it is not immediately apparent how the goal can be attained. The conceptual framework for analyzing such situations has 3 components. (Newell and Simon 1972)

- a) the initial problem state;
- b) operators that transform problem states into new states
- c) operators that test whether a problem state constitutes a solution.

The application of a sequence of operators to the initial states and the resulting states leads to a whole space of states.

A problem consists of a given state (i.e., a description of the current situation), a goal state (i.e., a description of the desired situation), and a set of operators (i.e., rules or procedures for moving from one state to another). A problem occurs when a situation is in one state, the problem solver wants it to be in another state, and there are obstacles to a smooth transition from one state to the other.

**Definition for ‘problem solving’**

Let us now consider the following three definitions of problem solving.

1. It may be defined as a planned attack upon a difficulty or perplexity for the purpose of finding a solution. There is then recourse to reflective thinking which is a process of careful conscious consideration of facts, beliefs or other elements of mental experience for the purpose of arriving at rational conclusions relevant to some problem or perplexity.
2. It is the process of raising a problem in the minds of students in such a way as to stimulate purposeful reflective thinking arriving at a rational solution. Three elements seem to be involved here
  - a situation; which presents some difficulty, perplexity or doubt requiring solution,
  - a goal or an end involving some aspect of the situation for which no ready answer can be given
  - and a desire or motive that stimulates an attempt to find the answer.

3. Problem solving takes place when a problem solver accepts to solve it as well as when his previous knowledge or patterns of behavior are insufficient or inappropriate to enable him to provide an acceptable solution. In such a case solutions become possible only when he acquires new knowledge or capitalizes relationships, which have not been seen earlier.

Polya (1981 p.ix) defined problem solving as " finding a way out of a difficulty, a way around an obstacle, attaining an aim that was not immediately attainable.

Mayer (1992) summarizes three major aspects of a definition of problem solving:

a) Problem solving is cognitive, because it occurs internally within the problem solver's cognitive system. b) Problem solving is a process, because it involves manipulating or performing operations on the problem solver's knowledge and c) Problem solving is directed, because the problem solver is attempting to achieve some goal.

### **Different approaches towards the study of Problem Solving**

1. Experiment: The behaviour of actual subject is studied under controlled conditions.
2. Factor Analysis: This type of studies has led to identify a set of operations involved in Problem Solving.
3. Task analysis: This type of studies are performed independently or in combination with various empirical research methods and has resulted in the formulation of several different sets of steps involved in Problem Solving.

4. Mass Observation Method: It is used in the study of concept formation in children, which depends upon interview, cross-questioning etc.
5. Psychological Test: This type of tests yield a certain amount of information about the factors involved in thinking and their operational availability in testing situations.
6. Cross sectional and Longitudinal studies: Such studies were used by J. S Bruner in identifying and classifying the enactive, iconic, and symbolic modes of representing experience and also in explaining facts of cognitive growth, language and strategies of learning.
7. Introspection and Self knowledge: Although liable to error, one can get considerable stimulus from observing something of one's own reaction and those of one's family and friends.

#### **2.1.2.2 Historical Over-view**

The history of scientific research on thinking and problem solving dates back to 1901, when researchers at the University of Wourzburg began publishing their findings concerning the thought processes involved in making free associations concerning words or pairs of words (Humphrey 1951, Mandler and Mandler 1964).

Most of the subsequent research on thinking and problem solving falls within three categories: associationist, Gestalt and cognitive. The associationist approach, which dominated psychology through out the first half of the twentieth century, views problem solving as the production of a series of responses until one works. A major criticism

of this approach concerns how it can account for creative problem solving.

The gestalt approach, developed in Germany in the 1920 s and 1930 s, view problem solving as mentally reorganizing the elements of the problem so that they fit together in a new way. Thus the major task in problem solving is to achieve structural understanding, that is to see how the given elements mesh with the requirements of the goal. A major criticism of this approach concerns the need for clearly testable theories.

The cognitive view, which began in the late 1950 s and evolved into the cognitive science approach by the 1980 s, provides for an integration of the positive features of both approaches (Gardner 1985, Mayer 1992). According to this approach, problem solving involves a series of mental computations, so a theory of problem solving must specify the specific mental processes used to solve a problem as well as the methods that problem solvers employ for selecting and controlling their cognitive processes.

### **Theoretical Formulations**

Problem Solving is combining what we had known with various aspects of problem situation to arrive at a desired solution. A variety of basic thought processes like perceiving, remembering, reasoning, inferring are involved while solving a problem. The ability to formulate creative solutions to problem is considered as the central aspect of thinking. Various theoretical formulations by the exponents in the field are detailed below.

## 1. Wallas's Classic Description of Creative Problem Solving

Wallas's (1926) considered that Problem Solving process covers a number of stages and strategies in progressing towards a final solution. His classic description included:

- Preparation – defining the problem, making first attempts to solve it.
- Incubation – where the problem is left aside to develop
- Illumination – where the solution comes in a sudden and
- Verification – in which the solution is evaluated to make sure that it really works.

Eysenck and Keane, however considered that this approach is rather too general and remarked that the stages incubation and illumination are vague.

## 2. Dewey's Description Theory of Problem Solving

Dewey (1933) characterise thought as a Problem Solving behaviour. This conception emphasizes that thought may have grown out of man's need to adopt himself to a difficult and often hostile environment. Dewey remarks that reflective thinking begins when there is doubt that leads to a search for material that will resolve the doubt and dispose the perplexity. The first phase is the pre-reflective which establishes the nature of the problem to be solved. The last phase is the post-reflective which result in a feeling of mastery and satisfaction, between these two phases are the states of thinking which include - suggestions in which the mind anticipates possible solutions, recognition of the nature of the problem, use of hypothesis to initiate and guide the

search for relevant material, mental testing of the hypothesis and actual testing of hypothesis.

### 3. Cognitive and Gestalt views on Problem Solving

Gestalt psychologists and other wholistically oriented psychologists have pointed to the integrative aspects of thought, the ways in which our understanding of a problem, and of the tools that may lead to its solution is more than a sum of the parts. It can be restructured by the interactions among the parts and by the unique whole, including attention, set and expectations and even by the whole past experience and personality of the person attempting a solution.

### 4. Duncker's Funneling theory of Problem Solving

Duncker (1945) brought forth a new explanation on the nature of Problem Solving. According to him, Problem Solving consists of series of restatements of the problem – each funneling into a more narrowly defined statement until the final solution is reached. Duncker's description is based on observation of what people actually do and say as they go about solving a problem that has been set up in the laboratory. His analysis shows that when an individual starts solving problem, his concepts can be described as progressing through three major stages – from the general range, through a functional solution to a specific solution.

### 5. Gagne's theory of hierarchy of learning

Gagne (1965) identified a distinct hierarchy of learning in the order 1. Signal learning 2. Stimulus-response learning 3. Chaining 4.

Verbal association 5. Multiple Discrimination 6. Concept learning 7. Principle learning and 8. Problem Solving. Gagne considers Problem Solving as the highest form of learning, the accomplishment of which demands the ability to deal successfully with the pre-requisite principles that are in turn preceded sequentially by necessary concepts, multiple discriminations, verbal associations, chain and stimulus-response experiences (with the possible exception of the signal type).

#### 6. Bransford's 'ideal' thinking strategy.

Bransford et al. (1984) list the 5 steps that they believe lead to effective Problem Solving: Identify, Define, Explore, Act and Look and Learn. It may be noticed that the first letters of the steps spell "ideal". To apply this thinking strategy one should identify the problem, define it clearly and then explore the possible solution and relevant knowledge. Next he should act by trying a possible solution or hypothesis. Finally he should look at the result and learn from them. Of course each attempted solution may identify sub problems. These can again be tackled with the 'ideal' steps until a final satisfactory solution is found.

#### 7. Marzano's model for the process of Problem Solving.

Marzano (1997) believes that providing a model is a good way to help students feel comfortable with the Problem Solving process. The steps in the process are stated as follows: 1. Identify the goal you are trying to accomplish. 2. Identify the constraints or limiting conditions. 3. Determine exactly how these constraints or limiting conditions are preventing you from reaching your goal. 4. Identify different ways of overcoming the constraints or meeting the limiting conditions. 5. Select

and try out the alternative that appears to be the best. 6. Evaluate the effectiveness of the alternative you have tried.

## 8. Mayer's Design for Teaching Problem Solving

Mayer (1992) has summarised three major issues in the design of an effective program for teaching Problem Solving: what to teach, how to teach and where to teach. First, Problem Solving can be taught as a single, monolithic ability that can be strengthened through training and exercise (eg., mathematical problem-solving skill or language skill), or as a collection of smaller, component skills that can be specifically taught (eg., how to represent problems, how to devise solution plans, or how to monitor one's comprehension). Second, Problem Solving can be taught by emphasizing the product of Problem Solving (namely, getting the right answer), or by emphasizing the process of Problem Solving (that is the method or steps that one goes through to arrive at an answer). Third, Problem Solving can be taught in a general, domain-free context in hopes of promoting transfer across many domains or within the context of specific subject domains such as mathematics, social studies, or writing, with the expectation that students are generally able to apply a problem-solving strategy only within a particular domain. Mayer suggests that Problem Solving is most effectively taught when the focus is on teaching the component skills rather than a single general ability, on process rather than product, and on domain-specific rather than context-free settings.

### **Strategies for Problem Solving**

Decomposition - If a problem is too complicated a strategy called

decomposition can be used. This is done by dividing the problem into smaller more manageable sub problems.

**Working Backward** – Many problems are like trees. The trunk is the information you are given; the solution is a twig on one of the branches. If you work forward by taking the ‘givens’ of the problem and trying to find the solution, it is easy to branch off in the wrong direction. Some times the more efficient approach is to start at the end, working backward from your goal.

**Finding Analogies** – To take advantage of analogies, one must first recognize the similarities between current and previous problems. Then it becomes easier to recall the solution that worked before for an earlier but similar problem. Surprisingly, most people are not very good at seeing the similarities between new and old problems.

**Allowing to Incubate** – In the case of a difficult problem a helpful strategy is to allow it to ‘incubate’ by laying it aside for a while. A solution that once seemed out of reach may suddenly appear when you engage in unrelated mental activity. The benefits of incubation probably arise from forgetting incorrect ideas that may have been blocking the path to a correct solution.

### **Research on Problem solving in Real situations**

Research on every day problem solving reveals that people rarely use school-taught methods to solve problems encountered outside of school (Lave1988, Rogoff and Lave 1984).

An important area of research involves comparing of how experts and novices solve problems in domains such as medical diagnosis, computer programming and Physics (Chi et al. 1988) as well as in the game of chess (De Groot 1965). For example when Larkin (1983) asked experts and novices in Physics to think aloud as they solved physics problems, she found that experts were more likely to describe the problem in terms of its physics concepts (such as forces and weights), whereas novices focused on the surface features of the problems (such as pulleys and ropes). Similarly when Chi et al. (1981) asked experts and novices to sort physics problems into groups, experts sorted problems based on their underlying physics principles (such as conservation of energy) whereas novices sorted the problems based on their surface characteristics (such as inclined planes or springs). Results of expert- novice studies suggest that experts represent and solve problems differently from novices, and so instruction can focus on helping novices to think more like experts.

Another important area is the study of human problem solving within subject matter areas such as reading, writing, mathematics and science, that is psychologies of subject matter (Mayer 1987). Instead of studying how people think in general, psychologists of subject matter investigate how people think scientifically or mathematically or how people think within the process of reading or writing a passage. For example in scientific problem solving, the problem solver must overcome preconceptions that he or she brings to the situation. This approach suggests that instruction in subject matter areas should focus on helping students learn the cognitive process and strategies required for successful problem solving.

## **Relation between Problem solving, Thinking and Reasoning**

Problem solving is a common and pervasive type of thinking, namely directed thinking in which the thinker is attempting to achieve some goal; in contrast, non directed thinking in which the thinker is not attempting to achieve some goal, includes daydreaming and the abnormal thinking of autistic and schizophrenic people. Reasoning can be viewed as a type of problem solving.

### **Types of Problems**

#### **Well - defined problems and ill - defined problems**

A distinction based on the clarity of the problem statement, can be made between well - defined problems and ill - defined problems. A well - defined problem has a clear given state, a clear goal state and a clear set of allowable operators. For example, finding the value of 'x' in an algebraic equation such as  $x^2 + x + 4 = 0$  is a well-defined problem. In contrast an ill - defined problem has a poorly specified given state, goal state and/or operators. For example, giving a persuasive speech is an ill - defined problem because the goal and the allowable operators are not clearly specified. In school, students often work on well - defined problems whereas most of the crucial problems in everyday life are ill defined.

#### **Routine and non - routine problems**

Another important distinction is that between routine and non - routine problems, and is based on the knowledge of the problem solver. Routine problems are identical or very similar to problems that the

problem solver has already solved, and therefore require reproductive thinking, reproducing responses that have been produced previously. For example, routine problems for most high school students are of the type: '5 + 5 = \_\_\_\_'. In the strictest sense, routine problems do not conform to the definition of problems, since they do not include an obstacle between the given and goal states. In contrast non - routine problems are different from any problems that the problem solver has solved previously, and therefore require productive thinking (Wertheimer 1959), that is, creating a novel situation. In school, students often work on routine problems called 'exercises', however most important problems in every day life are non-routine.

### **Problems requiring convergent and divergent thinking**

A third distinction can be made between problems requiring convergent and divergent thinking. Convergent thinking problems have a single correct answer that can be determined by applying a procedure or retrieving a fact from memory. Example includes arithmetic computation problems and typical multiple-choice items. Divergent thinking problems (Guilford 1967) have many possible answers, and so the problem solvers' job is to create as many solutions as possible. Classic examples includes 'uses problems' such as "List all of the possible uses of a brick", and 'consequences problems' such as "List all of the consequences of humans having six rather than five fingers". Originality and fluency in producing answers to divergent thinking problems are measures of creativity and are taught in instructional programs in critical thinking. Although divergent thinking is the

hallmark of creativity, most school-based problems emphasize convergent thinking.

### Rigidity in Thinking

A major obstacle to effective problem solving is rigidity in thinking. For eg., in some problem solving situations, the problem solver must use an object in a new way, such as using a brick as a doorstep or using chewing gum as an adhesive. When a problem solver can only conceive of using an object in its most common function, the problem cannot be solved. Duncker (1945) used the term “functional fixedness” to refer to such a situation. Another example of rigidity occurs when a problem solver uses a well-learned procedure on a problem for which the procedure is inappropriate.

### **The distinction between meaningful and rote learning**

Max Wertheimer (1959) suggested that there are two ways of learning. Learning by rote leads to reproductive thinking. Such problem solvers would perform well on retention tests but perform poorly on transfer tests. In contrast learning by understanding leads to productive thinking as measured by transfer tests.

## **2.2 REVIEW OF RELATED STUDIES**

Since, Mastery Learning Strategy, Problem Solving and Physics are the key terms used in the present study, the investigator has classified the entire studies as under:

1. Studies related to Mastery Learning Strategy.

2. Studies related to problem solving and related cognitive processes.
3. Studies conducted in Physics.

### 2.2.1 STUDIES RELATED TO MASTERY LEARNING STRATEGY

Yadav (1984) studied the effect of Mastery Learning Strategy on pupils' achievement in Mathematics, their self concept and attitude towards Mathematics. After the experimental treatment, the group taught through Mastery Learning Strategy exhibited a significantly higher achievement in Mathematics, evinced a more positive attitude towards Mathematics and showed improvement in self concept than the control group.

Koul (1986) compared the effects of Bloom's Mastery Learning Strategy and Keller's personalised system of instruction with the traditional method on achievement motivation and test anxiety of socially disadvantaged group. It was found that both Bloom's Mastery Learning Strategy as well as Keller's personalised system of instruction was effective to promote achievement motivation.

Salim (1988) tried to determine the effects of a Mastery Learning Strategy on the achievement of secondary school chemistry students in Sabha, Libya. The results suggested that the mastery learning students had significant achievement gains in Chemistry across all achievement tests. It was also concluded that although all students benefited from mastery learning, high and average aptitude students benefited more than low aptitude students.

Mathur (1988) studied the effect of the mastery learning programme on the achievement, self concept and attitude of undergraduate and postgraduate pupils towards Statistics. It was found that mastery learning programme is an effective strategy in terms of achievement, self concept and attitude. Mastery learning programme also reduced the gap between repeaters and non-repeaters.

Aranha (1988) showed the utility of mastery learning approach for slow learners. They gained in scores on final tests along with strong academic motivation and self concept habits as result of mastery learning programme.

Malini (1988) studied the effectiveness of Mastery Learning Strategy in the achievement of Mathematics at secondary school level. The results revealed that the mean achievement scores obtained using the Mastery Learning Strategy are greater than the mean achievement scores obtained using traditional classroom teaching methods. Also it was noted that Mastery Learning Strategy is effective irrespective of the three levels of intelligence (high-, average-, low-).

Prasad (1988) studied the effectiveness of Mastery Learning Strategy on achievement in English of secondary school pupils. The study revealed that pupils taught through Mastery Learning Strategy achieved significantly higher than the pupils taught through Conventional Strategy of teaching.

Monger (1989) examined the effects of a mastery learning instructional strategy on student achievement and on student's subject related attitudes. Bloom had predicted that mastery learning

instructional strategy would result in the majority of students reaching superior levels of cognitive achievement and positive subject related affect. But the results did not confirm the underlying theory of mastery learning as there was no significant difference in the achievement, subject related affect, mathematics problem solving and mathematics computations. Also in a specific case of the quasi-experimental design, the control group out performed the experimental group in mathematics concepts and total mathematics, disconfirming Bloom's theory in this case.

Divakaran (1989) studied the effectiveness of Mastery Learning Strategy on the achievement in Malayalam of low cognitive entry behaviour secondary school pupils. The study revealed that there exists a real difference in the mean achievement scores in Malayalam between experimental group and control group. Therefore it can be concluded that Mastery Learning Strategy is more effective than Conventional Strategy of teaching for low cognitive entry behaviour students.

Odud (1989) investigated the effects of strategies of instruction on mastery learning. It was found that there was no significant difference among different strategies of instruction on the criterion of immediate attainment of mastery.

Arredondo, et al. (1990) comments that in recent research, when teachers focus on higher mental processes (problem solving, application of principles, analytical skills, and creativity) within a mastery learning format, students' thinking skills and knowledge levels improve. Baltimore County (Maryland) and East Islip (New York) School Districts have programs integrating process and content.

Kulik et al. (1990) analysed the findings from 108 controlled evaluations and showed that mastery learning programs have positive effects on the examination performance of students in colleges, high schools, and the upper grades in elementary schools. Effects of mastery programs on student attitudes, instructional time, and college completion rates are discussed.

Malini (1990) determined the effect of certain cognitive variables namely Verbal Intelligence, Nonverbal Intelligence and mathematical creativity and Mastery Learning Strategy on achievement in Mathematics of secondary school pupils. The results showed that irrespective of the ability level of the pupils, Mastery Learning Strategy has significant advantage over traditional method of teaching. The study also indicated that the formative evaluation can be conveniently done after the completion of three or four lessons instead of giving at the end of each lesson with the effect of Mastery Learning Strategy kept intact.

Slavin (1990) evaluates that findings of positive effects of mastery learning on experimenter-made measures can be interpreted as supporting the view that this technique may help focus teachers on a given set of objectives. The claim that mastery learning can accelerate achievement, in general, in elementary and secondary schools is still awaiting evidence.

Maurer (1991) evaluated the effectiveness of a Mastery Learning Strategy in enhancing student's cognitive achievement, problem solving abilities and retention of these concepts in an introductory Chemistry program. Those students who received the Mastery Learning Strategy

had a significantly better cognitive achievement than those students that did not receive the treatment. However, the Mastery Learning Strategy did not significantly improve the cognitive retention of the treatment group.

Verma (1991) analysed the effect of personalized system of instruction and Bloom's Mastery Learning Strategy on the achievement and certain non-cognitive variables of students promoted by adopting lenient promotion criteria at school stage. The study revealed that the pass groups of students achieved higher on summative criterion test after receiving instruction through Keller's personalized system of instruction and through Bloom's Mastery Learning Strategy in comparison to the pass group of students taught through the Conventional Strategy.

Patadia (1991) tested the effectiveness of mastery learning in a group-oriented classroom to meet the conflictive demands of a classroom situation. The study revealed that the mastery in initial units facilitated the learning of subsequent units in terms of time. Remedial measures used had a positive effect on achievement. The role of IQ in learning was considerably reduced with the use of mastery learning.

Abadir (1992) examined the effects of two different mastery learning instructional strategies and the effect of the lecture strategy on community college student's achievement in Mathematics. In this study, mastery learning students were able to achieve academically. But there was no significant difference, among the instructional methods for students' attitude towards Mathematics.

Chen (1992) used selected mastery learning techniques in Mathematics for non-disabled, learning disabled and educable mentally retarded children. The results suggested that the mastery learning strategies promoted the learning outcomes of Mathematics for non disabled children, for learning disabled children, and for educable mentally retarded children, but the effects on the latter were not so significant as the use of the mastery learning strategies for the non disabled and learning disabled children.

Abadir et al. (1993) studied the effects of mastery learning strategies, interactive video mathematics (IVM), individualized instruction (IND), and the lecture method on mathematics achievement of community college students. Interactions among instructional methods, gender, and age were examined; and the grade success rate was determined for each instructional method. The IND and IVM methods were characterized by mastery learning principles. Pretest and posttest components determined the mathematics achievement of college freshmen. IVM and IND methods had a positive educational influence on students' achievement on mathematics basic skills posttest scores, but, because many of these students did not complete the course in 10 weeks, grade success rate was significantly lower for these methods than for the lecture method. No significant difference was found for gender on the main effects, but a significant difference for simple effects shows that males favor the IVM method.

Nichols (1993) determined if differing ability levels will affect the acquisition of problem- solving skills and self-esteem as a result of participation in two approaches to teaching problem-solving skills, a

study was conducted with sixth graders in a posttest-only control group experimental design. Results suggest that thinking-skills instruction does impact the development of creative and critical thinking and that the acquisition of these skills has a positive effect on self-esteem. The study also provides evidence that the length of training is an important consideration in providing thinking-skills instruction, and that such instruction should be an integral part of the curriculum rather than a supplementary or isolated program. In addition, thinking-skills instruction is appropriate for students at all ability levels.

Deshpande et al. (1994) attempted determining the effectiveness of mastery learning strategies across socio-economic levels in terms of VIII standard students' chemistry achievement and modification in their self concept. It was found that the students with high Socio-Economic Status achieved significantly higher than the students of low Socio-Economic Status. MLS was used more effective for above average and average intelligent students even though the below average students were also benefited. The self concept of all students enhanced significantly as a result of MLS.

Lai et al. (1994) compared data from 95 educationally disadvantaged Hong Kong students placed in mastery- learning classes with 64 control students in expository-learning classes. Results indicate that under mastery learning, deep- and surface-biased learners increasingly diverge in performance and attitude, with surface learners doing better unit-to-unit, and deep learners worse. Implications for mastery learning are discussed.

Ritchie et al. (1994) used a fifth-grade videodisc fractions program to examine accountability in mastery learning programs. Four classes were randomly assigned to two treatments (those who were and were not aware of participation in mastery learning). Results revealed standardized mean differences for achievement favoring knowledge of being in the mastery-learning program.

Whiting et al. (1995) investigated the cognitive and affective student learning outcomes of 36 semesters (equivalent to 18 years) using the mastery learning approach in high school distributive education classes (n=7,179 students). Student achievement in the cognitive area is reported by increasing grade point averages, and test scores are presented to show the consistent high level of academic achievement of students. Affective information (attitudes toward school and learning) has also been elicited from the entire sample and is presented to show positive changes.

Laney et al. (1996) examined economic concept learning and retention in 121 first and second graders who were randomly assigned (stratified by grade) to 1 of 4 instruction conditions: cooperative learning, mastery learning, cooperative-mastery learning, or control treatment. Found on posttest and delayed posttest that cooperative-mastery method was superior to other methods in promoting learning and retention.

Su (1996) attempted to determine whether low ability students in a mastery-learning program could attain the same level as high ability students in a traditional program. The result revealed that mastery

learning strategies are effective with low learning ability students to attain the same level as high ability students.

Vaidya (1997) attempted to study the effect of Mastery Learning Strategy on pupils' achievement, pupils' self concept and attitude towards Hindi. Mastery Learning Strategy was found more effective in facilitating learning and raising the achievement of the learners than either concept attainment model or the traditional method. Mastery Learning Strategy was more potent in bringing about improvement in the self concept as well as attitude towards Hindi of the pupils when compared to either concept attainment model or the traditional method.

Jaffer (2000) determined the effectiveness of Mastery Learning Strategy on achievement in geography of secondary school pupils. The study revealed that Mastery Learning Strategy was more effective than the traditional method in teaching Geography at the knowledge, understanding and application level.

Lee et al. (2000) evaluated the effect of using the mastery learning techniques of self-directed feedback, reinforcement, and remediation of knowledge on the performance of a work-related task involving transfer of training. The study supports the hypothesis that mastery learning would have a positive effect on transfer of knowledge from the classroom to a work-related task.

### 2.2.2 STUDIES RELATED TO PROBLEM SOLVING AND RELATED COGNITIVE PROCESSES.

Bloom and Broader (1950) studied the problem solving processes of college students and found that successful problem solvers differed

from unsuccessful problem solvers in respect of: (1) ability to use rather than possess the total fund of uniformed knowledge. (2) Extent of thought brought forward on a problem. (3) Attitude towards reasoning, confidence in the problem and the introduction of extraneous considerations into the problem situations.

Mealings (1961). studied some aspects of problem solving in science and found that problem solving is more related to intelligence than to chronological age. It appeared that there was a minimum mental age of 13 years before a child can reason formally about a problem. Children should not be expected to solve abstract problems below the mental age of 16.

Vaidya (1964) investigated the problem solving behaviour among certain groups of adolescent children in science. It was found that though adolescent pupils are in a position to state hypotheses, most of them were not in a position to test them.

Newell and Simon (1972) in their study on human problem solving understood that logic contributes to information processing through the presentation of ideas by symbols. The consequent alteration in meaningful ways by precisely defined, process symbol manipulation can refer to a much wider range of phenomena than simple deductive logic. The problem solver can be described and understood as an information processing system.

Linn and Levine (1976) studied adolescent reasoning and found that when the results were stressed and the procedure was hidden from view, the performance of the younger adolescent pupils was impaired

when compared to that of the older ones. The gap between the two was as wide as four years. Both groups of subject performed similarly on the problem when the results were not shown,

Mathur (1981) studied the growth of the experimental mind during adolescence and found that performance on piaget-type tasks shows an increasing trend with grade with some fluctuation in certain tasks. It was also found that the capacity of the adolescent pupils to grasp the essence of the problem increases with grade.

Raizada (1981) investigated the relationship between Problem Solving Ability and some relative personality traits using Piagetian tasks. The study revealed that Problem Solving Ability increases with age, grade and intelligence. Sex differences favouring girls existed in problem solving. Personality traits like persistency, erogenic tension, conformity and tender heartedness influenced problem solving.

Jain (1982) studied the problem solving behaviour in Physics of adolescent pupils and found that a large number of students who initially failed to solve problems correctly were able to solve most of the problems completely correct or partially correct after providing hints in relation to the strategies for problem solving. The hints were presented systematically and logically. It was also found that the problem solving scores differed significantly among the three groups of I.Q levels and also among the three groups of the level of intellectual development.

Shreshta (1983) conducted a study on the acquisition of problem solving processes during adolescence. The study revealed the following: 1. Each problem which inheres in a continuous chain of

reasoning has its own distinct factorial structure. 2. Processes of thought underlying the problem can be predetermined. 3. These processes of thought across the problem constitute distinct schemes of thought on appropriate grouping.

Jain (1984) carried out a study of Piagetian logical thinking among certain groups of adolescent pupils. The study revealed that the majority of adolescent pupils aged 11+ to 14+ are not in a position to reason formally. The mean performance of individual tasks, schemes of thought, and total adolescent thoughts show an increasing trend with age. The mathematical structures of tests and tasks showed the existence of six factors – combinatorial reasoning, grasping sense of the problem, supper ego strength, probability reasoning, classification-reasoning, and using constant differences.

Banerji (1987) used the programming language, LOGO, in its graphic mode as a method of teaching Mathematics and problem solving. The results suggested the new method had significant positive effect on students' application of problem solving strategies and ability to understand problem statements. Qualitative observations seemed to suggest improvements in some of the components of Problem Solving Abilities, but not in all.

Rekha (1988) studied the effect of piagetian model of teaching for the development of Problem Solving Ability in secondary school students. It was understood that the piagetian model of teaching is significantly capable of developing Problem Solving Ability over the traditional method of teaching, even though intelligence and achievement in the subject are controlled.

David (1988) carried out a comparative study of problem solving behaviour and found that the incidence of concrete thoughts favour boys rather than girls. There was a significant relationship between scores on concrete thought and measures of creativity. Directed observation or keenness of observation did not appear as a separate factor.

Suri (1989) studied the structure of the reasoning ability of rural and urban students. The study revealed that for the rural group, cognition of semantic classes, cognition of semantic relations and convergent production of semantic implications emerged as factors accounting for reasoning ability. And for the urban group, convergent production of semantic classes emerged as the only factor to account for reasoning ability.

Haridasan (1989) conducted a study of the Problem Solving Ability in biological science of high-, average-, and low- biology achievers at secondary school level. It was found that there is a significant relation between the Problem Solving Ability and achievement.

Darchingpui (1989) examined the relationships among variables such as achievement in science, attitude towards science and problem-solving ability under certain conditions such as location, socio-economic status, parental condition, occupation and typology of school among secondary school children. The study indicated significant relationship between scientific attitude and achievement in science. Significant sex differences in achievement in science and Problem Solving Ability existed. High socio-economic status, family facility and type of school

attended favoured achievement in sciences, scientific attitudes and Problem Solving Ability.

Dutt (1989) investigated the effect of problem solving strategies on Problem Solving Ability in science and examined its relationship with certain cognitive and personality variables. The study used tools of Problem Solving Ability test in science developed by the investigator; the group embedded figure test (GEFT) by Witkin, Oltman and Raskin; the General Mental Ability Test by S. Jalota and the comprehensive anxiety test by Sinha & Sinha. Data were analysed using mean, median, S.D, ANOVA and multiple regression analysis. It was found that strategies of problem solving significantly affect Problem Solving Ability of students. The focusing strategy was found to be superior to the scanning strategy. High intelligent students, irrespective of the strategies of training scored high on Problem Solving Ability test than low intelligent students.

Gill (1990) studied the effect of training strategies on creative Problem Solving Abilities and cerebral dominance in relation to intelligence, personality and cognitive style. The study showed that right brain- training strategy was superior to the left-brain training strategy, so far as creative Problem Solving Abilities in Mathematics were concerned. The group having the field independent cognitive style scored higher on originality than the field dependent group on creative Problem Solving Ability test.

Goel and Agbebi (1990) attempted to compare the relative effectiveness of the individualized method and the lecture-demonstration method of laboratory instruction of student acquisition of

psychomotor and related cognitive abilities when the specific behavioural objectives of five physics experiments in the subject area of light were pre-disclosed to students before instruction. The group of students who followed the individual lab method achieved significantly better on the psychomotor abilities whereas students who followed the lecture-demonstration method achieved higher level of cognitive abilities related to their respective counterparts.

Kanevsky (1990) experimented with forty children who were divided into four groups and administered the Tower of Hanoi puzzle using static and dynamic approaches. The benefits of age and ability were indicated by significant improvement from the general failure of the four- to five-year olds to the success of the majority of the high ability seven- to eight- year olds.

Parasnis (1990) constructed a test for Marathi medium students of standard IX to measure their Problem Solving Ability. Four hundred boys and girls drawn randomly from standard IX were used subjects for item analysis. For the study of reliability and validity an additional sample of 100 students was used. Percentages, t test and correlation were used for the analysis.

Pickering (1990) analyzed the performance of students on numerical versus conceptual chemistry problems in their freshman general chemistry course and their sophomore organic chemistry course. Data indicated that the ability to solve a problem did not necessarily imply an understanding of the concepts involved. ERIC Identifier: EJ409411

Sawrey (1990) compared in this research the performance of students on numerical versus conceptual chemistry problems at the introductory college level. Separate analyses were done to compare high and low achievers. It was shown that even the upper group of achievers had difficulty with concept questions. ERIC Identifier: EJ409410

Kumari (1991) studied the problem solving strategies and some cognitive capabilities of 10-12 year old children. The study revealed that the Problem Solving Ability and success on different types of problems were significantly and positively related to each cognitive capability separately as well as globally. There was some evidence for some sequential steps in problem solving at different forms or levels of responses to be associated with the tactics used by children.

Funkhouser (1992) administered Pretests measuring problem-solving ability to 71 students in a high school mathematics class. One group was given computer-augmented instruction; the other group was given instruction augmented by mathematics laboratory activities. Posttest results for problem-solving ability were mixed, but the group receiving computer-augmented instruction scored significantly higher on tests of mathematics content.

Shah (1992) examined the effectiveness of an educational programme on decision-making and intellectual abilities. The effect of the decision making programme was found to be more highly placed among girls than boys in the samples characterized by a lower intelligence. The creative thinking abilities development programme led to the development of fluency and originality of abilities in all the groups.

Granier (1992) investigated the effects of learning computer programming on the Problem Solving Abilities of community college students. Based upon the findings it was concluded that computer programming does provide an effective avenue to the development of Problem Solving Abilities in community college students.

Fischbach (1993) attempted an alternative method of instruction, called cognitive apprenticeship that utilizes the results of research in how students learn to solve problems in community college technical mathematical classes to improve student problem solving. But the results did not suggest the new method to be superior to the traditional method.

Nichols (1993) determined if differing ability levels will affect the acquisition of problem-solving skills and self-esteem as a result of participation in two approaches to teaching problem-solving skills, a study was conducted with sixth graders in a posttest-only control group experimental design. Results suggest that thinking-skills instruction does impact the development of creative and critical thinking and that the acquisition of these skills has a positive effect on self-esteem. The study also provides evidence that the length of training is an important consideration in providing thinking-skills instruction, and that such instruction should be an integral part of the curriculum rather than a supplementary or isolated program. In addition, thinking-skills instruction is appropriate for students at all ability levels.

Sumathy (1994) studied the hemisphericity, divergent thinking and Problem Solving Ability in Physical Science of the plus two students in Salem and found that boys and girls did not show any

difference in the deductive thinking skill, Inductive thinking skill, analytical thinking skill, convergent thinking skill, Divergent thinking skill and symbolic thinking skill and that girls were better than boys in solving problems involving recall/recognition and in problems involving more than one principle skill and synthetic skill.

Sherzer (1995) compared two groups of Israeli College preparatory students in their ability to solve algebra-rate problems using a computer program. One group received combined meta cognitive/meta affective abilities training. The second group received only meta cognitive training. It was predicted that the first group would out perform the second group on algebra-rate problems, meta-strategy knowledge, feelings of self-control and transfer. The results showed no significant difference between the groups in algebra – rate problems. Inconsistent with the hypothesis, the group which had meta cognitive abilities training only showed significant superiority over the group with combined abilities training for level of meta strategy knowledge.

Armstrong (1995) developed a high school physics laboratory manual designed to develop critical thinking, problem solving and creativity. The students are required to not only determine what information is needed for the data sheet, but they also must develop this data sheet. The final component of this manual is the in depth analysis the students must do.

Curtis (1995) investigated through a case study approach problem solving instruction occurring within a vocational technical school in Oklahoma. Problem solving was a planned and powerful part of the instruction. Instructors taught the following Problem Solving Abilities:

using problem solving steps, drawing parts of a problem, using different technologies and troubleshooting. Instructors encouraged the following characteristics of good problem solvers: intrinsic motivation, informal cooperation and creativity. Instructional strategies used to facilitate problem solving were questioning, coaching, scaffolding, modeling, articulation, exploration and reflection.

Dyer, James E.; Osborne, Edward W. (1996) In their study a group of Illinois secondary agriculture students was taught using a problem- solving approach (PSA), the other with a subject-matter approach (SMA). A problem- solving posttest and Group Embedded Figures Test showed significantly higher problem-solving ability in the PSA group. Field independent learners in the PSA group significantly increased their scores. There were no score changes for other learning styles or for the SMA group.

Oughton (1997) studied the effect of hypermedia development o high school students' knowledge acquisition, problem solving and general design abilities. The results indicated that the students increased their declarative and procedural knowledge and could use the knowledge in more complex ways at the end of the treatment. In addition, the students' general Problem Solving Abilities increased and the general design abilities emulated a cognitive framework.

Babarasch (1997) determined the effect of parenting style, and social Problem Solving Abilities on the ability of sixth graders to cope with the transition to middle school. The study revealed no significant relationships between social problem solving and parenting style.

Savelsbergh et al. (1997) identified the reasoning mechanisms that available the problem solver to achieve the transformation to a physics structure of the problem situation. Elaboration is explored as a mechanism in fulfilling this transformation by providing beginning problem solvers with elaborations that they failed to infer. Findings of the study provide evidence that that the reasoning processes in weak students may be qualitatively different from the reasoning processes in proficient students, and that the major problem for weak-problem solvers is not that they do not know problem types but rather that they fail to elaborate on a given situation properly.

Neto and Valente (1997) explored the possibility of developing classroom strategies that would encourage Physics teachers to put greater focus on a more qualitative, meta cognitive approach to problem solving. This research was carried out with students approximately 16 years of age in physics classes at two Portuguese high schools with both qualitative and quantitative procedures being used. The results suggest that a meta-cognitively oriented problem solving approach might be a suitable means to assure a synergetic interaction between the scientific concepts and the thinking abilities.

Hong (1998) set forth to test the theory that the problem abilities used for well structured problems are necessary but not sufficient for solving ill structured problems in the context of an open minded, multi media problem solving environment. The results of this study verified past research conclusions that well structured and ill structured problems require different components for reaching successful solutions. Cognition, including domain-specific knowledge and structural

knowledge and justification abilities were critical components in well-structured problem solving whereas Meta cognition, non-cognitive variables, justification abilities as well as cognition were essential components needed to solve ill structured problems.

Kelley (1998) compared the computer aided drafting (CAD) problem solving abilities of students taught with two different teaching methodologies via; cooperative learning and traditional individualistic form of teaching. The results of the study showed that both teaching methodologies were equally as effective at developing CAD problem solving achievement in students.

Kota et al. (1998) hypothesizes that the incidence of process-oriented thinking increases with the syntactic complexity of the problem presentation. Presents data confirming students' arithmetic preferences in the form of left-to-right translation along with evidence to show the effects of the ordering of data presentation in the problem statements on the problem-solving abilities of students.

Noh et al. (2000) studied the effects of Visual Organization and Cooperative Learning in Problem-Solving Strategy. The study examined participating students' multiple-choice problem-solving ability, strategy performing ability, anxiety about chemistry learning, perception of involvement, and motivation to learning science and reported a significant main effect in strategy performing ability. ERIC Identifier: EJ656441

Lin et al. (2002) investigated the efficacy of promoting 8th grade students' problem-solving ability through history of science teaching.

After one year of teaching, with the statistical procedure of the analysis of covariance, finds that the experimental group students outperformed their counterparts in the chemistry conceptual problem-solving ability. Initial results revealed that students benefited from the introduction of development of scientific concepts. ERIC Identifier: EJ649512

Chang et al. (2002) explored the interrelationship between students' problem-solving ability and their science-process skills in earth science. Statistical analyses indicated that a significantly moderate correlation existed between students' problem-solving ability and their science process skills. Results of a t-test also revealed that there were significant mean differences in students' skills of observation, data interpretation, and hypothesis formulation between higher-level and lower-level problem solvers.

Reid and Yang (2002) investigated Open-Ended Problem Solving in School Chemistry using a new set of 14 open-ended problems to gain some initial insights into the way pupils solve open-ended chemistry problems. The study emphasizes how concepts and linkages between concepts influence success in solving such problems and suggests that creating links between "islands" of knowledge is an important skill in Problem solving. ERIC Identifier: EJ659919

Sriraman (2003) studied Nine freshmen in a ninth-grade accelerated algebra class who were asked to solve five non routine combinatorial problems. The four mathematically gifted students were successful in discovering and verbalizing the generality that characterized the solutions to the five problems, whereas the five non gifted students were unable to discover the hidden generality.

Fawcett, L. and Garton, A.F. (2005) investigated the effect of collaborative learning on children's problem-solving ability and whether differences in knowledge status or the use of explanatory language were contributing factors. It was found that children who collaborated collectively obtained a significantly higher number of correct sorts than children who worked individually. However, post-testing indicated that only those children of lower sorting ability who collaborated with higher sorting ability peers showed a significant improvement in sorting ability from pre-test scores. In addition, it was found that when analysis was limited to this particular group, only those children who were required to explain the sort for their partner to carry out improved significantly from Pre to post test.

### 2.2.3 STUDIES CONDUCTED IN PHYSICS

Anantha ramaiah (1980) compared activity method with the lecture method to develop science talent among a few high school children in Bangalore city. The study revealed that activity method was better than the lecture method in Physics.

Vijaya kumari (1985) investigated the effectiveness of problem solving method in terms of behavioural change in teaching physics to IX standard students. The problem solving method had a positive effect on the learning of students. This was pronounced in the area of understanding, application and drawing abilities.

Murthy (1989) tried to develop creative thinking abilities among eighth standard students through teaching of Physics using synectic

model and found a positive effect. The synectic approach also developed fluency, flexibility and originality when taken separately.

Gurumurthy (1990) tried to compare the effectiveness of a guided discovery approach of carrying out physics experiments versus instructed performance approach at pre university level. Significant differences were observed between the students of the guided discovery group and instructed performance group. I mean scores of 1. comprehensive achievement and its components such as knowledge, understanding and application and practical ability abilities.

Devi (1991) studied the effectiveness of multimedia approach in learning Physics and found that the multimedia package was effective in improving the achievements of students. It was found that the high intelligence group and high socio-economic status group performed better.

Usman (1991) studied the effectiveness of concept attainment model in teaching Physics at secondary school level and found that it was an effective method for developing concepts. Concepts like wave motion, wave length, transverse wave etc. were difficult to follow in spite of the teaching through concept attainment model.

## **Conclusion**

Research studies (Pickering 1990, Sawrey 1990) indicated that numerical problems and conceptual problems had different impacts on students. It was shown that even the upper group of achievers with high numerical Problem Solving ability had difficulty with conceptual problems. These researches indicated that the ability to solve a

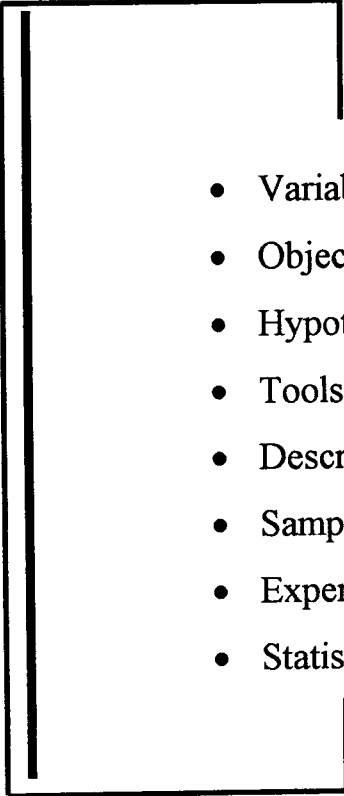
numerical problem did not necessarily imply an understanding of the concepts involved in it.

Alternative methods of instruction like cognitive apprenticeship that utilizes the results of research in how students learn to solve problems did not improve student problem solving. In one research it was found that girls were better than boys in solving problems involving recall/recognition and in problems involving a combination of principle skill and synthetic skill. Statistical analyses indicated that a significantly moderate correlation existed between students' problem-solving ability and their science process skills.

The studies on Mastery Learning Strategy show that this strategy definitely increases achievement and retention. Only very few studies are conducted to study the effect of Mastery Learning Strategy on higher order cognitive abilities. Certain research studies (Arredondo and Block, 1990; Mevarech, 1985; Soled, 1987) show that Mastery Learning Strategy increases high-level outcomes such as problem solving, drawing inferences, deductive reasoning and creative expression.

Nevertheless, what is known about the effect of Mastery Learning Strategy on higher order cognitive abilities is only on the basis of studies undertaken in the west, which may not be completely true in our state, with a different curricular approach, a different curriculum-transaction pattern and a different curriculum.

## METHODOLOGY

- 
- Variables of the Study
  - Objectives
  - Hypotheses
  - Tools used for Collection of data
  - Description of the Tools
  - Sample
  - Experimental Procedure
  - Statistical Techniques

## METHODOLOGY

Methodology discusses the systematic procedures by which the researcher starts from the initial identification of the problem to its final conclusions.

The present study examines the effect of Mastery Learning Strategy on the Problem Solving Ability of secondary school students in Physics. The variables of the study, tools used for measurement, sample of the study, data collection procedures, scoring procedures and statistical techniques used in this study are detailed in this chapter.

### 3.1 VARIABLES OF THE STUDY

Variables are the conditions or characteristics that the experimenter manipulates, controls or observes. The independent variables, dependent variables and the controlled variables of the present study are detailed below.

#### **Dependent Variable**

The dependent variable in the present study was Problem Solving Ability in Physics of students of standard IX.

#### **Independent Variable**

The independent variable for the present study was the Instructional Strategy (Mastery Learning Strategy / Conventional Strategy).

### **Controlled Variables**

The controlled variables were Non-verbal intelligence, Verbal Intelligence, Socio-Economic Status, Previous Achievement and Sex.

### **3.2 OBJECTIVES**

The objectives of the present study are presented below as one general objective and a set of specific objectives.

#### **General Objective**

To find out the effect of Mastery Learning Strategy on the Problem Solving Ability in Physics of secondary school students.

#### **Specific Objectives**

1. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability in Physics of students of Standard IX.
2. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on the first component of Problem Solving Ability (Comprehending the Problem) in Physics of students of Standard IX.
3. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on

the second component of Problem Solving Ability (Clarifying the problem) in Physics of students of Standard IX.

4. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on third component of Problem Solving Ability (Finding Solution to the Problem) in Physics of students of Standard IX.
5. To study the Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for the total sample.
6. To study the Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for girls of the total sample.
7. To study the Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for boys of the total sample.
8. To study the Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for total sample.

9. To study the Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for girls of the total sample.
10. To study the Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for boys of the total sample.

### **3.3 HYPOTHESES**

1. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability in Physics of students of Standard IX.
2. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 1 viz; Comprehending the Problem, in Physics of students of Standard IX.
3. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 2 viz; Clarifying the Problem, in Physics of students of Standard IX.

4. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 3 viz; Finding Solution to the Problem, in Physics of students of Standard IX.
5. There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for the total sample.
6. There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for girls of the total sample.
7. There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for boys of the total sample.
8. There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the total sample.
9. There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed

any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the girls of the total sample.

10. There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the boys of the total sample.

### **3.4 TOOLS USED FOR COLLECTION OF DATA**

The various tools used for measuring the parameters of this study are listed in table 3.1.

**TABLE 3.1**  
**Tools Used in the Study**

Sl. No.	Variable	Tools
1	Non-verbal Intelligence	Raven's Standard Progressive Matrices
2	Verbal Intelligence	Verbal Intelligence Test based on triarchic theory
3	Socio-economic status	Socio-Economic Status Scale
4	Previous Achievement	Standardised Achievement Test developed by the investigator (Pre test scores)
5	Problem Solving Ability	Problem Solving Ability Test in Physics developed by the investigator

### **3.5. DESCRIPTION OF THE TOOLS**

The general structure, the scoring procedure and the psychometric properties of the tools employed in this study are detailed below.

#### **3.5.1 RAVEN'S STANDARD PROGRESSIVE MATRICES**

The Nonverbal Intelligence of students were tested with Standard Progressive Matrices 1996 Edition prepared by Raven, Court and Raven published by Oxford Psychologists Press, Lambourne House, Oxford, UK. Nonverbal Intelligence of the subjects were measured by administering the Raven's Standard Progressive Matrices Test. This nonverbal test is intended to estimate the subjects' ability to discern and utilize a logical relationship presented by nonverbal materials. The test consists of 5 subtests of 12 items each. In each item a part of the geometrical design is missing. Six or eight alternatives are given for each design. All of these fit the missing part, but only one logically belongs to it. The test is a popular measure of the "g" factor of intelligence.

Validity of the test has been studied in a variety of usual ways. When Stanford-Binet test was used as the criterion, correlation varied from 0.50 to 0.86. The reliability coefficients as reported by Raven vary from 0.80 to 0.90.

### 3.5.2 VERBAL INTELLIGENCE TEST BASED ON TRIARCHIC THEORY

To test the Verbal Intelligence the Verbal Intelligence Test based on Triarchic Theory developed by Dr.V. Sumangala and Sholy Joseph (2005) of the Department of Education, University of Calicut was used. The test contains 38 questions in three sections. The first section contains 14 questions, second section has 13 questions and the third section has 11 questions. The test was based on Triarchic Intelligence theory of Sternberg.

The scoring procedure of the test is to give one score for each correct answer and zero score for each incorrect ones, except in cases of tests I (iii) and I (iv). In test I (iii) the strategy used by the respondent for arriving at the solution is critical and hence score depends on the systematic strategy used. An additional score of 1 will be given to items under these tests if the strategy followed is systematic. In test I (iv) the nature of representation is crucial. Therefore scoring depends on whether the respondent used an external or literal representation of the information for arriving at the right answer. Here also an additional score of one will be given if there is correct external representation.

The validity of the test was estimated empirically by comparing the scores of the test with 'The Kerala Non Verbal Group Test of Intelligence for Secondary School Pupils' (Nair, 1968). The coefficient of correlation so obtained is 0.62 (N=40) indicating that the test has concurrent validity. Reliability of the test was established by the test-retest method. The test-retest reliability coefficient is 0.79 (N=40). The

above evidences suggest that the test is reliable and valid to measure intelligence of secondary school pupils.

### 3.5.3 SOCIO-ECONOMIC STATUS SCALE

The scale developed by Kuppaswami was modified by K.S. Pillai in 1973. The criteria adopted for giving weightage to the level of income was further modified by Dr. Sivarajan and Subrahmaniadas (1998) with the consent of the experts in educational research and The Department of Economics and Statistics, Government of Kerala. The investigator used the same scale without major modifications. The weightage has been given according to the table 3.2.

**TABLE 3.2**  
**Weightage given in the SES scale according**  
**to Educational level, Occupation and Income of Parents**

Sl. No.	Education	Wtg.	Occupation	Wtg.	Income Per month	Wtg.
1	Masters Degree, Professional Degree, above	10	Professional	10	Above 8000	10
2	Bachelor's Degree	8	Semi-professional	8	6001-8000	8
3	Higher Secondary	5	Skilled worker	7	4001-6000	6
4	SSLC	4	Semi-skilled worker	4	2401-4000	4
5	Up to Std. VIII	2	Unskilled / Labourer	2	801-2400	2
6	Literate	1	Unemployed	0	800 and below	1
7	Illiterate	0				

**Note on the jobs coming under each category of occupation.**

Professional – Ministers, Judges, Bank Executives and Officials, Doctors, Engineers, Lawyers, University level Teachers, Heads of organizations, Heads of Government Departments, Secretaries of the Government, Business Executives etc. belong to the professional category.

Semi-Professional – Chemists, Druggists, Qualified Nurses, Teachers, managers, Superintendent officer, Minor Business man, contractors, small land lords, sub-inspectors of Police, Excise Inspectors, Sub-registrar, Assistant Educational Officers, Block Development Officers, Officers of the sub district etc. will come under this category.

Skilled Workers – Mechanics, Fitters, Electricians, Drivers, Photographers, Laboratory Assistants, Carpenter, mason, Vakil Clerks, Police head Constables, and the like will come under this category.

Semi-skilled workers – Farmers, Small-scale mechanics, Library attenders, Police Constables etc. belong to this category.

Unskilled workers/ Labourers – Coolies, Ordinary Labourers, Watchman. Peons etc belong to this category.

### 3.5.4 STANDARDISED ACHIEVEMENT TEST

An achievement test for the first four chapters of Physics of the IX standard was developed and standardised by the investigator. The description of the content, the procedure of administration, scoring and technical data about reliability and validity are detailed below.

The First step in constructing an achievement test is to design the test. There are three dimensions to the design. They are: Weightage to the objectives, Weightage to the content and Weightage to the Type of Questions.

The objectives to be tested were selected based on the Bloom's Taxonomy. Thus the six objectives of the cognitive domain viz., Knowledge, Understanding, Application, analysis, Synthesis and Evaluation were selected for testing.

**TABLE 3.3**  
**Weightage to the objectives**

<b>Sl. No.</b>	<b>Objectives</b>	<b>Marks</b>	<b>%</b>
1	Knowledge	4	11.4
2	Understanding	4	11.4
3	Application	11	31.4
4	Analysis	6	17.2
5	Synthesis	4	11.4
6	Evaluation	6	17.2
	Total	35	100

The achievement test was prepared for the first four chapters of Physics in the IX standard. The chapters are 1. Colours of Light, 2. Motion, 3. Force and 4. Gravitation.

**TABLE 3.4**  
**Weightage to the content**

<b>Sl. No.</b>	<b>Content</b>	<b>Marks</b>	<b>%</b>
1	Chapter I	7	20.0
2	Chapter II	6	17.1
3	Chapter III	12	34.3
4	Chapter IV	10	28.6
	Total	35	100

As the test was designed to measure different objectives including higher-level outcomes like Analysis, Synthesis and Evaluation different types of questions were necessary to be included. Thus essay and short answer questions were included in addition to objective type questions.

**TABLE 3.5**  
**Weightage to the type of questions**

Sl. No.	Type of questions	Marks	%
1	Objective	7	20.0
2	Short Answer	20	57.1
3	Essay	8	22.9
	Total	35	100

Thus the weightages were properly decided with respect to objectives, content and the type of questions so that a blue print of the test could be made.

#### **3.5.4.1 Blue Print of a Test**

A blue print gives the details of the design in concrete terms. It is a three dimensional chart giving the placement of different questions with respect to objectives tested, content area and form of questions. In addition to these dimensions, the blue print will also indicate the numerical weightage to each question, individually.

**TABLE 3.6**  
**Blue Print for Achievement Test in Physics**

Objective Type of Qn Content	Knowledge			Understanding			Application			Analysis			Synthesis			Evaluation			Total
	O	SA	E	O	SA	E	O	SA	E	O	SA	E	O	SA	E	O	SA	E	
Chapter I		1(2)					1(1)				1(2)						1(2)		7
Chapter II	2(1)				1(2)			1(2)											6
Chapter III				1(1)			1(1)	2(2)			1(2)				1(4)				12
Chapter IV				1(1)			1(1)	1(2)			1(2)							1(4)	10
Sub -total	2	2		2	2		3	8			6				4		2	4	
<b>Total</b>	4			4			11			6			4			6			<b>35</b>

Note: The figure inside the bracket indicates question number and outside the bracket indicates the marks allotted.

O: Objective  
SA: Short Answer  
E: Essay

The question paper prepared for the pilot test was submitted to subject experts – the physical science teachers of Farook high School And Tirur Government Girls High School - for seeking critical comments. The draft test was prepared by incorporating their suggested modifications. The draft test prepared for the pilot test contained 20 objective questions, 16 short answer questions and 2 essay questions. A copy of the draft test is given in the Appendix VII. The test was for 60 marks and was administered for a total duration of 1 hour 20 minutes. The test was administered in two sessions. The first section of 20 objective questions and 2 essay questions was administered to 100 students of Farook High School, Farook College, Calicut. The scores so obtained were subjected to item analysis. On the basis of item analysis out of the 20 objective questions 7 items were selected to be incorporated in the final test. These items were selected according to the steps suggested by Garrett (1973). Garrett (1962, p.368) suggests that items with discriminating power of 0.20 or more and difficulty index of 0.40 to 0.60 are regarded as satisfactory.

**TABLE 3.7**  
**Summary of Item Analysis**  
**of the Achievement Test (Objective Type)**

Qn. No	Discriminating Power	Difficulty Index	Selected or not
1	0.37*	0.82	
2	0.30*	0.30	
3	0.15	0.15	
4	-0.15	0.22	
5	0.74*	0.41*	✓
6	0.11	0.32	
7	0.52*	0.59*	✓
8	0.41*	0.65*	✓
9	0.30*	0.33	
10	0.04	0.32	
11	0.04	0.39	
12	0.30*	0.44	
13	0.44*	0.63*	✓
14	0.37*	0.33	
15	0.33*	0.80	
16	0.44*	0.74*	✓
17	0.26*	0.83	
18	0.37*	0.37*	✓
19	0.407*	0.43*	✓
20	0.19	0.87	

Note: The asterisk mark indicates that the value agrees the criterion for selection.

The second section of 16 short answer questions was administered to the same students. Discrimination indices of the items were found out using the Pearson's Product Moment Correlation Method. Of the 16 short answer questions 12 were significant of which 10 items were selected for the final test. The two essay questions were significant and were included in the final test. The item analysis of these items is detailed in the table 3.8.

**TABLE 3.8**  
**Item Analysis of the Achievement Test (short answer & Essay Type)**

Qn. No.	Correlation coefficient	Selected or not
1	.48**	✓
2	.48**	
3	.70**	
4	.45**	✓
5	.47**	
6	.26	✓
7	.55**	✓
8	.26	
9	.68**	✓
10	.32	
11	.59**	✓
12	.60**	✓
13	.62**	✓
14	.41*	
15	.63**	✓
16	.71**	✓

\* indicates that value is significant at .01 level

\*\* indicates that value is significant at .001 level

A copy of the final achievement test is given as Appendix VIII.

### **Reliability**

The reliability of the test was established by the test – retest method. The test was administered to 40 students of Government Girls High School, Tirur and the retest was conducted after three weeks from first administration. Thus the reliability was calculated using the Pearson Correlation Coefficient Method and was found to be 0.74.

### **Validity**

Since the test was conducted keeping in view the weightage for content and instructional objectives, on the one hand, and the experts' comments on the other, it was treated as a valid test. Also to ensure criterion validity the correlation between the scores of the test with the marks in Science was found out. For this marks obtained by the students were collected from school records. Thus the concurrent validity was calculated using the Pearson Correlation Coefficient Method and was found to be 0.64.

### **3.5.5 PROBLEM SOLVING ABILITY TEST DEVELOPED BY THE INVESTIGATOR**

Since no Problem Solving Ability test was available ready at hand, the investigator had to begin from the roots to construct one suited for the purpose. Studies on higher cognitive abilities are scarce and those on problem solving are even less. Even though theories on scientific problem solving are in plenty, none of them directly mentioned the components of problem solving. Various authors have

elaborated upon the steps in problem solving but the ingredients of the concept were hardly touched. The components of Problem Solving Ability had to be made up carefully by assimilating the theories and by consulting with experts in the field.

Analyzing the various attributes of the construct- problem solving, a list of possible components of Problem Solving Ability was initially made. The preliminary list consisted of 30 items.

The following abilities were identified as the sub components of Problem Solving Ability and this formed the preliminary list of sub components of Problem Solving Ability.

1. Sensing a problem
2. Stating the problem
3. Skill of observation
4. Comprehending
5. Observing closely (in detail) the problem in its gestalt (scanning).
6. Discriminate between closely related concepts
7. Analysis (breaking down the elements in the problem)
8. Identifying the connections/ relations of the problem space
9. Divergent thinking of the connections or relations of the problem space (seeing it from different angles)
10. Inductive reasoning
11. Relating new problem with familiarized problems (transfer of learning)
12. Visualizing a range of possible solutions
13. Memory

14. Deductive reasoning
15. Detecting errors/ logical flaws (in hypothesis)
16. Using analogies for reasoning.
17. Eliminating superfluous hypothesis. (Focusing /filtering/ sorting of multiple hypothesis to reduce the no.)
18. Prediction of happenings.
19. Conceiving appropriate (experimental) procedure to test hypotheses (transform the theory to practical.)
20. Controlling of variables.
21. Picture drawing skill
22. Skill in selecting and setting up of apparatus
23. Recording (Accuracy in) observation and measurement.
24. Drawing inference from (relevant) observed data/ observation
25. Conceiving identical set of procedures for test of hypotheses (or is it inference/conclusion)
26. Controlling variables.
27. Skill in selecting and setting up of apparatus
28. Recording (Accuracy in) observation and measurement.
29. Picture drawing skill
30. Arriving at generalization.

This list was presented before subject experts and a consolidated list was arrived at. Some of them were not viable for a paper pencil test. Thus after expert screening some components were deleted, some were added and a few were renamed. The new list of components was rescheduled under three heads.

### **3.5.5.1 Components of Problem Solving Ability**

The final list of the components was arranged as below. It contains three components viz; Comprehending the Problem, Clarifying the Problem and Finding Solution to the Problem. Each component has its subcomponents.

#### **1. COMPREHENDING THE PROBLEM**

1. Sensing a problem
2. Defining the problem
3. Analysis of the problem into discrete elements.

#### **2. CLARIFYING THE PROBLEM**

1. Ability to discriminate between the most relevant and closely related concepts.
2. Using analogies for reasoning
3. Using Inductive/deductive reasoning.
4. Hypothesizing
5. Checking the testability of hypotheses

#### **3. FINDING SOLUTION TO THE PROBLEM**

1. Controlling of variables.
2. Prediction of Happening.
3. Conceiving ideas using diagrammatic representation.
4. Conceiving a strategy to execute a plan of action to test the hypothesis.
5. Drawing inference from relevant observed data.
6. Generalizing.

The first major component viz; comprehending problem represents the initial stage of acquainting with the problem. To attack it intellectually one has to build a rapport with the structure of the problem. Comprehending involves mental processes, which would help the problem solver to evolve a more concrete structure of the problem. The subcomponents that come under this head are detailed below.

**3.5.5.1.1 Sensing a problem** - Only a few can wilfully take up a problem. There are thousands of problems. But an individual may not respond to all. Some problems affect the individual and put him in disequilibrium. The individual can be in equilibrium only after solving it. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

In a room, yellow light is produced with a sodium vapour lamp. In the next room, yellow light is produced by combining the primary colours red and green. When red, green and white buttons were inspected in these lights the following facts were observed. Of these which fact seems to be not natural to you?

1. In the room where red and green lights are mixed to produce yellow light, the red button appeared red and the green appeared green.
2. In the light of sodium vapour lamp, the red and green buttons appeared dark.
3. In the light of sodium vapour lamp, the white button appeared yellow.
4. In the room where composite yellow colour is present, white button appeared yellow.

**3.5.5.1.2 Defining the problem** - Perceiving the problem is one thing but to put it verbally is another thing. Statement of the problem is very important. Well begun is half done – goes the saying. Putting the mental imagery of the problem into a verbal statement is the right beginning towards problem solving. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

A lorry driver was carefully driving his vehicle through a road in the high range in the night. There was thick fog in the atmosphere. It was difficult to see far. The driver switched on two more white lights (additional lamps) other than the headlights. But it did not help to see far; rather, the fog appeared more illuminated. To see far through the fog is really a difficult task. Which of the following statements given below does exactly describe the problem here?

1. To drive through a high range road in the night is very difficult.
2. White light just illuminates the fog and does not help seeing far.
3. Tiny water droplets condense and remain suspended in the atmosphere making it very difficult to see through the fog.
4. The additional white lights do not help to see through the fog.

**3.5.5.1.3 Analysis of the problem into discrete elements.** – This involves breaking down the problem into simpler constituents - concepts, quantities, persons, things etc- so as to comprehend its structure. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

Ramu was watering the plants in his garden with a hose in front of his home at night. Since the length of the hose was a bit short of the required length he squeezed at the bore of the hose so as to force a jet of water gush up to the far end. Further he held the hose at different angles. Ramu was trying to make the distance of fall of water (range) to a maximum. Which group given below represents the main factors in this situation?

1. angle, maximum range, absence of light
2. range, water, hose
3. force of flow of water, angle, maximum range
4. night, maximum, hose

The second major component viz; Clarifying the problem is an attempt to untangle the intricacies of the problem so as to attack the problem intellectually. Clarifying involves mental processes of employing common thinking strategies, which would help the researcher to solve the problem. The subcomponents that come under this head are detailed below.

**3.5.5.1.4 Ability to discriminate between the most relevant and closely related concepts.** – This involves differentiating and discriminating the minor concepts involved in the problem, which are quite fundamental in the constitution of the problem. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

Two friends A and B went into the forest. When B was resting under a mango tree, A went in search of water. But he lost his way on

return. A wandered for kilometers in several directions in search of B. But he was never far from B for more than a hundred metres. Which is the most relevant and closely related pair of concepts pertinent to this situation?

1. Velocity and acceleration
2. Distance and displacement
3. Velocity and displacement
4. Kilometer and metre

**3.5.5.1.5 Using analogies for reasoning** – Analogies consist of an organized system of symmetrical relations based on identities of parts of structures. Mere similarity of shared features by two objects cannot possibly account for an analogy. Analogies provide comparisons which can be used to explain a difficult-to-understand concept by pointing out its similarities to something easier to understand or already understood. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

Friction between two surfaces is caused by the irregular ups and downs on the surface. When a body is dragged over another these microscopic ups and downs mutually get locked and a force is produced in the opposite direction of movement. This force is the frictional force. Which of the situations given below is similar to this phenomenon?

1. The rough surfaces of two sand papers rubbed each other.
2. A pad lock is opened and locked using its key.
3. Two knives are rubbed mutually and vertically.
4. Two hooks are mutually hooked in and pulled

**3.5.5.1.6 Using Inductive/deductive reasoning.** – Problem solving is a building up process. For this, specific relations or specific instances of the problem are worked out and the inferences are extrapolated to a general situation. Thinking both ways – inferring from specific instances and generalizing as well as applying a generalization to a specific instance – is part of the intellectual processes involved in solving a problem. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

Read the three sentences in this paragraph. (i) Earth attracts all objects, which are near to the Earth towards its centre. (ii) Earth attracts all objects below the surface of Earth towards its centre. (iii) Earth attracts all objects above the surface of Earth towards its centre. On the basis of the above statements what inference can we make?

1. Earth attracts all objects towards its centre.
2. Earth attracts almost all objects towards its centre.
3. All objects attract Earth towards them.
4. Earth attracts objects that are away from Earth towards its centre.

**3.5.5.1.7 Hypothesizing** - A hypothesis is essentially a product of constructive imagination. According to James Creighton, “Hypothesis is a tentative supposition or provisional guess, which seems to explain the situation under observation.” Without some such supposition it is not possible to make any progress in scientific enquiry. Analogy and simple methods of induction are helpful in framing hypothesis. Depth of knowledge, imagination and genuine interest in the subject help in framing fruitful hypothesis. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

An athlete instead of throwing the javelin from the place where he stands, runs fast from a distance and throws the javelin. What could be the reason?

1. The distance through which the athlete runs and the range of the javelin may be related.
2. The speed attained by the athlete and the range of the javelin may be related.
3. The speed attained by the athlete and the muscle power gained by the athlete may be related.
4. A running person may have control over the angle at which the javelin is held.

**3.5.5.1.8 Checking the testability of hypotheses** - A hypothesis can be accepted only when it is consistent with all relevant facts and well-established laws of nature. Also all such hypotheses are not viable for actual experimentation. Only those hypotheses that can be tested facilitate the real problem solving process. The success of a scientific investigation depends on the formulation of a good hypothesis, without the guidance of which we shall not know what to do or observe or what experiment to perform. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

Given below are logical statements. Among these which one is testable with a simple experiment?

1. When different colours are made to pass through a glass slab, the largest deviation will be for the violet light ray.
2. When light of different frequencies is made to pass through a

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glass slab, the largest deviation will be for the light ray with the maximum frequency.

3. When light of different wavelengths is made to pass through a glass slab, the least deviation will be for the light ray with the maximum wavelength.
4. When a light ray passes through a glass slab its speed changes.

The third major component of Problem Solving Ability is Finding Solution to the Problem. This component includes cognitive efforts to experiment, infer and generalize.

**3.5.5.1.9 Controlling of variables.** - This is one of the important process skills a science student should possess. In fact an experiment is an active observation where the variables are controlled. The ability to decide which variables are to be controlled and which are to be observed is the crux of experimenting skill. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

To study whether different masses take different times while falling down from a height, an experiment was conducted on the surface of the Moon. Different masses were allowed to fall freely. In this experiment the down ward acceleration is fixed. Also there is no air resistance. To find out the correct relation between mass and the time of fall which factor then has to be controlled and kept constant?

1. the surface area of the object
2. spherical shape of the object.
3. density of the object.
4. height of fall.

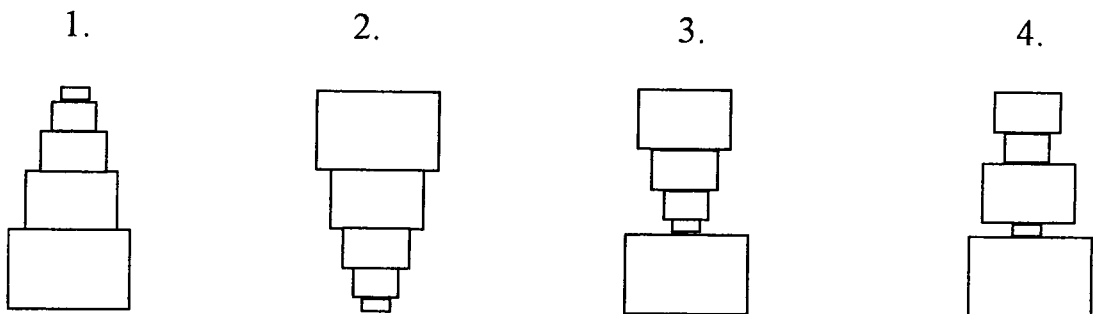
**3.5.5.1.10 Prediction of Happening.** - This component tests the ability of a student to extrapolate the known facts and concepts, already assimilated, into the unknown, unfamiliar or new situations. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

Aero planes have a streamlined design. The front end is pointed to reduce friction while traveling through air. Suppose a space vehicle is designed to travel only through the outer space, then

1. the front as well as the rear end should be pointed.
2. the front end alone need be pointed.
3. the shape should be spherical.
4. there is no need to make it stream lined.

**3.5.5.1.11 Conceiving ideas using diagrammatic representation.** - In Science, diagrams and pictures are inevitable tools for concept formation. Most of the abstract ideas and concepts in Physics find meaningful expressions in the form of symbols or diagrams. In problem solving also, a science student employs mental imagery to concretize his ideas. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

In the diagrams given below are square cubes of different sizes placed one over the other. Of the given arrangements, which is most stable?



**3.5.5.1.12 Conceiving a strategy to execute a plan of action to test the hypothesis.** - Imagining an experiment before actually performing it helps the scientist to optimize the settings, eradicate logical flaws and strike upon the best possible way of obtaining sharp results. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

Some rays emanating from the remote control of the TV and falling on the set control the TV set. To test the truth of this statement, which experimental procedure is the most appropriate?

1. The remote is operated with its battery placed in and removed.
2. The power supply of the TV set is switched on and off and the remote is test operated.
3. The outer cover of the remote control is opened and the inner parts are observed and sketched.
4. A thick screen is placed in between the remote control and the TV set and the remote is test operated.

**3.5.5.1.13 Drawing inference from relevant observed data.** - The renowned astronomer, Tycho Brahe (1546-1601) amassed accurate

observations of astronomical data using his superior instruments. His intention was to adduce sufficient proof for the geocentric theory of Universe. But it is one of the remarkable ironies of History that the very same data was used by his assistant and successor, Johann Kepler, to banish geocentrism once and for all from astronomic circles, and to enthrone the very Copernican system, which his master so vehemently distrusted. This anecdote suggests, how the inference drawn from a set of given data becomes crucial in solving a problem. This subcomponent tests the student’s ability to meaningfully interpret the data in the light of common sense. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

The velocity of a moving object and the corresponding time is given in the chart below. Which of the following inferences is correct?

Velocity (m/s)	40	40	38	36	34	36	38	40	40
Time interval (second)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9

1. The object accelerated in the interval of 0-1 seconds
2. The object accelerated in the interval of 0-2 seconds
3. The object accelerated in the interval of 5-8 seconds
4. The object accelerated in the interval of 7-9 seconds

**3.5.5.1.14 Generalizing.** - Generalisation is made when similar sets of experiments show the same result. A sample item from the draft test for Problem Solving Ability, testing this subcomponent, is illustrated below.

When an object was dragged along the surface of a table with a spring balance attached to it the reading initially increased but decreased when the object started moving and remained constant thereafter.

When Ramu tried to push a wheelbarrow with load he had to use a lot of force, but when it started moving, he found a lesser force was sufficient.

People were trying to push a bus that had a break down from the road to the side. At first more people had to push together to move the bus. Later only lesser people pushed the moving bus to the side of the road.

From these situations what general principle about frictional force can be reached at?

1. The frictional force is less before the object moved.
2. The frictional force is maximum before the object starts moving and decreases when it starts moving.
3. The variations in frictional force cause many difficulties in life.
4. The sliding friction is more than the rolling friction.

#### **3.5.5.2 Design of the Problem Solving Ability Test**

The Problem Solving Ability test was developed for the first four chapters in the subject of Physics of IX standard. The chapters were;

1. Colours of Light
2. Motion
3. Force
4. Gravitation

Multiple choice items were prepared so as to test the Problem Solving Ability in the four units of Physics. Ebel (1972) suggests that multiple choice items are currently the most highly regarded and widely used form of objective test items. Multiple choice tests tend to be more objective, more efficient and less subject to sampling errors. Students often find multiple choice items less ambiguous than other test forms. Again there is convenience for scoring and analysis, if multiple choice items are selected.

The draft of the Problem Solving Ability test was prepared such that each sub component of the Problem Solving Ability is tested in all the four chapters. And a few additional items were prepared wherever possible so as to compensate the weightage of content in the event of elimination of some of the items on item analysis. A total of 62 items were prepared giving due weightage to the content portion as well as to the ability sub components. A copy of the draft test is given as Appendix III.

TABLE 3.9

**Summary of the Weightage given to subcomponents  
and chapters in the draft test of Problem Solving Ability**

Sl. No.	Sub-components	Chapter 1	Chapter 2	Chapter 3	Chapter 4	TOTAL
1	Sensing a problem	1	2	1	1	5
2	Defining the problem	1	1	1	1	4
3	Analysis of the problem into discrete elements.	1	1	1	2	5
4	Ability to discriminate between the most relevant and closely related concepts.	1	1	1	1	4
5	Using analogies for reasoning	2	1	1	1	5
6	Using Inductive/ deductive reasoning.	1	1	1	1	4
7	Hypothesizing	1	1	1	1	4
8	Prediction of Happening.	1		2	1	4
9	Checking the testability of hypotheses	1		1	2	4
10	Conceiving a strategy to execute a plan of action to test the hypothesis.	1	1	1	2	5
11	Controlling of variables.		1	1	2	4
12	Conceiving ideas using diagrammatic representation.	2	1	1	1	5
13	Drawing inference from relevant observed data.	1	1		3	5
14	Generalizing.	1	2	1		4
	<b>TOTAL</b>	<b>15</b>	<b>14</b>	<b>14</b>	<b>19</b>	<b>62</b>

The draft test was administered to a total of 132 students from three divisions of ninth standard students. The students were from Farook High School, Farook College, Calicut and from Tirur Government Girls High School, Tirur. Discriminating power of the items were calculated using the formula  $D = (U-L) / N$ , where U - the number of students who answered correctly in upper group. L - the number of students who answered correctly in lower group and N - Total number of students in each group. The size of the upper and lower group was taken as 27 percent of the total group; hence  $N = 36$ .

The table 3.10 shows the break up of the sample selected for administration of the draft test of Problem Solving Ability.

**TABLE 3.10**

**Break up of the sample selected for administration of the draft test of Problem Solving Ability**

<b>Name of School</b>	<b>Boys</b>	<b>Girls</b>	<b>Total</b>
Tirur Govt. Girls HS	0	37	37
Farook HS, Division A	20	29	49
Farook HS, Division B	23	23	46
<b>Total</b>	<b>43</b>	<b>89</b>	<b>132</b>

The draft test contained 62 items; each item carried one mark and was administered for a total duration of 1 hour 20 minutes. There was no time restriction for the test. However most of the students answered the test in an hour. The scores so obtained were subjected to item analysis. On the basis of item analysis out of the 62 objective questions

50 items were selected to be incorporated in the final test. These items were selected according to the steps suggested by Garrett (1973). Garrett (1962, p.368) suggests that items with discriminating power of 0.20 or more are regarded as satisfactory. Most of the items selected for the final test had a discriminating index of 0.30 or above. However a few items with discriminating indices ranging in between 0.25 and 0.30 also were selected to ensure due weightage to the content areas

**TABLE 3.11**

**Summary of Item Analysis  
of the Problem Solving Ability Test**

Sl no.	Item no	discr index
1	11A	0.36*
2	11B	0.25*
3	11C	0.36*
4	11D	0.31*
5	11E	0.11
6	12A	0.33*
7	12B	0.42*
8	12C	-0.03
9	12D	0.25*
10	13A	0.28*
11	13B	0.33*
12	13C	0
13	13D	0.28*
14	13E	0.28*
15	14A	0.28*
16	14B	0.25*
17	14C	0.19
18	14D	0.47*
19	21A	0.53*

20	21B	0.31*
21	21C	0.19
22	21D	0.36*
23	21E	0.47*
24	22A	0.39*
25	22B	0.45*
26	22C	0.14
27	22D	0.33*
28	23A	0.25*
29	23B	0.59*
30	23C	0.25*
31	23D	0.42*
32	24A	0.31*
33	24B	0.31*
34	24C	0.14
35	24D	0.33*
36	31A	0.33*
37	31B	0.31*
38	31C	0.33*
39	31D	0
40	32A	0.64*
41	32B	0.47*
42	32C	0.42*
43	32D	0.67*
44	32E	0.22
45	33A	0.31*
46	33B	0.33*
47	33C	0.28*
48	33D	0.08
49	34A	0.31*
50	34B	0.47*
51	34C	0.44*

52	34D	0.56*
53	34E	0.11
54	36A	0.39*
55	36B	0.31*
56	36C	0.28*
57	36D	0.53*
58	36E	0.56*
59	46A	0.44*
60	46B	0.39*
61	46C	0.5*
62	46D	-0.06

Note: The asterisk mark indicates that the value agrees the criterion for selection.

### 3.5.5.3 Scoring Procedure

Students were asked to encircle the number of the alternative on the very question paper itself. This avoided confusion and possible errors while marking answers on a separate paper. Each item was given a score of one. Thus the test had a maximum score of 50.

### 3.5.5.4 Reliability

The reliability of the test was established by the test – retest method. The Problem Solving Ability Test in Physics was administered to 40 students of Government Boys High School, Tirur and the retest was conducted after three weeks from first administration. Thus the reliability was calculated using the Pearson Correlation Coefficient Method for the test as a whole and for the three components separately.

The correlation coefficient of the Problem Solving Ability Test in Physics is furnished in the table 3.12.

**TABLE 3.12**  
**Test-Retest Reliability of**  
**Problem Solving Ability Test in Physics**

Name of the test/components	Pearson's correlation Coefficient (N=40)
Problem Solving Ability Test in Physics	0.74
Comprehending the Problem	0.61
Clarifying the Problem	0.56
Finding Solution to the Problem	0.54

The reliability values for the test and its components are reasonably high and hence the test is assumed to be reliable.

#### **3.5.5.5 Validity**

Since the test was prepared with the necessary theoretical support in identifying the subcomponents of Problem Solving Ability under the close supervision of expert teachers in the fields of Education and Psychology and since that the items were moulded so as to reflect the true intention of testing the particular sub-component, the Problem Solving Ability Test in Physics can be said to have content validity.

Also to ensure criterion validity the correlation was found out between the scores of the Problem Solving Ability Test in Physics with the scores of Nonverbal Intelligence Test (Raven's Standard Progressive Matrices) and Verbal Intelligence Test (Verbal Intelligence Test based

on triarchic theory). For this all the three tests were administered to 40 students of ninth standard of Government Boys Higher Secondary School, Tirur.

The validity coefficient of the Problem Solving Ability Test in Physics was calculated using the Pearson's correlation coefficient. The criterion validity with the Verbal Intelligence Test based on triarchic theory and its three components are furnished in the table 3.13

**TABLE 3.13**  
**Validity Coefficient of Problem Solving Ability Test in Physics with the Verbal Intelligence Test based on triarchic theory**

Name of the test/components	Pearson's correlation Coefficient (N=40)
Verbal Intelligence Test based on triarchic theory (Total Score)	0.56
Verbal Intelligence Test based on triarchic theory (part I)	0.37
Verbal Intelligence Test based on triarchic theory (part II)	0.47
Verbal Intelligence Test based on triarchic theory (part III)	0.45

Again the validity coefficient of the Problem Solving Ability Test in Physics was calculated using the Pearson's correlation coefficient by comparing it with the with the Nonverbal Intelligence Test and was found to be 0.55.

The Problem Solving Ability Test in Physics shows a fairly good correlation with the Nonverbal Intelligence and Verbal intelligence tests and hence it can be concluded that the test has the necessary criterion validity.

### 3.5.6 DESIGN OF MASTERY LEARNING UNITS

As detailed in Chapter II, mastery learning units were prepared keeping in mind the four basic tasks and their related subtasks as suggested by Block and Anderson (1985). The complete mastery model as detailed in chapter II served as the master plan in the execution phase of the intervention. Thus a mastery learning unit of instruction will include:

1. A general introduction
2. Specific Objectives
3. Pre-assessments
4. Primary instruction (3 or 4 lesson plans)
5. Alternative instruction
6. Formative evaluations
7. Summative evaluations

In accordance with the Mastery Learning model given in chapter II a format was designed for the actual implementation of the Mastery Learning Strategy in the real classroom situation. The flow chart in figure 3-1 demonstrates the phases of Mastery Learning Strategy used in the experiment.

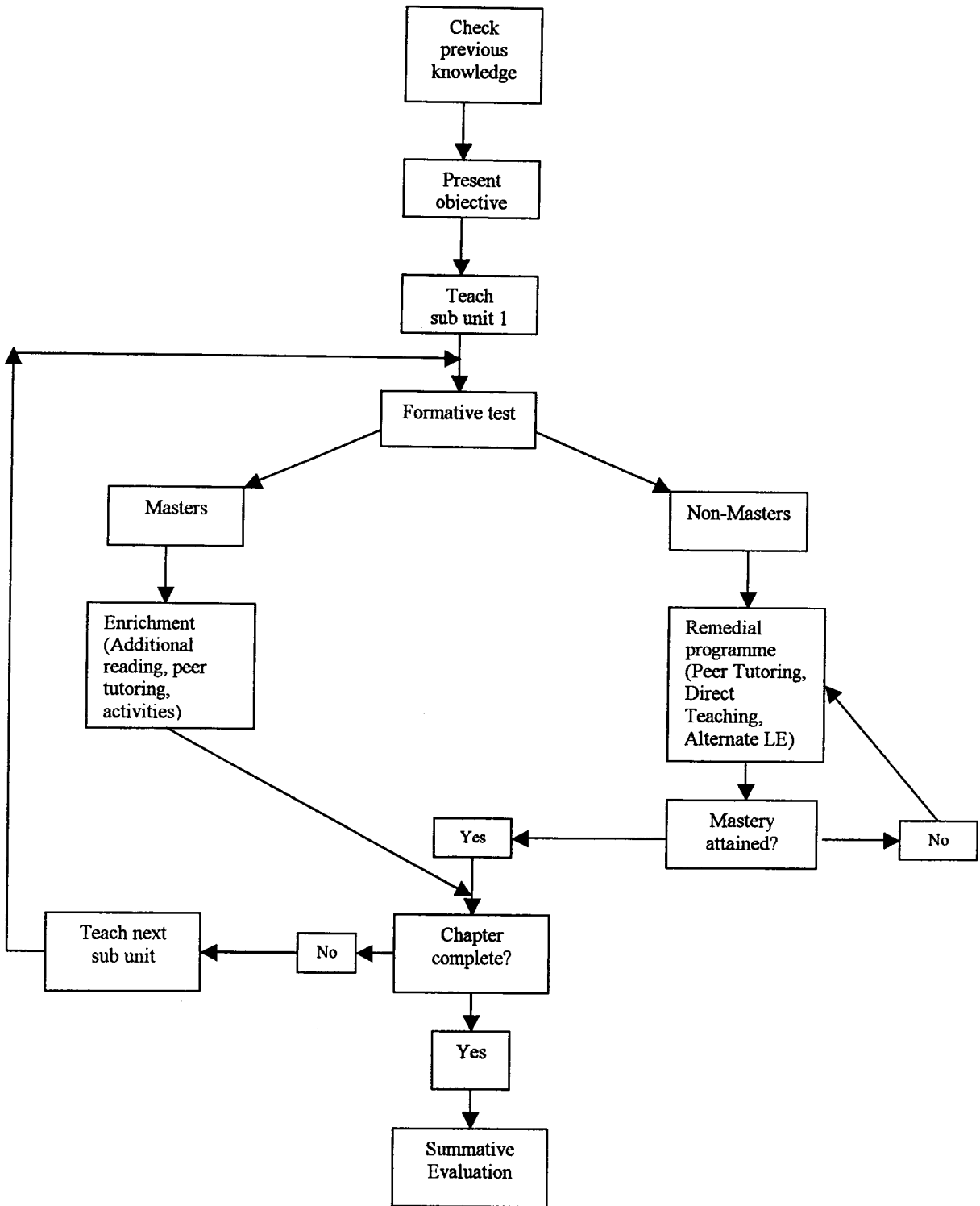


FIGURE 3-1. Flow chart indicating the phases of Mastery Learning Strategy (as employed in the real class room situation)

A sample format showing of the mastery learning subunits of the first chapter is given as Appendix I and a sample lesson plan with anticipated remedial measures and enrichment activities employed for Mastery Learning Strategy which forms part of this subunit is given as Appendix II.

The original learning experiences provided in both the groups- experimental and control groups- were the same for curriculum transaction. Thus the same lesson plan with the original set of learning experiences was employed in both groups for regular instruction. Additional learning experiences were provided apart from this to the experimental group in the form of enrichment activities / corrective measures which form part of the mastery learning cycle.

### **3.6 SAMPLE FOR THE STUDY**

The sample for the present study comprised of 74 students from two divisions, 9Q and 9G of Feroke Government Ganapet Vocational Higher Secondary School, Feroke.

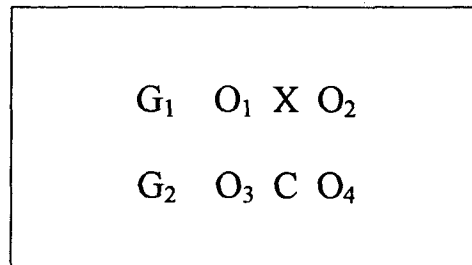
The school had 19 divisions for standard IX. Each division was a random mix of students of different achievement level, intelligence and socio-economic status since no criterion was used by the school to assign a student to a particular division. Each division included both boys and girls and roughly had strength of 40 students. The investigator had the freedom to choose two divisions from the 17 divisions for conducting the study. And thus the two divisions 9Q and 9G were selected on a random basis. Out of the two, 9Q was selected as the

control group and 9G as the experimental group purely on a random basis.

### **3.7 EXPERIMENTAL PROCEDURE**

#### **3.7.1 THE RESEARCH DESIGN**

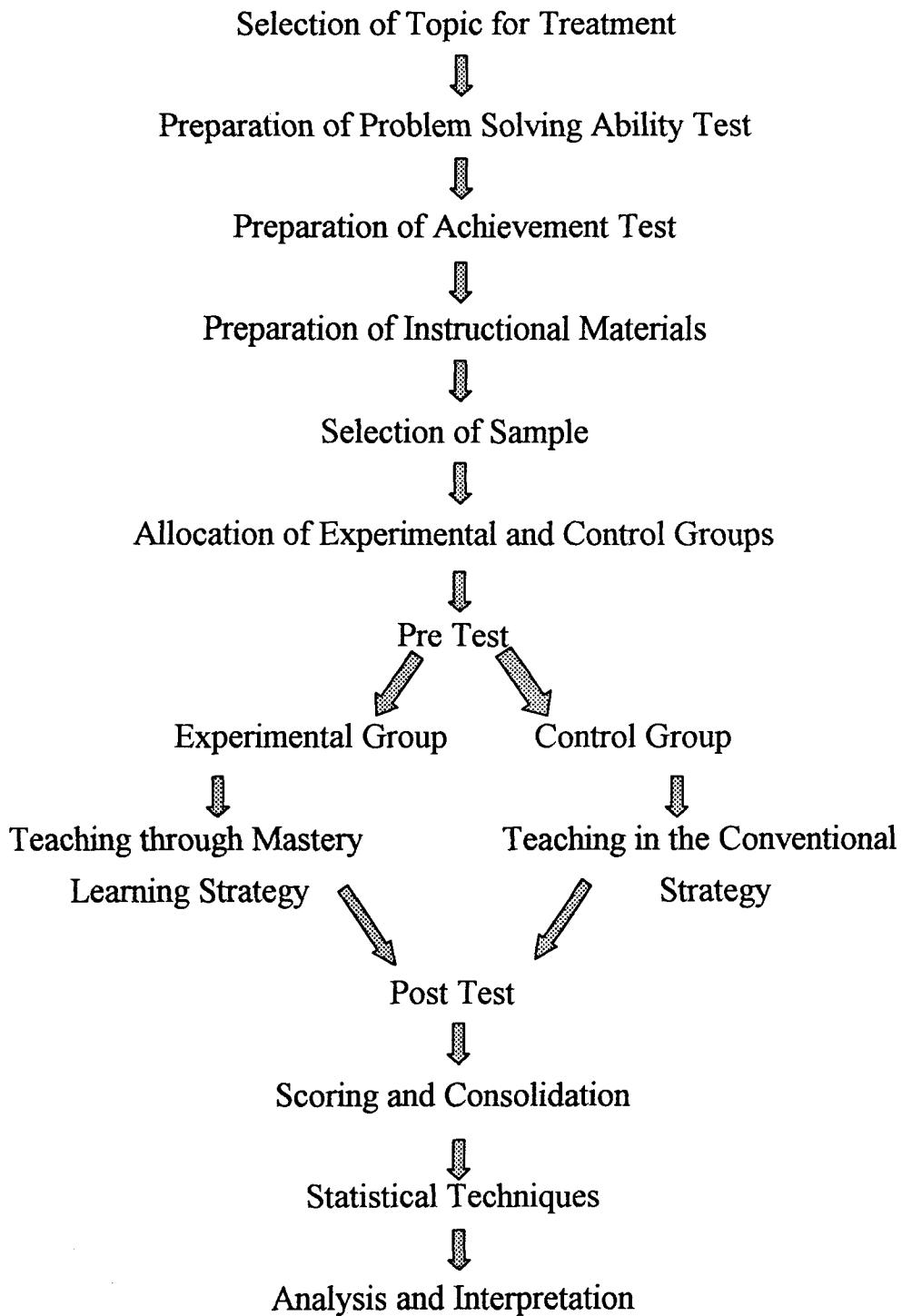
The symbolic representation of the study is given below



- $O_1, O_3$  - Pre tests
- $O_2, O_4$  - Post tests
- $O_2 - O_1$  - Gain Score
- $O_4 - O_3$  - Gain Score
- $G_1$  - Experimental Group
- $G_2$  - Control Group
- X - Application of Experimental Treatment
- C - Application of Control Treatment

The design of the present treatment is illustrated in the following chart.

**Chart showing the pivotal steps in the design of the study**



### 3.7.2 ALLOCATION OF EXPERIMENTAL GROUP AND CONTROL GROUP

The present study is an experimental one and the design applied here is pre-test post-test design. Two class divisions from the same school (Feroke Government Ganapet Vocational Higher Secondary School, Feroke.) were taken for the experiment. For this the investigator obtained permission from the headmistress of the school. The classes selected for the study were selected on a random basis. The two classes were tested for homogeneity by Multivariate ANOVA for Nonverbal Intelligence, Verbal Intelligence, sex and Socio-Economic Status and were found to be matching so as to be considered as homogeneous groups. Out of which one was assigned to be control group and other the experimental group on a random basis.

### 3.7.3 DATA COLLECTION PROCEDURE

The data required for the actual study was collected during the progressive stages of the treatment itself. The Nonverbal Intelligence, Verbal Intelligence and Previous Achievement were measured right at the beginning, as they were the variables to be treated as covariates. All the tests were administered during morning sessions before the commencement of the class.

#### 3.7.3.1 Pre Test

In the first stage of the experiment, apart from the measurement of nonverbal intelligence, Verbal Intelligence and Socio-Economic Status for ensuring the homogeneity of the groups- the initial scores on

achievement (Previous Achievement) and Problem Solving Ability were measured in both groups. For this the standardised achievement test and the standardised Problem Solving Ability test prepared by the investigator were given as pre test. The pre test scores on achievement were very low signifying the lack of competency over the content portion, yet to be taught. But the pre test scores on Problem Solving Ability showed a healthier distribution suggesting that Problem Solving Ability is more innate rather than trained or taught.

### **3.7.3.2 Experimental Treatment (The Mastery Learning Strategy)**

The investigator himself taught the experimental group as well as the control group. The experimental group was taught through Mastery Learning Strategy. The pattern of instruction followed in the experimental treatment is already detailed in section 3.5.6 of this chapter. Mastery Learning Strategy demands congruence among instructional components – the learning outcomes, instruction, evaluation and the feedback and corrective component. For example, if students are expected to learn higher level abilities such as those involved in application or analysis, mastery learning stipulates that instructional activities be planned to give students opportunities to engage actively in those abilities (Guskey, 1995). The new revised state curriculum is based on the problem solving way of learning with emphasis on activities and process skills during instruction. Evaluation also is in congruence with the instruction in the sense that the questions are out to test the higher-level outcomes of learning including Problem Solving Ability.

### **3.7.3.3 Control Treatment (The Conventional Strategy of Teaching)**

The control group was taught in the Conventional Strategy. The Conventional Strategy denotes the new method associated with the new curricular revision, which emphasizes the constructivist viewpoint of learning. Thus the teaching–learning process is more activity oriented and promotes collaborative learning so as to develop process skills and Problem Solving Ability.

This would mean that the interventions in the groups differed only in the pattern of instruction- the mastery learning pattern; whereas the learning experiences employed to produce learning outcomes remained the same in both groups. Hence the investigator could do justice to both the experimental group as well as the control group by teaching them with emphasis to problem solving approach and development of process skills by virtue of the fact that the new textbook is written on these lines- upholding the spirit of constructivist learning.

The time taken for the entire treatment session was three months for both the study groups. However the actual instructional time spent in the experimental group for teaching through the Mastery Learning Strategy was much more than what was spent in the control group. The actual instructional time taken in periods is illustrated in the table 3.14.

TABLE 3.14

**Time taken in the two Strategies of teaching  
(Mastery Learning Strategy and the Conventional Strategy)**

<b>Unit No.</b>	<b>Periods in control group</b>	<b>Periods in experimental group</b>
Unit 1	6	10
Unit 2	5	9
Unit 3	6	10
Unit 4	6	10
<b>Total</b>	<b>23</b>	<b>39</b>

#### **3.7.3.4 Administration of Post Test**

The standardised achievement test and the standardised Problem Solving Ability Test were re-administered after the completion of the treatment period of three months.

#### **3.7.3.5 Scoring and Consolidation of data**

The Nonverbal Intelligence test, Verbal Intelligence test and Problem Solving Ability test were administered as paper pencil tests with no time restriction. The scoring of the Problem Solving Ability test was made on the question paper itself and was scored appropriately using a scoring key. The scoring key is given as Appendix VI. The difference between the posttest and the pretest (the gain score) was taken as a measure of the Problem solving ability. The Problem solving ability scores were calculated component wise as well as totally. Thus the maximum score for the first component of Problem Solving Ability

was 11, the maximum score for the second component of Problem Solving Ability was 17, the maximum score for the third component of Problem Solving Ability was 22 and the maximum score for Problem Solving Ability as a whole was 50.

The achievement test was scored using a suitable scoring key and marking scheme, the copy of which is given as Appendix X. The maximum marks for the achievement test was 35 and the test was to be performed in time duration of 40 minutes. The pretest scores were taken as the measure of Previous Achievement. Even though it was not essential in the study, the gain scores in achievement (the difference between the posttest scores and the pretest scores) were found out simply to compare the achievement gain in the two study groups.

The Verbal Intelligence test was administered in the initial stage of the study and was scored with the appropriate scoring key. Similarly, The Standard Progressive matrices was to be administered at the initial stage of the study. This was scored with the help of scoring key and guidelines given in the Manuel for Raven's Progressive Matrices and Vocabulary Series (1996) authored by Raven, J. C., et al. The Socio – Economic Status Scale was administered before the treatment and was used only for statistical matching of the study groups.

The subjects were students of divisions, 9Q and 9G of Feroke Government Ganapet Vocational Higher Secondary School, Feroke. Even though two intact divisions were taken for study some students who were repeaters and some who were not punctual in the class were avoided for the final data analysis. The table 3.15 shows the number of

subjects in the experimental and control groups who were taken in to consideration for final data analysis.

**TABLE 3.15**

**Actual number of subjects for final data analysis**

<b>Nature of Group</b>	<b>Boys</b>	<b>Girls</b>	<b>Total</b>
Experimental Group	20	17	37
Control Group	20	17	37
<b>Total</b>	<b>40</b>	<b>34</b>	<b>74</b>

### 3.7.4 PROCEDURE USED FOR ANALYSIS OF DATA

The hypotheses of the present study were tested by employing appropriate statistical techniques. The major statistical processing like ANOVA and ANCOVA were done using computer facility with the software STATISTICA Ver. 5.1 (1995). To analyse the effects of factors like, Nonverbal Intelligence, Verbal Intelligence, Previous Achievement etc, the subjects were classified into two levels each with respect to the factors.

#### 3.7.4.1 Classificatory Techniques

The classifications of the subjects into two groups were done with respect to Nonverbal Intelligence, Verbal Intelligence and Previous Achievement. In each case, median was taken as the cut off point and subjects with scores less than the median score fell into the below

average category whereas, subjects with scores equal to or greater than the median score moved into the above average category.

**Classification based on Nonverbal Intelligence.**

Subjects were classified into Below-Average-Nonverbal-Intelligence Group and Above-Average-Nonverbal-Intelligence Group on the basis of nonverbal intelligence test scores. Median was used as the cutoff point since the sample for experimentation was not large. In the present study, the median point for nonverbal intelligence of total sample was 40. Subjects who scored below the median point were classified as the Below-Average-Nonverbal-Intelligence Group (BANI) and those subjects who scored equal to or above than the median point were classified as the Above-Average-Nonverbal-Intelligence Group (AANI). The number of subjects who fell under each category when this classification was effected in the case of total subjects, girls and boys, is detailed in the table 3.16.

**TABLE 3.16**

**Classification of subjects on the basis of Nonverbal Intelligence**

	Boys		Girls		Total Sample	
	BANI	AANI	BANI	AANI	BANI	AANI
Control Group	10	10	8	9	18	19
Exptl Group	10	10	9	8	19	18
Total	20	20	17	17	37	37

**Classification based on Verbal Intelligence**

Subjects were classified into Below-Average-Verbal-Intelligence Group and Above-Average-Verbal-Intelligence Group on the basis of Verbal Intelligence test scores. Median was used as the cutoff point since the sample for experimentation was not large. In the present study, the median point for Verbal Intelligence of total subjects was 14.5. Subjects who scored below the median point were classified as the Below-Average-Verbal-Intelligence Group (BAVI) and those subjects who scored equal to or above than the median point were classified as the Above-Average-Verbal-Intelligence Group (AAVI). The number of subjects who fell under each category when this classification was effected in the case of total subjects, girls and boys, is detailed in the table 3.17.

**TABLE 3.17**

**Classification of subjects on the basis of Verbal Intelligence**

	Boys		Girls		Total Sample	
	BAVI	AAVI	BAVI	AAVI	BAVI	AAVI
Control Group	12	8	8	9	20	17
Exptl. Group	10	10	7	10	17	20
Total	22	18	15	19	37	37

**Classification based on Previous Achievement.**

Subjects were classified into Below-Average-Previous Achievement Group and Above-Average-Previous Achievement Group on the basis of Achievement pre-test scores. Median was used as the

cutoff point since the sample for experimentation was not large. In the present study, the median point for Previous Achievement of total subjects was 3. Subjects who scored below the median point was classified as the Below-Average-Previous Achievement Group (BAA) and those subjects who scored equal to or above than the median point were classified as the Above-Average-Previous Achievement Group (AAA).

**TABLE 3.18**

**Classification of subjects on the basis of Previous Achievement**

	Boys		Girls		Total Sample	
	BAA	AAA	BAA	AAA	BAA	AAA
Control Group	12	8	5	12	17	20
Exptl Group	7	13	5	12	12	25
Total	19	21	10	24	29	45

### **3.8 STATISTICAL TECHNIQUES USED**

The statistical techniques used for the analysis of the data in the present study were

#### **3.8.1 ONE WAY ANCOVA**

Effect of Mastery Learning Strategy on the Problem Solving Ability over the Conventional Strategy of Teaching was examined using one way ANCOVA. Since the experiment was conducted using intact classes of pupils of standard IX, it was suspected that classes differ slightly in Nonverbal Intelligence, Verbal Intelligence, Socio-Economic

Status and Previous Achievement in spite of checking the homogeneity of the groups. In such situation Analysis of Covariance serves the purpose of statistically removing the effects of extraneous variables from the dependent variable. Situations arise, however, where the effect of a classification variable is of main interest, or the investigator has to use intact groups for different treatments. The groups are then unlikely to be equivalent. The Analysis of Covariance may be used to adjust for the initial difference among the groups on certain known variables (Ferguson, 1989). This statistical technique represents an extension of Analysis of Variance to allow for the correlation between initial and final score.

ANCOVA serves the purpose of statistically removing the effects of extraneous variables from the dependent variable (Ferguson, 1996). In the present study, ANCOVA is used to remove statistically the effects of the extraneous cognitive variables (Nonverbal Intelligence, Verbal Intelligence and Previous Achievement in Physics) which would have an effect upon the dependent variable, the Problem Solving Ability.

Post hoc comparisons were done between pairs of groups of the selected variables wherever F-ratios were found to be significant in ANCOVA. t-Test was used for this purpose and the mean gain scores were compared with respect to the standard deviations of the group. The t values further confirmed the difference between the groups and the higher mean score indicated the direction of difference.

### 3.8.2 THREE WAY ANOVA

Following these analyses three way ANOVA were performed for those components of Problem Solving Ability in which the effect of Instructional Strategy showed a significant difference. This was performed to find out the main effects and interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the relevant component of Problem Solving Ability.

Further analysis of variance was done for testing the main effects and interaction effect of Instructional Strategy and Previous Achievement on those components of Problem Solving Ability for which the effect of Instructional Strategy showed a significant difference. The researcher considered examining the interaction effects of intelligence with Instructional Strategy and that of Previous Achievement with Instructional Strategy separately. At first, the main effects and interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability components were tested using ANOVA. Hence the ANOVA technique used is in the 2 X 2 X 2 factorial design. Also this was to be performed for the total sample as well as for boys and girls separately.

### 3.8.3 TWO WAY ANOVA

Further to examine the main effects and interaction effect of Instructional Strategy and Previous Achievement, on the components of Problem Solving Ability, two way analysis of variance was performed with 2X2 factorial design.

## **ANALYSIS AND INTERPRETATION**

- Preliminary Analysis
- Effect of Mastery Learning Strategy on Problem Solving Ability
- Effect of Mastery Learning Strategy on the components of Problem Solving Ability
- Main effects and interaction effects of Instructional strategy, Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem
- Main effects and interaction effects of Instructional Strategy and Previous Achievement on Clarifying the Problem.

## **ANALYSIS AND INTERPRETATION**

The core purpose of the present study was to determine the effect of Mastery Learning Strategy on the Problem Solving Ability in Physics of secondary school students.

The focus of the study was to determine the effect of Instructional Strategy (Mastery Learning strategy/Conventional Strategy of Teaching) on Problem Solving Ability in Physics of secondary school students, treating Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates. For this ANCOVA was performed for the total sample.

Further analysis was done to test whether the effect of the strategy was significant on the three components of Problem Solving Ability. Three separate ANCOVA were performed for the three components namely, Comprehending the Problem, Clarifying the Problem and Finding Solution to the Problem whereas the independent variable, Instructional Strategy and the covariates viz; Nonverbal Intelligence, Verbal Intelligence and Previous Achievement remained the same.

Following these analyses three way ANOVA were performed for those components of Problem Solving Ability in which the effect of strategy showed a significant difference. This was performed to find out the main effects and interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the relevant component of Problem Solving Ability.

Further analysis of variance was done for testing the main effects and interaction effect of Instructional Strategy and Previous Achievement on those components of Problem Solving Ability for which the effect of Instructional Strategy showed a significant difference.

#### **4.1 PRELIMINARY ANALYSIS**

The groups for the study were selected on a random basis. The study groups and the sex groups were tested for homogeneity by Multivariate ANOVA for Nonverbal Intelligence, Verbal Intelligence, and Socio-Economic Status. The result of the MANOVA is given in Table 4.1.

**TABLE 4.1**  
**Summary of Multivariate ANOVA**  
**for the two study groups and sex groups**

<b>Source of Variation</b>	<b>Wilks' Lambda</b>	<b>Rao's R</b>	<b>df 1</b>	<b>df 2</b>	<b>p-level</b>
Instructional Strategy	0.99	0.07	3	68	0.97
Sex	0.94	1.28	3	68	0.28
Instructional Strategy-Sex interaction	0.94	1.34	3	68	0.26

The table 4.1 shows that the differences in Nonverbal Intelligence, Verbal Intelligence, and Socio-Economic Status are not

significant at 0.05 level between the classes. Also it becomes evident that the differences in Nonverbal Intelligence, Verbal Intelligence, and Socio-Economic Status are not significant at 0.05 level between the sex groups. Considering the interaction effect between the class and the sex groups, it can be seen that the differences in Nonverbal Intelligence, Verbal Intelligence, and Socio-Economic Status are not significant at 0.05 level between the sex groups within the classes.

Hence it is concluded that the study groups (Control /Experimental) are homogeneous with respect to Nonverbal Intelligence, Verbal intelligence and Socio-Economic Status. Also the Nonverbal Intelligence, Verbal intelligence and Socio -economic Status scores are homogeneous within the sex group for experimental as well as Control group.

Even though the two study groups were considered to be homogeneous, slight initial differences in cognitive variables viz; Previous Achievement, Nonverbal Intelligence and Verbal intelligence needed to be controlled so as to assess the effect of the Instructional Strategy on Problem Solving Ability and hence the right statistical technique could be Analysis of Covariance by which the effects of the extraneous variables are controlled.

### **Basic Assumptions of ANCOVA**

Prior to ANCOVA, the data used for analysis was subjected to a thorough examination with a view to know whether the data is sufficient to satisfy the major assumption suggested by Winer (1977), Ferguson

(1971) and Widt and Ahtola (1978) to carry over the ANCOVA procedure.

1. The scores on the dependent variable are a linear combination of independent components, an over all mean, a treatment effect, a linear covariate effect and an error term.
2. The error is normally and independently distributed with mean zero and variance  $\sigma^2E$ .
3. The (weighted) sum of all groups of the treatment/ group effect is zero.
4. The coefficient of the covariate (slope of the regression line) is the same for each treatment group.
5. The covariate is a fixed mathematical variable measured without error, not a stochastic variable.

### **Tests for Basic Assumptions**

To satisfy the basic assumptions of ANCOVA procedure, the collected data were specifically analysed and examined. For this the Normal probability plots for the dependent variable for each group were tested and the values were found to be normal. Entire computations were done using the software, STATISTICA Version 5.1 (1995).

The various plots for each dependent variable viz; (i) Total score of Problem Solving Ability (ii) Score of the first component of Problem Solving Ability (Comprehending the Problem) (iii) Score of the second component of Problem Solving Ability (Clarifying the Problem) and

(iii) Score of the third component of Problem Solving Ability (Finding Solution to the Problem) are given in Figures 4-1, 4-2, 4-3 and 4-4. Also the variances within the group were checked and were found to be homogeneous with respect to the covariates in the case of each dependent variable.

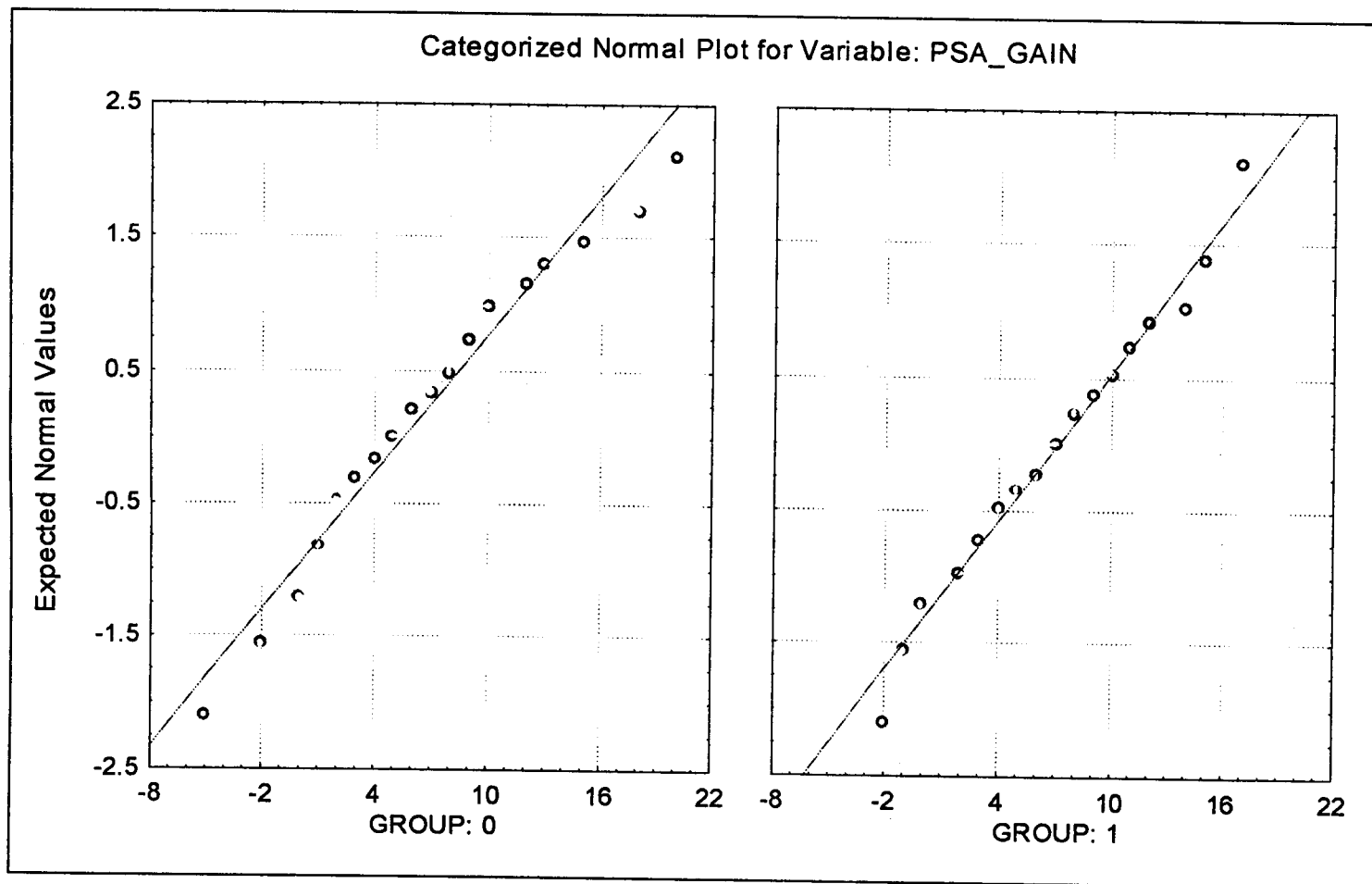


FIGURE 4-1 Categorized Normal Plot for Control group and Experimental group for the dependent variable: Problem Solving Ability. Group 0 represents the Control group and Group 1 represents the Experimental group.

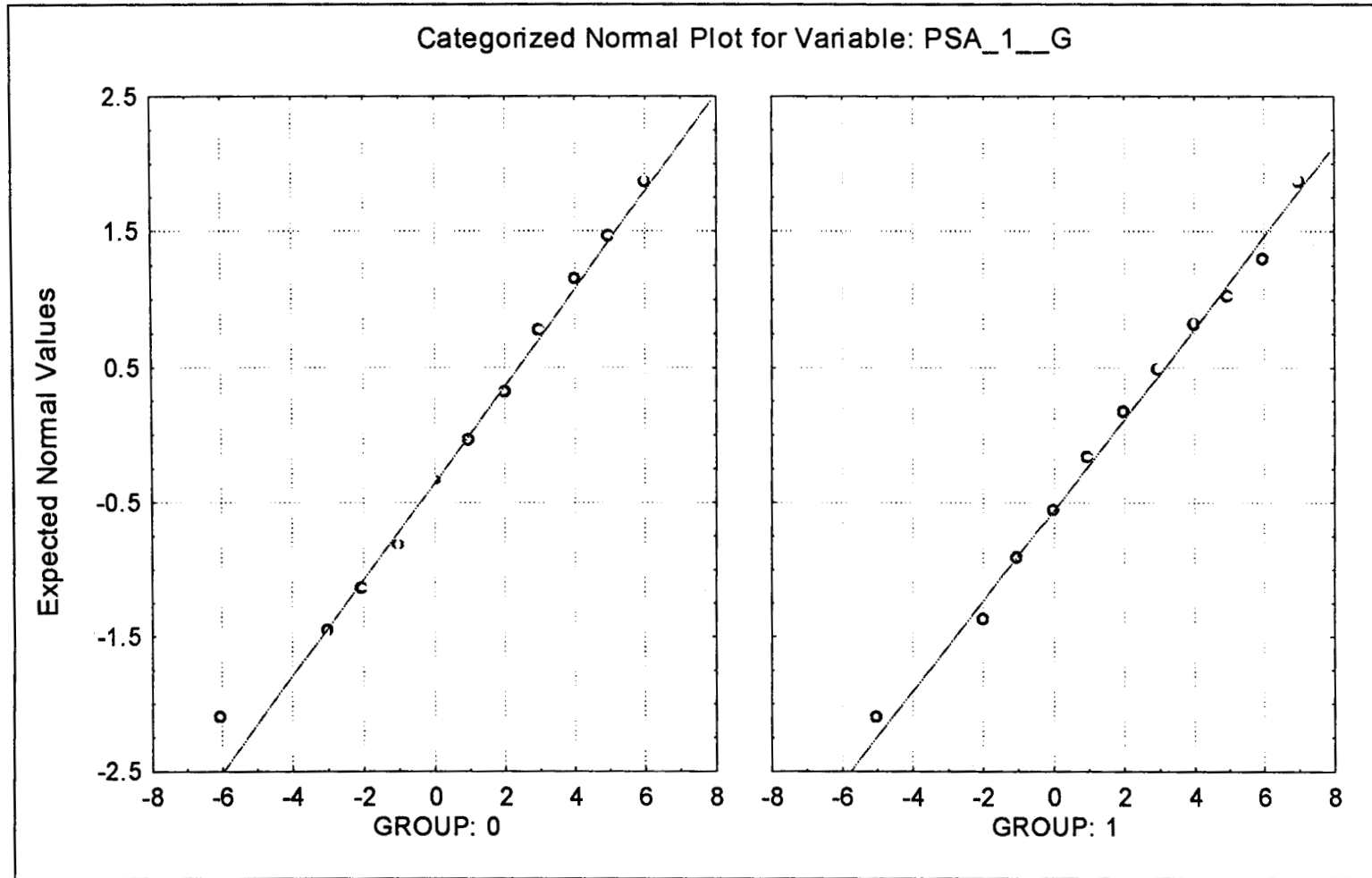


FIGURE 4-2 Categorized Normal Plot for Control group and Experimental group for the dependent variable: Comprehending the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA\_1\_G stands for the variable, Comprehending the Problem

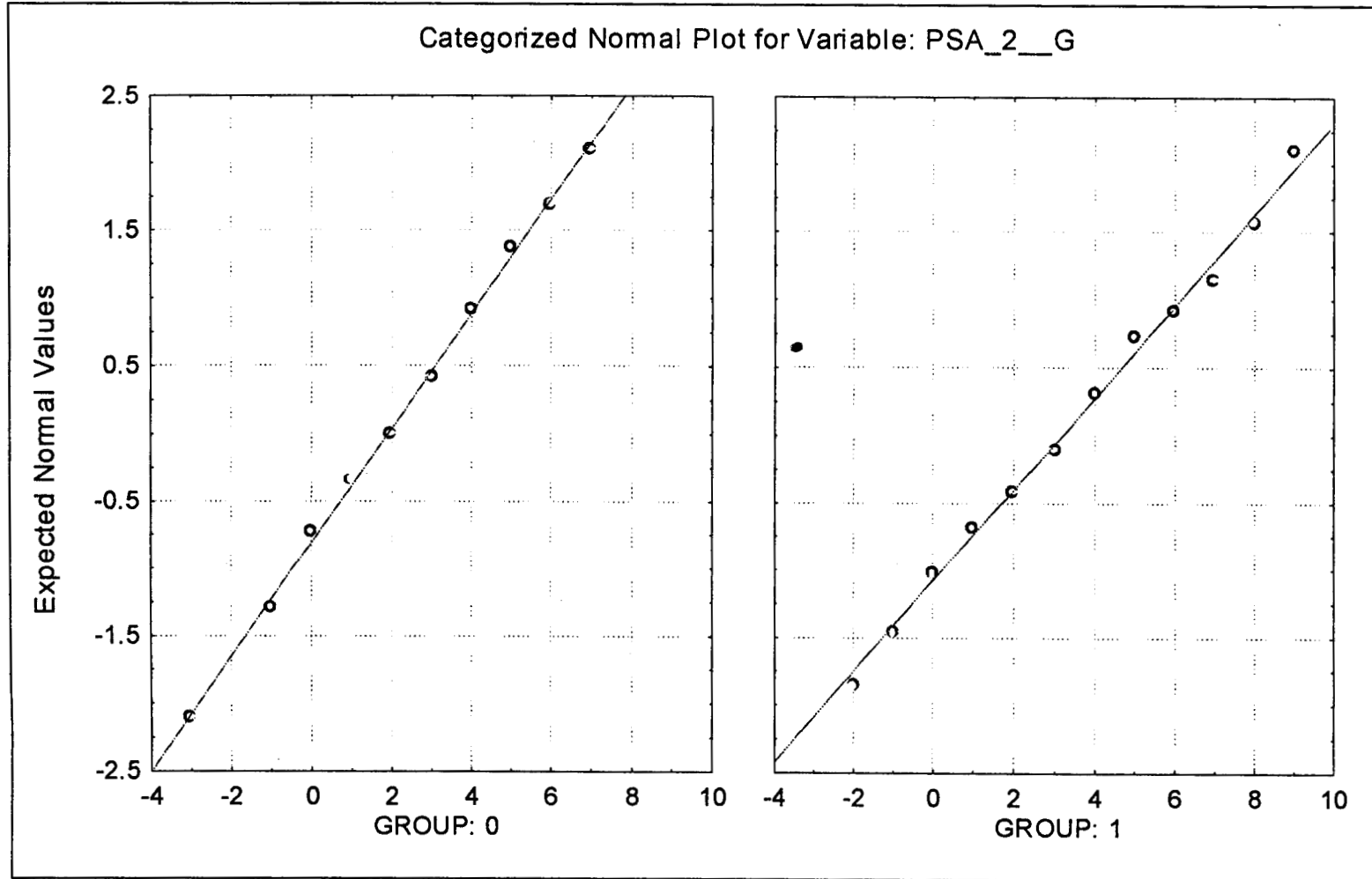


FIGURE 4-3 Categorized Normal Plot for Control group and Experimental group for the dependent variable: Clarifying the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA\_2\_G stands for the variable, Clarifying the Problem

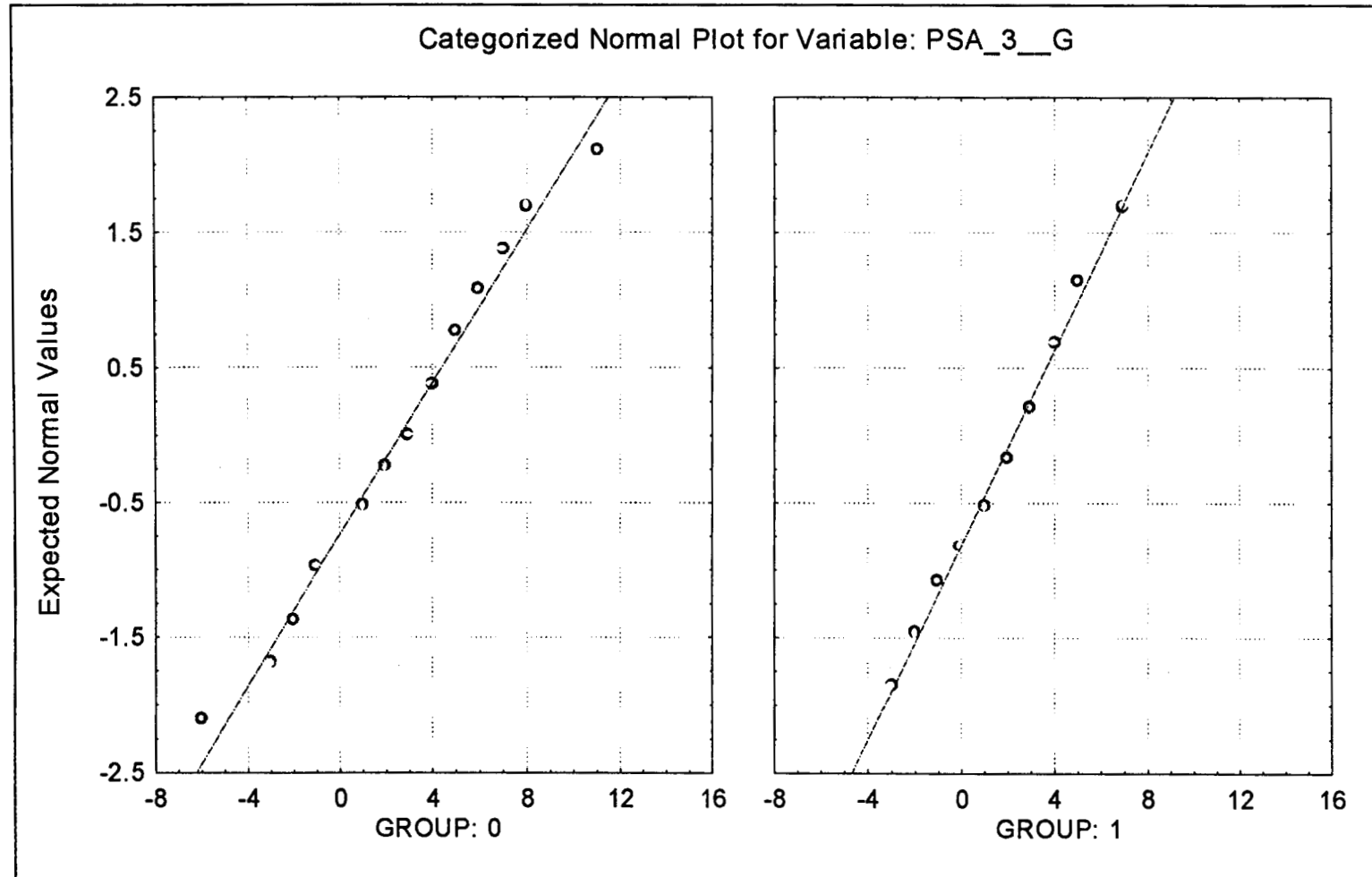


FIGURE 4-4 Categorized Normal Plot for Control group and Experimental group for the dependent variable: Finding Solution to the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA\_3\_G stands for the variable, Finding Solution to the Problem.

The categorized plots in the figures given above ascertain that the distribution of the scores of dependent variables viz; (i) Total score of Problem Solving Ability (ii) Score of the first component of Problem Solving Ability (Comprehending the Problem) (iii) Score of the second component of Problem Solving Ability (Clarifying the Problem) and (iii) Score of the third component of Problem Solving Ability (Finding Solution to the Problem) are normal in both Experimental as well as Control groups. Thus it validates the use of ANCOVA upon the sample.

Further to test the homogeneity of variances within the group for Experimental as well as Control groups with respect to the covariates in the case of each dependent variable, the F-max, C and Chi-square values were found out to see whether the variances are homogeneous. The table 4.2 exhibits the differences in variances among the Experimental and Control groups indicated by the F-max, C and Chi-square values for the variables Comprehending the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.

TABLE 4.2

**Homogeneity of Variances of the  
variables Comprehending the Problem, Nonverbal  
Intelligence, Verbal Intelligence and Previous Achievement**

<b>Tests of Homogeneity of Variances</b>					
<b>Variables</b>	<b>Hartley F-max</b>	<b>Cochran C</b>	<b>Bartlett Chi-sqr</b>	<b>df</b>	<b>p-level</b>
Comprehending the Problem	1.14	0.53	0.16	1	0.68
Nonverbal Intelligence	1.00	0.50	0.0	1	0.99
Verbal Intelligence	1.41	0.58	1.06	1	0.30
Previous Achievement	1.04	0.51	0.02	1	0.88

The test reveals that the differences in variances in the Experimental and Control groups are not statistically significant for all the four variables viz; Comprehending the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.

The table 4.3 exhibits the differences in variances among the Experimental and Control groups indicated by the F-max, C and Chi-square values for the variables Clarifying the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.

TABLE 4-3

**Homogeneity of Variances of the  
variables, Clarifying the Problem, Nonverbal  
Intelligence, Verbal Intelligence and Previous Achievement**

<b>Tests of Homogeneity of Variances</b>					
<b>Variables</b>	<b>Hartley F-max</b>	<b>Cochran C</b>	<b>Bartlett Chi-sqr</b>	<b>df</b>	<b>p-level</b>
Clarifying the Problem	1.58	0.61	1.84	1	0.17
Nonverbal Intelligence	1.00	0.50	0.0	1	0.99
Verbal Intelligence	1.41	0.58	1.06	1	0.30
Previous Achievement	1.04	0.51	0.02	1	0.88

The test reveals that the differences in variances in the Experimental and Control groups are not statistically significant for all the four variables viz; Clarifying the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.

The table 4.4 exhibits the differences in variances among the Experimental and Control groups indicated by the F-max, C and Chi-square values for the variables Finding Solution to the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.

TABLE 4.4

**Homogeneity of Variances of the  
variables Finding Solution to the Problem, Nonverbal  
Intelligence, Verbal Intelligence and Previous Achievement**

<b>Tests of Homogeneity of Variances</b>					
<b>Variables</b>	<b>Hartley F-max</b>	<b>Cochran C</b>	<b>Bartlett Chi-sqr</b>	<b>df</b>	<b>p-level</b>
Clarifying the Problem	1.69	0.62	2.46	1	0.11
Nonverbal Intelligence	1.00	0.50	0.0	1	0.99
Verbal Intelligence	1.41	0.58	1.06	1	0.30
Previous Achievement	1.04	0.51	0.02	1	0.88

The test reveals that the differences in variances in the Experimental and Control groups are not statistically significant for all the four variables viz; Finding Solution to the Problem, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement.

The above plots and the tests of homogeneity validate the sanctity of using ANCOVA in the sample for the study.

## 4.2. EFFECT OF MASTERY LEARNING STRATEGY ON PROBLEM SOLVING ABILITY

The effect of the Mastery Learning Strategy upon the Problem Solving Ability was tested using ANCOVA with Instructional Strategy as the independent variable and Problem Solving Ability (Total gain score of Problem Solving Ability) as the dependent variable treating the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates. Table 4.5 shows the result of the ANCOVA performed for the total sample.

**TABLE 4.5**  
**Summary of**  
**Analysis of Covariance with**  
**Instructional Strategy as the independent variable**  
**and Problem Solving Ability as the dependent variable**  
**treating the cognitive variables namely, Nonverbal Intelligence,**  
**Verbal Intelligence and Previous Achievement as covariates**

Source of Variation	df Effect	MS Effect	df Error	MS Error	F	p-level
Instructional Strategy	1	28.46	69	26.57	1.07	0.30

The table 4.5 shows that the F value obtained is 1.07 at 69 degrees of freedom, which acquires statistical significance only at a probability level of 0.30. The required value for F to be significant at 0.05 level for 69 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on the total score of Problem Solving Ability is not statistically significant.

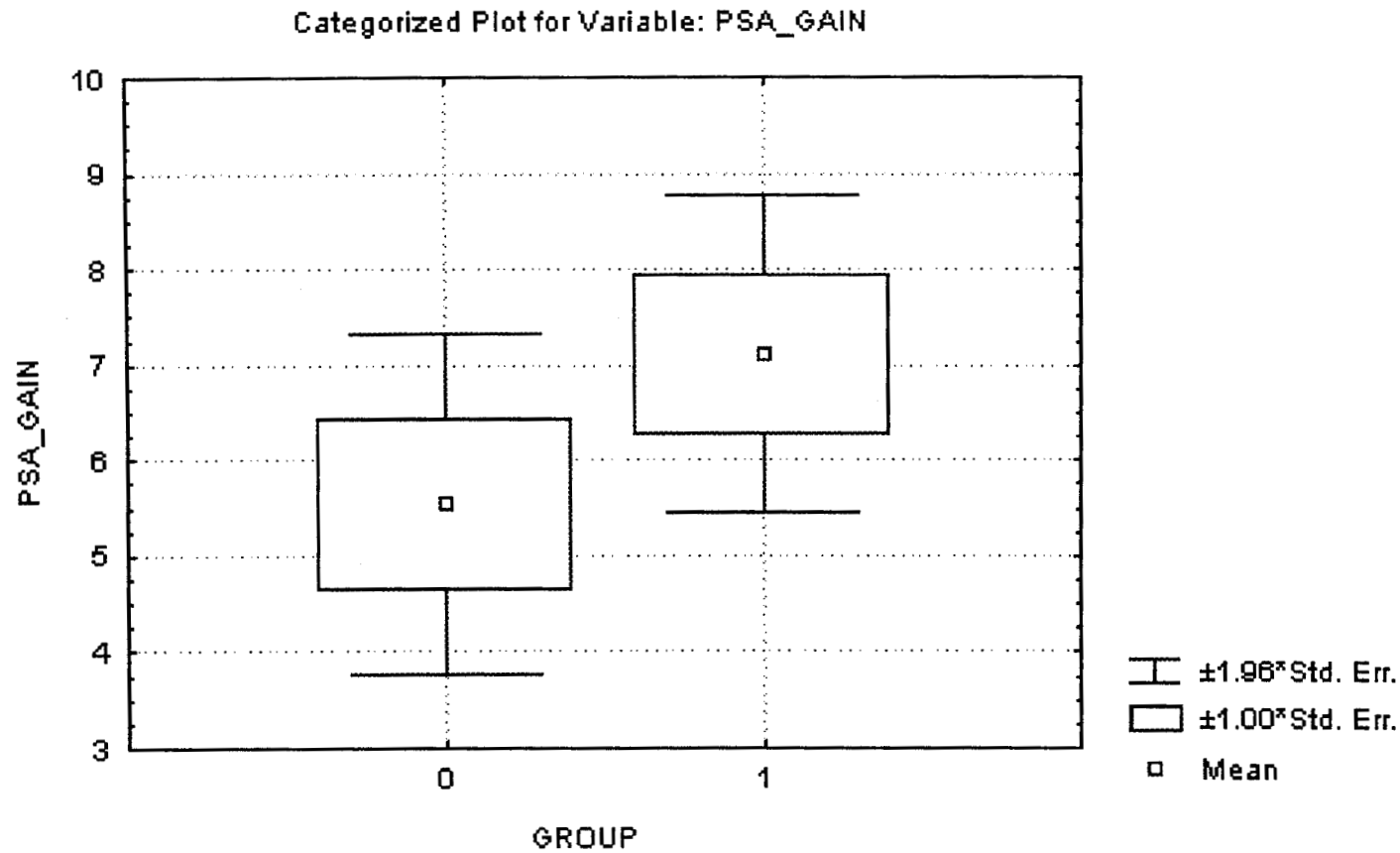


FIGURE 4-5 Categorized Plot for Control group and Experimental group for the dependent variable: Problem Solving Ability. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA\_GAIN stands for the variable, Problem Solving Ability.

The table 4.5 and the figure 4-5 reveal that Mastery Learning Strategy does not affect the total score of Problem Solving Ability. Thus by analysis it was ascertained that Mastery Learning Strategy does not significantly foster the mental processes and skills associated with Problem Solving of students better than the Conventional Strategy.

### **Comment**

This result contradicts the research studies which show that Mastery Learning is highly effective when instruction focuses on high-level outcomes such as problem solving, drawing inferences, deductive reasoning and creative expression (Arredondo and Block 1990, Mevarech 1985, Soled 1987).

The present study was undertaken in the changed context of the new school curriculum of the state of Kerala, which emphasizes Problem Solving approach in the mode of transaction of the curriculum as well as in the presentation of content in the textbook. Thus Mastery Learning Strategy was studied against the Conventional Strategy based on collaborative learning and problem solving approach. The result of this investigation thus, could either mean that Mastery Learning Strategy is not exceedingly good when compared to the Conventional Strategy presently practised in schools or the Conventional Strategy presently practised in schools is as good as the Mastery Learning Strategy in fostering Problem Solving Ability.

All the same, it is of special interest to monitor the gain in achievement made by the two study groups. Achievement as well as Previous Achievement was measured using the same Achievement test

prepared by the investigator. Whereas the pre test scores served as a measure of Previous Achievement, the gain scores, that is, the difference in the posttest scores and the pretest scores served as the measure of achievement for both the study groups. To compare the mean gain in achievement among the study groups, t-test for small sample size was employed and the result shows that the Experimental group had an advantage in gain scores with mean value 17.74 and standard deviation 5.27 while the Control group had a lower value of gain score with mean value 13.85 and standard deviation of 4.60. The t-value obtained is 3.39 for 72 degrees of freedom. And hence the difference between the mean gain scores is statistically significant even at 0.001 level. The result shows that the effect of Mastery Learning Strategy on achievement is significant.

Thus the proven theory that Mastery Learning Strategy increases achievement is applicable in this study also; but what is strikingly noticeable is that the strategy is not better than the conventional Strategy in effecting an increase in Problem Solving Ability.

Looking at the pre test scores of Achievement as well as Problem Solving Ability, the difference is once again striking. The pre test scores on Achievement were very low signifying the lack of competency over the content portion, yet to be taught. But the pre test scores on Problem Solving Ability showed a healthier distribution suggesting that Problem Solving Ability is more innate rather than trained or taught.

While checking the correlation between the gain scores in achievement and the gain scores of Problem Solving Ability in the total sample, it can be seen that the correlation coefficient is only 0.47. This

reveals that the constructs, Problem solving Ability and Achievement are not highly correlated.

In spite of the result that Mastery Learning Strategy did not increase the total score of Problem Solving Ability, the effect of Mastery Learning Strategy on the individual components of Problem Solving Ability was studied.

### **4.3 EFFECT OF MASTERY LEARNING STRATEGY ON THE COMPONENTS OF PROBLEM SOLVING ABILITY**

This section deals with the tests to check whether there is significant effect of Mastery Learning Strategy upon any of the components of the Problem Solving Ability viz; Comprehending the Problem, Clarifying the Problem and Finding Solution to the Problem.

#### **4.3.1 EFFECT OF MASTERY LEARNING STRATEGY ON COMPREHENDING THE PROBLEM**

This was tested using ANCOVA with Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) as the independent variable, Problem Solving Ability component No.1 (Total gain score of Problem Solving Ability component No.2 viz; Comprehending the Problem) as the dependent variable and the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement were treated as covariates. Given below is the result of the ANCOVA performed for the total sample.

**TABLE 4.6**  
**Summary of**  
**Analysis of Covariance with**  
**Instructional Strategy as the independent variable**  
**and Comprehending the Problem as the dependent variable**  
**treating the controlled variables namely, Nonverbal Intelligence,**  
**Verbal Intelligence and Previous Achievement as covariates**

Source of Variation	df Effect	MS Effect	df Error	MS Error	F	p-level
Instructional Strategy	1	10.77	69	7.16	1.50	0.22

The table 4.6 shows that the F value obtained is 1.50 at 69 degrees of freedom, which acquires statistical significance only at a probability level of 0.22. The required value for F to be significant at 0.05 level for 69 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Comprehending the Problem is not statistically significant.

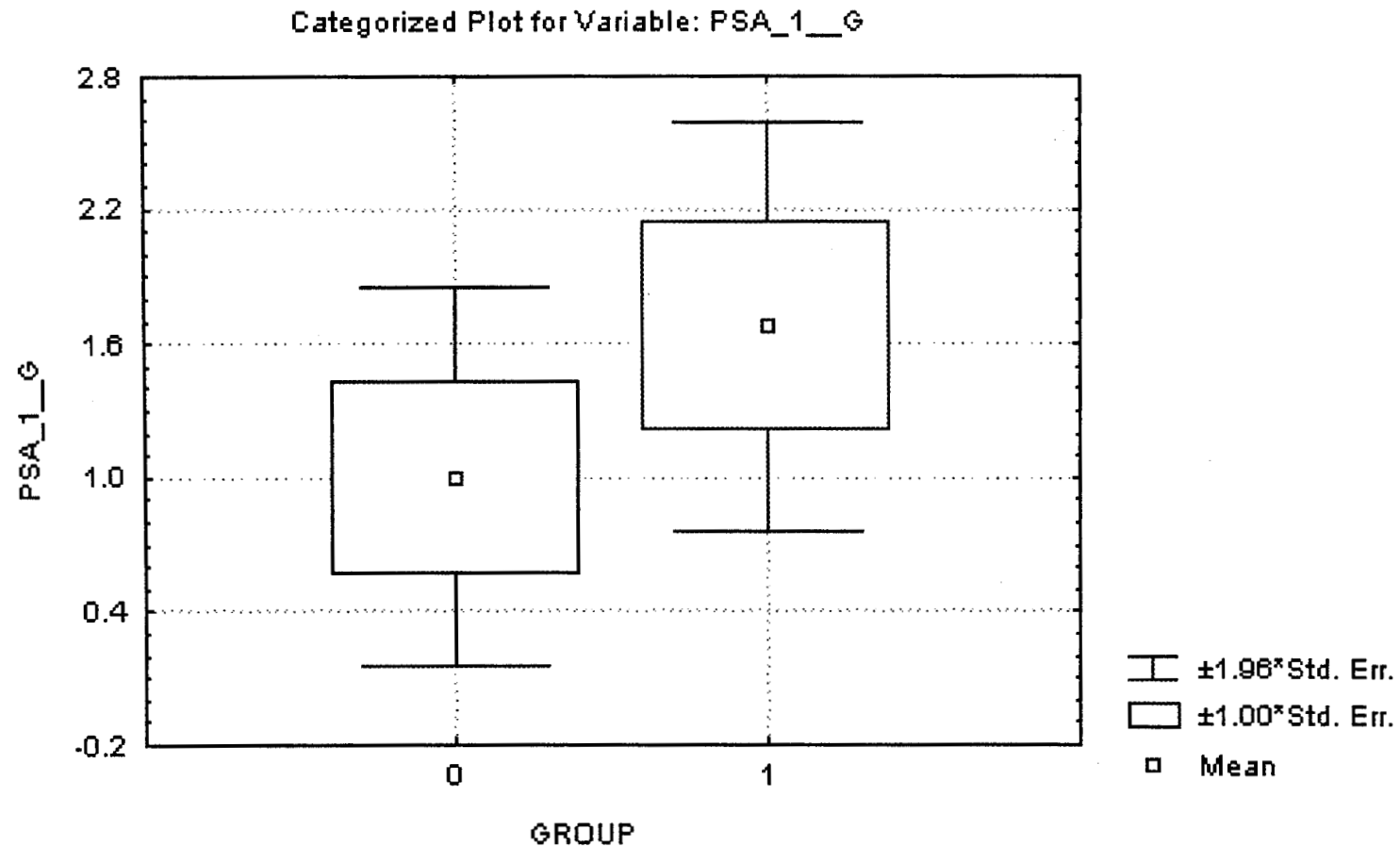


FIGURE 4-6 Categorized Plot for Control group and Experimental group for the dependent variable: Comprehending the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA\_1\_G stands for the variable, Comprehending the Problem.

The table 4.6 and the figure 4-6 reveal that Mastery Learning Strategy does not significantly improve Comprehending the Problem of students than the Conventional Strategy in Physics of Standard IX.

Thus by analysis it was ascertained that Mastery Learning Strategy does not significantly foster the mental processes and skills associated with Comprehending the Problem of students in Physics of Standard IX better than the Conventional Strategy.

#### 4.3.2 EFFECT OF MASTERY LEARNING STRATEGY ON CLARIFYING THE PROBLEM

To see whether there is an effect of Mastery Learning Strategy upon the second component of the Problem Solving Ability, ANCOVA was used with Instructional Strategy as the dependent variable, Problem Solving Ability component No.2 (Total gain score of Problem Solving Ability component No.2 viz; Clarifying the Problem) as the independent variable and the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates. Given below is the result of the ANCOVA performed for the total sample.

TABLE 4.7

**Summary of Analysis of  
Covariance with Instructional  
Strategy as the independent variable and  
Clarifying the Problem as the dependent variable  
treating the controlled variables namely, Nonverbal  
Intelligence, Verbal Intelligence and Previous Achievement as covariates**

Source of Variation	df Effect	MS Effect	df Error	MS Error	F	p-level
Instructional Strategy	1	27.64	69	6.15	4.49	0.03

The table 4.7 shows that the F value obtained is 4.49 at 69 degrees of freedom, which acquires statistical significance at a probability level of 0.03. The required value for F to be significant for 69 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98 at 0.05 level and 7.01 at 0.01 level. Considering the F value obtained, it can be ascertained that the value is significant at 0.05 level. Hence the effect of Instructional Strategy on Clarifying the Problem is statistically significant

The result shows that the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) on Problem Solving Ability component No.2- Clarifying the Problem is significant. Post hoc comparison was done using t-test to find out the group that had an advantage in gain scores. For this t-test for small sample size was employed and the result is given below.

TABLE 4.8

**Summary of the t – Test to find out the Significance of Difference in mean gain scores of Clarifying the Problem**

Group	Mean gain Score	Standard Deviation	t- value
Control group	1.92	2.24	2.15
Experimental group	3.19	2.81	

The table 4.8 shows that the Experimental group had an advantage in gain scores with mean value 3.19 and standard deviation 2.81 while the Control group had a lower value of gain score with mean value 1.92 and standard deviation of 2.24. The t-value to be obtained for the difference to be significant at 0.05 level is 2.00 and that at 0.01 level is 2.65 for 72 degrees of freedom. The value obtained in this case is 2.15, and hence the difference between the mean gain scores is statistically significant at 0.05 level. The result shows that the effect of Mastery Learning Strategy on the Problem Solving Ability component No.2- Clarifying the Problem is significantly higher than that of Conventional Strategy.

The categorized Plot for the dependent variable - Problem Solving Ability component No.2 viz; Clarifying the Problem is given below.

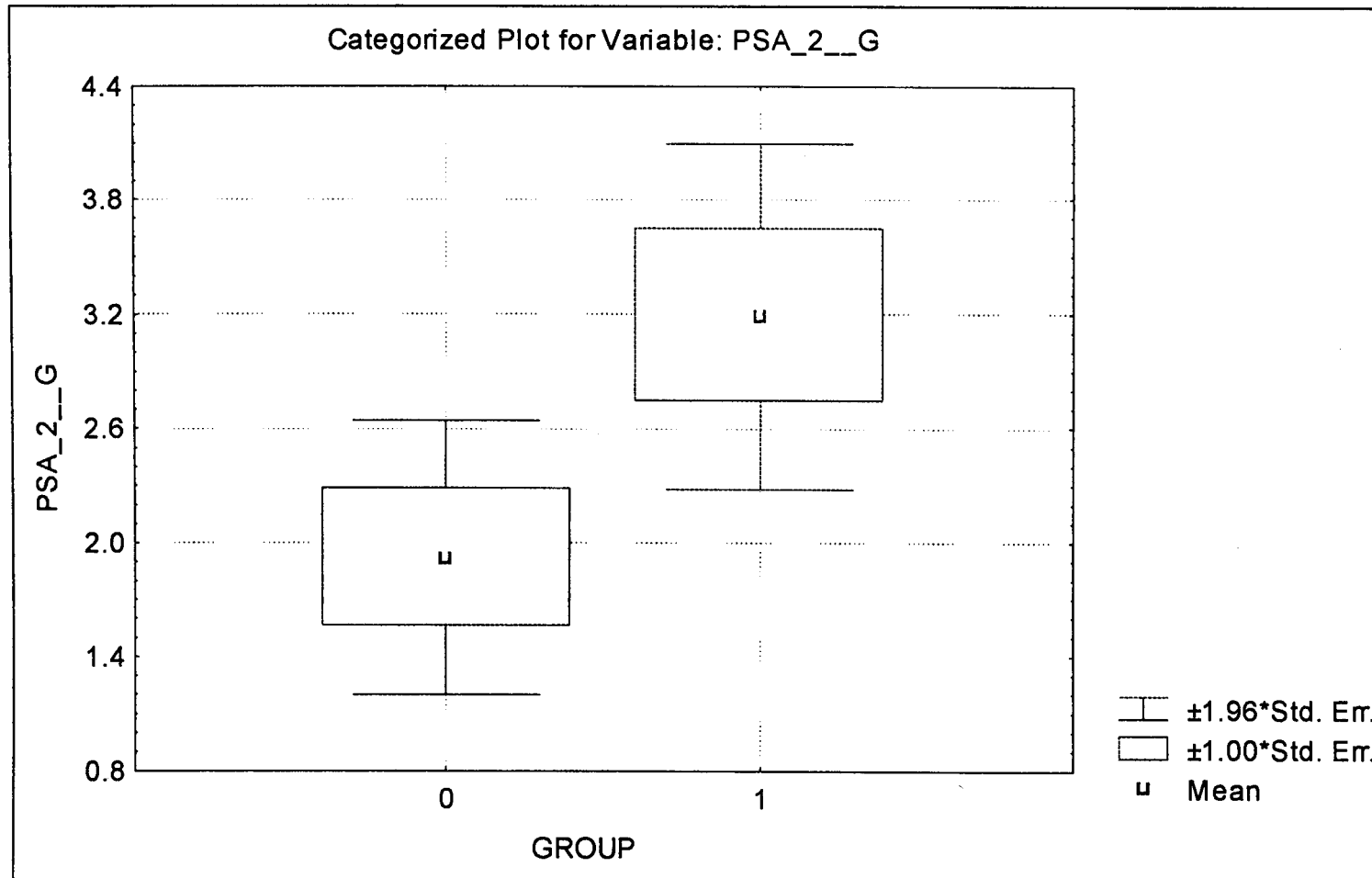


FIGURE 4-7 Categorized Plot for Control group and Experimental group for the dependent variable: Clarifying the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA\_2\_G stands for the variable, Clarifying the Problem.

The categorized plot, figure 4-7, gives a visual representation of the mean gain scores for the Clarifying the Problem (PSA\_2\_G) for the two groups. It is clear that the mean gain scores is significantly high for the Experimental group (Group 1) as compared to the mean gain scores for the Control group (Group 0) as given in the diagram. This ascertains that there is a significant effect of Mastery Learning Strategy on Clarifying the Problem and that the mental processes and skills associated with Clarifying the Problem can be improved with Mastery Learning Strategy significantly better than with the Conventional Strategy.

#### 4.3.3 EFFECT OF MASTERY LEARNING STRATEGY ON FINDING SOLUTION TO THE PROBLEM

To see whether there is an effect of Mastery Learning Strategy upon the third component of the Problem Solving Ability, ANCOVA was used with Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) as the dependent variable, Problem Solving Ability component No.3 (Total gain score of Problem Solving Ability component No.3- Finding Solution to the Problem) as the independent variable and the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement were treated as covariates. Given in table 4.9 is the result of the ANCOVA performed for the total sample.

TABLE 4.9

**Summary of Analysis of  
Covariance with Instructional Strategy  
as the independent variable and Finding Solution  
to the Problem as the dependent variable treating  
the controlled variables namely, Nonverbal Intelligence,  
Verbal Intelligence and Previous Achievement as covariates**

Source of Variation	df Effect	MS Effect	df Error	MS Error	F	p-level
Instructional Strategy	1	10.28	69	8.79	1.16	0.28

The table 4.9 shows that the F value obtained is 1.16 at 69 degrees of freedom, which acquires statistical significance only at a probability level of 0.28. The required value for F to be significant at 0.05 level for 69 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Finding Solution to the Problem is not statistically significant.

The categorized Plot for the dependent variable - Problem Solving Ability component No.3 viz; Finding Solution to the Problem is given as Figure 4-8.

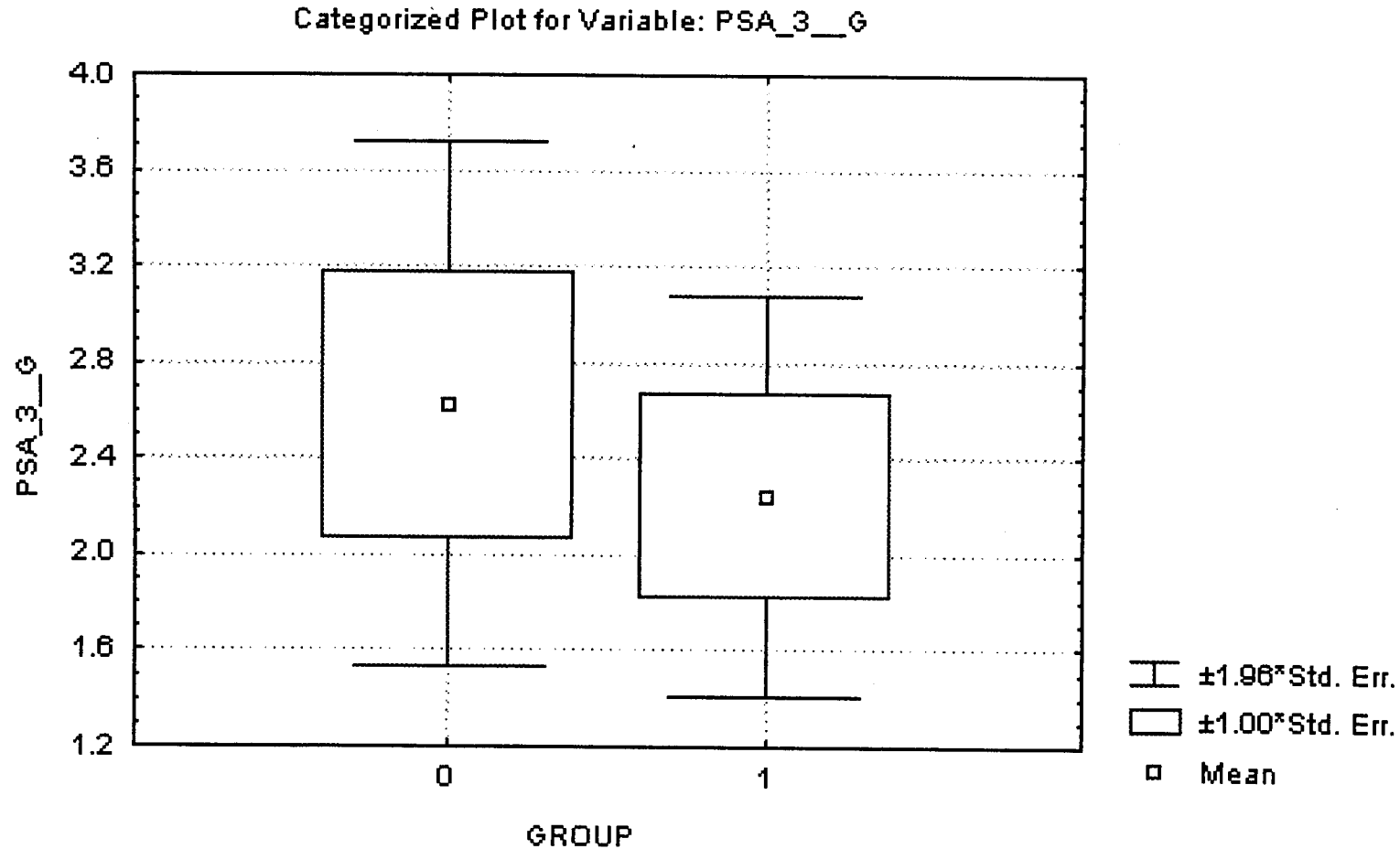


FIGURE 4-8 Categorized Plot for Control group and Experimental group for the dependent variable: Finding Solution to the Problem. Group 0 represents the Control group and Group 1 represents the Experimental group. PSA\_3\_G stands for the variable, Finding Solution to the Problem.

The table 4.9 and the figure 4-8 reveal that Mastery Learning Strategy does not affect Finding Solution to the Problem of students in Physics of Standard IX significantly better than the Conventional Strategy.

Thus by analysis it was ascertained that Mastery Learning Strategy does not significantly foster the mental processes and skills associated with Finding Solution to the Problem of students in Physics of Standard IX better than the Conventional Strategy. Putting together all the above analyses, which tested the effect of Instructional Strategy on the components of Problem Solving Ability, it can be concluded that Mastery Learning strategy even though does not significantly improve total Problem Solving Ability as a whole when compared to the Conventional Strategy, it does have a significantly better effect upon mental abilities associated with the Clarifying the Problem such as Ability to discriminate between the most relevant and closely related concepts, Using analogies for reasoning, Using Inductive/deductive reasoning, Hypothesizing and Checking the testability of hypotheses.

### **Comment**

Pooling the results of ANCOVA performed upon the components of Problem Solving Ability, it becomes evident that Mastery Learning Strategy does not enhance the thought processes that are required for Comprehending the Problem and Finding Solution to the Problem better than the Conventional Strategy. To put it differently, the very original act of interiorising the problem and the crucial act of solving the problem could not be improved quite easily. But it enhances the thought processes associated with Clarifying the Problem. While glancing at the

subcomponents of Clarifying the Problem it becomes revealed that they comprise of the usual thought processes much necessary for academic exercises in the classroom. The subcomponents of Clarifying the Problem are Ability to discriminate between the most relevant and closely related concepts, Using analogies for reasoning, Using Inductive/Deductive reasoning, Hypothesizing and Checking the testability of hypotheses. The enhancement of such abilities is due to the fact that in repeated sessions of corrective measures / remedial measures of the Mastery Learning Strategy Cycle, the students were made to think and master the content repeatedly, during which such mental processes were indispensable.

#### **4.4 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY, NONVERBAL INTELLIGENCE AND VERBAL INTELLIGENCE ON CLARIFYING THE PROBLEM**

Following the analyses using ANCOVA, Three way ANOVA was performed for that component of Problem Solving Ability for which the effect of Instructional Strategy showed a significant difference.

The researcher aimed at finding out the main effects and interaction effects of Instructional Strategy and the cognitive variables on the relevant Problem Solving Ability component upon which an effect of Instructional Strategy was established by the earlier test using ANCOVA. The cognitive variables Nonverbal Intelligence, Verbal Intelligence and Previous Achievement were of prime concern in the study. The researcher wanted to find out the effect of these factors on

Problem Solving Ability along with the effect caused by the Instructional Strategy. The factors were varied in two levels and the subjects were classified into Below Average and Above Average Categories with regard to the scores on these factors. The classifications of subjects into these categories were already discussed in chapter III. Thus each of the factors, Instructional Strategy, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement is presented at two levels. The first factor, Instructional Strategy is varied in two ways: Mastery Learning Strategy and the Conventional Strategy; the second factor, Nonverbal Intelligence, is presented at two levels: Below Average Nonverbal Intelligence (BANI) Group and Above average Nonverbal Intelligence (AANI) Group; the third factor is presented at two levels: Below average Verbal Intelligence (BAVI) Group and Above average Verbal Intelligence (AAVI) Group; the fourth factor, Previous Achievement, is presented at two levels: Below average Previous Achievement (BAA) Group and Above average Previous Achievement (AAA) Group.

The researcher considered examining the interaction effects of intelligence with Instructional Strategy and that of Previous Achievement with Instructional Strategy separately. At first, the main effects and interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2- Clarifying the Problem was tested using ANOVA. Hence the ANOVA technique used is in the 2 X 2 X 2 factorial design. Also this was to be performed for the total sample as well as for boys and girls separately.

#### 4.4.1 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY, NONVERBAL INTELLIGENCE AND VERBAL INTELLIGENCE ON CLARIFYING THE PROBLEM FOR THE TOTAL SAMPLE.

In this analysis ANOVA technique used is in the 2 X 2 X 2 factorial design, where the factors are the two types of intelligences in addition to the Instructional Strategy employed in the two study groups.

Given in table 4.10 is the result of the ANOVA performed for the total sample with factors Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2. viz; Clarifying the Problem.

The analysis of variance is performed for the total sample and each factor is presented at two levels. The first factor, Instructional Strategy is varied in two ways: Mastery Learning Strategy and the Conventional Strategy; the second factor, Nonverbal Intelligence, is presented at two levels: Below Average Nonverbal Intelligence (BANI) Group and Above average Nonverbal Intelligence (AANI) Group; the third factor is presented at two levels: Below average Verbal Intelligence (BAVI) Group and Above average Verbal Intelligence (AAVI) Group.

TABLE 4.10

**Summary of ANOVA  
to find the main and interaction  
effects of Instructional Strategy,  
Nonverbal Intelligence and Verbal Intelligence  
on Clarifying the Problem for the total sample.**

<b>Source of Variation</b>	<b>df Effect</b>	<b>MS Effect</b>	<b>df Error</b>	<b>MS Error</b>	<b>F</b>	<b>p-level</b>
Instructional Strategy	1	24.67	66	6.79	3.62	0.06
Nonverbal Intelligence	1	11.02	66	6.79	1.62	0.20
Verbal Intelligence	1	0.53	66	6.79	0.07	0.78
Instructional Strategy-Nonverbal Intelligence	1	0.04	66	6.79	0.006	0.93
Instructional Strategy-Verbal Intelligence	1	0.14	66	6.79	0.02	0.88
Nonverbal Intelligence-Verbal Intelligence	1	1.15	66	6.79	0.17	0.68
Instructional Strategy-Nonverbal Intelligence-Verbal Intelligence	1	1.80	66	6.79	0.26	0.60

Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 3.62 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.06. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the total sample.

Analysing the main effect of Nonverbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 1.62 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.20. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Nonverbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

Analysing the main effect of Verbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 0.07 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.78. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Verbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

Analysing the interaction effect of Instructional Strategy and Nonverbal Intelligence upon Clarifying the Problem, the table 4.10

shows that the F value obtained is 0.006 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.93. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Instructional Strategy and Nonverbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

Analysing the interaction effect of Instructional Strategy and Verbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 0.02 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.88. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Instructional Strategy and Verbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

Analysing the interaction effect of Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 0.17 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.68. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

Analysing the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.10 shows that the F value obtained is 0.26 at 66 degrees of freedom, which acquires statistical significance only at a probability level of 0.60. The required value for F to be significant at 0.05 level for 66 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for the total sample.

The result shows that none of the factors, Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence has an effect on Clarifying the Problem, when the total sample is considered.

#### 4.4.2 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY, NONVERBAL INTELLIGENCE AND VERBAL INTELLIGENCE ON CLARIFYING THE PROBLEM FOR THE GIRLS' SAMPLE.

Given below is the result of the ANOVA performed for girls with the factors Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2. In this case the total number of girls in both study groups put together was 34. Total Number of subjects under the category AANI was 17 and that in the category BANI was also 17. Similarly the total Number of subjects under the category AAVI was 19 and that in the category BAVI was also 15.

TABLE 4.11

**Summary of ANOVA  
to find the main and interaction effects of  
Instructional Strategy, Nonverbal Intelligence and  
Verbal Intelligence on Clarifying the Problem for girls.**

Source of Variation	df Effect	MS Effect	df Error	MS Error	F	p-level
Instructional Strategy	1	40.46	26	7.87	5.13*	0.03
Nonverbal Intelligence	1	10.34	26	7.87	1.31	0.26
Verbal Intelligence	1	5.62	26	7.87	0.71	0.40
Instructional Strategy-Nonverbal Intelligence	1	0.19	26	7.87	0.02	0.87
Instructional Strategy-Verbal Intelligence	1	5.84	26	7.87	0.74	0.39
Nonverbal Intelligence-Verbal Intelligence	1	4.36	26	7.87	0.55	0.46
Instructional Strategy-Nonverbal Intelligence-Verbal Intelligence	1	2.47	26	7.87	0.31	0.58

\* - significant at 0.05 level

Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 5.13 at 26 degrees of freedom, which acquires statistical significance at a probability level of 0.03. The required value for F to be significant for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22 at 0.05 level and 7.72 at 0.01 level. Hence the effect of Instructional Strategy on Clarifying the Problem is statistically significant for girls at 0.05 level.

Analysing the main effect of Nonverbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 1.31 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.26. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the effect of Nonverbal Intelligence on Clarifying the Problem is not statistically significant for girls.

Analysing the main effect of Verbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.71 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.40. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the effect of Verbal Intelligence on Clarifying the Problem is not statistically significant for girls.

Analysing the interaction effect of Instructional Strategy and Nonverbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.02 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.87. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the interaction effect of Instructional Strategy and Nonverbal Intelligence on Clarifying the Problem is not statistically significant for girls.

Analysing the interaction effect of Instructional Strategy and Verbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.74 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.39. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the interaction effect of Instructional Strategy and Verbal Intelligence on Clarifying the Problem is not statistically significant for girls.

Analysing the interaction effect of Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.55 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.46. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the interaction effect of

Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for girls.

Analysing the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.11 shows that the F value obtained is 0.31 at 26 degrees of freedom, which acquires statistical significance only at a probability level of 0.58. The required value for F to be significant at 0.05 level for 26 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.22. Hence the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for girls.

The result shows that the effect of Instructional Strategy on Problem Solving Ability component No.2 viz; Clarifying the Problem is significant for girls. Post hoc comparison was done using t-test to find out the study group that had an advantage in gain scores. For this t-test for small sample size was employed and the result is given below.

TABLE 4.12

Summary of the *t* – Test to find out the Significance of Difference in mean gain scores of Clarifying the Problem for girls.

Group	Mean gain Score	Standard Deviation	t- value
Control group (girls)	1.65	2.47	2.52
Experimental group (girls)	4.0	2.96	

The table 4.12 shows that the girls in the Experimental group had an advantage in gain scores with value 4.0 with standard deviation 2.96 while the girls in the Control group had a lower value of gain score with value 1.65 and standard deviation of 2.47. The *t*-value to be obtained for the value to be significant at 0.05 level is 2.12 and at 0.01 level is 2.92 at 16 degrees of freedom. The value obtained in this case is 2.52, and hence the difference between the mean gain scores is statistically significant at 0.05 level. The result shows that the effect of Mastery Learning Strategy on the Problem Solving Ability component No.2- Clarifying the Problem is significant for girls.

Also it is ascertained that the other factors, Nonverbal Intelligence and Verbal Intelligence do not significantly effect the Problem Solving Ability component No.2- Clarifying the Problem for girls.

The categorized Plot for the dependent variable - Problem Solving Ability component No.2 viz; Clarifying the Problem is presented in figure 4-9.

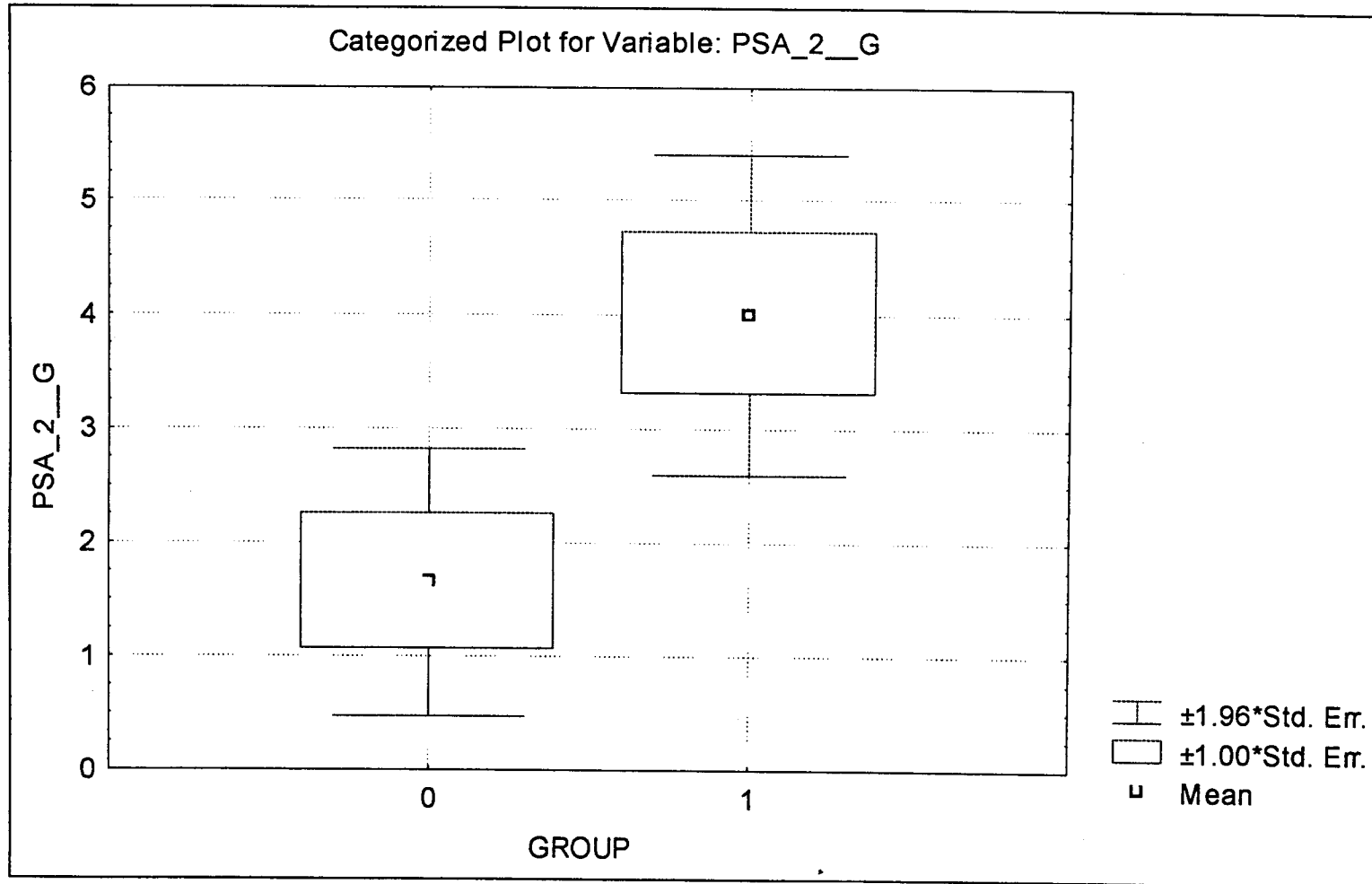


FIGURE 4-9 Categorized Plot for girls of Control group and Experimental group for the dependent variable: Clarifying the Problem. Group 0 represents the girls of Control group and Group 1 represents the girls of Experimental group. PSA\_2\_G stands for the variable, Clarifying the Problem.

The categorized plot in figure 4-9 gives a visual representation of the mean gain scores for the Problem Solving Ability component No.2 viz; Clarifying the Problem (PSA\_2\_G) for the two groups. It is clear that the mean gain scores is significantly high for the girls in the Experimental group (Group 1) as compared to the mean gain scores for the girls in the Control group (Group 0) as given in the diagram. This ascertains that there is a significant effect of Mastery Learning Strategy on Clarifying the Problem in the case of girls and that the mental skills associated with Clarifying the Problem can be improved for girls with Mastery Learning Strategy.

Taking a closer look at the subcomponents of Clarifying the Problem, it can be seen that they consist of usual thought processes usually employed in the class room situation and much necessary for academic exercises as compared to the subcomponents which come under the other two components of Problem Solving Ability. The subcomponents of Clarifying the Problem are Ability to discriminate between the most relevant and closely related concepts, Using analogies for reasoning, Using Inductive/deductive reasoning, Hypothesizing and Checking the testability of hypotheses. The enhancement of such abilities is due to the fact that in repeated sessions of corrective measures / remedial measures of the Mastery Learning Strategy Cycle, the students were made to think and master the content repeatedly, during which such mental processes were indispensable.

There is no main effect for variables Verbal Intelligence and Nonverbal Intelligence in enhancing the ability in Clarifying the Problem. Hence it is also clear that the variables Verbal Intelligence

and Nonverbal Intelligence do not interact with Instructional Strategy in enhancing the ability in Clarifying the Problem.

#### 4.4.3 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY, NONVERBAL INTELLIGENCE AND VERBAL INTELLIGENCE ON CLARIFYING THE PROBLEM FOR THE BOYS' SAMPLE.

Given below in table 4.13 is the result of the ANOVA performed for boys with the factors Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2, viz., Clarifying the Problem.

**TABLE 4.13**  
**Summary of ANOVA**  
**to find the main and interaction effects**  
**of Instructional Strategy, Nonverbal Intelligence**  
**and Verbal Intelligence on Clarifying the Problem for boys.**

Source of Variation	df Effect	MS Effect	df Error	MS Error	F	p-level
Instructional Strategy	1	0.23	32	5.88	0.04	0.84
Nonverbal Intelligence	1	5.11	32	5.88	0.86	0.35
Verbal Intelligence	1	1.66	32	5.88	0.28	0.59
Instructional Strategy-Nonverbal Intelligence	1	0.01	32	5.88	0.003	0.95
Instructional Strategy-Verbal Intelligence	1	10.35	32	5.88	1.75	0.19
Nonverbal Intelligence-Verbal Intelligence	1	0.10	32	5.88	0.01	0.89
Instructional Strategy-Nonverbal Intelligence-Verbal Intelligence	1	1.16	32	5.88	0.19	0.66

Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.04 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.84. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the main effect of Nonverbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.86 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.35. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the effect of Nonverbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the main effect of Verbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.28 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.59. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the effect of Verbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the interaction effect of Instructional Strategy and Nonverbal Intelligence upon Clarifying the Problem, the table 4.13

shows that the F value obtained is 0.003 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.95. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the interaction effect of Instructional Strategy and Nonverbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the interaction effect of Instructional Strategy and Verbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 1.75 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.19. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the interaction effect of Instructional Strategy and Verbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the interaction effect of Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.01 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.89. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the interaction effect of Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

Analysing the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon Clarifying the Problem, the table 4.13 shows that the F value obtained is 0.19 at 32 degrees of freedom, which acquires statistical significance only at a probability level of 0.66. The required value for F to be significant at 0.05 level for 32 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.14. Hence the interaction effect of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on Clarifying the Problem is not statistically significant for boys of the total sample.

The result shows that none of the factors, Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), Nonverbal Intelligence (Above Average Nonverbal Intelligence/Below Average Nonverbal Intelligence) and Verbal Intelligence (Above Average Verbal Intelligence/Below Average Verbal Intelligence) has an effect on Problem Solving Ability component No.2 when boys of the total sample are considered.

### **Comment**

This result draws attention to the gender difference in acquiring Problem Solving Ability through Mastery Learning Strategy. Whereas girls got benefited by the Mastery Learning Strategy in acquiring the ability of Clarifying the Problem, boys did not. The subcomponents of Clarifying the Problem are Ability to discriminate between the most relevant and closely related concepts, Using analogies for reasoning, Using Inductive/Deductive reasoning, Hypothesizing and Checking the testability of hypotheses. The enhancement of such abilities is due to

the fact that in repeated sessions of corrective measures / remedial measures of the 'Mastery Learning Strategy Cycle', the students were made to think and master the content repeatedly, during which such mental processes were indispensable. Enhancement of such processes in girls might be the result of the fact that girls take up more sincerely the corrective and remedial measures in a disciplined manner. Boys rather went through the procedures casually without much mental deliberation. And thus girls got themselves rewarded.

Sumathy (1994) studied the hemisphericity, divergent thinking and Problem Solving Ability in Physical Science of the plus two students in Salem and found that boys and girls did not show any difference in the deductive thinking skill, inductive thinking skill, analytical thinking skill, convergent thinking skill, divergent thinking skill and symbolic thinking skill and that girls were better than boys in solving problems involving recall/recognition and in problems involving a combination of principle skill and synthetic skill.

The above study found an increased problem solving ability in Physical Science for girls only in problems involving recall/recognition and in problems involving more than one principle skill and synthetic skill. Thus the gender difference in Problem Solving Ability in the above study is in line with the results obtained in the present study.

Pooling the results of ANOVA on the total sample, girls and boys, it becomes evident that Nonverbal Intelligence (Above Average Nonverbal Intelligence/Below Average Nonverbal Intelligence) and Verbal Intelligence (Above Average Verbal Intelligence/Below Average Verbal Intelligence) have no effect on enhancing the ability in

Clarifying the Problem while using Mastery Learning Strategy. This could be treated as a positive sign in the sense that if at all Problem Solving Ability could be improved by a new technique, it can be improved in all students regardless of their intelligence level.

Another notable point could be the result which indicates that the effect of Instructional Strategy on Clarifying the Problem is not statistically significant when the total sample was considered, especially in the context of ANCOVA performed earlier with Instructional Strategy as the independent variable and Clarifying the Problem as the dependent variable showed a statistically significant effect in the total sample. The analysis of covariance is the better statistical test considering the effect of extraneous variables; hence the result of ANCOVA is taken into confidence admitting the fact that the effect is rather at a lower level of significance.

#### **4.5 MAIN EFFECTS AND INTERACTION EFFECTS OF INSTRUCTIONAL STRATEGY AND PREVIOUS ACHIEVEMENT ON CLARIFYING THE PROBLEM.**

Finally to find out if there existed any main effects or interaction effect of the factors Instructional Strategy and Previous Achievement upon Problem Solving Ability component No.2, viz; Clarifying the Problem, ANOVA with 2X2 factorial design was done for the total sample, girls and boys.

4.5.1 MAIN EFFECTS AND INTERACTION EFFECT OF INSTRUCTIONAL STRATEGY AND PREVIOUS ACHIEVEMENT ON CLARIFYING THE PROBLEM FOR THE TOTAL SAMPLE.

Table 4.14 presents the result of ANOVA performed with factors Instructional Strategy and Previous Achievement upon Clarifying the Problem for the total sample.

**TABLE 4.14**

**Summary of ANOVA to find the main effects and interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem for the total sample**

Source of Variation	df Effect	MS Effect	df Error	MS Error	F	p-level
Instructional Strategy	1	20.44	70	6.39	3.20	0.07
Previous Achievement	1	2.54	70	6.39	0.40	0.53
Instructional Strategy - Previous Achievement	1	16.91	70	6.39	2.65	0.11

Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.14 shows that the F value obtained is 3.20 at 70 degrees of freedom, which acquires statistical significance only at a probability level of 0.07. The required value for F to be

significant at 0.05 level for 70 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the total sample.

Analysing the main effect of Previous Achievement upon Clarifying the Problem, the table 4.14 shows that the F value obtained is 0.40 at 70 degrees of freedom, which acquires statistical significance only at a probability level of 0.53. The required value for F to be significant at 0.05 level for 70 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the total sample.

Analysing the interaction effect of Instructional Strategy and Previous Achievement upon Clarifying the Problem, the table 4.14 shows that the F value obtained is 2.65 at 70 degrees of freedom, which acquires statistical significance only at a probability level of 0.11. The required value for F to be significant at 0.05 level for 70 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 3.98. Hence the interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem is not statistically significant for the total sample.

The result shows that neither Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) nor Previous Achievement (Above Average Previous Achievement/Below Average Previous Achievement) has a significant effect on Clarifying the Problem when the total sample is considered.

4.5.2 MAIN EFFECTS AND INTERACTION EFFECT OF INSTRUCTIONAL STRATEGY AND PREVIOUS ACHIEVEMENT ON CLARIFYING THE PROBLEM FOR THE GIRLS' SAMPLE.

Further to test the main effects and interaction effect of the factors Instructional Strategy and Previous Achievement upon Problem Solving Ability component No.2, viz; Clarifying the Problem, ANOVA with 2X2 factorial design was done for girls of the total sample. Table 4.15 presents the result of ANOVA performed with factors Instructional Strategy and Previous Achievement upon Clarifying the Problem for the girls of the total sample.

**TABLE 4.15**

**Summary of ANOVA to find the main effects and interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem for girls.**

<b>Source of Variation</b>	<b>df Effect</b>	<b>MS Effect</b>	<b>df Error</b>	<b>MS Error</b>	<b>F</b>	<b>p-level</b>
Instructional Strategy	1	29.50	30	7.02	4.20	0.05
Previous Achievement	1	7.8	30	7.02	1.11	0.30
Instructional Strategy - Previous Achievement	1	20.15	30	7.02	2.87	0.10

Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.15 shows that the F value obtained is 4.20 at 30 degrees of freedom, which acquires statistical significance at a probability level of 0.05. The required value for F to be significant at 0.05 level for 30 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.17. Hence the effect of Instructional Strategy on Clarifying the Problem is statistically significant for the girls of the total sample.

Analysing the main effect of Previous Achievement upon Clarifying the Problem, the table 4.15 shows that the F value obtained is 1.11 at 30 degrees of freedom, which acquires statistical significance only at a probability level of 0.30. The required value for F to be significant at 0.05 level for 30 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.17. Hence the effect of Previous Achievement on Clarifying the Problem is not statistically significant for the girls of the total sample.

Analysing the interaction effect of Instructional Strategy and Previous Achievement upon Clarifying the Problem, the table 4.15 shows that the F value obtained is 2.87 at 30 degrees of freedom, which acquires statistical significance only at a probability level of 0.10. The required value for F to be significant at 0.05 level for 30 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.17. Hence the interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem is not statistically significant for the girls of the total sample.

The result shows that Instructional Strategy has a significant effect on Clarifying the Problem when the girls of the total sample are considered. This result has been already obtained from table 4.11. Accordingly post hoc comparison was done using t-test to find out the study group that had an advantage in gain scores. Consequently it was found that Mastery Learning Strategy had significant effect on Clarifying the Problem in the case of girls.

The present analysis reveals that the factor, Previous Achievement (Above average Previous Achievement / Below Average Previous Achievement) has no significant effect on Clarifying the Problem when the girls of the total sample are considered.

#### 4.5.3 MAIN EFFECTS AND INTERACTION EFFECT OF INSTRUCTIONAL STRATEGY AND PREVIOUS ACHIEVEMENT ON CLARIFYING THE PROBLEM FOR THE BOYS' SAMPLE.

To find out the main effects and interaction effect of the factors Instructional Strategy and Previous Achievement upon Problem Solving Ability component No.2, viz; Clarifying the Problem, ANOVA with 2X2 factorial design was done for boys of the total sample. Table 4.16 presents the result of ANOVA performed with factors Instructional Strategy and Previous Achievement upon Clarifying the Problem for the boys of the total sample.

TABLE 4.16

**Summary of ANOVA to find the main effects and interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem for boys.**

Source of Variation	df Effect	MS Effect	df Error	MS Error	F	p-level
Instructional Strategy	1	1.12	36	5.67	0.20	0.66
Previous Achievement	1	0.03	36	5.67	0.01	0.94
Instructional Strategy - Previous Achievement	1	1.45	36	5.67	0.26	0.62

Analysing the main effect of Instructional Strategy upon Clarifying the Problem, the table 4.16 shows that the F value obtained is 0.20 at 36 degrees of freedom, which acquires statistical significance only at a probability level of 0.66. The required value for F to be significant at 0.05 level for 36 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.12. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the boys of the total sample.

Analysing the main effect of Previous Achievement upon Clarifying the Problem, the table 4.16 shows that the F value obtained is 0.01 at 36 degrees of freedom, which acquires statistical significance

only at a probability level of 0.94. The required value for F to be significant at 0.05 level for 36 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.12. Hence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant for the boys of the total sample.

Analysing the interaction effect of Instructional Strategy and Previous Achievement upon Clarifying the Problem, the table 4.16 shows that the F value obtained is 0.26 at 36 degrees of freedom, which acquires statistical significance only at a probability level of 0.62. The required value for F to be significant at 0.05 level for 36 degrees of freedom of smaller mean square and for one degree of freedom for greater mean square happens to be 4.12. Hence the interaction effect of Instructional Strategy and Previous Achievement on Clarifying the Problem is not statistically significant for the boys of the total sample.

The result shows that neither Instructional Strategy (Mastery Learning Strategy/Conventional Strategy) nor Previous Achievement (Above Average Previous Achievement/Below Average Previous Achievement) has a significant effect on Clarifying the Problem when the boys of the total sample are considered.

Pooling up the ANOVA results of Instructional Strategy and Previous Achievement on the total sample, girls and boys, no significant effect was pronounced for Previous Achievement on Clarifying the Problem. Thus effect of Previous Achievement upon Clarifying the Problem can be ruled out in all cases. Thus all the chances of interaction effects of Previous Achievement with Instructional Strategy also is ruled out.

## **Comment**

The effect of Previous Achievement upon Clarifying the Problem can be ruled out in all cases of girls, boys and the total sample. This means that Previous Achievement will not be a barrier for any effort to increase Problem Solving ability by some new strategy or technique

Here also as in the case of the three way ANOVA with factors, Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence the effect of Instructional Strategy on Clarifying the Problem is not statistically significant when the total sample was considered. The ANCOVA performed earlier with Instructional Strategy as the independent variable and Clarifying the Problem as the dependent variable showed a statistically significant effect in the total sample. The analysis of covariance is the better statistical test considering the effect of extraneous variables; hence the result of ANCOVA is taken into confidence admitting the fact that the effect is rather at a lower level of significance.

## **SUMMARY, CONCLUSION AND SUGGESTIONS**

- Study in retrospect
- Major findings of the study
- Conclusion
- Tenability of Hypotheses
- Educational Implications
- Suggestions for Further Research

## **SUMMARY, CONCLUSION AND SUGGESTIONS**

This chapter presents the entire study in a nut shell, highlighting the major findings emerged from the study, conclusions arrived, tenability of hypotheses, the educational implications and the suggestions for further research.

### **5.1 STUDY IN RETROSPECT**

This section looks back at the title, variables, objectives, hypotheses, tools, and statistical techniques of the study.

#### **5.1.1 RESTATEMENT OF THE PROBLEM.**

The present study was entitled “EFFECT OF MASTERY LEARNING STRATEGY ON PROBLEM SOLVING ABILITY IN PHYSICS OF SECONDARY SCHOOL STUDENTS.”

#### **5.1.2 VARIABLES**

The variables of the present study were as follows.

##### **Dependent Variable**

In the present study, Problem Solving Ability (Total Score and Component wise Score) was treated as the dependent variable.

##### **Independent Variable**

The independent variable for the present study was the Instructional Strategy (Mastery Learning Strategy/Conventional Strategy).

### **Controlled Variables**

The controlled variables were Non-verbal intelligence, Verbal Intelligence, Socio-Economic Status, Previous Achievement and Sex

### **5.1.3 OBJECTIVES**

The objectives of the present study are presented below as one general objective and a set of specific objectives.

#### **General Objective**

To find out the effect of Mastery Learning Strategy on the Problem Solving Ability in Physics of secondary school students.

#### **Specific Objectives**

1. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability in Physics of students of Standard IX.
2. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on the first component of Problem Solving Ability (Comprehending the Problem) in Physics of students of Standard IX.
3. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on

the second component of Problem Solving Ability (Clarifying the Problem) in Physics of students of Standard IX.

4. To find out the effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on third component of Problem Solving Ability (Finding solution to the problem) in Physics of students of Standard IX.
5. To study the Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for the total sample.
6. To study the Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for girls of the total sample.
7. To study the Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for boys of the total sample.
8. To study the Main effects and Interaction effect of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for total sample.

9. To study the Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for girls of the total sample.
10. To study the Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability for boys of the total sample.

#### 5.1.4 HYPOTHESES

1. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability in Physics of students of Standard IX.
2. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 1 viz; Comprehending the Problem, in Physics of students of Standard IX.
3. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 2 viz; Clarifying the Problem, in Physics of students of Standard IX.

4. There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 3 viz; Finding Solution to the Problem, in Physics of students of Standard IX.
5. There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for the total sample.
6. There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for girls of the total sample.
7. There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for boys of the total sample.
8. There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the total sample.

9. There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the girls of the total sample.
10. There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the boys of the total sample.

#### 5.1.5 TOOLS

The data necessary for the study was collected using the following tools

- (i) Raven's Standard Progressive Matrices
- (ii) Verbal Intelligence Test based on triarchic theory
- (iii) Socio-Economic Status Scale
- (iv) Standardised Achievement test developed by the investigator (The Pre test scores were taken as a measure of Previous Achievement. Whereas the gain scores i.e., the difference between post test scores and pre test scores, were taken as a measure of achievement of the study groups).
- (v) Problem Solving Ability Test in Physics developed by the investigator

### 5.1.6 STATISTICAL TECHNIQUES USED

- (i) One way Analysis of Covariance
- (ii) Two tailed test of significance of difference between means.
- (iii) Three way Analysis of Variance
- (iv) Two way Analysis of Variance

## 5.2 MAJOR FINDINGS OF THE STUDY

The major findings of the study revealed through the various statistical analyses are the following.

1. There is no significant effect of Mastery Learning Strategy on the total score of Problem Solving Ability in Physics for the secondary school students.
2. There is no significant effect of Mastery Learning Strategy on the first component of Problem Solving Ability, viz; Comprehending the Problem in Physics for the secondary school students.
3. There is significant effect of Mastery Learning Strategy on the second component of Problem Solving Ability, viz; Clarifying the Problem in Physics for the secondary school students.
4. There is no significant effect of Mastery Learning Strategy on the third component of Problem Solving Ability, viz; Finding Solution to the Problem in Physics for the secondary school students.
5. There is no significant effect of the factors, Nonverbal Intelligence and Verbal Intelligence on the second component of

Problem Solving Ability, viz; Clarifying the Problem in Physics for the secondary school students.

6. There is significant effect of Mastery Learning Strategy on second component of Problem Solving Ability, viz; Clarifying the Problem in Physics for girls of the secondary school. Whereas there is no significant main or interaction effects of the factors, Nonverbal Intelligence and Verbal Intelligence on the second component of Problem Solving Ability, viz; Clarifying the Problem in Physics for girls of the secondary school students.
7. There is no significant effect of Mastery Learning Strategy on second component of Problem Solving Ability, viz; Clarifying the Problem in Physics for boys of the secondary school. Also there is no significant main or interaction effects of the factors, Nonverbal Intelligence and Verbal Intelligence on the second component of Problem Solving Ability, viz; Clarifying the Problem in Physics for boys of the secondary school students.
8. There is no significant effect of Previous Achievement on the second component of Problem Solving Ability, viz; Clarifying the Problem in Physics for the secondary school students.
9. There is no significant effect of Previous Achievement on the second component of Problem Solving Ability, viz; Clarifying the Problem in Physics for girls of the secondary school.
10. There is no significant effect of Previous Achievement on the second component of Problem Solving Ability, viz; Clarifying the Problem in Physics for boys of the secondary school.

## 5.3 TENABILITY OF HYPOTHESES

5.3.1 The first hypothesis states that “there will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability in Physics of students of Standard IX.”

The ANCOVA with Instructional Strategy as the independent variable and Problem Solving Ability (Total gain score of Problem Solving Ability) as the dependent variable treating the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates ascertained that effect of Instructional Strategy on the total score of Problem Solving Ability is not statistically significant. Therefore the first hypothesis is rejected.

5.3.2 The second hypothesis states that “there will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 1 viz; Comprehending the Problem, in Physics of students of Standard IX.”

The ANCOVA with Instructional Strategy as the independent variable and Problem Solving Ability component 1 viz; Comprehending the Problem as the dependent variable treating the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates ascertained that the effect of Instructional

Strategy on Comprehending the Problem is not statistically significant. Therefore the second hypothesis is fully rejected.

5.3.3 The third hypothesis states that “there will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 2 viz; Clarifying the Problem, in Physics of students of Standard IX.”

The ANCOVA with Instructional Strategy as the independent variable and Problem Solving Ability component 2 viz; Clarifying the Problem as the dependent variable treating the controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates ascertained that the value is significant at 0.05 level. Hence the effect of Instructional Strategy on Clarifying the Problem is statistically significant. Therefore the third hypothesis is fully substantiated and hence retained.

5.3.4 The fourth hypothesis states that “There will be significant effect of Instructional Strategy (Mastery Learning Strategy/Conventional Strategy), with Nonverbal Intelligence, Verbal Intelligence and Previous Achievement as covariates, on Problem Solving Ability component 3 viz; Finding Solution to the Problem, in Physics of students of Standard IX.”

The ANCOVA with Instructional Strategy as the dependent variable, Problem Solving Ability component No.3 (Finding Solution to the Problem) as the independent variable treating controlled variables namely, Nonverbal Intelligence, Verbal Intelligence and Previous

Achievement as covariates ascertained that the effect of Instructional Strategy on Finding Solution to the Problem is not statistically significant. Therefore the fourth hypothesis is rejected.

5.3.5 The fifth hypothesis states that “There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for the total sample.”

The ANOVA performed for the total sample with factors Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2. viz; Clarifying the Problem for the total sample ascertains that none of the factors, Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence has an effect on Clarifying the Problem, when the total sample is considered. Therefore the fifth hypothesis is rejected.

5.3.6 The sixth hypothesis states that “There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for girls of the total sample.”

The ANOVA performed for girls with the factors Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2. ascertains that the effect of Mastery Learning Strategy on Clarifying the Problem is significant for girls. Also it is ascertained that the other factors, Nonverbal Intelligence

and Verbal Intelligence do not significantly effect the Problem Solving Ability component No.2- Clarifying the Problem for girls. Therefore the sixth hypothesis is partially substantiated.

5.3.7 The seventh hypothesis states that “There will be significant Main effects and Interaction effects of Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence on those Components of Problem Solving Ability upon which there existed an effect of Instructional Strategy, for boys of the total sample.”

The ANOVA performed for boys with the factors Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence upon the Problem Solving Ability component No.2- Clarifying the Problem ascertained that none of the factors, Instructional Strategy, Nonverbal Intelligence and Verbal Intelligence have an effect on Clarifying the Problem when boys of the total sample are considered. Therefore the seventh hypothesis is rejected.

5.3.8 The eighth hypothesis states that “There will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the total sample.”

The result of ANOVA performed with factors Instructional Strategy and Previous Achievement upon Clarifying the Problem for the total sample ascertained that Previous Achievement has no significant effect on Clarifying the Problem when the total sample is considered. Therefore the eighth hypothesis is rejected.

5.3.9 The ninth hypothesis states that “there will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the girls of the total sample.”

The ANOVA performed with factors Instructional Strategy and Previous Achievement upon Clarifying the Problem for the girls of the total sample ascertained that Previous Achievement has no significant effect on Clarifying the Problem when the girls of the total sample are considered. Therefore the ninth hypothesis is rejected.

5.3.10 The tenth hypothesis states that “there will be significant Main effects and Interaction effects of Instructional Strategy and Previous Achievement, if there existed any effect of Instructional Strategy, on the Components of Problem Solving Ability, for the boys of the total sample.”

The ANOVA performed with factors Instructional Strategy and Previous Achievement upon Clarifying the Problem for the boys of the total sample ascertained that Previous Achievement has no significant effect on Clarifying the Problem when the boys of the total sample are considered. Therefore the tenth hypothesis is rejected.

## **5.4 CONCLUSION**

Apart from the effect of Mastery Learning Strategy on Clarifying the Problem, it was ascertained that Mastery Learning Strategy does not significantly foster the mental processes and skills associated with Problem Solving of students better than the Conventional Strategy.

This result contradicts the research studies (Arredondo and Block 1990, Mevarech 1985, Soled 1987) which show that Mastery Learning is highly effective when instruction focuses on high-level outcomes such as problem solving, drawing inferences, deductive reasoning and creative expression.

The present study was undertaken in the changed context of the new curriculum of the state of Kerala, which emphasizes Problem Solving approach in the mode of transaction of the curriculum as well as in the presentation of content in the textbook. Thus Mastery Learning Strategy was compared against the Conventional Strategy based on collaborative learning and problem solving approach. The result of this investigation thus, could either mean that Mastery Learning Strategy is not exceedingly good when compared to the Conventional Strategy presently practised in schools or the Conventional Strategy presently practised in schools is as good as the Mastery Learning Strategy in fostering Problem Solving Ability.

Mastery Learning Strategy however, enhances the thought processes and mental skills associated with Clarifying the Problem especially in girls.

Taking a closer look at the subcomponents of Clarifying the Problem, it can be seen that they consist of usual thought processes usually employed in the class room situation and much necessary for academic exercises as compared to the subcomponents which come under the other two components of Problem Solving Ability. The subcomponents of Clarifying the Problem are Ability to discriminate between the most relevant and closely related concepts, Using analogies

for reasoning, Using Inductive/deductive reasoning, Hypothesizing, Checking the testability of hypotheses. The enhancement of such abilities is due to the fact that in repeated sessions of corrective measures / remedial measures of the Mastery Learning Strategy Cycle, the students were made to think and master the content repeatedly, during which such mental processes were indispensable. Thus the gender difference in acquiring Problem Solving Ability through Mastery Learning Strategy could be accounted considering the fact that girls take up more sincerely the corrective and remedial measures in a disciplined manner whereas boys rather went through the procedures casually without much mental deliberation. And thus girls got themselves rewarded.

It follows that the abilities indicated by the components Comprehending the Problem and Finding solution to the Problem need to be included in the routine academic exercises practised in the classroom situation. This could be made possible by giving opportunities for the students to deal with a variety of life related curricular problems after attaining mastery of the concept and content.

Even though the effect of Nonverbal Intelligence, Verbal Intelligence and Previous Achievement is negative upon the increased Problem solving ability, its implication happens to be positive. To put it clearly, the above-mentioned factors, which are to some extent predetermined, do not influence the enhancement of Problem Solving Ability. Thus a teacher with a new strategy, which would increase Problem Solving Ability, can hope to make the effect in almost all

students irrespective of their Intelligence level and Previous Achievement level.

## **5.5 EDUCATIONAL IMPLICATIONS**

In the present study the investigator attempted to find out the effect of Mastery Learning Strategy on the Problem Solving Ability in Physics of secondary school students.

It was found that Mastery Learning Strategy does not significantly foster the mental processes and skills associated with Problem Solving of students better than the Conventional Strategy. Mastery Learning Strategy however, enhances the thought processes and mental skills associated with Clarifying the Problem especially in girls.

The present study was undertaken in the changed context of the new curriculum of the state of Kerala, which emphasizes Problem Solving approach in the mode of transaction of the curriculum as well as in the presentation of content in the textbook. Thus Mastery Learning Strategy was compared against the Conventional Strategy based on collaborative learning and problem solving approach. The result of this investigation thus, could either mean that Mastery Learning Strategy is not exceedingly good when compared to the Conventional Strategy presently practised in schools or the Conventional Strategy presently practised in schools are as good as the Mastery Learning Strategy in fostering Problem Solving Ability.

Anyhow, in the light of the present investigation, it is obvious that repeated learning, even though with alternate learning experiences, limited by the curriculum in the school context do not significantly

contribute to the enhancement of Problem Solving Ability. More time spent with enrichment and remedial measures can definitely improve Achievement and Problem Solving Ability associated with Clarifying the Problem but the original ability to interiorise a problem and the crucial ability to solve the problem cannot be significantly trained for improvement.

The researcher feels that even deeper exposures made to the once-familiar situations do not increase Problem Solving Ability in its real sense. To develop the original abilities of Problem Solving, students should be made to realize that there is more than one way of solving a single problem. The transfer of training helps the student to solve stereotyped problems by training and practice. But the original ability to solve problems develops only by handling diverse problems. Students should work out different problems on the same concept using different intellectual ways.

It also follows that the abilities indicated by the components Comprehending the Problem and Finding solution to the Problem need to be explicitly included in the routine academic exercises practised in the classroom situation. Diverse problems require different patterns of thinking, different styles of solving and different abilities that constitute for Problem Solving from the part of the problem solver. Thus it is imperative that the textbook and the process of curriculum transaction employ diverse problematic situations associated with a single topic so as to foster the ability to solve problems in Physics as well as in life.

## **5.6 SUGGESTIONS FOR FURTHER RESEARCH**

Keeping in view the limitations of the present study, and the constraints under which it was conducted, the findings do not warrant

wide generalization. It is therefore, felt that replication of this study on a larger sample is requisite to arrive at still reliable and precise results to test the effect of Mastery Learning Strategy on Problem Solving Ability. Also the researcher feels that other studies related to Problem Solving Ability should be conducted on the following themes.

1. Effect of different Problem Solving Approaches on increasing Problem solving Ability could be studied.
2. The relation between life related problem solving abilities and curriculum related problem solving abilities could be explored.
3. The relation between problem solving ability and other aspects of thinking like, divergent thinking and convergent thinking could be analysed.
4. Effect of Mastery Learning Strategy on Problem Solving Ability could be studied using a larger sample and ensuring both boys and girls are equally serious in going through the Corrective Measures/ Enrichment Activities, which form part of the Mastery Learning Strategy.
5. Effect of Mastery Learning Strategy on Problem Solving Ability could be studied using a larger sample concentrating on each subcomponent of Problem Solving Ability and monitor the effect at a micro level.

**APPENDICES**

**Mastery learning units of Chapter – 1 (Colours of Light)**  
**(English Translation)**

Sl No.	Name of the Mastery learning unit	Main Teaching Points
1	Dispersion of Light	Dispersion, composite light, component colours, Recombination of component colours, Rainbow – shape, colours and scientific principle.
		Newton's Colour disc, Persistence of Vision, Primary Colours and Secondary Colours, Complimentary Colours.
2	Colours and Pigments	Colour of opaque and transparent objects, Uses of Colour filters,
		Primary Pigments and secondary pigments. Absorption of Colours.
3	Scattering	Effects of Scattering, Red colour as danger signal, Yellow light as streetlight.
		Infra red waves, Ultra violet waves, Ozone layer, Fluorescence.

**Sample lesson plan with anticipated remedial measures and enrichment activities employed for Mastery Learning Strategy,  
which forms part of first subunit of the first chapter**

**(English Translation of the original Malayalam script)**

Name of the Teacher	: Manoj Praveen G.	Standard	: 9Q, 9G
Name of the School	: Farook Govt. Ganapet HSS.	Strength	: 37,37
Subject	: Physics	Duration	: 40'
Unit	: 1, Colours of Light	Date	: 2-6-05
Topic	: Dispersion and Recombination of light	Age	: 12+

Terms: Wavelength, Spectrum, Recombination, Rainbow, Refraction, Total Internal Reflection.

Concepts: Dispersion, Composite light, Component colours, Rainbow.

Curriculum Objective: To conceptualize Dispersion of Light, Composite light, Recombination of light and Persistence of Vision by observing, discussing and experimenting the different phenomena of light occurring in nature and to make short notes upon their realistic effects in daily life.

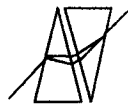
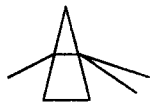
- Objectives of the lesson:
1. To realize and appreciate the wonders of light.
  2. To analyse the dispersion and recombination of light by comprehending the diagram and by performing the experiment.
  3. To realize the difference in wavelengths of different colours and to discuss the different deviations effected to them by referring the textbook.
  4. To discuss the circumstances essential for the formation of the rainbow and to analyse the structure of rainbow.

### PROCESS

Teacher tells a story of a village of blind. One day the villagers gained sight by eating a special fruit. The joy and elation to see the symphony of colours for the first time would be exceptional.

Teacher asks to hold transparent and new plastic scale or dot pen against sunlight to see the spectrum. The sunlight is white in colour. From where did the colours come?

Students form groups and experiment with prisms to understand dispersion and recombination of light.



Each group discusses the experiment draws diagrams and prepare short notes based on the questions on the slip provided by the teacher.

- Label the parts of the diagram
- Which colour deviated most?
- Which colour deviated least?
- How do the prism split colours?

Teacher shows the chart of different colours and their wavelengths. How is the wavelength and deviation of the colour related?

### EVALUATION

In 9Q students really appreciated the nature and the power of sight. In 9G pupils took it lightly and simply laughed.

Pupils recalled other objects which produced similar effect.

Diana of 9G asked why the second prism recombines sunlight whereas the first one splits up.

Students easily identified the connection between wavelength and deviation.

<p>When do you usually see a <u>rainbow</u>?          What are the distinct features of a rainbow?          Teacher discusses the formation of a rainbow.          How many refractions occur in the rain drop?</p>	<p>Students actively involved in discussions.</p>
<p>Students form groups and discuss the <u>arc shape of rainbow</u>. Teacher gives necessary scaffolding in each group. Each group presents their arguments.</p>	<p>Students write down the reason for the rainbow appearing bent.</p>

**ASSIGNMENT**

1. Hold a piece of mirror in a trough filled with water. Place the setting in sunlight and adjust the mirror position to see spectrum.
2. Take mouthful of water and spit it forcefully spreading the water into tiny droplets into the air while the sun is behind you.  
 What do you observe?
3. Why does the violet ray deviate more?
4. Why does the rainbow appear in the shape of an arc?

<b>Anticipated remedial measures</b>	<b>Anticipated enrichment activities</b>
<ul style="list-style-type: none"> <li>• Re-teaching of difficult portions</li> <li>• Peer teaching for slow learners.</li> <li>• Labeling of readymade diagrams.</li> <li>• Drawing and colouring of rainbow.</li> </ul>	<ul style="list-style-type: none"> <li>• Component colours of different sources of light.</li> <li>• Relation between wavelength and speed of light.</li> <li>• Secondary Rainbow.</li> </ul>

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**PROBLEM SOLVING ABILITY TEST IN PHYSICS**

**(DRAFT)**

**MALAYALAM VERSION**

**Dr. Sivarajan, K. and Manoj Praveen, G.**

**This book let contains 14 sections (PART 1 TO PART 14) in 14 pages. Each section contains four or five questions that test your ability to solve conceptual problems in Physics. Read the instructions for each section carefully and choose the right answer by encircling the serial number of the relevant response on the question paper itself.**

PART - 1

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തോടും അനുബന്ധിച്ച് 1,2,3,4 എന്നിങ്ങനെ കൊടുത്തിരിക്കുന്ന നാലു വസ്തുതകളിൽ ഏറ്റവും അസാദ്ധ്യമാകുമെന്ന് തോന്നുന്നത് നമ്പരിനു ചുറ്റും വട്ടം വരച്ച് മാർക്ക് ചെയ്യുക.

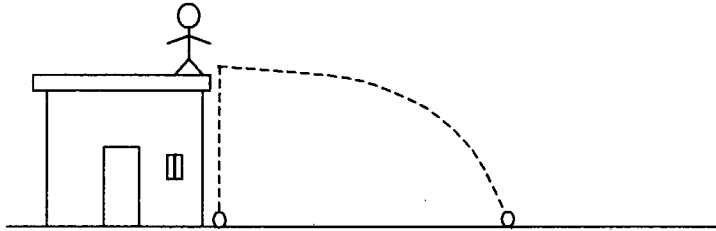
I.I.A ഭാരമുള്ള ഒരു പെട്ടി തറയിൽ വച്ചിരിക്കുന്നു. അതു തള്ളുമ്പോൾ ഉണ്ടായ സാഹചര്യങ്ങളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഇതിൽ ഏതാണ് നിങ്ങളെ ആശ്ചര്യപ്പെടുത്തുന്നത്. നാം പെട്ടി തള്ളുമ്പോൾ നമുക്ക് ബുദ്ധിമുട്ട് അനുഭവപ്പെടുന്നു.

1. തള്ളുമ്പോൾ ഉണ്ടാകുന്ന എതിർബലം പെട്ടി നീങ്ങിത്തുടങ്ങുമ്പോൾ അൽപം കുറയുന്നു.
2. പെട്ടി നീങ്ങിത്തുടങ്ങുമ്പോൾ തറയിൽ പോറൽ ഉണ്ടാവുന്നു.
3. നീങ്ങിത്തുടങ്ങിയ പെട്ടിമേൽ തള്ളുന്നത് നിർത്തുമ്പോൾ പെട്ടി നിശ്ചലാവസ്ഥയിലാവുന്നു.

I.I.B. ഒരു ബക്കറ്റ് വെള്ളം തറയ്ക്ക് ലംബമായി വട്ടത്തിൽ ചുഴറ്റുമ്പോൾ അനുഭവപ്പെടുന്ന ചില സാഹചര്യങ്ങളാണ് ചുവടെ ചേർത്തിരിക്കുന്നത്. ഇതിൽ ഏത് സാഹചര്യമാണ് സാധാരണ നാം പ്രതീക്ഷിക്കുന്നതിൽ നിന്നു വ്യത്യസ്തമായി അനുഭവപ്പെടുന്നത്.

1. ഒരു ബലം നമ്മുടെ കൈയ്യിൻമേൽ അനുഭവപ്പെടുന്നു എന്നത്.
2. ബക്കറ്റ് വൃത്തത്തിൽ കറങ്ങുന്നു എന്നത്.
3. ചുറ്റുന്നതിന്റെ വേഗത വളരെ കുറയ്ക്കുമ്പോൾ ബക്കറ്റ് വർത്തുളപാതയിൽ ചലിക്കുന്നില്ല എന്നത്.
4. ലംബമായി ചുഴറ്റുമ്പോൾ ബക്കറ്റിൽ നിന്ന് വെള്ളം താഴേക്ക് വീഴുന്നില്ല എന്നത്.

I.I.C ഒരേ പോലെയുള്ള രണ്ടു പന്തുകളിൽ ഒന്ന് കെട്ടിടത്തിന്റെ മുകളിൽ നിന്ന് തിരശ്ചീനമായി വലി ചെറിയതു. രണ്ടാമത്തേതാവട്ടെ അതേ സമയം തന്നെ വെറുതെ ഇട്ടു. താഴെ കൊടുത്തിരിക്കുന്ന ചിത്രം ശ്രദ്ധിക്കുക.



രണ്ടു പന്തുകളും വ്യത്യസ്ത ദൂരമാണ് സഞ്ചരിക്കുന്നത്. ഈ ചലനങ്ങളെ പറ്റി താഴെ പറയുന്നവയിൽ ഏത് വസ്തുതയാണ് നിങ്ങളെ ആശ്ചര്യപ്പെടുത്തുന്നത്?

1. രണ്ടു പന്തുകൾക്കും ചലനദിശ വ്യത്യസ്തമാണ് എന്നത്.
2. രണ്ടു പന്തുകളും ഭൂമിയുടെ ആകർഷണത്തിന് വിധേയമാണ് എന്നത്.
3. രണ്ടു പന്തുകളും ഒരേ സമയം നിലത്തു വീഴുന്നു എന്നത്.
4. രണ്ടു പന്തുകൾക്കും താഴേയ്ക്കുള്ള പ്രവേഗം ക്രമേണ കൂടി വരുന്നു എന്നത്.

I.I.D. ഒരു മുറിയിൽ സോഡിയം വേപ്പർ വിളക്ക് ഉപയോഗിച്ച് മഞ്ഞ നിറം ഉണ്ടാക്കിയിട്ടുണ്ട്. തൊട്ടടുത്ത മുറിയിൽ പ്രാഥമിക വർണങ്ങളായ ചുവപ്പും പച്ചയും പ്രകാശം ചേർത്ത് മഞ്ഞ നിറം സൃഷ്ടിച്ചിട്ടുണ്ട്. ചുവപ്പ്, പച്ച, വെള്ള എന്നീ നിറങ്ങളിലുള്ള ബട്ടണുകൾ ഓരോ മുറിയിലും കൊണ്ടു പോയി പരിശോധിച്ചപ്പോൾ കണ്ട വസ്തുതകളാണ് താഴെ ചേർത്തിരിക്കുന്നത്. ഇതിൽ ഏത് വസ്തുതയാണ് നിങ്ങൾക്ക് അസാദ്ധ്യമാകുമായി തോന്നുന്നത്.

1. ചുവപ്പും പച്ചയും ചേർന്ന സമന്വൃത മഞ്ഞ പ്രകാശമുള്ള മുറിയിൽ ചുവപ്പ് ബട്ടൺ ചുവപ്പായും പച്ച ബട്ടൺ പച്ചയായും കാണാൻ സാധിച്ചു.
2. സോഡിയം വേപ്പർ ലാമ്പ് ഉപയോഗിച്ചുള്ള മഞ്ഞ പ്രകാശത്തിൽ ചുവപ്പ് പച്ച ബട്ടണുകൾ ഇരുണ്ടതായി കണ്ടു.
3. സോഡിയം വേപ്പർ ലാമ്പ് ഉപയോഗിച്ചുള്ള മഞ്ഞ പ്രകാശത്തിൽ വെള്ള ബട്ടൺ മഞ്ഞയായി തോന്നി.
4. സമന്വൃത മഞ്ഞ പ്രകാശമുള്ള മുറിയിൽ വെള്ള ബട്ടൺ മഞ്ഞയായി തോന്നി.

I.I.E. അന്തരീക്ഷവും വായുവുമില്ലാത്ത ചന്ദ്രോപരിതലത്തിൽ വച്ച് ഒരു തൂവലും നാണയവും ഒരു നിശ്ചിതദൂരം ഒരുമിച്ച് വീഴാൻ അനുവദിച്ചു. ഇതേ പരീക്ഷണം ഭൂമിയിൽ വച്ച് വായു നീക്കം ചെയ്ത ഒരു സ്പെട്രിക്കുഴലിൽ ചെയ്തതുമുതലായി പരീക്ഷണം നടത്തിക്കിട്ടിയ നിരീക്ഷണഫലങ്ങളിൽ ഏതാണ് സാധാരണ നാം ചിന്തിക്കുന്നതിൽനിന്നും വ്യത്യസ്തമായി തോന്നുന്നത്?

1. ചന്ദ്രനിൽ വച്ച് നാണയവും തൂവലും ഒരുമിച്ച് നിലംപതിച്ചു.
2. ഭൂമിയിൽ വായു നീക്കം ചെയ്ത സ്പെട്രിക്കുഴലിൽ വച്ച് നാണയവും തൂവലും ഒരുമിച്ച് നിലം പതിച്ചു.
3. ചന്ദ്രനിൽ വച്ചും ഭൂമിയിൽ വച്ചും നടത്തിയ പരീക്ഷണങ്ങളിൽ വായുവിന്റെ പ്രതിരോധം ഉണ്ടായിരുന്നില്ല.
4. ചന്ദ്രനിൽ നിശ്ചിത ദൂരം വീഴാനെടുത്ത സമയം ഭൂമിയിൽ വീഴാനെടുത്ത സമയത്തേക്കാൾ കൂടുതലായിരുന്നു.

PART - 2

ദൈനം ദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തിലും ഒരു കാതലായ പ്രശ്നം അടങ്ങിയിട്ടുണ്ട്. ഓരോ സന്ദർഭത്തോടും അനുബന്ധിച്ച് കൊടുത്തിരിക്കുന്ന നാലു പ്രസ്താവനകളിൽ ഏതാണ് പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത് എന്ന് നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് മാർക്ക് ചെയ്യുക

**I.2.A.** അതിരാവിലെ അഞ്ചുമണിക്ക് ഒരു ഹോട്ടലിന്റെ എട്ടാം നിലയിൽ കറുത്ത ഷർട്ട് ധരിച്ച ഒരു റ്റംബോയ് ഒരാൾക്ക് കട്ടൻ കാപ്പി ഫ്ലാസ്കിലേക്ക് പകർന്നു കൊടുക്കുകയായിരുന്നു. ഇതിനായി ഒരു വലിയ പാത്രത്തിൽ കട്ടൻകാപ്പിയ്ക്കിടയിൽ പഞ്ചസാര ചേർത്ത് ഒരു വെള്ളി സ്പൂൺ കൊണ്ട് നന്നായി വട്ടത്തിൽ ഇളക്കി. പാത്രത്തിലെ കാപ്പിയുടെ ചലനം അവസാനിക്കുന്നതിനു മുമ്പ് തന്നെ അത് ഫ്ലാസ്കിലേക്ക് പകരുവാൻ ശ്രമിച്ചു. വളരെ ശ്രദ്ധിച്ച് ഫ്ലാസ്കിനോട് ചേർത്ത് വച്ച് ഒഴിച്ചിട്ടും കാപ്പി അതിന്റെ വർത്തുള ചലനത്തിന്റെ ദിശയിൽ പുറത്തേക്ക് തെറിച്ചു വീണു. ഇവിടെ അനുഭവപ്പെട്ട പ്രശ്നം താഴെ പറയുന്നതിൽ ഏത് പ്രസ്താവനയിലാണ് ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കപ്പെട്ടിരിക്കുന്നത്.

1. വർത്തുള ചലനത്തിലായിരുന്ന കാപ്പി മറ്റൊരു പാത്രത്തിലേക്ക് പകരുന്ന അവസരത്തിൽ ചലനത്തിന്റെ ദിശയിൽ പുറത്തേക്ക് തെറിച്ചു.
2. എട്ടാമത്തെ നിലയിൽ നിൽക്കുന്ന റ്റംബോയ് ഒരു വെള്ളി സ്പൂൺ ഉപയോഗിച്ച് കട്ടൻകാപ്പി വട്ടത്തിൽ ഇളക്കി.
3. കറുത്ത ഷർട്ട് ആൾ കാപ്പിയുടെ ചലനം നിൽക്കുന്നതിനു മുമ്പ് ഫ്ലാസ്കിലേക്ക് ഒഴിച്ചു.
4. വളരെ ശ്രദ്ധയോടെ ഒഴിച്ചിട്ടും വാട്ടം കുറഞ്ഞ ഫ്ലാസ്കിലേക്ക് ഒഴിച്ചപ്പോൾ കാപ്പി തെറിച്ചു പോയി.

**I.2.B.** രാത്രിയിൽ ഒരു ലോഗി ഡ്രൈവർ അതീവശ്രദ്ധയോടെ ഹൈറേഞ്ചിലുള്ള റോഡിലൂടെ വാഹനം ഓടിക്കുകയായിരുന്നു. അന്തരീക്ഷത്തിൽ നല്ല മഞ്ഞുണ്ടായിരുന്നു. ദൂരേക്ക് കാണാൻ വലിയ ബുദ്ധിമുട്ടായിരുന്നു. ഡ്രൈവർ വാഹനത്തിന്റെ ഹെഡ്‌ലൈറ്റുകൾക്കു പുറമേ വെള്ള ലൈറ്റുകൾ രണ്ടെണ്ണം കൂടി (അഡിഷണൽ ലാമ്പുകൾ) പ്രകാശിപ്പിച്ചു. എന്നാൽ മഞ്ഞു കൂടുതൽ തിളങ്ങുന്നതായി തോന്നിയതല്ലാതെ ദൂരക്കാഴ്ചയ്ക്ക് അത് ഒട്ടും ഉപകരിച്ചില്ല. മഞ്ഞിലൂടെ ദൂരേക്ക് കാണുന്നത് ശരിക്കും ബുദ്ധിമുട്ടുള്ള ഒരു കാര്യമാണ്. താഴെ പറയുന്നതിൽ ഏത് പ്രസ്താവനയാണ് ഇവിടുത്തെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

1. രാത്രിയിൽ ഹൈറേഞ്ച് റോഡിലൂടെ വാഹനമോടിക്കുന്നത് വളരെ ദുഷ്കരമാണ്.
2. വെള്ള പ്രകാശം മഞ്ഞിനെ കൂടുതൽ തിളക്കമുള്ളതാക്കി മാറ്റും എന്നല്ലാതെ മഞ്ഞിലൂടെ ദൂരേക്ക് കാണാൻ സഹായിക്കുന്നില്ല.
3. അന്തരീക്ഷത്തിൽ വളരെ ചെറിയ ജല കണികകൾ ഘനീഭവിച്ച് തങ്ങിനിൽക്കുന്നതിനാൽ മഞ്ഞിലൂടെ ദൂരേക്ക് കാണുന്നത് വളരെ ദുഷ്കരമാണ്.
4. ഹെഡ്‌ലൈറ്റിനു പുറമേയുള്ള വെള്ള ലൈറ്റുകൾ മഞ്ഞിലൂടെ കാണാൻ സഹായിക്കുന്നില്ല.

**I.2.C** ക്രിക്കറ്റ് കളിയിൽ ചില ബൗളർമാർ ഉയർന്ന വേഗതയിൽ പന്തെറിയുന്നു. എന്നാൽ ചിലർ താരതമ്യേന കുറഞ്ഞ സ്പീഡിലാണ് പന്തെറിയുന്നത്. അഭിലാഷ് എന്ന ബാറ്റ്സ്മാൻ വേഗത്തിലുള്ള പന്തുകളെ ബാറ്റ് കൊണ്ട് ചെറുതായി തട്ടി ദിശ തിരിച്ചുവിടുന്ന സ്വഭാവക്കാരനാണ്. ബാറ്റിൽ തട്ടിയ പന്ത് വളരെ വേഗത്തിൽ ബൗണ്ടറിയിലേക്ക് കുതിക്കുകയും ചെയ്യുന്നു. എന്നാൽ വേഗം കുറഞ്ഞ പന്തുകളെ നേരിടുമ്പോൾ അഭിലാഷ് ആകെ കൂഴയുന്നു. പന്തിന്റെ ദിശ തിരിച്ചു വിടുന്ന സ്ഥിരം ശൈലി ഉപയോഗിക്കുമ്പോൾ പന്ത് അൽപം ദൂരം മാത്രമേ പോകുന്നുള്ളൂ. വേഗം കുറഞ്ഞ ബൗളർമാർ പന്തെറിയുമ്പോൾ അഭിലാഷിന് ബൗണ്ടറിയിലേക്ക് പന്തടിച്ചുവിടാൻ സാധിക്കാറില്ല. താഴെ പറയുന്നതിൽ ഏത് പ്രസ്താവനയാണ് ഇതിലെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്.

1. വേഗത്തിലുള്ള പന്തുകൾ എല്ലാവർക്കും നേരിടാൻ എളുപ്പമല്ല.
2. വേഗത്തിലുള്ള പന്തുകൾ ദിശതിരിച്ചു വിടുന്നത് ബുദ്ധിമുട്ടാണ്.
3. പതിയെ എറിയുന്ന പന്തിനെ അടിച്ചു ദൂരേക്ക് എത്തിക്കുന്നത് ബുദ്ധിമുട്ടാണ്.
4. പതിയെ എറിയുന്ന പന്തിനെ ദിശ തിരിച്ചുവിടുന്നത് ബുദ്ധിമുട്ടാണ്.

**I.2.D.** ഇന്ത്യയിൽനിന്ന് ധ്രുവപ്രദേശത്തുള്ള അന്റാർട്ടിക്ക പഠിക്കുവാൻ ഒരു സംഘം പുറപ്പെട്ടു. അവിടെ വച്ച് സംഘത്തിലെ ഒരാൾ സഹപ്രവർത്തകനിൽ നിന്ന് 24ഗ്രാം ഭാരമുള്ള ഒരു സ്വർണമാല വില കൊടുത്തു വാങ്ങി സ്വന്തം നാട്ടിലെത്തി തുക്കി നോക്കിയപ്പോൾ അതിന്റെ ഭാരം കുറഞ്ഞതായി കണ്ടു. മാലയിൽ നിന്നും ഒട്ടും സ്വർണം നഷ്ടപ്പെടുകയോ കൂട്ടിച്ചേർക്കപ്പെടുകയോ ചെയ്തിട്ടില്ല എന്ന കാര്യം ഉറപ്പാണ്. താഴെ പറയുന്നതിൽ ഏത് പ്രസ്താവനയാണ് ഇതിലെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

1. താപ നില കുറഞ്ഞ പ്രദേശത്ത് വച്ച് തുക്കിയപ്പോൾ മാലയുടെ ഭാരം 24 ഗ്രാം ആയി കണ്ടു.
2. മാല വാങ്ങിയ ആൾക്ക് നഷ്ടം സംഭവിച്ചു.
3. സ്വർണം വില കൂടിയ ലോഹമായതിനാൽ ഭാരത്തിലുണ്ടാകുന്ന ചെറിയ വ്യത്യാസം പോലും വലിയ ലാഭനഷ്ടങ്ങളുണ്ടാക്കുന്നു.
4. നിശ്ചിത പിണ്ഡമുള്ള സ്വർണമാല ഭൂമിയുടെ വ്യത്യസ്ത പ്രദേശങ്ങളിൽ വ്യത്യസ്ത ഭാരം കാണിച്ചി.

PART - 3

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തിലും ഒരു ശാസ്ത്ര പ്രശ്നം അടങ്ങിയിരിക്കുന്നു. ഈ പ്രശ്നത്തിലെ പ്രധാന ഘടകങ്ങൾ ഏതാണെന്ന് കണ്ടുപിടിക്കുകയാണ് നിങ്ങൾ ചെയ്യേണ്ടത്. പ്രധാനഘടകങ്ങളുടെ ശരിയായ കൂട്ടം കണ്ടെത്തി അതിന്റെ നമ്പറിനു ചുറ്റും വട്ടം വരയ്ക്കുക.

I.3.A. തന്റെ വീടിനു മുമ്പിലുള്ള തോട്ടത്തിലെ ചെടികൾക്ക് രാത്രിയിൽ ഹോസ് ഉപയോഗിച്ച് വെള്ളമൊഴിക്കുകയായിരുന്നു രാമു. ഹോസിന് നീളം കുറവായിരുന്നതിനാൽ വെള്ളം ദൂരേക്ക് എത്തിക്കുന്നതിനുവേണ്ടി അവൻ ഹോസിന്റെ ദ്വാരം തെക്കിപ്പിടിച്ച് വെള്ളം ചീറ്റിച്ചു നോക്കി. പിന്നീട് ഹോസ് വിവിധ കോണുകളിൽ പിടിച്ചുനോക്കി. വെള്ളം വീഴുന്ന ദൂരം (റേഞ്ച്) പരമാവധി ആക്കുന്നതിനു വേണ്ടി രാമു ശ്രമിക്കുകയായിരുന്നു. ഈ സന്ദർഭത്തിലെ പ്രധാനഘടകങ്ങളുടെ കൂട്ടം ഏതാണ്?

1. കോൺ, പരമാവധി റേഞ്ച്, പ്രകാശത്തിന്റെ അഭാവം
2. റേഞ്ച്, വെള്ളം, ഹോസ്
3. വെള്ളത്തിന്റെ ഒഴുക്കിന്റെ ശക്തി, കോൺ, പരമാവധി റേഞ്ച്
4. രാത്രി, പരമാവധി, ഹോസ്.

I.3.B. ചെറിയ കുട്ടികൾ ഭാരമുള്ള ഇഷ്ടികക്കട്ടകൾ കൊണ്ട് മുറ്റത്ത് വീടുണ്ടാക്കി കളിക്കുകയായിരുന്നു. ഇഷ്ടികകൾ ഒരു മരപ്പലകമേൽ ഒന്നിനു പുറത്ത് ഒന്നായി വയ്ക്കും. എന്നിട്ട് മരപ്പലകയെ ഒരു ചരട് കൊണ്ട് മണലിലൂടെ കെട്ടി വലിക്കും. ഇങ്ങനെ നിരക്കിയാണ് കുട്ടികൾ ഇഷ്ടികകൾ കളി സ്ഥലത്തേക്ക് കൊണ്ട് വന്നത്. ഇതു വളരെ ബുദ്ധിമുട്ടായിരുന്നു. ഘർഷണം ചലനത്തെ തടസ്സപ്പെടുത്തുമല്ലോ. ഈ പ്രശ്നത്തിലെ പ്രധാന ഘടകങ്ങളുടെ ശരിയായ കൂട്ടം ഏതാണ്?

1. നിരങ്ങൾ, ഘർഷണം, ഭാരം
2. ചലനം, മരപ്പലക, പ്രയത്നം
3. നിരങ്ങൾ, ഇഷ്ടിക, ചരട്
4. കുട്ടികൾ, ഇഷ്ടിക, ഉരുളൽ

I.3.C. രാമുവും ശ്യാമുവും വ്യത്യസ്ത ഭാരമുള്ള കുട്ടികളായിരുന്നു. രാമു അഞ്ചുകിലോ തൂക്കമുള്ള ഇരുമ്പുഗോളവും ശ്യാമു പത്തുകിലോ തൂക്കമുള്ള ഇരുമ്പു ഗോളവും എടുത്ത് വീടിന് മുകളിൽ കയറി. രണ്ടു പേരും ഒരേ സമയം ഗോളങ്ങൾ താഴേയ്ക്ക് വലിച്ചെറിഞ്ഞു. പത്തുകിലോ തൂക്കമുള്ള ഗോളം ആദ്യം താഴെയെത്തി. താഴെ പറയുന്നതിൽ ഏതൊക്കെ ഘടകങ്ങളാണ് ഈ സംഭവത്തെ സ്വാധീനിച്ചത്?

(a) കുട്ടികളുടെ വ്യത്യസ്ത ഭാരം (b) ഗോളങ്ങളുടെ വ്യത്യസ്ത ഭാരം (c) ഗോളം നിർമ്മിച്ചിരിക്കുന്ന പദാർത്ഥം (d) ഗോളങ്ങളെ താഴേയ്ക്കെറിഞ്ഞപ്പോൾ അവയ്ക്ക് ലഭിച്ച ആദ്യപ്രവേഗം.

1. a & b
2. a, b & c
3. b & d
4. d മാത്രം

I.3.D. ഒരു പെൺകുട്ടി ഊഞ്ഞാലാടിക്കൊണ്ടിരിക്കുകയായിരുന്നു. അവളുടെ സഹോദരി പുറകിൽ നിന്ന് വന്ന് ഊഞ്ഞാലിനെ കൂടുതൽ ഉയരത്തിലേക്ക് ആട്ടി വിട്ടു. ഉയരത്തിൽ നിന്ന് താഴേക്ക് ആടി വന്നപ്പോൾ കുട്ടിക്ക് സ്വന്തം ഭാരം കുറഞ്ഞതുപോലെ തോന്നി. താഴേക്ക് വരുന്നതിനുള്ള ത്വരണത്തിനുവേണ്ടി കുട്ടിയുടെ ഭാരം ഉപയോഗപ്പെടുത്തുമല്ലോ. ഈ സാഹചര്യത്തിൽ കുട്ടിക്ക് അനുഭവപ്പെട്ട ഭാരക്കുറവുമായി ബന്ധപ്പെട്ട പ്രധാന ഘടകങ്ങൾ ഏതെല്ലാം.

1. ഭാരക്കുറവ്, മാസ്, തള്ളൽ ഊഞ്ഞാൽ
2. ഊഞ്ഞാൽ, തള്ളൽ, ഭാരക്കുറവ്, പ്രവേഗം
3. ഭാരക്കുറവ്, താഴേക്കുള്ള ചലനം, മാസ്, ഊഞ്ഞാൽ
4. കുടിയ ഉയരം, താഴേക്കുള്ള ചലനം, ത്വരണം, ഭാരക്കുറവ്.

I.3.E. അച്ഛനും മകനും തീവണ്ടിയിൽ ഗ്രാമത്തിൽ നിന്നും പട്ടണത്തിലേക്ക് യാത്ര ചെയ്യുകയായിരുന്നു. ഗ്രാമത്തിലെ തെളിഞ്ഞ നീല ആകാശത്തിൽ നിന്ന് വ്യത്യസ്തമാണ് പട്ടണത്തിലെ ആകാശമെന്ന് മകൻ ശ്രദ്ധിച്ചു. പൊടിപടലങ്ങളും പുകയും എല്ലാം നിറഞ്ഞതാണ് പട്ടണം. ആകാശത്തിന്റെ നിറം ചാര നിറമാണ്. നീല നിറത്തിലാല്ലോ ആകാശം കാണപ്പെടേണ്ടത്. ഇവിടെ എന്തുകൊണ്ടാണ് ആകാശം ചാരനിറമായി കാണപ്പെടുന്നത് എന്ന് മകൻ ചോദിച്ചു. പട്ടണങ്ങളിൽ പൊടിപടലങ്ങളുടെ വലിയ കണികകൾ എല്ലാം വ്യത്യസ്ത നിറങ്ങളേയും ഏതാണ്ട് ഒരേ തോതിൽ വിസരണ വിധേയമാക്കുന്നു എന്ന് അച്ഛൻ പറഞ്ഞു. ആകാശത്തിന്റെ നിറം മാറ്റത്തിന് കാരണമായ പ്രധാന ഘടകങ്ങളുടെ ശരിയായ കൂട്ടം ഏത്?

1. അന്തരീക്ഷം, ആകാശം, പൊടിപടലം, തീവണ്ടി.
2. പുക, ആകാശം, നീലനിറം, ചാര നിറം.
3. വലിയകണികകൾ, വ്യത്യസ്തനിറങ്ങൾ, വിസരണതോത്, ചാരനിറം.
4. പൊടിപടലം, പുക, ചാരനിറം, തീവണ്ടി.

PART - 4

താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങളിലെല്ലാം പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ രണ്ട് ശാസ്ത്ര ആശയങ്ങൾ അടങ്ങിയിട്ടുണ്ട്. തന്നിരിക്കുന്ന സന്ദർഭങ്ങൾ ശ്രദ്ധയോടെ വായിച്ച് പ്രസക്തമായ ആശയങ്ങളുടെ ജോഡി കണ്ടെത്തി നമ്പറിന് ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക.

I.4.A. രണ്ടു സുഹൃത്തുക്കൾ A യും B യും കാട്ടിലെത്തി. B ഒരു മാവിന്റെ ചുവട്ടിൽ വിശ്രമിച്ചപ്പോൾ A വെള്ളം തേടിപ്പോയി. പക്ഷേ തിരിച്ചുവരുമ്പോൾ വഴിതെറ്റി A സുഹൃത്തിനെത്തേടി പല ദിശകളിലും കിലോമീറ്ററുകളോളം പരതി നടന്നു. എന്നാൽ ഒരിക്കലും B യുടെ അരികിൽനിന്നും അവൻ ന്യൂമീറ്ററിൽ കൂടുതൽ അകലെയായിരുന്നില്ല. ഈ സന്ദർഭത്തിൽ ഏറ്റവും പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

- 1. പ്രവേഗവും താരണവും
- 2. ദൂരവും സ്ഥാനാന്തരവും
- 3. പ്രവേഗവും സ്ഥാനാന്തരവും
- 4. കിലോമീറ്ററും മീറ്ററും.

I.4.B. ഒരു ഭാരമുള്ള പെട്ടി മിനുസമുള്ള ഒരു തറയിൽ കൂടി വലിക്കുകയായിരുന്നു. ആദ്യം 50 N ബലം പ്രയോഗിച്ചു; പെട്ടി അനങ്ങിയില്ല. തുടർന്ന് 60, 70, 80, 90, 100 N പ്രയോഗിച്ചു. എന്നിട്ടും പെട്ടി അനങ്ങിയില്ല. എന്നാൽ 101 N പ്രയോഗിച്ചപ്പോൾ പെട്ടി ചലിച്ചു തുടങ്ങി. അധികമായി ഒരു ന്യൂട്ടൺ പ്രയോഗിച്ചതാണ് ഇവിടെ പെട്ടിയെ ചലിപ്പിച്ചത്. ഈ സന്ദർഭത്തിൽ ഏറ്റവും പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

- 1. ബലവും ആവേഗവും
- 2. തള്ളും വലിയും
- 3. ഘർഷണവും കൊഴുപ്പിലും
- 4. സ്ഥിതഘർഷണവും ഘർഷണപരിധിയും

I.4.C. ചൈനക്കാർ ഒരു ഉപഗ്രഹം ഉണ്ടാക്കി. അത് വിക്ഷേപിച്ചാൽ എപ്പോഴും ചൈനയ്ക്കു മുകളിൽ സ്ഥിതി ചെയ്യുന്നവിധം ഭൂമിയുടെ ഭ്രമണത്തിനൊപ്പിച്ച് കറങ്ങുന്ന വിധമാണ് അതിന്റെ വേഗത ഉദ്ദേശിച്ചിരുന്നത്. എന്നാൽ വിക്ഷേപണസമയത്തുണ്ടായ ഒരു ചെറിയ പിശക്മൂലം അത് ഭൂമിയുടെ ആകർഷണവലയം ഭേദിച്ച് ബഹിരാകാശത്തേക്ക് നഷ്ടപ്പെട്ടുപോയി. ഇവിടെ ഏറ്റവും പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

- 1. ഭൂസ്ഥിര ഉപഗ്രഹവും പോളാർ ഉപഗ്രഹവും
- 2. ഗുരുത്വാകർഷണവും ന്യൂട്ടന്റെ മൂന്നാം ചലനനിയമവും
- 3. ഓർബിറ്റൽ പ്രവേഗവും പലായനപ്രവേഗവും
- 4. പലായനപ്രവേഗവും ഗുരുത്വാകർഷണവും

I.4.D. ഒരു വൃത്താകൃതിയിലുള്ള തകിടിനെ മൂന്ന് സമഭാഗങ്ങളാക്കി ചുവപ്പ്, പച്ച, നീല എന്നീ നിറങ്ങൾ കൊടുത്തിരിക്കുന്നു. ഇത് വേഗത്തിൽ കറക്കുമ്പോൾ, വ്യത്യസ്തനിറങ്ങൾ കാണാതാവുകയും തകിട് വെള്ള നിറമായി കാണപ്പെടുകയും ചെയ്യുന്നു. ഇവിടെ ഏറ്റവും പ്രസക്തമായതും തമ്മിൽ ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

- 1. പ്രകാശപ്രകീർണനവും വീക്ഷണസ്ഥിരതയും
- 2. പ്രാഥമികവർണവും ദ്വീതിയവർണവും
- 3. വർണങ്ങളുടെ സംയോജനവും വീക്ഷണസ്ഥിരതയും
- 4. തകിടിന്റെ ആകൃതിയും വർണങ്ങളുടെ പുനർസംയോജനവും

PART 5

താഴെ കൊടുത്തിരിക്കുന്ന ശാസ്ത്രീയ പ്രതിഭാസങ്ങൾക്ക് സമാനമായ അവസ്ഥ കണ്ടെത്തി അടയാളപ്പെടുത്തുക.

2.1.A. രണ്ടു പ്രതലങ്ങൾ തമ്മിലുള്ള ഘർഷണം ഉണ്ടാകുന്നതിനു കാരണം വസ്തുവിന്റെ ഉപരിതലത്തിലുള്ള ക്രമരഹിതമായ ഉയർച്ചകളും താഴ്ചകളും ആണ്. ഒരു വസ്തു മറ്റൊരു വസ്തുവിൻമേൽ നിരങ്ങി നിങ്ങുമ്പോൾ സൂക്ഷ്മമായ ഈ ഉയർച്ച താഴ്ചകൾ പരസ്പരം കൊളുത്തി, ചലനത്തിന് എതിർദിശയിൽ സൃഷ്ടിക്കുന്ന ബലമാണ് ഘർഷണബലം. ഈ പ്രതിഭാസത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നതിൽ ഏതാണ്.

1. രണ്ട് സാൻഡ് പേപ്പറുകളുടെ പരുപരുത്ത പ്രതലങ്ങൾ പരസ്പരം ഉരയ്ക്കുന്നത്.
2. താക്കോൽ ഉപയോഗിച്ച് ഒരു താഴു പൂട്ടുകയും തുറക്കുകയും ചെയ്യുന്നത്.
3. രണ്ടു കത്തികൾ ലംബമായി പരസ്പരം ഉരസുന്നത്.
4. രണ്ടു കൊളുത്തുകൾ പരസ്പരം കൊളുത്തിവലിക്കുന്നത്.

2.1.B. പ്രകാശരശ്മി ഒരു മാധ്യമത്തിൽനിന്ന് മറ്റൊന്നിലേക്ക് ചരിഞ്ഞ് പ്രവേശിക്കുമ്പോൾ വിഭജനതലത്തിൽ വച്ച് വളയുന്നു. ഇതിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നവയിൽ ഏതാണ്?

1. ഒരു കപ്പൽ പുഴയിൽനിന്ന് കടലിലേക്ക് കടക്കുമ്പോൾ അൽപം ഉയരുന്നു.
2. ഒരു സൈക്കിൾ ടാറിട്ട റോഡിൽനിന്ന് പുഴമണൽനിറഞ്ഞ സ്ഥലത്തേക്ക് ചരിഞ്ഞ് പ്രവേശിക്കുമ്പോൾ സഞ്ചാരദിശ പെട്ടെന്ന് വ്യതിചലിക്കുന്നു.
3. പറക്കുന്ന പക്ഷിക്ക് എതിരെ ശക്തമായി കാറ്റുവീശുമ്പോൾ കൂടുതൽ ഉയരത്തിലേക്ക് പറന്നുകയറുന്നു.
4. ഒരു കുഴലിലൂടെ ഒഴുകുന്ന വെള്ളം കുഴലിന്റെ വണ്ണം കുറഞ്ഞ ഭാഗത്തെത്തുമ്പോൾ വേഗത്തിലൊഴുകുന്നു.

2.1.C. പ്രകാശതരംഗം അന്തരീക്ഷത്തിൽ കൂടി കടക്കുമ്പോൾ പൊടിപടലങ്ങളിലും തന്മാത്രകളിലും മറ്റും തട്ടി വിസരണത്തിനു വിധേയമാകുന്നു. തരംഗദൈർഘ്യം കുറവുള്ള പ്രകാശതരംഗത്തിന് വിസരണം കൂടുതലും തരംഗദൈർഘ്യം കൂടിയതിന് വിസരണം കുറവും ആയിരിക്കും. ഈ പ്രതിഭാസത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നതിൽ ഏതാണ്?

1. നീളമുള്ള കാലുകളുള്ള മനുഷ്യൻ നടക്കുമ്പോൾ പാതയിലുള്ള ചെറിയ പ്രതിബന്ധങ്ങൾ കാര്യമാക്കേണ്ടി വരാറില്ല.
2. ബലമുള്ള മാംസപേശികളുള്ള വ്യക്തിക്ക് തന്റെ മുമ്പിലുള്ള പ്രതിബന്ധങ്ങളെ എളുപ്പം തകർത്ത് മുന്നേറാനാവും.
3. നീളമുള്ള കാലുകളുള്ള മനുഷ്യന് വേഗത്തിൽ നീന്താനാവും.
4. ബലമുള്ള മാംസപേശികളുള്ള വ്യക്തി ബലമില്ലാത്തവരെ കീഴ്പ്പെടുത്തും.

2.1.D. ഒരു സെക്കണ്ട് സമയത്തിൽ ഒരു വസ്തുവിനുണ്ടാകുന്ന പ്രവേഗവ്യത്യാസമാണല്ലോ ത്വരണം. തുല്യസമയാന്തരങ്ങളിൽ ഒരു വസ്തുവിനുണ്ടാകുന്ന പ്രവേഗമാറ്റം തുല്യങ്ങളാകുമ്പോൾ ത്വരണം സമത്വമാകുന്നു. താഴെ പറയുന്ന സന്ദർഭങ്ങളിൽ ഏതാണ് സമത്വത്വം എന്ന ആശയത്തിനു സമാനമായി നിലകൊള്ളുന്നത്?

1. ഒരാൾ ഓരോ മിനിറ്റിലും ഒരു അപ്പം കഴിക്കുന്നു.
2. ഒരാൾ ആദ്യമിനിറ്റിൽ 1, രണ്ടാം മിനിറ്റിൽ 2, മൂന്നാം മിനിറ്റിൽ 4, നാലാം മിനിറ്റിൽ 8 എന്ന കണക്കിൽ അപ്പം കഴിക്കുന്നു.
3. ഒരാൾ ആദ്യമിനിറ്റിൽ 1, രണ്ടാം മിനിറ്റിൽ 2, മൂന്നാം മിനിറ്റിൽ 3, നാലാം മിനിറ്റിൽ 4 എന്ന കണക്കിൽ അപ്പം കഴിക്കുന്നു.
4. ഒരാൾ ആദ്യമിനിറ്റിൽ 1, രണ്ടാം മിനിറ്റിൽ 3, മൂന്നാം മിനിറ്റിൽ 9, നാലാം മിനിറ്റിൽ 27 എന്ന കണക്കിൽ അപ്പം കഴിക്കുന്നു.

2.1.E. രണ്ടു വസ്തുക്കൾ തമ്മിലുള്ള ഗുരുത്വാകർഷണബലം അവ തമ്മിലുള്ള അകലം കൂടുന്നതിനനുസരിച്ചു കുറയുന്നു. ഈ പ്രതിഭാസത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നതിൽ ഏതാണ്?

1. രണ്ടു കാന്തങ്ങൾ തമ്മിലുള്ള ആകർഷണം അകലം വർദ്ധിക്കുന്നതിനനുസരിച്ച് കുറയുന്നു.
2. രണ്ടു കാന്തങ്ങൾ തമ്മിലുള്ള വികർഷണം അകലം വർദ്ധിക്കുന്നതിനനുസരിച്ച് കുറയുന്നു.
3. രണ്ടു പ്രതലങ്ങൾ തമ്മിലുള്ള ഘർഷണബലം സ്നേഹകം ഉപയോഗിക്കുമ്പോൾ കുറയുന്നു.
4. രണ്ടു പ്രതലങ്ങൾ തമ്മിലുള്ള ഘർഷണബലം ചൂടാകുന്നതിനനുസരിച്ചു കൂടുന്നു.

PART - 6

താഴെകൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യങ്ങളിലും ശാസ്ത്രീയമായി തെളിയിക്കപ്പെട്ടിട്ടുള്ള ഒന്നിലേറെ പ്രസ്താവനകൾ അടങ്ങിയിരിക്കുന്നു. ഈ പ്രസ്താവനകളെ മാത്രം അടിസ്ഥാനമാക്കിയാൽ ഏത് അനുമാനത്തിലെത്തിച്ചേരാനാകുമെന്ന് നിർണ്ണയിച്ച് ശരിയായ അനുമാനത്തിനു നേരെയുള്ള നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക

2.2.A. ഈ പാഠശാലിലെ മൂന്നു വാചകങ്ങൾ ശ്രദ്ധിക്കുക. (i) ഭൂമിക്ക് സമീപത്തുള്ള എല്ലാ വസ്തുക്കളെയും ഭൂമി അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു. (ii) ഭൂമിയുടെ ഉപരിതലത്തിന് താഴെയുള്ള എല്ലാ വസ്തുക്കളെയും ഭൂമി അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു. (iii) ഭൂമിയുടെ ഉപരിതലത്തിന് മുകളിലുള്ള എല്ലാ വസ്തുക്കളെയും ഭൂമി അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു. ഈ പ്രസ്താവനകളെ അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം?

1. ഭൂമി എല്ലാ വസ്തുക്കളെയും അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു.
2. ഭൂമി മിക്കവാറും എല്ലാ വസ്തുക്കളെയും അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു.
3. എല്ലാ വസ്തുക്കളും ഭൂമിയെ അവയിലേക്ക് ആകർഷിക്കുന്നു.
4. ഭൂമിയിൽ നിന്ന് അകലെയുള്ള വസ്തുക്കളെ ഭൂമി അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു.

2.2.B. ദൃശ്യപ്രകാശത്തിലെ ഘടകവർണങ്ങൾ വയലറ്റ്, ഇൻഡിഗോ, നീല, പച്ച, മഞ്ഞ, ഓറഞ്ച്, ചുവപ്പ്, എന്നിവയാണല്ലോ? ഇനി ഈ പാഠശാലിലെ മൂന്നു വാചകങ്ങൾ ശ്രദ്ധിക്കുക.

- (i) ഫ്ലൂറസെന്റ് പദാർത്ഥം A വയലറ്റ് നിറത്തെ ആഗിരണം ചെയ്ത് നീല നിറം ഉൽസർജിച്ചു.
- (ii) ഫ്ലൂറസെന്റ് പദാർത്ഥം B ഇൻഡിഗോ നിറം ആഗിരണം ചെയ്ത് നീലനിറം ഉൽസർജിച്ചു. (iii) ഫ്ലൂറസെന്റ് പദാർത്ഥം C പച്ചനിറം ആഗിരണം ചെയ്ത് ചുവന്ന നിറം ഉൽസർജിച്ചു. ഈ പ്രസ്താവനകളിൽ നിന്ന് നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം?
1. ഫ്ലൂറസെന്റ് പദാർത്ഥങ്ങൾ വയലറ്റ് നിറം ആഗിരണം ചെയ്യുകയും നീല നിറം ഉൽസർജിക്കുകയും ചെയ്യും.
2. ഫ്ലൂറസെന്റ് പദാർത്ഥങ്ങൾ തരംഗദൈർഘ്യം കുറഞ്ഞ പ്രകാശം ആഗിരണം ചെയ്ത് കൂടിയ പ്രകാശം ഉൽസർജിക്കും.
3. ഫ്ലൂറസെന്റ് പദാർത്ഥങ്ങൾ എന്തെങ്കിലും പ്രകാശം ആഗിരണം ചെയ്യുകയും ഏതെങ്കിലും പ്രകാശം ഉൽസർജിക്കുകയും ചെയ്യും.
4. ഫ്ലൂറസെന്റ് പദാർത്ഥങ്ങൾ കുറഞ്ഞ ആവൃത്തിയുള്ള പ്രകാശം ആഗിരണം ചെയ്ത് കൂടിയ ആവൃത്തിയുള്ള പ്രകാശം ഉൽസർജിക്കും.

2.2.C. ഈ പാഠശാലിലെ മൂന്നു പ്രസ്താവനകൾ ശ്രദ്ധിക്കുക.

- (i) നിശ്ചലാവസ്ഥയിൽ നിന്ന് താഴേയ്ക്ക് സ്വതന്ത്രമായി പതിക്കുന്ന ഒരു വസ്തു ഒന്നാമത്തേയും രണ്ടാമത്തേയും മൂന്നാമത്തേയും സെക്കന്റിൽ സഞ്ചരിക്കുന്ന ദൂരം 1:3:5 എന്ന അനുപാതത്തിൽ ആണ്. (ii) നിശ്ചലാവസ്ഥയിൽ ഇരിക്കുന്ന ഒരു വസ്തു ഒരു ചരിഞ്ഞ പ്രതലത്തിൽ കൂടി സ്വതന്ത്രമായി താഴേക്ക് ഉരുളുമ്പോൾ ഒന്നാമത്തേയും രണ്ടാമത്തേയും മൂന്നാമത്തേയും സെക്കന്റിൽ സഞ്ചരിച്ച ദൂരം 1:3:5 എന്ന അനുപാതത്തിൽ ആണ്. (iii) നിശ്ചലാവസ്ഥയിൽ നിന്നും സമാനതാരണത്തോടെ ചലിച്ചുതുടങ്ങുന്ന ഒരു കാർ ഒന്നാമത്തേയും രണ്ടാമത്തേയും മൂന്നാമത്തേയും സെക്കന്റിൽ സഞ്ചരിക്കുന്ന ദൂരം 1:3:5 എന്ന അനുപാതത്തിൽ ആണ്.
- ഈ പ്രസ്താവനകളിൽ നിന്ന് നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം?
1. നിശ്ചലാവസ്ഥയിൽ നിന്ന് ചലിച്ച് തുടങ്ങുന്ന ഏതൊരു വസ്തുവും ഒന്നാമത്തേയും രണ്ടാമത്തേയും മൂന്നാമത്തേയും സെക്കന്റിൽ സഞ്ചരിക്കുന്ന ദൂരം 1:3:5 എന്ന അനുപാതത്തിൽ ആണ്.
2. നിശ്ചലാവസ്ഥയിൽ നിന്നും സമാനതാരണത്തോടെ ചലിച്ചുതുടങ്ങുന്ന ഏതൊരു വസ്തുവും ഒന്നാമത്തേയും രണ്ടാമത്തേയും മൂന്നാമത്തേയും സെക്കന്റിൽ സഞ്ചരിക്കുന്ന ദൂരം 1:3:5 എന്ന അനുപാതത്തിൽ ആണ്.
3. നിശ്ചലാവസ്ഥയിൽ നിന്നും ചലിച്ചുതുടങ്ങുന്ന ഏതൊരു വസ്തുവിനും സമാനതാരണമുണ്ടായിരിക്കും.
4. സമാനതാരണത്തോടെ സഞ്ചരിക്കാത്ത വസ്തുക്കളും സമാനതാരണത്തോടെ സഞ്ചരിക്കുന്ന വസ്തുക്കളും ഒന്നാമത്തേയും രണ്ടാമത്തേയും മൂന്നാമത്തേയും സെക്കന്റിൽ സഞ്ചരിക്കുന്ന ദൂരം 1:3:5 എന്ന അനുപാതത്തിൽ ആണ്.

2.2.D. ഈ ഖണ്ഡികയിലെ മൂന്നു പ്രസ്താവനകൾ ശ്രദ്ധിക്കുക.

- (i) തോക്ക് നിറയൊഴിക്കുമ്പോൾ വെടിയുണ്ട മുന്നോട്ട് പായുകയും തോക്ക് പിന്നോട്ട് തിരികുകയും ചെയ്യുന്നു. (ii) തോണിയിൽ നിന്നു ഒരു കുട്ടി കരയിലേക്ക് ചാടുമ്പോൾ തോണി പുഴയുടെ വശത്തേക്ക് ചലിക്കുന്നു. (iii) ജെറ്റ് പ്ലെയിൻ പുകയും ഗ്യാസും കീഴ്ക്കോട്ട് പുറന്തള്ളുമ്പോൾ പ്ലെയിൻ പടഞ്ഞാരോട്ട് കുതിക്കുന്നു. ഈ പ്രസ്താവനകളെ മാത്രം അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം?
1. ഒരു പ്രവർത്തനത്തിന് തുല്യമായ പ്രതിപ്രവർത്തനം ഉണ്ടാകും.
2. ഒരു പ്രവർത്തനത്തിന് എതിർ ദിശയിൽ പ്രതിപ്രവർത്തനം ഉണ്ടാകും.
3. ഒരു പ്രവർത്തനത്തിന് പ്രതിപ്രവർത്തനം ഉണ്ടാകും.
4. ഒരോ പ്രവർത്തനത്തിനോടും ഒരു ദിശ ബന്ധപ്പെട്ടിരിക്കുന്നു.

PART - 7

താഴെതന്നിരിക്കുന്ന സന്ദർഭങ്ങളിലെല്ലാം ഒരു ശാസ്ത്ര പ്രശ്നം അടങ്ങിയിട്ടുണ്ട്. ഈ പ്രശ്നത്തെ മനസ്സിലാക്കിയതിനു ശേഷം അതിന് ഒരു യുക്തിസഹമായ ന്യായീകരണം തരുന്ന പ്രസ്താവനയെ നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക

2.3.A. ജാവലിൻ എറിയുന്ന ഒരു അത്ലറ്റ് ഒരിടത്തുനിന്ന് ജാവലിൻ വലിച്ചെറിയുന്നതിനുപകരം ദൂരെ നിന്ന് കൂതിച്ച് ഓടി വന്ന് എറിയുന്നു. എന്തായിരിക്കും ഇതിന് കാരണം?

- 1. അത്ലറ്റ് ഓടുന്ന ദൂരവും ജാവലിന്റെ റേഞ്ചും തമ്മിൽ ബന്ധമുണ്ടാവാം.
- 2. അത്ലറ്റ് ഓടി എടുക്കുന്ന വേഗതയും ജാവലിന്റെ റേഞ്ചും തമ്മിൽ ബന്ധമുണ്ടാവാം.
- 3. അത്ലറ്റ് ഓടി എടുക്കുന്ന വേഗതയും അത്ലറ്റിന് ലഭിക്കുന്ന പേശീ ബലവും തമ്മിൽ ബന്ധമുണ്ടാവാം.
- 4. ഓടുന്ന ആൾക്ക് ജാവലിൻ പിടിക്കുന്ന കോൺ നിയന്ത്രിക്കാൻ സാധിക്കുന്നുണ്ടാവാം.

2.3.B. ഓടിക്കൊണ്ടിരിക്കുന്ന ഒരു ബസിൽ നിന്ന് പുറത്തേക്ക് ഒരാൾ ഇറങ്ങുകയാണ്. വീഴാതിരിക്കുന്നതിനു വേണ്ടി അയാൾ ബസ്സിന്റെ ദിശയിൽ അൽപം ദൂരം മുന്നോട്ട് ഓടി പിന്നീട് പ്രയാസമില്ലാതെ നടന്നു പോവുകയും ചെയ്തു. ബസ്സിൽ നിന്ന് ഇറങ്ങിയ ആൾ മുന്നോട്ട് അൽപദൂരം ഓടിയതിനു കാരണമെന്ത്?

- 1. ചലനാവസ്ഥയിൽ തുടരുന്ന സ്വന്തം ശരീരത്തിന്റെ ചലനജഡത്വം ക്രമേണ കുറയ്ക്കുന്നതിനു വേണ്ടിയാവാം.
- 2. നിശ്ചലാവസ്ഥയിൽ തുടരുന്ന സ്വന്തം ശരീരത്തിന്റെ നിശ്ചലജഡത്വം ക്രമേണ കുറയ്ക്കുന്നതിനു വേണ്ടിയാവാം.
- 3. നിശ്ചലാവസ്ഥയിലുള്ള ആളിന്റെ പ്രവേഗം ബസ്സിനൊപ്പം ആക്കുന്നതിനു വേണ്ടിയാവാം.
- 4. യാത്രക്കാരന്റെ ശരീരം തറയെ അപേക്ഷിച്ച് നിശ്ചലാവസ്ഥയിലായതിനാൽ ഓടുന്നത് സ്ഥിരത കൈവരിക്കാൻ ഉപകരിച്ചേക്കാം.

2.3.C. സമുദ്രവും വളരെ ആഴമുള്ള ജലാശയങ്ങളും നീലനിറത്തിൽ കാണപ്പെടുന്നു. ഇതിനു കാരണം സൂര്യപ്രകാശത്തിലെ നീല വർണം ജലത്തിൽ വച്ച് വിസരണം ചെയ്യപ്പെടുന്നു എന്നതാണ്. കിണറുകളിലേയും കുളങ്ങളിലേയും ജലം നീല നിറത്തിൽ കാണാത്തത് എന്തു കൊണ്ടാണ്.

- 1. ജലത്തിന്റെ ആഴവും പരപ്പും കൂടുന്നതിനനുസരിച്ച് വിസരണം ചെയ്യപ്പെടുന്ന പ്രകാശത്തിന്റെ അളവും കൂടുമായിരിക്കാം.
- 2. ജലത്തിന്റെ ഇളക്കം വിസരണം ചെയ്യപ്പെടുന്ന പ്രകാശത്തിന്റെ നിറത്തെ സ്വാധീനിച്ചേക്കാം.
- 3. ജലത്തിൽ അലിഞ്ഞു ചേർന്നിരിക്കുന്ന ലവണങ്ങൾ വിസരണം ചെയ്യപ്പെടുന്ന പ്രകാശത്തിന്റെ നിറത്തെ സ്വാധീനിച്ചേക്കാം.
- 4. തീരമാലകൾ കൂടുന്നതിനനുസരിച്ച് വിസരണം ചെയ്യപ്പെടുന്ന പ്രകാശത്തിന്റെ അളവും കൂടുമായിരിക്കാം.

2.3.D. ഭാരമുള്ള ഒരു ഇരുമ്പ് ഗോളം സ്പ്രിംഗ് ബാലൻസിൽ തൂക്കിയിട്ടിരിക്കുകയായിരുന്നു. പെട്ടെന്ന് സ്പ്രിംഗ് ബാലൻസും തൂക്കിയിട്ടിരിക്കുന്ന ഗോളവും ഒപ്പം താഴേയ്ക്ക് വീണു. വീഴ്ചയിൽ സ്പ്രിംഗ് ബാലൻസ് പുഷ്യം റീഡിംഗ് കാണിച്ചു. എന്തായിരിക്കും ഇതിന്റെ കാരണം?

- 1. ചലിക്കുമ്പോൾ സ്പ്രിംഗിന്റെ പ്രവർത്തനം നിലയ്ക്കുന്നുണ്ടാവാം.
- 2. വീഴുന്ന വസ്തുക്കളുടെമേൽ ഗുരുത്വാകർഷണബലം പ്രയോഗിക്കപ്പെടുന്നില്ലായിരിക്കാം.
- 3. ഗോളത്തിന് വീഴ്ചയുടെ ഇടയിൽ പിണ്ഡം നഷ്ടപ്പെടുന്നുണ്ടാവാം.
- 4. ഗോളത്തിന്റെ ഭാരം വീഴ്ചയ്ക്ക് വേണ്ടി ഉപയോഗിച്ചതിനാൽ ഭാരം പുഷ്യമാവുന്നുണ്ടാവാം.

**PART - 8**

താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങൾ സങ്കല്പിച്ച് ഉണ്ടാക്കേണ്ടവയാണ്. നമുക്കറിയാവുന്ന ശാസ്ത്ര സത്യങ്ങളുടേയും തത്വങ്ങളുടേയും വെളിച്ചത്തിൽ ശരിയെന്ന് നമുക്ക് ഉറപ്പിക്കാവുന്ന ഉത്തരം നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക.

**2.4.A.** നാം കാണുന്ന മഴവില്ലിന് ഒരു ചാപത്തിന്റെ ആകൃതിയാണുള്ളത്. മഴവില്ലിന്റെ താഴത്തെ ഭാഗം ചക്രവാള സീമ മറയ്ക്കുന്നു. വളരെ ഉയരത്തിൽ വിമാനത്തിൽ പറക്കുന്നു ഒരു നിരീക്ഷകൻ എന്തായിരിക്കും കാണുക?

1. മഴവില്ല് എന്ന് വൃത്തത്തിന്റെ താഴെയുള്ള ഭാഗം.
2. വ്യത്യസ്ത നിറങ്ങളുള്ള മറ്റൊരു മഴവില്ല്.
3. നിറമില്ലാത്ത മഴവില്ല് കാണാം.
4. മുകളിലേക്ക് ഉയരുന്നതിനനുസരിച്ച് കൂടുതൽ മഴവില്ലുകൾ ഒന്നിനു താഴെ ഒന്നായി കാണാം.

**2.4.B.** വിമാനങ്ങളുടെ ആകൃതി ധാരാരേഖിതമാക്കിയിരിക്കുന്നു. വായുവിലൂടെ പറക്കുമ്പോൾ ഘർഷണം കുറയ്ക്കാനുമാർന്ന വിധം മുൻവശം കൂർപ്പിച്ചിരിക്കുന്നു. ബഹിരാകാശത്തുകൂടി മാത്രം സഞ്ചരിക്കുവാനുള്ള ഒരു വാഹനം നിർമ്മിച്ചു എന്നിരിക്കട്ടെ. എന്നാൽ ഈ വാഹനത്തിന്

1. മുന്നറ്റവും പിന്നറ്റവും കൂർപ്പിക്കേണ്ടിയിരിക്കുന്നു.
2. മുന്നറ്റം മാത്രം കൂർപ്പിച്ചാൽ മതിയാവും
3. ഗോളാകൃതിയായിരിക്കും
4. ധാരാരേഖിതമാക്കേണ്ട ആവശ്യമില്ല.

**2.4.C.** പുഴയിലൂടെ സഞ്ചരിക്കുകയായിരുന്ന ഒരു വഞ്ചിയിൽ പത്ത് തുഴക്കാർ ഉണ്ടായിരുന്നു. അവർ സഞ്ചരിക്കുന്ന ദിശയിലേക്ക് അനുകൂലമായ ഒഴുക്ക് ഉണ്ടായിരുന്നതിനാൽ വഞ്ചിയുടെ വേഗം കൂടി കൂടി വന്നു. പെട്ടെന്ന് വഞ്ചി നിർത്തണമെന്ന് വഞ്ചിക്കാരന് തോന്നി. താഴെപറയുന്നതിൽ ഏത് കാര്യം ചെയ്യുന്നതാണ് വഞ്ചി വേഗം കുറഞ്ഞ് നിൽക്കുന്നതിന് ഏറ്റവും ഫലപ്രദം.

1. പത്തുപേരും തുഴകൾ വെള്ളത്തിൽ വിലങ്ങനെ വച്ച് വഞ്ചിയുടെ മുന്നോട്ടുള്ള ഗതി പ്രതിരോധിക്കുന്നു.
2. പത്തുപേരും എതിർ ദിശയിലേക്ക് തുഴയുന്നു.
3. മുന്നിലുള്ള അഞ്ചുപേർ തുഴകൾ വെള്ളത്തിൽ വിലങ്ങനെ വച്ച് വഞ്ചിയുടെ മുന്നോട്ടുള്ള ഗതി പ്രതിരോധിക്കുകയും പിറകിലുള്ള അഞ്ചുപേർ എതിർ ദിശയിലേക്ക് തുഴയുകയും ചെയ്യുന്നു.
4. മുന്നിലുള്ള അഞ്ചുപേർ എതിർ ദിശയിലേക്ക് തുഴയുകയും പിറകിലുള്ള അഞ്ചുപേർ തുഴകൾ വിലങ്ങനെ വെച്ച് വഞ്ചിയുടെ മുന്നോട്ടുള്ള ഗതി പ്രതിരോധിക്കുകയും ചെയ്യുന്നു.

**2.4.D.** ഭൂമിയുടെ അടിയിലേക്ക് പോകുന്നതോടൊപ്പം വസ്തുവിന്റെ ഭാരം കുറയുകയാണ് ചെയ്യുന്നത് എന്ന് നിങ്ങൾക്ക് അറിയാമല്ലോ. ഭൂമിയുടെ ഒരറ്റത്തുനിന്നും ഒരു കൂഴി കൂഴിച്ച് ഭൂകേന്ദ്രത്തിലൂടെ മറുവശത്ത് എത്തി എന്ന് സങ്കല്പിക്കുക. ഈ തുരങ്കത്തിലൂടെ ഒരു വസ്തു ഭൂമിയുടെ ഒരു വശത്തു നിന്നും ഭൂകേന്ദ്രത്തിലൂടെ മറുവശത്തേക്ക് കൊണ്ടുപോവുകയാണ്. വസ്തുവിന്റെ ഭാരം എങ്ങനെ വ്യത്യാസപ്പെടും?

1. ആദ്യം കുറയുന്നു, പിന്നീട് പുഷ്യമാവുന്നു, വീണ്ടും കുറയുന്നു.
2. ആദ്യം കൂടുന്നു, പിന്നീട് പുഷ്യമാവുന്നു, പിന്നീട് കുറയുന്നു.
3. ആദ്യം കുറയുന്നു, പിന്നീട് പുഷ്യമാവുന്നു, പിന്നീട് കൂടുന്നു.
4. ആദ്യം കൂടുന്നു. പിന്നെ കുറയുന്നു, പിന്നെ പുഷ്യമായി തുടരുന്നു.

PART - 9

താഴെകൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും അവതരിപ്പിച്ചിരിക്കുന്ന ശാസ്ത്രപ്രശ്നത്തിന് ന്യായീകരണമായേക്കാവുന്ന പ്രസ്താവനകളാണ് 1, 2, 3, 4 എന്നിങ്ങനെ കൊടുത്തിരിക്കുന്നത്. ഇവയിൽ ഏറ്റവും യുക്തി സഹമായതും ഒരു ലഘു പരീക്ഷണം കൊണ്ട് തെളിയിക്കാനാവുന്നതുമായ അനുമാനം (പരികല്പന) അടയാളപ്പെടുത്തുക.

3.1.A താഴെതന്നിരിക്കുന്നവയെല്ലാം യുക്തിസഹമായ പ്രസ്താവനകളാണ്. ഇവയിൽ ഏതാണ് ഒരു ലഘു പരീക്ഷണത്താൽ തെളിയിക്കാനാവുന്നത്.

1. ഒരു ഗ്ലാസ് സ്റ്റാമ്പിലൂടെ വ്യത്യസ്ത നിറങ്ങൾ കടത്തിവിട്ടാൽ ഏറ്റവും കൂടുതൽ വ്യതിയാനം സംഭവിക്കുന്നത് വയലറ്റ് നിറമുള്ള പ്രകാശരശ്മിക്കായിരിക്കും.
2. ഒരു ഗ്ലാസ് സ്റ്റാമ്പിലൂടെ വ്യത്യസ്ത ആവൃത്തിയുള്ള പ്രകാശരശ്മികൾ കടത്തിവിട്ടാൽ ഏറ്റവും കൂടുതൽ വ്യതിയാനം സംഭവിക്കുന്നത് ആവൃത്തി കൂടിയ പ്രകാശരശ്മിക്കായിരിക്കും.
3. ഒരു ഗ്ലാസ് സ്റ്റാമ്പിലൂടെ വ്യത്യസ്ത തരംഗദൈർഘ്യമുള്ള പ്രകാശരശ്മികൾ കടത്തിവിട്ടാൽ ഏറ്റവും കുറഞ്ഞ വ്യതിയാനം സംഭവിക്കുന്നത് തരംഗദൈർഘ്യം കൂടിയ പ്രകാശരശ്മിക്കായിരിക്കും.
4. ഒരു പ്രകാശരശ്മി ഗ്ലാസ് സ്റ്റാമ്പിലൂടെ സഞ്ചരിക്കുമ്പോൾ വേഗതക്ക് വ്യത്യാസം ഉണ്ടാവുന്നു.

3.1.B താഴെതന്നിരിക്കുന്ന പ്രസ്താവനകൾ എല്ലാം തന്നെ യുക്തിസഹമാണ് എന്നാൽ ഇതിൽ ഒരേണ്ണമാത്രം ഒരു ലഘുപരീക്ഷണം നടത്തി തെളിയിക്കാൻ സാധ്യമല്ല. എളുപ്പത്തിൽ തെളിയിക്കാനാവാത്ത പ്രസ്താവന ഏതാണ് ?

1. ഒരു മീറ്റർ സ്കെയിലിന്റെ ഒരറ്റത്ത് ഭാരം കെട്ടിവെച്ചാൽ ഗുരുത്വകേന്ദ്രം ആ വശത്തേക്ക് സ്ഥാനം മാറുന്നു.
2. ഒരു തകിടിന്റെ ആകൃതി മാറുന്നതിനനുസരിച്ച് ഗുരുത്വകേന്ദ്രത്തിന്റെ സ്ഥാനം മാറുന്നു.
3. വസ്തുക്കൾ ചൂടാക്കുമ്പോൾ ഗുരുത്വകേന്ദ്രത്തിന്റെ സ്ഥാനത്തിന് വ്യത്യാസം ഉണ്ടാകുന്നില്ല.
4. വസ്തുക്കളെ ചൂടാക്കുമ്പോൾ അതിൽ കമ്പനം ചെയ്യുന്ന തന്മാത്രകളുടെ എണ്ണത്തിന് വ്യതിയാനം സംഭവിക്കുന്നു.

3.1.C കുട്ടികൾ മൈതാനത്തിൽ ഓടിക്കളിക്കുമ്പോൾ നല്ല വണ്ണമുള്ള ആളിന് വേഗം ഓട്ടം നിർത്താനും അതുപോലെ ഓടിതുടങ്ങാനും പ്രയാസം അനുഭവപ്പെടുന്നു. ഇതിന് കാരണം മനസ്സിലാക്കുന്നതിന് മാസും ജഡത്വവും തമ്മിൽ ബന്ധം ഉണ്ടോ എന്ന് കണ്ടുപിടിക്കേണ്ടതുണ്ട്. ഇതിന് താഴെ പറയുന്നതിൽ ഏത് അനുമാനം ആണ് ഒരു ലഘുപരീക്ഷണം നടത്തി തെളിയിക്കാനാവുന്നത്?

1. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ മിനുസമുള്ള തറയിൽ കൂടി ഒരേ വേഗതയിൽ ഉരുട്ടി വിട്ടാൽ മാസ് കൂടുതലുള്ള ഗോളം കൂടുതൽ സമയം ഉരുളും.
2. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങളിൽ മാസ് കൂടിയതിന്റെ ഭൂഗുരുത്വകേന്ദ്രം മദ്ധ്യത്തിൽ ആയിരിക്കും.
3. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ ശൂന്യാകാശത്തിൽ ഉരുട്ടി നോക്കിയാൽ മാസ് കൂടുതലുള്ള ഗോളം കൂടുതൽ സമയം ഉരുളും.
4. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾക്ക് പലായന പ്രവേഗം കൊടുത്താൽ എല്ലാ ഗോളങ്ങളും ശൂന്യാകാശത്ത് എത്തിച്ചേരും.

3.1.D അഞ്ചാംക്ലാസിലെ കുട്ടികൾക്ക് ഒരു അധ്യാപകൻ ഗുരുതാകർഷണബലം വിശദീകരിച്ചുകൊടുത്തപ്പോൾ അവർ മുന്നോട്ട് വച്ച യുക്തിസഹമായ പ്രസ്താവനകളാണ് താഴെകൊടുത്തിരിക്കുന്നത്. ഇതിൽ ഏത് പ്രസ്താവനയാണ് ഒരു ലഘുപരീക്ഷണം ഉപയോഗിച്ച് തെളിയിക്കാവുന്നത്.

1. ഭൂമിയേക്കാൾ ഭാരം കുറവുള്ള ഗ്രഹങ്ങളിൽ ഗുരുതാകർഷണ താരണം കുറവായിരിക്കും
2. വസ്തുക്കിൽ ഭൂമി പ്രയോഗിക്കുന്ന ഗുരുതാകർഷണ ബലവും അവയുടെ മാസും തമ്മിൽ ബന്ധം ഉണ്ട്.
3. രണ്ട് കുട്ടികൾ തമ്മിലുള്ള ഗുരുതാകർഷണ ബലം അവർ ചലിക്കുന്ന ദിശയുമായി ബന്ധപ്പെട്ടിരിക്കുന്നു.
4. ഒരു ബെഞ്ചിൽ ഇരിക്കുന്ന കുട്ടികളും അടുത്ത ബെഞ്ചിൽ ഇരിക്കുന്ന കുട്ടികളും തമ്മിൽ ഗുരുതാകർഷണ ബലം ഉണ്ട്.

**PART - 10**

താഴെകൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും ഒരു ശാസ്ത്ര പ്രസ്താവന കൊടുത്തിട്ടുണ്ട്. ഈ പ്രസ്താവന ശരിയാണോ എന്ന് പരിശോധിച്ചറിയാൻ ഏറ്റവും അനുയോജ്യമായ പരീക്ഷണക്രമം തിരഞ്ഞെടുത്ത് നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക

**3.2.A** ഒരു വസ്തുവിന് മറ്റൊതിലെങ്കിലും ഒരു ആഘാതം ഉണ്ടാക്കാനുള്ള കഴിവ് അതിന്റെ പ്രവേഗത്തിനു നുസരിച്ച് കൂടുന്നു. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെപ്പറയുന്നതിൽ ഏത് പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

1. വ്യത്യസ്ത പിണ്ഡമുള്ള ഇരുമ്പു ഗോളങ്ങൾ ഒരു മൺകുന്നമേൽ വീഴ്ത്തി അങ്ങനെ ഉണ്ടാവുന്ന കുഴിയുടെ താഴ്ച അളക്കുന്നത്.
2. പ്രവേഗത്തിന്റേയും പിണ്ഡത്തിന്റേയും ഗ്രാഫ് വരയ്ക്കുന്നത്.
3. ഒരു ഇരുമ്പു ഗോളം വ്യത്യസ്ത ഉയരങ്ങളിൽ നിന്ന് ഒരു മൺകുന്നമേൽ വീഴ്ത്തി അങ്ങനെ ഉണ്ടാവുന്ന കുഴിയുടെ താഴ്ച അളക്കുന്നത്.
4. വ്യത്യസ്ത പിണ്ഡമുള്ള ഇരുമ്പു ഗോളങ്ങൾ ഒരു കൽഭിത്തിമേൽ എറിഞ്ഞ് ഗോളം തെറിച്ചു വീഴുന്ന ദൂരം അളക്കുന്നത്.

**3.2.B** ഘർഷണബലം വസ്തുവിന്റെ ഭാരത്തെ ആശ്രയിച്ചിരിക്കുന്നു. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെപറയുന്നതിൽ ഏത് പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

1. ഒരു കിലോ ഭാരമുള്ള ഒരു വസ്തു സ്പ്രിംഗ് ബാലൻസിനോട് ബന്ധിച്ച ശേഷം വ്യത്യസ്ത പ്രതലങ്ങളിലൂടെ നിരക്കി വലിക്കുകയും റീഡിംഗുകൾ കുറിച്ചെടുക്കുകയും ചെയ്യുന്നത്.
2. വ്യത്യസ്ത ഭാരമുള്ള വസ്തുക്കൾ മേശമേൽ നിരക്കി വലിക്കുകയും അവയോരോന്നും വലിക്കുമ്പോൾ ബന്ധിച്ചിരിക്കുന്ന സ്പ്രിംഗ് ബാലൻസിലെ റീഡിംഗുകൾ കുറിച്ചെടുക്കുകയും ചെയ്യുന്നത്.
3. ഒരേ ഭാരമുള്ള വ്യത്യസ്ത വസ്തുക്കൾ ഒരു റബ്ബർ ഷീറ്റിനു മുകളിലൂടെ നിരക്കി വലിക്കുകയും അവയോരോന്നും വലിക്കുമ്പോൾ ബന്ധിച്ചിരിക്കുന്ന സ്പ്രിംഗ് ബാലൻസിലെ റീഡിംഗുകൾ കുറിച്ചെടുക്കുകയും ചെയ്യുന്നത്.
4. ഒരു കിലോ ഭാരമുള്ള വസ്തു നിരങ്ങുമ്പോഴും, ഉറച്ചുമ്പോഴുമുള്ള ഘർഷണബലം സ്പ്രിംഗ് ബാലൻസ് ഉപയോഗിച്ച് കണ്ടുപിടിക്കുന്നത്.

**3.2.C** ഒരു ടി.വി.യുടെ റിമോട്ട് കൺട്രോളിൽനിന്നും പുറപ്പെട്ട ടി.വി. സെറ്റിൽ വീഴുന്ന ഏതോ ചില കിരണങ്ങൾ മുഖേനയാണ് ടി.വി. നിയന്ത്രിക്കപ്പെടുന്നത്. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെപറയുന്നതിൽ ഏത് പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

1. റിമോട്ട് കൺട്രോളിലെ ബാറ്ററി ഊരിയും ഇടും റിമോട്ട് പ്രവർത്തിപ്പിച്ചു നോക്കുന്നത്.
2. ടി.വി.സെറ്റിന്റെ പവർസപ്ലൈ ഓണാക്കുകയും ഓഫാക്കുകയും ചെയ്ത് റിമോട്ട് പ്രവർത്തിപ്പിച്ചു നോക്കുന്നത്.
3. റിമോട്ട് കൺട്രോളിന്റെ പുറം കവർ തുറന്ന ഉൾഭാഗം നിരീക്ഷിച്ച് ചിത്രം വരയ്ക്കുന്നു.
4. റിമോട്ട് കൺട്രോളിനും ടി.വി. സെറ്റിനും ഇടയിൽ കട്ടികൂടിയ ഒരു സ്ക്രീൻ വെച്ചിട്ട് റിമോട്ട് പ്രവർത്തിപ്പിച്ചു നോക്കുന്നത്.

**3.2.D** ഒരു നിശ്ചിത ആദ്യപ്രവേഗമുള്ള ഒരു ഷോട്ട് 45° കോണിൽ എറിഞ്ഞാലാണ് ഏറ്റവും ദൂരത്തേക്ക് പോവുക. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെ പറയുന്നതിൽ ഏത് പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം.

1. വ്യത്യസ്ത അത്ലറ്റുകൾ ഷോട്ട് പൂട്ട് എറിയുന്നത് കണ്ട് മനസ്സിലാക്കുന്നത്.
2. വ്യത്യസ്ത കോണുകളിൽ ഷോട്ട് സ്വയം എറിഞ്ഞുനോക്കുന്നത്.
3. വ്യത്യസ്ത ദിശകളിൽ ഷോട്ട് സ്വയം എറിഞ്ഞുനോക്കുന്നത്.
4. വ്യത്യസ്ത പ്രവേഗത്തോടെ ഷോട്ട് എറിഞ്ഞാൽ പരമാവധി റേഞ്ച് സമവാക്യം ഉപയോഗിച്ച് കണക്കാക്കുന്നത്.

**3.2.E** സ്ഥിരതയും ഗുരുത്വകേന്ദ്രത്തിന്റെ സ്ഥാനവും തമ്മിൽ ബന്ധമുണ്ട്. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെ പറയുന്നതിൽ ഏത് പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം.

1. ഗുരുത്വകേന്ദ്രം താഴെയും മദ്ധ്യത്തിലും മുകളിലുമുള്ള ഓരോ വസ്തുക്കൾ എടുത്ത് അവയിൽ ബലം പ്രയോഗിച്ച് വീഴ്ത്താൻ ശ്രമിക്കുന്നു.
2. ഗുരുത്വകേന്ദ്രം താഴെയും മദ്ധ്യത്തിലും മുകളിലുമുള്ള ഓരോ വസ്തുക്കൾ എടുത്ത് മുകളിലേക്ക് എറിഞ്ഞ ശേഷം സഞ്ചരിച്ച ദൂരം അളക്കുക.
3. സ്ഥിരത കൂടുതലും കുറവുമുള്ള ഓരോ വസ്തുക്കൾ എടുത്ത് വെള്ളത്തിലും മണ്ണെണ്ണയിലും ഇടുക.
4. സ്ഥിരത കൂടുതലും കുറവുമുള്ള ഓരോ വസ്തുക്കൾ എടുത്ത് മുകളിലേക്ക് എറിഞ്ഞ ശേഷം സഞ്ചരിച്ച ദൂരം അളക്കുക.

**PART - 11**

**ഒരു ശാസ്ത്ര പ്രക്രിയയെ സാധിനിക്കുന്ന ഘടകങ്ങൾ ഒന്നിലേറെ ഉണ്ടാവുമല്ലോ. നിർണ്ണായകമായ ഉത്തരം ഘടകങ്ങളുടെ സാധിനം മനസ്സിലാക്കി ശരിയായ ഉത്തരം അടയാളപ്പെടുത്തുക.**

**3.3.A** ഒരു ഹോസ്പൈപ്പിൽനിന്നും വെള്ളം പുറത്തേക്ക് വീഴുകയാണ്. ഇത് പ്രോജക്ട്‌ടെൽ ചലനത്തിന് ഉദാഹരണമാണല്ലോ. വെള്ളം പുറത്തേക്ക് തെറിക്കുന്ന കോണും വെള്ളം ചെന്നുവീഴുന്ന ദൂരവും തമ്മിൽ എന്തെങ്കിലും ബന്ധമുണ്ടോ എന്നറിയാൻ കോൺ മാറ്റി മാറ്റി നടത്തുന്ന പരീക്ഷണത്തിൽ സ്ഥിരമായി ഇരിക്കേണ്ട ഘടകമേതാണ്?

1. വെള്ളം ചെന്നുവീഴുന്ന ദൂരം.
2. ഓരോ പരീക്ഷണത്തിനും എടുക്കുന്ന സമയം
3. വെള്ളത്തിന്റെ ഒഴുക്കിന്റെ ശക്തി.
4. പതനകോൺ

**3.3.B** വസ്തുവിന്റെ ഭാരവും ഘർഷണബലവും തമ്മിലുള്ള ബന്ധം മനസ്സിലാക്കാൻ വ്യത്യസ്തഭാരമുള്ള വസ്തുക്കൾ റബ്ബർ പ്രതലത്തിലൂടെ ഒരു സ്പ്രിംഗ് ബാലൻസ് ഉപയോഗിച്ച് നിശ്ചിത വേഗത്തിൽ വലിക്കുകയാണ്. പരീക്ഷണ വസ്തുക്കളുടെ എല്ലാം പ്രതലവിസ്തീർണ്ണം ഒന്നുതന്നെയാണ്. ഈ പരീക്ഷണങ്ങളിൽ സ്ഥിരമായി നാം നിലനിർത്തുന്ന ഘടകങ്ങൾ ഏതൊക്കെയാണ്?

1. വസ്തുവിന്റെ ഭാരം, ഘർഷണബലം, പരീക്ഷണത്തിന്റെ സമയം.
2. പരീക്ഷണം നടത്തുന്ന പ്രതലം, വസ്തുനിരക്കുന്ന വേഗത, വസ്തുവിന്റെ ആകൃതി.
3. പരീക്ഷണം നടത്തുന്നപ്രതലം, വസ്തുവിന്റെ പ്രതല വിസ്തീർണ്ണം, വസ്തുനിരക്കുന്ന വേഗത.
4. വസ്തുവിന്റെ ഭാരം, വസ്തുവിന്റെ പ്രതലവിസ്തീർണ്ണം, വസ്തുനിരക്കുന്ന വേഗത.

**3.3.C** വ്യത്യസ്ത ഭാരമുള്ള വസ്തുക്കൾ ഉയരത്തിൽ നിന്ന് താഴേക്ക് പതിക്കുമ്പോൾ എടുക്കുന്ന വീഴ്ചയുടെ സമയം വ്യത്യസ്തമായിരിക്കുമോ എന്ന് പഠിക്കുവാൻ ചന്ദ്രനിലെ ഉപരിതലത്തിൽ വച്ച് വ്യത്യസ്ത ഭാരമുള്ള വസ്തുക്കൾ താഴേക്ക് വീഴാൻ അനുവദിച്ചു. ഈ പരീക്ഷണത്തിൽ എല്ലായ്പ്പോഴും താരണം സ്ഥിരമാണല്ലോ. അതുപോലെ വായുവിന്റെ പ്രതിരോധവുമില്ല. വസ്തുവിന്റെ ഭാരവും വീഴ്ചയ്ക്ക് എടുക്കുന്ന സമയവും തമ്മിലുള്ള ബന്ധം ശരിയായി കണ്ടെത്തണമെങ്കിൽ ഇനി ഏത് ഘടകമാണ് സ്ഥിരമാക്കി നിയന്ത്രിച്ച് നിർത്തേണ്ടത്?

1. വസ്തുവിന്റെ പ്രതലവിസ്തീർണ്ണം
2. വസ്തുവിന്റെ ഗോളാകൃതി
3. വസ്തുവിന്റെ സാന്ദ്രത
4. വീഴ്ചയുടെ ഉയരം

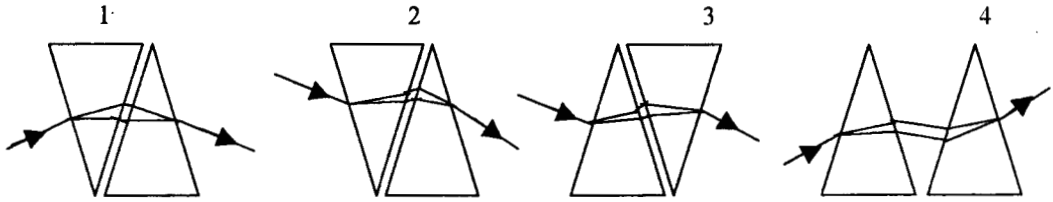
**3.3.D** താഴെക്ക് പതിക്കുന്ന വ്യത്യസ്ത ഭാരമുള്ള വസ്തുക്കൾ ഒരേ സമയം നിലത്ത് പതിക്കും എന്ന ശാസ്ത്ര സത്യം പരീക്ഷിക്കുവാൻ വ്യത്യസ്ത ഭാരമുള്ള രണ്ട് കുട്ടികൾ രാമുവും ശ്യാമുവും വീട്നൂ മുകളിൽ കയറി രാമു 50 ഗ്രാം ഭാരമുള്ള ഇരുമ്പു ഗോളം താഴേക്ക് എറിഞ്ഞു ഇതേ സമയം തന്നെ ശ്യാമു 5 കിലോ ഭാരമുള്ള ചെമ്പ് ഗോളം താഴേക്ക് വലിച്ചെറിഞ്ഞു. രണ്ടു ഗോളങ്ങളും വ്യത്യസ്ത സമയത്താണ് താഴെ വീണത്. ഈ പരീക്ഷണം പരാജയപ്പെടാൻ കാരണം ഇതിലെ ഏത് ഘടകം സ്ഥിരമാക്കാത്തതാണ്?

1. പരീക്ഷണം നടത്തിയ കുട്ടികളുടെ ഭാരം
2. താഴേക്ക് വീഴ്ത്തിയ ഗോളങ്ങളുടെ ഭാരം
3. താഴേക്കെറിയപ്പെട്ട ഗോളങ്ങൾ നിർമ്മിച്ചിരിക്കുന്ന പദാർത്ഥത്തിന്റെ സാന്ദ്രത.
4. ഗോളങ്ങളെ താഴെക്കെറിഞ്ഞപ്പോൾ അവയ്ക്ക് ലഭിച്ച ആദ്യ പ്രവേഗം.

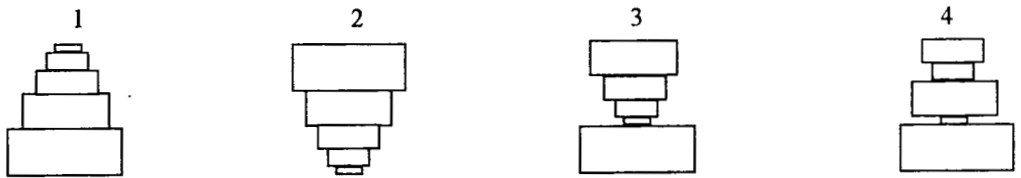
### PART - 12

ഓരോ ചോദ്യത്തിലും തന്നിരിക്കുന്ന ചിത്രങ്ങളെ അപഗ്രഥിച്ച് ചോദ്യത്തിനുള്ള ഉത്തരങ്ങൾ അടയാളപ്പെടുത്തുക.

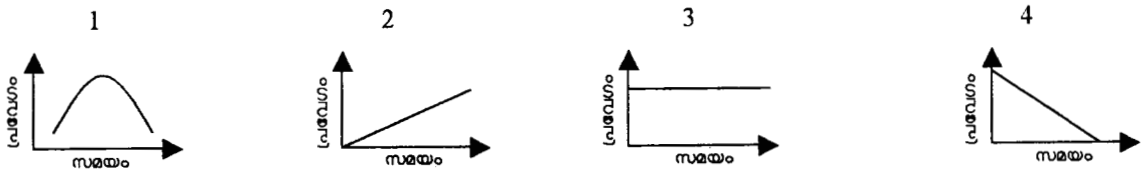
**3.4.A** താഴെക്കൊടുത്തിരിക്കുന്ന ചിത്രങ്ങളിൽ പ്രിസം ഉപയോഗിച്ചുള്ള പ്രകാശ പ്രതിഭാസങ്ങളാണ് കാണിച്ചിരിക്കുന്നത്. ഇതിൽ ഒരു ചിത്രം മാത്രം ശരിയാണ്. അത് ഏതാണ്? (അപവർത്തന രശ്മി പ്രിസത്തിന്റെ പാദത്തിന്റെ വശത്തേക്ക് വളയുന്നു എന്ന് ഓർക്കുക)



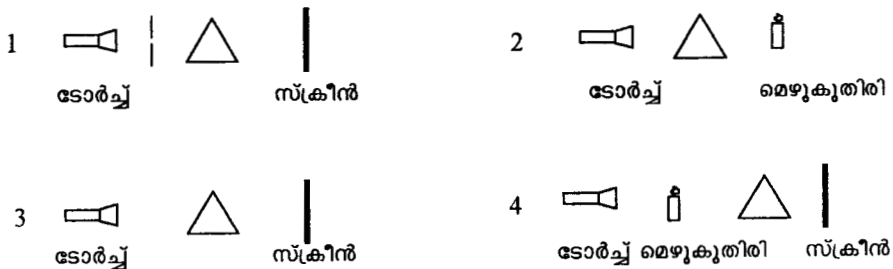
**3.4.B** താഴെക്കൊടുത്തിരിക്കുന്ന ചിത്രങ്ങളിൽ വ്യത്യസ്ത വലിപ്പമുള്ള ചതുരക്കട്ടകൾ ഒന്നിനുമുകളിൽ ഒന്നായി അടുക്കിയിരിക്കുന്ന ക്രമീകരണങ്ങളാണ് കാണിച്ചിരിക്കുന്നത്. തന്നിരിക്കുന്ന ക്രമീകരണങ്ങളിൽ ഏതിനാണ് കൂടുതൽ സ്ഥിരത?



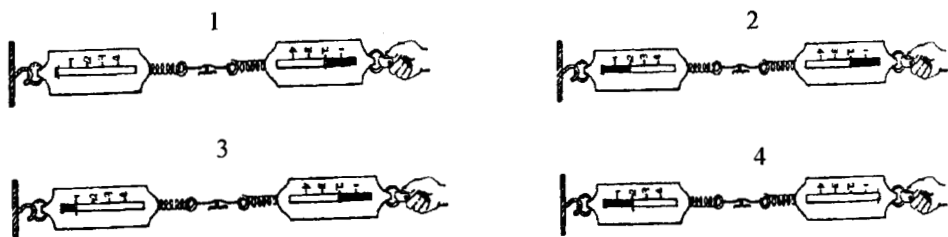
**3.4.C** താഴെക്കൊടുത്തിരിക്കുന്ന ഗ്രാഫുകളിൽ ഏതാണ് സമചലനം സൂചിപ്പിക്കുന്നത്.



**3.4.D** ഒരു ടോർച്ചിൽ നിന്നുള്ള പ്രകാശത്തിന്റെ പ്രകീർണ്ണം മനസ്സിലാക്കാൻ താഴെകാണിച്ചിരിക്കുന്ന തിരിൽ ഏത് ക്രമീകരണമാണ് ഏറ്റവും അനുയോജ്യം.



**3.4.E** ഭിത്തിയിലെ കൊളുത്തിൽ ഒരു Spring balance തൂക്കിയിട്ടുണ്ട്. ഇതിന്റെ കൊളുത്തിൽ മറ്റൊരു Spring balance കൊളുത്തി വലിച്ചു. താഴെക്കൊടുത്തിരിക്കുന്ന ചിത്രങ്ങളിൽ ഏതാണ് ഈ സംഭവത്തെ ശരിയായി ചിത്രീകരിക്കുന്നത്.



**PART - 13**

പരീക്ഷണം ചെയ്തപ്പോൾ കണ്ടെത്തിയ വിവരങ്ങളാണ് താഴെയുള്ള ഓരോ ചോദ്യങ്ങളിലും കൊടുത്തിരിക്കുന്നത്. ഈ വിവരങ്ങൾ ഉപയോഗിച്ച് ശരിയായ അനുമാനം കണ്ടെത്തി അതിന്റെ നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക

**3.6.A** ഒരു കളർ ഫിൽട്ടറിൽ കൂടി നീലപ്പുറവിനെ നോക്കിയപ്പോൾ നീലയായി തന്നെ കണ്ടു. ഒരു ചുവന്ന പുസ്തകം കുറുപ്പായും വെള്ളപ്പുസ്തകം നീലയായും കണ്ടു. തന്നിരിക്കുന്ന വിവരങ്ങളിൽ നിന്നും കളർഫിൽട്ടറിന്റെ നിറം എന്താണെന്ന് അനുമാനിക്കുക.

1. കുറുപ്പ്
2. നീല
3. ചുവപ്പ്
4. നിറമില്ല.

**3.6.B** ഒരു ചലിക്കുന്ന വസ്തുവിന്റെ പ്രവേഗം സമയത്തോടൊപ്പം താഴെയുള്ള ചാർട്ടിൽ കൊടുത്തിരിക്കുന്നു. ഇവിടെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരി?

പ്രവേഗം (m/s)	40	40	38	36	34	36	38	40	40
സമയ ഇടവേള (സെക്കന്റ്)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9

1. 0 - 1 സെക്കണ്ട് എന്ന ഇടവേളയിൽ വസ്തുവിന് ത്വരണം ഉണ്ടായി.
2. 0 - 2 സെക്കണ്ട് എന്ന ഇടവേളയിൽ വസ്തുവിന് ത്വരണം ഉണ്ടായി.
3. 5 - 8 സെക്കണ്ട് എന്ന ഇടവേളയിൽ വസ്തുവിന് ത്വരണം ഉണ്ടായി.
4. 7 - 9 സെക്കണ്ട് എന്ന ഇടവേളയിൽ വസ്തുവിന് ത്വരണം ഉണ്ടായി.

**3.6.C** ഒരു ചെറിയ ഇരുമ്പു ഗോളം ഒരു നിശ്ചിത ഉയരത്തിൽ നിന്ന് വീഴുന്നതിനോട് അനുബന്ധിച്ച് അതിന്റെ ചലനത്തെ സംബന്ധിച്ച ചില വിവരങ്ങളാണ് ഇവിടെ കൊടുത്തിരിക്കുന്നത്. ഈ വിവരങ്ങൾ കണക്കിലെടുത്ത് താഴെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരിയെന്ന് കണ്ടെത്തുക.

സമയം (സെക്കന്റ്)	0	1	2	3	4
പ്രവേഗം (m/s)	0	9.8	19.6	29.4	39.2

1. പ്രവേഗം ഓരോ സെക്കണ്ടിലും വർദ്ധിക്കുന്നു.
2. പിണ്ഡം ഓരോ സെക്കണ്ടിലും വർദ്ധിക്കുന്നു.
3. ഓരോ സെക്കണ്ടിലേയും സ്ഥാനാന്തരം തുല്യമാണ്.
4. പ്രവേഗം, പിണ്ഡം, സ്ഥാനാന്തരം എന്നിവ ക്രമേണ കൂടി വരുന്നു.

**3.6.D** നാലു കൃത്രിമ ഉപഗ്രഹങ്ങളുടെ ഓർബിറ്റൽ പ്രവേഗങ്ങളാണ് താഴെ ചാർട്ടിൽ കൊടുത്തിരിക്കുന്നത്. തന്നിരിക്കുന്ന വിവരങ്ങളെ അടിസ്ഥാനമാക്കി ശരിയായ അനുമാനം ഏതെന്ന് കണ്ടെത്തുക.

ഉപഗ്രഹം	A	B	C	D
ഓർബിറ്റൽ പ്രവേഗം (km/s)	3.0	8.6	9.2	12.0

1. A യും B യും ഭൂമിയിലേക്ക് പതിക്കും.
2. D എന്ന ഉപഗ്രഹം ആകർഷണ വലയം ഭേദിച്ചു പുറത്തു പോവും.
3. A യും B യും C യും ഉപഗ്രഹങ്ങൾ ഭൂമിയിലേക്ക് വീണുപോകും.
4. C യും D യും ഉപഗ്രഹങ്ങൾ ഭൂമിയുടെ ആകർഷണ വലയം ഭേദിച്ചു പുറത്തു പോകും.

**3.6.E** ഒരു ഊർജ്ജതന്ത്ര ശാസ്ത്രജ്ഞൻ 1 കി.ഗ്രാം മാസുള്ള വസ്തു വ്യത്യസ്ത സ്ഥലങ്ങളിൽ വച്ച് സ്പ്രിംഗ് ത്രാസ് ഉപയോഗിച്ചും സാധാരണ ത്രാസ് ഉപയോഗിച്ചും തൂക്കി നോക്കി. ഇങ്ങനെ കിട്ടിയ തൂക്കങ്ങളാണ് ചുവടെ കൊടുത്തിരിക്കുന്നത്.

	സ്ഥലം A	സ്ഥലം B	സ്ഥലം C
സ്പ്രിംഗ് ത്രാസ് കാണിച്ച തൂക്കം	1 Kgt	1.01 Kgt	0.99 Kgt
സാധാരണ ത്രാസ് കാണിച്ച തൂക്കം	1 Kgt	1 Kgt	1 Kgt

- ഈ മൂന്നു സ്ഥലങ്ങളും പരീക്ഷിക്കുമ്പോൾ പൊതുവായ എന്ത് നിഗമനത്തിലെത്താം.
1. സ്പ്രിംഗ് ത്രാസ് ഒരേ സ്ഥലത്ത് തന്നെ ഒരു വസ്തുവിന് വ്യത്യസ്ത തൂക്കങ്ങൾ കാണിക്കുന്നു.
  2. സാധാരണ ത്രാസ് ഒരേ സ്ഥലത്ത് തന്നെ ഒരു വസ്തുവിന് വ്യത്യസ്ത തൂക്കങ്ങൾ കാണിക്കുന്നു.
  3. സ്പ്രിംഗ് ത്രാസ് ഒരേ വസ്തുവിന് വ്യത്യസ്ത സ്ഥലങ്ങളിൽ വ്യത്യസ്ത തൂക്കങ്ങൾ കാണിക്കുന്നു.
  4. സാധാരണ ത്രാസ് ഒരേ വസ്തുവിന് വ്യത്യസ്ത സ്ഥലങ്ങളിൽ വ്യത്യസ്ത തൂക്കങ്ങൾ കാണിക്കുന്നു.

PART - 14

ഒന്നിലേറെ സമാനമായ സന്ദർഭങ്ങൾ താഴെയുള്ള ഓരോ ചോദ്യത്തിലും ഉണ്ട്. ഈ സന്ദർഭങ്ങളെ ശ്രദ്ധയോടെ മനസ്സിലാക്കി ശരിയായ പൊതു തത്വത്തിൽ എത്തിച്ചേരുക.

4.6.A മേശയിൽ വച്ചിരിക്കുന്ന ഭാരം ഒരു സ്പ്രിംഗ് ബാലൻസ് ഉപയോഗിച്ച് കൊളുത്തിവെച്ചപ്പോൾ റീഡിംഗ് ആദ്യം കുടിയെങ്കിലും വസ്തു നിരത്തിത്തുടങ്ങിയപ്പോൾ റീഡിംഗ് കുറയുകയും സ്ഥിരമായി നിൽക്കുകയും ചെയ്തു.

രാമു ഉന്തുവണ്ടിയിൽ ഭാരം കയറ്റി തള്ളാൻ ശ്രമിച്ചപ്പോൾ വണ്ടി നീങ്ങിത്തുടങ്ങുന്നതിന് വളരെയധികം ബലം പ്രയോഗിക്കേണ്ടിവന്നു. എന്നാൽ വണ്ടി നീങ്ങിത്തുടങ്ങിയപ്പോൾ ആദ്യം പ്രയോഗിച്ച ബലത്തേക്കാൾ കുറച്ചു മതിയാകും എന്നുകണ്ടു.

ഭവേകൻഡൗൺ ആയ വണ്ടി റോഡിൽ നിന്ന് തള്ളി വശത്തേക്ക് മാറ്റിയിടാൻ യാത്രക്കാർ ശ്രമിക്കുകയായിരുന്നു. തുടക്കത്തിൽ വണ്ടി നീങ്ങിത്തുടങ്ങാൻ കൂടുതൽ യാത്രക്കാർ തള്ളേണ്ടിവന്നുവെങ്കിലും പിന്നീട് കുറച്ചു പേർ മാത്രം ചേർന്ന് വണ്ടി തള്ളി റോഡിന്റെ സൈഡിലേക്ക് മാറ്റി.

ഈ സന്ദർഭങ്ങളിൽ നിന്ന് ഘർഷണബലത്തേ പറ്റി എന്തു പൊതു തത്വത്തിലെത്താം.

1. വസ്തു നീങ്ങിത്തുടങ്ങുന്നതിനു മുമ്പ് ഘർഷണ ബലം കുറവായിരുന്നു.
2. വസ്തു നീങ്ങിത്തുടങ്ങുന്നതിനു മുമ്പ് ഘർഷണ ബലം പരമാവധി ആണെങ്കിലും നീങ്ങിത്തുടങ്ങുമ്പോൾ ഘർഷണബലം കുറയുന്നു.
3. ഘർഷണബലത്തിലെ വ്യതിയാനങ്ങൾ നിത്യജീവിതത്തിൽ പല ബുദ്ധിമുട്ടുകളും ഉണ്ടാക്കുന്നു.
4. നിരങ്ങൾ ഘർഷണബലം ഉറുളൽ ഘർഷണബലത്തേക്കാൾ കൂടുതലാണ്.

4.6.B മഞ്ഞയും സയനും മജന്റയും നിറങ്ങൾ ദിതീയ വർണ്ണങ്ങൾ ആണല്ലോ. ഈ നിറങ്ങളിലുള്ള സൂതാര്യ വസ്തുക്കൾ ഏതൊക്കെ നിറങ്ങളെ കടത്തി വിടുന്നു എന്ന് ഒരു അദ്ധ്യാപകൻ പരീക്ഷണശാലയിൽ പരിശോധിക്കുകയായിരുന്നു.

മഞ്ഞനിറത്തിലുള്ള സൂതാര്യ വസ്തു മഞ്ഞ, ചുവപ്പ് പച്ച എന്നീ നിറങ്ങൾ കടത്തിവിടുകയും മറ്റെല്ലാ നിറങ്ങളെയും ആഗിരണം ചെയ്യുകയും ചെയ്യുന്നു എന്ന് കണ്ടെത്തി.

സയൻ നിറത്തിലുള്ള സൂതാര്യ വസ്തു സയൻ, നീല, പച്ച എന്നീ നിറങ്ങൾ കടത്തിവിടുകയും മറ്റെല്ലാ നിറങ്ങളിലേയും ആഗിരണം ചെയ്യുകയും ചെയ്യുന്നു എന്ന് കണ്ടെത്തി.

മജന്റ നിറത്തിലുള്ള സൂതാര്യ വസ്തു മജന്റ, നീല, ചുവപ്പ് എന്നീ നിറങ്ങൾ കടത്തിവിടുകയും മറ്റെല്ലാ നിറങ്ങളെയും ആഗിരണം ചെയ്യുകയും ചെയ്യുന്നു എന്ന് കണ്ടെത്തി.

ഈ സന്ദർഭങ്ങളിൽ നിന്നും ദിതീയ വർണ്ണത്തിലുള്ള സൂതാര്യ വസ്തുവിന്റെ എന്തു പ്രത്യേകതയാണ് മനസ്സിലാവുന്നത്.

1. ദിതീയ വർണ്ണത്തിലുള്ള സൂതാര്യ വസ്തു എല്ലാ പ്രാഥമിക വർണ്ണങ്ങളെയും കടത്തിവിടുന്നു.
2. ദിതീയ വർണ്ണത്തിലുള്ള സൂതാര്യ വസ്തു എല്ലാ ദിതീയ വർണ്ണങ്ങളെയും കടത്തിവിടുന്നു.
3. ദിതീയ വർണ്ണത്തിലുള്ള സൂതാര്യ വസ്തു അതേ വർണ്ണത്തേയും കൂടാതെ അതിന്റെ ഘടകവർണ്ണങ്ങളെയും കടത്തിവിടുന്നു.
4. ദിതീയ വർണ്ണത്തിലുള്ള സൂതാര്യ വസ്തു അതേ വർണ്ണത്തേയും കൂടാതെ എല്ലാ പ്രാഥമിക വർണ്ണങ്ങളെയും കടത്തിവിടുന്നു.

4.6.C പുനോട്ടം നനച്ചു കൊണ്ടിരുന്ന കുട്ടി വെള്ളം വീഴുന്ന ഹോസ് പൈപ്പ് 45° കോണിൽ പിടിച്ചപ്പോൾ വെള്ളം പരമാവധി ദൂരത്തേക്ക് വീഴുന്നത് കണ്ടു. 45° കോണിൽ കൂട്ടുകയോ കുറയ്ക്കുകയോ ചെയ്താൽ വെള്ളം ചെന്നു വീഴുന്ന ദൂരം കുറയുന്നു.

ക്രിക്കറ്റ് ഗ്രൗണ്ടിൽ കൂട്ടികൾ പന്ത് ദൂരേക്ക് എറിഞ്ഞു പരശീലിക്കുകയായിരുന്നു. പരമാവധി ദൂരേക്ക് പന്ത് എത്തിക്കുവാൻ എറിയുന്ന കോൺ 45° ആവണമെന്ന് അവർ മനസ്സിലാക്കി. കോണളവ് ഇതിൽ നിന്ന് കൂടുകയോ കുറയുകയോ ചെയ്താൽ പന്ത് ചെന്നു വീഴുന്ന ദൂരം കുറയുന്നു.

ജാവലിൻ എറിയുവാൻ പരിശീലിക്കുന്ന കുട്ടികൾ 45° കോണിൽ എറിഞ്ഞപ്പോൾ ജാവലിൻ പരമാവധി ദൂരത്തിൽ ചെന്നു വീണു. വിക്ഷേപണ കോൺ കൂട്ടുകയോ കുറയ്ക്കുകയോ ചെയ്താൽ ജാവലിൻ കുറഞ്ഞ ദൂരം മാത്രമേ താണ്ടുകയുള്ളൂ.

ഈ സന്ദർഭങ്ങളിൽ നിന്ന് വിക്ഷേപണ കോണിനേപ്പറ്റി എന്തു പൊതു തത്വത്തിലെത്താം.

1. വിക്ഷേപണ കോൺ വർദ്ധിക്കുമ്പോൾ എറിയപ്പെടുന്ന വസ്തു ചെന്നു പതിക്കുന്ന ദൂരം വർദ്ധിക്കുന്നു.
2. വിക്ഷേപണ കോൺ വർദ്ധിക്കുമ്പോൾ എറിയപ്പെടുന്ന വസ്തു ചെന്നു പതിക്കുന്ന ദൂരം കുറയുന്നു.
3. വിക്ഷേപണ കോൺ 45° കൂടിയായും കുറഞ്ഞായും എറിയപ്പെടുന്ന വസ്തു ചെന്നു പതിക്കുന്ന ദൂരം കൂടുന്നു.
4. വിക്ഷേപണ കോൺ 45° കൂടിയായും കുറഞ്ഞായും എറിയപ്പെടുന്ന വസ്തു ചെന്നു പതിക്കുന്ന ദൂരം കുറയുന്നു.

4.6.D താഴെകൊടുത്തിരിക്കുന്ന സമാനമായ സന്ദർഭങ്ങൾ ശ്രദ്ധയോടെ മനസ്സിലാക്കി ഒരു പൊതുതത്വത്തിൽ എത്തിച്ചേരുക.

ഒരു കുട്ടി നൂലിൽ കല്ലുകെട്ടി കറക്കി കളിക്കുകയായിരുന്നു. ക്രമേണ വേഗത വർദ്ധിച്ചപ്പോൾ നൂൽ പൊട്ടി കല്ല് തെറിച്ച് പോയി.

ഒരു കുട്ടി മഴയത്ത് കൂട കറക്കുകയായിരുന്നു. അതിൻമേൽ പറ്റിപ്പിടിച്ചിരുന്ന മഴത്തുള്ളികൾ കറക്കത്തിന്റെ വേഗത വർദ്ധിച്ചപ്പോൾ തെറിച്ച് പോയി.

ഒരു സൈക്കിൾ അതിന്റെ സ്റ്റാൻഡിൽ വച്ചിരിക്കുകയാണ്. പുറകിലെ ടയർ ഇപ്പോൾ പെഡൽ കറക്കുന്നതിന് നൂസരിച്ച് കറക്കാവുന്നതാണ്. ടയറിൽ പറ്റിപ്പിടിച്ചിരിക്കുന്ന ചെളിക്കട്ടകൾ ടയർ കറങ്ങിത്തുടങ്ങുമ്പോൾ തെറിച്ച് പോവുന്നില്ലെങ്കിലും ക്രമേണ വേഗത വർദ്ധിക്കുമ്പോൾ തെറിച്ച് പോവുന്നത് കണ്ടു.

ഈ സന്ദർഭങ്ങളിൽ നിന്ന് നമുക്ക് എന്ത് പൊതു തത്വത്തിലെത്താം?

1. വർത്തുള്ള ചലനത്തിലുള്ള ഏതു വസ്തുവും പുറത്തേക്ക് തെറിച്ച് പോവും.
2. കുറഞ്ഞ വേഗതയിൽ വസ്തുക്കൾക്ക് അഭികേന്ദ്രബലമുണ്ടെങ്കിലും കറക്കത്തിന്റെ വേഗത വർദ്ധിപ്പിക്കുമ്പോൾ വസ്തുക്കൾക്ക് അഭികേന്ദ്ര ബലം കുറയുന്നു.
3. കറക്കത്തിന്റെ വേഗത വർദ്ധിക്കുമ്പോൾ വസ്തുക്കൾക്ക് അഭികേന്ദ്ര ബലം കൂടുന്നു.
4. കറക്കത്തിന്റെ വേഗതയിൽ വരുന്ന വ്യതിയാനം വർത്തുള്ള ചലനത്തിന്റെ പാതയിലും വ്യതിയാനം സൃഷ്ടിക്കും.

**University of Calicut**

**Department of Adult and Continuing Education and Extension  
Services**

**PROBLEM SOLVING ABILITY TEST IN PHYSICS**

**(FINAL)**

**Malayalam Version**

**Dr. Sivarajan, K. and Manoj Praveen, G.**

**This book let contains 14 sections (PART 1 TO PART 14) in 14 pages. Each section contains four or five questions that test your ability to solve conceptual problems in Physics. Read the instructions for each section carefully and choose the right answer by encircling the serial number of the relevant response on the question paper itself.**

**PART - 1**

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തോടും അനുബന്ധിച്ച് 1,2,3,4 എന്നിങ്ങനെ കൊടുത്തിരിക്കുന്ന നാലു വസ്തുതകളിൽ ഏറ്റവും അസാധാവികമെന്ന് തോന്നുന്നത് നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് മാർക്ക് ചെയ്യുക

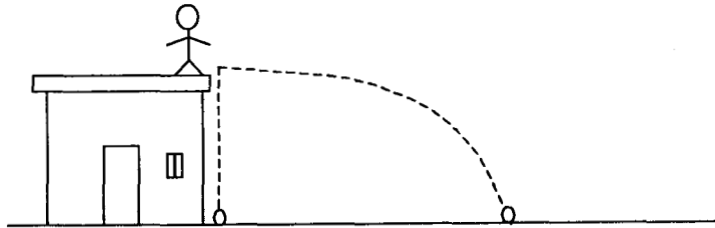
**I.1.A** ഭാരമുള്ള ഒരു പെട്ടി തറയിൽ വച്ചിരിക്കുന്നു. അതു തള്ളുമ്പോൾ ഉണ്ടായ സാഹചര്യങ്ങളാണ് താഴെ കൊടുത്തിരിക്കുന്നത്. ഇതിൽ ഏതാണ് നിങ്ങളെ ആശ്ചര്യപ്പെടുത്തുന്നത്.

1. നാം പെട്ടി തള്ളുമ്പോൾ നമുക്ക് ബുദ്ധിമുട്ട് അനുഭവപ്പെടുന്നു.
2. തള്ളുമ്പോൾ ഉണ്ടാകുന്ന എതിർബലം പെട്ടി നീങ്ങിത്തുടങ്ങുമ്പോൾ അൽപം കുറയുന്നു.
3. പെട്ടി നീങ്ങിത്തുടങ്ങുമ്പോൾ തറയിൽ പോറൽ ഉണ്ടാവുന്നു.
4. നീങ്ങിത്തുടങ്ങിയ പെട്ടിമേൽ തള്ളുന്നത് നിർത്തുമ്പോൾ പെട്ടി നിശ്ചലാവസ്ഥയിലാവുന്നു.

**I.1.B.** ഒരു ബക്കറ്റ് വെള്ളം തറയ്ക്ക് ലംബമായി വട്ടത്തിൽ ചുഴറ്റുമ്പോൾ അനുഭവപ്പെടുന്ന ചില സാഹചര്യങ്ങളാണ് ചുവടെ ചേർത്തിരിക്കുന്നത്. ഇതിൽ ഏത് സാഹചര്യമാണ് സാധാരണ നാം പ്രതീക്ഷിക്കുന്നതിൽ നിന്നു വ്യത്യസ്തമായി അനുഭവപ്പെടുന്നത്.

1. ഒരു ബലം നമ്മുടെ കൈയ്യിൻമേൽ അനുഭവപ്പെടുന്നു എന്നത്.
2. ബക്കറ്റ് വൃത്തത്തിൽ കറങ്ങുന്നു എന്നത്.
3. ചുറ്റുന്നതിന്റെ വേഗത വളരെ കുറയ്ക്കുമ്പോൾ ബക്കറ്റ് വർത്തുളപാതയിൽ ചലിക്കുന്നില്ല എന്നത്.
4. ലംബമായി ചുഴറ്റുമ്പോൾ ബക്കറ്റിൽ നിന്ന് വെള്ളം താഴേക്ക് വീഴുന്നില്ല എന്നത്.

**I.1.C** ഒരേ പോലെയുള്ള രണ്ടു പന്തുകളിൽ ഒന്ന് കെട്ടിടത്തിന്റെ മുകളിൽ നിന്ന് തിരശ്ചീനമായി വലി ചെറിയൊരു തൂണിലേക്ക് തൂങ്ങിക്കിടക്കുന്നു. രണ്ടാമത്തേതാവട്ടെ അതേ സമയം തന്നെ വെറുതെ ഇട്ടു. താഴെ കൊടുത്തിരിക്കുന്ന ചിത്രം ശ്രദ്ധിക്കുക.



രണ്ടു പന്തുകളും വ്യത്യസ്ത ദൂരമാണ് സഞ്ചരിക്കുന്നത്. ഈ ചലനങ്ങളെ പറ്റി താഴെ പറയുന്നവയിൽ ഏത് വസ്തുതയാണ് നിങ്ങളെ ആശ്ചര്യപ്പെടുത്തുന്നത്?

1. രണ്ടു പന്തുകൾക്കും ചലനദിശ വ്യത്യസ്തമാണ് എന്നത്.
2. രണ്ടു പന്തുകളും ഭൂമിയുടെ ആകർഷണത്തിന് വിധേയമാണ് എന്നത്.
3. രണ്ടു പന്തുകളും ഒരേ സമയം നിലത്തു വീഴുന്നു എന്നത്.
4. രണ്ടു പന്തുകൾക്കും താഴേയ്ക്കുള്ള പ്രവേഗം ക്രമേണ കൂടി വരുന്നു എന്നത്.

**I.1.D.** ഒരു മുറിയിൽ സോഡിയം വേപ്പർ വിളക്ക് ഉപയോഗിച്ച് മഞ്ഞ നിറം ഉണ്ടാക്കിയിട്ടുണ്ട്. തൊട്ടടുത്ത മുറിയിൽ പ്രാഥമിക വർണങ്ങളായ ചുവപ്പും പച്ചയും പ്രകാശം ചേർത്ത് മഞ്ഞ നിറം സൃഷ്ടിച്ചിട്ടുണ്ട്. ചുവപ്പ്, പച്ച, വെള്ള എന്നീ നിറങ്ങളിലുള്ള ബട്ടണുകൾ ഓരോ മുറിയിലും കൊണ്ടു പോയി പരിശോധിച്ചപ്പോൾ കണ്ട വസ്തുതകളാണ് താഴെ ചേർത്തിരിക്കുന്നത്. ഇതിൽ ഏത് വസ്തുതയാണ് നിങ്ങൾക്ക് അസാധാവികമായി തോന്നുന്നത്.

1. ചുവപ്പും പച്ചയും ചേർന്ന സമന്വൃത മഞ്ഞ പ്രകാശമുള്ള മുറിയിൽ ചുവപ്പ് ബട്ടൺ ചുവപ്പായും പച്ച ബട്ടൺ പച്ചയായും കാണാൻ സാധിച്ചു.
2. സോഡിയം വേപ്പർ ലാമ്പ് ഉപയോഗിച്ചുള്ള മഞ്ഞ പ്രകാശത്തിൽ ചുവപ്പ് പച്ച ബട്ടണുകൾ ഇരുണ്ടതായി കണ്ടു.
3. സോഡിയം വേപ്പർ ലാമ്പ് ഉപയോഗിച്ചുള്ള മഞ്ഞ പ്രകാശത്തിൽ വെള്ള ബട്ടൺ മഞ്ഞയായി തോന്നി.
4. സമന്വൃത മഞ്ഞ പ്രകാശമുള്ള മുറിയിൽ വെള്ള ബട്ടൺ മഞ്ഞയായി തോന്നി.

PART - 2

ദൈനം ദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തിലും ഒരു കാതലായ പ്രശ്നം അടങ്ങിയിട്ടുണ്ട്. ഓരോ സന്ദർഭത്തോടും അനുബന്ധിച്ച് കൊടുത്തിരിക്കുന്ന നാലു പ്രസ്താവനകളിൽ ഏതാണ് പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത് എന്ന് നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് മാർക്ക് ചെയ്യുക

I.2.A. അതിരാവിലെ അഞ്ചുമണിക്ക് ഒരു ഹോട്ടലിന്റെ ഏട്ടാം നിലയിൽ കറുത്ത ഷർട്ട് ധരിച്ച ഒരു റൂം ബോയ് ഒരാൾക്ക് കട്ടൻ കാപ്പി ഫ്ലാസ്കിലേക്ക് പകർന്നു കൊടുക്കുകയായിരുന്നു. ഇതിനായി ഒരു വലിയ പാത്രത്തിൽ കട്ടൻകാപ്പിയ്ക്കുമ്പോൾ പഞ്ചസാര ചേർത്ത് ഒരു വെള്ളി സ്പൂൺ കൊണ്ട് നന്നായി വട്ടത്തിൽ ഇളക്കി. പാത്രത്തിലെ കാപ്പിയുടെ ചലനം അവസാനിക്കുന്നതിനു മുമ്പ് തന്നെ അത് ഫ്ലാസ്കിലേക്ക് പകരുവാൻ ശ്രമിച്ചു. വളരെ ശ്രദ്ധിച്ച് ഫ്ലാസ്കിനോട് ചേർത്ത് വച്ച് ഒഴിച്ചിട്ടും കാപ്പി അതിന്റെ വർത്തുള ചലനത്തിന്റെ ദിശയിൽ പുറത്തേക്ക് തെറിച്ചു വീണു. ഇവിടെ അനുഭവപ്പെട്ട പ്രശ്നം താഴെ പറയുന്നതിൽ ഏത് പ്രസ്താവനയിലാണ് ഏറ്റവും കൃത്യമായി അവതരിക്കപ്പെട്ടിരിക്കുന്നത്.

1. വർത്തുള ചലനത്തിലായിരുന്ന കാപ്പി മറ്റൊരു പാത്രത്തിലേക്ക് പകരുന്ന അവസരത്തിൽ ചലനത്തിന്റെ ദിശയിൽ പുറത്തേക്ക് തെറിച്ചു.
2. എട്ടാമത്തെ നിലയിൽ നിൽക്കുന്ന റൂംബോയ് ഒരു വെള്ളി സ്പൂൺ ഉപയോഗിച്ച് കട്ടൻകാപ്പി വട്ടത്തിൽ ഇളക്കി.
3. കറുത്ത ഷർട്ടിട്ട ആൾ കാപ്പിയുടെ ചലനം നിൽക്കുന്നതിനു മുമ്പ് ഫ്ലാസ്കിലേക്ക് ഒഴിച്ചു.
4. വളരെ ശ്രദ്ധയോടെ ഒഴിച്ചിട്ടും വാവട്ടം കുറഞ്ഞ ഫ്ലാസ്കിലേക്ക് ഒഴിച്ചപ്പോൾ കാപ്പി തെറിച്ചു പോയി.

I.2.B. രാത്രിയിൽ ഒരു ലോഗി ഡ്രൈവർ അതീവശ്രദ്ധയോടെ ഹൈറേഞ്ചിലുള്ള റോഡിലൂടെ വാഹനം ഓടിക്കുകയായിരുന്നു. അന്തരീക്ഷത്തിൽ നല്ല മഞ്ഞുണ്ടായിരുന്നു. ദൂരേക്ക് കാണാൻ വലിയ ബുദ്ധിമുട്ടായിരുന്നു. ഡ്രൈവർ വാഹനത്തിന്റെ ഹെഡ്ലൈറ്റുകൾക്കു പുറമെ വെള്ള ലൈറ്റുകൾ രണ്ടെണ്ണം കൂടി (അഡീഷണൽ ലാമ്പുകൾ) പ്രകാശിപ്പിച്ചു. എന്നാൽ മഞ്ഞ കൂടുതൽ തിളങ്ങുന്നതായി തോന്നിയതല്ലാതെ ദൂരക്കാഴ്ചയ്ക്ക് അത് ഒട്ടും ഉപകരിച്ചില്ല. മഞ്ഞിലൂടെ ദൂരേക്ക് കാണുന്നത് ശരിക്കും ബുദ്ധിമുട്ടുള്ള ഒരു കാര്യമാണ്. താഴെ പറയുന്നതിൽ ഏത് പ്രസ്താവനയാണ് ഇവിടുത്തെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

1. രാത്രിയിൽ ഹൈറേഞ്ച് റോഡിലൂടെ വാഹനമോടിക്കുന്നത് വളരെ ദുഷ്കരമാണ്.
2. വെള്ള പ്രകാശം മഞ്ഞിനെ കൂടുതൽ തിളക്കമുള്ളതാക്കി മാറ്റും എന്നല്ലാതെ മഞ്ഞിലൂടെ ദൂരേക്ക് കാണാൻ സഹായിക്കുന്നില്ല.
3. അന്തരീക്ഷത്തിൽ വളരെ ചെറിയ ജല കണികകൾ ഘനീഭവിച്ച് തങ്ങിനിൽക്കുന്നതിനാൽ മഞ്ഞിലൂടെ ദൂരേക്ക് കാണുന്നത് വളരെ ദുഷ്കരമാണ്.
4. ഹെഡ്ലൈറ്റിനു പുറമെയുള്ള വെള്ള ലൈറ്റുകൾ മഞ്ഞിലൂടെ കാണാൻ സഹായിക്കുന്നില്ല.

I.2.C. ഇന്ത്യയിൽനിന്ന് ധ്രുവപ്രദേശത്തുള്ള അന്റാർട്ടിക്ക പഠിക്കുവാൻ ഒരു സംഘം പുറപ്പെട്ടു. അവിടെ വച്ച് സംഘത്തിലെ ഒരാൾ സഹപ്രവർത്തകനിൽ നിന്ന് 24 ഗ്രാം ഭാരമുള്ള ഒരു സ്വർണമാല വില കൊടുത്തു വാങ്ങി സ്വന്തം നാട്ടിലെത്തി തൂക്കി നോക്കിയപ്പോൾ അതിന്റെ ഭാരം കുറഞ്ഞതായി കണ്ടു. മാലയിൽ നിന്നും ഒട്ടും സ്വർണം നഷ്ടപ്പെടുകയോ കൂട്ടിച്ചേർക്കപ്പെടുകയോ ചെയ്തിട്ടില്ല എന്ന കാര്യം ഉറപ്പാണ്. താഴെ പറയുന്നതിൽ ഏത് പ്രസ്താവനയാണ് ഇതിലെ പ്രശ്നത്തെ ഏറ്റവും കൃത്യമായി അവതരിപ്പിക്കുന്നത്?

1. താപ നില കുറഞ്ഞ പ്രദേശത്ത് വച്ച് തൂക്കിയപ്പോൾ മാലയുടെ ഭാരം 24 ഗ്രാം ആയി കണ്ടു.
2. മാല വാങ്ങിയ ആൾക്ക് നഷ്ടം സംഭവിച്ചു.
3. സ്വർണം വില കൂടിയ ലോഹമായതിനാൽ ഭാരത്തിലുണ്ടാകുന്ന ചെറിയ വ്യത്യാസം പോലും വലിയ ലാഭനഷ്ടങ്ങളുണ്ടാക്കുന്നു.
4. നിശ്ചിത പിണ്ഡമുള്ള സ്വർണമാല ഭൂമിയുടെ വ്യത്യസ്ത പ്രദേശങ്ങളിൽ വ്യത്യസ്ത ഭാരം കാണിച്ചു.

PART - 3

ദൈനംദിന ജീവിതത്തിലെ ചില സന്ദർഭങ്ങളാണ് താഴെയുള്ള ചോദ്യങ്ങളിൽ പ്രതിപാദിച്ചിരിക്കുന്നത്. ഓരോ സന്ദർഭത്തിലും ഒരു ശാസ്ത്ര പ്രശ്നം അടങ്ങിയിരിക്കുന്നു. ഈ പ്രശ്നത്തിലെ പ്രധാന ഘടകങ്ങൾ ഏതാണെന്ന് കണ്ടുപിടിക്കുകയാണ് നിങ്ങൾ ചെയ്യേണ്ടത്. പ്രധാനഘടകങ്ങളുടെ ശരിയായ കൂട്ടം കണ്ടെത്തി അതിന്റെ നമ്പറിനു ചുറ്റും വട്ടം വരയ്ക്കുക.

I.3.A. തന്റെ വീടിനു മുമ്പിലുള്ള തോട്ടത്തിലെ ചെടികൾക്ക് രാത്രിയിൽ ഹോസ് ഉപയോഗിച്ച് വെള്ളമൊഴിക്കുകയായിരുന്നു രാമു. ഹോസിന് നീളം കുറവായിരുന്നതിനാൽ വെള്ളം ദൂരേക്ക് എത്തിക്കുന്നതിനുവേണ്ടി അവൻ ഹോസിന്റെ ദ്വാരം തെക്കിട്ടിട്ട് വെള്ളം ചീറ്റിച്ചു നോക്കി. പിന്നീട് ഹോസ് വിവിധ കോണുകളിൽ പിടിച്ചുനോക്കി. വെള്ളം വീഴുന്ന ദൂരം (റേഞ്ച്) പരമാവധി ആക്കുന്നതിനു വേണ്ടി രാമു ശ്രമിക്കുകയായിരുന്നു. ഈ സന്ദർഭത്തിലെ പ്രധാനഘടകങ്ങളുടെ കൂട്ടം ഏതാണ്?

1. കോൺ, പരമാവധി റേഞ്ച്, പ്രകാശത്തിന്റെ അഭാവം
2. റേഞ്ച്, വെള്ളം, ഹോസ്
3. വെള്ളത്തിന്റെ ഒഴുക്കിന്റെ ശക്തി, കോൺ, പരമാവധി റേഞ്ച്
4. രാത്രി, പരമാവധി, ഹോസ്.

I.3.B. ചെറിയ കുട്ടികൾ ഭാരമുള്ള ഇഷ്ടികക്കട്ടകൾ കൊണ്ട് മുറ്റത്ത് വീടുണ്ടാക്കി കളിക്കുകയായിരുന്നു. ഇഷ്ടികകൾ ഒരു മരപ്പലകമേൽ ഒന്നിനു പുറത്ത് ഒന്നായി വയ്ക്കും. എന്നിട്ട് മരപ്പലകയെ ഒരു ചരട് കൊണ്ട് മണലിലൂടെ കെട്ടി വലിക്കും. ഇങ്ങനെ നിരക്കിയാണ് കുട്ടികൾ ഇഷ്ടികകൾ കളി സ്ഥലത്തേക്ക് കൊണ്ട് വന്നത്. ഇതു വളരെ ബുദ്ധിമുട്ടായിരുന്നു. ഘർഷണം ചലനത്തെ തടസ്സപ്പെടുത്തുമല്ലോ. ഈ പ്രശ്നത്തിലെ പ്രധാന ഘടകങ്ങളുടെ ശരിയായ കൂട്ടം ഏതാണ്?

1. നിരങ്ങൾ, ഘർഷണം, ഭാരം
2. ചലനം, മരപ്പലക, പ്രയത്നം
3. നിരങ്ങൾ, ഇഷ്ടിക, ചരട്
4. കുട്ടികൾ, ഇഷ്ടിക, ഉരുളൽ

I.3.C. ഒരു പെൺകുട്ടി ഊഞ്ഞാലാടിക്കൊണ്ടിരിക്കുകയായിരുന്നു. അവളുടെ സഹോദരി പുറകിൽ നിന്ന് വന്ന് ഊഞ്ഞാലിനെ കൂടുതൽ ഉയരത്തിലേക്ക് ആട്ടി വിട്ടു. ഉയരത്തിൽ നിന്ന് താഴേക്ക് ആടി വന്നപ്പോൾ കുട്ടിക്ക് സ്വന്തം ഭാരം കുറഞ്ഞതുപോലെ തോന്നി. താഴേക്ക് വരുന്നതിനുള്ള താരണത്തിനുവേണ്ടി കുട്ടിയുടെ ഭാരം ഉപയോഗപ്പെടുത്തുമല്ലോ. ഈ സാഹചര്യത്തിൽ കുട്ടിക്ക് അനുഭവപ്പെട്ട ഭാരക്കുറവുമായി ബന്ധപ്പെട്ട പ്രധാന ഘടകങ്ങൾ ഏതെല്ലാം.

1. ഭാരക്കുറവ്, മാസ്, തള്ളൽ ഊഞ്ഞാൽ
2. ഊഞ്ഞാൽ, തള്ളൽ, ഭാരക്കുറവ്, പ്രവേഗം
3. ഭാരക്കുറവ്, താഴേക്കുള്ള ചലനം, മാസ്, ഊഞ്ഞാൽ
4. കൂടിയ ഉയരം, താഴേക്കുള്ള ചലനം, താരണം, ഭാരക്കുറവ്.

I.3.D. അച്ഛനും മകനും തീവണ്ടിയിൽ ഗ്രാമത്തിൽ നിന്നും പട്ടണത്തിലേക്ക് യാത്ര ചെയ്യുകയായിരുന്നു. ഗ്രാമത്തിലെ തെളിഞ്ഞ നീല ആകാശത്തിൽ നിന്ന് വ്യത്യസ്തമാണ് പട്ടണത്തിലെ ആകാശമെന്ന് മകൻ ശ്രദ്ധിച്ചു. പൊടിപടലങ്ങളും പുകയും എല്ലാം നിറഞ്ഞതാണ് പട്ടണം. ആകാശത്തിന്റെ നിറം ചാര നിറമാണ്. നീല നിറത്തിലാല്ലോ ആകാശം കാണപ്പെടേണ്ടത്. ഇവിടെ എന്തുകൊണ്ടാണ് ആകാശം ചാരനിറമായി കാണപ്പെടുന്നത് എന്ന് മകൻ ചോദിച്ചു. പട്ടണങ്ങളിൽ പൊടിപടലങ്ങളുടെ വലിയ കണികകൾ എല്ലാം വ്യത്യസ്ത നിറങ്ങളേയും ഏതാണ്ട് ഒരേ തോതിൽ വിസരണ വിധേയമാക്കുന്നു എന്ന് അച്ഛൻ പറഞ്ഞു. ആകാശത്തിന്റെ നിറം മാറ്റത്തിന് കാരണമായ പ്രധാന ഘടകങ്ങളുടെ ശരിയായ കൂട്ടം ഏത്?

1. അന്തരീക്ഷം, ആകാശം, പൊടിപടലം, തീവണ്ടി.
2. പുക, ആകാശം, നീലനിറം, ചാര നിറം.
3. വലിയകണികകൾ, വ്യത്യസ്തനിറങ്ങൾ, വിസരണതോത്, ചാരനിറം.
4. പൊടിപടലം, പുക, ചാരനിറം, തീവണ്ടി.

PART - 4

താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങളിലെല്ലാം പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ രണ്ട് ശാസ്ത്ര ആശയങ്ങൾ അടങ്ങിയിട്ടുണ്ട്. തന്നിരിക്കുന്ന സന്ദർഭങ്ങൾ ശ്രദ്ധയോടെ വായിച്ച് പ്രസക്തമായ ആശയങ്ങളുടെ ജോഡി കണ്ടെത്തി നമ്പറിന് ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക.

2.1.A. രണ്ടു സുഹൃത്തുക്കൾ A യും B യും കാട്ടിലെത്തി B ഒരു മാവിന്റെ ചുവട്ടിൽ വിശ്രമിച്ചപ്പോൾ A വെള്ളം തേടിപ്പോയി. പക്ഷേ തിരിച്ചുവരുമ്പോൾ വഴിതെറ്റി. A സുഹൃത്തിനെത്തേടി പല ദിശകളിലും കിലോമീറ്ററുകളോളം പരതി നടന്നു. എന്നാൽ ഒരിക്കലും B യുടെ അരികിൽനിന്നും അവൻ നൂറുമീറ്ററിൽ കൂടുതൽ അകലെയായിരുന്നില്ല. ഈ സന്ദർഭത്തിൽ ഏറ്റവും പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

1. പ്രവേഗവും ത്വരണവും
2. ദൂരവും സ്ഥാനാന്തരവും
3. പ്രവേഗവും സ്ഥാനാന്തരവും
4. കിലോമീറ്ററും മീറ്ററും.

2.1.B. ഒരു ഭാരമുള്ള പെട്ടി മിനുസമുള്ള ഒരു തറയിൽ കൂടി വലിക്കുകയായിരുന്നു. ആദ്യം 50 N ബലം പ്രയോഗിച്ചു; പെട്ടി അനങ്ങിയില്ല. തുടർന്ന് 60, 70, 80, 90, 100 N പ്രയോഗിച്ചു. എന്നിട്ടും പെട്ടി അനങ്ങിയില്ല. എന്നാൽ 101 N പ്രയോഗിച്ചപ്പോൾ പെട്ടി ചലിച്ചു തുടങ്ങി. അധികമായി ഒരു ന്യൂട്ടൺ പ്രയോഗിച്ചതാണ് ഇവിടെ പെട്ടിയെ ചലിപ്പിച്ചത്. ഈ സന്ദർഭത്തിൽ ഏറ്റവും പ്രസക്തമായതും പരസ്പരം ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

1. ബലവും ആവേഗവും
2. തള്ളും വലിയും
3. ഘർഷണവും കൊഴുപ്പിടലും
4. സ്ഥിരഘർഷണവും ഘർഷണപരിധിയും

2.1.C. ഒരു വൃത്താകൃതിയിലുള്ള തകിടിനെ മൂന്ന് സമഭാഗങ്ങളാക്കി ചുവപ്പ്, പച്ച, നീല എന്നീ നിറങ്ങൾ കൊടുത്തിരിക്കുന്നു. ഇത് വേഗത്തിൽ കറക്കുമ്പോൾ, വൃത്യസ്തനിറങ്ങൾ കാണാതാവുകയും തകിട് വെള്ള നിറമായി കാണപ്പെടുകയും ചെയ്യുന്നു. ഇവിടെ ഏറ്റവും പ്രസക്തമായതും തമ്മിൽ ബന്ധപ്പെട്ടതുമായ ആശയങ്ങളുടെ ജോഡി ഏത്?

1. പ്രകാശപ്രകീർണനവും വീക്ഷണസ്ഥിരതയും
2. പ്രാഥമികവർണ്ണവും ദ്വീതിയവർണ്ണവും
3. വർണ്ണങ്ങളുടെ സംയോജനവും വീക്ഷണസ്ഥിരതയും
4. തകിടിന്റെ ആകൃതിയും വർണ്ണങ്ങളുടെ പുനർസംയോജനവും

PART 5

താഴെ കൊടുത്തിരിക്കുന്ന ശാസ്ത്രീയ പ്രതിഭാസങ്ങൾക്ക് സമാനമായ അവസ്ഥ കണ്ടെത്തി അടയാളപ്പെടുത്തുക.

2.2.A. രണ്ടു പ്രതലങ്ങൾ തമ്മിലുള്ള ഘർഷണം ഉണ്ടാകുന്നതിനു കാരണം വസ്തുവിന്റെ ഉപരിതലത്തിലുള്ള ക്രമരഹിതമായ ഉയർച്ചകളും താഴ്ചകളും ആണ്. ഒരു വസ്തു മറ്റൊരു വസ്തുവിൻമേൽ നിരങ്ങി നീങ്ങുമ്പോൾ സൂക്ഷ്മമായ ഈ ഉയർച്ച താഴ്ചകൾ പരസ്പരം കൊളുത്തി, ചലനത്തിന് എതിർദിശയിൽ സൃഷ്ടിക്കുന്ന ബലമാണ് ഘർഷണബലം. ഈ പ്രതിഭാസത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നതിൽ ഏതാണ്.

1. രണ്ട് സാൻഡ് പേപ്പറുകളുടെ പരസ്പരം പ്രതലങ്ങൾ പരസ്പരം ഉരയ്ക്കുന്നത്.
2. താക്കോൽ ഉപയോഗിച്ച് ഒരു താഴ്ച പൂട്ടുകയും തുറക്കുകയും ചെയ്യുന്നത്.
3. രണ്ടു കത്തികൾ ലംബമായി പരസ്പരം ഉരസുന്നത്.
4. രണ്ടു കൊളുത്തുകൾ പരസ്പരം കൊളുത്തിവലിക്കുന്നത്.

2.2.B. പ്രകാശരശ്മി ഒരു മാധ്യമത്തിൽനിന്ന് മറ്റൊന്നിലേക്ക് ചരിഞ്ഞ് പ്രവേശിക്കുമ്പോൾ വിഭജനതലത്തിൽ വച്ച് വളയുന്നു. ഇതിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നവയിൽ ഏതാണ്?

1. ഒരു കപ്പൽ പുഴയിൽനിന്ന് കടലിലേക്ക് കടക്കുമ്പോൾ അൽപം ഉയരുന്നു.
2. ഒരു സൈക്കിൾ ടാറിട്ട റോഡിൽനിന്ന് പുഴിമണൽനിറഞ്ഞ സ്ഥലത്തേക്ക് ചരിഞ്ഞ് പ്രവേശിക്കുമ്പോൾ സഞ്ചാരിശ പെട്ടെന്ന് വ്യതിചലിക്കുന്നു.
3. പറക്കുന്ന പക്ഷിക്ക് എതിരെ ശക്തമായി കാറ്റുവീശുമ്പോൾ കൂടുതൽ ഉയരത്തിലേക്ക് പറന്നുകയരുന്നു.
4. ഒരു കുഴലിലൂടെ ഒഴുകുന്ന വെള്ളം കുഴലിന്റെ വണ്ണം കുറഞ്ഞ ഭാഗത്തെത്തുമ്പോൾ വേഗത്തിലൊഴുകുന്നു.

2.2.C. ഒരു സെക്കണ്ട് സമയത്തിൽ ഒരു വസ്തുവിനുണ്ടാകുന്ന പ്രവേഗവ്യത്യാസമാണല്ലോ ത്വരണം. തുല്യസമയാന്തരങ്ങളിൽ ഒരു വസ്തുവിനുണ്ടാകുന്ന പ്രവേഗമാറ്റം തുല്യങ്ങളാകുമ്പോൾ ത്വരണം സമതരണമാകുന്നു. താഴെ പറയുന്ന സന്ദർഭങ്ങളിൽ ഏതാണ് സമതരണം എന്ന ആശയത്തിനു സമാനമായി നിലകൊള്ളുന്നത്?

1. ഒരാൾ ഓരോ മിനിറ്റിലും ഒരു അപ്പം കഴിക്കുന്നു.
2. ഒരാൾ ആദ്യമിനിറ്റിൽ 1, രണ്ടാം മിനിറ്റിൽ 2, മൂന്നാം മിനിറ്റിൽ 4, നാലാം മിനിറ്റിൽ 8 എന്ന കണക്കിൽ അപ്പം കഴിക്കുന്നു.
3. ഒരാൾ ആദ്യമിനിറ്റിൽ 1, രണ്ടാം മിനിറ്റിൽ 2, മൂന്നാം മിനിറ്റിൽ 3, നാലാം മിനിറ്റിൽ 4 എന്ന കണക്കിൽ അപ്പം കഴിക്കുന്നു.
4. ഒരാൾ ആദ്യമിനിറ്റിൽ 1, രണ്ടാം മിനിറ്റിൽ 3, മൂന്നാം മിനിറ്റിൽ 9, നാലാം മിനിറ്റിൽ 27 എന്ന കണക്കിൽ അപ്പം കഴിക്കുന്നു.

2.2.D. രണ്ടു വസ്തുക്കൾ തമ്മിലുള്ള ഗുരുത്വാകർഷണബലം അവ തമ്മിലുള്ള അകലം കൂടുന്നതിനനുസരിച്ചു കുറയുന്നു. ഈ പ്രതിഭാസത്തിന് സമാനമായ അവസ്ഥ താഴെ പറയുന്നതിൽ ഏതാണ്?

1. രണ്ടു കാന്തങ്ങൾ തമ്മിലുള്ള ആകർഷണം അകലം വർദ്ധിക്കുന്നതിനനുസരിച്ച് കുറയുന്നു.
2. രണ്ടു കാന്തങ്ങൾ തമ്മിലുള്ള വികർഷണം അകലം വർദ്ധിക്കുന്നതിനനുസരിച്ച് കുറയുന്നു.
3. രണ്ടു പ്രതലങ്ങൾ തമ്മിലുള്ള ഘർഷണബലം സ്നേഹകം ഉപയോഗിക്കുമ്പോൾ കുറയുന്നു.
4. രണ്ടു പ്രതലങ്ങൾ തമ്മിലുള്ള ഘർഷണബലം ചൂടാകുന്നതിനനുസരിച്ചു കൂടുന്നു.

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താഴെകൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യങ്ങളിലും ശാസ്ത്രീയമായി തെളിയിക്കപ്പെട്ടിട്ടുള്ള ഒന്നിലേറെ പ്രസ്താവനകൾ അടങ്ങിയിരിക്കുന്നു. ഈ പ്രസ്താവനകളെ മാത്രം അടിസ്ഥാനമാക്കിയാൽ ഏത് അനുമാനത്തിലേത്തിച്ചേരാനാകുമെന്ന് നിർണ്ണയിച്ച് ശരിയായ അനുമാനത്തിനു നേരെയുള്ള നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക

- 2.3.A. ഈ പാഠഗ്രാഹിലെ മൂന്നു വാചകങ്ങൾ ശ്രദ്ധിക്കുക. (i) ഭൂമിക്ക് സമീപത്തുള്ള എല്ലാ വസ്തുക്കളെയും ഭൂമി അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു. (ii) ഭൂമിയുടെ ഉപരിതലത്തിന് താഴെയുള്ള എല്ലാ വസ്തുക്കളെയും ഭൂമി അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു. (iii) ഭൂമിയുടെ ഉപരിതലത്തിന് മുകളിലുള്ള എല്ലാ വസ്തുക്കളെയും ഭൂമി അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു. ഈ പ്രസ്താവനകളെ അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം?
1. ഭൂമി എല്ലാ വസ്തുക്കളെയും അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു.
  2. ഭൂമി മിക്കവാറും എല്ലാ വസ്തുക്കളെയും അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു.
  3. എല്ലാ വസ്തുക്കളും ഭൂമിയെ അവയിലേക്ക് ആകർഷിക്കുന്നു.
  4. ഭൂമിയിൽ നിന്ന് അകലെയുള്ള വസ്തുക്കളെ ഭൂമി അതിന്റെ കേന്ദ്രത്തിലേക്ക് ആകർഷിക്കുന്നു.

- 2.3.B. ദൃശ്യപ്രകാശത്തിലെ ഘടകവർണ്ണങ്ങൾ വയലറ്റ്, ഇൻഡിഗോ, നീല, പച്ച, മഞ്ഞ, ഓറഞ്ച്, ചുവപ്പ്, എന്നിവയാണല്ലോ? ഇനി ഈ പാഠഗ്രാഹിലെ മൂന്നു വാചകങ്ങൾ ശ്രദ്ധിക്കുക.
- (i) ഫ്ലൂറസന്റ് പദാർത്ഥം A വയലറ്റ് നിറത്തെ ആഗിരണം ചെയ്ത് നീല നിറം ഉൽസർജിച്ചു. (ii) ഫ്ലൂറസന്റ് പദാർത്ഥം B ഇൻഡിഗോ നിറം ആഗിരണം ചെയ്ത് നീലനിറം ഉൽസർജിച്ചു. (iii) ഫ്ലൂറസന്റ് പദാർത്ഥം C പച്ചനിറം ആഗിരണം ചെയ്ത് ചുവന്ന നിറം ഉൽസർജിച്ചു. ഈ പ്രസ്താവനകളിൽ നിന്ന് നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം?
1. ഫ്ലൂറസന്റ് പദാർത്ഥങ്ങൾ വയലറ്റ് നിറം ആഗിരണം ചെയ്യുകയും നീല നിറം ഉൽസർജിക്കുകയും ചെയ്യും.
  2. ഫ്ലൂറസന്റ് പദാർത്ഥങ്ങൾ തരംഗദൈർഘ്യം കുറഞ്ഞ പ്രകാശം ആഗിരണം ചെയ്ത് കൂടിയ പ്രകാശം ഉൽസർജിക്കും.
  3. ഫ്ലൂറസന്റ് പദാർത്ഥങ്ങൾ എന്തെങ്കിലും പ്രകാശം ആഗിരണം ചെയ്യുകയും എന്തെങ്കിലും പ്രകാശം ഉൽസർജിക്കുകയും ചെയ്യും.
  4. ഫ്ലൂറസന്റ് പദാർത്ഥങ്ങൾ കുറഞ്ഞ ആവൃത്തിയുള്ള പ്രകാശം ആഗിരണം ചെയ്ത് കൂടിയ ആവൃത്തിയുള്ള പ്രകാശം ഉൽസർജിക്കും.

- 2.3.C. ഈ ഖണ്ഡികയിലെ മൂന്നു പ്രസ്താവനകൾ ശ്രദ്ധിക്കുക.
- (i) തോക്ക് നിറയൊഴിക്കുമ്പോൾ വെടിയുണ്ട മുന്നോട്ട് പായുകയും തോക്ക് പിന്നോട്ട് തെറിക്കുകയും ചെയ്യുന്നു. (ii) തോണിയിൽ നിന്നു ഒരു കുട്ടി കരയിലേക്ക് ചാടുമ്പോൾ തോണി പുഴയുടെ വശത്തേക്ക് ചലിക്കുന്നു. (iii) ജെറ്റ് പ്ലെയിൻ പുകയും ഗ്യാസും കിഴക്കോട്ട് പുറന്തള്ളുമ്പോൾ പ്ലെയിൻ പടഞ്ഞാറോട്ട് കുതിക്കുന്നു. ഈ പ്രസ്താവനകളെ മാത്രം അടിസ്ഥാനപ്പെടുത്തി നമുക്ക് എന്ത് അനുമാനത്തിലെത്താം?
1. ഒരു പ്രവർത്തനത്തിന് തുല്യമായ പ്രതിപ്രവർത്തനം ഉണ്ടാകും.
  2. ഒരു പ്രവർത്തനത്തിന് എതിർ ദിശയിൽ പ്രതിപ്രവർത്തനം ഉണ്ടാകും.
  3. ഒരു പ്രവർത്തനത്തിന് പ്രതിപ്രവർത്തനം ഉണ്ടാകും.
  4. ഒരോ പ്രവർത്തനത്തിനോടും ഒരു ദിശ ബന്ധപ്പെട്ടിരിക്കുന്നു.

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താഴെതന്നിരിക്കുന്ന സന്ദർഭങ്ങളിലെല്ലാം ഒരു ശാസ്ത്ര പ്രശ്നം അടങ്ങിയിട്ടുണ്ട്. ഈ പ്രശ്നത്തെ മനസ്സിലാക്കിയതിനു ശേഷം അതിന് ഒരു യുക്തിസഹമായ ന്യായീകരണം തരുന്ന പ്രസ്താവനയെ നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക

2.4.A. ജാവലിൻ എറിയുന്ന ഒരു അൽലറ്റ് ഒരിടത്തുനിന്ന് ജാവലിൻ വലിച്ചെറിയുന്നതിനുപകരം ദൂരെ നിന്ന് കുതിച്ച് ഓടി വന്ന് എറിയുന്നു. എന്തായിരിക്കും ഇതിന് കാരണം?

1. അൽലറ്റ് ഓടുന്ന ദൂരവും ജാവലിന്റെ റേഞ്ചും തമ്മിൽ ബന്ധമുണ്ടാവാം.
2. അൽലറ്റ് ഓടി എടുക്കുന്ന വേഗതയും ജാവലിന്റെ റേഞ്ചും തമ്മിൽ ബന്ധമുണ്ടാവാം.
3. അൽലറ്റ് ഓടി എടുക്കുന്ന വേഗതയും അൽലറ്റ് ലഭിക്കുന്ന പേശീ ബലവും തമ്മിൽ ബന്ധമുണ്ടാവാം.
4. ഓടുന്ന ആൾക്ക് ജാവലിൻ പിടിക്കുന്ന കോൺ നിയന്ത്രിക്കാൻ സാധിക്കുന്നുണ്ടാവാം.

2.4.B. ഓടിക്കൊണ്ടിരിക്കുന്ന ഒരു ബസ്സിൽ നിന്ന് പുറത്തേക്ക് ഒരാൾ ഇറങ്ങുകയാണ്. വീഴാതിരിക്കുന്നതിനു വേണ്ടി അയാൾ ബസ്സിന്റെ ദിശയിൽ അൽപം ദൂരം മുന്നോട്ട് ഓടി പിന്നീട് പ്രയാസമില്ലാതെ നടന്നു പോവുകയും ചെയ്തു. ബസ്സിൽ നിന്ന് ഇറങ്ങിയ ആൾ മുന്നോട്ട് അൽപദൂരം ഓടിയതിനു കാരണമെന്ത്?

1. ചലനാവസ്ഥയിൽ തുടരുന്ന സ്വന്തം ശരീരത്തിന്റെ ചലനജഡതം ക്രമേണ കുറയ്ക്കുന്നതിനു വേണ്ടിയാവാം.
2. നിശ്ചലാവസ്ഥയിൽ തുടരുന്ന സ്വന്തം ശരീരത്തിന്റെ നിശ്ചലജഡതം ക്രമേണ കുറയ്ക്കുന്നതിനു വേണ്ടിയാവാം.
3. നിശ്ചലാവസ്ഥയിലുള്ള ആളിന്റെ പ്രവേഗം ബസ്സിനൊപ്പം ആക്കുന്നതിനു വേണ്ടിയാവാം.
4. യാത്രക്കാരന്റെ ശരീരം തറയെ അപേക്ഷിച്ച് നിശ്ചലാവസ്ഥയിലായതിനാൽ ഓടുന്നത് സ്ഥിരത കൈവരിക്കാൻ ഉപകരിച്ചേക്കാം.

2.4.C. സമുദ്രവും വളരെ ആഴമുള്ള ജലാശയങ്ങളും നീലനിറത്തിൽ കാണപ്പെടുന്നു. ഇതിനു കാരണം സൂര്യപ്രകാശത്തിലെ നീല വർണം ജലത്തിൽ വച്ച് വിസരണം ചെയ്യപ്പെടുന്നു എന്നതാണ്. കിണറുകളിലേയും കുളങ്ങളിലേയും ജലം നീല നിറത്തിൽ കാണാത്തത് എന്തു കൊണ്ടാണ്.

1. ജലത്തിന്റെ ആഴവും പരപ്പും കൂടുന്നതിനനുസരിച്ച് വിസരണം ചെയ്യപ്പെടുന്ന പ്രകാശത്തിന്റെ അളവും കൂടുമായിരിക്കാം.
2. ജലത്തിന്റെ ഇളക്കം വിസരണം ചെയ്യപ്പെടുന്ന പ്രകാശത്തിന്റെ നിറത്തെ സ്വാധീനിച്ചേക്കാം.
3. ജലത്തിൽ അലിഞ്ഞു ചേർന്നിരിക്കുന്ന ലവണങ്ങൾ വിസരണം ചെയ്യപ്പെടുന്ന പ്രകാശത്തിന്റെ നിറത്തെ സ്വാധീനിച്ചേക്കാം.
4. തിരമാലകൾ കൂടുന്നതിനനുസരിച്ച് വിസരണം ചെയ്യപ്പെടുന്ന പ്രകാശത്തിന്റെ അളവും കൂടുമായിരിക്കാം.

2.4.D. ഭാരമുള്ള ഒരു ഇരുമ്പ് ഗോളം സ്പ്രിംഗ് ബാലൻസിൽ തൂക്കിയിട്ടിരിക്കുകയായിരുന്നു. പെട്ടെന്ന് സ്പ്രിംഗ് ബാലൻസും തൂക്കിയിട്ടിരിക്കുന്ന ഗോളവും ഒപ്പം താഴേയ്ക്ക് വീണു. വീഴ്ചയിൽ സ്പ്രിംഗ് ബാലൻസ് പുഷ്യം റീഡിംഗ് കാണിച്ചു. എന്തായിരിക്കും ഇതിന്റെ കാരണം?

1. ചലിക്കുമ്പോൾ സ്പ്രിംഗിന്റെ പ്രവർത്തനം നിലയ്ക്കുന്നുണ്ടാവാം.
2. വീഴുന്ന വസ്തുക്കളുടെമേൽ ഗുരുത്വാകർഷണബലം പ്രയോഗിക്കപ്പെടുന്നില്ലായിരിക്കാം.
3. ഗോളത്തിന് വീഴ്ചയുടെ ഇടയിൽ പിണ്ഡം നഷ്ടപ്പെടുന്നുണ്ടാവാം.
4. ഗോളത്തിന്റെ ഭാരം വീഴ്ചയ്ക്ക് വേണ്ടി ഉപയോഗിച്ചതിനാൽ ഭാരം പുഷ്യമാവുന്നുണ്ടാവാം.

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താഴെകൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും അവതരിപ്പിച്ചിരിക്കുന്ന ശാസ്ത്രപ്രശ്നത്തിന് ന്യായീകരണമായേക്കാവുന്ന പ്രസ്താവനകളാണ് 1, 2, 3, 4 എന്നിങ്ങനെ കൊടുത്തിരിക്കുന്നത്. ഇവയിൽ ഏറ്റവും യുക്തി സഹമായതും ഒരു ലഘു പരീക്ഷണം കൊണ്ട് തെളിയിക്കാനാവുന്നതുമായ അനുമാനം (പരികല്പന) അടയാളപ്പെടുത്തുക.

2.5.A താഴെതന്നിരിക്കുന്നവയെല്ലാം യുക്തിസഹമായ പ്രസ്താവനകളാണ്. ഇവയിൽ ഏതാണ് ഒരു ലഘു പരീക്ഷണത്താൽ തെളിയിക്കാനാവുന്നത്.

1. ഒരു ഗ്ലാസ് സ്റ്റാമ്പിലൂടെ വ്യത്യസ്ത നിറങ്ങൾ കടത്തിവിട്ടാൽ ഏറ്റവും കൂടുതൽ വ്യതിയാനം സംഭവിക്കുന്നത് വയലറ്റ് നിറമുള്ള പ്രകാശരശ്മിക്കായിരിക്കും.
2. ഒരു ഗ്ലാസ് സ്റ്റാമ്പിലൂടെ വ്യത്യസ്ത ആവൃത്തിയുള്ള പ്രകാശരശ്മികൾ കടത്തിവിട്ടാൽ ഏറ്റവും കൂടുതൽ വ്യതിയാനം സംഭവിക്കുന്നത് ആവൃത്തി കൂടിയ പ്രകാശരശ്മിക്കായിരിക്കും.
3. ഒരു ഗ്ലാസ് സ്റ്റാമ്പിലൂടെ വ്യത്യസ്ത തരംഗദൈർഘ്യമുള്ള പ്രകാശരശ്മികൾ കടത്തിവിട്ടാൽ ഏറ്റവും കുറഞ്ഞ വ്യതിയാനം സംഭവിക്കുന്നത് തരംഗദൈർഘ്യം കൂടിയ പ്രകാശരശ്മിക്കായിരിക്കും.
4. ഒരു പ്രകാശരശ്മി ഗ്ലാസ് സ്റ്റാമ്പിലൂടെ സഞ്ചരിക്കുമ്പോൾ വേഗതക്ക് വ്യത്യാസം ഉണ്ടാവുന്നു.

2.5.B താഴെതന്നിരിക്കുന്ന പ്രസ്താവനകൾ എല്ലാം തന്നെ യുക്തിസഹമാണ് എന്നാൽ ഇതിൽ ഒരേണ്ണം മാത്രം ഒരു ലഘുപരീക്ഷണം നടത്തി തെളിയിക്കാൻ സാധ്യമല്ല. എളുപ്പത്തിൽ തെളിയിക്കാനാവാത്ത പ്രസ്താവന ഏതാണ് ?

1. ഒരു മീറ്റർ സ്കെയിലിന്റെ ഒരറ്റത്ത് ഭാരം കെട്ടിവെച്ചാൽ ഗുരുത്വകേന്ദ്രം ആ വശത്തേക്ക് സ്ഥാനം മാറുന്നു.
2. ഒരു തകടിന്റെ ആകൃതി മാറുന്നതിനനുസരിച്ച് ഗുരുത്വകേന്ദ്രത്തിന്റെ സ്ഥാനം മാറുന്നു.
3. വസ്തുക്കൾ ചൂടാക്കുമ്പോൾ ഗുരുത്വകേന്ദ്രത്തിന്റെ സ്ഥാനത്തിന് വ്യത്യാസം ഉണ്ടാകുന്നില്ല.
4. വസ്തുക്കളെ ചൂടാക്കുമ്പോൾ അതിൽ കമ്പനം ചെയ്യുന്ന തൻമാത്രകളുടെ എണ്ണത്തിന് വ്യതിയാനം സംഭവിക്കുന്നു.

2.5.C. കുട്ടികൾ മൈതാനത്തിൽ ഓടിക്കളിക്കുമ്പോൾ നല്ല വണ്ണമുള്ള ആളിന് വേഗം ഓട്ടം നിർത്താനും അതുപോലെ ഓടിക്കൂടാണെന്നും പ്രയാസം അനുഭവപ്പെടുന്നു. ഇതിന് കാരണം മനസ്സിലാക്കുന്നതിന് മാസും ജഡത്വവും തമ്മിൽ ബന്ധം ഉണ്ടോ എന്ന് കണ്ടുപിടിക്കേണ്ടതുണ്ട്. ഇതിന് താഴെപറയുന്നതിൽ ഏത് അനുമാനം ആണ് ഒരു ലഘുപരീക്ഷണം നടത്തി തെളിയിക്കാനാവുന്നത്?

1. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ മിനുസമുള്ള തറയിൽ കൂടി ഒരേ വേഗതയിൽ ഉരുട്ടി വിട്ടാൽ മാസ് കൂടുതലുള്ള ഗോളം കൂടുതൽ സമയം ഉരുളും.
2. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങളിൽ മാസ് കൂടിയതിന്റെ ഭൂഗുരുത്വകേന്ദ്രം മദ്ധ്യത്തിൽ ആയിരിക്കും.
3. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾ ശൂന്യാകാശത്തിൽ ഉരുട്ടി നോക്കിയാൽ മാസ് കൂടുതലുള്ള ഗോളം കൂടുതൽ സമയം ഉരുളും.
4. വ്യത്യസ്ത മാസുള്ള ഗോളങ്ങൾക്ക് പലായന പ്രവേഗം കൊടുത്താൽ എല്ലാ ഗോളങ്ങളും ശൂന്യാകാശത്ത് എത്തിച്ചേരും.

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ഒരു ശാസ്ത്ര പ്രക്രിയയെ സാധ്യമാക്കുന്ന ഘടകങ്ങൾ ഒന്നിലേറെ ഉണ്ടാവുമല്ലോ. നിർണ്ണായകമായ ഉത്തരം ഘടകങ്ങളുടെ സാധ്യത മനസ്സിലാക്കി ശരിയായ ഉത്തരം അടയാളപ്പെടുത്തുക.

**3.1.A** ഒരു ഹോസ്പിറ്റലിൽനിന്നും വെള്ളം പുറത്തേക്ക് വീഴുകയാണ്. ഇത് പ്രൊജക്ട് ചെയ്ത അതിന് ഉദാഹരണമാണല്ലോ. വെള്ളം പുറത്തേക്ക് തെറിക്കുന്ന കോണും വെള്ളം ചെന്നുവീഴുന്ന ദൂരവും തമ്മിൽ എന്തെങ്കിലും ബന്ധമുണ്ടോ എന്നറിയാൻ കോൺ മാറ്റി മാറ്റി നടത്തുന്ന പരീക്ഷണത്തിൽ സ്ഥിരമായി ഇരിക്കേണ്ട ഘടകമെന്താണ്?

1. വെള്ളം ചെന്നുവീഴുന്ന ദൂരം.
2. ഓരോ പരീക്ഷണത്തിനും എടുക്കുന്ന സമയം
3. വെള്ളത്തിന്റെ ഒഴുക്കിന്റെ ശക്തി.
4. പതനകോൺ

**3.1.B** വസ്തുവിന്റെ ഭാരവും ഘർഷണബലവും തമ്മിലുള്ള ബന്ധം മനസ്സിലാക്കാൻ വ്യത്യസ്തഭാരമുള്ള വസ്തുക്കൾ റബ്ബർ പ്രതലത്തിലൂടെ ഒരു സ്പ്രിംഗ് ബാലൻസ് ഉപയോഗിച്ച് നിശ്ചിത വേഗത്തിൽ വലിക്കുകയാണ്. പരീക്ഷണ വസ്തുക്കളുടെ എല്ലാം പ്രതലവിസ്തീർണ്ണം ഒന്നുതന്നെയാണ്. ഈ പരീക്ഷണങ്ങളിൽ സ്ഥിരമായി നാം നിലനിർത്തുന്ന ഘടകങ്ങൾ ഏതൊക്കെയാണ്?

1. വസ്തുവിന്റെ ഭാരം, ഘർഷണബലം, പരീക്ഷണത്തിന്റെ സമയം.
2. പരീക്ഷണം നടത്തുന്ന പ്രതലം, വസ്തുനിരക്കുന്ന വേഗത, വസ്തുവിന്റെ ആകൃതി.
3. പരീക്ഷണം നടത്തുന്ന പ്രതലം, വസ്തുവിന്റെ പ്രതല വിസ്തീർണ്ണം, വസ്തുനിരക്കുന്ന വേഗത.
4. വസ്തുവിന്റെ ഭാരം, വസ്തുവിന്റെ പ്രതലവിസ്തീർണ്ണം, വസ്തുനിരക്കുന്ന വേഗത.

**3.1.C** വ്യത്യസ്ത ഭാരമുള്ള വസ്തുക്കൾ ഉയരത്തിൽ നിന്ന് താഴേക്ക് പതിക്കുമ്പോൾ എടുക്കുന്ന വീഴ്ചയുടെ സമയം വ്യത്യസ്തമായിരിക്കുമോ എന്ന് പഠിക്കുവാൻ ചന്ദ്രനിലെ ഉപരിതലത്തിൽ വച്ച് വ്യത്യസ്ത ഭാരമുള്ള വസ്തുക്കൾ താഴേക്ക് വീഴാൻ അനുവദിച്ചു. ഈ പരീക്ഷണത്തിൽ എല്ലായ്പ്പോഴും താരണം സ്ഥിരമാണല്ലോ. അതുപോലെ വായുവിന്റെ പ്രതിരോധവുമില്ല. വസ്തുവിന്റെ ഭാരവും വീഴ്ചയ്ക്ക് എടുക്കുന്ന സമയവും തമ്മിലുള്ള ബന്ധം ശരിയായി കണ്ടെത്തണമെങ്കിൽ ഇനി ഏത് ഘടകമാണ് സ്ഥിരമാക്കി നിയന്ത്രിച്ച് നിർത്തേണ്ടത്?

1. വസ്തുവിന്റെ പ്രതലവിസ്തീർണ്ണം
2. വസ്തുവിന്റെ ഗോളാകൃതി
3. വസ്തുവിന്റെ സാന്ദ്രത
4. വീഴ്ചയുടെ ഉയരം

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താഴെ കൊടുത്തിരിക്കുന്ന സന്ദർഭങ്ങൾ സങ്കല്പിച്ച് ഉണ്ടാക്കേണ്ടവയാണ്. നമുക്കറിയാവുന്ന ശാസ്ത്ര സത്യങ്ങളുടേയും തത്വങ്ങളുടേയും വെളിച്ചത്തിൽ ശരിയെന്ന് നമുക്ക് ഉറപ്പിക്കാവുന്ന ഉത്തരം നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക.

3.2.A. നാം കാണുന്ന മഴവില്ലിന് ഒരു ചാപത്തിന്റെ ആകൃതിയാണുള്ളത്. മഴവില്ലിന്റെ താഴത്തെ ഭാഗം ചക്രവാള സീമ മറയ്ക്കുന്നു. വളരെ ഉയരത്തിൽ വിമാനത്തിൽ പറക്കുന്നു ഒരു നിരീക്ഷകൻ എന്തായിരിക്കും കാണുക?

1. മഴവില്ലിന് എന്ന് വൃത്തത്തിന്റെ താഴെയുള്ള ഭാഗം.
2. വൃത്യസ്ത നിറങ്ങളുള്ള മറ്റൊരു മഴവില്ലിന്.
3. നിറമില്ലാത്ത മഴവില്ലിന് കാണാം.
4. മുകളിലേക്ക് ഉയരുന്നതിനനുസരിച്ച് കൂടുതൽ മഴവില്ലുകൾ ഒന്നിനു താഴെ ഒന്നായി കാണാം.

3.2.B. വിമാനങ്ങളുടെ ആകൃതി ധാരാരേഖിതമാക്കിയിരിക്കുന്നു. വായുവിലൂടെ പറക്കുമ്പോൾ ഘർഷണം കുറയ്ക്കാനുവശം മുൻവശം കുർപ്പിച്ചിരിക്കുന്നു. ബഹിരാകാശത്തുകൂടി മാത്രം സഞ്ചരിക്കുവാനുള്ള ഒരു വാഹനം നിർമ്മിച്ചു എന്നിരിക്കട്ടെ. എന്നാൽ ഈ വാഹനത്തിന്

1. മുന്നറ്റവും പിന്നറ്റവും കുർപ്പിക്കേണ്ടിയിരിക്കുന്നു.
2. മുന്നറ്റം മാത്രം കുർപ്പിച്ചാൽ മതിയാവും
3. ഗോളാകൃതിയായിരിക്കും
4. ധാരാരേഖിതമാക്കേണ്ട ആവശ്യമില്ല.

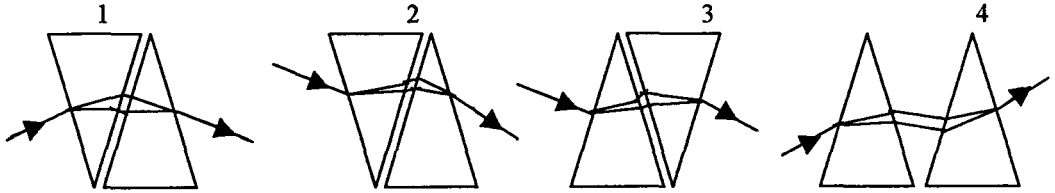
3.2.C. ഭൂമിയുടെ അടിയിലേക്ക് പോകുന്നോറും വസ്തുവിന്റെ ഭാരം കുറയുകയാണ് ചെയ്യുന്നത് എന്ന് നിങ്ങൾക്ക് അറിയാമല്ലോ. ഭൂമിയുടെ ഒരറ്റത്തുനിന്നും ഒരു കൂഴി കുഴിച്ച് ഭൂകേന്ദ്രത്തിലൂടെ മറുവശത്ത് എത്തി എന്ന് സങ്കല്പിക്കുക. ഈ തുരങ്കത്തിലൂടെ ഒരു വസ്തു ഭൂമിയുടെ ഒരു വശത്തു നിന്നും ഭൂകേന്ദ്രത്തിലൂടെ മറുവശത്തേക്ക് കൊണ്ടുപോവുകയാണ്. വസ്തുവിന്റെ ഭാരം എങ്ങനെ വ്യത്യാസപ്പെടും?

1. ആദ്യം കുറയുന്നു, പിന്നീട് പുഷ്യമാവുന്നു, വീണ്ടും കുറയുന്നു.
2. ആദ്യം കൂടുന്നു, പിന്നീട് പുഷ്യമാവുന്നു, പിന്നീട് കുറയുന്നു.
3. ആദ്യം കുറയുന്നു, പിന്നീട് പുഷ്യമാവുന്നു, പിന്നീട് കൂടുന്നു.
4. ആദ്യം കൂടുന്നു. പിന്നെ കുറയുന്നു, പിന്നെ പുഷ്യമായി തുടരുന്നു.

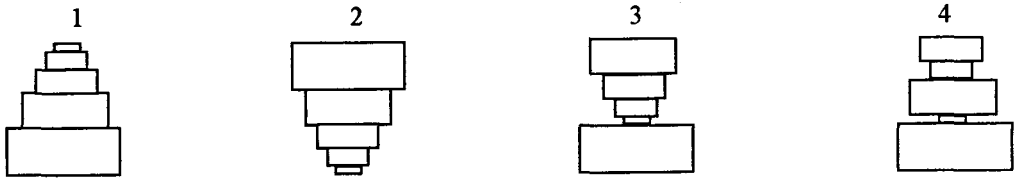
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ഓരോ ചോദ്യത്തിലും തന്നിരിക്കുന്ന ചിത്രങ്ങളെ അപഗ്രഥിച്ച് ചോദ്യത്തിനുള്ള ഉത്തരങ്ങൾ അടയാളപ്പെടുത്തുക.

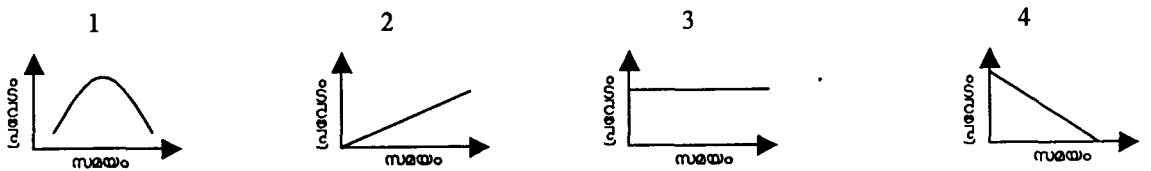
3.3.A താഴെക്കൊടുത്തിരിക്കുന്ന ചിത്രങ്ങളിൽ പ്രിസം ഉപയോഗിച്ചുള്ള പ്രകാശ പ്രതിഭാസങ്ങളാണ് കാണിച്ചിരിക്കുന്നത്. ഇതിൽ ഒരു ചിത്രം മാത്രം ശരിയാണ്. അത് ഏതാണ്? (അപവർത്തന രശ്മി പ്രിസത്തിന്റെ പാദത്തിന്റെ വശത്തേക്ക് വളയുന്നു എന്ന് ഓർക്കുക)



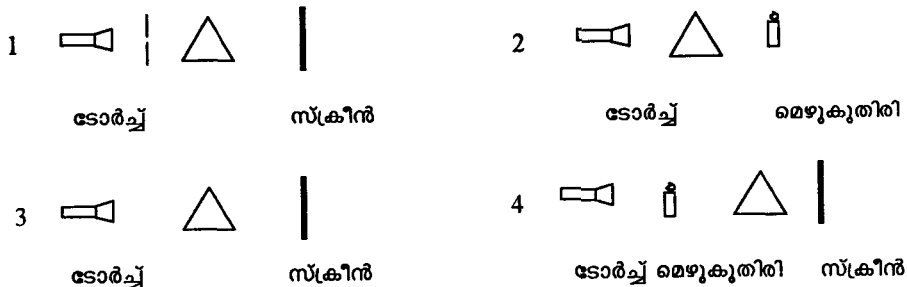
3.3.B താഴെക്കൊടുത്തിരിക്കുന്ന ചിത്രങ്ങളിൽ വ്യത്യസ്ത വലിപ്പമുള്ള ചതുരക്കട്ടകൾ ഒന്നിനുമുകളിൽ ഒന്നായി അടുക്കിയിരിക്കുന്ന ക്രമീകരണങ്ങളാണ് കാണിച്ചിരിക്കുന്നത്. തന്നിരിക്കുന്ന ക്രമീകരണങ്ങളിൽ ഏതീനാണ് കൂടുതൽ സ്ഥിരത?



3.3.C താഴെക്കൊടുത്തിരിക്കുന്ന ഗ്രാഫുകളിൽ ഏതാണ് സമചലനം സൂചിപ്പിക്കുന്നത്.



3.3.D ഒരു ടോർച്ചിൽ നിന്നുള്ള പ്രകാശത്തിന്റെ പ്രകീർണനം മനസ്സിലാക്കാൻ താഴെകാണിച്ചിരിക്കുന്നതിൽ ഏത് ക്രമീകരണമാണ് ഏറ്റവും അനുയോജ്യം.



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താഴെകൊടുത്തിരിക്കുന്ന ഓരോ ചോദ്യത്തിലും ഒരു ശാസ്ത്ര പ്രസ്താവന കൊടുത്തിട്ടുണ്ട്. ഈ പ്രസ്താവന ശരിയാണോ എന്ന് പരിശോധിച്ചറിയാൻ ഏറ്റവും അനുയോജ്യമായ പരീക്ഷണക്രമം തിരഞ്ഞെടുത്ത് നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക

3.4.A ഒരു വസ്തുവിന് മറ്റൊന്നിലേക്കിലും ഒരു ആഘാതം ഉണ്ടാക്കാനുള്ള കഴിവ് അതിന്റെ പ്രവേഗത്തിനനുസരിച്ച് കൂടുന്നു. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെപ്പറയുന്നതിൽ ഏത് പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

1. വ്യത്യസ്ത പിണ്ഡമുള്ള ഇരുമ്പു ഗോളങ്ങൾ ഒരു മൺകുന്നമേൽ വീഴ്ത്തി അങ്ങനെ ഉണ്ടാവുന്ന കുഴിയുടെ താഴ്ച അളക്കുന്നത്.
2. പ്രവേഗത്തിന്റേയും പിണ്ഡത്തിന്റേയും ഗ്രാഫ് വരയ്ക്കുന്നത്.
3. ഒരു ഇരുമ്പു ഗോളം വ്യത്യസ്ത ഉയരങ്ങളിൽ നിന്ന് ഒരു മൺകുന്നമേൽ വീഴ്ത്തി അങ്ങനെ ഉണ്ടാവുന്ന കുഴിയുടെ താഴ്ച അളക്കുന്നത്.
4. വ്യത്യസ്ത പിണ്ഡമുള്ള ഇരുമ്പു ഗോളങ്ങൾ ഒരു കൽഭിത്തിമേൽ എറിഞ്ഞ് ഗോളം തെറിച്ച് വീഴുന്ന ദൂരം അളക്കുന്നത്.

3.4.B ഘർഷണബലം വസ്തുവിന്റെ ഭാരത്തെ ആശ്രയിച്ചിരിക്കുന്നു. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെപറയുന്നതിൽ ഏത് പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

1. ഒരു കിലോ ഭാരമുള്ള ഒരു വസ്തു സ്പ്രിംഗ് ബാലൻസിനോട് ബന്ധിച്ച ശേഷം വ്യത്യസ്ത പ്രതലങ്ങളിലൂടെ നിരക്കി വലിക്കുകയും റീഡിംഗുകൾ കുറിച്ചെടുക്കുകയും ചെയ്യുന്നത്.
2. വ്യത്യസ്ത ഭാരമുള്ള വസ്തുക്കൾ മേശമേൽ നിരക്കി വലിക്കുകയും അവയോരോന്നും വലിക്കുമ്പോൾ ബന്ധിച്ചിരിക്കുന്ന സ്പ്രിംഗ് ബാലൻസിലെ റീഡിംഗുകൾ കുറിച്ചെടുക്കുകയും ചെയ്യുന്നത്.
3. ഒരേ ഭാരമുള്ള വ്യത്യസ്ത വസ്തുക്കൾ ഒരു റബ്ബർ ഷീറ്റിനു മുകളിലൂടെ നിരക്കി വലിക്കുകയും അവയോരോന്നും വലിക്കുമ്പോൾ ബന്ധിച്ചിരിക്കുന്ന സ്പ്രിംഗ് ബാലൻസിലെ റീഡിംഗുകൾ കുറിച്ചെടുക്കുകയും ചെയ്യുന്നത്.
4. ഒരു കിലോ ഭാരമുള്ള വസ്തു നിരങ്ങുമ്പോഴും, ഉരുളുമ്പോഴുമുള്ള ഘർഷണബലം സ്പ്രിംഗ് ബാലൻസ് ഉപയോഗിച്ച് കണ്ടുപിടിക്കുന്നത്.

3.4.C ഒരു ടി.വി.യുടെ റിമോട്ട് കൺട്രോളിൽനിന്നും പുറപ്പെട്ട ടി.വി. സെറ്റിൽ വീഴുന്ന ഏതോ ചില കിരണങ്ങൾ മുഖേനയാണ് ടി.വി. നിയന്ത്രിക്കപ്പെടുന്നത്. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെപറയുന്നതിൽ ഏത് പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം?

1. റിമോട്ട് കൺട്രോളിലെ ബാറ്ററി ഊരിയും ഇട്ടും റിമോട്ട് പ്രവർത്തിപ്പിച്ചു നോക്കുന്നത്.
2. ടി.വി.സെറ്റിന്റെ പവർസപ്ലൈ ഓണാക്കുകയും ഓഫാക്കുകയും ചെയ്ത് റിമോട്ട് പ്രവർത്തിപ്പിച്ചു നോക്കുന്നത്.
3. റിമോട്ട് കൺട്രോളിന്റെ പുറം കവർ തുറന്ന ഉൾഭാഗം നിരീക്ഷിച്ച് ചിത്രം വരയ്ക്കുന്നു.
4. റിമോട്ട് കൺട്രോളിനും ടി.വി. സെറ്റിനും ഇടയിൽ കട്ടികൂടിയ ഒരു സ്ക്രീൻ വെച്ചിട്ട് റിമോട്ട് പ്രവർത്തിപ്പിച്ചു നോക്കുന്നത്.

3.4.D ഒരു നിശ്ചിത ആദ്യപ്രവേഗമുള്ള ഒരു ഷോട്ട് 45° കോണിൽ എറിഞ്ഞാലാണ് ഏറ്റവും ദൂരത്തേക്ക് പോവുക. ഈ പ്രസ്താവന ശരിയാണോ എന്നറിയാൻ താഴെ പറയുന്നതിൽ ഏത് പരീക്ഷണക്രമമാണ് കൂടുതൽ അനുയോജ്യം.

1. വ്യത്യസ്ത അത്ഭുക്കൾ ഷോട്ട് പൂട്ട് എറിയുന്നത് കണ്ട് മനസ്സിലാക്കുന്നത്.
2. വ്യത്യസ്ത കോണുകളിൽ ഷോട്ട് സ്വയം എറിഞ്ഞുനോക്കുന്നത്.
3. വ്യത്യസ്ത ദിശകളിൽ ഷോട്ട് സ്വയം എറിഞ്ഞുനോക്കുന്നത്.
4. വ്യത്യസ്ത പ്രവേഗത്തോടെ ഷോട്ട് എറിഞ്ഞാൽ പരമാവധി റേഞ്ച് സമവാക്യം ഉപയോഗിച്ച് കണക്കാക്കുന്നത്.

### PART - 13

പരീക്ഷണം ചെയ്തപ്പോൾ കണ്ടെത്തിയ വിവരങ്ങളാണ് താഴെയുള്ള ഓരോ ചോദ്യങ്ങളിലും കൊടുത്തിരിക്കുന്നത്. ഈ വിവരങ്ങൾ ഉപയോഗിച്ച് ശരിയായ അനുമാനം കണ്ടെത്തി അതിന്റെ നമ്പറിനു ചുറ്റും വട്ടം വരച്ച് അടയാളപ്പെടുത്തുക

**3.5.A** ഒരു കളർ ഫിൽട്ടറിൽ കൂടി നീലപ്പുറവിനെ നോക്കിയപ്പോൾ നീലയായി തന്നെ കണ്ടു. ഒരു ചുവന്ന പൂവ് കറുപ്പായും വെള്ളപ്പൂവ് നീലയായും കണ്ടു. തന്നിരിക്കുന്ന വിവരങ്ങളിൽ നിന്നും കളർഫിൽട്ടറിന്റെ നിറം എന്താണെന്ന് അനുമാനിക്കുക.

1. കറുപ്പ്
2. നീല
3. ചുവപ്പ്
4. നിറമില്ല.

**3.5.B** ഒരു ചലിക്കുന്ന വസ്തുവിന്റെ പ്രവേഗം സമയത്തോടൊപ്പം താഴെയുള്ള ചാർട്ടിൽ കൊടുത്തിരിക്കുന്നു. ഇവിടെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരി?

പ്രവേഗം (m/s)	40	40	38	36	34	36	38	40	40
സമയ ഇടവേള (സെക്കന്റ്)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9

1. 0 - 1 സെക്കണ്ട് എന്ന ഇടവേളയിൽ വസ്തുവിന് താരണം ഉണ്ടായി.
2. 0 - 2 സെക്കണ്ട് എന്ന ഇടവേളയിൽ വസ്തുവിന് താരണം ഉണ്ടായി.
3. 5 - 8 സെക്കണ്ട് എന്ന ഇടവേളയിൽ വസ്തുവിന് താരണം ഉണ്ടായി.
4. 7 - 9 സെക്കണ്ട് എന്ന ഇടവേളയിൽ വസ്തുവിന് താരണം ഉണ്ടായി.

**3.5.C** ഒരു ചെറിയ ഇരുമ്പു ഗോളം ഒരു നിശ്ചിത ഉയരത്തിൽ നിന്ന് വീഴുന്നതിനോട് അനുബന്ധിച്ച് അതിന്റെ ചലനത്തെ സംബന്ധിച്ച ചില വിവരങ്ങളാണ് ഇവിടെ കൊടുത്തിരിക്കുന്നത്. ഈ വിവരങ്ങൾ കണക്കിലെടുത്ത് താഴെ തന്നിരിക്കുന്ന അനുമാനങ്ങളിൽ ഏതാണ് ശരിയെന്ന് കണ്ടെത്തുക.

സമയം (സെക്കന്റ്)	0	1	2	3	4
പ്രവേഗം (m/s)	0	9.8	19.6	29.4	39.2

1. പ്രവേഗം ഓരോ സെക്കണ്ടിലും വർദ്ധിക്കുന്നു.
2. പിണ്ഡം ഓരോ സെക്കണ്ടിലും വർദ്ധിക്കുന്നു.
3. ഓരോ സെക്കണ്ടിലേയും സ്ഥാനാന്തരം തുല്യമാണ്.
4. പ്രവേഗം, പിണ്ഡം, സ്ഥാനാന്തരം എന്നിവ ക്രമേണ കൂടി വരുന്നു.

**3.5.D** നാലു കൃത്രിമ ഉപഗ്രഹങ്ങളുടെ ഓർബിറ്റൽ പ്രവേഗങ്ങളാണ് താഴെ ചാർട്ടിൽ കൊടുത്തിരിക്കുന്നത്. തന്നിരിക്കുന്ന വിവരങ്ങളെ അടിസ്ഥാനമാക്കി ശരിയായ അനുമാനം ഏതെന്ന് കണ്ടെത്തുക.

ഉപഗ്രഹം	A	B	C	D
ഓർബിറ്റൽ പ്രവേഗം (km/s)	3.0	8.6	9.2	12.0

1. A യും B യും ഭൂമിയിലേക്ക് പതിക്കും.
2. D എന്ന ഉപഗ്രഹം ആകർഷണ വലയം ഭേദിച്ചു പുറത്തു പോവും.
3. A യും B യും C യും ഉപഗ്രഹങ്ങൾ ഭൂമിയിലേക്ക് വീണുപോകും.
4. C യും D യും ഉപഗ്രഹങ്ങൾ ഭൂമിയുടെ ആകർഷണ വലയം ഭേദിച്ച് പുറത്തു പോകും.

**3.5.E** ഒരു ഊർജ്ജതന്ത്ര ശാസ്ത്രജ്ഞൻ 1 കിഗ്രാം മാസുള്ള വസ്തു വ്യത്യസ്ത സ്ഥലങ്ങളിൽ വച്ച് സ്പ്രിംഗ് ത്രാസ് ഉപയോഗിച്ചും സാധാരണ ത്രാസ് ഉപയോഗിച്ചും തൂക്കി നോക്കി. ഇങ്ങനെ കിട്ടിയ തൂക്കങ്ങളാണ് ചുവടെ കൊടുത്തിരിക്കുന്നത്.

	സ്ഥലം A	സ്ഥലം B	സ്ഥലം C
സ്പ്രിംഗ് ത്രാസ് കാണിച്ച തൂക്കം	1 Kgt	1.01 Kgt	0.99 Kgt
സാധാരണ ത്രാസ് കാണിച്ച തൂക്കം	1 Kgt	1 Kgt	1 Kgt

1. ഈ മൂന്നു സ്ഥലങ്ങളും പരീഗണിക്കുമ്പോൾ പൊതുവായ എന്ത് നിഗമനത്തിലെത്താം.
2. സ്പ്രിംഗ് ത്രാസ് ഒരേ സ്ഥലത്ത് തന്നെ ഒരു വസ്തുവിന് വ്യത്യസ്ത തൂക്കങ്ങൾ കാണിക്കുന്നു.
3. സാധാരണ ത്രാസ് ഒരേ സ്ഥലത്ത് തന്നെ ഒരു വസ്തുവിന് വ്യത്യസ്ത തൂക്കങ്ങൾ കാണിക്കുന്നു.
4. സ്പ്രിംഗ് ത്രാസ് ഒരേ വസ്തുവിന് വ്യത്യസ്ത സ്ഥലങ്ങളിൽ വ്യത്യസ്ത തൂക്കങ്ങൾ കാണിക്കുന്നു.
5. സാധാരണ ത്രാസ് ഒരേ വസ്തുവിന് വ്യത്യസ്ത സ്ഥലങ്ങളിൽ വ്യത്യസ്ത തൂക്കങ്ങൾ കാണിക്കുന്നു.

PART - 14

ഒന്നിലേറെ സമാനമായ സന്ദർഭങ്ങൾ താഴെയുള്ള ഓരോ ചോദ്യത്തിലും ഉണ്ട്. ഈ സന്ദർഭങ്ങളെ ശ്രദ്ധയോടെ മനസ്സിലാക്കി ശരിയായ പൊതു തത്വത്തിൽ എത്തിച്ചേരുക.

**3.6.A** മേശയിൽ വച്ചിരിക്കുന്ന ഭാരം ഒരു സ്പ്രിംഗ് ബാലൻസ് ഉപയോഗിച്ച് കൊളുത്തിവെച്ചപ്പോൾ റീഡിംഗ് ആദ്യം കൂടിയെങ്കിലും വസ്തു നിരത്തിത്തുടങ്ങിയപ്പോൾ റീഡിംഗ് കുറയുകയും സ്ഥിരമായി നിൽക്കുകയും ചെയ്തു.

രാമു ഉന്തുവണ്ടിയിൽ ഭാരം കയറ്റി തള്ളാൻ ശ്രമിച്ചപ്പോൾ വണ്ടി നീങ്ങിത്തുടങ്ങുന്നതിന് വളരെയധികം ബലം പ്രയോഗിക്കേണ്ടിവന്നു. എന്നാൽ വണ്ടി നീങ്ങിത്തുടങ്ങിയപ്പോൾ ആദ്യം പ്രയോഗിച്ച ബലത്തേക്കാൾ കുറച്ചു മതിയാകും എന്നുകണ്ടു.

ഭ്രബക്ഡൗൺ ആയ വണ്ടി റോഡിൽ നിന്ന് തള്ളി വശത്തേക്ക് മാറ്റിയിടാൻ യാത്രക്കാർ ശ്രമിക്കുകയായിരുന്നു. തുടക്കത്തിൽ വണ്ടി നീങ്ങിത്തുടങ്ങാൻ കൂടുതൽ യാത്രക്കാർ തള്ളേണ്ടിവന്നുവെങ്കിലും പിന്നീട് കുറച്ചു പേർ മാത്രം ചേർന്ന് വണ്ടി തള്ളി റോഡിന്റെ സൈഡിലേക്ക് മാറ്റി.

ഈ സന്ദർഭങ്ങളിൽ നിന്ന് ഘർഷണബലത്തെ പറ്റി എന്തു പൊതു തത്വത്തിലെത്താം.

1. വസ്തു നീങ്ങിത്തുടങ്ങുന്നതിനു മുമ്പ് ഘർഷണ ബലം കുറവായിരുന്നു.
2. വസ്തു നീങ്ങിത്തുടങ്ങുന്നതിനു മുമ്പ് ഘർഷണ ബലം പരമാവധി ആണെങ്കിലും നീങ്ങിത്തുടങ്ങുമ്പോൾ ഘർഷണബലം കുറയുന്നു.
3. ഘർഷണബലത്തിലെ വ്യതിയാനങ്ങൾ നിത്യജീവിതത്തിൽ പല ബുദ്ധിമുട്ടുകളും ഉണ്ടാക്കുന്നു.
4. നിരങ്ങൾ ഘർഷണബലം ഉറുളൽ ഘർഷണബലത്തേക്കാൾ കൂടുതലാണ്.

**3.6.B** മഞ്ഞയും സയനും മജന്റയും നിറങ്ങൾ ദിതീയ വർണ്ണങ്ങൾ ആണല്ലോ. ഈ നിറങ്ങളിലുള്ള സുതാര്യ വസ്തുക്കൾ എത്രതാഴെ നിറങ്ങളെ കടത്തി വിടുന്നു എന്ന് ഒരു അദ്ധ്യാപകൻ പരീക്ഷണശാലയിൽ പരിശോധിക്കുകയായിരുന്നു.

മഞ്ഞനിറത്തിലുള്ള സുതാര്യ വസ്തു മഞ്ഞ, ചുവപ്പ് പച്ച എന്നീ നിറങ്ങൾ കടത്തിവിടുകയും മറ്റൊരു നിറങ്ങളെയും ആഗിരണം ചെയ്യുകയും ചെയ്യുന്നു എന്ന് കണ്ടെത്തി.

സയൻ നിറത്തിലുള്ള സുതാര്യ വസ്തു സയൻ, നീല, പച്ച എന്നീ നിറങ്ങൾ കടത്തിവിടുകയും മറ്റൊരു നിറങ്ങളിലേയും ആഗിരണം ചെയ്യുകയും ചെയ്യുന്നു എന്ന് കണ്ടെത്തി.

മജന്റ നിറത്തിലുള്ള സുതാര്യ വസ്തു മജന്റ, നീല, ചുവപ്പ് എന്നീ നിറങ്ങൾ കടത്തിവിടുകയും മറ്റൊരു നിറങ്ങളെയും ആഗിരണം ചെയ്യുകയും ചെയ്യുന്നു എന്ന് കണ്ടെത്തി.

ഈ സന്ദർഭങ്ങളിൽ നിന്നും ദിതീയ വർണ്ണത്തിലുള്ള സുതാര്യ വസ്തുവിന്റെ എന്തു പ്രത്യേകതയാണ് മനസ്സിലാവാൻ.

1. ദിതീയ വർണ്ണത്തിലുള്ള സുതാര്യ വസ്തു എല്ലാ പ്രാഥമിക വർണ്ണങ്ങളേയും കടത്തിവിടുന്നു.
2. ദിതീയ വർണ്ണത്തിലുള്ള സുതാര്യ വസ്തു എല്ലാ ദിതീയ വർണ്ണങ്ങളേയും കടത്തിവിടുന്നു.
3. ദിതീയ വർണ്ണത്തിലുള്ള സുതാര്യ വസ്തു അതേ വർണ്ണത്തേയും കൂടാതെ അതിന്റെ ഘടകവർണ്ണങ്ങളേയും കടത്തിവിടുന്നു.
4. ദിതീയ വർണ്ണത്തിലുള്ള സുതാര്യ വസ്തു അതേ വർണ്ണത്തേയും കൂടാതെ എല്ലാ പ്രാഥമിക വർണ്ണങ്ങളേയും കടത്തിവിടുന്നു.

**3.6.C** പുന്തോട്ടം നനച്ചു കൊണ്ടിരിക്കുന്ന കുട്ടി വെള്ളം വീഴുന്ന ഹോസ് പൈപ്പ് 45° കോണിൽ പകിച്ചപ്പോൾ വെള്ളം പരമാവധി ദൂരത്തേക്ക് വീഴുന്നത് കണ്ടു. 45° കോണിൽ കുട്ടുകയോ കുറയ്ക്കുകയോ ചെയ്താൽ വെള്ളം ചെന്നു വീഴുന്ന ദൂരം കുറയുന്നു.

ക്രിക്കറ്റ് ഗ്രൗണ്ടിൽ കുട്ടികൾ പന്ത് ദൂരേക്ക് എറിഞ്ഞു പരശീലിക്കുകയായിരുന്നു. പരമാവധി ദൂരേക്ക് പന്ത് എത്തിക്കുവാൻ എറിയുന്ന കോൺ 45° ആവണമെന്ന് അവർ മനസ്സിലാക്കി. കോണളവ് ഇതിൽ നിന്ന് കൂടുകയോ കുറയുകയോ ചെയ്താൽ പന്ത് ചെന്നു വീഴുന്ന ദൂരം കുറയുന്നു.

ജാവലിൻ എറിയുവാൻ പരിശീലിക്കുന്ന കുട്ടികൾ 45° കോണിൽ എറിഞ്ഞപ്പോൾ ജാവലിൻ പരമാവധി ദൂരത്തിൽ ചെന്നു വീണു. വിക്ഷേപണ കോൺ കുട്ടുകയോ കുറയ്ക്കുകയോ ചെയ്താൽ ജാവലിൻ കുറഞ്ഞ ദൂരം മാത്രമേ താണ്ടുകയുള്ളൂ.

ഈ സന്ദർഭങ്ങളിൽ നിന്ന് വിക്ഷേപണ കോണിനേപ്പറ്റി എന്തു പൊതു തത്വത്തിലെത്താം.

1. വിക്ഷേപണ കോൺ വർദ്ധിക്കുമ്പോൾ എറിയപ്പെടുന്ന വസ്തു ചെന്നു പതിക്കുന്ന ദൂരം വർദ്ധിക്കുന്നു.
2. വിക്ഷേപണ കോൺ വർദ്ധിക്കുമ്പോൾ എറിയപ്പെടുന്ന വസ്തു ചെന്നു പതിക്കുന്ന ദൂരം കുറയുന്നു.
3. വിക്ഷേപണ കോൺ 45° കൂടിയായാലും കുറഞ്ഞാലും എറിയപ്പെടുന്ന വസ്തു ചെന്നു പതിക്കുന്ന ദൂരം കൂടുന്നു.
4. വിക്ഷേപണ കോൺ 45° കൂടിയായാലും കുറഞ്ഞാലും എറിയപ്പെടുന്ന വസ്തു ചെന്നു പതിക്കുന്ന ദൂരം കുറയുന്നു.

**University of Calicut**

**Department of Adult and Continuing Education and Extension Services**

**PROBLEM SOLVING ABILITY TEST IN PHYSICS**

**(FINAL)**

**English version**

**Dr. Sivarajan, K. and Manoj Praveen, G.**

**This book let contains 14 sections (PART 1 TO PART 14) in 14 pages. Each section contains four or five questions that test your ability to solve conceptual problems in Physics. Read the instructions for each section carefully and choose the right answer by encircling the serial number of the relevant response on the question paper itself.**

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## PART – 1

Day to day life situations are described in the questions given below. With respect to each question, four facts are listed in the order 1,2,3,4. From them choose the event that appears most unnatural to you and mark it by encircling its number on the question paper itself.

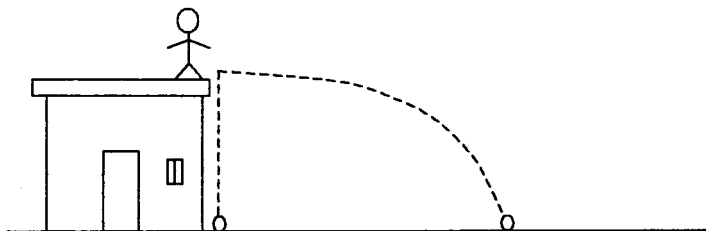
1.1.A A heavy box is placed on the floor. The following statements are situations, which occurred while pushing the box along the floor. Which among them makes you surprised?

1. When we push the box we feel difficulty.
2. The opposing force while we push decreases slightly while when the box starts moving.
3. Scratch marks are formed when the box started moving.
4. When pushing is stopped, the box that started moving comes into a stationary state.

1.1.B Given below are situations felt, when a bucket full of water is swirled along a vertical circle. Among these, which situation is seems different from what we expect normally?

1. A force is exerted on our hand.
2. Bucket moves in a circle.
3. When the speed of swirling is reduced, the bucket does not move in the circular path.
4. Water does not fall from the bucket as it is swirled vertically.

1.1.C Of the two identical balls, one is thrown off horizontally and the other is simply dropped down. See the figure below.



The two balls traveled different distances. Which fact given below regarding the movement of the balls makes you surprised?

1. The direction of movement is different for the two balls.
2. Both the balls experience Earth's gravitational pull.
3. Both the balls fall on ground simultaneously.
4. The velocity of fall increases gradually for both the balls.

1.1.D In a room, yellow light is produced with a sodium vapour lamp. In the next room, yellow light is produced by combining the primary colours red and green. When red, green and white buttons were inspected in these lights the following facts were observed. Of these which fact seems to be not natural to you?

1. In the room where red and green lights are mixed to produce yellow light, the red button appeared red and the green appeared green.
2. In the light of sodium vapour lamp, the red and green buttons appeared dark.
3. In the light of sodium vapour lamp, the white button appeared yellow.
4. In the room where composite yellow colour is present, white button appeared yellow.

**PART – 2**

**Day to day life situations are described in the questions given below. Each situation has a core problem involved in it. With respect to each question, four statements are listed in the order 1,2,3,4. From them choose the one that describes the problem most exactly and mark it by encircling its number on the question paper itself.**

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**1.2.A** On the eighth floor of a Hotel at 5'O Clock in the early morning, a room boy in black shirt was serving black coffee to a man by pouring it into a flask. For this, he added sugar with a silver spoon in to a big vessel full of black coffee and stirred well in round. Before the movements of the coffee settled down in the vessel, he tried to pour it into the flask. Even though it was poured carefully, with the vessel brought close to the flask, the coffee spilled over in the direction of the circular motion. Which statement given below exactly describes the problem felt here?

1. The coffee, which was in circular motion spilled over in the direction of the motion while pouring in to another vessel.
2. The room boy at the eighth floor stirred the black coffee with a silver spoon in round.
3. The man in black shirt poured coffee into the flask before the movements of the coffee settled down.
4. Even though it was poured carefully, in to the narrow mouthed flask, the coffee spilled over.

**1.2.B** A lorry driver was carefully driving his vehicle through a road in the high range in the night. There was thick fog in the atmosphere. It was difficult to see far. The driver switched on two more white lights (additional lamps) other than the headlights. But it did not help to see far; rather, the fog appeared more illuminated. To see far through the fog is really a difficult task. Which of the following statements given below does exactly describe the problem here?

1. To drive through a high range road in the night is very difficult.
2. White light just illuminates the fog and does not help seeing far.
3. Tiny water droplets condense and remain suspended in the atmosphere making it very difficult to see through the fog..
4. The additional white lights do not help to see through the fog.

**1.2.C** A group from India went to study Antarctica in the polar region. One person in the group bought a gold chain weighing 24 gram from another group member paying its price. When the person reached home and weighed the chain again, it weighed less. It is definite that no gold was either added or taken from the chain. Which statement given below exactly describes the problem felt here?

1. The weight of the chain was observed to be 24 gram at a region of low temperature.
2. The person who bought the chain suffered loss.
3. Since gold is a precious metal, even slight differences in weight causes large profit and loss.
4. The gold chain with a definite mass showed different weights at different places on Earth.

## PART – 3

Day to day life situations are described in the questions given below. Each situation has a scientific problem involved in it. You have to find out the major factors of this problem. Choose the correct group of major factors in the problem and mark it by encircling its number on the question paper itself.

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**1.3.A** Ramu was watering the plants in his garden with a hose in front of his home at night. Since the length of the hose was a bit short of the required length he squeezed at the bore of the hose so as to force a jet of water gush up to the far end. Further he held the hose at different angles. Ramu was trying to make the distance of fall of water (range) to a maximum. Which group given below represents the main factors in this situation?

1. angle, maximum range, absence of light
2. range, water, hose
3. force of flow of water, angle, maximum range
4. night, maximum, hose

**1.3.B** Small children were playing with heavy bricks to build a house in the ground. They will pile up the bricks one over another on a wooden plank. Then they will tie the plank with a string and pull along the sand. Thus they brought the bricks sliding on to the playground. This was really very difficult as friction prevented motion. Which group given below represents the main factors in this situation?

1. sliding, friction, weight
2. motion, wooden plank, effort
3. sliding, brick, string
4. children, brick, rolling

**1.3.C** A girl was riding a swing. Her sister came from behind and pushed the swing to increased height. When the girl swung from the height downwards, she felt her weight reduced. We know that the weight of the girl will be used to produce the required downward acceleration. In this situation which group given below represents the main factors associated with the weightlessness experienced by the girl?

1. weightlessness, mass, push, swing
2. swing, push, weightlessness, velocity
3. weightlessness, downward movement, mass, swing
4. increased height, downward movement, acceleration, weightlessness

**1.3.D** Father and son were traveling from village to city on a train. The son noticed that the sky in the city is different from the clear blue sky of the village. City is filled with dust and smoke and the sky is gray in colour. We know that the sky usually appear blue. The son asked why the sky appeared gray in the city and the father answered that the bigger particles of smoke and dust scattered all colours at the same rate. Which group given below represents the main factors causing the colour change of the sky in the city?

1. atmosphere, sky, dust, train
2. smoke, sky, blue-colour, gray-colour
3. Bigger particles, different colours, rate of scattering, gray-colour
4. dust, smoke, gray-colour, train

**PART – 4**

**In the situations given below a pair of most relevant and closely related concepts is involved. You have to find out the major factors of this problem. Carefully read the situations and find out the most relevant and closely related pair of concepts pertinent to this situation. and mark it by encircling its number on the question paper itself.**

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**2.1.A** Two friends a and B went into the forest. When B was resting under a mango tree, A went in search of water. But he lost his way on return. A wandered for kilometers in several directions in search of B. But he was never far from B for more than a hundred metres. Which is the most relevant and closely related pair of concepts pertinent to this situation?

1. Velocity and acceleration
2. Distance and displacement
3. Velocity and displacement
4. Kilometer and metre

**2.1.B** A heavy box was being dragged along a floor. At first 50N force was applied. The box did not move. Further 60, 70, 80, 90, 100N was applied. Still the box did not move. But when 101N was applied, the box started moving. It was the excess 1N applied which made the box move. Which is the most relevant and closely related pair of concepts pertinent to this situation?

1. Force and Impulse
2. Push and Pull
3. Friction and Lubrication
4. Static Friction and Limiting Friction

**2.1.C** A circular disc is divided into three section to which red, blue and green colours are applied. When this is rotated fast, the different colours disappear and the disc appears white in colour. Which is the most relevant and closely related pair of concepts pertinent to this situation?

1. Dispersion of Light and Persistence of Vision.
2. Primary Colour and Secondary Colour.
3. Combination of Colours and Persistence of vision.
4. Shape of the disc and Recombination of Colours.

## PART – 5

A scientific phenomenon is presented in each question. Find out the situation, which is most similar to the given phenomenon, and mark it by encircling its number on the question paper itself.

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**2.2.A** Friction between two surfaces is caused by the irregular ups and downs on the surface. When a body is dragged over another these microscopic ups and downs mutually get locked and a force is produced in the opposite direction of movement. This force is the frictional force. Which of the situations given below is similar to this phenomenon?

1. The rough surfaces of two sand papers rubbed each other.
2. A pad lock is opened and locked using its key.
3. Two knives are rubbed mutually and vertically.
4. Two hooks are mutually hooked in and pulled

**2.2.B** When a light ray enters one medium slanting from another it deviates. Which of the situations given below is similar to this phenomenon?

1. When a ship enters from a river into a sea it gets raised a little.
2. When a cycle enters slanting from a tarred road into a sand bed, its direction of motion changes.
3. When strong wind blows against a flying bird, the bird flies on to increased heights.
4. Water which flows through a tube flow faster at regions where the tube gets narrower.

**2.2.C** Acceleration is the velocity-change in one second. When the change in velocity is equal in equal intervals of time, the acceleration is said to be uniform. Which of the situations given below is similar to the concept of uniform acceleration?

1. A person eats one biscuit every minute.
2. A person eats biscuit in the order, 1 in the first minute, 2 in the second minute, 4 in the third minute, 8 in the fourth minute etc.
3. A person eats biscuit in the order, 1 in the first minute, 2 in the second minute, 3 in the third minute, 4 in the fourth minute etc.
4. A person eats biscuit in the order, 1 in the first minute, 3 in the second minute, 9 in the third minute, 27 in the fourth minute etc.

**2.2.D** The gravitational force between two objects decreases as the distance between them increases. Which of the situations given below is similar to this phenomenon?

1. The attraction between two magnets decrease as the distance between them increases.
2. The repulsion between two magnets decrease as the distance between them increases.
3. The frictional force between two surfaces decrease when a lubricant is used.
4. The frictional force between two surfaces increases as the temperature is increased..

**PART – 6**

Each of the questions given below contains a set of scientifically proven statements. Choose the inference that can be reached upon on the basis of these statements alone and mark it by encircling its number on the question paper itself.

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**2.3.A** Read the three sentences in this paragraph. (i) Earth attracts all objects, which are near to the Earth towards its centre. (ii) Earth attracts all objects below the surface of Earth towards its centre. (iii) Earth attracts all objects above the surface of Earth towards its centre. On the basis of the above statements what inference can we make?

1. Earth attracts all objects towards its centre.
2. Earth attracts almost all objects towards its centre.
3. All objects attract Earth towards them.
4. Earth attracts objects that are away from Earth towards its centre.

**2.3.B** The component colours of visible light are violet, indigo, blue, green, yellow, orange and red. Now read the three sentences in the following paragraph.

(i) Fluorescent substance A absorbed violet light and emitted blue light (ii) Fluorescent substance B absorbed indigo light and emitted blue light. (iii) Fluorescent substance C absorbed green light and emitted red light. On the basis of the above statements what inference can we make?

1. Fluorescent substances absorb violet light and emit blue light.
2. Fluorescent substances absorb light of lower wavelength and emit light of greater wavelength.
3. Fluorescent substances absorb any light and emit any light.
4. Fluorescent substances absorb light of lower frequency and emit light of greater frequency.

**2.3.C** Read the three sentences in this paragraph. (i) When a pistol is fired, the bullet moves forward and the pistol recoils backward. (ii) When a child jumps on to shore from a boat, the boat moves towards the side of the river. (iii) When a jet plane ejects gas and smoke towards east, the plain moves towards west. On the basis of the above statements what inference can we make?

1. For an action there will be an equal reaction.
2. For an action there will be a reaction in the opposite direction.
3. For an action there will be a reaction.
4. To every action, a direction is associated with.

**PART – 7**

Each situation presented below has a scientific problem involved in it. Comprehend the situation and find out the statement that gives a logical explanation to the problem and mark it by encircling its number on the question paper itself.

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**2.4.A** An athlete instead of throwing the javelin from the place where he stands, runs fast from a distance and throws the javelin. What could be the reason?

1. The distance through which the athlete runs and the range of the javelin may be related.
2. The speed attained by the athlete and the range of the javelin may be related.
3. The speed attained by the athlete and the muscle power gained by the athlete may be related.
4. A running person may have control over the angle at which the javelin is held.

**2.4.B** A person is getting down from a moving bus. He ran a little in the direction of the moving bus to avoid falling down. Then he walked away without any difficulty. Why did the person who got down from the bus run a little in the direction of the moving bus?

1. Might be to gradually reduce the inertia of motion of his body, which is still in motion.
2. Might be to gradually reduce the inertia of rest of his body, which is still in rest.
3. Might be to make the velocity of the person at rest equal to that of the bus.
4. As the body of the person is at rest in relation to the ground, running might help to gain stability.

**2.4.C** Sea and deep waters appear blue in colour. The reason is that the blue colour in sunlight get scattered in water. Why the water in wells and ponds does not appear blue in colour?

1. The quantity of scattered light might increase with increase in depth and extent of water.
2. The disturbances of water might influence the colour of light being scattered.
3. The salts dissolved in water might influence the colour of light being scattered.
4. The increase in waves might increase the quantity of light being scattered.

**2.4.D** A heavy iron sphere was hung on a spring balance. Suddenly the spring balance together with the hung iron sphere fell down. The spring balance showed zero reading during the fall. What could be the reason?

1. The action of the spring might stop during motion.
2. Gravitational force might not be acting upon falling bodies.
3. The sphere might lose weight during fall.
4. As the weight of the sphere was used for the fall, weight might become zero.

**PART – 8**

In the following questions, statements numbered 1,2,3,4 are given that could be justifiable reasons for a certain scientific problem. Choose and encircle the most logical supposition (hypothesis) that could be easily tested using a simple experiment.

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**2.5.A** Given below are logical statements. Among these which one is testable with a simple experiment?

1. When different colours are made to pass through a glass slab, the largest deviation will be for the violet light ray.
2. When light of different frequencies is made to pass through a glass slab, the largest deviation will be for the light ray with the maximum frequency.
3. When light of different wavelengths is made to pass through a glass slab, the least deviation will be for the light ray with the maximum wavelength.
4. When a light ray passes through a glass slab its speed changes.

**2.5.B** Given below are logical statements. Among these one cannot be easily proved with a simple experiment. Which is that statement that cannot be easily proved?

1. If a weight is tied to one end of a metre scale, centre of gravity shifts to that side.
2. The position of centre of gravity changes with change in the shape of a disc.
3. When substances are heated the position of the centre of gravity does not change.
4. When substances are heated the number of vibrating molecules changes.

**2.5.C** Among the children running in the playground, a heavy person experience difficulty in starting the run and stopping the run. To find out the reason behind this, the relation between mass and inertia had to be found out. For this which supposition is easily testable with a simple experiment?

1. If spheres of different masses are rolled off on a smooth surface with equal speed, the one with greater mass shall roll for a longer time.
2. Among spheres of different masses, the one with greater mass shall have the centre of gravity at the centre.
3. If spheres of different masses are rolled in the outer space, the one with greater mass shall roll for a longer time.
4. If spheres of different masses are given escape velocity, all of them will reach outer space.

## PART - 9

We know that there will be more than one factor that influences a scientific process. Realize the influence of such critical factors and choose the correct answer and encircle it on the question paper itself.

---

**3.1.A** Water is flowing out of a hosepipe. This is an example of projectile motion. To see whether there is a relation between the angle at which the water flow out and the distance up to which the water falls, an experiment is done changing the angle of flow of water. Which factor should be kept constant?

1. The distance through which the water falls.
2. The time taken for each experiment.
3. The force of flow of water.
4. The angle of incidence.

**3.1.B** To study the relation between weight of a substance and its frictional force, substances of different weights are being dragged along a rubber surface with a spring balance at a particular speed. The surface area of all the substances selected for experimenting is same. Which are the factors that are kept constant in this experiment?

1. Weight of the substance, frictional force, time of the experiment.
2. Surface on which experiment is done, Speed at which the substance is dragged. Shape of the substance.
3. Surface on which experiment is done, Surface Area of the substance, Speed at which the substance is dragged.
4. Weight of the substance, Surface Area of the substance, Speed at which the substance is dragged.

**3.1.C** To study whether different masses take different times while falling down from a height, an experiment was conducted on the surface of the Moon. Different masses were allowed to fall freely. In this experiment the down ward acceleration is fixed. Also there is no air resistance. To find out the correct relation between mass and the time of fall which factor then has to be controlled and kept constant?

1. The surface area of the object
2. Spherical shape of the object.
3. Density of the object.
4. Height of fall.

**PART – 10**

The situations presented below have to be imagined. Find out the correct answer for each question in the light of already known scientific facts and principles and mark it by encircling its number on the question paper itself.

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**3.2.A** The rainbow we see has the shape of an arc. The bottom portion of the rainbow is obscured by the horizon. What would an observer flying very high on an aeroplane see?

1. The bottom portion of the rainbow, which is a circle.
2. A different rainbow with different colours.
3. A rainbow without colours can be seen.
4. As we go high, more rainbows can be seen one below the other.

**3.2.B** Aeroplanes have a streamlined design. The front end is pointed to reduce friction while traveling through air. Suppose a space vehicle is designed to travel only through the outer space, then

1. The front as well as the rear end should be pointed.
2. The front end alone need be pointed.
3. The shape should be spherical.
4. There is no need to make it stream lined.

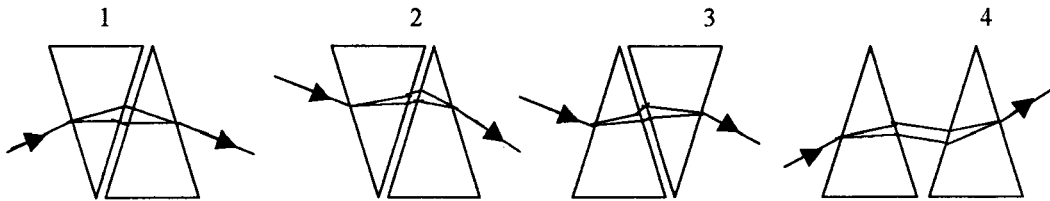
**3.2.C** We know that as one goes deeper into the earth, weight of a body decreases. Imagine that a hole is dug right through the centre of the earth reaching the other side of earth's surface. An object is taken from one end of this tunnel to the other end through the centre of the earth. How does the weight of the object vary?

1. Decreases first, then become zero, further decreases.
2. Increases first, then become zero, further decreases.
3. Decreases first, then become zero, further increases.
4. Increases first, then decreases, further remains zero.

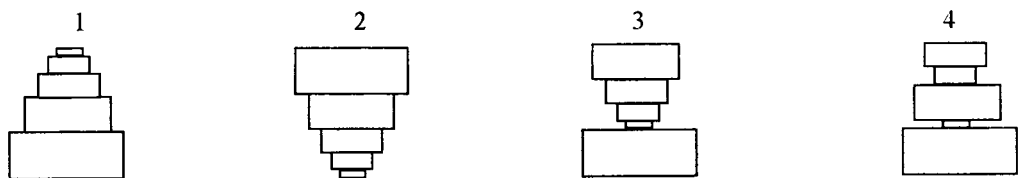
**PART – 11**

Analyse the diagrams given in each question and select the right answer by encircling the number.

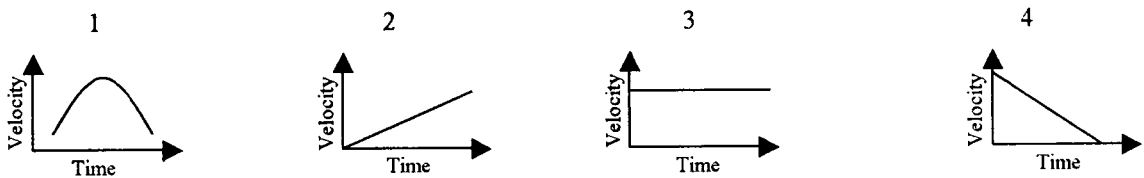
**3.3.A** In the diagrams given below light phenomena using prisms are illustrated. Of them only one is correct. Which is that? (Remember that the refracted ray always deviates towards the base.)



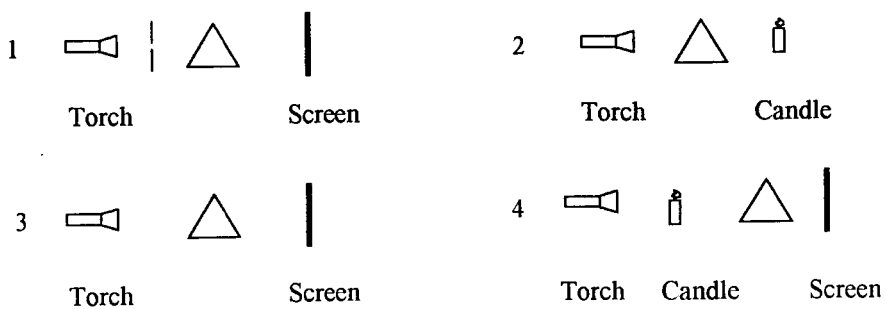
**3.3.B** In the diagrams given below are square cubes of different sizes placed one over the other. Of the given arrangements, which is most stable?



**3.3.C** Among the graphs given below, which one indicates uniform motion?



**3.3.D** To study the dispersion of light from a torch, which arrangement given below is the most suitable?



## PART – 12

In each of the following questions a certain scientific statement is given. Choose the most suitable experimental procedure to check the correctness of this statement by encircling on the question paper itself.

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**3.4.A** The ability of an object to make an impact upon another one increases with its velocity. To test the truth of this statement, which experimental procedure is the most appropriate?

1. Iron spheres of different masses are made to fall on a heap of sand and the depth of the hole thus formed is measured.
2. A graph is drawn with velocity and mass.
3. An iron sphere is made to fall from different heights on a heap of sand and the depth of the hole thus formed is measured.
4. Iron spheres of different masses are made to strike on a stonewall and the distance is measured through which the sphere is thrown away.

**3.4.B** Frictional force depends on the weight of the substance. To test the truth of this statement, which experimental procedure is the most appropriate?

1. A substance of weight one Kg is attached to a spring balance and is dragged along different surfaces and readings are taken.
2. Substances of different weights are dragged along a table and the reading on the attached spring balance is taken while dragging.
3. Different substances of same weight are dragged along a rubber sheet and the reading on the attached spring balance is taken while dragging.
4. The frictional force of a substance of weight one Kg while being dragged as well as rolled is measured using a spring balance.

**3.4.C** Some rays emanating from the remote control of the TV and falling on the set control the TV set. To test the truth of this statement, which experimental procedure is the most appropriate?

1. The remote is operated with its battery placed in and removed.
2. The power supply of the TV set is switched on and off and the remote is test operated.
3. The outer cover of the remote control is opened and the inner parts are observed and sketched.
4. A thick screen is placed in between the remote control and the TV set and the remote is test operated.

**3.4.D** A shot with a certain initial velocity shall go off to a maximum distance if it is thrown at an angle of  $45^\circ$ . To test the truth of this statement, which experimental procedure is the most appropriate?

1. Observing and understanding different athletes throwing the shot-put.
2. Throwing the shot oneself at different angles.
3. Throwing the shot oneself at different directions.
4. Calculating the maximum range for different initial velocities using formula.

## PART - 13

Data obtained from experiments are presented in the questions below. Using these data find out the correct inference and mark it by encircling the number beside it.

3.5.A When a blue flower was viewed through a colour filter it appeared blue itself. A red flower appeared black and a white flower appeared blue. From this data, infer the colour of the filter?

1. Black
2. Blue
3. Red
4. Colourless

3.5.B The velocity of a moving object and the corresponding time is given in the chart below. Which of the following inferences is correct?

Velocity (m/s)	40	40	38	36	34	36	38	40	40
Time interval (second)	0-1	1-2	2-3	3-4	4-5	5-6	6-7	7-8	8-9

1. The object accelerated in the interval of 0-1 seconds
2. The object accelerated in the interval of 0-2 seconds
3. The object accelerated in the interval of 5-8 seconds
4. The object accelerated in the interval of 7-9 seconds

3.5.C The data with regard to the motion of a small iron sphere falling from a certain height is given below. Considering this data, choose the correct inference from those given below.

Time (second)	0	1	2	3	4
Velocity (m/s)	0	9.8	19.6	29.4	39.2

1. Velocity increases every second.
2. Mass increases every second.
3. The displacement in each second is equal.
4. Velocity, mass and displacement gradually increase.

3.5.D The orbital velocities of four artificial satellites are presented in the chart below. On the basis of the given data, choose the correct inference.

Satellite	A	B	C	D
Orbital Velocity (Km/s)	3.0	8.6	9.2	12.0

1. A and B will fall back to earth.
2. The satellite D will break the attraction of earth and go to outer space.
3. The satellites A, B and C will fall back to earth.
4. The satellites C and D will break the attraction of earth and go to outer space.

3.5.E A Physics Scientist weighed 1 kilogram substance at different places using spring balance as well as common balance. the weights thus measured are given below.

	Place A	Place B	Place C
Weight as measured by spring balance	1 Kgw	1.01 Kgw	0.99 Kgw
Weight as measured by common balance	1 Kgw	1 Kgw	1 Kgw

Considering the three situations, what general inference could be reached upon?

1. Spring balance shows different weighing at the same place.
2. Common balance shows different weighing at the same place.
3. Spring balance shows different weighing at different places.
4. Common balance shows different weighing at different places.

## PART - 14

**More than one similar instance is given in the questions given below. Carefully comprehend these situations and arrive at a general principle.**

---

**3.6.A** When an object was dragged along the surface of a table with a spring balance attached to it, the reading initially increased but decreased when the object started moving and remained constant thereafter.

When Ramu tried to push a wheelbarrow with load he had to use a lot of force, but when it started moving, he found that a lesser force was sufficient.

People were trying to push a bus that had a break down from the road to the side. At first more people had to push together to move the bus. Later only lesser people pushed the moving bus to the side of the road.

From these situations what general principle about frictional force can be reached at?

1. The frictional force is less before the object moved.
2. The frictional force is maximum before the object starts moving and decreases when it starts moving.
3. The variations in frictional force cause many difficulties in life.
4. The sliding friction is more than the rolling friction.

**3.6.B** We know that yellow, cyan and magenta secondary colours. A teacher was experimenting with transparent substances of these colours in the lab to find out the colours, which they allow to pass through them.

It was found that the yellow transparent object transmitted yellow, red and green colours but absorbed all other colours.

It was found that the cyan transparent object transmitted cyan, blue and green colours but absorbed all other colours.

It was found that the magenta transparent object transmitted magenta, blue and red colours but absorbed all other colours.

From these instances which general property of the transparent substances of secondary colour can be understood?

1. The transparent object with a secondary colour transmits all primary colours.
2. The transparent object with a secondary colour transmits all secondary colours.
3. The transparent object with a secondary colour transmits its own colour and its component colours.
4. The transparent object with a secondary colour transmits its own colour and all primary colours.

**3.6.C** A boy watering plants in his garden found that when the hose pipe was held at an angle  $45^\circ$ , the water reached a maximum distance. If the angle was increased or decreased from  $45^\circ$ , the distance of fall decreased.

Children were practicing to throw the cricket ball to a maximum distance in the cricket ground. They found that to send the ball to a maximum distance the throw should be made at  $45^\circ$ . When the angle was decreased or increased the distance of fall decreased.

When the children practicing to throw javelin threw it at  $45^\circ$  the javelin fell to a maximum distance. If the angle of projection was increased or decreased, the javelin would travel a lesser distance. From these instances what general principle can be understood about the angle of projection?

1. When the angle of projection increases, the distance of fall of the thrown object increases.
2. When the angle of projection increases, the distance of fall of the thrown object decreases.
3. When the angle of projection was decreased or increased from  $45^\circ$  the distance of fall of the thrown object increased.
4. When the angle of projection was decreased or increased from  $45^\circ$  the distance of fall of the thrown object decreased.

### Scoring key for Problem Solving ability Test in Physics (Final)

Part 1	Part 2	Part 3	Part 4	Part 5	Part 6	Part 7	Part 8	Part 9	Part 10	Part 11	Part 12	Part 13	Part 14
11A (2)	12A (1)	13A (3)	21A (2)	22A (1)	23A (1)	24A (2)	25A (1)	31A (3)	32A (1)	33A (2)	34A (3)	35A (2)	36A (2)
11B (4)	12B (2)	13B (1)	21B (4)	22B (2)	23B (2)	24B (1)	25B (4)	31B (3)	32B (4)	33B (1)	34B (2)	35B (3)	36B (3)
11C (3)	12C (4)	13C (4)	21C (3)	22C (3)	23C (2)	24C (1)	25C (1)	31C (4)	32C (3)	33C (3)	34C (4)	35C (1)	36C (4)
11D (2)		13D (3)		22D (1)		24D (4)				33D (1)	34D (2)	35D (2)	
												35E (3)	

ACHIEVEMENT TEST IN PHYSICS

(DRAFT)

Malayalam version

ഉറർജ്ജതന്ത്രം

Marks: 60

Time: 80 minutes

PART - A

1 മുതൽ 20 വരെ ചോദ്യങ്ങൾക്ക് ശരിയായ ഉത്തരം ബ്രാക്കറ്റിൽ നിന്ന് തിരഞ്ഞെടുത്തെഴുതുക

- 1. സമന്വൃത പ്രകാശം അതിന്റെ ഘടകവർണ്ണങ്ങളായി പിരിയുന്ന പ്രതിഭാസം (പ്രതിഫലനം, പ്രകാശപ്രകീർണനം, അപവർത്തനം, വീക്ഷണസ്ഥിരത)
- 2. സൂര്യപ്രകാശത്തിന്റെ ചൂടിന് കാരണമായ രശ്മി (ദൃശ്യപ്രകാശം, ഇൻഫ്രാറെഡ് കിരണം, ആൽഫാകിരണം, അൾട്രാവയലറ്റ് കിരണം.)
- 3. താഴെകൊടുത്തിരിക്കുന്ന വർണ്ണങ്ങളിൽ ഏതിനാണ് ആവൃത്തി കൂടുതൽ (വയലറ്റ്, പച്ച, മഞ്ഞ, ചുവപ്പ്)
- 4. താഴെപറയുന്നവയിൽ ചിത്രകാരൻമാർ പ്രാഥമിക ചായമായി കരുതാത്തത് ഏതാണ്? (ചുവപ്പ്, പച്ച, നീല, മഞ്ഞ)
- 5. ചുവന്ന കളർ ഫിൽട്ടറിൽ സൂര്യപ്രകാശം പതിച്ചാൽ പുറത്ത് എത്തുന്ന പ്രകാശം ഏത് നിറത്തിലുള്ളതായിരിക്കും. (വെള്ള, കറുപ്പ്, ചുവപ്പ്, സയൻ)
- 6. ഒരു ഫ്ലൂറോസസ് പദാർത്ഥത്തിൽ പച്ച പ്രകാശം വീണപ്പോൾ അത് ഒരു പ്രത്യേക നിറത്തിലുള്ള പ്രകാശം ഉൽസർജിച്ചു. താഴെപറയുന്നതിൽ ഏത് നിറമായിരിക്കാവസ്തു ഉൽസർജിച്ചത്. (പച്ച, നീല, വയലറ്റ്, ഓറഞ്ച്)
- 7. ഏത് കോണളവിൽ വിക്ഷേപിക്കുമ്പോഴാണ് ഒരു വസ്തു ഏറ്റവും ദൂരെ പോയി വീഴുന്നത്? ( $20^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $65^\circ$  )
- 8. വർത്തുള്ള ചലനത്തിൽ വൃത്തപാതയുടെ കേന്ദ്രത്തിലേക്ക് അനുഭവപ്പെടുന്ന ബലം ഏത്? (പരിക്രമണം, ഘർഷണബലം, ഗുരുത്വാകർഷണബലം, അഭികേന്ദ്രബലം)
- 9. ഓടിക്കൊണ്ടിരിക്കുന്ന ഒരു ബസ് പെട്ടെന്ന് നിർത്തുമ്പോൾ യാത്രക്കാർ മുമ്പോട്ട് വീഴുന്നതിനു കാരണം എന്ത്? (ജഡത്വം, ആക്കം, ആവേഗം, ഘർഷണം)

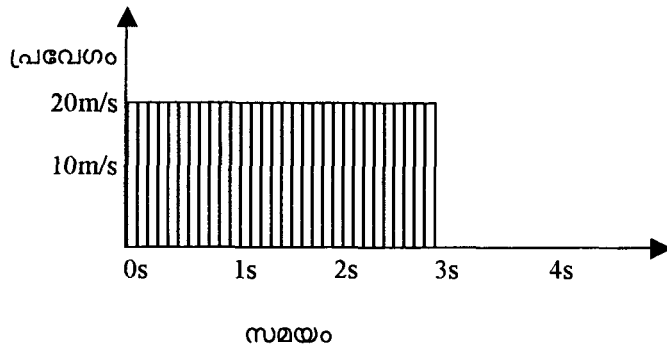
10. കുറഞ്ഞ സമയം കൊണ്ട് പ്രയോഗിക്കപ്പെടുന്ന വലിയ ബലമാണ് (ന്യൂക്ലിയാർ ബലം, ആവേഗബലം, ഘർഷണബലം, ജഡത്വം)
11. 50 gm പിണ്ഡമുള്ള വസ്തു 10 m/s എന്ന പ്രവേഗത്തിൽ സഞ്ചരിക്കുമ്പോഴുണ്ടാകുന്ന ആക്കം എത്ര? ( 5 kg m/s, 50 kg m/s, 500 kg m/s, 2 kg m/s,)
12. താഴെകൊടുത്തിരിക്കുന്നവയിൽ ഘർഷണം കുറയ്ക്കാനുള്ള രീതിയല്ലാത്തത് ഏത്? (സ്നേഹകം ഉപയോഗിക്കൽ, മിനുസപ്പെടുത്തൽ, ബോൾബെയറിംഗ് ഉപയോഗിക്കൽ, ചൂടാക്കൽ)
13. റെയിൽ പാളത്തിലൂടെ തെക്കോട്ടു കുതിക്കുന്ന ഒരു തീവണ്ടിക്ക് അനുഭവപ്പെടുന്ന ഘർഷണബലം ഏത് ദിശയിലായിരിക്കും (പടിഞ്ഞാറോട്ട്, കിഴക്കോട്ട്, വടക്കോട്ട്, തെക്കോട്ട്)
14. കേടായ ബസ്സ് തള്ളി നീക്കുവാൻ യാത്രക്കാർ അവരുടെ ഇരിപ്പിടത്തിൽ ഇരുന്ന് കൊണ്ടു തന്നെ മുന്നോട്ട് ബലം പ്രയോഗിച്ചു. പക്ഷേ ബസ്സ് നീങ്ങിയില്ല കാരണമെന്ത്? (ബലം അസന്തുലിതമാണ്, ബാഹ്യബലം ഇല്ല, സ്ഥാനാന്തരം ഇല്ല, സന്തുലിതബലം ഇല്ല)
15. സാർവത്രിക ഗുരുത്വാകർഷണനിയമം കണ്ടുപിടിച്ചത് (ഗലീലിയോ, ന്യൂട്ടൻ, ഫാരഡേ, ഐൻസ്റ്റീൻ)
16. ഗുരുത്വാകർഷണതരണത്തിന്റെ മൂല്യം ----- ആണ്. (10.98 m/s<sup>2</sup>, 9.8 m/s<sup>2</sup>, 8.9 m/s<sup>2</sup>, 89.10 m/s<sup>2</sup>)
17. ഭൂസ്ഥിര ഉപഗ്രഹത്തിന്റെ പരിക്രമണകാലം എത്രയാണ്. (6 മണിക്കൂർ, 12 മണിക്കൂർ, 24 മണിക്കൂർ, 36 മണിക്കൂർ)
18. ഒരു വസ്തു ധ്രുവപ്രദേശത്തു നിന്നും ഭൂമദ്ധ്യരേഖാ പ്രദേശത്തേക്ക് കൊണ്ടുവരുമ്പോൾ ഏത് അളവാണ് വ്യത്യാസപ്പെടുന്നത്? (നീളം, വീതി, മാസ്, ഭാരം)
19. ഭൂമിയിൽ നിന്ന് ഒരു വസ്തു നേരെമുകളിലേക്ക് 20km/s എന്ന വേഗതയിൽ വിക്ഷേപിച്ചാൽ (ക്രമേണ വേഗം കുറഞ്ഞ് പുജ്യമാവും, വേഗത ക്രമേണ കൂടി വരും, ഭൂമിക്കു ചുറ്റും പ്രദക്ഷിണം വയ്ക്കും, ഭൂമിയുടെ ആകർഷണ വലയം ഭേദിച്ച് ശൂന്യാകാശത്തേക്ക് പോവും).
20. ഒരു ലോറിയിൽ വ്യത്യസ്ത ഭാരമുള്ള പെട്ടികൾ കയറ്റുകയാണ്. ലോറിക്ക് സ്ഥിരത കൂടുന്നതിന് (ഭാരമുള്ള പെട്ടികൾ അടിയിൽ കയറ്റണം, ഭാരം കുറഞ്ഞ പെട്ടികൾ ഏറ്റവും അടിയിൽ കയറ്റണം, ഭാരം കൂടിയ പെട്ടികളും കുറഞ്ഞ പെട്ടികളും ഇടകലർത്തി കയറ്റണം, വലിപ്പം കൂടിയ പെട്ടികൾ ഏറ്റവും മേലെ കയറ്റണം)

(1 x 20 = 20 marks)

**PART B**

1 മുതൽ 16 വരെയുള്ള ചോദ്യങ്ങൾക്ക് ഒന്നോ രണ്ടോ വരികളിൽ ഉത്തരമെഴുതുക

1. വീക്ഷണസ്ഥിരത എന്നാൽ എന്ത്?
2. ഒരു പച്ചയില ചുവന്ന ഗ്ലാസ് പേപ്പറിലൂടെ നോക്കുമ്പോൾ ഏത് നിറത്തിൽ കാണുന്നു. ഇതിന് കാരണമെന്ത്?
3. ഹൈറേഞ്ചിലൂടെ സഞ്ചരിക്കുന്ന വാഹനങ്ങളിൽ മഞ്ഞ ഹെഡ്ലാമ്പുകൾ ഫിറ്റ് ചെയ്യുന്നതെന്തിന്?
4. അന്തരീക്ഷത്തിൽ തങ്ങി നിൽക്കുന്ന ജലകണികകളിൽ വച്ച് സൂര്യരശ്മി എങ്ങനെയാണ് ഘടകവർണങ്ങളായി വേർതിരിയുന്നത്?
5. അൾട്രാവയലറ്റ് രശ്മികൾ മനുഷ്യശരീരത്തെ ഏതൊക്കെ രീതിയിൽ ബാധിക്കുന്നു?
6. വർത്തുള ചലനത്തിന് രണ്ട് ഉദാഹരണങ്ങൾ എഴുതുക?
7. ഭ്രമണവും പരിക്രമണവും തമ്മിലുള്ള വ്യത്യാസം എന്ത്?
8. താഴെക്കൊടുത്തിരിക്കുന്ന സമയ പ്രവേഗ ഗ്രാഫ് ശ്രദ്ധിച്ച് ആദ്യത്തെ മൂന്ന് സെക്കണ്ടിൽ വസ്തുവിനുണ്ടായ സ്ഥാനാന്തരം കണക്കാക്കുക.



9. നനഞ്ഞ തുണി വട്ടത്തിൽ ശക്തിയായി ചുഴറ്റിയാൽ ജലത്തിന്റെ തുള്ളികൾ പുറത്തേക്ക് തെറിക്കുന്നു ഇത് എന്തുകൊണ്ട്?
10. 10 m/s പ്രവേഗത്തിൽ തുടങ്ങി സമതരണത്തിൽ സഞ്ചരിക്കുന്ന ഒരു തീവണ്ടിയുടെ സമയ-പ്രവേഗ പട്ടികയാണ് കൊടുത്തിരിക്കുന്നത്.

സമയം (സെക്കന്റ്)	0	2	4	6	8	10
പ്രവേഗം (മീറ്റർ/സെക്കന്റ്)	10	20	30	40	50	60

(എ) തീവണ്ടിയുടെ ത്വരണം എത്ര?

(ബി) തീവണ്ടിക്ക് ആദ്യ നാല് സെക്കണ്ടിൽ ഉണ്ടായ പ്രവേഗ മാറ്റം എത്ര?

11. സ്പോർട്സിൽ 100 മീറ്റർ ദൂരം ഓടുന്ന ഓട്ടക്കാർ ഫിനിഷിംഗ് ലൈനിൽ എത്തിയാലും തുടർന്ന് കുറച്ചു ദൂരം കൂടി ഓടിയശേഷമേ നിൽക്കൂ. ഇതിനു കാരണമെന്ത്?
12. ചുവരിന്മേൽ ആണി തറയ്ക്കുന്നതിന് ചുറ്റിക ആണി മേൽ വച്ച് ഞെക്കുന്നതിനേക്കാൾ എത്രയോ ഫലവത്താണ് ചുറ്റിക കൊണ്ട് ആണിമേൽ പ്രഹരിക്കുന്നത്. ഇതിനു കാരണമെന്ത്?
13. വായു നിറച്ച് ഒരു ബലൂണിൽ നിന്ന് അതിന്റെ നോസിലിൽ കൂടി വായു പുറത്തു പോവാൻ അനുവദിച്ചാൽ ബലൂണിന്റെയും വായുപ്രവാഹത്തിന്റെയും ചലനദിശ എപ്രകാരമായിരിക്കും? ഇത് എന്തുകൊണ്ട് സംഭവിക്കുന്നു?

(2x4 = 8 marks)

38. B. ഭൂമിയിലെ ഗിരിയാകാശകാലങ്ങളിലെ ജീവികളുടെ കൃപണകാലം പലായനപ്രവേശനത്തിന് എന്തിന് വിശ്വാസപാത്രം എന്ന് കണ്ടെത്തുക.
- A. പലായനപ്രവേശനം എന്താണ്?
37. B. ഭൂമിയിലെ ജീവികളുടെ മറ്റൊരു വിഭാഗം പലായനപ്രവേശനത്തിന് എന്തിന് വിശ്വാസപാത്രം എന്ന് കണ്ടെത്തുക.
- A. പലായനപ്രവേശനം എന്താണ്?

PART C

16. ഭൂമിയിലെ ജീവികളുടെ മറ്റൊരു വിഭാഗം പലായനപ്രവേശനത്തിന് എന്തിന് വിശ്വാസപാത്രം എന്ന് കണ്ടെത്തുക.
15. ഭൂമിയിലെ ജീവികളുടെ മറ്റൊരു വിഭാഗം പലായനപ്രവേശനത്തിന് എന്തിന് വിശ്വാസപാത്രം എന്ന് കണ്ടെത്തുക.
14. ഭൂമിയിലെ ജീവികളുടെ മറ്റൊരു വിഭാഗം പലായനപ്രവേശനത്തിന് എന്തിന് വിശ്വാസപാത്രം എന്ന് കണ്ടെത്തുക.

13

**University of Calicut**

**Department of Adult and Continuing Education and Extension Services**

**ACHIEVEMENT TEST IN PHYSICS**

**(FINAL)**

**MALAYALAM VERSION**

**Dr. Sivarajan, K. and Manoj Praveen, G.**

### ACHIEVEMENT TEST IN PHYSICS (FINAL)

Time : 40 Minutes

Std : IX  
Marks : 35

#### PART - A

- 1 മുതൽ 7 വരെ ചോദ്യങ്ങൾക്ക് ശരിയായ ഉത്തരം ബ്രാക്കറ്റിൽ നിന്ന് തിരഞ്ഞെടുത്തെഴുതുക
1. ചുവന്ന കളർ ഫിൽട്ടറിൽ സൂര്യപ്രകാശം പതിച്ചാൽ പുറത്ത് എത്തുന്ന പ്രകാശം ഏത് നിറത്തിലുള്ളതായിരിക്കും.  
(വെള്ള, കറുപ്പ്, ചുവപ്പ്, സയൻ)
  2. ഏത് കോണളവിൽ വിക്ഷേപിക്കുമ്പോഴാണ് ഒരു വസ്തു ഏറ്റവും ദൂരെ പോയി വീഴുന്നത്?  
( $20^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $65^\circ$ )
  3. വർത്തുള ചലനത്തിൽ വൃത്തപാതയുടെ കേന്ദ്രത്തിലേക്ക് അനുഭവപ്പെടുന്ന ബലം ഏത്?  
(പരിക്രമണം, ഘർഷണബലം, ഗുരുത്വാകർഷണബലം, അഭികേന്ദ്രബലം)
  4. താഴെകൊടുത്തിരിക്കുന്നവയിൽ ഘർഷണം കുറയ്ക്കാനുള്ള രീതിയല്ലാത്തത് ഏത്?  
(സ്നേഹകം ഉപയോഗിക്കൽ, മിനുസപ്പെടുത്തൽ, ബോൾബെയറിംഗ് ഉപയോഗിക്കൽ, ചുടാക്കൽ)
  5. റെയിൽ പാളത്തിലൂടെ തെക്കോട്ടു കുതിക്കുന്ന ഒരു തീവണ്ടിക്ക് അനുഭവപ്പെടുന്ന ഘർഷണബലം ഏത് ദിശയിലായിരിക്കും  
(പടിഞ്ഞാറോട്ട്, കിഴക്കോട്ട്, വടക്കോട്ട്, തെക്കോട്ട്)
  6. ഒരു വസ്തു ധ്രുവപ്രദേശത്തു നിന്നും ഭൂമദ്ധ്യരേഖാ പ്രദേശത്തേക്ക് കൊണ്ടുവരുമ്പോൾ ഏത് അളവാണ് വ്യത്യാസപ്പെടുന്നത്?  
(നീളം, വീതി, മാസ്, ഭാരം)
  7. ഭൂമിയിൽ നിന്ന് ഒരു വസ്തു നേരെമുകളിലേക്ക്  $20\text{km/s}$  എന്ന വേഗതയിൽ വിക്ഷേപിച്ചാൽ  
(ക്രമേണ വേഗം കുറഞ്ഞ് പൂജ്യമാവും, വേഗത ക്രമേണ കൂടി വരും, ഭൂമിക്കു ചുറ്റും പ്രദക്ഷിണം വയ്ക്കും, ഭൂമിയുടെ ആകർഷണ വലയം ഭേദിച്ച് ശൂന്യാകാശത്തേക്ക് പോവും).

( 1 x 7 = 7 marks)

#### PART B

- 8 മുതൽ 17 വരെയുള്ള ചോദ്യങ്ങൾക്ക് ഒന്നോ രണ്ടോ വരികളിൽ ഉത്തരമെഴുതുക
8. വീക്ഷണസ്ഥിരത എന്നാൽ എന്ത്?
  9. അന്തരീക്ഷത്തിൽ തങ്ങി നിൽക്കുന്ന ജലകണികകളിൽ വച്ച് സൂര്യരശ്മി എങ്ങനെയാണ് ഘടകവർണങ്ങളായി വേർതിരിയുന്നത്?
  10. അൾട്രാവയലറ്റ് രശ്മികൾ മനുഷ്യശരീരത്തെ ഏതൊക്കെ രീതിയിൽ ബാധിക്കുന്നു?
  11. ഭ്രമണവും പരിക്രമണവും തമ്മിലുള്ള വ്യത്യാസം എന്ത്?
  12. നനഞ്ഞ തുണി വട്ടത്തിൽ ശക്തിയായി ചൂഴ്ന്നിട്ടാൽ ജലത്തിന്റെ തുള്ളികൾ പുറത്തേക്ക് തെറിക്കുന്നു ഇത് എന്തുകൊണ്ട്?
  13. സ്പോർട്സിൽ 100 മീറ്റർ ദൂരം ഓടുന്ന ഓട്ടക്കാർ ഫിനിഷിംഗ് ലൈനിൽ എത്തിയാലും തുടർന്ന് കുറച്ചു ദൂരം കൂടി ഓടിയശേഷമേ നിൽക്കൂ. ഇതിനു കാരണമെന്ത്?
  14. ചുവരിന്മേൽ ആണി തറയ്ക്കുന്നതിന് ചുറ്റിക ആണി മേൽ വച്ച് തെക്കുന്നതിനേക്കാൾ എത്രയോ ഫലവത്താണ് ചുറ്റിക കൊണ്ട് ആണിമേൽ പ്രഹരിക്കുന്നത്. ഇതിനു കാരണമെന്ത്?

- 15. വായു നിറച്ച് ഒരു ബലൂണിൽ നിന്ന് അതിന്റെ നോസിലിൽ കൂടി വായു പുറത്തു പോവാൻ അനുവദിച്ചാൽ ബലൂണിന്റെയും വായുപ്രവാഹത്തിന്റെയും ചലനദിശ എപ്രകാരമായിരിക്കും? ഇത് എന്തുകൊണ്ട് സംഭവിക്കുന്നു?
- 16. ഒരു തോണിയിൽ കടത്തു കടക്കുമ്പോൾ എല്ലാവരോടും ഇരിക്കുവാൻ കടത്തുകാരൻ ആവശ്യപ്പെടാറുണ്ട്. ഇതിനുകാരണമെന്ത്?
- 17. രണ്ടു വസ്തുക്കൾ തമ്മിലുള്ള ഗുരുത്വാകർഷണബലത്തെ സ്വാധീനിക്കുന്ന ഘടകങ്ങൾ ഏതൊക്കെ?

(10 x 2 = 20 marks)

**PART C**

താഴെ കൊടുത്തിരിക്കുന്ന ചോദ്യങ്ങൾക്ക് നാലോ അഞ്ചോ വാചകങ്ങളിൽ ഉത്തരമെഴുതുക.

- 18. A വിവിധ തരത്തിലുള്ള ഘർഷണബലങ്ങൾ ഏതൊക്കെ?  
 B. ഒരു കുട്ടി ഇഷ്ടികകളെടുക്കൽ മുറ്റത്തുകൂടി നിരക്കി വലിക്കുകയായിരുന്നു ഇഷ്ടികകളെ നീങ്ങിത്തുടങ്ങിയപ്പോൾ വലിക്കുന്നത് എളുപ്പമായി. പിന്നീട് കൂടുതൽ എളുപ്പത്തിനു വേണ്ടി അവ ചക്രങ്ങൾ പിടിപ്പിച്ച കളിവണ്ടിമേൽ വച്ച് നീക്കിത്തുടങ്ങി. ഇവിടെ ഓരോ ഘട്ടത്തിലും അനുഭവപ്പെട്ട ഘർഷണബലങ്ങൾ ഏതൊക്കെയാണെന്നു വിശദീകരിക്കുക.
- 19. A പലായനപ്രവേഗം എന്നാലെന്ത്?  
 B ഭൂമിയുടെ ഗുരുത്വാകർഷണബലം ഇപ്പോഴുള്ളതിനേക്കാൾ കുറഞ്ഞാൽ പലായനപ്രവേഗത്തിന് എന്തു വ്യത്യാസം വരും? എന്തു കൊണ്ട്?

(2x4= 8 marks)

**University of Calicut**

**Department of Adult and Continuing Education and Extension Services**

**ACHIEVEMENT TEST IN PHYSICS**

**(FINAL)**

**ENGLISH VERSION**

**Dr. Sivarajan, K. and Manoj Praveen, G.**

## ACHIEVEMENT TEST IN PHYSICS

Time : 40 minutes

Std : IX  
Max Marks: 35

### Part A

For questions 1 to 7 choose the correct answer from the bracket.

1. Which is the colour of the light that comes out of a red colour filter when sunlight is incident on it?  
(white, black, red, green )
2. What is the angle of projection for which a projected object flies off to a maximum distance?  
( $20^\circ$ ,  $30^\circ$ ,  $45^\circ$ ,  $65^\circ$ )
3. Which force is exerted towards the centre of a circular orbit in the case of circular motion?  
(revolution, frictional force, gravitational force, centripetal force)
4. Which of the following is not a method to reduce friction?  
(using lubricants, polishing, using ball bearings, heating)
5. For a train speeding towards south, which is the direction of frictional force?  
(towards west, towards east, towards north, towards south)
6. Which quantity changes when an object is brought from the polar region towards the equatorial region?  
(length, breadth, mass, weight)
7. What happens when an object is projected from earth vertically upwards at a velocity of 20 km/s?  
(gradually speed reduces to zero, speed increases gradually, revolves round the earth, overcomes the attractive force of the earth and escapes into outer space)

### Part B

For questions 8 to 17 write answers in one or two lines

8. What is persistence of vision?
9. How does the sunlight split into the component colours inside a water drop in the atmosphere?
10. In what all ways does the ultraviolet rays affect human body?
11. What is the difference between rotation and revolution?
12. Water drops are thrown off from a wet piece of cloth when whirled round. How does this happen?
13. Athletes who run for a hundred-metre race in sports run for a while even after reaching the finishing line. Why is it so?

14. To fix a nail on a wall it is easier to hit the nail with a hammer than pressing it with the hammer. Why?
15. Air is allowed to escape through the nozzle of an inflated balloon. What is the direction of the movement of balloon and the jet of air? Why?
16. Why are people asked to sit while crossing the river on a boat?
17. Which are the factors that influence the gravitational force between two objects?

### Part C

**For the questions given below write answers in four or five sentences**

18. A. Which are the different types of frictional forces?  
B. A boy was dragging bricks along the ground. When the bricks started moving it became easy to drag. To make the task easier he placed the bricks on a toy cart with wheels and began to pull it. Explain the frictional forces experienced during each stage.
19. A. What is escape velocity?  
B. What change will happen to the escape velocity if the earth's gravitational force is reduced? Why?

## Scoring key for Achievement Test in Physics

### Part A

1. Red.
2.  $45^\circ$
3. Centripetal force.
4. Heating.
5. Towards north.
6. Weight.
7. Overcomes the attractive force of the earth and escapes into outer space.

### Part B

#### Marking Scheme

Qn. No.	Value Points	Marks	Total
8	<ul style="list-style-type: none"> <li>• 1/16 th of a second</li> <li>• Even after the object is removed from sight it appears to remain</li> </ul>	$\frac{1}{2}$  $\frac{1}{2}$	1
9	<ul style="list-style-type: none"> <li>• One total internal reflection</li> <li>• Two refractions</li> </ul>	$\frac{1}{2}$  $\frac{1}{2}$	1
10	<ul style="list-style-type: none"> <li>• Skin turns brown/sun burn/cancer</li> <li>• Vitamin D</li> </ul>	$\frac{1}{2}$  $\frac{1}{2}$	1
11	<ul style="list-style-type: none"> <li>• Rotation- axis inside the object</li> <li>• Revolution – axis outside the object</li> </ul>	$\frac{1}{2}$  $\frac{1}{2}$	1

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12	<ul style="list-style-type: none"> <li>• Circular motion</li> <li>• Centripetal force- inability to provide</li> </ul>	$\frac{1}{2}$ $\frac{1}{2}$	1
13	<ul style="list-style-type: none"> <li>• Inertia of motion</li> </ul>	1	1
14	<ul style="list-style-type: none"> <li>• Change in momentum</li> <li>• Effected in a short time</li> </ul>	$\frac{1}{2}$ $\frac{1}{2}$	1
15	<ul style="list-style-type: none"> <li>• Opposite direction</li> <li>• Newton's third law- according to</li> </ul>	$\frac{1}{2}$ $\frac{1}{2}$	1
16	<ul style="list-style-type: none"> <li>• To keep the center of gravity down</li> </ul>	1	1
17	<ul style="list-style-type: none"> <li>• Mass</li> <li>• Distance</li> </ul>	$\frac{1}{2}$ $\frac{1}{2}$	1

### Part C

Qn. No.	Value Points	Marks	Total
18 A	<ul style="list-style-type: none"> <li>• Limiting friction</li> <li>• Static friction</li> <li>• Sliding Friction</li> <li>• Rolling Friction</li> </ul>	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	2
B	<ul style="list-style-type: none"> <li>• About to be dragged-Limiting friction</li> <li>• When pulled but not moved-Static friction</li> <li>• When dragged-Sliding Friction</li> <li>• When pulled on a toy-Rolling Friction</li> </ul>	$\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$ $\frac{1}{2}$	2
19 A	<ul style="list-style-type: none"> <li>• Minimum velocity</li> <li>• To overcome earths pull</li> </ul>	1 1	2
B	<ul style="list-style-type: none"> <li>• Decreases</li> <li>• Less velocity and less force is required to overcome a weaker pull</li> </ul>	1 1	2

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