

**THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)
EXAMINATION, NOVEMBER 2021**

(CBCSS)

Chemistry

CHE 3E 03—GREEN CHEMISTRY AND NANO CHEMISTRY

(2019 Admission onwards)

Time : Three Hours

Maximum : 30 Weightage

General Instructions

1. *In cases where choices are provided, students can attend all questions in each section.*
2. *The minimum number of questions to be attended from the Section/Part shall remain the same.*
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4. *There will be an overall ceiling for each Section/Part that is equivalent to the maximum weightage of the Section/Part.*

Section A

Answer any eight questions.

Each question carries a weightage of 1.

1. Using a Diels-Alder reaction as an example, show how Atom Economy AE can be calculated.
2. What is the frequency of microwave radiation used in microwave chemical reactors ? How do microwave irradiation promotes chemical reaction ?
3. What are *ionic liquids* ? Write two examples.
4. What is the basis for classifying a material as a nanomaterial ?
5. Write an example of a photochemical Friedel-Crafts reaction.
6. What is meant by sonochemical reactions ? How are these conducted ?
7. Describe the principle of surface plasmon spectroscopy.
8. Suggest a green alternative for anhy. AlCl_3 used in the Friedel Crafts alkylations. Illustrate the use of such an alternative.

Turn over

9. How was C60 discovered ? How can it be made ?
10. Describe an example of a polymer-mediated nanomaterial synthesis.

(8 × 1 = 8 weightage)

Section B

Answer any six questions.

Each question carries a weightage of 2

11. Write an account of alternative starting materials for chemical manufacture as advocated by green chemistry.
12. What are the advantages of microwave assisted reactions ? Explain with examples.
13. Write an account of phase transfer catalysis, highlighting its advantages.
14. Describe the synthesis, properties and uses of quantum dots as nanomaterials.
15. Discuss with specific examples, the use of ionic liquids in condensation, addition and epoxidation reactions.
16. Describe the preparation and application of any one green oxidant.
17. With suitable examples, illustrate the use of alternative feedstocks for sustainable chemical manufacture.
18. Write brief notes on (i) Fullerenes with sixty carbons and with more than sixty carbons ; and (ii) Alkali- doped C60.

(6 × 2 = 12 weightage)

Section C

Answer any two questions.

Each question carries a weightage of 5.

19. Describe briefly the twelve principles of Green Chemistry
20. Describe with examples the general methods available for nanomaterial synthesis.
21. Write an account of scanning microscopy methods such as STM, SNOM, and AFM in nanomaterial characterisation.
22. What are single-walled and multi-walled carbon nanotubes ? Discuss their structure, synthesis, properties chemical modification and applications.

(2 × 5 = 10 weightage)

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)
EXAMINATION, NOVEMBER 2021

(CBCSS)

Chemistry

CHE 3E 01—SYNTHETIC ORGANIC CHEMISTRY

(2019 Admission onwards)

Time : Three Hours

Maximum : 30 Weightage

General Instructions

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Section A

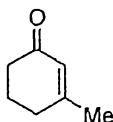
Answer any **eight** questions.

Each question carries a weight of 1.

1. Give an example each for two different types of synthetically useful oxidation reactions of *m*-chloroperbenzoic acid.
2. Predict the major product in the following reaction:



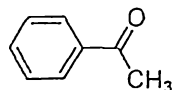
3. How will you synthesise the following compound starting from cyclohex-2-enone ?



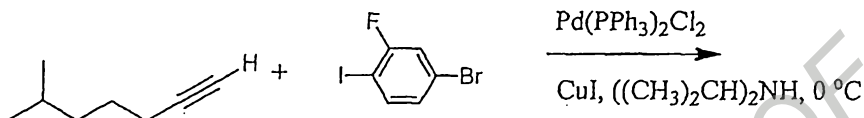
4. Illustrate the application of allyl silanes in organic synthesis.

Turn over

5. Suggest a logical disconnection for the following target compound. Justify the answer :



6. Write down the structure of aldol condensation product/s obtained from benzaldehyde and acetone.
 7. Write down the structure of the major cross coupling product in the following reaction.



8. Differentiate between synthons and synthetic equivalents. Give examples.
 9. What is the significance of functional group interconversions in organic synthesis ?
 10. Write down the conditions and reagents used for the protection and deprotection of alcohols as THP ethers.

(8 × 1 = 8 weightage)

Section B

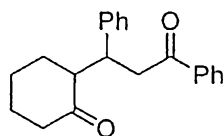
*Answer any six questions.
 Each question carries a weight of 2.*

11. Indicate the differences in reactivity shown by LiAlH_4 and NaBH_4 in their reaction with carbonyl compounds.
 12. Give one example each of a homogeneous and a heterogeneous hydrogenation catalyst and illustrate typical applications of each.
 13. How will you account for the retention of configuration in the following substitution reaction ?

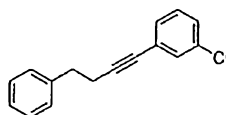


14. Illustrate the synthetic applications of Dieckmann reaction with a suitable example.

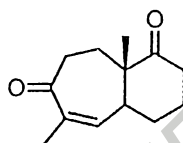
15. Suggest a one pot synthesis for the following compound starting from an appropriate carbonyl compounds. Explain the reaction involved.



16. Outline a synthesis for the following compound starting from simple acetylenic substrates.



17. How was the following ketone transformed into longifolene in the Corey's synthesis ?



18. Write down a laboratory synthesis of 8-hydroxy quinolone.

(6 × 2 = 12 weightage)

Section C

Answer any two questions.

Each question carries a weight of 5.

19. Write a note on Sharpless asymmetric epoxidation and explain the stereochemical outcome observed.
20. Discuss the applications of alkylboranes in organic synthesis. Give examples.
21. Illustrate Stork-enamine reaction and explain its advantages with appropriate examples.
22. Outline the synthetic strategy in the Reichstein process for Vitamin C.

(2 × 5 = 10 weightage)

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)
EXAMINATION, NOVEMBER 2021

(CBCSS)

Chemistry

CHE 3C 11—REAGENTS AND TRANSFORMATIONS IN ORGANIC CHEMISTRY

(2019 Admission onwards)

Time : Three Hours

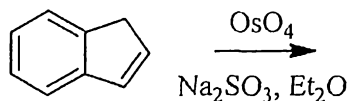
Maximum : 30 Weightage

General Instructions

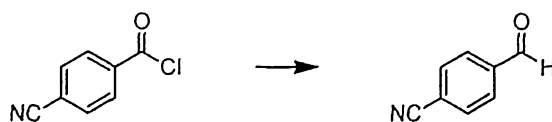
1. In cases where choices are provided, students can attend **all** questions in each section.
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Section A*Answer any **eight** questions.**Each question carries a weightage of 1.*

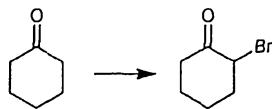
1. Predict the product in the following reaction :



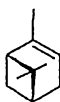
2. Write down the structure of Jacobsen catalyst and indicate its application/s.
3. Suggest suitable reagents and conditions required to effect the following conversion in a single step.

**Turn over**

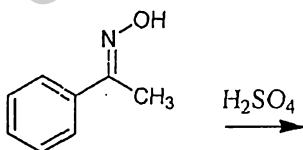
4. Give an example of Wolff Kishner reduction. Comment on the functional group tolerance of this reaction.
5. How will you effect the following transformation in a one pot procedure ?



6. Write down the structure of 9-BBN. Give the structure of the product obtained by its addition reaction with the following compound.



7. What are the two common secondary structural elements in proteins? What are the forces stabilizing these structures?
8. Write down the structure of : a) Oxirane ; b) Guanine.
9. Outline the mechanism of Fries rearrangement with a suitable example.
10. The following compound undergoes an acid catalyzed rearrangement. Predict the major product obtained.



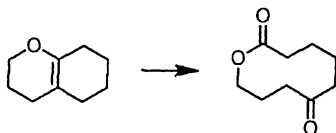
(8 × 1 = 8 weightage)

Section B

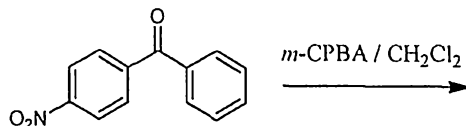
Answer any **six** questions.

Each question carries a weightage of 2.

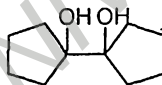
11. How will you effect the following conversion ?



12. Predict the major product in the following reaction. Justify the answer.



13. Write down the mechanism of alkyne reduction with Na and $\text{NH}_3(\text{liq})$. Justify the stereochemical outcome.
14. What is a pinacol coupling reaction? Illustrate the synthetic applications with examples. What are the limitations of this C-C bond formation strategy?
15. Write down the mechanism of DCC mediated ester formation reaction from carboxylic acids and alcohols.
16. How is the terminal amino acids of a peptide chain determined?
17. Illustrate the mechanism of Wagner-Meerwein rearrangement with an appropriate example.
18. The following diol undergoes a rearrangement reaction when treated with a strong acid. Indicate the structure of the product and give a plausible mechanism.



(6 × 2 = 12 weightage)

Section C

Answer any **two** questions.

Each question carries a weightage of 5.

19. Write a brief note on : a) oxidations with Dess-Martin periodinane, b) Riley reaction.
20. a) α , β -Unsaturated compounds undergo reduction with Na and $\text{NH}_3(\text{liq})$. Indicate the major products obtained and outline the mechanism involved.
b) Illustrate the application of diimide reductions.
21. Write notes on : a) reaction of tributyltin hydride with organic halides, b) application of 1,3-dithiane in reactivity *umpolung*.
22. Give a short account of Merrifield solid phase peptide synthesis and enumerate the scheme for the synthesis of phenylalaninyl-glycinyl-valine.

(2 × 5 = 10 weightage)

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)
EXAMINATION, NOVEMBER 2021

(CBCSS)

Chemistry

CHE 3C 10—ORGANOMETALLIC AND BIO-INORGANIC CHEMISTRY

(2019 Admission onwards)

Time : Three Hours

Maximum : 30 Weightage

General Instructions

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Section A

Answer any eight questions.

Each question carries a weight of 1.

1. What is meant by reductive carbonylation ? Explain with an example.
2. Which is more reactive ; Fischer carbene or Schrock carbene ? Substantiate your answer.
3. Discuss the structure and bonding in metal-acetylene complexes.
4. What hapticities are possible for 1, 3-butadiene ? Sketch the interactions.
5. What is Collman's reagent ? Give any *one* of its synthetic applications.
6. Explain anation reaction with a suitable example.
7. Calculate the number of metal-metal bonds in : (a) $\text{Co}_4(\text{CO})_{12}$; and (b) $\text{Ru}_3(\text{CO})_{12}$.
8. What is superoxide dismutase ? Explain its structure and function.
9. Differentiate between active and passive transport across cell membrane.
10. Identify the co-ordination sites in proline and α -alanine.

(8 × 1 = 8 weightage)

Turn over

Section B

Answer any **six** questions.

Each question carries a weight of 2.

11. State and explain 16-electron and 18-electron rules as applied to organometallic compounds.
12. How is Zeise's salt synthesized ? Give an account of the structure and bonding in this compound.
13. Describe the catalytic process and the mechanism of the reactions involved in Monsanto acetic acid process.
14. Discuss the factors that favour the formation of metal clusters.
15. Explain the role of calcium in blood clotting process.
16. Describe the mechanism of the action of *cis*-platin as an anticancer drug.
What are the side effects of this drug ?
17. How is methyl lithium prepared ? How this compound forms molecular aggregate ? Explain.
18. Discuss the structure and functions of cytochrome P₄₅₀.

(6 × 2 = 12 weightage)

Section C

Answer any **two** questions.

Each question carries a weight of 5.

19. Give an account of the synthesis, structure and important reactions of ferrocene.
20. Describe the mechanisms involved in oxidative addition, reductive elimination and insertion reaction of organometallic compounds, giving suitable examples.
21. What is biological nitrogen fixation ? Explain the structure and functions of M-cluster and P-cluster of nitrogenase in nitrogen fixation. Mention the role of metal-dinitrogen complexes in nitrogen fixation.
22. Write briefly on :
 - (a) Sodium-potassium pump in biological systems.
 - (b) Physiology of myoglobin and hemoglobin.
 - (c) Hydroformylation of alkene.

(2 × 5 = 10 weightage)

THIRD SEMESTER M.Sc. DEGREE (REGULAR/SUPPLEMENTARY)
EXAMINATION, NOVEMBER 2021

(CBCSS)

Chemistry

CHE 3C 09—MOLECULAR SPECTROSCOPY

(2019 Admission onwards)

Time : Three Hours

Maximum : 30 Weightage

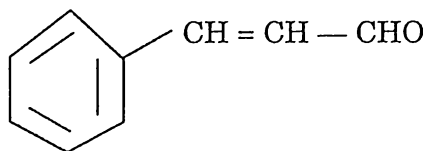
General Instructions

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Section A*Answer any **eight** questions.**Each question carries a weightage of 1.*

1. Which of the following molecules are microwave active ? Justify your answer CH_2Cl_2 , CHCl_3 , CCl_4 , BCl_3 ?
2. Define normal mode of vibration.
3. A set of protons absorb at a frequency 900 Hz higher w.r.t. TMS in 100 MHz NMR instrument. Calculate the chemical shift δ (delta).
4. Define of factor. Explain its significance.

5. Predict λ_{max} for



6. What do you mean by first order NMR spectrum ?
7. δ (delta) values of ^{13}C are appreciably higher compound to proton. Why ?

Turn over

8. State and explain nitrogen rule.
9. What is Karplus relationship ?
10. How many lines do you expect in the EPR spectrum of benzene negative ion ? Justify your answer.
(8 × 1 = 8 weightage)

Section B

Answer any six questions.

Each question carries a weightage of 2.

11. How would you find dipole moment of a molecule from microwave spectroscopy ? Explain.
12. Write Morse equation-represent graphically. Show that it approximates to simple harmonic oscillator for low amplitude vibrations.
13. How you determine spin-spin relaxation time T_2 using pulsed NMR ? Discuss.
14. Briefly discuss zero field splitting.
15. How would you establish conformation and configuration of 3-methyl cyclohexanone by ORD ?
16. Discuss the various mechanisms of spin-spin coupling.
17. What is NOE ? Discuss.
18. With the help of suitable examples discuss McLafferty rearrangement.
(6 × 2 = 12 weightage)

Section C

Answer any two questions.

Each question carries a weightage of 5.

19. What are the drawbacks of conventional NMR spectrum ? How are they overcome in FT NMR ? Discuss.
20. Discuss theory and applications of Mössbauer spectroscopy.
21. The spectral data of a compound is given IR 1620 cm^{-1} (m), 1695 cm^{-1} (s)
NMR : 1.9 δ (3H, singlet) 2.1 δ (6H, singlet)
UV : λ_{max} 238 nm ($\epsilon = 11700$)
MS $\frac{m}{z}$ (100), 83 (90), 43 (78), 98 (49), 29 (46), 39 (43), 27 (42), 53 (13), 41 (13), 28 (8).
Deduce the structure and assign the peaks.
22. Discuss the applications of ORD in structural investigation.
(2 × 5 = 10 weightage)

**THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION
NOVEMBER 2021**

(CUCSS)

Chemistry

CH 3E 01—SYNTHETIC ORGANIC CHEMISTRY

(2015 to 2018 Admissions)

Time : Three Hours

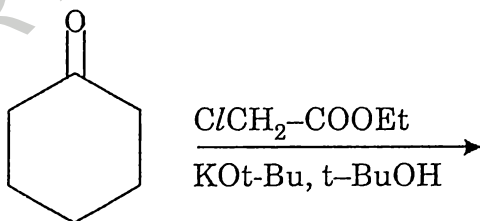
Maximum : 36 Weightage

Section A

Answer all questions.

Each question carries 1 weightage.

1. Write a note on Stille carbonylative cross coupling.
2. Draw the structure of PCC and give its applications.
3. Differentiate between homogeneous and heterogeneous catalytic hydrogenation reaction.
4. Write a note on tri n-butyl tin hydride.
5. What is Dieckmann reaction ?
6. Predict the product and explain the mechanism of the reaction.



7. What is Stork-enamine reaction ?
8. What is target selection in multistep synthesis ?
9. Draw the structures of :
 - (a) Quinoline.
 - (b) Oxepines.
10. Write a short note on combinatorial chemistry.

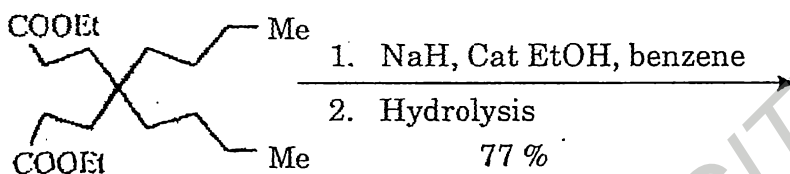
11. Explain Sharpless asymmetric epoxidation with example.
12. Write down the basic principles of retrosynthetic analysis.

(12 × 1 = 12 weightage)

Section B

Answer any **eight** questions.
Each question carries 2 weightage.

13. Differentiate between Woodward and Prevost hydroxylation.
14. Give the name of the following reaction and write its mechanism



15. Write the mechanism of reactions :
 - (a) Claisen.
 - (b) Perkin.
16. Write down the protection and deprotection of amino group with suitable examples.
17. Give the mechanism of the following reactions :
 - (a) Suzuki-Miyaura.
 - (b) Heck.
18. Write down the synthesis of any two fused ring heterocycles.
19. Explain Umpolung equivalent with suitable example.
20. What are the important strategies of functional group transposition ?
21. Give short note on Reichstein process.
22. Give the mechanism of :
 - (a) Birch reduction.
 - (b) Swern oxidation.
23. Write down the retrosynthetic analysis of :
 - (a) Paracetamol from phenol.
 - (b) Benzocain from toluene.
24. Discuss the synthesis and reactions of Oxadiazole.

(8 × 2 = 16 weightage).

Section C

Answer any **two** questions.

Each question carries 4 weightage.

25. (a) Give an introduction to multistep synthesis.
- (b) Write down the retrosynthetic analysis of :
- (1) Longifolene. (2) Djerassi Prelog Lactone.
26. Write down the mechanism of following reactions :
- (a) Prins. (b) Mannich.
- (c) Claisen. (d) Darzen.
27. Write down the structure and synthesis of the following :
- (a) Diazepines. (b) Benzimidazole.
- (c) Benzodiazepines. (d) Indole.
28. Explain the mechanism of the following coupling reactions :
- (a) Negishi. (b) Hiyama.
- (c) Sonogashira. (d) Kumada.

(2 × 4 = 8 weightage)

**THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION
NOVEMBER 2021**

(CUCSS)

Chemistry

CH 3C 11—REAGENTS AND TRANSFORMATIONS IN ORGANIC CHEMISTRY

(2015 to 2018 Admissions)

Time : Three Hours

Maximum : 36 Weightage

Section A

*Answer all twelve questions.
Each question carries 1 weightage.*

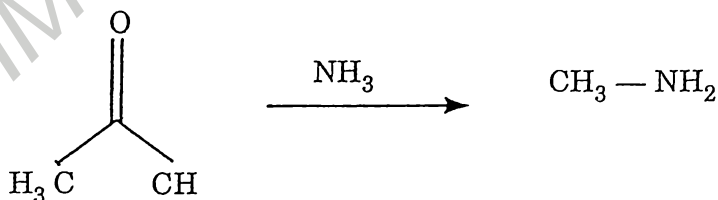
1. What is Baker's yeast ? Give one application in organic synthesis.
2. Give one oxidative method for the conversion of an alkene to alcohol.
3. Give any two applications of Wilkinson's catalyst.
4. What is DIBAL-H ? Give any two applications of DIBAL-H.
5. Give one synthetic application of LDA in organic synthesis.
6. How does a PTC work ?
7. Explain electrophilic substitution in thiophene.
8. How is indole synthesised ?
9. What are carbocations ? Discuss their formation, structure and stability.
10. Draw and explain the structure of carbene and its stability.
11. What are the addition polymers of isoprene ?
12. What happens when benzene is treated with Na in liquid Ammonia ? Name the reaction.

(12 × 1 = 12 weightage)

Section B

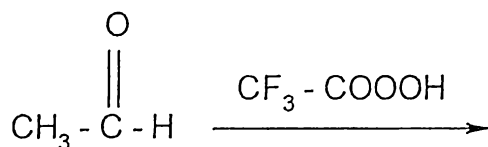
*Answer any eight questions.
Each question carries 2 weightage.*

13. Discuss the mechanism and application of :



Turn over

14. Complete the reaction with reasons :



15. Explain with mechanism : a) Birch Reduction ; b) MPV reduction.
 16. Explain the role of trimethylsilyl group in organic synthesis.
 17. Give the structure of NBS and DCC. Suggest one important use for each.
 18. Explain cationic polymerisation with example.
 19. What are the addition polymers of isoprene ?
 20. Give one method for the synthesis of : (a) Oxazole ; (b) Thiophene.
 21. Explain with mechanism : a) Clemmensen Reduction ; b) Bouveault - Blanc reduction.
 22. What is Negishi and Sonogashira cross coupling reactions ? Explain with suitable examples.
 23. Discuss the contraction and expansion of ring systems in organic synthesis.
 24. Explain the synthesis of : a) guanine ; b) thymine.

(8 × 2 = 16 weightage)

Section C

Answer any two questions.

Each question carries 4 weightage.

25. Explain with mechanism : a) Shapiro Reaction ; b) Noyori asymmetric hydrogenation ; c) McMurray Coupling ; and d) Hydroboration.
 26. Explain : a) C - Terminal Analysis ; b) N - Terminal Analysis ; and c) Structure of DNA.
 27. Explain the synthesis of : a) uracil ; b) cytosine ; and c) adenine.
 28. a) Explain the mechanism of Baeyer Villiger Oxidation. Give a suitable example.
 b) Write a note on Peterson Olefination.

(2 × 4 = 8 weightage)

**THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION
NOVEMBER 2021**

(CUCSS)

Chemistry

CH 3C 10—ORGANOMETALIC AND BIO-INORGANIC CHEMISTRY

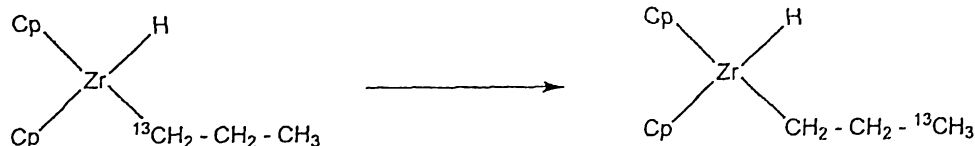
(2015 to 2018 Admissions)

Time : Three Hours

Maximum : 36 Weightage

Part A*Answer all questions.**Each question carries a weightage of 1.*

1. What is 16 electron rule ? Carbonyls of the heavier metals of groups 9 and 10 obey this rule. Why ?
2. What are the different co-ordination modes of NO in nitrosyl complexes ? How does the hybridisation of nitrogen changes and Why ?
3. What is hapticity of an organic ligand ? Write the molecular formula and predict the hapticity of cyclopentadienyl ligand in ferrocene.
4. What are fluxional organometallic compounds ? Explain the fluxional behaviour of $(\eta^1 - C_5H_5)_2 (\eta^5 - C_5H_5)_2 Ti$.
5. Explain with suitable example, the Dewar-Chat-Duncanson model of bonding in organometallic compounds.
6. What is Wade-Mingos-Lauher rule ? What is its significance ?
7. What is Vaska's compound ? Give its Structure. It undergo addition reaction with H_2 readily. Why ?
8. Give a suitable mechanism for the following conversion :



(Cp = Cyclopentadienyl Group)

Turn over

9. What are Siderophores ? How is it classified ? How they are helpful in transporting iron in micro-organism ?
10. Distinguish between bulk metals, trace metals and ultra-trace metals in living system.
11. Give an example for a platinum based anticancer Drug. Explain its structure and synthesis.
12. Give the structural features and function of Ferritin.

(12 × 1 = 12 weightage)

Part B

Answer any eight questions.

Each question carries a weightage of 2.

13. Explain the co-operativity of haemoglobin.
14. What is Nitrogenases ? Discuss its structure and function.
15. What is Photosystem ? Explain Photosystem I and II.
16. Discuss the similarities and differences of Haemerythrin with Haemoglobin and Myoglobin.
17. What is isolobal analogy ? Find out the isolobal fragments from the following and verify your answer. CH_2^+ , CH_2 , $\text{Mn}(\text{CO})_4$, $\text{Fe}(\text{CO})_4$, $[\text{PtCl}_4]^{2-}$, $\text{Cr}(\text{CO})_6$.
18. Discuss the nature and strength of the Metal - Metal bond in the acetate complexes of Copper and Chromium and compare with the bond length in their pure metals. Explain the reason for any difference.
19. What are different types of carbene metal complexes ? Give a brief account of the bonding in different carbene metal complexes.
20. Explain oxidative addition and reductive elimination with suitable example. What are the requirements for a metal complex to undergo oxidative addition reactions ? Discuss the mechanism of oxidative addition of hydrogen to metal complexes.
21. What are 1, 1 and 1, 2 insertion reactions ? Explain with suitable examples. Predict the product including its stereochemistry, of the reaction between $[\text{MnMe}(\text{CO})_5]$ and PPh_3 .
22. What is Ziegler-Natta catalyst ? What is the industrial importance of this catalyst ? Give the mechanism of the catalytic activity in olefin polymerisation.
23. What is Wacker Process ? Which is catalyst used and explain the mechanism of the process ?
24. What is Collman's reagent ? Give the method of preparation and its role in synthetic organic chemistry ?

(8 × 2 = 16 weightage)

Part C

Answer any two questions.

Each question carries a weightage of 4.

25. What is hydroformylation reaction ? Give the mechanism of the reaction. Explain how CO concentration influence the rate of the reaction ? Suggest a method to get linear aldehyde as major product than branched isomer ? Justify your answer.
26. Give the structure of Vitamin B₁₂ ? What are vitamin B_{12r}, B_{12s} and coenzyme B₁₂ ? Discuss the important functions of Vitamin B₁₂.
27. Give the method of preparation and important reactions of Ferrocene. Discuss the bonding and give the MO diagram of Ferrocene. Compared to ferrocene, Cp complexes of Co and Ni readily undergo oxidation while that of V and Cr readily undergo reduction ? Why ?
28. What is olefin metathesis ? Give the different catalyst employed and explain the mechanism. What are the various type of olefin metathesis ? Explain with examples.

(2 × 4 = 8 weightage)

THIRD SEMESTER M.Sc. DEGREE (SUPPLEMENTARY) EXAMINATION
NOVEMBER 2021

(CUCSS)

Chemistry

CH 3C 09—MOLECULAR SPECTROSCOPY

(2015 to 2018 Admissions)

Time : Three Hours

Maximum : 36 Weightage

Section A

Answer all questions.

Each question carries 1 weightage.

1. Explain why anti-Stokes lines are less intense than Stokes lines ?
2. Explain anharmonicity in vibrational spectroscopy.
3. What is Larmor frequency in Nuclear Magnetic Resonance Spectroscopy ?
4. Explain why in a doublet of ^1H NMR spectrum the relative peak areas are in the ratio of 1 : 1 ?
5. Draw the EPR spectrum of methyl free radical.
6. Explain uncertainty principle in spectral transitions.
7. What is meant by rigid rotor ?
8. Give examples for spherical top molecules and give the symmetric criteria.
9. What is zero point energy of simple harmonic oscillator ?
10. What is collision broadening in spectroscopy ?
11. ^{19}F is NMR active or not ? Why ?
12. Explain rule of thirteen in mass spectrometry.

(12 × 1 = 12 weightage)

Section B

Answer any eight questions.

Each question carries 2 weightage.

13. Explain the factors responsible for the hyperfine structure in ESR spectra. EPR.
14. Write a note on solvent polarity and steric parameters in UV-Vis Spectroscopy.
15. Write notes on : (i) Cotton effect (ii) Octant rule.

Turn over

16. a) How many hertz does 1 ppm correspond to, for a ^1H NMR instrument operating at a radiofrequency of 60 MHz ?
- b) The magnetic field (in Tesla) required for flipping a ^1H nucleus in an NMR spectrometer operating at 400 MHz is _____ [Given : $\gamma = 2.67 \times 10^8 \text{ T}^{-1} \text{ s}^{-1}$, $\pi = 3.14$]
17. What is Franck Condon principle ?
18. Detail electronic spectra of conjugated molecules.
19. Write a note on ionization techniques in Mass Spectrometry. What is FAB spectra ?
20. Draw a diagram showing the allowed rotational energies of a rigid diatomic molecule and explain.
21. The fundamental vibrational frequency of HCl is 2890 cm^{-1} . Calculate the force constant of this molecule. The atomic masses are $\text{H}^1 = 1.673 \times 10^{-27} \text{ kg}$; $\text{Cl}^{35} = 58.06 \times 10^{-27} \text{ kg}$.
22. The rotational Raman spectrum of H_2 gas is found to consist of a series of Stokes and anti-Stokes lines, the first of it appears at 3459 cm^{-1} relative to the source of excitation. Calculate the bond distance of H_2 .
23. Explain the microwave spectrum of a nonlinear polyatomic molecule.
24. Analyse the vibrations of CO_2 molecule to assess which are Raman active and which are IR active ?

(8 × 2 = 16 weightage)

Section C

Answer any **two** questions.

Each question carries 4 weightage.

25. a) Discuss FT techniques in NMR spectroscopy and explain its advantages.
- b) Relaxation methods in NMR spectroscopy.
26. a) Explain the origin of Stokes and anti-Stokes lines.
- b) Write a note on Resonance Raman Spectroscopy.
27. Write briefly on the Vibrational-rotational spectra of diatomics showing the origin of P branch and R branch of lines.
28. a) Explain the principle of EPR spectrum. What is “g” factor ?
- b) What is Zero field splitting in EPR ?

(2 × 4 = 8 weightage)