1M3N25337 (Pages : 3) Reg. No:.....

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Chemistry Degree Examination, November 2025

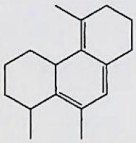
MCH3C09 – Molecular Spectroscopy

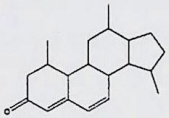
(2022 Admission onwards)

Time: 3 hours Max. weightage : 30

Section A Short Answer
Answer 8 Questions out of 12.
Each question carries a weightage of 1 (8 X 1 = 8)

1) If the rotational constant B of CO is 1.9225 cm^{-1}, calculate the bond length. (μ (CO) = 6.857×10^{-27} kg).
2) The vibrational frequency of HCl is approximately 2886 cm^{-1}. Calculate the force constant of the bond. (Given: $\mu = 1.626 \times 10^{-27}$ kg)
3) In an electronic spectrum of a diatomic molecule, the vibrational spacing decreases in the excited state. Why?
4) How do ladder operators (I_+ I_-) determine NMR transitions?
5) State the McConnell relation and its use.
6) State the Mossbauer effect and the condition for recoil-free fraction f to be significant.
7) Using Woodward Fieser rules, calculate the UV- λ_{max} of the following compounds.





8) If we add 20 ml of CCl_4 to 4 ml of ethyl alcohol how the position of O-H stretching frequency of ethyl alcohol is varied from the pure state. Give a suitable explanation.
9) Explain why the NMR spectrum of dimethylformamide (DMF) shows two CH_3 singlets at room temperature but a single signal at 150 °C.
10) How will you account triplet splitting pattern of $CDCl_3$ at δ 76, 77, 78 ppm in ^{13}C NMR?
11) What information does HMQC give that COSY cannot?
12) How will you differentiate 3-methylcyclohexene from 4-methylcyclohexene by mass Spectrometry?

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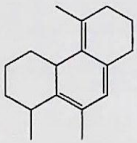

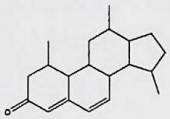

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Section B Short Essay
Answer 4 Questions out of 7.
Each question carries a weightage of 3 (4 X 3 = 12)

13) Compare and contrast the microwave rotational spectra of symmetric, asymmetric, and spherical top molecules. How do the differences in molecular geometry and moment of inertia affect the spectral patterns? Briefly describe the effect of isotopic substitution on rotational spectra.

14) Describe the classical and quantum mechanical explanations of the Raman effect. Differentiate between pure rotational Raman spectra and vibrational-rotational Raman spectra.

15) Explain the concept of chemical shift in NMR spectroscopy. Discuss spin-spin coupling and illustrate the origin of signal splitting using the AX, AB spin systems with appropriate quantum mechanical explanation.

16) Deduce the structure of the compound from the following spectral data. Explain the pattern of each and every signal with suitable explanation.
Molecular Formula- $C_{10}H_{12}O_2$
IR- 1730, 3000 cm^{-1}
1H NMR – δ (ppm)- 6.8-7.3 (m, 5H), 4.3 (t, 2H), 2.93 (t, 2H), 2.0 (s, 3H)
Mass- m/z- 73, 91, 149, 164

17) Discuss the principles of Optical Rotatory Dispersion (ORD) and Circular Dichroism (CD) spectroscopy. Specifically, describe the Octant Rule for determining the conformation and configuration of 3-methyl cyclohexanone.

18) (a) A compound with molecular formula C_7H_6O shows peaks at δ (ppm) 9.8, s, 1H and 7.2, m, 5H. It is on reaction with hydroxylamine followed by P_2O_5 resulted another compound with molecular formula C_7H_5N which showed an IR peak 2210 cm^{-1} and a ^1H NMR signal at δ (ppm) 7.3, s, 5H. Deduce the structure of these two compounds writing the reaction scheme. (2 weightage)
b) How will you differentiate enantiotopic protons from diastereotopic protons by ^1H NMR spectroscopy. (1 weightage)

19) (a) Explain the basic principles of Electron Impact Mass Spectrometry (EIMS). (1 weightage)
(b) How can we differentiate isomeric compounds with molecular formula $C_5H_{10}O$ by mass spectrometry. (2 weightage)

Section C Essay

Answer 2 Questions out of 4.

Each question carries a weightage of 5 (2 X 5 = 10)

20) (a) Deduce the structure and stereochemistry of the compound from the following spectral data. Explain the pattern of each and every signal with suitable explanation.

(i) UV- 284 nm, 308 nm

(ii) IR- 1690 cm^{-1}

(iii) ^1H NMR – δ (ppm)- 6.7 (dd, *J*= 16 Hz, 8 Hz, 1H), 7.40 (m, 5H), 7.45 (d, *J*= 16 Hz, 1H), 9.75 (d, *J*= 8 Hz, 1H)

(iv) ^{13}C NMR- δ (ppm) - 128.2, 128.3, 128.8, 131.0, 134.0, 152.0, 193.0.

(v) Mass- *m/z*- 132, 131, 103 (4 weightage)

(b) Explain off-resonance and noise decoupled spectra with examples. (1 weightage)

21) (a) Describe the principles and working of the Attenuated Total Reflection (ATR) FTIR spectroscopy technique. (1 weightage)

(b) Write a note on P, Q & R branches in vibrational spectrum (2 weightage)

(c) Explain the concept of Surface Enhanced Raman Scattering (SERS). Discuss the factors that lead to the enhancement of Raman signals and provide a practical example of how SERS is used in chemical analysis. (2 weightage)

22. (a) Describe the basic principles of ESR spectroscopy, with quantum mechanical treatment of electron spin in a magnetic field. Discuss the McConnell relation and the ESR spectra of systems containing equivalent and non-equivalent nuclei. (3 weightage)

(b) Discuss dissociation & predissociation. (2 weightage)

23. (a) Discuss the techniques used to simplify complex NMR spectra. Explain the principles behind double resonance, shift reagents, and the effect of increased field strength on NMR spectra. Provide examples of how these techniques can be applied to identify molecular structures. (4 weightage)

(b) A compound with molecular formula C_8H_9NO shows following peaks

IR – 3210, 1685 cm^{-1}

^1H NMR δ (ppm)- 2.4 (s, 3H), 6.8-7.5 (m, 5H) 8.1 (bs, 1H)

Mass- *m/z*-105

Deduce the structure of the compound. (1 weightage)

1M3N25338 (Pages : 2) Reg. No:..... (7)

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Chemistry Degree Examination, November 2025

MCH3C10 – Organometallic & Bio inorganic Chemistry

(2022 Admission onwards)

Time: 3 hours Max. weightage : 30

Section A : Short Answer
Answer 8 Questions out of 12.
Each question carries a weightage of 1 (8 X 1 = 8)

1 Discuss the preparation and bonding of η^3-allyl complexes.

2 Explain the role of π- back bonding in stabilising olefin and alkyne complexes.

3 How IR spectroscopy is useful in distinguishing bridging and non-bridging CO ligands.

4 Define oxidative addition and reductive elimination. Give one example each.

5 What is CO insertion reaction? Illustrate with a suitable mechanism.

6 Explain the fluxional behaviour of η^5-cyclopentadienyl ligands.

7 Describe the water-gas shift reaction.

8 Differentiate between polymers with organometallic moieties in the main chain and pendant groups.

9 State the structural role of calcium in the biological system.

10 What is cooperativity in heme-oxygen binding in hemoglobin?

11 Explain the Lewis acid role of Zn(II) in metalloenzymes with examples.

12 Explain the importance of Vitamin B12 and its coenzymes in biological systems.

Section B: Short Essay
Answer 4 Questions out of 7.
Each question carries a weightage of 3 (4 X 3 = 12)

13 Define metallocenes. Discuss the bonding in dibenzenechromium.

14 Explain the structure and bonding of metal nitrosyl complexes. Differentiate between linear and bent NO bonding modes.

15 Explain how Cativa process is better than Monsanto process.

16 Discuss the structure and synthesis of rigid rod polyyne polymers.

17 What are organometallic dendrimers? Discuss its structure and application.

18 Write short on the storage and transport of metal ions in biological systems.

19 Compare the oxygen transport mechanism in hemerythrin and hemicyanin.

Section C: Essay
Answer 2 Questions out of 4.
Each question carries a weightage of 5 (2 X 5 = 10)

20 (a) Explain the structure and bonding in diene complexes.

(b) Differentiate between Fischer and Schrock carbene complexes.

21 (a) Discuss the concepts of LNCC and HNCC rules in carbonyl clusters

(b) Show how isoelectronic and isolobal analogy helps in predicting cluster structures.

22 (a) Explain the concept of Tolman catalytic loop in homogeneous catalysis.

(b) Describe the mechanism of alkene hydrogenation using Wilkinson's catalyst.

23 Discuss the photosynthetic electron transport in PS-I and PS-II. Explain the role of Mg in chlorophyll.

1M3N25339 (Pages : 2) Reg. No:..... (8)

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Chemistry Degree Examination, November 2025

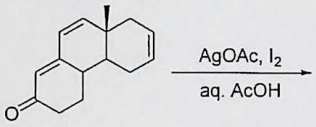
MCH3C11 – Reagents and Transformations in organic chemistry

(2022 Admission onwards)

Time: 3 hours Max. weightage : 30

Section A Short Answer
Answer 8 Questions out of 12.
Each question carries a weightage of 1 (8 X 1 = 8)

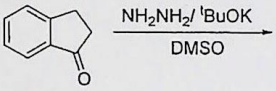
1) Outlining the mechanism, find out the major product of the following.



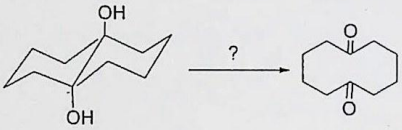
2) What is Bouveault- Blanc reduction? What is its synthetic importance?

3) Write a note on McMurry coupling reaction.

4) Giving the mechanism, identify the major product of the following reaction.



5) Suggest a suitable reagent for the following reaction. Justify your answer.



6) What is meant by free-radical polymerisation? Give an example.

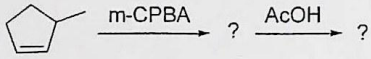
7) What are block and graft copolymers? Give examples.

8) Giving any two examples, mention the applications of synthetic rubbers.

9) What is the product formed when glyoxal reacts with ammonia and formaldehyde? Explain.

10) Give a synthetic method for uracil.

11) Complete and explain the following reaction.



12) Give the structure of Mukaiyama reagent/salt. What is its importance?

Section B Short Essay

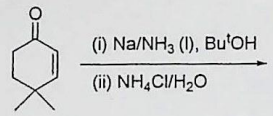
Answer 4 Questions out of 7.

Each question carries a weightage of 3 (4 X 3 = 12)

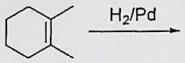
13) Emphasizing mechanism, explain briefly the synthetic importance of Sharpless asymmetric epoxidation.

14) Giving mechanisms, identify the major product of the following reactions. Indicate stereochemistry of the product wherever applicable.

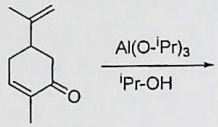
(i)



(ii)



15) Predict the major product of the following reaction. Explain the mechanism.



16) What are crown ethers? Add a note on their important synthetic applications.

17) Giving the structure of cellulose, explain the conversion of cellulose to rayon.

18) Explain Merrifield peptide synthesis.

19) Illustrating the mechanism of Ugi MCR, explain the synthetic potential of isocyanides in isocyanide based MCRs.

Section C Essay

Answer 2 Questions out of 4.

Each question carries a weightage of 5 (2 X 5 = 10)

20) Write a detailed account on the mechanisms of:

(i) Dess- Martin oxidation; (ii) Riley oxidation;

(iii) Jacobsen epoxidation; (iv) Sharpless asymmetric dihydroxylation.

21) Discuss the synthetic applications of the following reagents.

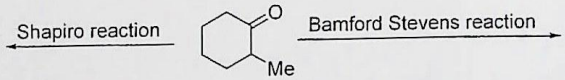
(i) DCC; (ii) Lindlar catalyst; (iii) DABCO; (iv) Gilman's reagent; (v) DDQ.

22) Explain one synthetic method each for:

(i) Quinoline; (ii) Isoquinoline; (iii) Aziridine; (iv) Azepine; (v) Benzodiazepine.

23) (a) Emphasizing the structure of Grubb's catalyst, write a note on olefin metathesis reactions. Your answer should contain a special mention on the mechanism and synthetic applications of the reaction.

(b) Suggest the reagents required for the following reactions and predict the major product in each case. Add their mechanisms.



(c) What is Baylis Hillman reaction? Write down the mechanism.

1M3N25340 (Pages : 2) Reg. No:..... (9)

Name: .....

FAROOK COLLEGE (AUTONOMOUS), KOZHIKODE

Third Semester M.Sc Chemistry Degree Examination, November 2025

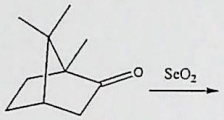
MCH3E01 – Synthetic Organic Chemistry

(2022 Admission onwards)

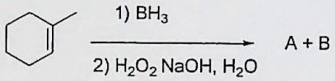
Time: 3 hours Max. weightage : 30

Section A Short Answer
Answer 8 Questions out of 12.
Each question carries a weightage of 1 (8 X 1 = 8)

1) Predict the product of the following reaction

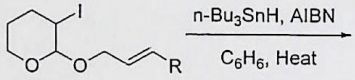


2) Identify A and B

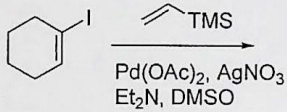


3) Write any two synthetic applications of Benzene tricarbonyl chromium

4) Identify the product of the following reaction

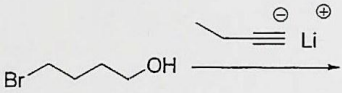


5) Predict the product and identify the reaction



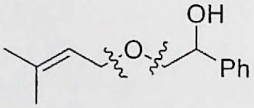
6) Suggest a protecting group for carboxylic acids, which is stable towards nucleophiles and bases. Indicate the conditions for removal.

7) How to do S_N2 in the following reaction?



8) Illustrate the concepts of synthon and synthetic equivalent with a retrosynthetic analysis of acetophenone.

9) Identify the best disconnection and provide the reason.



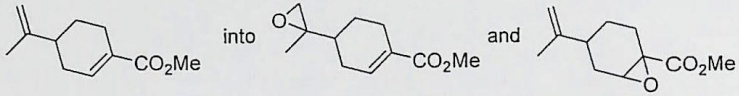
10) Two group disconnection is better than one. Justify the statement.

11) Using the principles of retrosynthetic analysis, propose a synthetic route for the preparation of 3-bromoaniline from simple aromatic starting materials.

12) Write short notes on the general structure and significance of anthocyanins.

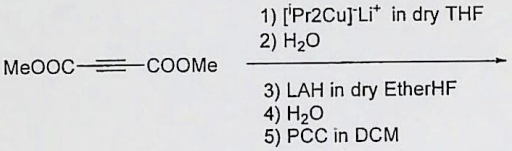
Section B Short Essay
Answer 4 Questions out of 7.
Each question carries a weightage of 3 (4 X 3 = 12)

13) Rationalize the following conversion with a proper explanation.



14) Explain the two synthetic application of the phase transfer catalyst.

15) Identify the product.



16) Write the mechanism of the Kumada reaction.

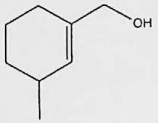
17) Explain the synthesis of Djerassi Prelog lactone.

18) Illustrate the use of the umpolung concept with reference to Benzoin condensation.

19) Discuss the complete structure elucidation of quinine, including the classical chemical degradations.

Section B Essay
Answer 2 Questions out of 4.
Each question carries a weightage of 5 (2 X 5 = 10)

20) (a) The following substrate is subjected to Sharpless asymmetric epoxidation in the presence of (-)-DET. Clearly illustrate the steps that impart enantioselectivity to the product.



(b) Illustrate the use of a heterogeneous catalyst in catalytic hydrogenation. (3+2)

21) Write the mechanism of Sonogashira coupling reaction and fetch its synthetic application in the preparation of cyclic peptides.

22) Explain the fundamental principles of retrosynthetic analysis. Illustrate these principles by providing retrosynthetic pathways for the following compounds:
(a) Paracetamol, (b) Benzocaine, and (c) Propranolol

23) Explain the synthesis of cephalosporin.