

Exam Code: 224702
(20)

Paper Code: 2224

Programme: Master of Science (Chemistry)
Semester-II

Course Title: Biology for Chemists

Course Code: MCHL-2056 ✓

Time Allowed: 3 Hours

Max Marks: 35

Note: Attempt five questions in all, selecting one question from each section (A to D). Fifth question can be attempted from any section. Each question carries equal (7) marks.

Section A

1. Differentiate DNA and RNA.
2. Difference between prokaryotic and eukaryotic cell.

Section B

3. Describe structure of neurons.
4. Give detail about connective tissue.

Section C

5. What is genetic code and its characteristics?
6. Discuss process of transcription in detail.

Section D

7. Who gave the five kingdom system of classification and explain this system?
8. Draw structure of virus and give its characteristics.

Exam Code: 224702
(20)

Paper Code: 2218

Programme: Master of Science (Chemistry)
Semester-II

Course Title: Organometallics Chemistry

Course Code: MCHL-2081

Time Allowed: 3 Hours

Max Marks: 70

Note: Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section. Each question carries 14 marks.

Section-A

1. (a) What do you mean by organolithium reagents? Discuss their preparation, structure With special reference to methyl lithium, and role in organic and inorganic synthesis. Support your answer with suitable examples.
- (b) Write a short note on each of the following:
 - (i) Role of trimethylaluminium in Zeigler-Natta polymerization of olefins
 - (ii) Structure of Zeise's salt

2. (a) Describe the preparation, bonding, and applications of organomercury compounds.
- (b) What are metal acetylenic complexes? Describe their structure and bonding with suitable examples.

Section B

3. (a) Explain the synthesis and structure of metal cyclobutadiene complexes. How does cyclobutadiene get stabilized by complexing with transition metals?
 - (b) What is ferrocene? Describe the bonding in ferrocene and discuss its stability, using molecular orbital treatment.
4. (a) Write a short note on Multidecker sandwich compounds. Give examples.
 - (b) Discuss the role of benzene and its derivatives in organometallic chemistry. Support your answer with suitable examples.

Section-C

5. (a) Describe in detail the mechanism of hydrocyanation of alkenes. Also, discuss the advantages of the process.
 - (b) What is the water gas shift reaction? Discuss its mechanism and industrial application.
6. (a) Explain with suitable examples the role of metal ions in the hydrolysis of amino acid esters and amides.
 - (b) Write a short note on modified aldol condensation.

Section-D

7. (a) What do you mean by pi-acid ligands? By taking the example of CO ligand, describe the bonding in metal complexes of such ligands using Molecular Orbital Model. Also, discuss the synergetic effect in such types of complexes.
- (b) How does vibrational spectroscopy assist in structure elucidation of metal carbonyls with special reference to:
- (i) Detection of terminal and bridging CO groups
 - (ii) Geometry of metal carbonyl
8. (a) Describe the following reactions of metal carbonyls along with balanced
- (i) chemical equation: Oxidative addition reaction
 - (ii) Insertion reaction
 - (iii) Substitution reaction
 - (iv) Action with metals
- (b) Explain the preparation, bonding and important reactions of metal nitrosyl complexes.

Exam Code: 224702
(20)

Paper Code: 2219

Programme: Master of Science (Chemistry) Semester-II

Course Title: Organic Reaction Mechanism-II

Course Code: MCHL-2082

Time Allowed: 3 Hours

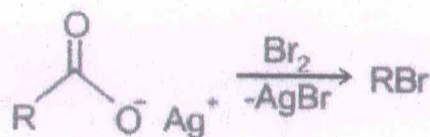
Max Marks: 70

Note: Attempt FIVE questions in all, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries 14 marks.

Section I

- 1 a Explain the formation of free radical species and effect of H on rate of reaction in Fenton's process.

b

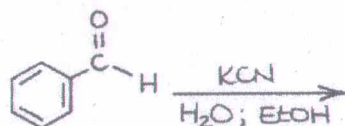


Name the reaction and explain the mechanism of the reaction.

- 2 Explain the following :-
(a) Oxidation of aldehydes to acids.
(b) Hunsdicker reaction.
(c) Free radical substitution at an aromatic substrate.

Section II

- 3 a What is nucleophilic addition to carbon-carbon double bond? How is it different from free radical addition to carbon-carbon double bond?
b State and explain Michael reaction.
4 a Explain the mechanism for the following reaction



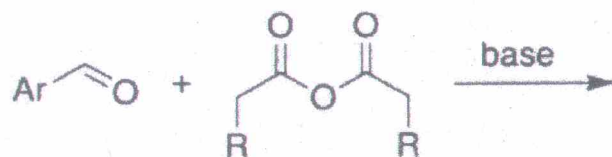
- b Write short note on Stobbe's reaction.

Section III

- 5 a What are the Limitations of the Friedel-Crafts Alkylation Reaction?
Endo product is the major product in Diel's Alder reaction, explain with help of mechanism

b

6 a



Name the reaction and discuss the mechanism.

- b Discuss the necessary conditions for 1-3 Dipolar additions

Section IV

- 7 Explain the following:

Mechanism of reduction of saturated and unsaturated carbonyl compounds by metal hydrides.

Addition of Grignard's reagent, ethyl lithium to carbonyl compounds followed by hydrolysis.

- 8 a Write the detailed mechanism and name of the reaction if ethyl methyl ketone is reacted with zinc amalgam and HCl.

- b What is the synthetic utility of ruthenium tetroxide?

Exam Code: 224702
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Paper Code: 2220

Programme: Master of Science (Chemistry)
Semester-II

Course Title: Physical Chemistry-Quantum Chemistry

Course Code: MCHL-2083

Time Allowed: 3 Hours

Max Marks: 70

Note: The candidates are required to attempt five questions in all. Selecting one question each from section A, B, C, D and fifth question may be attempted from any section. Use of nonprogrammable calculator is allowed. Each question carries 14 marks.

Section-A

1. (a) What is Compton effect? What is Compton shift? Write expression for Compton shift and explain the results obtained for scattering angle of 0° , 90° and 180° .
(b) Discuss the Rydberg relation for explaining atomic spectrum of hydrogen.
2. (a) Explain photoelectric effect. How it supported plank's concept?
(b) State and explain Heisenberg's uncertainty principle.

Section-B

3. (a) Verify the given function $\Psi = xe^{-\frac{1}{2}x^2}$ an Eigen function of operator $A = \frac{d}{dx^2} - x^2$
- (b) Briefly explain the following terms:
- (i) Normal and Orthogonal functions
 - (ii) Momentum operator
4. (a) Solve classical wave equation and discuss its relevance to quantum mechanics.
- (b) What are hermitian operators? Why quantum mechanical operators are hermitian in nature? Prove that two different Eigen functions of hermitian operators with different Eigen values are orthogonal in nature.

Section-C

5. Write Schrodinger equation for rigid rotator and solve it for the energy and wave function. Describe the conclusions also
6. (a) What are ladder operators? What is their importance?
- (b) Prove that Eigen values of L^2 operator are $2l+1$ times degenerate.

Section-D

7. Explain perturbation approximation method including perturbation of second order.
8. Explain Huckel molecular orbital theory for conjugated molecules. How it is applied and what information can be extracted from the results.

Exam Code: 224702
(20)

Paper Code: 2221

Programme: Master of Science (Chemistry) Semester-II

Course Title: Reaction Mechanisms and Metal Clusters

Course Code: MCHL-2084 ✓

Time Allowed: 3 Hours

Max Marks: 70

Note: Candidates are required to attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any section. Each question carries 14 marks.

Section-A

1. (a) Explain the dissociative mechanism of ligand substitution reactions in octahedral complexes. Also, discuss the types of intermediates formed and their stability.
1. (b) Differentiate between inert and labile complexes. Give suitable examples.
1. (c) Write a short note on metal carbonyl reaction species with 17 electrons.
2. (a) What is the *trans* effect? Discuss the polarization theory of the *trans* effect. Also, describe its applications.
2. (b) Explain the mechanism of ligand replacement reactions in square planar complexes. What is the role of solvent in these reactions?

Section B

3. (a) Consider the following reaction:

$$[\text{Cr}(\text{H}_2\text{O})_6]^{2+} + [\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]^{3+} \rightarrow [\text{Cr}(\text{H}_2\text{O})_6]^{3+} + [\text{Co}(\text{NH}_3)_5(\text{H}_2\text{O})]^{2+}$$

With appropriate reason explain the mechanism followed in the above electron transfer reaction. Also, discuss whether the electron transfer is fast or slow.
3. (b) What do you mean by cross-reactions in electron transfer processes? Discuss its general features.
4. (a) State and explain Marcus theory. Also, explain its kinetics and applications in detail.
4. (b) Describe the general features of the outer sphere mechanism in electron transfer reactions between transition metals

Section-C

5. (a) Describe the types of two-electron transfer reactions. Support your answer with suitable examples.
5. (b) What is metal carbonyl scrambling? What is its significance?
5. (c) What do you mean by stereochemical nonrigidity? Explain the phenomenon by taking an example of a trigonal bipyramidal complex.
5. (a) How does the nature of metal ions affect the stability of metal complexes? Give suitable examples.
6. (b) Describe stepwise and overall formation constant in metal-ligand equilibria in solution.
6. (c) Explain the determination of binary formation constant by Job's method.

Section-D

7. (a) What are phosphazenes? Describe their structure, bonding, and applications.
7. (b) Describe the various types of boranes and the basis on which these compounds are classified. How do carboranes differ from boranes?
8. (a) What do you mean by isopoly acids and salts? Describe these chemical species with examples.
8. (b) Describe isolobal analogy and its application.
8. (c) Explain trinuclear clusters having metal-metal bonds. Describe their structure and bonding by taking example of at least two clusters.

Exam Code: 224702
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Paper Code: 2222

Programme: Master of Science (Chemistry) Semester-II

Course Title: Spectroscopy B: Techniques for Structure
Elucidation of Inorganic Compounds

Course Code: MCHL-2085

Time Allowed: 3 Hours

Max Marks: 70

Note: Attempt FIVE question in all selecting one question from each of four sections. The fifth question may be attempted from any section. Each question carries 14 marks. Non-programmable calculator can be used.

Section-I

Q1 a For trans N_2F_2 molecule

- How many fundamental vibrations are expected?
- To which species do the following vibrations belong? N-N stretch, symmetric N-F stretch, and asymmetric N-F stretch.
- Can the N-N stretch and N-F stretch couple?

Q1 b Calculate the equilibrium internuclear separation and rotational constant in HF molecule given moment of inertia is $1.34 \times 10^{-40} \text{ g cm}^2$.

Q2 a Compare the intensities of overtones and fundamental bands in IR spectra.

Q2 b Discuss the Morse curves for a ground and excited state of a diatomic molecule with the help of harmonic and anharmonic vibrations.

Section-II

Q3 a A molecule AB_2 has the following infra-red and Raman spectra, the rotational fine structure of infra-red bands is complex and does not show simple PR or PQR characteristics. Comment on the molecular structure, and assign the observed lines to specific molecular vibrations as far as possible.

cm^{-1}	Infra-red	Raman
3756	Very strong; perpendicular	-
3652	Strong; parallel	Strong; polarized
1595	Very strong; parallel	

Q3 b Explain the importance of finger printing region.

Q4 a Discuss vibrational spectroscopy and its applications.

Q4 b How many normal modes of vibrations are possible for a) HBr b) NH_3 c) N_2F_2 d) CH_4 .

Section-III

Q5 a Explain the origin of lines in the epr spectrum of $(\text{CN})_5\text{CoO}_2\text{Co}(\text{NH}_3)_5$.

Q5 b Copper (II) acetate is a dimer, and the two copper atoms are strongly interacting. The epr spectrum consists of seven lines with intensity ratios 1:2:3:4: 3: 2:1. Copper nuclei have an I value of $3/2$, and copper acetate consists of a ground state that is a singlet and an excited state that is a triplet. Explain the number and relative intensity of the lines in the spectrum.

Q6 a Write short notes on the

Dissociation in XPS

Predissociation in XPS.

Q6 b Compare the phenomenon of XPS and UPS.

Section-IV

Q7a Consider the nitrogen nqr of each of the following systems. How many lines would you expect with and without a magnetic field? (For ^{14}N , $I = 1$.), Explain the reason also.

a. NH_3

b. NH_4^+

Q7 b Write the principle and applications of NQR.

Q8 a Illustrate the influence of a non-cubic electronic environment on (A) the nuclear energy states of ^{57}Fe and (B) the Mössbauer spectrum. (C) The iron MB spectrum of $\text{Fe}(\text{CO})_5$ at liquid N_2 temperature.

Q8 b What kind of structural information can be obtained from Mössbauer spectroscopy?

Exam Code: 224702
(20)

Paper Code: 2223

Programme: Master of Science (Chemistry) Semester-II

Course Title: Mathematics for Chemists

Course Code: MCHL-2336 ✓

Time Allowed: 3 Hours

Max Marks: 35

Note: Attempt five questions in all, selecting at least one question from each section. The fifth question can be attempted from any Section. Each question carries 7 marks.

Section-A

Q.1 (a) The Minute hand of a watch is 3 cm long. How far does its tip move in 20 Minutes?

(b) Find the degree measure corresponding to the radian measure $\frac{7\pi}{6}$

Q.2 (a) Find the value of the trigonometric function $\operatorname{cosec}(-1410^\circ)$

(b) Prove that $\tan 3x \tan 2x \tan x = \tan 3x - \tan 2x - \tan x$

Section-B

Q.3 (a) If $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 3 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & -1 & 3 \\ -1 & 0 & 2 \end{bmatrix}$. Find $2A - B$

(b) Express the Matrix $B = \begin{bmatrix} 3 & 3 & -1 \\ -2 & -2 & 1 \\ -4 & -5 & -2 \end{bmatrix}$ as the sum of symmetric and skew symmetric matrix.

Q.4 (a) Solve the following system of the equation by matrix method

$$3x - 2y + 3z = 8, \quad 2x + y - z = 1, \quad 4x - 3y + 2z = 4$$

(b) Reduce the matrix $\begin{bmatrix} 3 & -2 & 1 \\ 2 & -1 & 3 \\ 1 & -2 & 1 \end{bmatrix}$ to form I_3 and hence find its rank.

Section - C

Q.5 (a) Differentiate the function $\cos x^3 \cdot \sin^2(x^5)$ w.r.t. x

(b) Find $\frac{dy}{dx}$ of the function $y = \sin^{-1}\left(\frac{2x}{1+x^2}\right) - 1 < x < 1$

Q.6 (a) Find $\frac{dy}{dx}$, if $y^x + x^y + x^x = a^b$.

(b) If $y = \sin^{-1} x$, find the value of the following expression

$$(1 - x^2) \frac{d^2y}{dx^2} - x \frac{dy}{dx}$$

Section-D

Q.7 (a) Find the value of the integral $\int \frac{\sin x}{\sin(x+a)} dx$

(b) Solve the integral $\int \frac{dx}{\sqrt{5x^2-2x}}$.

Q.8 (a) Find $\int_0^2 (x^2 + 1) dx$ as the limit of a sum.

(b) Find the area enclosed by the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

Exam Code: 224702
 (20)

Paper Code: 9a37.

Programme: Master of Science (Chemistry) Semester-II

Course Title: Mathematics for Chemists

Course Code: MCHL-2336 ✓

Time Allowed: 3 Hours

Max Marks: 40

Note: Attempt five questions in all, selecting at least one question from each section. The fifth question can be attempted from any Section. Each question carries 8 marks.

Section-A

Q.1 (a) The Minute hand of a watch is 3 cm long. How far does its tip move in 20 Minutes?

(b) Find the degree measure corresponding to the radian measure $\frac{7\pi}{6}$

Q.2 (a) Find the value of the trigonometric function $\operatorname{cosec}(-1410^\circ)$

(b) Prove that $\tan 3x \tan 2x \tan x = \tan 3x - \tan 2x - \tan x$

Section-B

Q.3 (a) If $A = \begin{bmatrix} 1 & 2 & 3 \\ 2 & 3 & 1 \end{bmatrix}$ and $B = \begin{bmatrix} 3 & -1 & 3 \\ -1 & 0 & 2 \end{bmatrix}$. Find $2A - B$

(b) Express the Matrix $B = \begin{bmatrix} 3 & 3 & -1 \\ -2 & -2 & 1 \\ -4 & -5 & -2 \end{bmatrix}$ as the sum of symmetric and skew symmetric matrix.

Q.4 (a) Solve the following system of the equation by matrix method

$$3x - 2y + 3z = 8, \quad 2x + y - z = 1, \quad 4x - 3y + 2z = 4$$

(b) Reduce the matrix $\begin{bmatrix} 3 & -2 & 1 \\ 2 & -1 & 3 \\ 1 & -2 & 1 \end{bmatrix}$ to form I_3 and hence find its rank.

Section - C

Q.5 (a) Differentiate the function $\cos x^3 \cdot \sin^2(x^5)$ w.r.t. x

(b) Find $\frac{dy}{dx}$ of the function $y = \sin^{-1}\left(\frac{2x}{1+x^2}\right) - 1 < x < 1$

Q.6 (a) Find $\frac{dy}{dx}$, if $y^x + x^y + x^x = a^b$.

(b) If $y = \sin^{-1} x$, find the value of the following expression

$$(1 - x^2) \frac{d^2y}{dx^2} - x \frac{dy}{dx}$$

Section-D

Q.7 (a) Find the value of the integral $\int \frac{\sin x}{\sin(x+a)} dx$

(b) Solve the integral $\int \frac{dx}{\sqrt{5x^2-2x}}$.

Q.8 (a) Find $\int_0^2 (x^2 + 1) dx$ as the limit of a sum.

(b) Find the area enclosed by the ellipse $\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$

Exam Code: 224704

Paper Code: 4209

Programme: Master of Science (Chemistry) Semester: IV

Course Title: Advanced Inorganic Chemistry

Course Code: MCHL-4081

Time Allowed: 3 Hours

Maximum Marks: 80

Note: Attempt five questions in all, selecting at least one question from each section. Fifth question may be attempted from any section. Each question carries 16 marks.

Section A

1. (a) Explain the laws of photochemistry?
(b) What is quantum yield? Explain radiative and non-radiative processes in detail?
2. (a) Write down the photo substitution reactions of Cr(III) complexes?
(b) Explain the Bacterio chlorophyll photosynthesis?

Section B

3. (a) Explain the C-H activation process in detail?
(b) Explain the CO₂, SO₂ and NO₂ insertion processes?
4. (a) Write down a short note on hydrogen and organic halide addition process?
(b) How the metal atoms can behave as acid base in complexes?

Section C

5. (a) Explain the following:
(i) Boron hydrides (ii) Aluminohydrides
(b) Write the methods for the synthesis of hydrides? Also write their chemical behaviour?
6. (a) Explain the synthetic applications of metal hydrides?
(b) Describe the nature of molecular hydrogen compounds and interactions between M and H atoms?

Section D

7. (a) Explain the oxo process in detail?
(b) Write down the acrylonitrile synthesis with mechanism?
8. (a) Explain homogeneous and phase transfer catalysis?
(b) What do you understand by reductive carbonylation of alcohols?

(FOR REAPPEAR CANDIDATES ONLY (2023-2024))

Exam Code: 224704
(20)

Paper Code: 9417

Programme: Master of Science (Chemistry)
Semester-IV

Course Title: Advanced Inorganic Chemistry

Course Code: MCHL-4081 ✓

Time Allowed: 3 Hours

Max Marks: 60

Note: Students are required to attempt five questions selecting one question from each section. The fifth question may be attempted from any section. Each question carries equal (12) marks.

Section A

1. a. Discuss photosubstitution reactions of Ru(III) polypyridyl complexes.
b. Define Thexi states with example and discuss the franck condon principle.
2. a. Discuss Photo redox reactions of complexes of Cobalt (III).
b. Discuss Primary and Secondary Photochemical Stages with suitable examples.

Section B

3. a. Discuss the H_2 addition, $H-X$ addition, organic halides addition reactions occurring in TMCs.
b. Discuss insertion of CO_2 in TMCs with suitable examples
4. a. Explain with examples the insertion of 'alkenes in C-H bond and alkane activations in TMCs.
b. Discuss the acid base behaviors of metals in TMCs A

Section C

5. Discuss the synthetic methods, characteristics and chemical behavior of hydride compounds.
6. a. Discuss Mononuclear and homoleptic polyhydrides in detail.
b. Discuss Various complexes of boron hydride and aluminohydrides

Section D

7. Discuss
 - a) homogenous hydrogenation of unsaturated compounds
 - b) Alkene metathesis reactions
8. a. Discuss Palladium catalysed oxidation of ethylene.
b. Discuss oxygen -transfer reactions from NO_2 groups.

Exam Code: 224704
(20)

Paper Code: 4210

Programme: Master of Science (Chemistry)
Semester-IV

Course Title: Chemistry of Natural Products

Course Code: MCHL-4082 ✓

Time Allowed: 3 Hours

Max Marks: 80

Candidates are required to attempt five questions, selecting at least question from each section. The fifth question may be attempted from any section. Each question carries 16 marks.

Section A

1. a. The naturally occurring phenols have meta orientation, Explain
- b. Write short notes on 8
 - i. Isoprene rule 4
 - ii. Biogenetic isoprene rule 4
2. Discuss the chemistry of Farnesyl pyrophosphate. 16

Section B

3. a. Discuss the different methods used for the structure elucidation of camphor. 8
- b. Discuss transformations in steroid molecules. 8

4. Discuss the synthesis of Progesterone using stigmasterol as precursor. 16

Section C

5. Write short notes on
 - a Porphyrins 4
 - b Synthesis of antibiotics 8
 - c Prostaglandins E1 4
6. Discuss the synthesis of D-penicillamine and prove its structure 16

Section D

7. a Compare the properties of starch and cellulose. 8
b Discuss briefly the structures of maltose, lactose and sucrose. 8
8. What are secondary structures of proteins? Discuss the α helix structure. 16

Exam Code: 224704
(20)

Paper Code: 4211

Programme: Master of Science (Chemistry)
Semester-IV

Course Title: Electrochemistry and Chemical Dynamics

Course Code: MCHL-4083

Time Allowed: 3 Hours

Max Marks: 80

Note: Attempt five questions in all, selecting at least one question from each section. Fifth question may be attempted from any section. Each question carries 16 marks.

Section A

1. (a) Explain in detail what is Tafel's Plot?
(b) Explain electro-capillarity and Lipmann equation?
2. (a) Explain in detail Debye-Huckel-Onsagar treatment?
(b) Explain the following:
(i) Ion Solvent Interactions
(ii) Overpotential

Section B

3. (a) Explain collision theory and steric factor to determine the rate of reaction?
(b) Define kinetic salt effect? How can you determine the value of rate constant using primary salt effect?

4. (a) Explain zero and first order reaction? Write an expression for the determination of rate constant for first and zero order reaction?
- (b) What are the assumptions of Arrhenius theory and derive an expression for the calculation of rate of reaction?

Section C

5. (a) Explain Photochemical reaction? How can you determine the value of rate constant in reaction between hydrogen and bromine?
- (b) Define oscillatory reaction. Explain the mechanism and expression of Belousov-Zhabotinsky reaction?
6. (a) Explain Photochemical reaction? How can you determine the value of rate constant in reaction between hydrogen and chlorine?
- (b) Define homogeneous catalysis and explain in detail the kinetics of enzyme reactions?

Section D

7. (a) Explain how polarography helps in determination of different organic compounds?
- (b) What is Dropping Mercury Electrode? Explain its merits and demerits?
8. (a) What is an Ilkovic equation? What are the factors that affect the polarographic current?
- (b) How cyclic voltammetry helps in interpretation of the data?