Exam Code- 220402 **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:** 40

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 marks.

Section A

1) What are proteins? Give its classification in brief. (8)
2) Draw structure of following :
   i) Mitochondria
   ii) Golgi Apparatus (4+4)

Section B

3) Explain three types of muscle tissues. (8)
4) Give detail about simple permanent tissue. (8)

Section C

5) What are monohybrid and dihybrid crosses? (8)
6) Discuss process of replication. (8)

Section D

7) Give criteria of classification. (8)
8) Discuss Whittaker's system of classification. (8)

Exam Code: 220402 **Paper Code: 2318**

Programme: Master of Science (Chemistry) Semester- II

Course Title: Organometallics Chemistry

Course Code: MCHL-2081

Time Allowed: 3 Hours **Max Marks: 80**

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

Section-A

1. (a) What do you mean by Grignard reagents? Discuss their preparation, structure, and role in organic and inorganic synthesis. Support your answer with suitable examples.

   (b) Write a short note on each of the following:
   (i) Energy polarity and reactivity of M-C bond in organometallic compounds
   (ii) Metal allyl complexes

2. (a) Describe the preparation, bonding, and applications of organozinc compounds.

   (b) What are metal olefenic complexes? Describe their structure and bonding with suitable examples.

Section-B

3. (a) Describe the synthesis and structure of metal complexes of heterocyclic pentadiene with Sulphur and Selenium being the heteroatom.

   (b) What are cyclopentadienyl complexes? Discuss their types along with appropriate examples in each case.

4. (a) Write a short note on Multidecker sandwich compounds. Give examples.

(b) Explain the preparation and bonding in metal complexes of benzene.

Section-C

5. (a) What is homogenous catalysis? Discuss in detail the homogenous hydrogenation of unsaturated compounds along with its mechanism. Also, discuss the advantages of the process.

(b) Describe in detail the Ziegler-Natta polymerization of ethylene. Also, discuss the mechanism of the process.

6. (a) Explain with suitable examples the role of metal ions in the hydrolysis of peptides and amides.

(b) Write a short note on the Template and Macrocyclic effect.

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. 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) Geometry of metal carbonyl
(ii) Bond order of CO group

8. (a) Describe the following reactions of metal carbonyls along with balanced chemical equation:

(i) Oxidation reaction
(ii) Elimination reaction
(iii) Substitution reaction
(iv) Formation of Carbonyl Hydrido Complexes

(b) Explain the preparation, bonding and important reactions of metal dinitrogen complexes.

(For Reappear Candidates (2022-23))

Exam Code: 220402 **Paper Code: 9236**

Programme: Master of Science (Chemistry)
Semester: II
Course Title: Organometallics Chemistry
Course Code: MCHL-2081

Time Allowed: 3 Hours **Maximum Marks: 40**

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

Section A

1. (a) Explain technical applications of Tris (alkyl)aluminium compounds? (4)

   (b) Explain energy polarity and reactivity of metal carbon bond and stability of metal carbon bond? (4)

2. (a) Define organometallic compounds. Explain structure, bonding and methods of preparations of organolithium compounds? (4)

   (b) What are allylic complexes? Write down its methods of preparations and chemical reactions? (4)

Section B

3. (a) Explain in detail the synthesis and structure of η^4 –ligands: cyclobutadiene? (4)

   (b) Define heterocyclic compounds? Explain in detail the chemistry of heterocyclic pentadiene (S, Se, Te)? (4)

4. (a) Write down the Classification and Nomenclature of cyclopentdienyl complex? (4)

   (b) What is ferrocene? Explain molecular orbital treatment of ferrocene ligands? (4)

Section C

5. (a) What is homogeneous hydrogenation of unsaturated compounds. Explain reversible cis-dihydrocatalysis? (4)

   (b) What is hydrosilation and how it is carried out in unsaturated compounds? (4)

6. (a) What is Ziegler-Natta catalyst and explain the mechanism of polymerization of ethylene and propylene? (4)

   (b) Explain water gas shift reaction and acetic acid synthesis by carbonyls? (4)

Section D

7. (a) Explain pi-acceptor ligands. Draw the molecular orbital diagram of N_2 molecules and its bonding with transition elements? (4)

   (b) Define metal nitrosyl and explain its molecular orbital theory and chemical reactions? (4)

8. (a) What are transition metal nitrosyls? Explain its classification, bonding, structure and vibrational spectra of metal nitrosyl for bonding and structural elucidation? (4)

   (b) Write down the chemical reactions of oxygen and dinitrogen molecules? (4)

For Reappear Candidates (Old Syllabus (2022-23))

Exam Code: 220402 **Paper Code: 9237**

Programme: Master of Science (Chemistry)
Semester II
Course Title: Organic Reaction Mechanism-II
Course Code: MCHL-2082

Time Allowed: 3 Hours **Max Marks: 40**

Note: Attempt five questions in all, selecting atleast one question from each section. The fifth question can be attempted from any section. Each question carries equal (8) marks.

Section-A

Q1 a) Discuss various types of free radical reactions with suitable example. (4)

b) Explain mechanism at an aromatic substrate for free radical reactions. (4)

Q2 a) Explain effect of substrate structure, leaving group, attacking base and reaction medium on reactivity of E1 mechanism. (4)

b) Explain reaction and mechanism of E1cb reaction with example. (4)

Section-B

Q3) a) Explain the mechanistic and stereochemical aspects of addition to cyclopropane ring. (4)

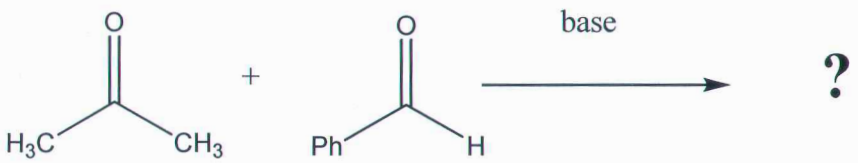
b) Discuss the reaction and mechanism of hydrogenation of aromatic rings with suitable example. (4)

Q4) a) Explain the reaction and mechanism of Wittig reaction with relevant example. (4)

b) Write note on Sharpless Assymmetric epoxidation with example. (4)

Section-C

Q5) a) Predict the product with mechanism. (4)



b) Explain reaction and applications of Claisen reaction with suitable example. (4)

Q6) a) Discuss applications of Mannich bases as an intermediate in organic synthesis. (4)

b) Write note on Michael addition reaction with suitable example. (4)

Section-D

Q7) a) Outline various oxidative processes and discuss two reagents used for the oxidation of alkenes. (4)

b) Discuss various reagents used for oxidation of carboxylic acids. (4)

Q8) a) Outline various reductive processes and discuss two reagents used for the reduction of aldehydes. (4)

b) Explain hydrogenolysis reaction for reduction of organic compounds. (4)

Exam Code: 220402 **Paper Code:2219**

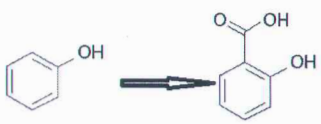
Master of Science (Chemistry)
Session: 2023-24
COURSE CODE: MCHL-2082
COURSE TITLE: Organic Reaction Mechanism - II

Time Allowed: 3 Hours **Maximum Marks: 80**

Note: (1) Attempt FIVE questions in all selecting one question from each of FOUR sections. The fifth question may be attempted from any Section.

(2) Each question carries 16 marks.

Section I

1 a)  6

Name the reaction and give the mechanism of the reaction.

b) With the help of example, explain pyrolytic elimination. 5

c) Writ the bromination products of 2 hexene with NBS and indicate the major product. 5

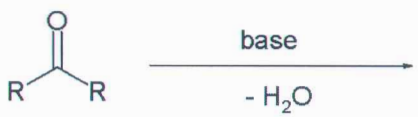
2 a) For allylic bromination NBS is preferred over other reagents, why? 6

b) What kind of effect is observed on the kinetics of free radical substitution reaction with the change of solvent from non-polar to polar? 10

Section II

3 a) How hydrogenation of carbon-carbon double bond is different from hydrogenation of carbon -carbon triple bond? 10

b) Write short note on hydrogenation of aromatic rings. 6

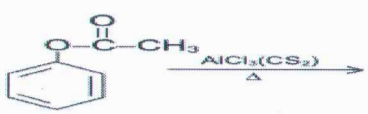
4 a)  12

Name the reaction and give the mechanism of the reaction.

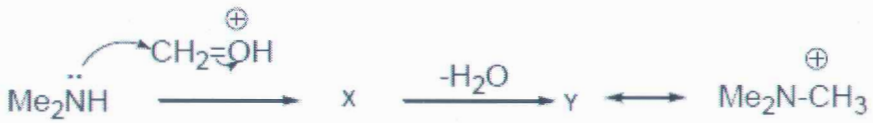
b) Write short note on Mannich reaction. 4

Section III

5 a) Discuss the role of Lewis acid in Friedel Craft's reaction. 4

 10

b) Name the reaction and discuss the mechanism.

6 a)  12

Draw the structures of X and Y and suggest the appropriate mechanism.

b) Discuss the necessary conditions for 1 -3 Dipolaradditions 4

Section IV

7 a) Write detailed mechanism of oxidation of 1° and 2° alcohols, also explain Why are tertiary alcohols not oxidized? 10

b) By taking two different examples illustrate the role of thallium nitrate in oxidation. 6

8 a) Write detailed mechanism of selective reduction of aldehydes, ketones and epoxides including all reaction intermediates. 12

b) Write short note on hydrogenolysis. 4

Exam Code: 220402 **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: 80**

Note: Attempt five questions in all, selecting atleast one question from each section. Fifth question may be attempted from any section. Each question carries 16 marks. Use of nonprogrammable calculator is allowed.

Section-A

1. State and explain
   (a) Compton effect
   (b) Heisenberg's Uncertainty principal. (8, 8)
2. (a) Explain the solution of classical wave equation by separation of variable method.
   (b) Calculate the short and long wavelength limits of Lyman series in the spectrum of hydrogen atom. (R_H=109691 cm^{-1}). (10, 6)

Section-B

3. Write a note on
   (a) Unity operator (b) eigen value equation
   (c) Hamiltonian operator (4,6,6)
4. (a) Write postulates of quantum mechanics.
   (b) Show that commutator $\left[x, \frac{d}{dx}\right]$= -1. (10, 6)

Section-C

5. (a) Derive the solution of Schrodinger wave equation for a particle in three-dimensional box.
   (b) What are ladder operators? What is their importance? (10, 6)
6. (a) Write a note on transformation of cartesian coordinate into polar coordinate.
   (b) Show that $\left[\hat{L}_y, \hat{L}_z = i\hbar\hat{L}_x\right]$. (10, 6)

Section-D

7. Discuss the linear combination of atomic orbital of allylic system? Also determine its bond order and charge density. (16)
8. Give applications of Variation method for Helium atom. (16)

Exam Code: 220402 Paper Code: 2221

Programme:Master of Science (Chemistry) Sem: II

Course Title: Reaction Mechanisms and Metal Clusters

Course Code: MCHL-2084

Time Allowed: 3 Hrs Maximum Marks: 80

Serial no.	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 equal marks.	Marks
	Section-A	
1. (a)	Explain the associative mechanism of ligand substitution reactions in octahedral complexes. Also, discuss the types of intermediates formed and their stability.	8
1. (b)	Differentiate between inert and labile complexes. Give suitable examples.	4
1. (c)	Write a short note on anation reactions.	4
2. (a)	What is the *trans* effect? Discuss the pi-bonding theory of the *trans* effect. Also, describe its applications.	8
2. (b)	Describe the factors that affect the ligand replacement reactions of square planar complexes? Also, explain the mechanism of reaction.	8
	Section-B	
3. (a)	Consider the following reaction: $[Fe(CN)_6]^{4-} + [Fe(CN)_6]^{3-} \rightarrow [Fe(CN)_6]^{3-} + [Fe(CN)_6]^{4-}$ With appropriate reason explain the mechanism followed in the above electron transfer reaction. Also, discuss whether the electron transfer is fast or slow.	10
3. (b)	Describe the general features of the inner sphere mechanism in electron transfer reactions between transition metals.	6
4. (a)	State and explain Marcus theory. Also, explain its kinetics and applications in detail.	10

4. (b)	Write a short note on the thermodynamics of electron transfer reactions.	6
	Section-C	
5. (a)	Differentiate between complimentary and non-complimentary reactions in two-electron transfer reactions. Support your answer with suitable examples.	4
5. (b)	Describe the process of isomerization and racemization of trischelates.	4
5. (c)	What do you mean by stereochemical nonrigidity? Explain the phenomenon by taking an example of a coordination complex with coordination number six or more.	8
6. (a)	How does the ligand chelate effect affect the stability of metal complexes? Give suitable examples.	4
6. (b)	Derive the relation between stepwise and overall formation constant in metal-ligand equilibria in solution.	4
6. (c)	Explain the determination of binary formation constant by pH-metry.	8
	Section-D	
7. (a)	What is borazine? Describe its preparation, bonding and structure. Why is it called inorganic benzene?	8
7. (b)	Describe the methods employed to classify boranes. What special type of bonding is present in boranes? Explain by taking a suitable example. How do carboranes differ from boranes?	8
8. (a)	What do you mean by heteropoly acids and salts? Describe these chemical species with examples.	4
8. (b)	Describe isolobal analogy and its application.	4
8. (c)	Explain binuclear clusters having metal-metal bonds. Describe their structure and bonding by taking example of atleast two clusters.	8

Exam Code: 220402 **Paper Code: 2222**

Master of Science (Chemistry)
Semester-II
COURSE TITLE: Spectroscopy B: Techniques for Structure Elucidation of Inorganic Compounds
COURSE CODE: MCHL-2085

Time: 3 Hrs **MM-80**

Attempt five questions, selecting at least one question from each section. The fifth question may be attempted from any Section. Each question carries equal marks. (16 Marks)

Section-A

Q1 a Write short note on

i Fermi resonance
ii Limitations of group vibration concept 8

Q1 b Find the moment of inertia of the hydrogen molecule about an axis passing through its center of mass and perpendicular to the inter-nuclear axis. Given: mass of the hydrogen atom $=1.7\times10^{-27}$ kg, inter-atomic distance $=4\times10^{-10}$m. 8

Q2a Categorize the molecules into groups according to their principal moments of inertia. 8

Q2b Three consecutive lines in the rotational spectrum of $H^{79}Br$ are observed at 84.544, 101.355 and 118.112 cm^{-1}. Assign the lines to their appropriate J''-J' transitions, then deduce values for B and D, and hence evaluate the bond length and approximate vibrational frequency. 8

Section-B

Q3a The symmetric stretch in CO_2 molecule is IR inactive whereas it is Raman active, explain the reason using selection rule. 8

Q3b Discuss the theory of pure rotational Raman spectra of linear molecule. Sketch the energy levels and the spectrum arising from transition between them. 8

Q 4 Discuss the quantum theory of Raman spectroscopy. Also show how stokes and anti-stokes lines appear in Raman spectrum of a molecule. 16

Section-C

Q5a Discuss the phenomenon of predissociation in photoelectron spectroscopy. 8
Q 5b Write short notes on 8
XPS
UPS.
Q6 Discuss the factors affecting line width in EPR spectrum. 8

Q6 b Write short notes on 8

Anisotropy in g value

The EPR of triplet state

Section-D

Q7a Calculate the energies of all the quadrupolar energy states for a nucleus with I = 2. Express the energies as a function of e2Qq. 8

Q7b In solid pyridine (CHN) at 77 K, 14N lines are found at 3.90 and 2.95 MHz. What are e2Qq/h and q for nitrogen in pyridine? 8

Q8 a Explain the effect of the Crystal Lattice on the Magnitude of e2Oq. 8

Q8 b The ^{59}Co *(1* = /2) frequencies in $ClSnCo(CO)_4$ occur at **35.02** MHz (+2 - i2), **23.37** MHz **(3/2 - ±/2),** and **11.68** MHz (±'/2 - ±3/2). Calculate **q** *and e2Qq.* 8

Exam Code: 220402 **Paper Code: 2223**
(20)

Programme: Master of Science (Chemistry)
Semester-II

Course Title: Mathematics for Chemists

Course Code: MCHL-2336

Time Allowed: 3 Hours **Max Marks: 40**

Paper consists of EIGHT questions of equal marks (8 marks each.) Attempt five questions in all by selecting atleast ONE question from each of Four section. Fifth question may be attempted from any section.

Section-A

1. (a) Show that 2 $\sin^2\beta$ + 4 cos $(\alpha + \beta)$ Sin α Sin β+ Cos 2 $(\alpha + \beta)$= Cos 2 α. 4

   (b) If α and β are the solutions of the equation a tan θ − b $sec\ \theta = c$, then show that tan $(\alpha + \beta)$ =$\frac{2ac}{a^2-c^2}$ 4

2. Show that

(a) $\begin{vmatrix} 1+a & 1 & 1 \\ 1 & 1+b & 1 \\ 1 & 1 & 1+c \end{vmatrix} = abc\left(1+\frac{1}{a}+\frac{1}{b}+\frac{1}{c}\right) =$

$abc + bc + ca + ab.$ 4

(b) If a,b,c are in AP find $\begin{vmatrix} 2y+4 & 5y+7 & 8y+a \\ 3y+5 & 6y+8 & 9y+b \\ 4y+6 & 7y+9 & 10y+c \end{vmatrix}$

4

Section-B

3. (a)Find the values of λ for which the equations

$$(2-\lambda)x + 2y + 3 = 0,$$
$$2x + (4-\lambda)y + 7 = 0,$$
$$2x + 5y + (6-\lambda) = 0$$

are consistent and find the values of x and y corresponding to each of these values of λ. 4

(b) Two eigen values of A are equal to 1. Find eigen value of A^{-1} where $A = \begin{bmatrix} 2 & 2 & 1 \\ 1 & 3 & 1 \\ 1 & 2 & 2 \end{bmatrix}$ 4

4. (a) For the matrix A = $\begin{bmatrix} 1 & 1 & 2 \\ 1 & 2 & 3 \\ 0 & -1 & -1 \end{bmatrix}$

find non- singular matrices P and Q such that PAQ is in the normal form. Hence find the rank of A. 8

Section-C

5. For a positive constant a find $\frac{dy}{dx}$, where

(a) $y = a^{t+\frac{1}{t}}$, and $x = \left(t + \frac{1}{t}\right)^a$ 4

(b) Differentiate $\text{Sin}^2 x$ w.r.t. e^{cosx}. 4

6. (a) Differentiate $y = \frac{x^3 \log 2x}{e^x \, sinx}$ with respect to x. 4

(b)Given $y = \frac{3e^{2\theta} \sec 2\theta}{\sqrt{\theta - 2}}$ determine $\frac{dy}{d\theta}$. 4

Section-D

7. (a) Evaluate $\int \left[\log(\log x) + \frac{1}{(\log x)^2}\right] dx$ 4

(b)Evaluate $\int_0^{\frac{\pi}{2}} \frac{sin^4 x}{\sin^4 x + cos^4 x}$ 4

8. (a) Find $\int \sqrt{\cot x} + + \sqrt{\tan x} \; dx$ 4

(b)Evaluate $\int_{\pi/6}^{\pi/3} \frac{dx}{1+\sqrt{tanx}}$ 4