

Total No. of Questions : 6]

SEAT No. :

PE4465

[Total No. of Pages : 4

[6510]-1

F.Y.M.Sc. (Physical Chemistry/Inorganic Chemistry/Analytical Chemistry/Organic Chemistry/Drug Chemistry)

CHE-501 : PHYSICAL CHEMISTRY - I

(2023 Credit Pattern) (Semester - I)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) Answer to the two sections should be written in separate answer books.
- 2) All questions are compulsory.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic table, calculator is allowed.
- 5) Neat diagrams must be drawn wherever necessary.

Physico - Chemical Constants

1. Avogadro Number	N	$= 6.022 \times 10^{23} \text{ mol}^{-1}$
2. Boltzmann Constant	k	$= 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3. Planck Constant	h	$= 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ Js}$
4. Electronic Charge	e	$= 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5. 1 eV		$= 23.06 \text{ kcal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6. Gas Constant	R	$= 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7. Faraday Constant	F	$= 96487 \text{ equiv}^{-1}$
8. Speed of light	c	$= 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9. 1 cal		$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10. 1 amu		$= 1.673 \times 10^{-27} \text{ kg}$
11. Bohr magneton	β_c	$= -9.274 \times 10^{-24} \text{ J T}^{-1}$
12. Nuclear magneton	β_n	$= 5.051 \times 10^{-27} \text{ J T}^{-1}$
13. Mass of an electron	m_e	$= 9.11 \times 10^{-31} \text{ kg}$

P.T.O.

SECTION-I

Q1) a) Answer the following. (any four) [8]

- i) What are the physical significance of ψ & ψ^2 ?
- ii) What do you mean by chemical potential?
- iii) What is Hamiltonian operator? Give its significance.
- iv) Explain exact differential.
- v) Give classical and quantum approach to Bohr's correspondence principle.

b) Find ΔU , q and w if 2 moles of hydrogen at 3 atm. pressure expand isothermally at 60° C and reversibly to a pressure of 1 atm. [3]

Q2) a) Attempt any three of the following [9]

- i) Derive Schrodinger's time independent wave equation.
- ii) What is expectation value of position $\langle \hat{x} \rangle$ for a particle present in one dimensional box?
- iii) Which of the following gives functions as Eigen functions for the operator $\frac{d^2}{dx^2}$?

$$f(x) = 6x \text{ and } 5\cos 2x.$$

iv) What are the postulates of quantum mechanics?

b) Which of the following operators commute with each other. [3]

i) $\left[\frac{\hat{d}}{dx}, \hat{x}^n \right]$

ii) $\left[\hat{x}, \hat{p}_x^n \right]$

Q3) a) Attempt any two of the following. [8]

i) Show that

$$1) \left(\frac{dT}{dV} \right)_s = - \left(\frac{dP}{dS} \right)_v$$

$$2) \left(\frac{dS}{dP} \right)_T = - \left(\frac{dV}{dT} \right)_p$$

- ii) Derive the Gibb's - Duhem Equation.
- iii) Derive the equation for change in entropy of mixing of two ideal gases.

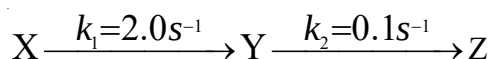
- b) Attempt any two of the following. [4]
- One mole of an ideal gas, maintain at 4.1 atmospheric pressure and at a certain temperature, absorb heat 3710 J and expand to two litres. Calculate the entropy change in expansion process.
 - For the reaction $\text{Ag}_2\text{O}_{(s)} \rightarrow 2\text{Ag}_{(s)} + \frac{1}{2}\text{O}_{2(g)}$
 $\Delta H = 30.56 \text{ KJ mol}^{-1}$ and $\Delta S = 6.66 \text{ JK}^{-1} \text{ mol}^{-1}$ at 1 atm. pressure. Calculate the temperature at which ΔG is equal to zero. Also predict the direction of the reaction at this temperature and below this temperature.
 - Show that, $C_p - C_v = nR$.

SECTION-II

- Q4) a) Solve any four of the following. [8]

- Plot schematically $\ln[A]_t$ v/s time for the first order reaction.
- What is stirring approximation? Find 50!
- What is the significance of k_m ?
- Write Arrhenius equation and explain the terms in it.
- What is canonical ensemble?

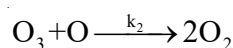
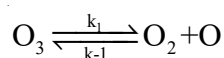
- b) For a consecutive reaction [3]



Find the time required for Y to reach its maximum concentration.

- Q5) a) Answer any three of the following [9]

- What is competitive enzyme inhibition? Derive its equation.
- The decomposition of ozone has the following mechanism



Show that Rate = $-k \frac{[\text{O}_3]^2}{[\text{O}_2]}$

- Discuss the explosion limits with suitable graph.
 - Explain any two methods for the determination of order of a reaction.
- b) Calculate the translational partition function for H_2 at 1000 K and 1 atm. [3]
 (Given Volume = 1m^3 , mass = $1.008 \times 10^{-3} \text{ kg}$)

Q6) a) Solve any two of the following. **[8]**

- i) Derive an expression for the rotational partition function.
- ii) Differentiate between the Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics.
- iii) Discuss Lindemann mechanism in detail.

b) Solve any 2 **[4]**

- i) Calculate the time required to complete the 99% of the first order reaction having half life of 10 min.
- ii) Calculate the temperature at which 10% of the molecule in a system is in the first excited state if this state is 400 KJ/mole above the ground state.
- iii) Find W for 15 molecules distributed among the energy levels of E_1, E_2, E_3 & E_4 as 6, 4, 2, 3 respectively where $S = k \ln W$.



Total No. of Questions : 6]

SEAT No. :

PE4466

[Total No. of Pages : 3

[6510]-2

M.Sc. (Part-I) (Physical/Inorganic/Analytical Chemistry)

CHE-502 : INORGANIC CHEMISTRY - I

(2023 Credit Pattern) (Semester - I) (4 Credits)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Answer to the two sections should be written separately in answer book.
- 3) Neat diagrams must be drawn wherever necessary.
- 4) Figures to the right indicate full marks.
- 5) Use of calculator and character table is allowed.

SECTION- I

Q1) a) Attempt the following. [8]

- i) Sketch any two symmetry operation of CH_2Cl_2 molecule.
- ii) List out symmetry element and point group for BF_3 molecule.
- iii) Prove that $i \times i = E$ using matrix multiplication method.
- iv) Enlist the symmetry element of CHCl_3

b) Find the product of [3]

- i) $C_2^{(z)} \times C_2^{(y)}$ and
- ii) $\sigma_v^{(xy)} \times \sigma_v^{(yz)}$ using matrix multiplication method.

Q2) a) Attempt any one of the following. [6]

- i) Find the product of symmetry operation and identify whether they are commutative or non-commutative.

1) $C_3^1 \times \sigma_{v_1}$

2) $C_3^1 \times C_3^1$

3) $\sigma_{v_3} \times \sigma_{v_2}$

P.T.O.

- ii) Draw all symmetry operation and assign the proper point group giving reason for following.
 - 1) PCl_5
 - 2) SF_6
- b) Attempt any two of the following. [6]
 - i) Identify and show the improper axis of rotation in CH_4 .
 - ii) Prepare group multiplication table for C_2V Point group.
 - iii) Find the order of group and number of classes in
 - 1) NH_3
 - 2) H_2O

Q3) Answer the following (any two) [12]

- a) Prove that $S_n^n = E$ using suitable example.
- b) Find out normal modes of vibration in following using their structures and appropriate formulae.
 - i) NH_3
 - ii) CO_2
 - iii) H_2O
- c) Enlist and explain all symmetry elements of XeOF_4 molecule.

SECTION- II

Q4) a) Answer the following: [8]

- i) Define electron precise hydrides with examples.
- ii) What are allotropes of carbon? Draw the structure of graphite.
- iii) Give any two examples of crown ethers with their structures.
- iv) What are pseudohalogens? Give their examples.

b) Give the synthesis and chemical reactions of borazine. [3]

Q5) a) Answer any one of the following. [6]

- i) Write a note on aluminosilicates
- ii) Explain the structure and bonding in:
 - 1) Diborane
 - 2) IF_7

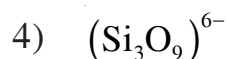
b) Answer any two of the following. [6]

- i) Write a note on phosphonitrilic compounds.
- ii) Give an account of xenon-fluorine compounds.
- iii) Give synthesis reactions and properties of organo-lithium compounds.

Q6) a) Answer any one of the following. [6]

i) Give an account of oxoanions of nitrogen.

ii) Draw the structures of following:



b) Answer any two of the following. [6]

- i) Write a note on metallic hydrides.
- ii) Give an account of boron hydrides.
- iii) Write a note on interhalogen compounds.



PE4467

[Total No. of Pages : 2

M.Sc.-I (Organic/Drug Chemistry)

CHEOD-502 MJ : INORGANIC CHEMISTRY - I
(2023 Credit Pattern) (Semester - I) (2 Credits)

[Max. Marks : 35

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicates full marks.*
- 3) *Neat diagrams must be drawn wherever necessary.*

- i) Define the symmetry elements and symmetry operations.
- ii) Sketch any two symmetry operations of SO_3 molecule.
- iii) Prove that $i \times i = E$ using matrices.
- iv) Enlist the symmetry elements of IF_7 molecule.

b) Find and explain the symmetry elements in NH_3 molecule. [3]

i) Using symmetry elements assign the point groups of the following molecule and justify your answer.

1) POCl_3

2) trans - ClCH=CHCl

ii) Using matrix multiplication method find the products of following.

$$1) \quad i \times \sigma h^{xz} \qquad 2) \quad C_2^z \times \sigma^{xy}$$

b) Attempt any two of the following. [6]

- i) Find the order of the group and number of classes in PCl_5 .
- ii) Using orthogonality theorem derive the character table for H_2O molecule.
- iii) Prepare group multiplication table for C_3V point-group.

P.T.O.

Q3) Answer the following. (any Two)

[12]

- a) Find out the normalized SALC for water molecule when projection operator B_1 operates on ϕ_1 orbital.

C_2V	E	C_2^z	σ_v^{xz}	σ_y^{yz}
B_1	1	-1	1	-1

- b) Sketch and explain all symmetry elements in CH_4 molecule.
- c) Label the following irreducible representations with appropriate Mulliken symbols using the rules.

	E	$2C_3$	$3C_2$	i	$2S_6$	$3\sigma_d$
$\bar{1}$	1	1	1	1	1	1
$\bar{2}$	1	1	-1	1	1	-1
$\bar{3}$	2	-1	0	2	-1	0
$\bar{4}$	1	1	1	-1	-1	-1
$\bar{5}$	1	1	-1	-1	-1	1

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Total No. of Questions : 8]

SEAT No. :

PE4468

[Total No. of Pages : 6

[6510]-4

M.Sc. - I (Organic / Drug Chemistry)

ORGANIC CHEMISTRY-I

CHE 503 MJ : Organic Reaction Mechanism, Stereochemistry and Reagents
(2023 Credit Pattern) (Semester - I) (4 Credits)

Time : 3Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Answer to the two sections should be written in separate answer book.

SECTION -I

Q1) Attempt the following.

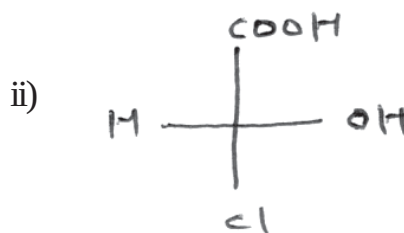
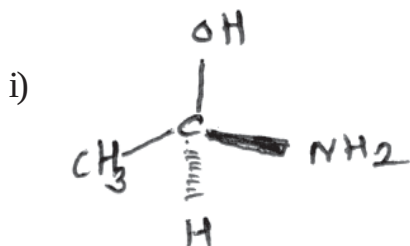
[5]

- a) Define inclusion compounds.
- b) Define Quasi-aromatic compounds.
- c) What is Ketene?
- d) Define stereo specific reaction with suitable example.
- e) Draw the structure of Cis-decalin.

Q2) A) Attempt any two of the following.

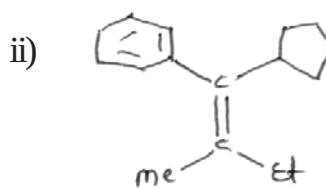
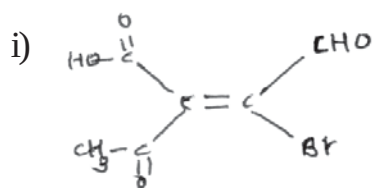
[6]

- a) Assign R/S configuration to the following compounds



P.T.O.

b) Assign E/Z configuration of the following compounds



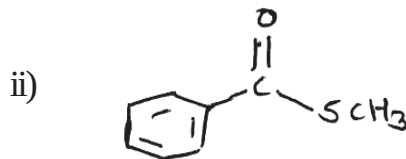
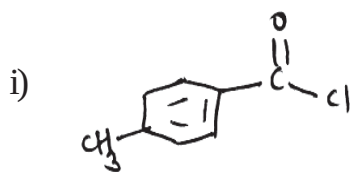
c) What are nitrenes? Give any two methods for the generators of nitrenes.

B) Write a notes on any two of the following. [4]

- Cryptates
- Annulenes
- Stability of free radicals

Q3) Attempt any five of the following. [10]

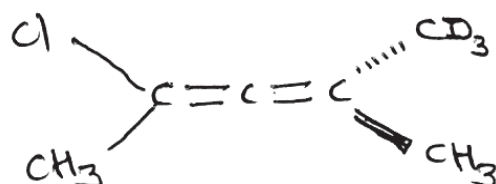
a) Assign Re/Si face labels to the following.



b) Comment on the stability of the following.

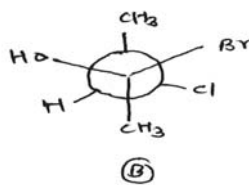
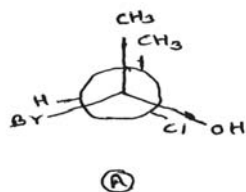


c) Comment on optical activity of the following with the justification.



d) Write the mechanism of reaction involving carbene intermediate.

- e) Explain optical activity of biphenyls with suitable example.
- f) Write a note on fullerenes.
- g) What is the relation between A & B?



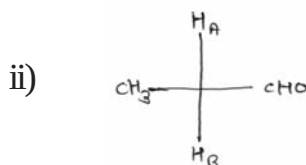
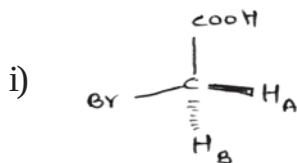
Q4) A) Attempt any two of the following.

[6]

- a) Comment on optical activity of the following.



- b) Assign Pro-R and Pro-S labels to H_A & H_B

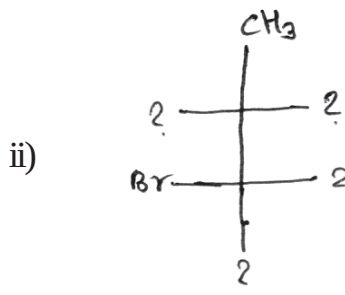
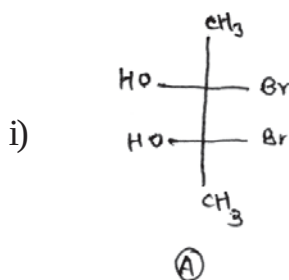


- c) Explain azulenes with suitable example.

B) Attempt any one of the following.

[4]

- a) Explain Stereochemical aspects of E_2 and E_1 elimination reaction.
- b) Write equivalent structure of compound A. Assign R/S configuration of Chiral centers.



SECTION - II

Q5) Attempt the following. [5]

- a) What is anchimeric assistance?
- b) What is tele substitution?
- c) What is DIBAL? Draw its structure.
- d) Pyrrole undergo electrophilic substitution at position.
- e) Give an application of TEMPO.

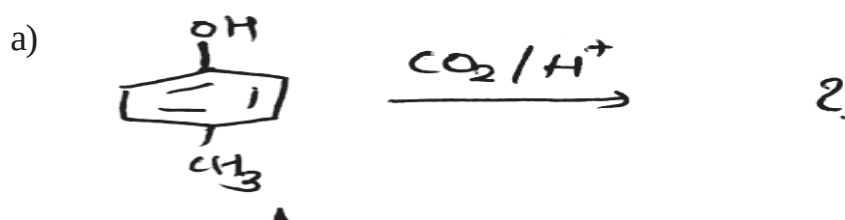
Q6) A) Attempt any two of the following. [6]

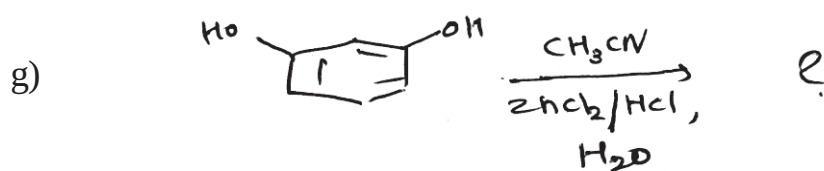
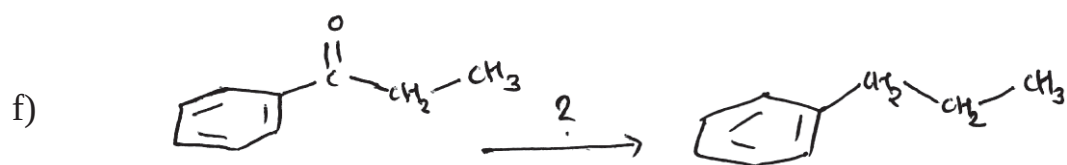
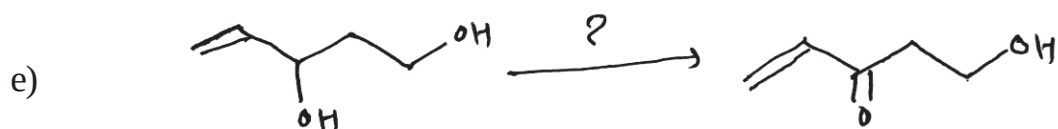
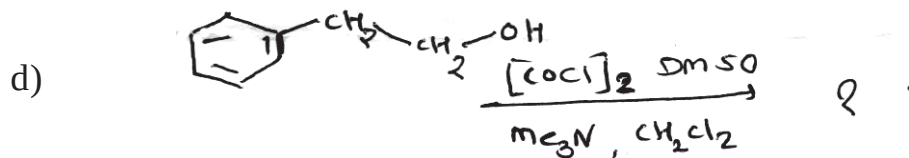
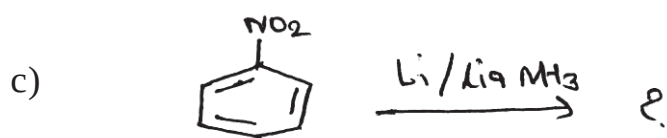
- a) Give two applications of RuO_4 with suitable example.
- b) Explain $\text{S}_{\text{N}}\text{i}$ reaction with stereochemical aspects.
- c) Explain Reimer-Tiemann reaction with mechanism.

B) Write notes on any two of the following. [4]

- a) Wolff-Kishner reduction
- b) Participation of Halogen atom in NGP.
- c) Sandmeyer reaction.

Q7) Attempt any five of the following. [10]





Q8) A) Attempt any two of the following.

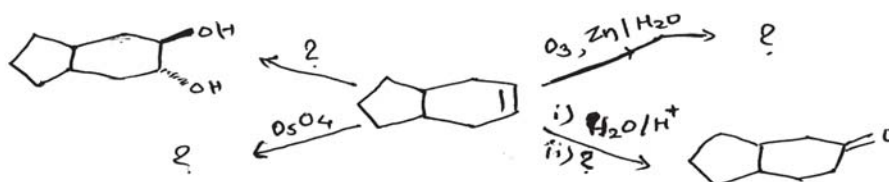
[6]

- Explain classical and non-classical carbocation with suitable example.
- Explain Vilsmeier-Haack reaction with suitable example.
- What is CAN? Give any two applications of CAN.

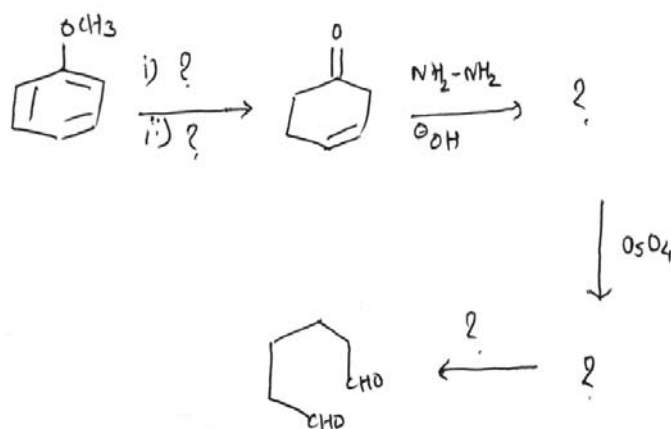
B) Attempt any one of the following.

[4]

a) Suggest the reagents/products of the following conversion.



b) Complete the following conversion.



Total No. of Questions : 4]

SEAT No. :

PE4469

[Total No. of Pages : 4

[6510]-5

M.Sc. - I (Physical/ Inorganic/ Analytical Chemistry)

ORGANIC CHEMISTRY - I

CHEPIA - 503 MJ : Aromaticity, Stereochemistry and Reagents
(2023 Credit Pattern) (Semester - I) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.

Q1) Attempt the following.

[5]

- a) Which of the following is non-aromatic.

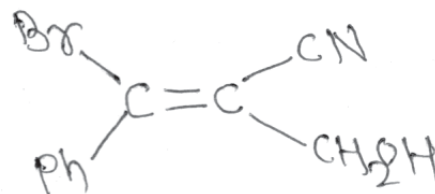
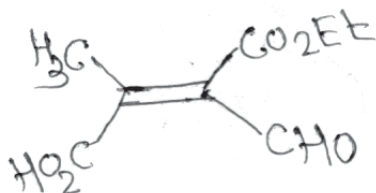


- b) Define diastereomers.
- c) What do you mean by prochiral carbon.
- d) Write the structure of IBX.
- e) Which reagent is suitable to convert primary alcohol to aldehyde?

Q2) A) Attempt any two of the following.

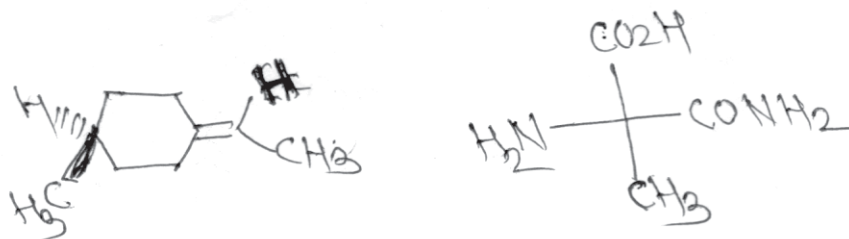
[6]

- a) Assign Elz configuration to the following compounds.



P.T.O.

b) Assign R/S configuration to the following compounds.



c) Comment on the aromaticity of [14] annulene.

B) Attempt any two of the following. [4]

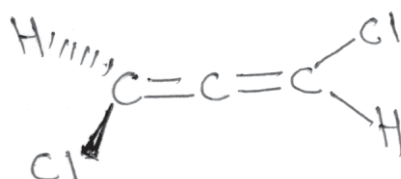
a) Suggest the reagents for the following reactions.



b) Predict the Product/s of the following reactions.



c) Comment on the optical activity of the following compound.



Q3) Attempt any five of the following. [10]

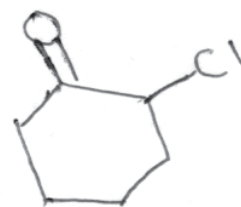
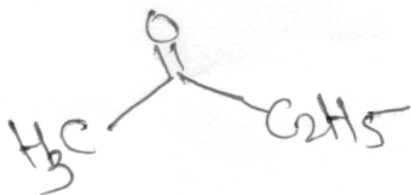
a) Comment on the stability of following compound.



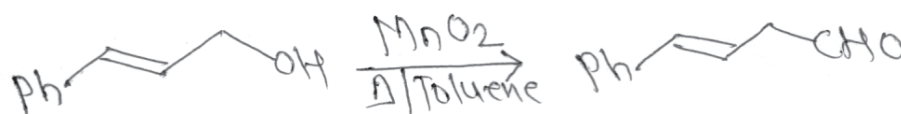
- b) Assign Pro-R and Pro-S labels to H_A and H_B



- c) Assign Re/Si labels to the following.



- d) Explain stereoselective reaction with suitable example.
e) Write the mechanism for the following reaction.

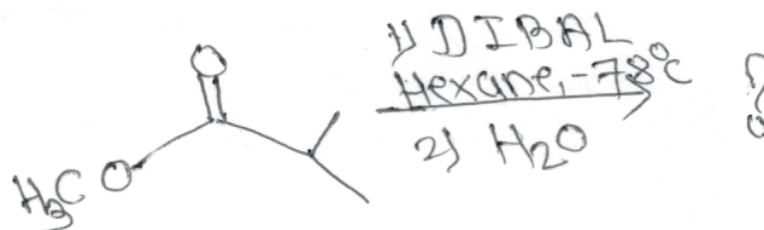


- f) What is TEMPO? Write any one application of it.
g) Azulene is stable compound & shows dipole moment. Explain.

Q4) A) Attempt any two of the following.

[6]

- Write a note on optical activity of ansa compound.
- Predict the product and write the suitable mechanism.

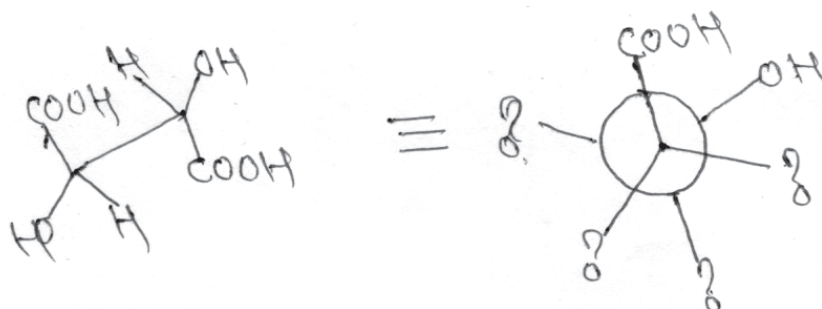


- Explain woodward dihydroxylation with suitable examples.

B) Attempt any two of the following.

[4]

- Convert Sawhorse projection formula to Newman projection as shown below.



- Write a note on prochirality.
- Write any one synthetic application of CAN and $NaBH_4/CeCl_3$.



[6510]-6

M.Sc. -I (Physical Chemistry/Inorganic Chemistry/Analytical
Chemistry/Organic Chemistry/Drug Chemistry)

CHE-507 (A) MJ : CHEMICAL MATHEMATICS

(2023 Credit Pattern) (Semester-I)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logarithmic table, calculator is allowed.

Q1) A) Solve the following any four.

[8]

a) $y = xe^{-ax}$, $\frac{dy}{dx} = ?$

b) $\int_0^{\pi/2} \sin x \, dx = ?$

c) Write any four rules of derivative.

d) If $A = \begin{bmatrix} 1 & 0 & 3 \\ 4 & 5 & 7 \\ 2 & -2 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 2 & 1 & -1 \\ 2 & 4 & 6 \\ 1 & 2 & 4 \end{bmatrix}$

What is $A \times B = ?$

e) Find $u \times v$ where $u = (3, 4, 7)$ $v = (2, -1, 7)$.

B) Find out whether the following equation is an exact or inexact.

[3]

$$3xy \, dx + 3y^2 x \, dy = 0$$

P.T.O.

Q2) A) Attempt any three of the following.

[9]

a) Find A^{-1} if $A = \begin{bmatrix} 1 & 2 & -1 \\ 0 & 1 & 3 \\ 7 & 2 & -1 \end{bmatrix}$

b) Find the inverse of the following matrix using minor, cofactor and adjoint.

$$A = \begin{bmatrix} 2 & 1 & 0 \\ -1 & 1 & 2 \\ 3 & 4 & 7 \end{bmatrix}$$

c) Find both the maximum value and minimum value of the function $f(x) = 3x^4 - 8x^3 - 48x + 25$ on the closed interval $[0, 3]$.

d) Determine the magnitude of the vector $A = 3i + 4j$

B) Solve $\int \log x \, dx = ?$

[3]

Q3) A) Attempt any two of the following.

[8]

a) i) Solve the determinant

$$A = \begin{bmatrix} 3 & 1 & 0 \\ 1 & -2 & 7 \\ 1 & 1 & 3 \end{bmatrix}$$

ii) Verify that $y = \cos x + c$ is a solution of $(\partial y / \partial x) + \sin x = 0$

b) Define the term.

i) Column matrix

ii) Row matrix

iii) Square matrix

iv) Diagonal matrix

c) Find partial derivation of f w.r.t. x .

$$f(x) = x^2y + 3xy$$

B) Solve any one.

[4]

a) i) $y = 2x^2 + e^x$, $\frac{dy}{dx} = ?$

ii) $\int_0^1 x \sin x \, dx = ?$

b) i) $\int_0^1 \left(3x^2 + \frac{x}{2} + 4 \right) dx = ?$

ii) If $A = \begin{bmatrix} 2 & 3 \\ -2 & 1 \end{bmatrix}$, $B = \begin{bmatrix} 1 & -2 \\ 7 & 2 \end{bmatrix}$

Find $A^T + 3B = ?$



Total No. of Questions : 3]

SEAT No. :

PE4471

[Total No. of Pages : 2

[6510]-7

M.Sc. - I (Physical Chemistry/Inorganic Chemistry/Analytical Chemistry)

GENERAL CHEMISTRY

CHE-507(B)-MJ : Chemistry of Nanomaterials

(2023 Credit Pattern) (Semester - I) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Neat diagrams must be drawn whenever necessary.*
- 3) *Figures to the right indicate full marks.*

Q1) a) Answer the following. [8]

- i) What do you mean by nanomaterial?
- ii) What is Schottky & Frenkel defect?
- iii) What is Band gap of material ? Give a diagram for band gap of semiconductor.
- iv) What are Non-stoichiometric materials?

b) What is sol-gel synthesis for nanomaterials? [3]

Q2) a) Answer any one of the following. [6]

- i) What is co-precipitation method? Explain advantages of co-precipitation method.
- ii) Explain the applications of nanomaterials in environmental remediation.

b) Attempt any two of the following. [6]

- i) Explain synthesis of MgAl_2O_4 by alkoxide sol gel method.
- ii) What do you mean by defects? Explain general defects in materials.
- iii) What is nano catalysis? Explain applications of nano catalysis.

P.T.O.

Q3) a) Answer any one of the following. **[6]**

- i) Explain synthesis of nanomaterials by
 - 1) Hydrothermal synthesis
 - 2) Microwave synthesis.
- ii) Discuss the applications of nanomaterials in fuel cells and photovoltaic cells.

b) Answer any two of the following. **[6]**

- i) Define bottom up and top-down approach.
- ii) What do you mean by colour centres? What is importance of colour centres?
- iii) What is photocatalysis? Explain role of nano catalyst in photo catalysis.



Total No. of Questions : 4]

SEAT No. :

PE4472

[Total No. of Pages : 2

[6510]-8

M.Sc. - I (Physical/Inorganic/Analytical/Organic/Drug Chemistry)

CHEMISTRY

CHE-507(C) MJ : Analytical Chemistry

(2023 Credit Pattern) (Semester - I)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Draw diagram wherever necessary.*

Q1) Answer the following.

[5]

- a) What is TOF Analyzer?
- b) Write any two applications of Mass Spectrometry.
- c) What is Laboratory accreditation?
- d) What is electronic records with respect to laboratory environment?
- e) Give importance of MSDS.

Q2) a) Attempt any two of the following.

[6]

- i) Explain electron ionisation in mass spectrometry.
- ii) Give the safety symbols & write their meaning.
- iii) Write a note on quality assurance.

b) Attempt any two of the following.

[4]

- i) What is TLV term?
- ii) Give the management of toxic gases.
- iii) Calculate the resolution in mass spectrum of a peak that is centred at 243 a.m.u. and has a peak width at 4% of the peak height that is 0.51 a.m.u.

P.T.O.

Q3) Attempt any five of the following. **[10]**

- a) Write the principle of magnetic analyzer in mass spectrometry.
- b) Write any two examples of oxygen displacing gases.
- c) Draw safety symbol for flammable material.
- d) What is CFR?
- e) Describe any two guidelines for labelling chemicals.
- f) Describe the importance of SOP.
- g) Write a note on fragmentation pattern in mass spectrometry.

Q4) a) Attempt any two of the following. **[6]**

- i) Explain the principle & working of Mass spectrometry.
- ii) What is fire extinguisher? Which type of fire extinguisher is used for chemical fire & electrical fire.
- iii) Write a note of first aid.

b) Attempt any one of the following. **[4]**

- i) Explain in detail secondary-ion mass spectrometry.
- ii) Write a note on Good Laboratory practices.



Total No. of Questions : 3]

SEAT No. :

PE4473

[Total No. of Pages : 2

[6510]-9

M.Sc. - I (Physical Chemistry/Inorganic Chemistry/Analytical Chemistry)
CHEPIA-507(D) MJ : BASIC ORGANIC CHEMISTRY
(2023 Credit Pattern) (Semester - I) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

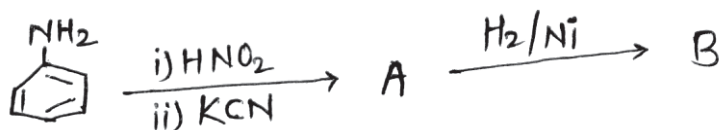
Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.

Q1) a) Answer the following (Any four). [8]

- i) Explain the term rotaxanes with suitable example.
- ii) Hydrolysis of $\text{Ph-CH}_2\text{-CH}_2\text{-OTs}$ is Faster than $\text{CH}_3\text{-CH}_2\text{-CH}_2\text{-OTs}$. Explain.
- iii) What is cine substitution?
- iv) Give any two methods for the generation of nitrenes.
- v) What is SN^1 reaction?

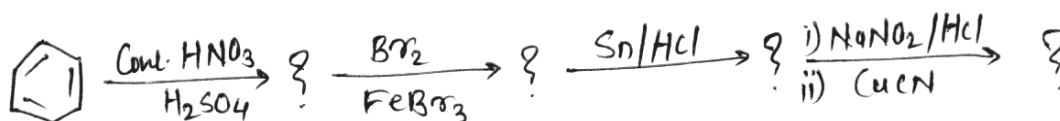
b) Identify the product A & B. [3]



Q2) a) Attempt any three of the following. [9]

- i) Explain structure, stability and methods for the generation of carbenes.
- ii) Explain Gatterman-Koch reaction with mechanism.
- iii) Comments on NGP by heteroatoms.
- iv) Discuss the formation of electron donor-acceptor complexes.

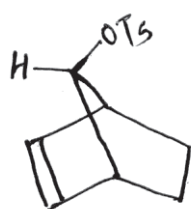
b) Complete the following reaction sequence. [3]



P.T.O.

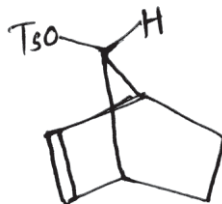
Q3) a) Attempt any two of the following. [8]

- The reaction of singlet carbene proceeds via concerted reaction while the reaction of triplet carbene proceeds via non-concerted pathway. Explain.
- Comment on the relative rates of acetolysis reaction for the following compounds.



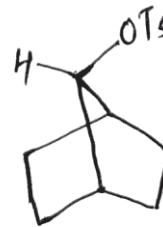
(A)

10^{11}



(B)

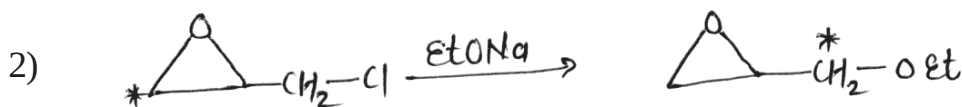
10^4



(C)

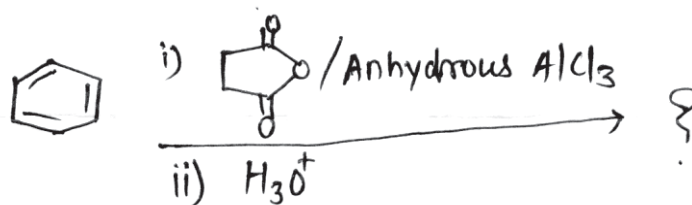
1

- Suggest the mechanism for the following reactions.



b) Attempt any two of the following. [4]

- Write a short note on chichibabin reaction.
- Vinyl chloride resists the hydrolysis while allyl chloride is easily hydrolysed by $\text{S}_\text{N}1$ mechanism. Explain.
- Predict the product for following reaction.



Ⓢ Ⓢ Ⓢ Ⓢ

[6510]-10

F.Y. M.Sc. (Organic Chemistry and Drug Chemistry)

ORGANIC CHEMISTRY

CHEOD - 507(D) - MJ: Organic Reactions and Reagents

(2023 Credit Pattern) (Semester - I) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

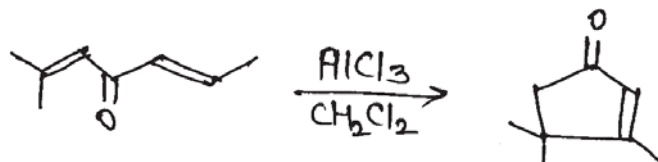
Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.

Q1) A) Answer the following (any 4). [8]

- a) Why secondary amine is more preferred in stork enamine reactions.
- b) Explain the role of TiCl_4 in McMurry reaction.
- c) Why are Grignard reagents unstable?
- d) Discuss the preparation of phosphorous ylide.
- e) Explain the role of organo zinc reagents in preparation of β - hydroxy esters.

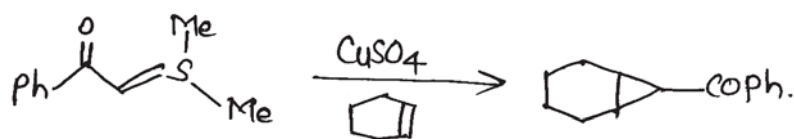
B) Suggest the Mechanism for following reaction. [3]



Q2) A) Attempt any three of the following. [9]

- a) Write a short note on Benzoin condensation.
- b) Write a note on Eschenmoser Tanabe reaction.
- c) Discuss the preparation and uses of Gilman reagents.
- d) Discuss the role of nitrogen ylide in polonovski reactions.

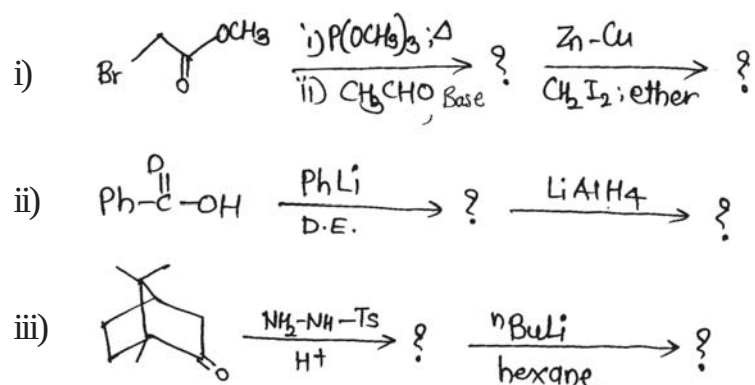
B) Suggest the Mechanism for following reaction. [3]



P.T.O.

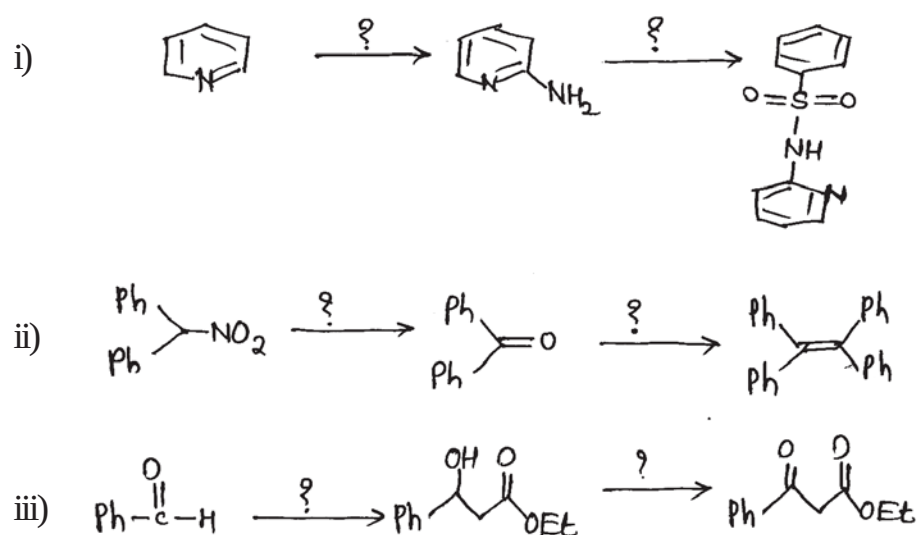
Q3) a) Predict the products with mechanisms (any two).

[8]



b) Suggest the reagents for following conversions (any two).

[4]



Total No. of Questions : 8]

SEAT No. :

PE4475

[6510]-11

[Total No. of Pages : 4

M.Sc.-I (Physical Chemistry/Inorganic Chemistry/Analytical Chemistry /
Organic/Drug Chemistry)

CHEMISTRY

CHE-508-MJ : Research Methodology
(2023 Credit Pattern) (Semester - I) (4 Credits)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Answer of the two sections should be written in separate answer book.
- 3) Figures to the right indicate full marks.

SECTION-I

Q1) Attempt the following. [5]

- a) What is mean by plagiarism?
- b) Define fundamental research.
- c) Write any two characteristics of good review.
- d) Define corrosive agent.
- e) Define ANOVA.

Q2) a) Attempt any two of the following. [6]

- i) Explain the types of research ethics.
- ii) Write a short note on literature survey.
- iii) What are the differences between patents and copyright?

b) Attempt any two of the following. [4]

- i) Write the symbols for corrosive substances and toxic substances.
- ii) How is sci finder used for online literature search?
- iii) What are objectives of research?

P.T.O.

Q3) Attempt any five of the following. **[10]**

- a) Write the importance of fire fighting devices.
- b) Explain theoretical and experimental research.
- c) Write a note on intellectual property right.
- d) What is mean by first aid and write their importance?
- e) Enlist different chemistry software used for drawing the chemical structure.
- f) Explain the characteristics of good research.
- g) How do you find abstract, keywords in research paper?

Q4) a) Attempt any two of the following. **[6]**

- i) What are the differences between research paper and review articles?
- ii) Explain Beilstein system.
- iii) How to write data analysis in research?

b) Attempt any two of the following. **[4]**

- i) What is science direct? Give its applications.
- ii) Write a note on hazardous chemicals.
- iii) Write the use of chem-Draw and Excel sheet in chemistry.

SECTION-II

Q5) Attempt the following. **[5]**

- a) Define SJR and SNIP.
- b) What is mean by Impact factor?
- c) Define hypothesis.
- d) What is CAS number?
- e) What is mean by SCOPUS?

Q6) a) Attempt any two of the following. **[6]**

- i) Describe the criteria for good research.
- ii) Give the classification of hazardous substances.
- iii) Write the differences between patents and copyrights.

b) Attempt any two of the following. **[4]**

- i) What is a role of science direct in research?
- ii) Write any two applications power point presentation in research.
- iii) Explain the term dead stock inventory.

Q7) Attempt any five of the following. **[10]**

- a) Enlist the names of any two research publishers in chemistry.
- b) Write a short note on IPP.
- c) Write in brief about scientific methods in research.
- d) Write a short note on monograph.
- e) Explain the term chemical waste management.
- f) Briefly explain the significance of data processing.
- g) What are the significance of google scholar.

Q8) a) Attempt any two of the following. **[6]**

- i) Define research methodology, Discuss various stages in research process.
- ii) What do you mean by bibliography? Name any two reference managing tools.
- iii) Briefly explain reuse of laboratory chemicals.

b) Attempt any one of the following. **[4]**

- i) Give the classification of hazardous chemicals.
- ii) Enlist the safety measures to be taken while handling chemicals.



Total No. of Questions : 8]

SEAT No. :

PE4476

[Total No. of Pages : 5

[6510]-21

M.Sc.-I (Physical Chemistry/Inorganic Chemistry/Analytical Chemistry)

CHE-551MJ : PHYSICAL CHEMISTRY-II

(NEP 2023 Credit Pattern) (Semester - II)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) Answer of two sections should be written in SEPARATE answer books.
- 2) All questions are Compulsory.
- 3) Figures to the Right side indicate full marks.
- 4) Use of logarithmic table and non-programmable calculator is allowed.
- 5) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

1) Avogadro Number	$N = 6.022 \times 10^{23} \text{ mol}^{-1}$
2) Boltzmann Constant	$k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ kcal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equiv}^{-1}$
8) Speed of light	$c = 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-24} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

SECTION - I

Q1) Answer the following. **[5]**

- a) Define Franck-Condon principle
- b) What is Morse potential curve?
- c) What is force constant?
- d) Classify molecule according to moment of inertia
 - i) BCl_3
 - ii) OCS
- e) Calculate the number of Fundamental vibrations in
 - i) C_6H_6
 - ii) H_2O

Q2) a) Answer any 2 **[6]**

- i) Derive the relation between Centrifugal constant D and vibrational constant B
- ii) Explain predissociation in electronic spectroscopy with diagram
- iii) Explain the principle of mossbauer spectroscopy.

b) Solve any 2 **[4]**

- i) Calculate the population of rotational energy level $v = 1$ at 30°C if the energy separation between $v = 0$ and $v = 1$ state is 2225 cm^{-1} and the population of the ground state energy level is 100000.
- ii) The rotational constant for $^{79}\text{Br } ^{19}\text{F}$ is 0.35717 cm^{-1} . What is the value of J for which the most intense line will be seen at 30°C ?
- iii) The fundamental vibration frequency for HCl is 2886 cm^{-1} and first overtone is 5668 cm^{-1} . Calculate anharmonicity constant and equilibrium vibrational frequency.

Q3) a) Answer any 2 **[6]**

- i) Explain the quantum mechanical theory of Raman effect.
- ii) Derive an equation for the vibrational energy level of a molecule at dissociation.
- iii) Write a note on coarse and fine structure in an electronic spectrum of molecule.

- b) Solve any 2 [4]
- i) Calculate the frequency of light whose energy is 850 kJ mole^{-1}
 - ii) Calculate the positions of fundamental mode of vibration and first overtone of CO if the vibrational frequency and anharmonicity constant are $6.43 \times 10^{13} \text{ Hz}$ and 0.0422 respectively.
 - iii) The vibrational frequency of $^1\text{H } ^{79}\text{Br}$ is 2558.94 cm^{-1} . Estimate the frequency of $^1\text{H } ^{81}\text{Br}$ if force constant does not change.

- Q4) a) Answer any 2 [6]
- i) Explain the Raman active vibrations of CO_2 molecule with the help of polarisability ellipsoids.
 - ii) Explain the principle of photoelectron spectroscopy
 - iii) Explain the isomeric shifts in Mossbauer spectra of the following species : Sn^{4+} , Sn^{2+} and S_n (Sp^3 hybridised).
- b) Solve any 1 [4]
- i) Calculate the separation between the first and second stokes lines in rotational Raman spectrum of H_2 molecules if the bond length is 74.1 pm .
 - ii) The first line in rotational spectrum of $^1\text{H}^{35}\text{Cl}$ is observed at 21.8 cm^{-1} . Calculate the bond length of the molecule

SECTION - II

- Q5) Solve the following [5]
- a) What are the types of radioactive decay?
 - b) What is Auger effects?
 - c) What is symmetric fission?
 - d) Name the medical applications of radioactivity
 - e) What is szillard-chalmer reaction?
- Q6) a) Solve any two. [6]
- i) Explain the charge distribution in nuclear fission
 - ii) Write a note on photoelectric effects
 - iii) Discuss the application of radioisotopes in the determination of surface area of powder or precipitate.

b) Solve any two [4]

- i) The symmetric fission of $^{250}_{100}\text{Fm}$ gives $^{125}_{50}\text{Sn}$ Find the fission energy. Given Atomic masses of F_m and S_n are 250.0795 and 124.9077 a.m.u. respectively
- ii) To assess the volume of blood in a patient 1ml of blood was withdrawn, mixed with radioisotope having activity of 280000 per 2 minutes After adequate time of homogenization, 1 ml of blood was again withdrawn and the sample showed the activity of 250 for 10 minutes. Calculate the volume of blood.
- iii) Pd-100 has half life 3.6 days If one had 6.02×10^{23} atoms at the starts, How many atoms would be present after 20 days.

Q7) a) Solve any two [6]

- i) Discuss industrial application of gamma radiography.
- ii) What are the characteristic features of radio active decay?
- iii) How does it is determined using Fricke dosimeter?

b) Solve any two. [4]

- i) 15 gram of sample absorbs 10 J of energy calculate the dose absorbed in grey.
- ii) Calculate the thickness of Zn ($z = 30$, $A = 64$) plate required to reduce the level of radiation from 1.2 Gy/min to 1.2 mGy/hr Given $\mu = 211 \text{ cm}^2/\text{g}$, density of Zn 7.19 g/cc.
- iii) Half life of ^{226}Ra is 1500 years. Calculate the activity corresponding to 2.5g of ^{226}Ra . Also determine the time required for ^{226}Ra to reduce to $3.5 \times 10^4 \text{ dps}$ if initial activity is 1 curie.

- Q8) a) Solve any two. [6]**
- i) Discuss any one application of physicochemical research of radioactivity
 - ii) Explain the Neutron energy distribution of the prompt and delayed neutrons.
 - iii) Derive expression for the determination of decay constant of radionuclide when daughter is stable
- b) Solve any one [4]**
- i) A 30 ml of sample of saturated solution containing 4mg/Lit of Labeled PbSO_4 has an activity of 1600 c pm. The solution was shaken with 1gm of precipitated PbSO_4 and filtered. The filtrate gives an activity of 900 cpm. All activities are net and free background surface area of one formula entity is $1.64 \times 10^{-17} \text{ cm}^2$ calculate the surface area of 1gm of precipitate
 - ii) It is known that 1 gm of ^{226}Ra emits 11.6×10^{17} atoms of radon per year. Given the half life Period of Ra to be 1600 years, compute the value of the Avagudras constant.



[6510]-22

F.Y.M.Sc. (Organic Chemistry/Drug Chemistry)
CHEOD-551 MJ : PHYSICAL CHEMISTRY - II
(2023 Credit Pattern) (Semester - II)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logarithmic table and non-programmable calculator is allowed.
- 4) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

1) Avogadro Number	$N = 6.022 \times 10^{23} \text{ mol}^{-1}$
2) Boltzmann Constant	$k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ k cal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equivalent}^{-1}$
8) Speed of light	$c = 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-24} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

- Q1)** Attempt the following. [5]
- Sketch and show moment of inertia of H_2O , asymmetric molecule is $I_a \neq I_b \neq I_c$.
 - Calculate number of vibrational degree of freedom in HCN .
 - What is essential condition for Raman shift in scattering?
 - Write Born. Oppenheimer approximation in terms of total energy for diatomic molecule.
 - Explain the role of Mossbauer spectroscopy in minerology.
- Q2)** a) Answer any two of the following. [6]
- Sketch and explain the various modes of vibrations for CO_2 molecule. Why the bending mode of vibration is degenerate?
 - Write a brief account of the quantum theory of Raman effect.
 - Write a note on 'Fortrat parabola'.
- b) Solve any two of the following. [4]
- What will be the force constant of $^{35.5}\text{HCl}$, if the fundamental vibrational frequency is $8.667 \times 10^{13} \text{s}^{-1}$?
 - In the $^{57}\text{Fe}^*$ Mössbauer experiment, the source of 14.4 k.eV. (equivalent to $3.48 \times 10^{12} \text{MHz}$) is moved toward absorber at a velocity of $2.2 \times 10^{-3} \text{m.s}^{-1}$. Find the shift in frequency.
 - The spacing between first stoke line and first antistokes line is 20B in $^{16}\text{O}_2$. Show by plotting spectrum.
- Q3)** a) Answer any two of the following. [6]
- State the selection rule for rigid rotator and derive an expression for internuclear distance of rigid diatomic molecule.
 - Compare Harmonic and anharmonic oscillator in terms of selection rule, zero point energy and energy level transitions or diagram.
 - Write a note on predissociation spectra.
- b) Solve any two of the following. [4]
- Calculate most populated line, if rotational lines are spaced 5cm^{-1} at 25°C .
 - Find the frequency of first antistoke and stoke line of H_2 having equilibrium vibrational frequency 4395.2cm^{-1} , if molecule is irradiated with 405 nm radiation.
 - Calculate energy in J.mol^{-1} of electromagnetic radiation of Iron having wavelength 248.3 nm.

Q4) a) Answer any two of the following. **[6]**

- i) Outline the effect of isotopic substitution on the rotational spectrum of molecule.
- ii) Sketch and explain the rule of mutual exclusion principle with example.
- iii) Write a note on isomeric shift in Mössbauer spectroscopy.

b) Solve any one of the following. **[4]**

- i) Calculate the bond length of $^{12}\text{C}^{16}\text{O}$ molecule, if the spacing between two rotational line is 3.84235 cm^{-1} .
- ii) Find the number of vibrational energy levels below the dissociation limit and hence the dissociation energy of molecule in both the states using data given below.

	ω_e/cm^{-1}	x_e
Ground state	1641.4	0.00711
Excited state	1788.2	0.00919

* * *

Total No. of Questions :6]

SEAT No. :

PE4478

[Total No. of Pages : 5

[6510]-23

M.Sc.-I (Physical Chemistry/Inorganic Chemistry/Analytical Chemistry/Organic Chemistry/Drug Chemistry)

INORGANIC CHEMISTRY-II

CHE- 552 -MJ : Coordination and Bioinorganic Chemistry
(2023 Credit Pattern) (Semester-II)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) Answer to the two sections should be written in separate answer books.
- 2) All questions are compulsory.
- 3) Figures to the right indicate full marks.
- 4) Use of calculator is allowed.
- 5) Neat diagrams must be drawn wherever necessary.

SECTION-I

Q1) a) Answer the following. [8]

i) Calculate total no. of microstates for Following configurations.

1) P^1d^2

2) $C(eg)^2$

ii) Arrange the following terms in increasing order of energy and justify your answer ^2P , ^3F , ^4G , ^2H , ^3I

iii) $MnSO_4$ is Faint pink in colour where as $KMnO_4$ is purple. Explain.

iv) Define: Ferromagnetism and anti Ferromagnetism

b) Write a note on: charge transfer spectra. [3]

Q2) a) Answer any one of the following. [6]

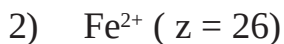
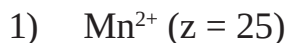
i) Prepare a table of microstates and obtain allowed term symbols for the s^1d^1 configuration.

ii) Give the splitting of ^6H R.S term in weak cubic Field using character table for pure rotational point group (O) and reduction formula.

P.T.O.

b) Answer any two of the following. [6]

i) Determine the ground state term symbol for:



ii) Ni^{2+} octahedral complex shows 22% increase in its observed magnetic moment value. Calculate spin orbital coupling constant for Ni^{2+} ion using following data [Given : $Dq = 850 \text{ cm}^{-1}$].

iii) Write a note on: Racah parameters.

Q3) a) Answer any one of the following. [6]

i) For a complex three absorption bands are observed at 7698 cm^{-1} , 12990 cm^{-1} and 24090 cm^{-1} . Calculate Δ_o , Racah parameter, nephelauxetic ratio and comment on nature of M-L bond. [Given : $B_0 = 970 \text{ cm}^{-1}$].

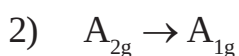
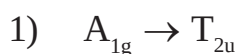
ii) How would you account for the magnetic moment listed against each of the following complexes?



b) Answer any two of the following. [6]

i) Write a note on : Orgel diagram for $n\text{P}$ and $n\text{F}$ R.S terms.

ii) Classify the following transitions in an octahedral complex as orbitally allowed, vibronically allowed and forbidden transitions. Justify your answer.



iii) Write a note on: First order and second order Zeeman effect.

SECTION-II

Q4) a) Answer any four of the following. **[8]**

- i) What are the oxidation states of iron in oxyhemoglobin and deoxy hemoglobin?
- ii) Why nature chooses the element from first series of d-block element in biological system?
- iii) What are the bridging groups present in oxyhemocyanin?
- iv) What are the functions of Ca and Mg in biological system?
- v) Explain biopolymer effect.

b) What is hydrolytic enzyme? Explain the different types of hydrolytic enzymes. **[3]**

Q5) a) Answer any one of the following. **[6]**

- i) What is enterobactin? Explain uptake of iron by E-coli.
- ii) How do ligand and stereochemistry can tune the redox potential of the metal. Explain with suitable example.

b) Answer any two of the following. **[6]**

- i) Explain the inner sphere electron transfer reaction in metal complexes
- ii) Explain the role of metal ion in communication
- iii) Discuss binding preferences of metal to ligand with the help of suitable example

Q6) a) Answer any one of the following. **[6]**

- i) Explain three pair electron transfer reactions occur by metalloprotein.
- ii) What is hard-soft acid-base concept? Explain the classification of metal ions and ligand as per concept.

b) Write notes on any two of the following. **[6]**

- i) [Fe-S] cluster
- ii) Ferritin
- iii) Chlorophyll

Direct Product

1. Group of the form $G \times i$ or $G \times \sigma_h$

The g, u, or 'x' additions to the IR symbol in this group satisfy

$$g \times g = u \times u = g, \quad g \times u = u, \quad 'x' \times 'x' = g$$

2. Product of the form $A \times A, B \times B, A \times B$

For all groups:

$$\text{Letter Symbol: } A \times A = A, \quad B \times B = B, \quad A \times B = B$$

$$\text{Subscript: } 1 \times 1 = 1, \quad 2 \times 2 = 1, \quad 1 \times 2 = 2$$

Except for the B representations of D_2 and D_2 where

$$B \times B = B, \quad \text{and } 1 \times 2 = 3, \quad 2 \times 3 = 1, \quad 3 \times 1 = 2$$

3. Products of the forms: $A \times E, B \times E$:

(a) For all groups $A \times E_k = E_k$ irrespective of the suffix on A.

(b) For all groups except D_{4h}, D_{4d}, S_8 :

$$B \times E_1 = E_2, \quad B \times E_2 = E_1$$

irrespective of the suffix on B (If the group has only one B representative put $E_1 = E_2 = E$)

(c) For D_{4h} :

$$B \times E_1 = E_3, \quad E \times E_2 = E_3, \quad B \times E_3 = E_3, \quad B \times E_2 = E_2, \quad B \times E_3 = E_1$$

Irrespective of the suffix on B:

(d) For D_{4d}, S_8 :

$$B \times E_1 = E_3, \quad B \times E_2 = E_2, \quad B \times E_3 = E_1$$

Irrespective of the suffix on B:

4. Products of the form $E \times E$:

(For groups which have A, B, or E symbols without suffixes put $A_1 = A_2 = A$, etc in the equation below)

(a) For $O_h, O, T_d, D_{6h}, D_2, C_{6v}, C_{6h}, C_6, S_6, D_{2d}, D_{2h}, D_3, C_2, C_{3h}, C_3$:

$$E_1 \times E_1 = E_2 \times E_2 = A_1 + A_2 + B_2; \quad E_1 \times E_2 = B_1 + B_2 + E_1$$

(b) For $D_{4h}, D_4, C_{4v}, C_{4h}, C_4, S_4, D_{2d}$:

$$E \times E = A_1 + A_2 + B_1 + B_2.$$

(c) For D_{6d} :

$$E_1 \times E_1 = E_3 \times E_3 = A_1 + A_2 + E_g$$

$$E_2 \times E_2 = E_4 \times E_4 = A_1 + A_2 + E_g$$

$$E_3 \times E_3 = A_1 + A_2 + B_1 + B_2$$

$$E_1 + E_2 = E_4 + E_3 = E_1 + E_3, \quad E_1 \times E_3 = E_3 \times E_1 = E_2 + E_1,$$

$$E_1 + E_4 = E_2 + E_3 = E_3 + E_3, \quad E_2 \times E_3 = E_3 \times E_4 = E_1 + E_3,$$

$$E_1 + E_3 = B_4 + B_2 + E_4, \quad E_2 \times E_4 = B_1 + B_2 + E_2,$$

(d) $D_{3d}, D_{2h}, D_3, C_{3v}, C_{3h}, C_3$:

$$E_1 \times E_1 = A_1 + A_2 + E_2, \quad E_2 \times E_2 = A_1 + A_2 + E_1$$

$$E_1 \times E_2 = E_1 + E_2$$

(e) For D_{4d}, S_8 :

$$E_1 \times E_1 = E_3 \times E_3 = A_1 + A_2 + E_2$$

$$E_2 \times E_2 = A_1 + A_2 + B_1 + B_2$$

$$E_1 \times E_2 = E_2 \times E_3 = E_1 + E_3, \quad E_1 \times E_3 = B_1 + B_2 + E_2$$

5. Product involving the T (or F) representation of O_h, O, T_d :

$$A_1 \times T_1 = T_1, \quad A_1 \times T_2 = T_2, \quad A_2 \times T_1 = T_2, \quad A_2 \times T_2 = T_1,$$

$$E \times T_1 = E \times T_2 = T_1 + T_2,$$

$$T_1 \times T_1 = T_2 \times T_2 = A_1 + E + T_1 + T_2$$

$$T_1 \times T_2 = A_2 + E + T_1 + T_2$$

6. To Complete result for O are

O	A ₁	A ₂	E	T ₁	T ₂
A ₁	A ₁	A ₂	E	T ₁	T ₂
A ₂	A ₂	A ₁	E	T ₂	T ₁
E	E	E	A ₁ + A ₂ + E	T ₁ + T ₂	T ₁ + T ₂
T ₁	T ₁	T ₂	T ₁ + T ₂	A ₁ + E + T ₁ + T ₂	A ₂ + E + T ₁ + T ₂
T ₂	T ₂	T ₁	T ₁ + T ₂	A ₂ + E + T ₁ + T ₂	A ₁ + E + T ₁ + T ₂

Character Table for O rotational group

O	E	6C ₄	3C ₂ (=C ₄ ²)	8C ₃	6C ₂		
A ₁	1	1	1	1	1		$x^2 + y^2 + z^2$
A ₂	1	-1	1	1	-1		$(2z^2 - x^2 - y^2, x^2 - y^2)$
E	2	0	2	-1	0	(R _x , R _y , R _z); (x, y, z)	
T ₁	3	1	-1	0	-1		(xy, xz, yz)
T ₂	3	-1	-1	0	1		

Correlation table for group Oh

Oh	O	Td	D _{4h}	D _{2d}	C _{4v}	C _{2v}	D _{3d}	D ₃	C _{2h}
A _{1g}	A ₁	A ₁	A _{1g}	A ₁	A ₁	A ₁	A _{1g}	A ₁	Ag
A _{2g}	A ₂	A ₂	B _{1g}	B ₁	B ₁	A ₂	A _{2g}	A ₂	Bg
E _g	E	E	A _{1g} + B _{1g}	A ₁ + B ₁	A ₁ + B ₁	A ₁ + A ₂	E _g	E	Ag + Bg
T _{1g}	T ₁	T ₁	A _{2g} + E _g	A ₂ + E	A ₂ + E	A ₂ + B ₁ + B ₂	A _{2g} + E _g	A ₂ + E	Ag + 2Bg
T _{2g}	T ₂	T ₂	B _{2g} + E _g	B ₂ + E	B ₂ + E	A ₁ + B ₁ + B ₂	A _{1g} + E _g	A ₁ + E	2Ag + Bg
A _{1u}	A ₁	A ₁	A _{1u}	B ₁	A ₂	A ₂	A _{1u}	A ₁	Au
A _{2u}	A ₂	A ₁	B _{1u}	A ₁	B ₂	A ₁	A _{2u}	A ₂	Bu
Eu	E	E	A _{1u} + B _{1u}	A ₁ + B ₁	A ₂ + B ₂	A ₁ + A ₂	Eu	E	Au + Bu
T _{1u}	T ₁	T ₂	A _{2u} + Eu	B ₂ + E	A ₁ + E	A ₁ + B ₁ + B ₂	A _{2u} + Eu	A ₁ + E	Au + 2Bu
T _{2u}	T ₂	T ₁	B _{2u} + Eu	A ₂ + E	B ₁ + E	A ₂ + B ₁ + B ₂	A _{1u} + Eu	A ₁ + E	2Au + Bu



Total No. of Questions : 6]

SEAT No. :

PE4479

[Total No. of Pages : 6

[6510]-24

M.Sc. - I (Organic/Drug Chemistry)

ORGANIC CHEMISTRY-II

CHE-553 MJ : Pericyclic Reactions, Molecular Rearrangements,
Photochemistry & Organic Spectroscopy
(2023 Credit Pattern) (Semester - II) (NEP 2020) (4 Credits)

Time : 3 Hours]

[Max. Marks : 70

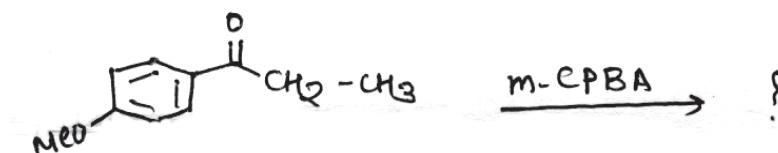
Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Answers of the two sections should be written on separate answer book.

SECTION- I

Q1) a) Answer any four of the following. [8]

- i) What are concerted reactions? Give any two silent features of concerted reaction.
- ii) Write the name of rearrangement reaction which gives cyclopropanone ring as intermediate product. Give one example.
- iii) Explain Ene reaction with suitable example.
- iv) Predict the product in following reaction.

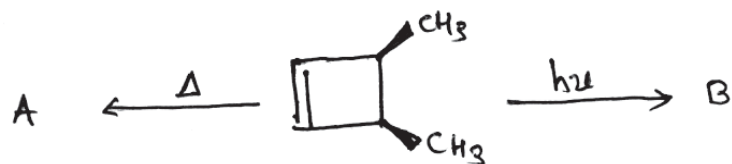


- v) Explain 1,3 - dipolar addition with suitable example.
- b) Write note on sigmatropic reaction. [3]

P.T.O.

Q2) a) Attempt any three of the following. **[9]**

i) Predict the product A and B with stereochemistry of following.

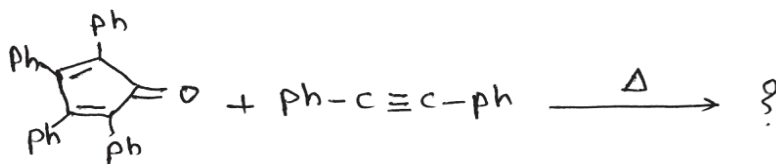


ii) Explain Dakin reaction with suitable example.

iii) Suggest the mechanism of following rearrangement.



iv) Predict the product with mechanism.

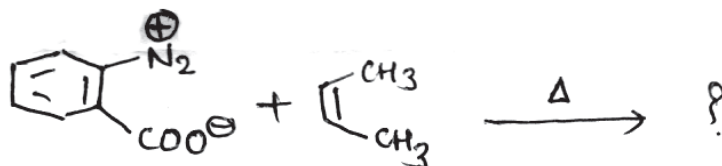


b) Using FMO approach, predict whether [4+2] cycloaddition reaction is thermally or photochemically allowed. **[3]**

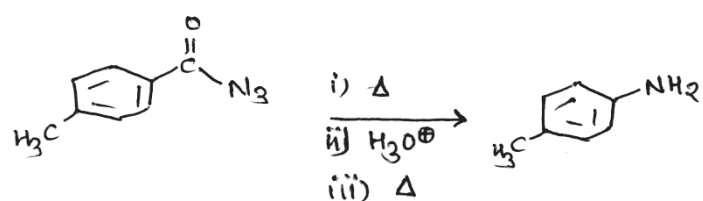
Q3) a) Attempt any four of the following. **[8]**

i) Explain mechanism of Benzil-benzilic acid rearrangement.

ii) Predict the products in the following reaction.

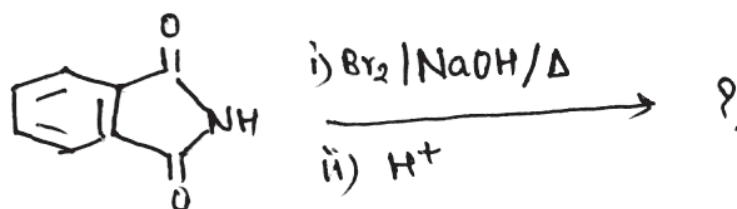


iii) Suggest the mechanism for following rearrangement reaction.



iv) Explain wolff rearrangement with suitable example.

v) Predict the product in the following reaction.



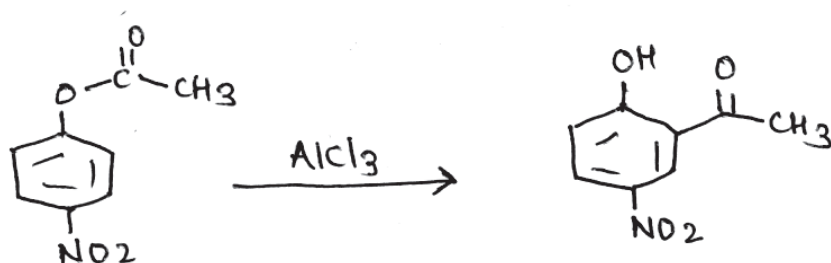
b) Attempt any two of the following.

[4]

i) Give the stereochemical aspects in Beckman rearrangement.

ii) Explain pericyclic reaction with suitable example.

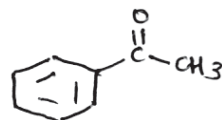
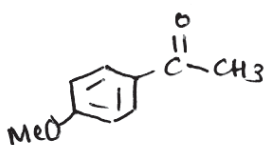
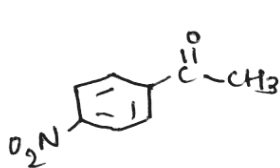
iii) Suggest the mechanism for following reaction.



SECTION- II

Q4) a) Answer the following (any four) **[8]**

- i) Write the principles of photochemistry.
- ii) How will you distinguish between 1-butanol, 2-methyl-1-Propanol by ^{13}C -NMR spectroscopy.
- iii) Arrange the following compounds according to increasing $\text{C}=\text{O}$ stretching frequency.



- iv) Explain Barton reaction with example.
 - v) Explain the factors affecting chemical shift in ^1H -NMR.
- b)** Predict the product/s indicating mechanism. **[3]**



Q5) a) Write notes on any three of the following. **[9]**

- i) Norrish reactions
 - ii) Joblanski diagram
 - iii) Photosensitization
 - iv) Paterno-Buchi reaction
- b)** Deduce the structure of compound on the basis of following spectroscopic data. **[3]**

M.F : $\text{C}_7\text{H}_5\text{O}_3\text{N}$

IR : 2890, 1705, 1620, 1550-1350, 850 cm^{-1}

CMR : 117.2 (d, strong), 130.6 (d, strong), 135 (s), 139.5 (s), 191.1(d)

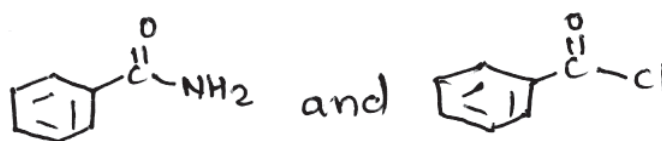
Q6) a) Attempt any two of the following.

[8]

- i) 1) Distinguish following pair by $^1\text{H-NMR}$ spectroscopy



- 2) Distinguish following pair by IR spectroscopy.



- ii) Deduce the structure of compound by following spectroscopic data.

M.F : $\text{C}_8\text{H}_6\text{O}_2\text{N}_2$

UV : 260 and 280 nm

IR : 2250, 1620, 1530-1350, 850 cm^{-1}

PMR : 3.1 δ (s, 2H)

7.9 δ (d, J = 8Hz, 2H)

7.2 δ (d, J = 8Hz, 2H)

- iii) Deduce the structure of compound by following spectroscopic data.

M.F : $\text{C}_9\text{H}_{12}\text{O}$

UV : 270 nm

IR : No bands above 3100 and in 2000-1600 cm^{-1}

PMR : 1.15 δ (t, J = 7.5Hz, 3H)

3.50 δ (q, J = 7.5 Hz, 2H)

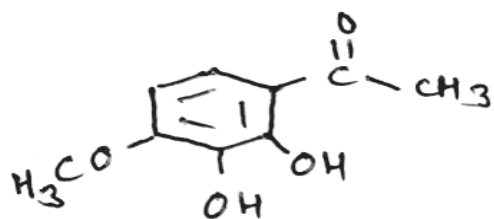
4.41 δ (s, 2H)

7.23 δ (s, 5H)

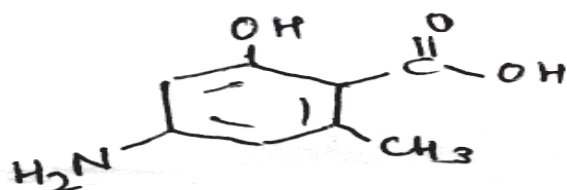
b) Calculate λ_{max} of any two compounds.

[4]

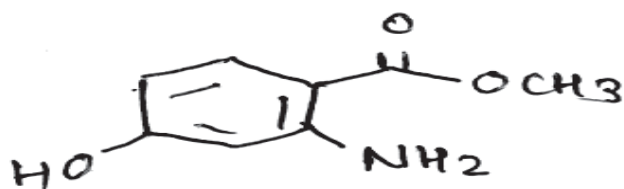
i)



ii)



iii)



* * *

Total No. of Questions : 4]

SEAT No. :

PE4480

[Total No. of Pages : 4

[6510]-25

M.Sc. - I (Physical, Inorganic and Analytical Chemistry)

CHE PIA - 553 MJ : ORGANIC CHEMISTRY-II

(Molecular Rearrangement and Organic Spectroscopy)

(2023 Credits Pattern) (Semester - II) (2 Credit)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.

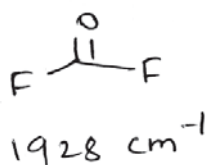
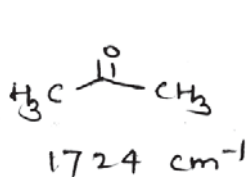
Q1) Answer the following.

[5]

- a) In Bayer-villiger oxidation tertiary Butyl migrate in preference to methyl group, explain.
- b) Write the name of intermediate formed in curtius rearrangement.
- c) Cis-stilbene & trans-stilbene shows UV absorption at 280 nm & 296 nm respectively, Why?
- d) How many ^{13}C NMR signals are present in proton decoupled spectrum of following compound?



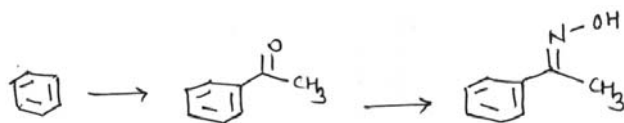
- e) Explain the following observation of carbonyl frequency.



P.T.O.

Q2) a) Answer any two of the following. [6]

- Write a short note on Schmidt rearrangements.
- How will you monitor the following reaction sequence by IR?



- Explain spin-spin coupling.

b) Answer any two of the following. [4]

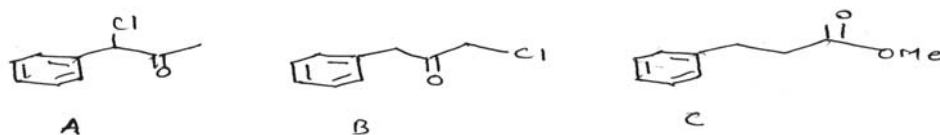
- How will you distinguish the following compounds by PMR?



- Arrange the following compounds in order of increasing absorption frequency of their carbonyl groups. Give reason for your answer.

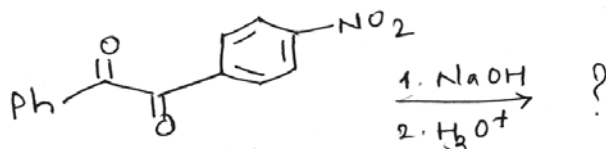


- Both compound A & B gives same product c when treated with NaOMe/MeOH, explain,



Q3) Answer any five of the following. [10]

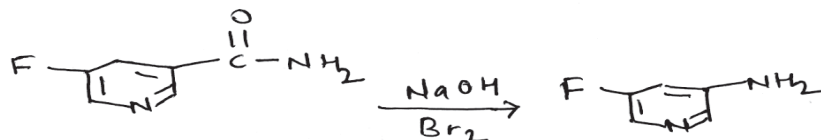
- Predict the product of following reaction.



- b) Calculate $\lambda_{\max}$ of following aromatic compound.



- c) Suggest the mechanism.



- d) Ethyl acetate shows $\nu_{\text{C=O}}$ absorption at 1735cm^{-1} , Whereas phenyl acetate at 1770cm^{-1} , explain.
- e) Acetylenic protons absorb at higher field than olefinic protons.
- f) Write short note on Pinacol-Pinacolone rearrangement.
- g) Explain migratory aptitude in rearrangement reaction.

Q4) a) Answer any two of the following.

[6]

- i) Deduce the structure using following spectral data & justify your answer

M.F. : $\text{C}_8\text{H}_8\text{O}_2$

UV : 280 nm

IR : 2740, 1695, 1600cm^{-1}

^1H NMR : $\delta = 3.8$ (s) 12 mm

6.9 (d) $J = 9\text{Hz}$ 8 mm

7.9 (d) $J = 9\text{Hz}$ 8 mm

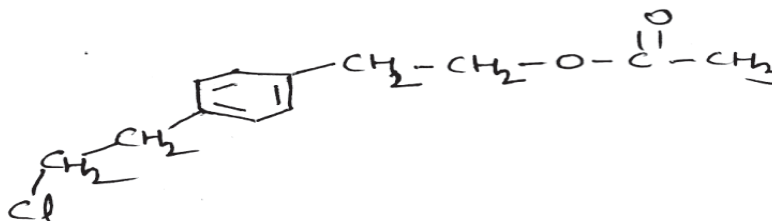
9.8 (s) 4mm

- ii) Deduce the structure using following spectral data & justify your answer.

M.F. : C_4H_8O
 IR : 1720 cm^{-1}
 ^{13}C NMR : $\delta = 8$ (q)
 30 (q)
 39 (t)
 207 (s)

- iii) Assign the chemical shifts for the following structure.

PMR : δ 2.04 (s, 3H)
 2.94 (t, $J = 6.5\text{ Hz}$, 2H)
 2.95 (t, $J = 7\text{ Hz}$, 2H)
 3.82 (t, $J = 6.5\text{ Hz}$, 2H)
 4.47 (t, $J = 7\text{ Hz}$, 2H)



- b) Answer any one of the following [4]

- i) Predict the structure using given spectral data & justify your answer.

MF : $C_8H_{14}O_3$
 IR : $1770, 1810\text{ cm}^{-1}$
 PMR : 1.00δ (t, $J = 6\text{ Hz}$, 6H)
 1.69δ (sext. $J = 6\text{ Hz}$, 4H)
 2.43δ (t, $J = 6\text{ Hz}$, 4H)

- ii) Write short note on Beckmann rearrangement.

* * *

Total No. of Questions : 3]

SEAT No. :

PE4481

[Total No. of Pages : 2

[6510]-26

M.Sc. - I (Physical, Inorganic, Analytical Chemistry)

CHEMISTRY

CHE - 561(A) MJ : Organometallic Compounds and Inorganic
Reaction Mechanism

(2023 Credit Pattern) (Semester - II)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logtable and calculator's is allowed.

Q1) a) Answer the following : **[8]**

- i) Define reductive elimination with suitable example.
- ii) Determine valence shell electron count for the following :
 - 1) Ferrocene
 - 2) $[\text{Co}(\text{Co})_5\text{H}]$
- iii) Draw the structure of the following complexes.
 - 1) $\text{Cr}(\text{Co})_6$
 - 2) $\text{Fe}_2(\text{Co})_9$

b) Explain in detail Wacker process. **[3]**

Q2) a) Answer any one of the following : **[6]**

- i) Give an account of synthesis and bonding properties and applications of phosphine compounds.
- ii) Write notes on following :
 - 1) The trans effect
 - 2) Dissociation reaction in coordination compounds.

P.T.O.

b) Answer any two of the following : [6]

- i) What hapticities are possible for following ligands?
 - 1) Butadiene
 - 2) Cyclooctatetraene
 - 3) C_5H_5
- ii) Write short note on Oxidative Addition.
- iii) Draw the structure of Zeise's salt, explain structural features of it.

Q3) a) Answer any one of the following : [6]

- i) Explain OXO catalytic cycle/process in detail.
- ii) Explain any three methods for synthesis of binary metal carbonyl complexes.

b) Answer any two of the following : [6]

- i) Calculate $18e^-$ and EAN rule for following complexes.
 - 1) $[Cr(CO)_6]$
 - 2) $[Co_2(CO)_8]$
- ii) Explain the typical reactions of arene compound.
- iii) What is synergic bonding? Explain with example.

x x x

Total No. of Questions : 4]

SEAT No. :

PE4482

[Total No. of Pages : 2

[6510]-27

M.Sc. - I (Physical Chemistry/Inorganic Chemistry/Analytical Chemistry/Organic/Drug Chemistry)

CHEMISTRY

CHE - 561(B) MJ : Material Characterization Techniques
(2023 Credit Pattern) (2 Credits) (Semester - II)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of calculator/logtable is allowed.

Q1) Answer the following : [5]

- a) Calculate the minimum wavelength in nm of the X ray radiation at an acceleration voltage of 20 kV.
- b) How are $K\alpha$ X rays generated?
- c) State one point of difference between EDS and WDS technique.
- d) Give any two lenses used in SEM.
- e) State any two errors that occur during para focusing in an X ray diffractometer.

Q2) a) Answer any two of the following : [6]

- i) Compare SEM and TEM.
- ii) Write a short note on X ray absorption filter.
- iii) Explain the working of a thermionic emission gun in brief.

b) Answer any two of the following : [4]

- i) Draw a schematic diagram of the generation of a characteristic photon and an Auger electron.
- ii) Explain pre thinning is the sample preparation of TEM.
- iii) Sketch a neat labelled diagram of an X ray tube.

P.T.O.

Q3) Answer any five of the following :

[10]

- a) Sketch 100 and 111 planes of a cubic lattice.
- b) Aluminum has a FCC lattice and the cube edge is $4.025\text{\AA}$. Calculate the angles for the first and second order reflections from the 100 plane if the X rays used having a wavelength of $1.54\text{\AA}$.
- c) Calculate the interplanar spacings of a set of planes if the angle for the first order diffraction is 22.5° when X rays of wavelength $1.53\text{\AA}$ are used.
- d) Sketch a neat labeled diagram of a Si(Li) detector.
- e) Explain phase contrast in TEM.
- f) State any four applications of XRF.

Q4) a) Answer any two of the following :

[6]

- i) Explain characteristic X rays in XRD.
- ii) State Braggs equation and sketch a neat labeled diagram showing path difference of incident X rays on a crystal plane.
- iii) Sketch a neat labeled diagram of SEM and explain its working.

b) Answer any one of the following :

[4]

- i) Explain Electron specimen interactions in SEM.
- ii) Explain qualitative analysis using X ray spectroscopy.

x x x

Total No. of Questions : 3]

SEAT No. :

PE4483

[Total No. of Pages : 2

[6510]-28

M.Sc. - I (Physical Chemistry/Inorganic Chemistry/
Analytical Chemistry/Organic Chemistry/Drug Chemistry)

CHE - 561(C) MJ : GREEN CHEMISTRY
(2023 Credit Pattern) (Semester - II) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.

Q1) a) Answer the following [Any 4] **[8]**

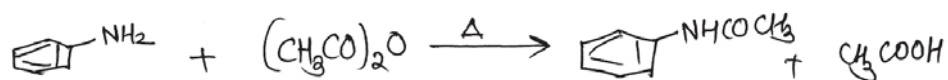
- i) Explain E-factor in green chemistry.
 - ii) What is volatile organic compounds (VOCs)? Give the effect of VOCs on environment.
 - iii) Discuss combinatorial green chemistry.
 - iv) Explain the green synthesis of adipic acid.
 - v) Explain enzymatic inter esterification with example.
- b) Commercial washing machine utilizes CO₂ and a CO₂ surfactant instead of perchloroethylene (PERC). Explain. **[3]**

Q2) a) Answer any three of the following : **[9]**

- i) Explain the advantages and challenges of supercritical CO₂ in green chemistry.
- ii) Write a note on microwave assisted oxidation reactions of alcohols in green chemistry.
- iii) Explain the role of biomimetic chemistry and multifunctional reagents in green chemistry.

P.T.O.

- iv) What is atom economy? Calculate the % atom economy for following reaction with respect to acetanilide.



- b) Explain phase transfer catalysis in green chemistry with suitable examples. [3]

Q3) a) Attempt any two of the following [8]

- i) Explain the following principles of green chemistry in details
 - 1) Use of catalyst
 - 2) Prevention of waste or by product
- ii) What is sonochemistry? Explain ultrasound assisted Simmon-Smith reaction with respect to green chemistry principle.
- iii) Smirotff - wheeler pathway represents as 'Green Synthesis' approach for synthesis of Vitamin C. Explain.

b) Attempt any two of the following : [4]

- i) Explain the role of green chemistry in global warming.
- ii) How click chemistry are carried out as green synthesis method? Explain.
- iii) Explain future trends in green chemistry.

x x x

Total No. of Questions : 4]

SEAT No. :

PE4484

[Total No. of Pages : 3

[6510]-29

F.Y.M.Sc. (Organic Chemistry/Drug Chemistry)

CHEOD-561(D) MJ : NUCLEAR AND RADIATION CHEMISTRY
(2023 Credit Pattern) (Semester - II)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logarithmic table and non-programmable calculator is allowed.
- 4) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

1) Avogadro Number	$N = 6.022 \times 10^{23} \text{ mol}^{-1}$
2) Boltzmann Constant	$k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ kcal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equiv}^{-1}$
8) Speed of light	$c = 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-24} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

Q1) Solve the following. [5]

- a) Arrange in increasing order for ionizing power of α, β, γ particle.
- b) Complete the following equation ${}_{99}^{249}\text{Es} + n \rightarrow {}_{64}^{161}\text{Gd} + ? + 2n$.
- c) Define Linear Energy Transfer (LET)
- d) Give preparation method for ${}^{22}\text{Na}$.
- e) Define rate of diffusion.

Q2) a) Solve any two [6]

- i) Define units of radioactivity: curie (ci), Becquerel and Rutherford.
- ii) What is spallation in nuclear fission and how does it differ from neutron evaporation?
- iii) Explain any one industrial application of radioactivity.

b) Solve any two [4]

- i) Given the electron absorption coefficient to be 0.211b per electron for 1MeV γ -radiation, calculate the molecular mass and linear coefficient for ethanol density of ethanol 0.789 gm/cm³.
- ii) The half life period of radioelement is 24.5 min. How much of it would be left after 30 min, If the initial amount of the radioelement is 1 gm.
- iii) In the fission of ${}_{92}^{235}\text{U}$ the end stable products are ${}_{40}^{94}\text{Zr}$ and ${}_{58}^{140}\text{Ce}$ what are primary fragments?

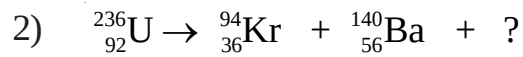
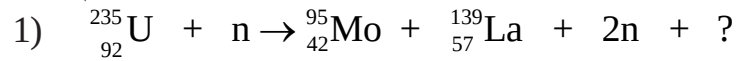
Q3) a) Solve any Two [6]

- i) How to determine surface of powder or precipitate using radioisotope?
- ii) Discuss the interaction of γ - radiation with matter.
- iii) Discuss neutron energy distribution of the prompt and delay neutrons.

b) Solve any Two [4]

i) What fraction of freshly prepared radon of half life period 3.82 days decay at the end of 1day, 5days?

ii) Complete the following equation



iii) Calculate the mass absorption coefficient for 1MeV γ -radiation for NaIO_3 [Given: au values O=1.69, I=12.03, Na= 2.32 b/atm]
Atomic mass of Na=23, I = 127, O=16

Q4) a) Solve any two [6]

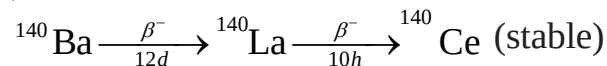
i) Discuss the industrial application of gamma radiography using radioisotopes.

ii) Discuss Fission Fragments and their mass distribution in nuclear fission.

iii) What are secular and transient equilibrium?

b) Solve any one [4]

i) Give the Filiation relation



Find the activity due to ${}^{140}\text{La}$ at the end of

1) 12hr

2) 24 day if we had pure ${}^{140}\text{Ba}$ only initially with an activity of 2000 disintegration per second.

(Hint: express time in units of half-lives of species)

ii) A ruby weighing 0.5g was irradiated in a neutron flux of $10^{12} \text{ n cm}^{-2} \text{ s}^{-1}$ for exactly 24 hr and ${}^{51}\text{Cr}$ activity ($T = 27.7 \text{ d}$) counted immediately thereafter. It was found to give 35000 count/sec Given that σ for ${}^{50}\text{Cr}$ to be 15.9 b the counting efficiency 10% and the ${}^{50}\text{Cr}$ content of natural chromium to be 4.35%. Find the chromium content of the ruby.



Total No. of Questions :4]

SEAT No. :

PE4485

[Total No. of Pages : 3

[6510]-30

M.Sc.-I

PHYSICAL, INORGANIC & ANALYTICAL CHEMISTRY
CHEPIA-561(D)MJ : Pericyclic Reactions & Photochemistry
(2023 Credit Pattern) (Semester-II) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*

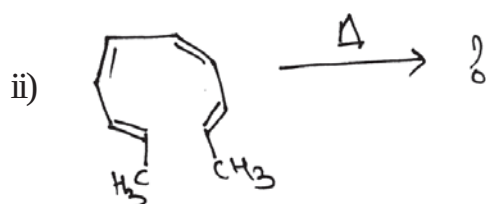
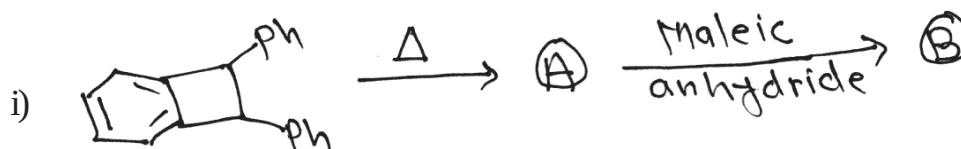
Q1) Answer the following.

[5]

- a) What is pericyclic reactions?
- b) What is mean by m-symmetry in π -molecular orbital?
- c) Define chemiluminescence
- d) What is singlet state in photochemistry?
- e) What is conrotatory motion?

Q2) a) Predict the product/s and explain the mechanism. (Any two)

[6]



P.T.O.

b) Answer the following. (Any two)

[4]

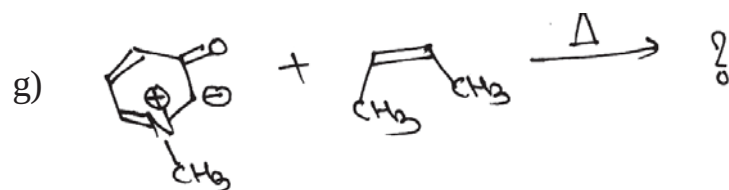
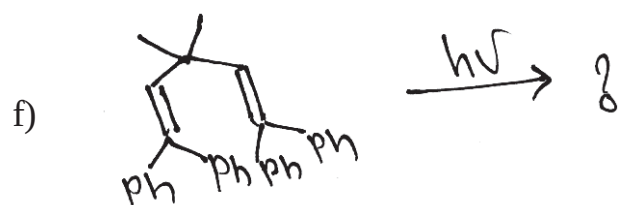
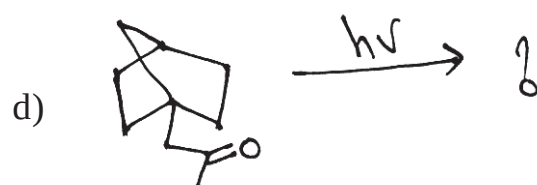
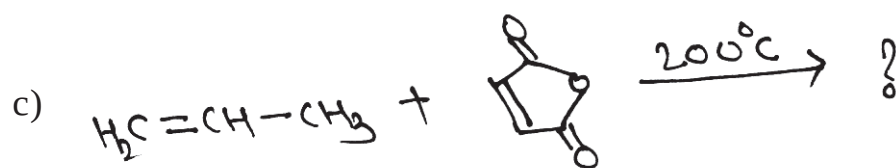
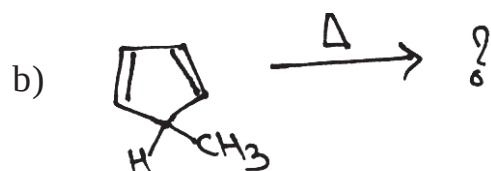
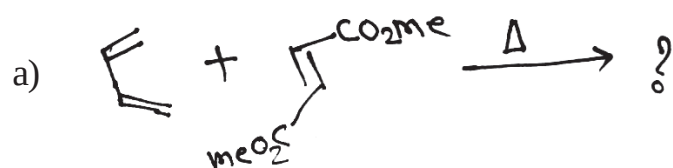
i) Draw the π molecular orbitals of $\text{H}_2\text{C}=\text{CH}-\text{CH}=\text{CH}_2$.

ii) Explain photoenolization.

iii) Benzophenone is used as sensitizer. Explain.

Q3) Predict the product with justification. (Any five)

[10]



- Q4) a)** Answer the following. (Any two) **[6]**
- i) How you prove the formation of acyl & alkyl radicals in Norrish type-I reaction?
 - ii) Write short note on photoreduction.
 - iii) Explain claisen rearrangement with suitable examples.
- b)** Answer the following. (Any one) **[4]**
- i) Write short note on photochemistry of benzene.
 - ii) With the help of FMO, Show that [2+2] cyclo addition reaction of two ethylene will be thermally or photochemically allowed.



Total No. of Questions : 6]

SEAT No. :

PE4486

[Total No. of Pages : 3

[6510]-31

M.Sc. - II

PHYSICAL CHEMISTRY - II

CHP-601MJ : Quantum and Solid State Chemistry

(2023 Credit Pattern) (Semester - III) (4 Credits)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Answer the two sections should be written in separate answer book.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic table and non-programmable calculator is allowed.
- 5) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

- | | |
|-------------------------|---|
| 1) Avogadro Number | $N = 6.022 \times 10^{23} \text{ mol}^{-1}$ |
| 2) Boltzmann Constant | $k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$
$= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$ |
| 3) Planck Constant | $h = 6.626 \times 10^{-27} \text{ erg s}$
$= 6.626 \times 10^{-34} \text{ J s}$ |
| 4) Electronic Charge | $e = 4.803 \times 10^{-10} \text{ esu}$
$= 1.602 \times 10^{-19} \text{ C}$ |
| 5) 1 eV | $= 23.06 \text{ k cal mol}^{-1}$
$= 1.602 \times 10^{-12} \text{ erg}$
$= 1.602 \times 10^{-19} \text{ J}$
$= 8065.5 \text{ cm}^{-1}$ |
| 6) Gas Constant | $R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$
$= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
$= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$ |
| 7) Faraday Constant | $F = 96487 \text{ C equivalent}^{-1}$ |
| 8) Speed of light | $c = 2.997 \times 10^{10} \text{ cm s}^{-1}$
$= 2.997 \times 10^8 \text{ m s}^{-1}$ |
| 9) 1 cal | $= 4.184 \times 10^7 \text{ erg}$
$= 4.184 \text{ J}$ |
| 10) 1 amu | $= 1.673 \times 10^{-24} \text{ kg}$ |
| 11) Bohr Magneton | $\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$ |
| 12) Nuclear Magneton | $\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$ |
| 13) Mass of an electron | $m_e = 9.11 \times 10^{-31} \text{ Kg}$ |

P.T.O.

Q1) a) Attempt any four of the following. **[8]**

- i) Evaluate $\left[x^3, \frac{d}{dx} \right]$.
- ii) State variation theorem.
- iii) Write the expression for raising and lowering operator. State the terms involved in it.
- iv) Give the properties of Slater determinant.
- v) Define operator. Give its properties.

b) Define symmetric and antisymmetric wave function. **[3]**

Q2) a) Attempt any three of the following. **[9]**

- i) Obtain the Spectroscopic term symbols for the following configuration.
 - 1) $2p^1 2d^1$
 - 2) $1s^1 2s^1$
 - 3) $2p^2 2d^1$
- ii) Formulate Hamiltonian operator for H_2 molecule and state the terms involved in it.
- iii) Define 'eigen function' and 'eigen value' with suitable example.
- iv) Derive expression for First order correction to the wave function for non-degenerate unperturbed level.

b) Classify with justification whether the following operators are linear or non-linear. **[3]**

- i) $\int dx$
- ii) $\exp$
- iii) $3x^2 \frac{d^2}{dx^2}$

Q3) a) Attempt any two of the following. **[8]**

- i) Apply Variation theorem to the system of He atom to calculate its energy.
- ii) Derive the expression for linear momentum operator $(\hat{p}_x)$.
- iii) Write a note on Hartree - Fock SCF method for multi electron system.

- b) Attempt any one of the following. [4]
- What is Commutator operator? Give properties of commutator.
 - Derive the expression for second order correction to the wave function for non-degenerate unperturbed level.
- Q4) a)** Attempt any four of the following. [8]
- Define screw and edge dislocations.
 - Enlist the various types of crystal growth techniques.
 - Define induction period for the decomposition reaction of a single solid.
 - Explain the formation of F and V colour centres.
 - What is P-n junction?
- b) What is lattice imperfection? Give its classification. [3]
- Q5) a)** Attempt any three of the following. [9]
- Describe hydrothermal method for crystals growth from solution.
 - Explain the mechanism of the following solid-solid reaction

$$\text{Cu}_{(s)} + \text{AgCl}_{(s)} \rightarrow \text{CuCl}_{(s)} + \text{Ag}_{(s)}$$
 - State and explain any two methods of electric break down in insulators.
 - Explain Hall effect in semi conductor.
- b) Write note on photo graphic process. [3]
- Q6) a)** Attempt any two of the following. [8]
- Derive the expression for schottky defects in a crystal.
 - Sketch and explain the hysteresis loop observed for magnetization of an insulator crystal.
 - Discuss the various rate laws for gas-solid reactions.
- b) Attempt any one of the following. [4]
- The density of Schottky defects in a sample of NaCl is 5×10^{11} per m^3 at 25°C . What is the average energy required to create one Schottky defect if the interionic distance is $2.82 \text{ \AA}$?
 - How deep will Aluminium penetrate in silicon at 1450°C in one hour? [Given : $\Delta H = 73 \text{ Kcal/mole}$, $D_0 = 1.55 \text{ cm}^2/\text{S}$].



Total No. of Questions : 6]

SEAT No. :

PE4487

[Total No. of Pages : 3

[6510]-32

S.Y. M.Sc.

PHYSICAL CHEMISTRY

CHP-602-MJ : Polymer Chemistry

(2023 Credit Pattern) (Semester - III) (4 Credits)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) Answer to the two sections should be written in separate answerbook.
- 2) All questions are compulsory.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic table, calculator is allowed.
- 5) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

1) Avogadro Number	$N = 6.022 \times 10^{23} \text{ mol}^{-1}$
2) Boltzmann Constant	$k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ k cal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equivalent}^{-1}$
8) Speed of light	$c = 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-27} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

SECTION - I

Q1) a) Answer the following (any 4). **[8]**

- i) Explain number average molecular weight.
- ii) Distinguish between polymer and macromolecule.
- iii) Explain linear and Branched chain polymer.
- iv) Explain functionality of polymer sample.
- v) State Mark-Houwink equation.

b) Write a note on Flory - Krigbaum theory. **[3]**

Q2) a) Attempt any three of the following. **[9]**

- i) Describe end group analysis for addition polymer.
- ii) Write a note on thermochemistry of chain polymerization.
- iii) Explain characterization of polymer.
- iv) Explain instantaneous composition of polymer.

b) Calculate $\bar{x}_n, \bar{x}_w$ and the weight fraction of $\bar{x}_n$ - mers when a step polymerization is 95% complete. **[3]**

Q3) a) Attempt any two of the following. **[8]**

- i) Explain viscometry technique to determine polymer molecular weight.
- ii) Write a note on ultra centrifugation technique.
- iii) Distinguish between condensation and addition polymerization.

b) Attempt any two of the following. **[4]**

- i) Write a note on monomer reactivity ratios.
- ii) Explain molecular weight distribution.
- iii) Distinguish biological and non - biological polymer.

SECTION - II

- Q4) a)** Answer the following (any 4). **[8]**
- i) Give the applications of conducting polymer.
 - ii) Define the term degree of polymerization.
 - iii) What is Rheology process?
 - iv) What is living polymer?
 - v) Define glass transition temperature.
- b) Describe the process of compression molding. **[3]**
-
- Q5) a)** Attempt any three of the following. **[9]**
- i) Why do IR spectra of crystalline and amorphous polymer differ.
 - ii) Define calendaring, dry spinning and moulding.
 - iii) It is almost impossible to obtain an 100% crystalline polymer, explain.
 - iv) Write a note on reinforcement.
- b) Describe synthesis of conducting polymer. **[3]**
-
- Q6) a)** Attempt any two of the following. **[8]**
- i) Write a note on x-ray diffraction in polymer analysis.
 - ii) Describe the Voigt model of viscoelasticity.
 - iii) Explain cross linking of polymer.
- b) Attempt any two of the following. **[4]**
- i) Write a short note on thermoset moulding.
 - ii) Draw neat diagram of injection moulding process.
 - iii) Explain random degradation.



Total No. of Questions : 3]

SEAT No. :

PE4488

[Total No. of Pages : 2

[6510]-33

M.Sc. - II

PHYSICAL CHEMISTRY

CHP-603-MJ : Nuclear and Radiation Chemistry
(2023 Credit Pattern) (Semester - III) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logarithmic table, calculator is allowed.
- 4) Neat diagrams must be drawn wherever necessary.

Physico - Chemical Constants

1. Avogadro Number	N	$= 6.023 \times 10^{23} \text{ mol}^{-1}$
2. Boltzmann Constant	k	$= 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3. Planck Constant	h	$= 6.626 \times 10^{-16} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J/s}$
4. Electronic Charge	e	$= 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5. 1 eV		$= 23.06 \text{ k cal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6. Gas Constant	R	$= 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7. Faraday Constant	F	$= 96487 \text{ C equivalent}^{-1}$
8. Speed of light	c	$= 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9. 1 cal		$= 4.187 \times 10^3 \text{ erg}$ $= 4.187 \text{ J}$
10. 1 amu		$= 1.673 \times 10^{-22} \text{ kg}$
11. Bohr magneton	β_e	$= -9.274 \times 10^{-24} \text{ J T}^{-1}$
12. Nuclear magneton	β_n	$= 5.051 \times 10^{-27} \text{ J T}^{-1}$
13. Mass of an electron	m_e	$= 9.11 \times 10^{-31} \text{ kg}$

P.T.O.

- Q1) a)** Answer the following (Any 4) : **[8]**
- i) Enlist the special nuclear reactions.
 - ii) Give the classification of nuclear reactors.
 - iii) Illustrate with example the significance of magic number.
 - iv) Draw the experimental configuration of PIXE analysis.
 - v) Write the two properties desirable in a good scintillating material.
- b) Explain Bethe's notation of writing nuclear reaction. **[3]**
-
- Q2) a)** Attempt any three of the following : **[9]**
- i) Describe general aspects of reactor design.
 - ii) Give salient features of liquid drop model.
 - iii) Explain surface analysis using RBS.
 - iv) Discuss theory of semiconductor detector.
- b) Calculate the number of uranium atoms that must fission per second. If the power generated is 95 MW. **[3]**
- (Given : Energy released per fission = 3.2×10^{-17} MJ)
-
- Q3) a)** Attempt any two of the following : **[8]**
- i) Describe Li-drifted semiconductor detector.
 - ii) Discuss principal and working of breeder reactor.
 - iii) Discuss the merits and demerits of nuclear shell model.
- b) Attempt any two of the following : **[4]**
- i) Explain thermonuclear reactions.
 - ii) What are inorganic scintillators?
 - iii) Draw schematic diagram of RBS experiment.



Total No. of Questions : 3]

SEAT No. :

PE4489

[Total No. of Pages : 2

[6510]-34

M.Sc. - II

PHYSICAL CHEMISTRY

CHP - 610(A) MJ : Photochemistry

(2023 Credit Pattern) (2 Credits) (Semester - III) (Elective) (Option - A)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logarithmic table, calculator is allowed.
- 4) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

1) Avogadro Number	$N = 6.022 \times 10^{23} \text{ mol}^{-1}$
2) Boltzmann Constant	$k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ k cal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equivalent}^{-1}$
8) Speed of light	$c = 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-27} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

- Q1) a)** Attempt any four of the following : **[8]**
- i) Explain the term stimulated emission and spontaneous emission.
 - ii) Give two important characteristics of fluorescence.
 - iii) State the law of photochemical equivalence.
 - iv) Which are the possible electronic transitions in organic molecule?
 - v) Define effective light of photochemical change.
- b)** Explain the mechanism of delayed fluorescence. **[3]**
-
- Q2) a)** Attempt any three of the following **[9]**
- i) Discuss the Einstein treatment of absorption and emission phenomenon.
 - ii) Explain the Jablonski diagram depicting photo physical process.
 - iii) Explain the mode locking method of Amplification of Laser.
 - iv) Explain E-type delayed fluorescence.
- b)** Explain the Ruby laser. **[3]**
-
- Q3) a)** Attempt any two of the following : **[8]**
- i) Explain the process of photosynthesis with mechanism.
 - ii) Derive the stern - volmer equation for kinetics of collision quenching.
 - iii) Explain Nano second flash photolysis.
- b)** Attempt any two of the following : **[4]**
- i) What is population inversion.
 - ii) State the importance of quenching.
 - iii) What is p-type delayed fluorescence?

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Total No. of Questions : 3]

SEAT No. :

PE4490

[Total No. of Pages : 2

[6510]-35

M.Sc. - II

PHYSICAL CHEMISTRY

**CHP - 610(B) MJ : Physicochemical Methods of Analysis
(2023 Credit Pattern) (2 Credits) (Semester - III) (Elective) (Option - B)**

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Use of logarithmic table, calculator is allowed.*
- 4) *Neat diagrams must be drawn wherever necessary.*

Physico-Chemical Constants

1) Avogadro Number	$N = 6.022 \times 10^{23} \text{ mol}^{-1}$
2) Boltzmann Constant	$k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ k cal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equivalent}^{-1}$
8) Speed of light	$c = 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-27} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

- Q1) a)** Attempt any four of the following : **[8]**
- i) Define the terms Fermi energy and binding energy.
 - ii) What are X-rays? Which is the useful region of X-ray for chemical analysis.
 - iii) What is meant by EXAFS? Give two application of X-ray absorption.
 - iv) Draw a neat labeled diagram of ESCA spectrometer.
 - v) What is meant by dynamic and isothermal thermogravimetry?
- b) Discuss the application of TGA technique. **[3]**
-
- Q2) a)** Attempt any three of the following **[9]**
- i) Explain Chemical shift observed in ESCA technique.
 - ii) Give the application of DSC technique.
 - iii) What are the advantages of X-ray radioactive source?
 - iv) Describe with an example neutralization thermometric titration.
- b) 120 mg sample containing a mixture of NaCl [Mol. Wt. 58.5] and $\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$ [Mol.Wt.146] showed a loss of 7.00 mg at 140°C on TG curve. Determine the percentage of calcium oxalate in the sample. **[3]**
-
- Q3) a)** Attempt any two of the following : **[8]**
- i) Draw the energy level diagram for the sample and spectrometer used in ESCA technique and explain the same.
 - ii) Describe heat flux DSC instrument.
 - iii) Write Duane Hunt equation and explain the term involved in it.
- b) Attempt any two of the following : **[4]**
- i) State the principle of thermometric titration.
 - ii) Give the application of DSC technique.
 - iii) Define the terms short-wavelength cutoff and Brems strahlung.

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Total No. of Questions : 3]

SEAT No. :

PE4491

[Total No. of Pages : 2

[6510]-36

M.Sc. - II

PHYSICAL CHEMISTRY

CHP-610(C)-MJ : Special Topics in Physical Chemistry
(2023 Credit Pattern) (Semester - III) (Elective) (Option - C)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logarithmic table, calculator is allowed.
- 4) Neat diagrams must be drawn wherever necessary.

Physico - Chemical Constants

1.	Avogadro Number	N	$= 6.022 \times 10^{23} \text{ mol}^{-1}$
2.	Boltzmann Constant	k	$= 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3.	Planck Constant	h	$= 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4.	Electronic Charge	e	$= 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5.	1 eV		$= 23.06 \text{ kcal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6.	Gas Constant	R	$= 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7.	Faraday Constant	F	$= 96487 \text{ C equiv}^{-1}$
8.	Speed of light	c	$= 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9.	1 cal		$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10.	1 amu		$= 1.673 \times 10^{-27} \text{ kg}$
11.	Bohr magneton	β_e	$= -9.274 \times 10^{-24} \text{ J T}^{-1}$
12.	Nuclear magneton	β_n	$= 5.051 \times 10^{-27} \text{ J T}^{-1}$
13.	Mass of an electron	m_e	$= 9.11 \times 10^{-31} \text{ kg}$

P.T.O.

- Q1) a)** Attempt the following. (any 4). **[8]**
- i) Write the two applications of nanoparticles.
 - ii) Explain electrochemical adsorption.
 - iii) What is the effect of temperature and pressure on storage of hydrogen.
 - iv) What is smart sensors?
 - v) Explain the applications of smart sensors.
- b) Describe electric double layer in metal nanoparticles. **[3]**
-
- Q2) a)** Attempt the following (any 3). **[9]**
- i) Explain hydrogen storage of bucky balls.
 - ii) Define smart polymers & give their uses.
 - iii) What are different methods of preparation of nanoparticles.
 - iv) Write a note on piezoelectric materials.
- b) Discuss the role of physisorption in hydrogen storage. **[3]**
-
- Q3) a)** Attempt the following (any 2). **[8]**
- i) Explain the size dependent properties of nanoparticles.
 - ii) Discuss the storage of hydrogen with carbon nanofibers and graphite.
 - iii) Write a note on smart ceramics & oxides.
- b) Attempt the following (any 2). **[4]**
- i) Explain optical properties of nanoparticles.
 - ii) Discuss the biomineralisation of biosensing of smart materials.
 - iii) Explain nano aerogel? Give examples.



Total No. of Questions : 6]

SEAT No. :

PE4492

[Total No. of Pages : 3

[6510]-37

M.Sc. - II (Inorganic Chemistry)

**CHI-601-MJ : ORGANOMETALLIC AND HOMOGENEOUS
CATALYSIS**

(2023 Credit Pattern) (NEP 2020) (Semester - III) (4 Credits)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Answer to the two sections should be written in separate answer books.
- 3) Figures to the right indicates full marks.
- 4) Neat diagram must be drawn wherever necessary.

SECTION - I

Q1) A) Answer the following. [8]

- a) What is Fischer carbene?
- b) What is EAN? Explain with suitable example.
- c) How many M-M bonds are present in the following complexes?
 - i) $\text{Ir}_4(\text{CO})_{12}$ [Atomic No. of Fe = 26, Ir = 77]
 - ii) $\text{Fe}_2(\text{CO})_9$
- d) Explain the term π = acid ligand.

B) Write short note on fluxional behaviour of organometallic compounds.[3]

Q2) A) Answer any One of the following. [6]

- a) Give an account of synthesis, bonding, properties and applications of cyclopentadienyls.
- b) Give the systematic classification of 6-bonded transition metal hydrocarbonyls.

B) Answer any two of the following. [6]

- a) What is the significance of 18 electron rule in organometallic compounds?
- b) Write a short note on transition metal atom cluster with suitable example.
- c) What is the term hapticity? What hapticities are possible for following ligands?
 - i) C_5H_5
 - ii) $\text{CH}_2=\text{CH}_2$

P.T.O.

- Q3) A)** Answer any ONE of the following [6]
- Give an account of synthesis of di-alkenes complexes.
 - Draw the structures of the following complexes.
 - $\text{Fe}(\eta^5 - \text{C}_5\text{H}_5)_2$
 - $\text{Co}_2(\text{CO})_8$
 - $\text{Fe}_4(\text{CO})_{12}$
 - $\text{Cp}(\eta^6 - \text{C}_6\text{H}_6)\text{Mn}$
 - $[\eta^5 - \text{Cp Mo}(\text{CO})_2]_2$
 - $[\text{Cr}(\text{CO})_6]$
- B)** Answer any two of the following. [6]
- Describe industrial applications of organometallic compounds.
 - What are Homoleptic and Heteroleptic sigma complexes?
 - Write short note on carbonyl metallates.

SECTION - II

- Q4) A)** Answer the following. [8]
- Why late transition element organometallic complexes are used as homogeneous catalysts?
 - What are the prerequisite conditions for asymmetric catalysis.
 - What are the characteristics of efficient catalyst?
 - Which are the commonly used Pd precursors as a catalyst for Heck reaction?
- B)** What is Tolman cone angle? How are they determined? Give its significance in homogeneous catalysis. [3]
- Q5) A)** Answer any one of the following. [6]
- What is Negishi coupling? Discuss it with the help of catalytic cycles.
 - Give an account of metathesis reaction along with catalysts used for it
- B)** Answer any two of the following. [6]
- Discuss Ziegler-Natta polymerization.
 - What are the advantages of catalytic route over the conventional routes in epoxidation of propylene?
 - Discuss different types of biphasic systems in homogeneous catalysis.

Q6) A) Answer any one of the following. **[6]**

- a) Give an overview of use of Homogeneous catalysts for synthesis of high value chemicals.
- b) Give an account of use of metallocene based catalysts for polymerization reaction.

B) Answer any two of the following. **[6]**

- a) Compare Monsanto and Cativa process for synthesis of acetic acid.
- b) Write a note on oxidative addition and reductive elimination reaction.
- c) Explain use of IR spectroscopy in homogeneous catalysis.

* * *

Total No. of Questions : 6]

SEAT No. :

PE4493

[Total No. of Pages : 3

[6510]-38

M.Sc. - II (Chemistry)

INORGANIC CHEMISTRY

CHI-602-MJ : Inorganic Reaction Mechanism, Photochemistry &
Reaction of Coordination Ligand
(2023 Credit Pattern) (Semester - III)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Neat diagram must be drawn whenever necessary.
- 3) Figures to the right indicate full marks.
- 4) Answer to the two section should be written in separate answer sheet.

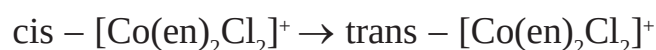
SECTION - I

Q1) a) i) What is Anation reaction? Give its example. [8]

ii) What do you mean by atom or group transfer reaction? Give suitable example?

iii) What do you mean by inert and labile complex?

iv) Explain the mechanism of cis-trans isomerisation in following metal complexes.



b) Give the classification of inorganic reactions of coordination compounds.[3]

Q2) a) Answer any one of the following. [6]

i) Discuss in brief about factor affecting stability constant.

ii) Discuss the mechanism of cis-trans isomerization in square planar complex.

b) Answer any two of the following. [6]

i) Role of solvent in octahedral substitution reaction.

ii) What is trans effect? Comment on trans effect series.

iii) Explain S_N2 reaction with example.

P.T.O.

- Q3) a)** Attempt the following (any one). **[6]**
- i) Discuss thermodynamically stable complexes could be kinetically inert or labile Explain with suitable example?
 - ii) Explain the relationship between of electron configuration of metal and lability of the complexes.
- b)** Attempt any two of the following. **[6]**
- i) Differentiate between intimate and stoichiometric mechanism of ligand substitution.
 - ii) Nucleophilic substitution in square planar complexes take place with retention of configuration explain.
 - iii) Discuss the role of spectator ligand in substitution of square planar complexes.

SECTION - II

- Q4) a)** Answer the following. **[8]**
- i) What do you mean by quantum yield in photochemical reaction?
 - ii) What is the role of d-d transition in photochemical reaction.
 - iii) Describe the phenomenon of fluorescence.
 - iv) Explain ligand substitution reaction with example.
- b)** Discuss in brief prompt and delayed reactions with suitable example. **[3]**
- Q5) a)** Answer any one of the following. **[6]**
- i) Comment on chelate ring modifying reactions.
 - ii) Discuss photochemical reaction of Co (III) complexes.
- b)** Attempt any two of the following. **[6]**
- i) Explain in detail halogenation of coordinational Nitrogen atom.
 - ii) Give an account of insertion reactions.
 - iii) What is S_N1CB mechanism? Explain it with suitable example?

Q6) a) Attempt any one of the following. **[6]**

- i) The extent of exchange interaction in the Cu_2O_2 ring system is greater than that in Cr_2O_2 ring system explain.
- ii) Discuss the inner sphere electron transfer reaction with the help of cobalt complex.

b) Write note on any two of the following. **[6]**

- i) Methyl migration.
- ii) Solvolysis of coordinated phosphorus atom.
- iii) Oxidative addition and reductive elimination reaction.



Total No. of Questions : 3]

SEAT No. :

[Total No. of Pages : 2

PE4494

[6510]-39

M.Sc. - II

INORGANIC CHEMISTRY

**CHI-603 MJ : Bioinorganic Chemistry
(2023 Credit Pattern) (Semester - III)**

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Draw neat and labelled diagrams wherever necessary.*

Q1) a) Answer the following. [8]

- i) Which metal present at the active site of vit. B₁₂? What is the function of vit. B₁₂?
- ii) What is Antagonism?
- iii) What is metalloenzyme? Give any two functions of metalloenzyme.
- iv) Enlist the functions of blue copper proteins.

b) Explain the mechanism of Cu-PSTM trapping inside cells. [3]

Q2) a) Attempt any one of the following. [6]

- i) Discuss the mechanistic aspects of the reaction of Hydrolysis of CO₂ catalyzed by carbonic anhydrase.
- ii) Mention the deficiency of vit. B₁₂ and give an Account of model compounds of vit. B₁₂.

b) Attempt any two of the following. [6]

- i) What are the blue oxidases? Give suitable example.
- ii) What is superoxide dismutase? Explain it's role in biological system.
- iii) What is mean by Non-heme iron?

P.T.O.

Q3) a) Attempt any one of the following. **[6]**

i) What is the function of carboxypeptidase? Explain in brief the structural features of carboxypeptidase.

ii) Give an account of metal clusters in nitrogenase.

b) Write note on any two. **[6]**

i) Galactose oxidase

ii) Ribonucleotide Reductase

iii) Role of M_n in peroxidase



Total No. of Questions : 6]

SEAT No. :

PE4495

[6510]-40

[Total No. of Pages :3

M.Sc. - II

INORGANIC CHEMISTRY - IV

CHI - 610 (A) MJ : Physical Methods in Inorganic Chemistry
(2023 Credit Pattern) (Semester - III)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Write each section in separate answer book.
- 4) Use of Logarithm table and calculators are allowed.

SECTION-I

(Thermal and Spectroscopic Techniques)

Q1) a) Answer the following. [8]

- i) Describe the role of reference material in DTA technique.
 - ii) What is the principle of TPD?
 - iii) Why KBr is inactive in IR analysis?
 - iv) Discuss the ^1H NMR Spectrum of HD molecule.
- b) What do you mean by hyperfine structure? How do they arise in ESR spectra? [3]

Q2) a) Answer any One of the following. [6]

- i) Describe the instrumentation and working of TGA with the help of block diagram.
 - ii) State the selection rule in NMR spectroscopy. Discuss the application of shift reagent in NMR spectroscopy with suitable example.
- b) Answer any Two of the following. [6]
- i) What is the principle of fluorescence spectroscopy? How does it differ from absorption spectroscopy?
 - ii) Derive Bragg's equation in XRD.
 - iii) Differentiate between DTA and DSC techniques.

P.T.O.

- Q3) a)** Attempt any One of the following. [6]
- Discuss the instrumentation and working of TPD technique. Give any two applications of TPD technique.
 - Describe the concepts of zero field splitting and Kramer's degeneracy with suitable example.
- b)** Attempt any Two of the following. [6]
- What is the principle of FT-IR spectroscopy? How does it differ from conventional IR spectroscopy?
 - Draw the TGA thermogram of calcium oxalate monohydrate ($\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$). Mention the chemical reactions involved.
 - Powder diffraction pattern was recorded for lead using CuK_α radiation with $\lambda = 1.58 \text{ \AA}$. What will be the interplanar distance if a first order line is obtained at $\theta = 0.9410^\circ$.

SECTION-II

(Material Characterization techniques and analytical techniques)

- Q4) a)** Attempt the following [8]
- Explain the principle of SEM technique.
 - Give any two applications of cyclic voltammetry.
 - What is the role of electron energy analyzer in XPS.
 - What type of materials are typically analyzed using UVDRS.
- b)** Describe the purpose of the electron gun and electromagnetic lenses in a TEM technique. [3]
- Q5) a)** Attempt any One of the following. [6]
- Discuss the principle working and applications of cyclic voltammetry (C.V).
 - Discuss the working of EDX technique. Give any four applications of EDX technique.
- b)** Attempt any TWO of the following. [6]
- Explain the principle of UV-DRS and how it differs from standard UV-Vis Spectroscopy.
 - Explain the principle of BET method. Give its application in the analysis of porous materials.
 - Write a note on XPS technique.

Q6) a) Attempt any One of the following. **[6]**

- i) Discuss the working and applications of SEM technique.
- ii) Explain the principle and working of Flame photometer. Discuss the applications of Flame photometer.

b) Attempt any Two of the following. **[6]**

- i) Calculate the BET surface area of a porous material, if the monolayer adsorption volume is $1.2 \text{ cm}^3/\text{g}$ and cross-sectional area of nitrogen is 0.162 nm^2
(Given: Molar mass of $\text{N}_2 = 28 \text{ g/mol}$; Avogadro's No. = 6.022×10^{23}).
- ii) In a cyclic voltammetry experiment, the peak current is measured at two different scan rates; when the peak current is $50 \mu\text{A}$ then scan rate is 0.02 V/S . Calculate the peak current at scan rate of 0.1 V/S .
- iii) Discuss the role of secondary electrons in SEM imaging. Give any two applications of SEM technique.



Total No. of Questions : 6]

SEAT No. :

PE4496

[Total No. of Pages : 3

[6510]-41

M.Sc. - II

INORGANIC CHEMISTRY - IV

**CHI - 610 (B) MJ : Magneto Chemistry & Inorganic Polymers
(2023 Credit Pattern) (Semester - III)**

Time : 3Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Neat diagrams must be drawn whenever necessary.*
- 3) *Use of calculator is allowed.*

SECTION - I

(Magneto - Chemistry)

Q1) a) Attempt the following. [8]

- i) Explain anti-ferromagnetic materials with one example.
 - ii) Find out R-S term symbol for Co^{3+} & Fe^{3+} .
 - iii) Define Solute-solute magnetic interactions.
 - iv) What is anisotropy in magnetic susceptibility?
- b) What is anomalous behaviour of magnetic moment? Explain with example. [3]

Q2) a) Answer any one of the following. [6]

- i) Why $\text{Mn}_2\text{CO}_{10}$ is diamagnetic? Explain.
 - ii) Explain magnetic interactions in Cu(II) acetate monohydrate complex.
- b) Attempt any two of the following. [6]
- i) Explain Curie & Curie-Weiss law.
 - ii) Explain experimental magnetic moment of $[\text{Ni}(\text{NH}_3)_6]\text{SO}_4$, $\mu_{\text{expt}} = \sim 2.84 \text{ BM}$.
 - iii) Define first & second order zeeman effect with examples.

P.T.O.

Q3) a) Answer any one of the following. **[6]**

- i) Explain an experimental set-up of Guoy method to measure magnetic susceptibility - Discuss merits & demerits of this method.
- ii) Explain in detail Van-Vleck's equation.

b) Answer any two of the following. **[6]**

- i) Explain characteristic properties of paramagnetic, diamagnetic, ferromagnetic & anti-ferromagnetic substances.
- ii) Discuss magnetic properties of lanthanides & actinides.
- iii) Describe the magnetic properties of mixed valence compounds.

SECTION - II

(Inorganic - Polymers)

Q4) a) Attempt the following. **[8]**

- i) Write a short note on classification of polymers.
- ii) Draw structure of Borazine.
- iii) Give brief account of silicon rubber.
- iv) Write advantages & disadvantages of synthetic & natural rubber.

b) Explain significance & properties of luminescent inorganic polymers. **[3]**

Q5) a) Answer any one of the following. **[6]**

- i) Write a note on Keolinite, Mica mineral and ultramarines.
- ii) Write a short note on SN compounds.

b) Answer any two of the following. **[6]**

- i) Discuss the structure of Carborundum.
- ii) Give the applications of polymers containing metal.
- iii) Write a note on PN compounds.

Q6) a) Answer any one of the following.

[6]

- i) Draw structure of S_4N_4 , S_2N_2 & $(SN)_x$ compounds.
- ii) Draw the structures and explain bonding in following.
 - 1) B_4H_{10}
 - 2) B_5H_9
 - 3) B_5H_{11}

b) Answer any two of the following.

[6]

- i) Complete the following reactions.
 - 1) $P_4O_{10} + H_2O \rightarrow ?$
 - 2) $B_2O_3 + NH_3 \rightarrow ?$
- ii) Explain allotrops of carbon.
- iii) Write a note on aluminium nitride.



Total No. of Questions : 6]

SEAT No. :

PE4497

[Total No. of Pages : 4

[6510]-42

S.Y. M.Sc.

ORGANIC CHEMISTRY

CHO - 601 - MJ : Organic Reaction Mechanism and Stereochemistry
(2023 Credit Pattern) (Semester - III) (4 Credits)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Answer to the two sections should be written in separate answer book.

SECTION - I

Q1) a) Answer the following (any four). [8]

- i) Explain primary isotope effect with suitable example.
- ii) Which of the following is more acidic? Justify.



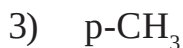
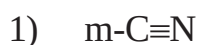
- iii) Explain the significance of σ (sigma)
- iv) Define imins with suitable example.
- v) Butane 2, 3 dione exists exclusively in keto form where as 1, 2 - cyclopentane dione is 100% enolised. Explain.

b) Write a short note on Darzens reaction. [3]

P.T.O.

Q2) a) Attempt any three of the following. **[9]**

i) Predict the sign of Hammett σ (sigma) constant for following substituents.

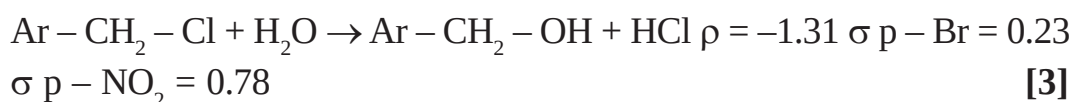


ii) Explain crossover experiment with stereo chemical evidence.

iii) Explain base catalysed mechanism of halogenation of Ketones.

iv) Explain stork enamine reaction with suitable example.

b) From the given data calculate how much faster p-bromobenzyl chloride will solvolysise in water than p-nitrobenzyl chloride



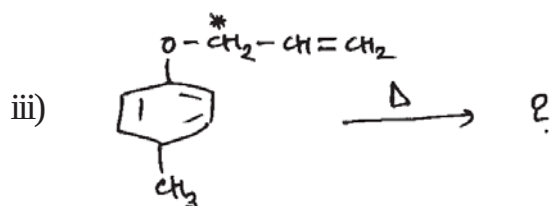
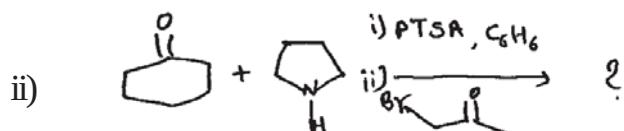
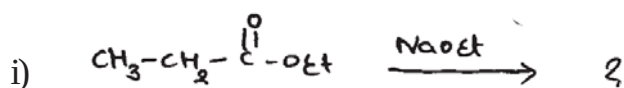
Q3) a) Attempt any two of the following. **[8]**

i) Derive Hammett equation.

ii) How product analysis helps to decide the reaction mechanism? Explain with suitable example.

iii) Explain Baylis - Hillman reaction with mechanism.

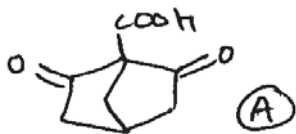
b) Predict the product of the following reaction (any two). **[4]**



SECTION - II

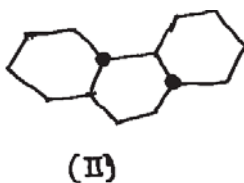
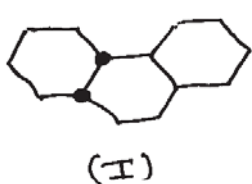
Q4) a) Answer the following (any four). **[8]**

- i) Explain (A) do not undergo decarboxylation.



- ii) Explain the term optical purity with example.
- iii) Draw the various conformations of cyclohexane.
- iv) Explain Von answers skita Hydrogenation rule.
- v) Predict the product formed by reaction of nitrous acid with cis and trans - 2 - aminocyclohexanol.

b) Draw conformational structures of compound (I) and (II). Discuss their stability. **[3]**



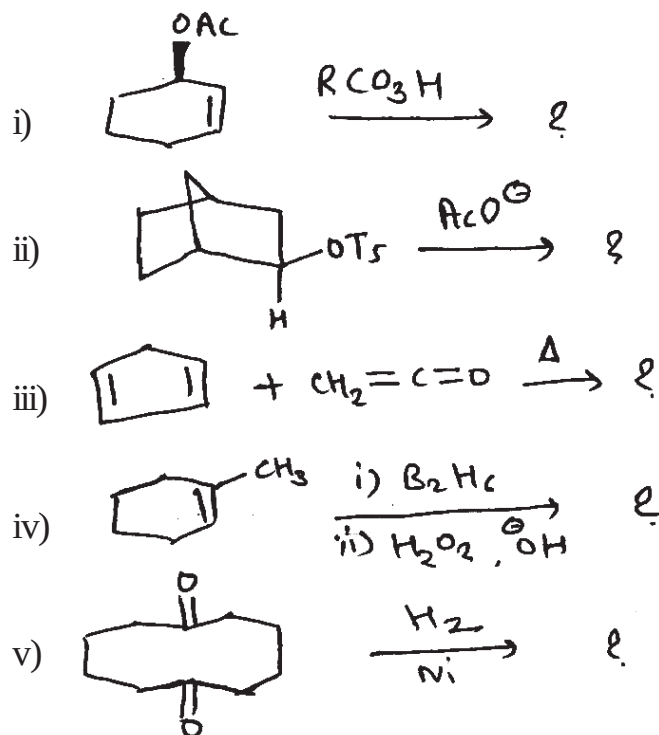
Q5) a) Attempt any three of the following. **[9]**

- i) Explain trans annular effect with suitable example.
- ii) Describe conformation effects in five membered ring.
- iii) Write a note on adamantane.
- iv) Explain 2-alkyl ketone effect with example.

b) Describe various conditions for good resolving agent. **[3]**

Q6) a) Predicts the product in any four of the following.

[8]



b) Predict the product of following reaction and interpret NMR signals of product. [4]



A : - 1.08 (s, 9H) 1.13 (s, 9H) 2.71 (dd, 17.7 & 1.9 Hz, 1H) 3.25 (dd, 17.7 & 10 Hz, 1H) 4.38 (dd, 1.9 & 10 Hz, 1H)



[6510]-43

M.Sc.-II

ORGANIC CHEMISTRY

CHO-602 Mj : Advanced Spectroscopic Methods in Structure Determination

(2023 Credit Pattern) (Semester - III) (4 Credits)

Time : 3 Hours]

[Max. Marks : 70

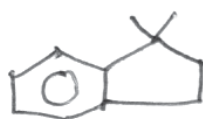
Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicates full marks.
- 3) Answer to the two sections should be written in the separate answer books.

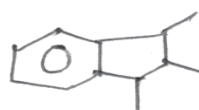
SECTION - I

Q1) a) Attempt any four of the following. [8]

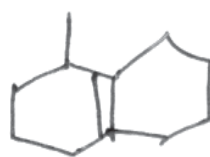
- i) Distinguish following pairs by PMR Spectroscopy.
 $\text{Ph-CH}_2\text{-OCH}_3$ and $\text{Ph-O-CH}_2\text{-CH}_3$
- ii) Distinguish following pairs by $^{13}\text{CNMR}$ Spectroscopy.



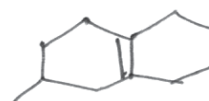
and



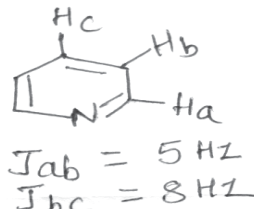
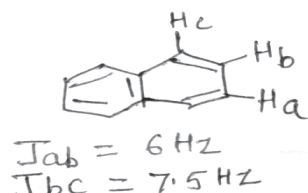
- iii) Distinguish following pairs by Mass spectrometry.



and



- iv) Explain the coupling constants observed in the following compounds.



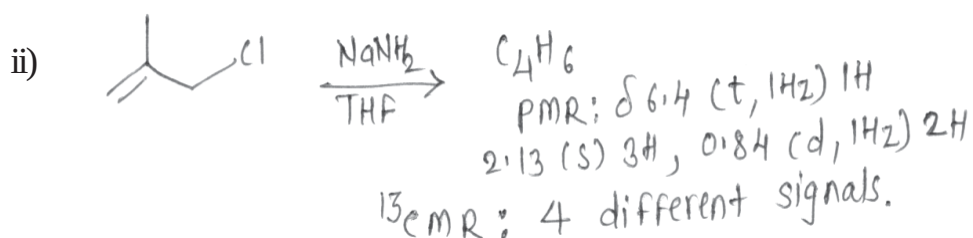
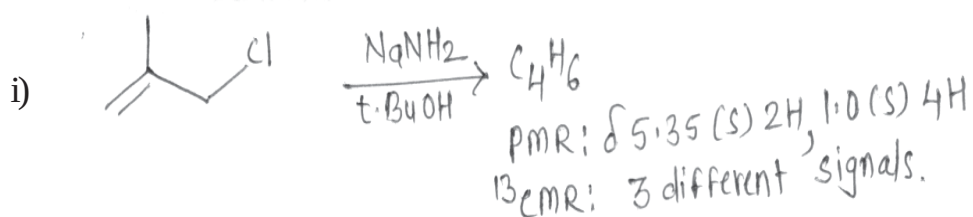
- v) Ethyl acetoacetate shows nine signals in its $^{13}\text{CNMR}$. Explain.
- b) COCl_3 shows triplet (1 : 1 : 1) in $^{13}\text{CNMR}$. Explain. [3]

P.T.O.

Q2) a) Deduce the correct structure from the given data. (any -3) **[9]**

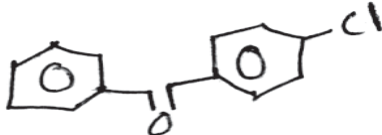
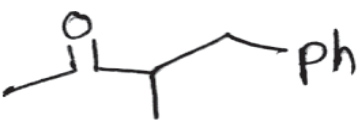
- i) M.wt. : 149
 IR : 2842, 2720 and 1661 cm^{-1}
 PMR : δ 3.1(s) 6H, 6.7 (d) 7.5Hz 2H, 7.72 (d) 7.5Hz 2H, 9.75 (s) 1H
- ii) Two isomeric compounds A and B of C_5H_{10} show the following peaks in ^{13}CMR . Assign the structures from the given data.
 Isomer A : 13 (Q), 17 (Q), 76(Q), 118(d), 132 (s) PPM
 Isomer B : 13 (Q), 22(Q), 31(t), 108 (t), 147 (s) PPM
- iii) M.F : $\text{C}_6\text{H}_8\text{Cl}_2\text{O}_2$
 PMR : 1.45 (d, J = 12Hz) 1H, 1.60 (s) 3H
 2.29 (d, J = 12Hz) 1H, 3.77 (s) 3H
 ^{13}CMR : 18, 31, 53, 63, 170
 DEPT 90 : No peak
 DEPT 135 : 18 & 53 (up), 31 (down)
- iv) M.F : $\text{C}_7\text{H}_{14}\text{O}_2$
 M/Z : 130, 115, 100, 73, 43
 ^{13}CMR : 208(s), 75(s), 54(t), 50(Q), 33 (Q), 25 (Q, strong)
 PMR : δ 1.3(s) 6H, 2.2(s) 3H, 2.5(s) 2H, 3.2(s) 3H

b) Predict the structure of the product of the following reaction and justify.[3]



- Q3) a)** Write short notes on (any-2) **[8]**
- i) Factors affecting vicinal coupling.
 - ii) MALDI and FAB techniques.
 - iii) Lanthanide shift reagents.
- b)** Attempt any two of the following. **[4]**
- i) How will you determine the stereochemical relations in a molecule on the basis of NOE.
 - ii) Discuss importance of Metastable Ion in MS.
 - iii) Discuss INEPT technique.

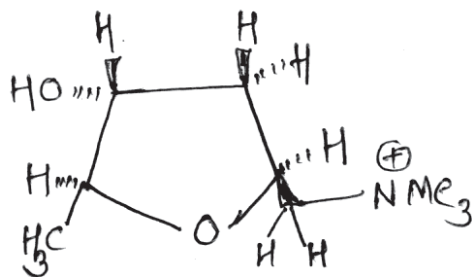
SECTION - II

- Q4) a)** Write the genesis of the Ions (any 4) **[8]**
- i)  M/Z : 97, 82, 68, 41
 - ii)  M/Z : 98, 83, 70, 55, 42
 - iii)  M/Z : 218, 216, 141, 139, 105, 77
 - iv)  M/Z : 162, 147, 91, 43
 - v) Ethyl, isobutyl ether M/Z : 102, 87, 73, 59, 29
- b)** A compound with molecular formula $C_8H_{10}O$ Shows the following peaks in its EIMS. Deduce the structure of compound and justify your answer. **[3]**
M/Z : 107, 79, 77, 51, 39

Q5) a) Attempt any two of the following.

[8]

- i) Assign the chemical shift values to various protons in the following structure. Use the NOE results to assign the protons. Justify your answer.



- 1.16 (d, 6.5Hz) 3H
 1.86 (ddd, 12.5, 9.5, 5.5Hz) 1H
 2.02 (ddd, 12.5, 2, 6Hz) 1H
 3.36 (s) 9H
 3.54 (dd 13 & 9Hz) 1H
 3.74 (dd, 13 & 1Hz) 1H
 3.92 (dq, 2.5 & 6.5Hz) 1H
 4.03 (m) 1H
 4.3 (d, 3.5Hz) 1H Exch.
 4.68 (M) 1H

NOE Expt :

Irradiation at

a) δ 4.68

b) δ 1.16

Decoupling Expt :

a) δ 1.16

b) δ 4.68

change in

7% enhancement at 3.92 δ

15% enhancement at 1.86 δ

changes at

3.92(dQ) $\rightarrow$ d (2.5Hz)

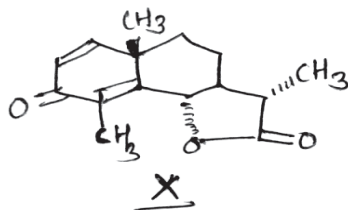
i) 3.54 (dd) $\rightarrow$ d(13Hz)

ii) 3.74 (dd) $\rightarrow$ d (13Hz)

iii) 1.86 (ddd) $\rightarrow$ dd (12.5 & 9.5 Hz)

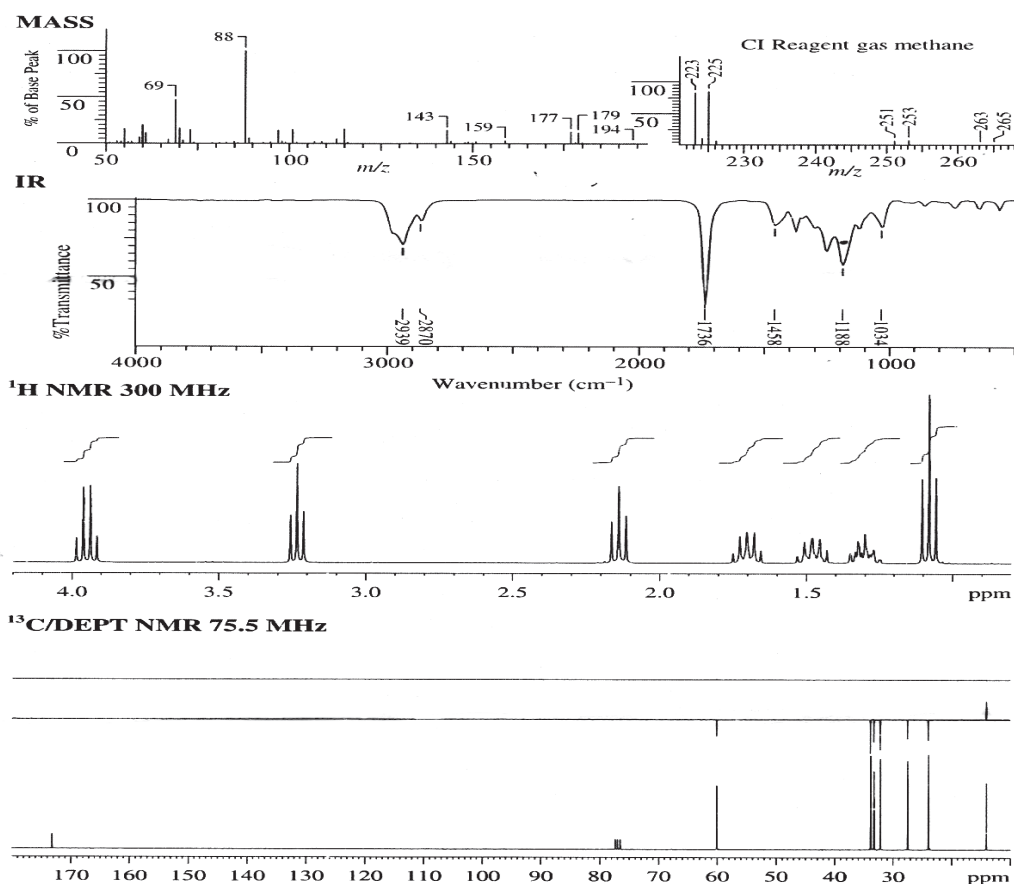
iv) 2.02 (ddd) $\rightarrow$ dd (12.5 & 2 Hz)

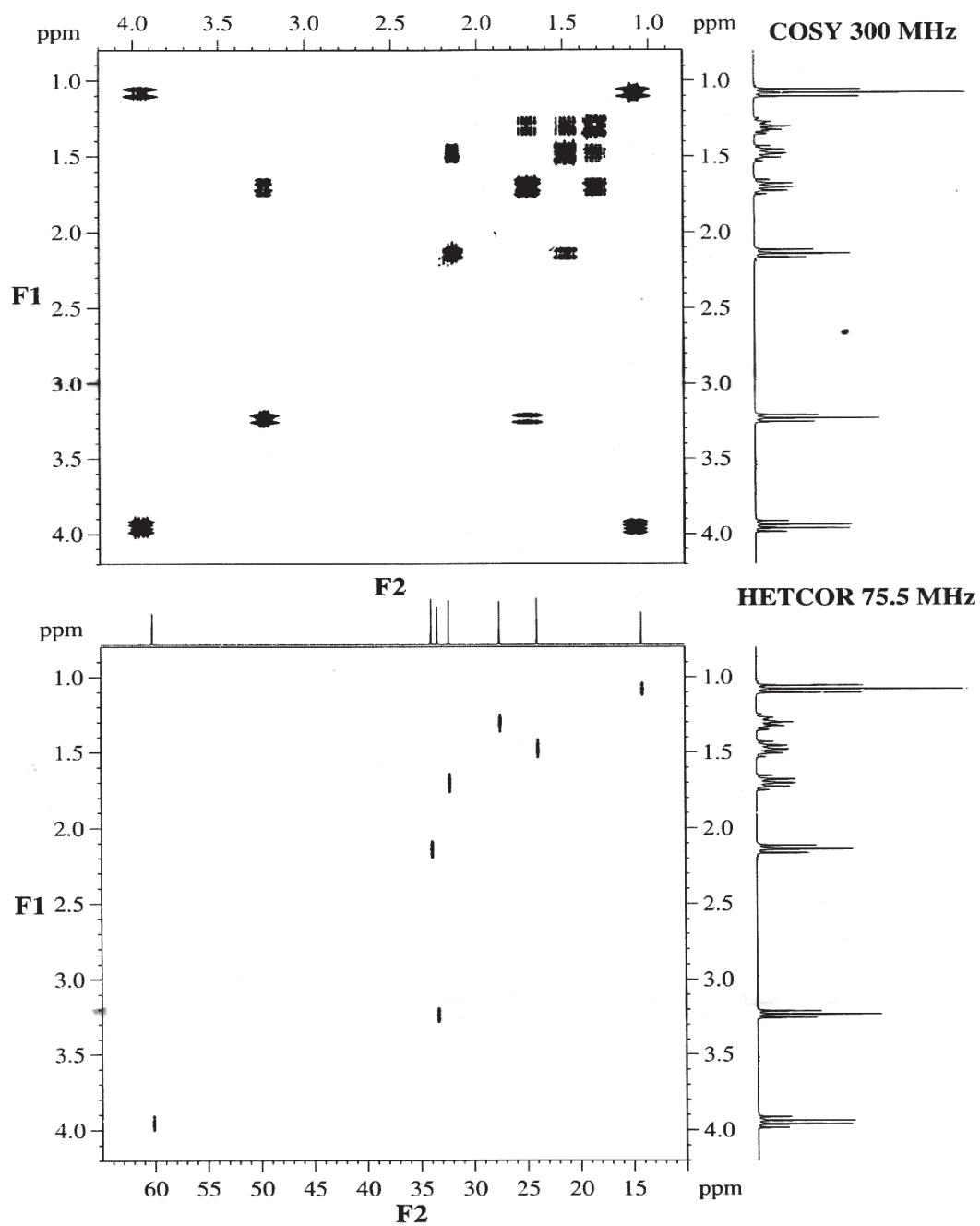
- ii) Assign the chemical shift for various carbons in the following compound X and justify.



^{13}CMR : 10(Q), 12(Q), 22(t), 24(Q)
 37(t), 40(d), 42(s), 53(Q)
 80 (d), 124(d), 126(s), 153(s)
 156 (d), 178(s), 185 (s)

- iii) Write a note on rearrangements in MS.
- b) Discuss applications of 2D NMR techniques in structure determination.[4]
- Q6) a)** 2, 2, 2 -tri fluoro ethanol shows triplet in ^{19}F NMR and Quartet in ^1H NMR. Explain. [3]
- b)** You are provided with spectra of a compound (M.wt = 222) on the adjacent page. Analyse these spectra and arrive at a correct structure and justify your answer. [9]





* * *

Total No. of Questions : 3]

SEAT No. :

PE4499

[Total No. of Pages : 3

[6510]-44

M.Sc. -II

ORGANIC CHEMISTRY

CHO-603 MJ : Heterocyclic Chemistry

(2023 Credit Pattern) (NEP) (Semester-III) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

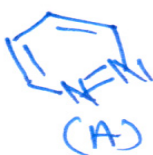
Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*

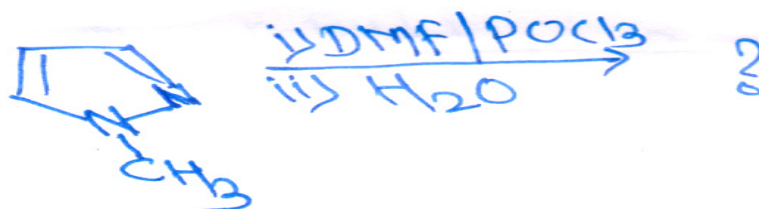
Q1) a) Answer the following (any 4).

[8]

- i) Name the following heterocycles by systematic Hantzsch-Widman nomenclature.



- ii) Furan is less aromatic than pyrrole and thiophene.
- iii) Why does pyridine undergo electrophilic substitution at the 3rd position?
- iv) Predict the correct product in following reaction.



- v) Benzofuran is more resistant to acid than Furan.
- b) Write short note on Skraup quinoline synthesis.

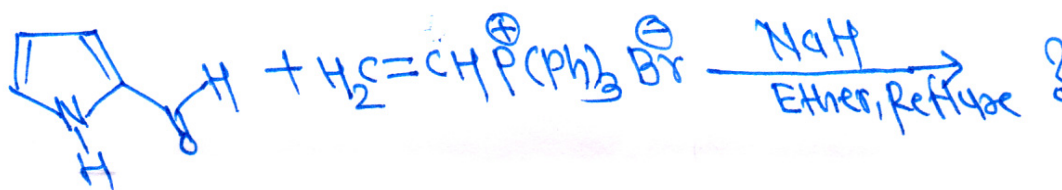
[3]

P.T.O.

Q2) a) Attempt any three of the following. [9]

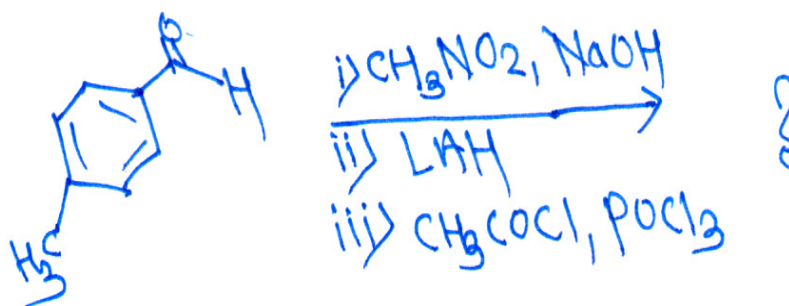
- i) P_{ka} value of imidazole is 7 and that of pyrazole is 2.5.
- ii) Give the reaction of following reagents with indole
 - 1) Me₂NCHO, POCl₃
 - 2) SO₃ in pyridine
 - 3) EtONO₂, NaOEt, Et₂O
- iii) Pyrimidine is resistant to electrophilic substitution reaction, however 2-amino pyrimidine easily undergo the same.
- iv) Write short note on Hinsberg thiophene synthesis.

b) Predict the product with suitable mechanism in the following reaction. [3]

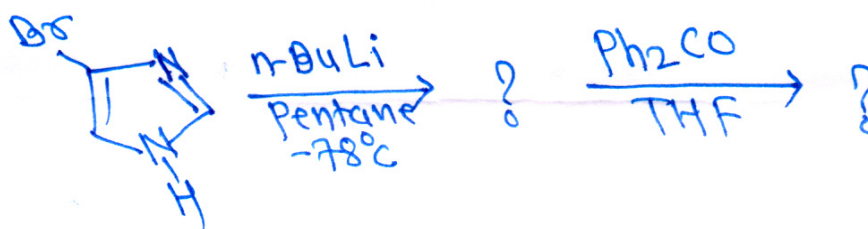


Q3) a) Attempt any two of the following. [8]

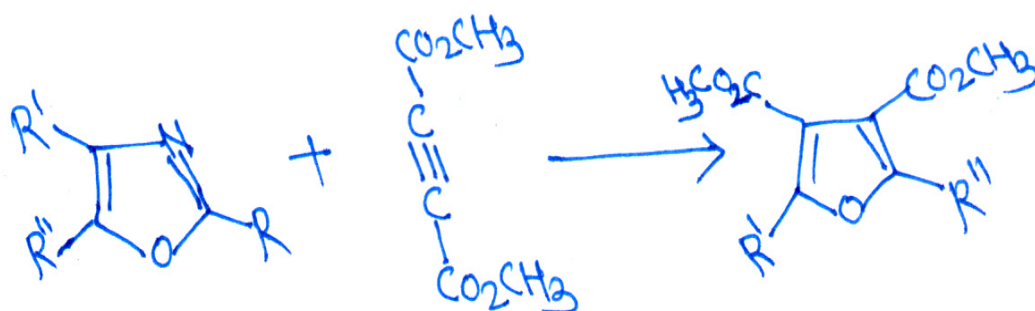
- i) Predict the product with suitable mechanism in the following reaction.



- ii) Complete the reaction sequence, write the suitable mechanism and predict the products.



iii) Suggest the suitable mechanism for following reaction.



b) Attempt any two of the following. [4]

- Pyridine N-oxide readily undergoes electrophilic substitution at 4 position. Explain.
- Quinoline is used as a solvent in decarboxylation reaction. Explain.
- Write short note on Chichibabin reaction.



[6510]-45

M.Sc. - II

ORGANIC CHEMISTRY

CHO-610(A)-MJ : Synthetic Methods in Organic Chemistry

(2023 Credit Pattern) (Semester - III) (2 Credits)

Time : 2 Hours]

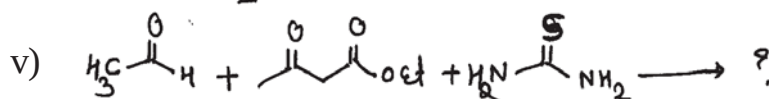
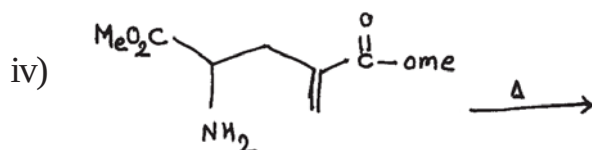
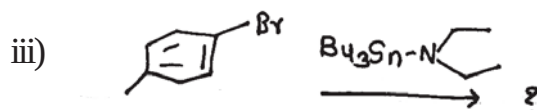
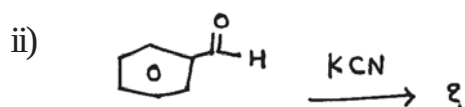
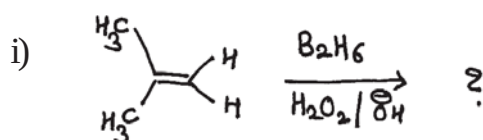
[Max. Marks : 35

Instructions to the candidates:

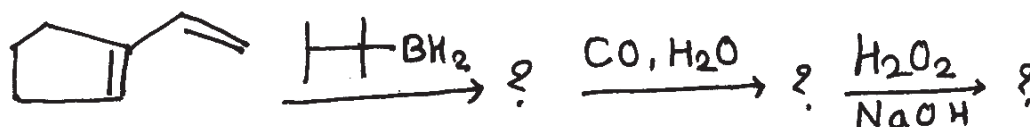
- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.

Q1) a) Predict the product of the following (any four).

[8]



b) Complete the following reaction sequence with possible mechanism. [3]



P.T.O.

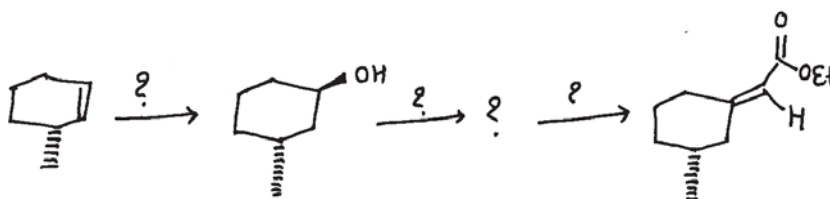
Q2) a) Answer the following (any three). **[9]**

- i) Use of disiamyl borane.
- ii) Explain the witting reaction can give stereoselective alkene.
- iii) Why IPC_2BH may be used for synthesis of optically active alcohol?
- iv) Write note on Pausan - Khand reaction.

b) Explain Bergman and Nazarov cyclization with suitable example. **[3]**

Q3) a) Attempt any two of the following. **[8]**

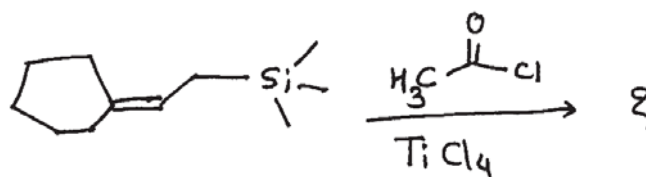
- i) Explain Baldwin's rule with suitable example.
- ii) Complete the following reaction sequence.



- iii) Write a note on Ugi reaction.

b) Attempt any two of the following. **[4]**

- i) Synthesis of 1, 2 dicarbonyl compounds involves the use of at least one reagent having umpolung activity.
- ii) Use of organotin compounds in organic synthesis.
- iii) What is the product of the following reaction.



Total No. of Questions : 3]

SEAT No. :

PE4501

[Total No. of Pages : 2

[6510]-46

M.Sc. - II

ORGANIC CHEMISTRY

CHO-610 (B) MJ : Carbohydrates & Chiron Approach
(2023 Credit Pattern) (Semester-III) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.

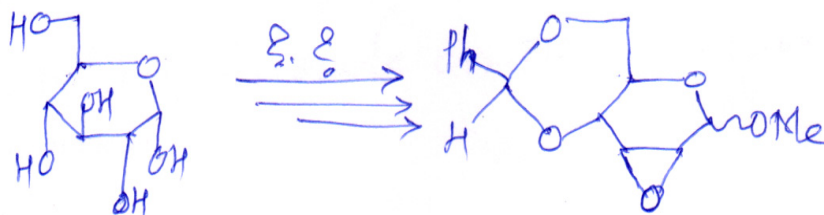
Q1) a) Answer any four of the following. [8]

- i) Draw ${}^1C_4$ & ${}^4C_1$ conformations of D-Glucose.
- ii) What are glycosyl donors?
- iii) What is mutarotation?
- iv) What are Chiral Auxilliarities?
- v) Explain the concept of Chiral templates.

b) Write the synthesis of (R)-Epichlorohydrin from D-mannitol. [3]

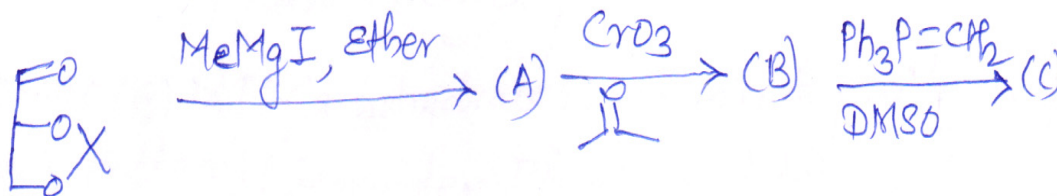
Q2) a) Attempt any three of the following. [9]

- i) Explain with mechanism protection & deprotection of hydroxy group by using benzyl bromide & MOM with suitable example.
- ii) Give the reagents for the following conversion.



P.T.O.

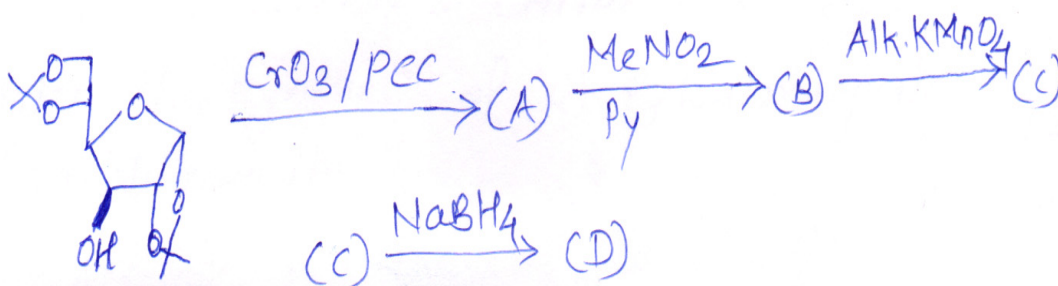
- iii) How can oxidation with HNO_3 be used to distinguish between D-erythrose & D-threose?
- iv) Predict the products for the following reaction.



- b) Write the Ruff degradation reaction by using suitable example. [3]

Q3) a) Attempt any two of the following. [8]

- i) Explain the effect of protecting groups on Glycosylation stereochemistry & coupling efficiency.
- ii) Write the synthesis of (S)-propane diol from D-mannose.
- iii) Predict the products for the following reaction.



- b) Attempt any two of the following. [4]

- i) Write a short note on Anomeric effect.
- ii) Give the retro synthesis of (–) pentanomycin.
- iii) Write a short note on THP (tetrahydropyran) protection.



Total No. of Questions : 3]

SEAT No. :

PE4502

[Total No. of Pages : 2

[6510]-47

M.Sc. - II

ORGANIC CHEMISTRY

CHO-610(C)-MJ : Medicinal Chemistry

(2023 Credit Pattern) (Semester - III) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.*
- 2) Figures to the right indicate full marks.*

Q1) a) Attempt any four of the following. **[8]**

- i) What is prodrug?
- ii) Explain SAR.
- iii) What is mean by active immunization?
- iv) What is anti-inflammatory agent?
- v) Give defination for lead optimization.

b) Explain modern drug discovery process. **[3]**

Q2) a) Attempt any three of the following. **[9]**

- i) Give principle and applications of antimicrobial Therapy.
- ii) Explain Docking study.
- iii) Explain drug absorption process.
- iv) Write a note on macrolides.

b) Give mechanism of action and limitations of tetracycline. **[3]**

P.T.O.

Q3) a) Attempt any two of the following. **[8]**

- i) Write a note on physico-chemical parameters in drug design.
- ii) Discuss binding site role of functional group in drug development.
- iii) Explain the process of selecting drug target for drug discovery.

b) Attempt any two of the following. **[4]**

- i) Write note on pharmacodynamics of drug.
- ii) Write biological applications of folic acid.
- iii) Give any two names of software for molecular docking.



Total No. of Questions : 6]

SEAT No. :

PE4503

[Total No. of Pages : 3

[6510]-48

S.Y. M.Sc.

ANALYTICAL CHEMISTRY

**CHA-601-MJ : Thermal and Extraction Techniques in Analytical Chemistry
(2023 Credit Pattern) (Semester - III) (NEP - 2020) (4 Credits)**

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Use of logtable and calculator are allowed.*
- 4) *Answers to two sections should be written on separate answer sheets.*

SECTION - I

Q1) a) Answer the following (any 4). **[8]**

- i) Define the terms heat capacity and enthalpy of a reaction.
- ii) What is the principle of DMA.
- iii) What the symbol 'T_g' Signifies.
- iv) What is evolved gas analysis?
- v) Name various methods involved in thermal analysis.

b) Write a note on 'TG-MS' Analysis. **[3]**

Q2) a) Attempt any three of the following. **[9]**

- i) Explain term – 'Polymer blends' in detail.
- ii) Draw and explain curve calcium oxalate monohydrate $[\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}]$
- iii) Give factors affecting thermal analysis.
- iv) How enthalpy of melting of sample is measured by DSC.

b) Mixture of magnesium oxalate and magnesium oxide with weight 2.59 and loss weight on heating at 500°C 1.5 g. Find composition of mix
[Given : At Wt of Mg = 24, O = 16, C = 12] **[3]**

P.T.O.

Q3) a) Attempt any two of the following. **[8]**

- i) Write a note on dielectric thermal analysis.
- ii) What is mean by thermomicroscopy? Give any two applications of it.
- iii) Which thermal method can be used to account following changes and why?
 - 1) Conversion of solid to liquid
 - 2) Decomposion of Inorganic complex
 - 3) Change in dimension

b) Attempt any two of the following. **[4]**

- i) Enlist thermal methods of simultaneous analysis.
- ii) Explain study of high alumina cement by DTA.
- iii) What is meant by crystalline phase transition?

SECTION - II

Q4) a) Answer any four of the following. **[8]**

- i) What is emulsion in liquid-liquid extraction? How can emulsion be remedied?
- ii) Enlist the factors affecting solid phase extraction (SPE).
- iii) What are the two functions of SPME holder?
- iv) What is persistent organic pollutant?
- v) What causes the heating effect of microwaves on samples?

b) In solvent extraction of uranium with 8-hydroxy quinoline in CHCl_3 , the volume of aqueous and organic phase was 25ml each. When the % extraction was 99.8% calculate the distribution ratio. **[3]**

Q5) a) Attempt any three of the following. **[9]**

- i) Discuss applications of ion exchange SPE for isolation of amino acids from liquid samples.
 - ii) Explain in detail determination of 'Be' by solvent extraction.
 - iii) Discuss the stages of solid phase extraction.
 - iv) Outline the analysis of abietic acid and dehydroabietic acid in food samples by SPME – LC – MS system.
- b) A certain extraction system has a distribution ratio of 10. If 300 mg of solute is dissolved in 100ml of solvent A, Find out the amount of solute extracted by one extraction with 100ml of solvent B and by two extractions with 50ml of the solvent B which is immiscible with solvent A. **[3]**

Q6) a) Attempt any two of the following. **[8]**

- i) What is MAE? Explain heating effect of microwaves in MAE.
 - ii) Discuss applications of reverse phase SPE.
 - iii) Discuss instrumentation of pressurized fluid extraction.
- b) Attempt any two of the following. **[4]**
- i) What is normal phase SPE?
 - ii) Write note on Headspace SPME.
 - iii) Explain automated soxhlet extraction.



Total No. of Questions : 6]

SEAT No. :

PE4504

[Total No. of Pages : 3

[6510]-49

M.Sc. - II

ANALYTICAL CHEMISTRY

**CHA-602-MJ : Advanced Chromatographic Methods of
Chemical Analysis
(2023 Pattern) (Semester - III)**

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Answers of two sections should be written on two separate answer books.*
- 3) *Figures to the right indicate full marks.*
- 4) *Use of logtable and calculator is allowed.*

SECTION - I

Q1) a) Answer the following (Any four) : **[8]**

- i) What is retention time?
 - ii) Explain the term resolution in chromatography.
 - iii) What is split and splitless injection in gas chromatography.
 - iv) Calculate peak area when peak height is 4020 mV and peak base in 1.82 minutes.
 - v) Give the principle of electron impact ionization.
- b) Gas chromatographic analysis of hydrocarbons was carried out using 20 m length column at gas velocity 35 cm s^{-1} . Retention times for octane and decane are observed at 2.53 and 4.75 min. having $W_{1/2}$ 0.28 and 0.55 min for both respectively. Then calculate retention factor and selectivity factor.

[3]

Q2) a) Solve any three of the following : **[9]**

- i) Explain kinetic theory of chromatographic separation.
- ii) Write note on stationary phases for packed columns in gas chromatography.
- iii) Explain construction and working of TCD.
- iv) What is supercritical fluid? Give the properties of supercritical fluid.

P.T.O.

- b) A sample of wine was analysed for alcohol content by gas chromatography. Sample showed four peaks at 1.23, 3.78, 4.92 and 8.32 minutes of peak area 270, 190, 3240 and 360 mV sec. the standard alcohol in water of conc. 10% W/V showed peak at 4.92 min having peak area 3049 mV sec. Calculate % alcohol content in wine. [3]

Q3) a) Attempt any two of the following. [8]

- Explain interface used in GC-MS.
- Explain concept of restructured chromatogram in GC-MS.
- Explain how phenols are analysed from waste water sample by gas chromatography and liquid-liquid extraction.

b) Attempt any two of the following. [4]

- Explain identification of substances by chromatographic method.
- What is background subtraction? Why it is needed?
- What is the difference between adsorption and liquid chromatography?

SECTION - II

Q4) a) Answer any four of the following. [8]

- What is guard column in HPLC?
- Explain principle of ion exchange chromatography.
- Why there is need of interface in LCMS?
- Describe drift and detection limit of a detector.
- What are advantages of internal standard method?

b) A standard solution of paracetamol of 6g 1 lit is prepared. It gives a peak area of 6800. The sample containing paracetamol gives a peak of 5100. Calculate calibration factor and amount of paracetamol in given sample. [3]

Q5) a) Attempt any three of the following : [9]

- Explain working of short stroke piston pump with suitable diagram.
- Write a short note on chemically modified silica phases in HPLC.
- Describe molecular mass determination by size exclusion chromatography.
- Write a short note on Chiral chromatography.

b) If separation with 70% of methanol gives adequate retention but poor selectivity, which other solvent could be tried? $\phi_{\text{meoH}} = 0.7$ $P'_{\text{meoH}} = 3.0$
 $P'_{\text{ACN}} = 3.1$ $P'_{\text{THF}} = 4.4$. [3]

Q6) a) Attempt any two of the following : **[8]**

- i) What is derivatization? Explain pre and post column derivatization in HPLC detection.
- ii) What are properties of ideal detector? Describe working of UV detector in HPLC.
- iii) Give advantages and disadvantages of thermospray interface in LC-MS.

b) Attempt any two of the following : **[4]**

- i) If a sample containing mixture of benzene toluence and ethylbenzene is passed through column containing reverse phase, which compound will elute first? Justify your answer.
- ii) Describe how mobile phase is prepared in HPLC.
- iii) Give applications of LCMS.



Total No. of Questions : 3]

SEAT No. :

PE4505

[Total No. of Pages : 2

[6510]-50

M.Sc. - II

ANALYTICAL CHEMISTRY

**CHA-603-MJ : Applied Electro - Analytical Techniques
(2023 Credit Pattern) (NEP - 2020) (Semester - III) (2 Credits)**

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Use of log table and calculator is allowed.*

Q1) a) Attempt any four of the following. **[8]**

- i) What is linear scan voltammetry? Explain the analytical principle of polarography.
- ii) How dissociation constant of weak acid is determined by potentiometry?
- iii) Explain the analytical significance of half wave potential and diffusion current by using polarogram.
- iv) 'The pulse voltammetric techniques are more sensitive than classical DC polarography' - explain.
- v) What is pulse voltammetry? Explain the different pulse voltammetric techniques.

b) Solve the following. **[3]**

In a polarographic analysis, a $4.0 \times 10^{-3} \text{M}$ of cadmium chloride solution in a 0.2M KCl solution shows the diffusion current of $49.5 \mu\text{A}$ at -0.8v versus SCE. The mercury dropping at a rate of 64 drops per 4 minutes. The 100 drops of mercury are collected and found weight 0.379 grams. Calculate the diffusion coefficient of cadmium ion.

P.T.O.

- Q2) a)** Attempt any three of the following. **[9]**
- i) What is potentiometric titration? Draw the different graphical methods of location of end point in neutralization titration.
 - ii) What is hydrodynamic voltammetry? What are the different ways of performing the hydrodynamic voltammetry?
 - iii) Explain the polarographic method of determination of dissolved oxygen in the sample solution.
 - iv) What is polarogram? Explain its use for qualitative & quantitative analysis in polarography.
- b)** Solve the following. **[3]**
- The pure silver metal rods are dipped into different silver ion solutions. Calculate the potential developed at 25°C on silver metal, when silver rod is dipped into :
- i) 10 M Ag^+ solution
 - ii) 1.0 M Ag^+ solution
 - iii) 0.1 M Ag^+ solution
- Q3) a)** Attempt any two of the following. **[8]**
- i) What is secondary reference electrode? Give construction of silver - silver chloride reference electrode. Write its electrode presentation & electrode reaction.
 - ii) Draw the ideal cyclic voltammogram for a reduction - oxidation of ferric - ferrous system in a 0.1 M KCl solution. Why cathodic peak current and anodic peak current are equal for this redox reaction?
 - iii) Draw the circuit diagram of the apparatus used in polarographic analysis. Explain the role of supporting electrolyte in polarographic analysis.
- b)** Attempt any two of the following. **[4]**
- i) Differentiate between anodic and cathodic stripping voltammetry with respect to the steps involved in analysis.
 - ii) Give the different applications of cyclic voltammetry.
 - iii) What is antimony - antimony oxide electrode? Give its application.



Total No. of Questions : 3]

SEAT No. :

PE4506

[Total No. of Pages : 2

[6510]-51

M.Sc. (Part - II)

ANALYTICAL CHEMISTRY

CHA-610(A)-MJ : Analytical Methods to Examining Water and Soil
(2023 Credit Pattern) (Semester - III) (2 - Credits)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use to log table and calculator is allowed.

Q1) a) Answer any four of the following: [8]

- i) Define the biological oxygen demand.
 - ii) At what condition CaCO_3 precipitated in waste water sample?
 - iii) Name four metal ions as pollutant in water.
 - iv) What is meant by lime requirement of water? Why it is determined?
 - v) What is importance of grinding and homogenization of sample?
- b) Phosphate from water sample was analysed by colorimetry. Std. phosphate containing 4, 8 and 12 microgram treated with coloring reagent and absorbance was determined. They showed absorbance 0.283 0.602 and 0.832. 5ml water sample treated as std showed absorbance 0.225. Calculate micrograms of phosphate in 100ml water by calibration curve method. [3]

Q2) a) Attempt any three of the following : [9]

- i) What is COD? How it is determined?
 - ii) Explain determination chlorine from water sample by DPD colorimetric method.
 - iii) How ammonia from water is determined? Explain in detail.
 - iv) Write note on trace element extractants.
- b) Fe from soil was determined by AAS method. 10 g soil sample was extracted in 50 ml extractant and introduced in flame. It showed absorbance 0.232. A std. sample of iron of conc. 5 microgram per 1000ml showed absorbance 0.348. Calculate micrograms of Fe in 100g sample. [3]

P.T.O.

Q3) a) Solve any two of the following : **[8]**

- i) Discuss in detail analysis of anions in water sample by capillary ion electrophoresis.
- ii) Explain determination of organic nitrogen in soil by kjeldahl method.
- iii) Discuss determination sulfide by colorimetric method.

b) Answer any two of the following : **[4]**

- i) What is the difference between organic and inorganic nitrogen?
- ii) How will you prepare 10 microgram per 1000ml NO_2^- solution from NaNO_2 (mol. wt $\text{NaNO}_2 = 69$, $\text{NO}_2^- = 46$).
- iii) What is meant by salinity of water?



Total No. of Questions : 3]

SEAT No. :

PE4507

[Total No. of Pages : 2

[6510]-52

S.Y. M.Sc.

ANALYTICAL CHEMISTRY

CHA-610(B) MJ : Clinical Analytical Chemistry

(2023 Credit Pattern) (Semester - III)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *Q.1 to Q.3 are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Use of log table and calculator are allowed.*

Q1) a) Answer the following. (Any 4) [8]

- i) Explain in short the method for collection of capillary blood.
 - ii) Draw the structure of vitamin B₁ (Thiamine).
 - iii) Define the term Therapeutic Drug Monitoring.
 - iv) Write a deficiency disease and sources of vitamin A.
 - v) What is anticoagulant? Give two examples.
- b) Explain in detail Method for therapeutic Monitoring of Lacosamide by LC-MS/MS method. [3]

Q2) a) Attempt any three of the following. [9]

- i) Explain in detail determination of blood glucose by glucose oxidase method.
 - ii) Discuss the determination of blood potassium level by flame photometry.
 - iii) Explain the determination of Riboflavin from biological sample by photo fluorometric method.
 - iv) Give principle and procedure of determination of ketone bodies in blood.
- b) Unknown blood sample of patient were analysed for creatinine content by picric acid method. The absorbance of sample is 0.008 and absorbance of standard is 0.045. Calculate the concentration of creatinine in 100mL of sample.

[Given:- conc of creatinine standard = 2mg/dL] [3]

P.T.O.

Q3) a) Attempt any two of the following. **[8]**

- i) Write detailed procedure for determination of leucocyte ascorbate.
- ii) Write a note on oral glucose tolerance test.
- iii) Give a detailed account of Quantification of eight cannabinoids including cannabidiol in Human urine by liquid chromatography tandem mass spectrometry.

b) Attempt any two of the following. **[4]**

- i) Write a short note on preservatives for urine.
- ii) Give the principle of Targeted opioid screening assay.
- iii) What are water insoluble vitamins? Give four examples.



Total No. of Questions : 3]

SEAT No. :

PE4508

[Total No. of Pages : 2

[6510]-53

M.Sc. - II

ANALYTICAL CHEMISTRY

CHA-610(C)-MJ : Forensic Analytical Chemistry

(2023 Credit Pattern) (Semester - III)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of scientific calculator is allowed.

Q1) a) Attempt any four of the following. **[8]**

- i) What are the macroscopic properties of cannabis?
 - ii) What do you mean by fire debris analysis?
 - iii) What is drug abuse?
 - iv) What are phenethylamines?
 - v) Write Meck's test.
- b) A sample of drugs containing amphetamine (A), Methamphetamine (M) and ephedrine (E) was analysed by TLC and the distance travelled by the solvent was 6.5cm. If the R_f values of A, M and E were 0.25, 0.65 and 0.35 respectively, calculate the distance travelled by each compound in the sample. **[3]**

Q2) a) Attempt any three of the following. **[9]**

- i) Explain the volatility test techniques.
 - ii) What are drugs? Discuss their origin.
 - iii) Write a note on stand - off detection of explosives.
 - iv) Discuss the general procedure for chemical colour tests.
- b) A sample of diacetylmorphine was analysed by LC method and it gave following observations $C_s = 4.5 \mu\text{g/ml}$, $A_s = 7.5 \text{ mAUmin}$, $P_s = 4.5 \text{ mAUmin}$, $P_x = 6.5 \text{ mAUmin}$, $A_x = 4.7 \text{ mAUmin}$
Calculate the concentration of diacetylmorphine in the sample. **[3]**

P.T.O.

Q3) a) Attempt any two of the following. **[8]**

- i) Discuss the extraction of mescaline from peyote.
- ii) Explain the breath test for the detection of alcohol.
- iii) Give an account of psychoactive compounds present in cannabis.

b) Attempt any two of the following. **[4]**

- i) What are the advantages of microcrystal techniques?
- ii) Write the structure & physiological effects of Phenylcyclohexyl Piperidine (PCP).
- iii) Define
 - 1) Psychoactive drugs
 - 2) Hemp.



Total No. of Questions : 6]

SEAT No. :

PE4509

[Total No. of Pages : 3

[6510]-61

M.Sc. - II

PHYSICAL CHEMISTRY

**CHP - 651 - MJ : Molecular Structure and Spectroscopy
(2023 Credit Pattern) (Semester - IV)**

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Answer of two sections should be written in separate answer books.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic table, calculator is allowed.
- 5) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

1) Avogadro Number	$N = 6.023 \times 10^{23} \text{ mol}^{-1}$
2) Boltzmann Constant	$k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ k cal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equivalent}^{-1}$
8) Speed of light	$c = 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-24} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

SECTION - I

Q1) a) Attempt any four of the following : **[8]**

- i) Explain the theory of spin-spin interaction for an A2 type case.
- ii) State application of ^{19}F NMR spectroscopy.
- iii) What is quadrupole moment?
- iv) Explain the working of magic T in ESR.
- v) Why derivative mode is preferred in ESR spectra?

b) Predict the intensity distribution in the hyperfine lines of the ESR spectrum of deuterium (^2_1H). **[3]**

Q2) a) Attempt any three of the following **[9]**

- i) State the applications of ^{19}F spectroscopy.
- ii) Distinguish between ^{13}C NMR and ESR spectroscopy.
- iii) Explain the term spin Hamiltonian in ESR spectroscopy.
- iv) Discuss zero field splitting in ESR.

b) Explain the following terms with respect to NMR spectroscopy. **[3]**

- i) Shielding
- ii) Deshielding
- iii) Coupling constant

Q3) a) Attempt any two of the following : **[8]**

- i) Explain the instrumentation involved in high resolution NMR spectroscopy.
- ii) Discuss McConnell equation to predict the number of unpaired electrons in a species.
- iii) Describe the working of ESR spectrometer using block diagram.

b) Attempt any one of the following : **[4]**

- i) Calculate the frequency required to excite proton from $m_1 = \frac{1}{2}$ to $m_2 = -\frac{1}{2}$.

(Given $g = 5.585$, $H = 1.4\text{T}$)

- ii) Calculate NMR frequency of ^{35}Cl in a magnetic field of intensity 1.8T (Given $I = \frac{3}{2}$).

SECTION - II

- Q4) a)** Attempt any four of the following : **[8]**
- i) How are X-rays detected?
 - ii) What is scattering intensity in electron diffraction?
 - iii) Give limitations of electron diffraction technique.
 - iv) Explain the term paramagnetic susceptibility.
 - v) Define the terms pole strength and magnetic field.
- b)** Discuss powder diffraction XRD method. **[3]**
-
- Q5) a)** Attempt any three of the following **[9]**
- i) Explain low energy electron diffraction technique.
 - ii) Discuss scattering intensity in electron diffraction.
 - iii) Give the advantages and disadvantages of Gouy technique.
 - iv) What is Pascal's constant? Give its uses.
- b)** What is the structure factor of simple cubic and face centre cubic lattice?**[3]**
-
- Q6) a)** Attempt any two of the following : **[8]**
- i) Discuss the remarkable differences between X-ray diffraction and electron diffraction technique.
 - ii) Draw a neat labelled diagram of neutron spectrometer and explain its working.
 - iii) Derive the Langevin equation for magnetic susceptibility.
- b)** Attempt any one of the following : **[4]**
- i) The gram susceptibility of $\text{Ni(en)}_3 \text{S}_2\text{O}_3$ is 11.03×10^{-6} CGS units at 290 K. Find the susceptibility at 500K.
 - ii) Calculate the typical wavelength of neutron that have reached thermal equilibrium with their surrounding at 373 K (Given : mass of neutron = 1.675×10^{-27} kg).

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Total No. of Questions : 6]

SEAT No. :

PE4510

[Total No. of Pages : 3

[6510]-62

M.Sc. - II

PHYSICAL CHEMISTRY

**CHP - 652 - MJ : Surface Chemistry and Electrochemistry
(2023 Credit Pattern) (Semester - IV)**

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Answer of two sections should be written in separate answer books.
- 3) Figures to the right side indicate full marks.
- 4) Use of logarithmic table, calculator is allowed.
- 5) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

1) Avogadro Number	$N = 6.023 \times 10^{23} \text{ mol}^{-1}$
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3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ k cal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equivalent}^{-1}$
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9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-24} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

SECTION - I

Q1) a) Attempt any four of the following : **[8]**

- i) What is Physical Adsorption?
- ii) Write B.E.T. equation and explain the terms.
- iii) Write four assumptions of potential theory for multilayer adsorption.
- iv) Define porous solids and give their types.
- v) Give the assumptions on which Langmuir Adsorption isotherm is based on.

b) Discuss the mechanism of chemisorptions on transition metals. **[3]**

Q2) a) Attempt any three of the following : **[9]**

- i) Explain mercury porosimeter method of determination of pore size.
- ii) Describe microtome method for verification of Gibb's equation.
- iii) Explain the volumetric method for measurement of adsorption.
- iv) How Harkins - Jura equation used to determine the surface area of solid.

b) Derive the expression for Langmuir Adsorption isotherm. **[3]**

Q3) a) Attempt any two of the following : **[8]**

- i) Derive the expression for enthalpy of Adsorption.
- ii) Derive and explain Gibb's adsorption equation.
- iii) Nitrogen gas is adsorbed on charcoal to extent of $0.921 \text{ cm}^2/\text{gm}$ at 4.8 atm and 190k temperature but at 250k the same amount of adsorption is achieved only when pressure was increased to 32atm. What is molar enthalpy of adsorption of N_2 on charcoal.

b) Attempt any two of the following : **[4]**

- i) Explain Freundlich adsorption isotherm.
- ii) What is surface tension? State its unit.
- iii) Explain phenomenon of detergency.

SECTION - II

- Q4) a)** Attempt any four of the following : **[8]**
- i) What is standard electrode potential?
 - ii) State the principle of Pogendroff's compensation.
 - iii) Define the terms activity and activity coefficient.
 - iv) Why does Debye-Huckel limiting law is referred as limiting law.
 - v) Explain diffusion with suitable example.
- b) Write a note on Lithium - ion battery. **[3]**
-
- Q5) a)** Attempt any three of the following : **[9]**
- i) Explain in detail parallel-plate condenser theory of double layer.
 - ii) Deduce Debye - Huckel limiting law.
 - iii) Write a note on Tafel plot.
 - iv) Derive Fick's first law of steady state diffusion.
- b) Write a note on primary cell. **[3]**
-
- Q6) a)** Attempt any two of the following : **[8]**
- i) What are the ways of transport of ions?
 - ii) Derive Tafel equation.
 - iii) Ionic strength of KCl solution is 0.04. Calculate the mean activity coefficient of electrolyte using Debye - Huckel limiting law.
- b) Attempt any two of the following : **[4]**
- i) What is electrokinetic phenomenon?
 - ii) Explain the term absolute mobility and conventional mobility with their units.
 - iii) Define following
 - 1) Electrode potential
 - 2) Interface

x x x

Total No. of Questions :3]

SEAT No. :

PE4511

[Total No. of Pages : 2

[6510]-63

M.Sc.-II

PHYSICAL CHEMISTRY

CHP-660(A) MJ: Material Chemistry

(2023 Credit Pattern) (Semester-IV)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logarithmic table, calculator is Allowed.
- 4) Neat diagrams must be drawn Wherever necessary.

Physico-Chemical Constants

1) Avogadro Number	$N = 6.023 \times 10^{23} \text{ mol}^{-1}$
2) Boltzmann Constant	$k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ k cal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equivalent}^{-1}$
8) Speed of light	$c = 2.997 \times 10^{10} \text{ cm s}^{-1}$ $= 2.997 \times 10^8 \text{ m s}^{-1}$
9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-24} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

- Q1) a)** Answer the following. (Any 4) **[8]**
- i) What are defect perovskites?
 - ii) What are thin films? Give one example of their application?
 - iii) State two properties of super conducting material.
 - iv) What is the primary function of a rectifier in electronic circuits?
 - v) Define capacitance and Give its SI unit.
- b) Explain sputtering and write the principle of RF sputtering system with the help of diagram. **[3]**
-
- Q2) a)** Attempt any three of the following. **[9]**
- i) Discuss three modes of operation of transition.
 - ii) What is rectifier? Write Working of full wave rectifier.
 - iii) Explain the application of LB films.
 - iv) Describe low dimensional quantum structures of IV-V compounds.
- b) Explain chemical vapour deposition with the help of suitable examples. **[3]**
-
- Q3) a)** Attempt any two of the following. **[8]**
- i) Explain preparation and characteristics of 1-2-3 super conducting cuprate materials.
 - ii) Describe N-P-N transistor.
 - iii) Discuss photolithography techniques with neat diagram.
- b) Attempt any two of the following. **[4]**
- i) Describe the multigap structure in hi-tech materials.
 - ii) Discuss the optical Properties solid device materials.
 - iii) Explain sol-gel method to prepare thin films.



Total No. of Questions : 3]

SEAT No. :

PE4512

[Total No. of Pages : 2

[6510]-64

S.Y. M.Sc.

PHYSICAL CHEMISTRY

CHP-660 (B) MJ : Chemistry of Catalysts

(2023 Credit Pattern) (Semester - IV)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logarithmic table, calculator is allowed.
- 4) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

- | | |
|-------------------------|---|
| 1) Avogadro Number | $N = 6.023 \times 10^{23} \text{ mol}^{-1}$ |
| 2) Boltzmann Constant | $k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$
$= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$ |
| 3) Planck Constant | $h = 6.626 \times 10^{-27} \text{ erg s}$
$= 6.626 \times 10^{-34} \text{ J s}$ |
| 4) Electronic Charge | $e = 4.803 \times 10^{-10} \text{ esu}$
$= 1.602 \times 10^{-19} \text{ C}$ |
| 5) 1 eV | $= 23.06 \text{ k cal mol}^{-1}$
$= 1.602 \times 10^{-12} \text{ erg}$
$= 1.602 \times 10^{-19} \text{ J}$
$= 8065.5 \text{ cm}^{-1}$ |
| 6) Gas Constant | $R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$
$= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$
$= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$ |
| 7) Faraday Constant | $F = 96487 \text{ C equivalent}^{-1}$ |
| 8) Speed of light | $c = 2.997 \times 10^{10} \text{ cm s}^{-1}$
$= 2.997 \times 10^8 \text{ m s}^{-1}$ |
| 9) 1 cal | $= 4.184 \times 10^7 \text{ erg}$
$= 4.184 \text{ J}$ |
| 10) 1 amu | $= 1.673 \times 10^{-24} \text{ kg}$ |
| 11) Bohr Magneton | $\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$ |
| 12) Nuclear Magneton | $\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$ |
| 13) Mass of an electron | $m_e = 9.11 \times 10^{-31} \text{ Kg}$ |

P.T.O.

- Q1) a)** Attempt any four of the following : [8]
- i) What is auto catalysis? Give one example.
 - ii) What is the purpose of calcination in catalyst activation?
 - iii) Explain VOCS?
 - iv) Define the term photocatalysis.
 - v) Write two principles of Green Chemistry.
- b) Discuss impregnation method of preparation of catalyst. [3]
-
- Q2) a)** Attempt any three of the following : [9]
- i) Describe intermediate compound formation theory of catalyst.
 - ii) Explain the effect of temperature on enzyme catalysed reaction.
 - iii) How are organic pollutants degraded using photo catalyst.
 - iv) Discuss auto exhaust catalyst.
- b) Discuss sol-gel method for preparing catalyst. [3]
-
- Q3) a)** Attempt any two of the following : [8]
- i) Write a note on enzyme catalysis.
 - ii) Explain precipitation method of preparation of catalyst.
 - iii) Describe adsorption-desorption method to determine size of pore.
- b) Attempt any two of the following : [4]
- i) Differentiate between homogeneous and heterogeneous catalysis.
 - ii) Describe the role of reduction in catalyst activation.
 - iii) Write a catalytic reaction that shows the decomposition of ozone.



Total No. of Questions : 3]

SEAT No. :

PE4513

[Total No. of Pages : 2

[6510]-65

M.Sc. - II (Physical Chemistry)

CHP-660(C) MJ : BIOPHYSICAL CHEMISTRY

(2023 Credit Pattern) (Semester - IV)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of logarithmic table, calculator is allowed.
- 4) Neat diagrams must be drawn wherever necessary.

Physico-Chemical Constants

1) Avogadro Number	$N = 6.023 \times 10^{23} \text{ mol}^{-1}$
2) Boltzmann Constant	$k = 1.38 \times 10^{-16} \text{ erg K}^{-1} \text{ molecule}^{-1}$ $= 1.38 \times 10^{-23} \text{ J K}^{-1} \text{ molecule}^{-1}$
3) Planck Constant	$h = 6.626 \times 10^{-27} \text{ erg s}$ $= 6.626 \times 10^{-34} \text{ J s}$
4) Electronic Charge	$e = 4.803 \times 10^{-10} \text{ esu}$ $= 1.602 \times 10^{-19} \text{ C}$
5) 1 eV	$= 23.06 \text{ k cal mol}^{-1}$ $= 1.602 \times 10^{-12} \text{ erg}$ $= 1.602 \times 10^{-19} \text{ J}$ $= 8065.5 \text{ cm}^{-1}$
6) Gas Constant	$R = 8.314 \times 10^7 \text{ erg K}^{-1} \text{ mol}^{-1}$ $= 8.314 \text{ J K}^{-1} \text{ mol}^{-1}$ $= 1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$
7) Faraday Constant	$F = 96487 \text{ C equivalent}^{-1}$
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9) 1 cal	$= 4.184 \times 10^7 \text{ erg}$ $= 4.184 \text{ J}$
10) 1 amu	$= 1.673 \times 10^{-24} \text{ kg}$
11) Bohr Magneton	$\beta_e = -9.274 \times 10^{-24} \text{ J T}^{-1}$
12) Nuclear Magneton	$\beta_n = 5.051 \times 10^{-27} \text{ J T}^{-1}$
13) Mass of an electron	$m_e = 9.11 \times 10^{-31} \text{ Kg}$

P.T.O.

- Q1) a)** Attempt any four of the following: [8]
- i) Mention the classification of RNA.
 - ii) Explain tertiary structure of proteins.
 - iii) Give two functions of amino acids.
 - iv) What are Biopolymers?
 - v) Explain chain configuration of macromolecular.
- b) Discuss double stranded formation in nucleic acids. [3]
- Q2) a)** Attempt any three of the following: [9]
- i) Write a note on proteins and nucleic acids.
 - ii) Describe Rhodopsin - A chromophoric protein.
 - iii) Explain the principle of optical rotator dispersion.
 - iv) Explain problems of protein folding.
- b) Discuss molecular interpretation of energy and enthalpy. [3]
- Q3) a)** Attempt any two of the following: [8]
- i) Differentiate between competitive and non-competitive inhibition with examples.
 - ii) State Bragg's law and explain its importance in x-ray diffraction studies.
 - iii) Explain Michaelis-Menten equation and the significance of K_m and V_{max} .
- b) Attempt any two of the following: [4]
- i) Write the reaction equation for ATP hydrolysis and mention the energy released.
 - ii) Mention two applications of CD spectroscopy in protein analysis.
 - iii) What is the importance of x-ray diffraction in studying molecular structure.



Total No. of Questions : 6]

SEAT No. :

PE4514

[Total No. of Pages : 3

[6510]-66

M.Sc. - II

INORGANIC CHEMISTRY

CHI-651-MJ : Heterogeneous Catalysis and its Applications

(2023 Credit Pattern) (Semester - IV)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Draw neat diagrams wherever necessary.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic tables and calculator is allowed.

SECTION - I

(Heterogeneous Catalysis)

Q1) a) Answer the following : **[8]**

- i) State sabatier's principle. Give its applications.
- ii) What is promoter in catalysis? Give one example.
- iii) Define hydrothermal synthesis and state one of its benefits.
- iv) What is TPD? What does it measure?

b) Discuss the classification of heterogeneous catalyst. **[3]**

Q2) a) Answer any one of the following : **[6]**

- i) Discuss the catalyst regeneration methods of a deactivated catalyst.
- ii) Discuss TPD technique for the characterization of solid catalysts with neat schematic diagram.

b) Answer any two of the following : **[6]**

- i) What is adsorption isotherm? Differentiate between Freundlich and Langmuir adsorption isotherms.
- ii) Give an account of impregnation method for the preparation of solid catalysts.
- iii) Discuss the IUPAC nomenclature of zeolites.

P.T.O.

- Q3) a)** Answer any one of the following : [6]
- i) Discuss the characterization of zeolite by powder XRD method.
 - ii) Give an account of factors influencing on zeolite synthesis.
- b)** Answer any two of the following : [6]
- i) Discuss post synthetic treatments of heterogeneous catalysts.
 - ii) Write a note on MEL-type zeolite framework.
 - iii) At 25°C and 1 atm. pressure, volume of N₂ gas required to cover a sample of silica gel is found to be 130cm³/g. Calculate the surface area per gram of the gel, if cross-sectional area of N₂ molecule is 0.162nm².

SECTION - II

(Applications of Heterogeneous Catalysis)

- Q4) a)** Answer the following : [8]
- i) What is hydrogen transfer in the context of zeolite catalysis?
 - ii) Give one example of an alkylation reaction involving zeolites.
 - iii) What is solid acid catalyst? Give any one example.
 - iv) What is water-gas shift reaction? Which catalyst is used in water-gas shift reaction.
- b)** How alkynes are converted to alkenes? Enlist the catalyst and reaction condition required for it. [3]
- Q5) a)** Answer any one of the following : [6]
- i) Draw the scheelite structure of BiMoO₄. Discuss the use of BiMoO₄ as oxidation and Ammoxidation catalysts.
 - ii) Describe the process and applications of Fischer-Tropsch synthesis.
- b)** Answer any two of the following : [6]
- i) What is catalytic reforming? Explain with suitable example.
 - ii) Discuss the advantages of intercalated clays over regular clays.
 - iii) What are perovskite oxides and why are they used as catalysts?

Q6) a) Answer any one of the following : **[6]**

- i) Semiconducting oxides are very good photocatalyst. Explain with the help of TiO_2 .
- ii) What is shape selective catalysis? Discuss the use of zeolite as shape selective catalyst.

b) Answer any two of the following : **[6]**

- i) What is hydrocracking? Discuss the applications of zeolite based hydrocracking.
- ii) Write a note on MCM-41 as a catalyst.
- iii) Discuss the industrial synthesis of methanol using heterogeneous catalyst.



Total No. of Questions : 6]

SEAT No. :

PE4515

[Total No. of Pages : 2

[6510]-67

M.Sc. - II

INORGANIC CHEMISTRY

CHI - 652 - MJ : Solid State and Nanomaterials

(2023 Credit Pattern) (Semester - IV)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Answer to the two sections should be written in separate answer books.
- 3) Figures to the right indicate full marks.

SECTION - I

(Solid State Chemistry)

- Q1) a)** Answer the following : **[8]**
- i) What are crystal defects?
 - ii) Define paramagnetism.
 - iii) Give the applications of superconductivity.
 - iv) Define biocompatibility.
- b)** Explain the piezo electric ceramic materials. **[3]**
- Q2) a)** Answer any one of the following : **[6]**
- i) Explain in detail BCS theory.
 - ii) Explain the mechanism of Formation of cement.
- b)** Answer any two of the following : **[6]**
- i) Give the applications of fullerenes. Draw the structure of fullerenes.
 - ii) Distinguish between Blended and non-portland cements.
 - iii) Explain any one method for preparation of solid state material.
- Q3) a)** Answer any one of the following : **[6]**
- i) What are Biomaterials? Explain bioactive glass with suitable example.
 - ii) What is hysteresis loop? Draw the hysteresis loops of different magnetic material.
- b)** Answer any two of the following : **[6]**
- i) Write a short note on Asphalt materials.
 - ii) Give the applications of carbon fibres.
 - iii) Explain the different types of ferrite materials.

P.T.O.

SECTION - II
(Nanomaterials)

Q4) a) Answer the following : **[8]**

- i) What is Nanotechnology?
- ii) What are quantum well?
- iii) Write the types of carbon nanotube.
- iv) Explain computational nanotechnology.

b) Explain the size dependent properties of nanomaterials with respect to **[3]**

- i) Melting point
- ii) Specific heat

Q5) a) Answer any one of the following : **[6]**

- i) What are nanomaterials? Explain the classification of nanomaterials.
- ii) Distinguish between wet and dry nanotechnology.

b) Answer any two of the following : **[6]**

- i) State Moore's law.
- ii) Discuss the synthesis of nanomaterial by Sol-gel method.
- iii) Explain the magnetic properties of nanomaterials.

Q6) a) Answer any one of the following : **[6]**

- i) Explain any two methods for preparation of nanomaterials with suitable example.
- ii) Explain the nanocomposite materials with respect to single particles as well as core shell nanomaterials.

b) Answer any two of the following : **[6]**

- i) Write short note on nanotribology.
- ii) Give the examples of natural and artificial nanoparticles.
- iii) Explain organic electronics with suitable example.

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Total No. of Questions : 3]

SEAT No. :

PE4516

[Total No. of Pages : 2

[6510]-68

M.Sc. - II

INORGANIC CHEMISTRY

**CHI - 660 (A) MJ : Industrial Applications of Inorganic Chemistry
(2023 Credit Pattern) (Semester - IV)**

Time : 2Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All Questions are compulsory.*
- 2) *Neat diagrams must be drawn whenever necessary.*
- 3) *Figures to the right indicate full marks.*

Q1) a) Answer the following. [8]

- i) Give the applications of corrosion inhibitor.
 - ii) Define green chemistry.
 - iii) Name the different sources of SO_2 in environment.
 - iv) Why is chemical safety important?
- b) What is electrodeposition process? Give its principle and working process. [3]

Q2) a) Attempt any one of the following. [6]

- i) What is ionic liquid? Explain any one process of treatment for enhanced corrosion resistance of Magnesium based substrates.
- ii) Explain about green chemistry in day to day life.

b) Attempt any two of the following. [6]

- i) Write a note on corrosion inhibitors for paint coating.
- ii) Explain the effect of industrial gases on human health.
- iii) Explain electro deposition of Cu and Ni.

P.T.O.

Q3) a) Attempt any one of the following. **[6]**

- i) Explain twelve principles of green chemistry.
- ii) What is chemical propellant? What is the difference between explosive and propellant? What types of explosive is a propellant?

b) Attempt any two of the following. **[6]**

- i) Explain the LPG boosting plant process.
- ii) What are semi conductors? Discuss electro deposition of semi conductors.
- iii) Write a note on “Handling and use of Chemicals”.



Total No. of Questions : 3]

SEAT No. :

[Total No. of Pages : 2

PE4517

[6510]-69

M.Sc. - II

INORGANIC CHEMISTRY

CHI-660(B)-MJ : Inorganic Medicinal Chemistry

(2023 Credit Pattern) (Semester - IV)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Draw neat and labelled diagram whenever necessary.*

Q1) a) Answer the following: [8]

i) Draw the structure of

1) Mycocrisin

2) Aurinofin

ii) What is chelation? Explain with suitable example.

iii) What are radiopharmaceuticals? Which elements are used for radioimaging purpose?

iv) Cis-platin and it's analog's binds with DNA to which base?

b) Explain the chemistry of Lithium. [3]

Q2) a) Answer any one of the following : [6]

i) What is intracavity and intra-arterial radio-Pharmaceuticals?

ii) Explain the model of pathway for reduction and accumulation of vanadium.

b) Answer any two of the following : [6]

i) Draw the structure of ^{99m}Tc mebrofenin? Give the uses of ^{99m}Tc mebrofenin.

ii) Explain the radiotherapeutic action of Tc, I and Cs.

iii) What are the steps involved in drug development?

P.T.O.

Q3) a) Answer any one of the following : **[6]**

- i) Explain in detail characterization of vanadium Insulin-Mimetic effects.
- ii) What is mean by pharmacology? Explain gold biochemistry in detail.

b) Answer any two of the following : **[6]**

- i) Explain the structural features of Insulin modification.
- ii) Write a short note on :
 - 1) Matrix metalloproteinases.
 - 2) Renal imaging agents.
- iii) Explain unwinding, shortening and bending of double helix of DNA.



Total No. of Questions : 3]

SEAT No. :

[Total No. of Pages : 2

PE4518

[6510]-70

S.Y.M.Sc.

INORGANIC CHEMISTRY

**CHI-660(C)-MJ : Inorganic Chemistry Applications in Environment
(2023 Credit Pattern) (Semester - IV)**

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*

Q1) a) Answer the following. **[8]**

- i) Write importance & working of Grit chamber.
- ii) Define water pollutants with two examples.
- iii) Explain about suspended solids and sediments in water pollution.
- iv) What is fuel cell? Give advantages of Alkaline fuel cell.

b) Write a note on Trickling filters. **[3]**

Q2) a) Attempt any one of the following. **[6]**

- i) Draw and labelled diagram for anaerobic treatment pond, and write its advantages and disadvantages.
- ii) Explain applications of biotechnology in treatment of waste water.

b) Attempt any two of the following. **[6]**

- i) Write a note on secondary sludge in treatment of waste water.
- ii) Enlist any three names of microorganisms used in treatment of waste water.
- iii) Write a note on various energy sources for the twenty first century.

P.T.O.

Q3) a) Attempt any one of the following. **[6]**

- i) What is biomass? Explain about production of biomass.
- ii) Define fuel cell and explain direct methanol and regenerative fuel cell.

b) Attempt any two of the following. **[6]**

- i) Differentiate between water and tidal power.
- ii) Explain solid phase extraction.
- iii) What are the disadvantages and advantages of geothermal power production?



Total No. of Questions : 6]

SEAT No. :

PE4519

[Total No. of Pages : 4

[6510]-71

M.Sc. - II

ORGANIC CHEMISTRY

CHO-651-MJ : Chemistry of Natural Products
(NEP 2020) (2023 Credit Pattern) (Semester - IV)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

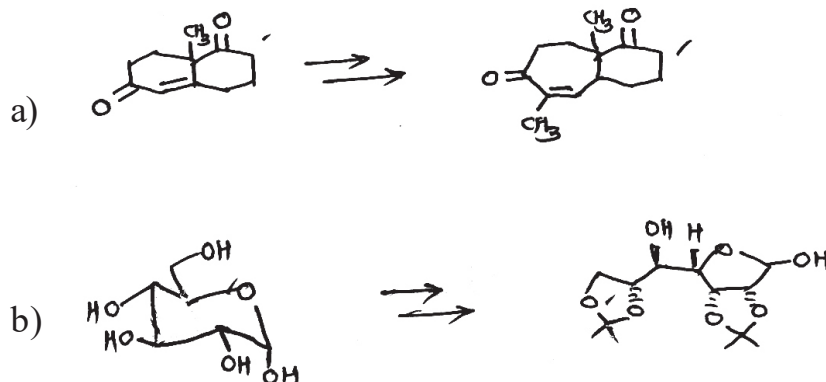
- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Answer of the two sections should be written on separate answer books.

SECTION - I

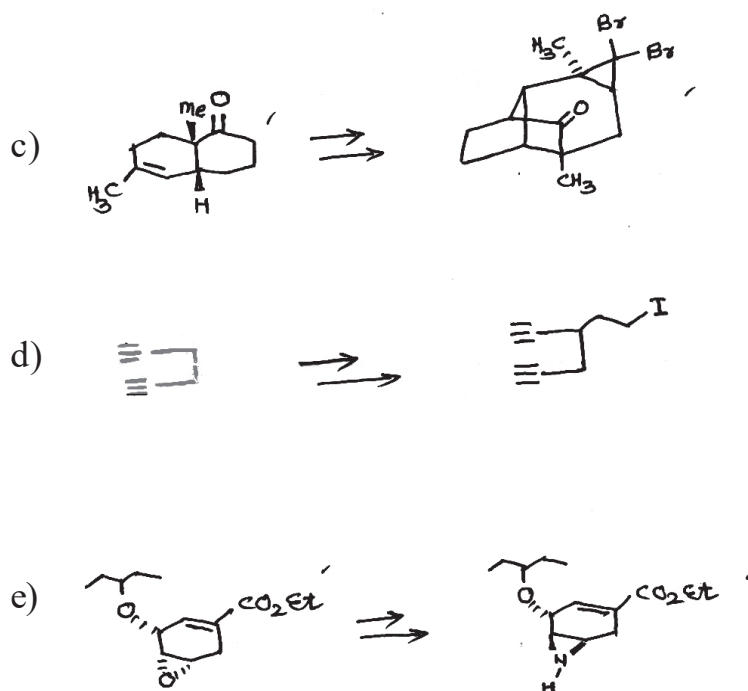
Q1) a) Answer the following : [8]

- i) Draw the structure of Hirsutellone-B with correct stereochemistry.
 - ii) Write a role of following reagents in the synthesis.
 - 1) NMP
 - 2) DMP
 - iii) How will prepare Wieland-Miescher ketone from Resorcinol?
 - iv) Discuss the applications of wittig reaction in natural product synthesis.
 - v) Write any two protecting reagents for amine group with suitable examples.
- b) Write the retro-synthesis of longifolence by E.J. Corey approach. [3]

Q2) Outline the steps involved in the following synthetic sequence. (Any four) [12]

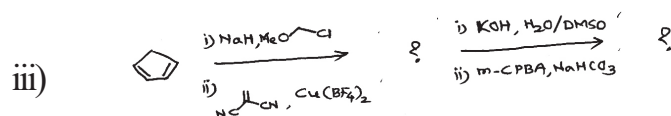
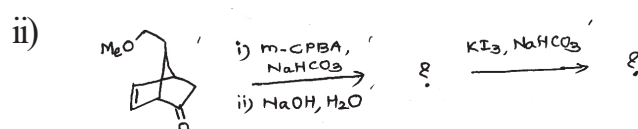
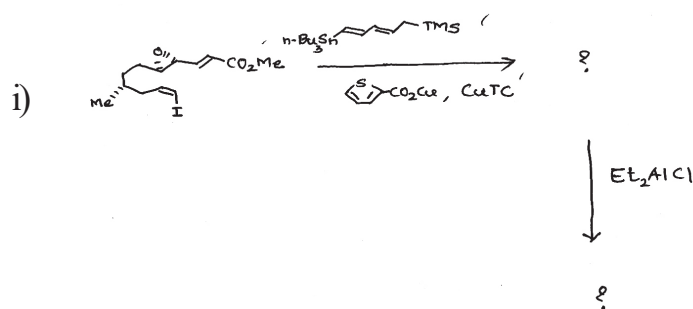


P.T.O.



Q3) a) Predict the product. (Any two)

[8]



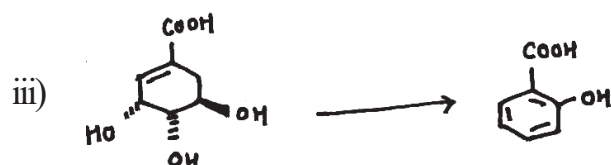
b) Attempt any two of the following :

[4]

- Write a note on 'Applications of Diels-Alder reactions in natural product synthesis.'
- Calculate total number of stereoisomers in menthol.
- Write a short note on Ugi-adduct in the synthesis of Atrovastatin.

SECTION - II

Q4) a) Suggest biogenetic scheme for any four of the following : [8]



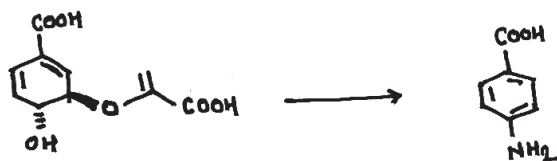
b) Indicate the position of label in each step and in the final product. [3]



Q5) a) Write the steps involved in any three of the following : [9]

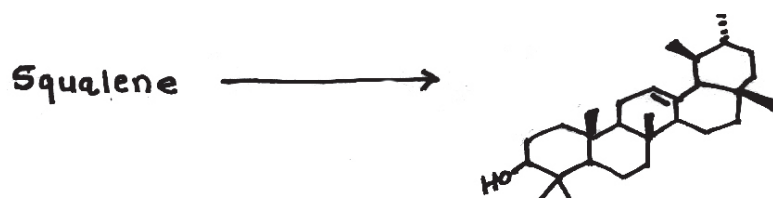


b) Complete the following biogenesis : [3]

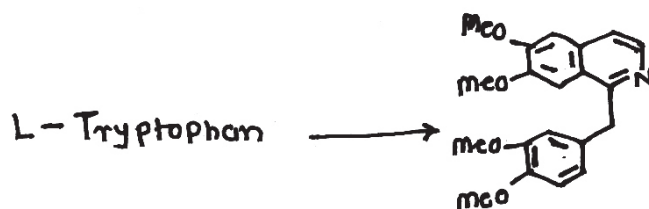


Q6) a) Attempt any two of the following : [8]

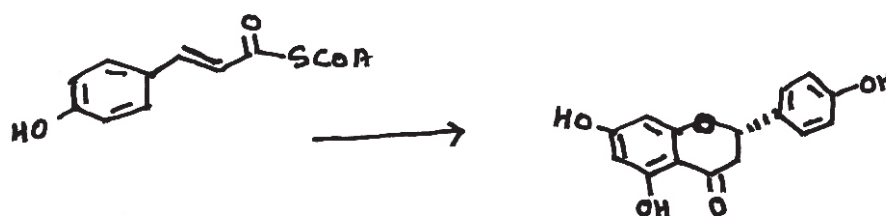
i) Complete the given biogenesis -



ii) Complete the steps involved in the given biogenesis :



iii) Complete the following biosynthetic steps.



b) Write short notes on any two of the following : [4]

- Classification of Terpenoids.
- Role of SAM in natural product synthesis.
- Oxidative deamination.



Total No. of Questions : 6]

SEAT No. :

PE4520

[Total No. of Pages : 4

[6510]-72

M.Sc. - II

ORGANIC CHEMISTRY-II

**CHO-652 MJ : Advanced Synthetic Organic Chemistry
(Credit 2023 Pattern) (Semester - IV) (4 Credits) (NEP 2020)**

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

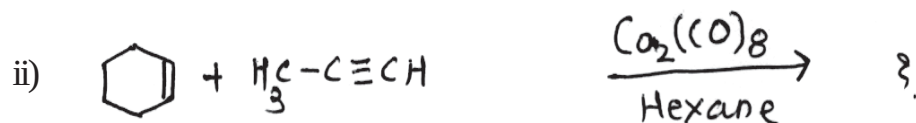
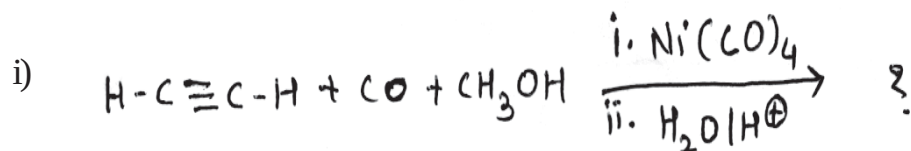
- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Answers of the two sections should be written on separate answer book.

SECTION- I

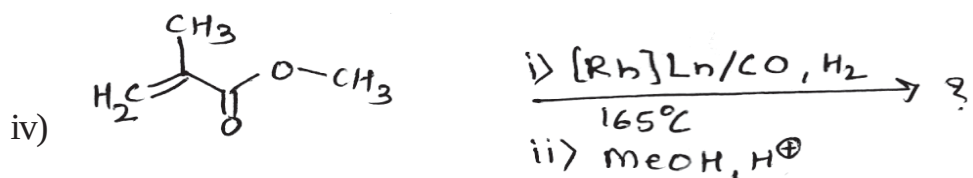
Q1) a) Answer the following (any 4) [8]

- i) Explain 'transmetalation' in a cross-coupling reaction.
 - ii) Explain the reaction involved in OXO process.
 - iii) Give any two application's of Wilkinson's catalyst.
 - iv) Explain Pauson-Khand reaction with suitable example.
 - v) Define turnover number (TON) in the context of catalyst.
- b) Describe the general catalytic cycle for pd-catalyzed cross-coupling reactions. [3]

Q2) a) Predict the product and explain the mechanism (any 3) [9]



P.T.O.

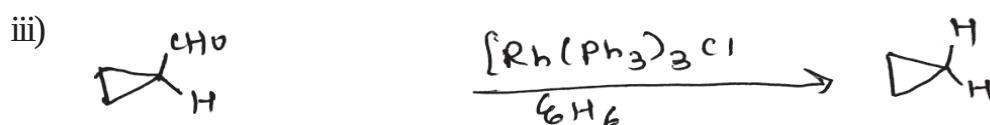
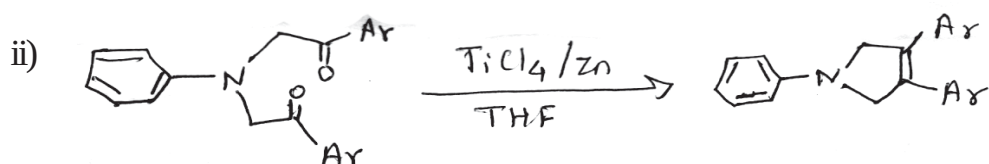
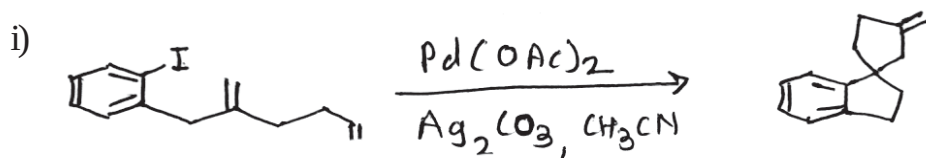


b) With the help of suitable example, explain 'Fukuyama reaction. [3]

Q3) a) Attempt any two of the following. [8]

- Explain the mechanism involved in Suzuki coupling reaction.
- Explain Hiyama coupling reaction with mechanism. What is the role of silane activators in Hiyama reaction.
- With the help of suitable example explain Buchwald-Hartwig amination reaction.

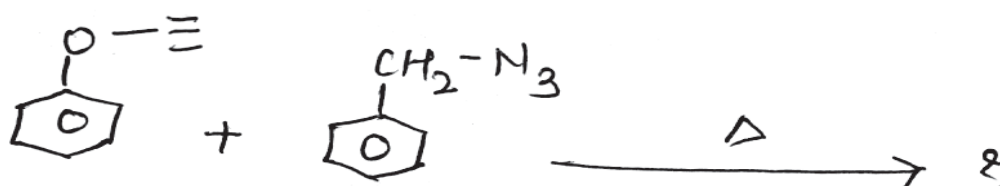
b) Explain the mechanism for the following reaction (any two) [4]



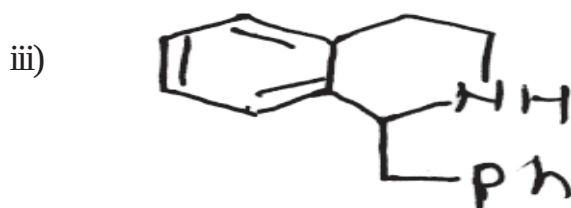
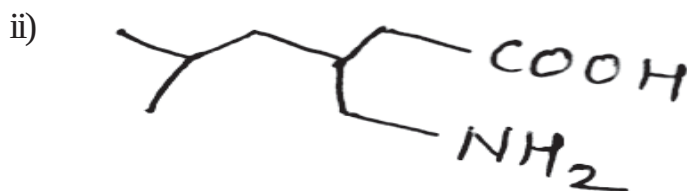
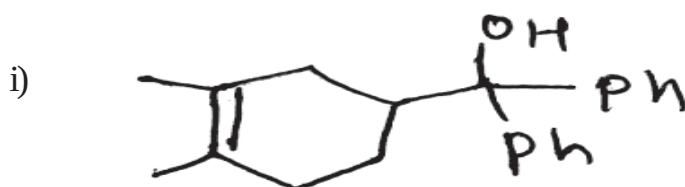
SECTION- II

Q4) a) Answer the following (any four) **[8]**

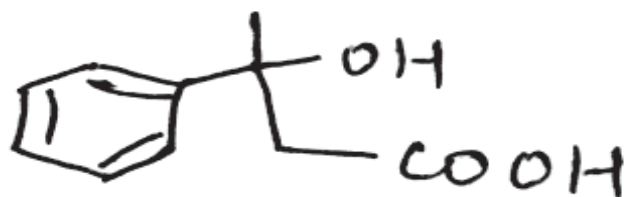
- i) Write the characteristic of click reaction.
 - ii) Give the synthetic equivalent to the following synthones
 $\oplus\text{CH}_2\text{COOH}$ $\oplus\text{CH}_2\text{CH}_2 - \text{OH}$
 - iii) With the help of suitable example-explain umpolung reactivity.
 - iv) Explain the driving force involved in the ring opening meta thesis reaction, explain with suitable example.
 - v) What is 'Convergent synthesis'? Explain with suitable example.
- b) Predict the product and explain the mechanism for the following reaction. **[3]**



Q5) a) Using retrosynthetic analysis, suggest the suitable method for the synthesis of following (Any three) **[9]**



iv)



b) Write the synthesis of 3-methyl-4-heptanone [3]

i) From 1-butanol

ii) From-3-hexanol

Q6) a) Attempt any two of the following. [8]

i) What is olefin metathesis? Explain with suitable example.

ii) Compare ring-opening Vs cross metathesis with example.

iii) What is enyne meta thesis? Explain with suitable example.

b) Answer Any two of the following. [4]

i) What are disadvantages of linear synthesis? Explain with suitable example.

ii) Write the reactions, how a ketone unit can be synthesized from two different functional groups

iii) Write a note on “stork enamine reaction”

* * *

Total No. of Questions : 3]

SEAT No. :

PE4521

[Total No. of Pages : 3

[6510]-73

M.Sc. - II

ORGANIC CHEMISTRY

CHO 660 (A) MJ : Asymmetric Synthesis (NEP 2023 Credit Pattern) (Semester - IV)

Time : 2 Hours]

[Max. Marks : 35

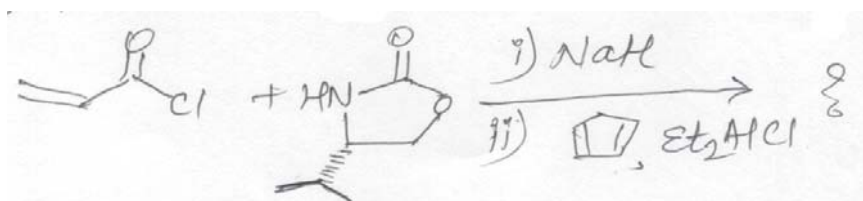
Instructions to the candidates:

- 1) All Questions are compulsory.
- 2) Figures to the right indicate full marks.

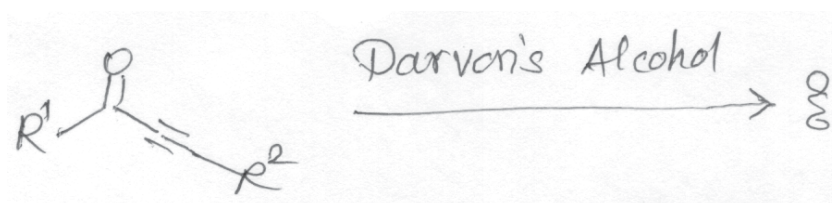
Q1) a) Answer any four of the following.

[8]

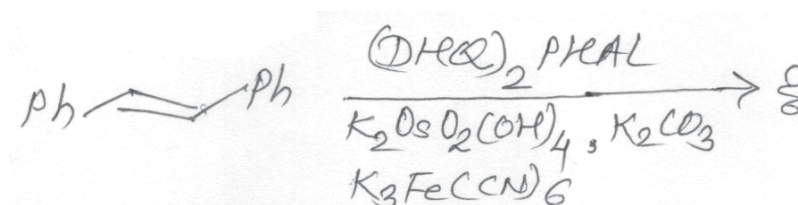
- i) Predict the product for the following reaction.



- ii) Predict the product with proper stereochemistry for the following reaction.



- iii) What is Prelog's rule in diastereoselective reaction?
- iv) Predict the product with stereochemistry for the following reaction.

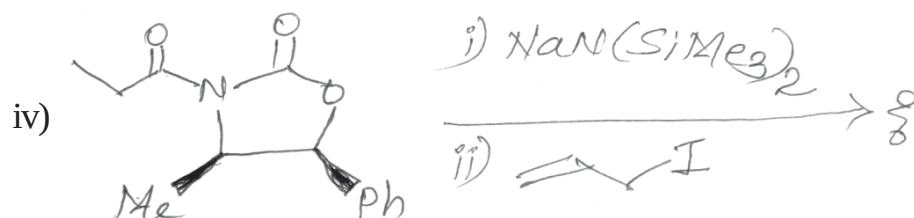
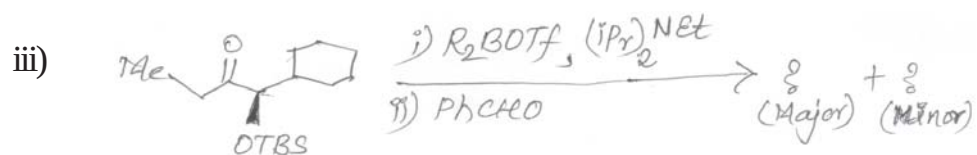
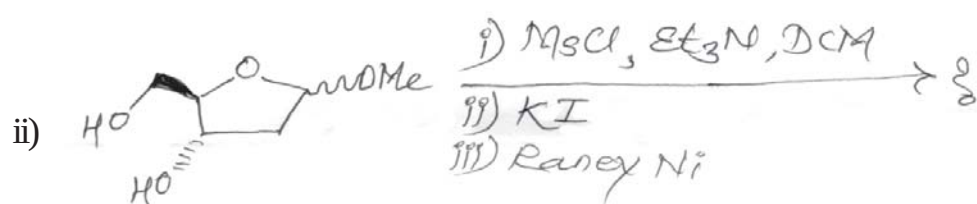
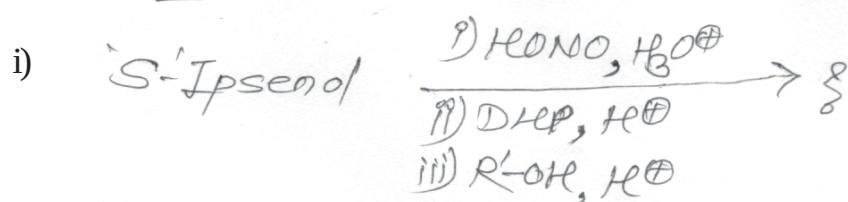


- v) What are 'stereotopic faces' in asymmetric synthesis?
- b) Write the synthesis of 'R'-sulcatol from 'S' ethyl lactate.

[3]

P.T.O.

Q2) a) Predict the product/s with mechanism for any three of the following. [9]

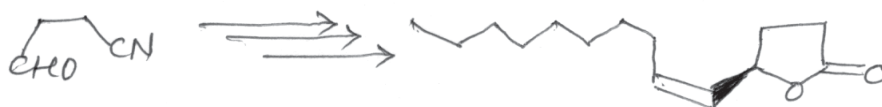


b) In aldol reaction 2-chiral aldehyde reacts with cis-enolate by anti-Felkin selectivity whereas trans-enolate by Felkin selectivity, Why? [3]

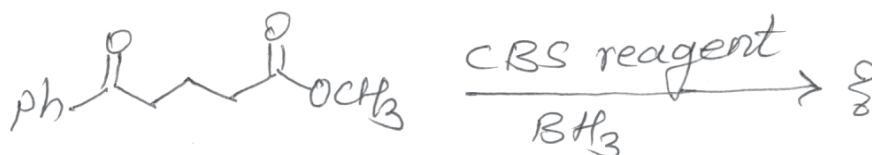
Q3) a) Answer any two of the following.

[8]

i) Complete the following reaction.



ii) Predict the product with mechanism for the following reaction.



iii) Explain the significance of 'Sharpless asymmetric epoxidation' in asymmetric synthesis.

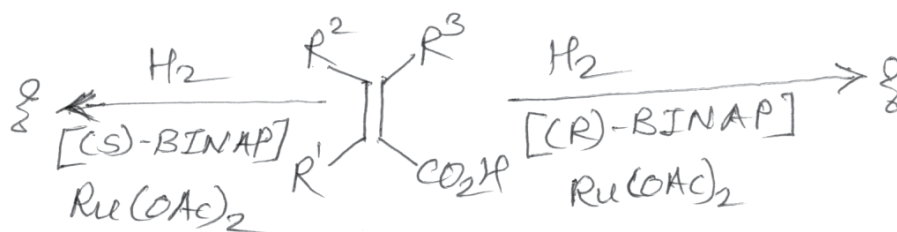
b) Attempt any two of the following.

[4]

i) What is 'Chiral Pool Strategy' in asymmetric synthesis?

ii) Write a note on 'Baker's Yeast' in asymmetric synthesis.

iii) Predict the products for the following reactions.



Total No. of Questions : 3]

SEAT No. :

PE4522

[Total No. of Pages : 2

[6510]-74

M.Sc. - II

ORGANIC CHEMISTRY

CHO - 660(B) MJ : Applied Organic Chemistry

(2023 Credit Pattern) (Semester - IV) (2 Credits) (NEP 2020)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.

Q1) a) Answer the following (Any 4) **[8]**

- i) Write down the impurities in APIs.
- ii) What are functional dyes? Give it's examples.
- iii) Define resin with suitable example.
- iv) What is mean by Zeolites with example.
- v) Define porous and cavity containing structures.

b) How are photochromic dyes used in smart window's or eyewears? **[3]**

Q2) a) Attempt any three of the following : **[9]**

- i) What is tubing? Discuss it with suitable examples.
- ii) Differentiate fluorescent sensors & probes.
- iii) Give types of porous polymers with suitable examples.
- iv) Discuss factors affecting the stability of MoFs's.

b) Give tautomers of rapamycin with their structures. **[3]**

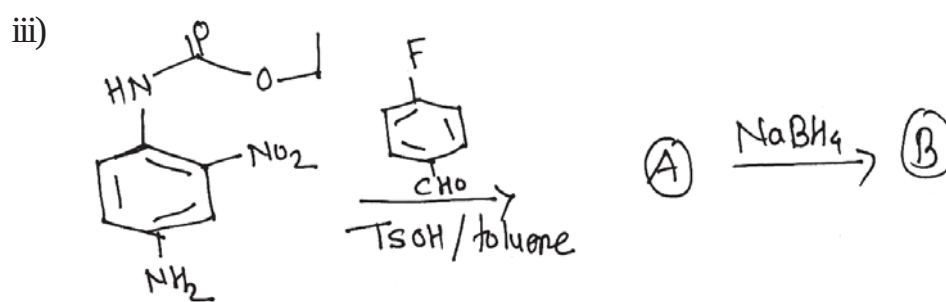
P.T.O.

Q3) a) Attempt any two of the following : **[8]**

- i) How will you synthesize phenol - formaldehyde resin? What are it's applications?
- ii) Write a note on Ziegler - Natta - catalysis with appropriate example.
- iii) Note on : Thermal printing & Network polymer.

b) Attempt any two of the following : **[4]**

- i) Mention two common methods use for the synthesis of MoF's.
- ii) What is Non-linear optical dyes? Give suitable examples.



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Total No. of Questions : 3]

SEAT No. :

PE4523

[Total No. of Pages : 2

[6510]-75

M.Sc. - II

ORGANIC CHEMISTRY

CHO-660(C)-MJ : Industrial Organic Chemistry

(2023 Credit Pattern) (NEP - 2020) (Semester - IV) (2 Credits)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*

Q1) a) Attempt any four of the following. **[8]**

- i) What microorganisms are commonly used in fermentation.
- ii) What is petroleum refining.
- iii) What are antibacterial agents give two examples.
- iv) Enlist the drugs that affecting the nervous system.
- v) What are primary raw material used in the production of industrial organic chemicals.

b) How are enzymes used as reagents in organic synthesis. **[3]**

Q2) a) Attempt any three of the following. **[9]**

- i) What is the use of fermentation technology in pharmaceutical industry.
- ii) What is use of xylene in plasticizers productions.
- iii) Define steriod drugs and mention their general uses.
- iv) Write note on zeigler - natta catalyst.

b) What are zeolites? Explain their use as a catalyst in petroleum refining. **[3]**

P.T.O.

Q3) a) Attempt any two of the following. **[8]**

- i) What are drugs that affecting the Nervous system? What is mechanism of action of barbiturates on the central Nervous system?
- ii) What is Reppe chemistry? Explain any two important reaction involved in Reppe chemistry.
- iii) Explain the fischer - tropsch reaction? How does it help in making industrial Chemicals.

b) Attempt any two of the following. **[4]**

- i) Write any three chemicals obtained from benzene.
- ii) Write short note on anti - inflammatory agent.
- iii) How to prepare nylon 6.



Total No. of Questions : 6]

SEAT No. :

PE4524

[6510]-76

[Total No. of Pages : 4

Second Year M.Sc.

ANALYTICAL CHEMISTRY

CHA-651-MJ : Applied Analytical Spectroscopy
(NEP 2023 Credit Pattern) (Semester - IV) (4 Credits)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions of the respective section are compulsory.
- 2) Answer of the two sections must be written on separate answer books.
- 3) Figures to the right indicate full marks.
- 4) Use of logarithmic table/non-programmable calculator is allowed.
- 5) Neat diagrams must be drawn wherever necessary.

SECTION-I

(Atomic Absorption and Emission Spectroscopy)

Q1) a) Attempt any four of the following. [8]

- i) State and explain the analytical terms:
 - 1) Accuracy
 - 2) Precision
 - ii) What is meant by 'dry ashing'? Give its disadvantages.
 - iii) Explain the cold vapour technique in atomic absorption spectroscopy.
 - iv) What are chemical interferences? Explain all types of chemical interferences.
 - v) What is plasma? Give its type.
- b) The energy difference between the 3P & 3S levels in sodium atom is 2.107 eV. Calculate the wavelength of emission line when the electron is de-excited from 3P to 3S level of sodium atom. [3]

Given : Planck's constant = 6.626×10^{-34} Js

Velocity of light = 3.0×10^{10} ms⁻¹

1eV = 1.602×10^{-19} J

P.T.O.

Q2) a) Attempt any three of the following. **[9]**

- i) What is nebulizer? Draw the schematic representation of pneumatic concentric nebulizer. How does it operated for liquid sample using argon gas?
 - ii) Explain isobaric & molecular interference in ICP-MS.
 - iii) Give the method of determination of metals in waste water sample by ICP-MS.
 - iv) Explain working of quadrupole mass analyzer in ICP-MS.
- b) A 400-mg sample of hair has from a young child is digested in $\text{HNO}_3\text{-HClO}_4$ and diluted to 30 mL. A 10.0 mL aliquot is diluted to 25.0mL and analyzed with a cadmium HCL. The absorbance reading is 0.13. To a second 10.0 mL aliquot is added 1.0 mL of 0.400ppm standard cadmium solution, Followed by dilution to 25.0 mL and analyzed for cadmium. The absorbance reading is 0.18. Calculate the cadmium content in 1.0g. of hair sample. **[3]**

Q3) a) Attempt any two of the following. **[8]**

- i) What is selective extraction? Explain variables for effective & quantitative separation of metal ions from aqueous sample using liquid-liquid extraction.
 - ii) Distinguish between continuum source & line source. Draw the schematic diagram of copper hollow cathode lamp. Explain its working as a line source for analysis of copper.
 - iii) Draw the schematic diagram of ICP-MS. Explain in brief the function of each component involved in it.
- b) Attempt any two of the following. **[4]**
- i) What mass of $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (mW = 249.55) would need to prepare 100 mL of 100 ppm stock solution of copper (At.Wt = 63.55)
 - ii) What is acid-digestion? Write the balance chemical reaction involved in digestion of silica using hydrofluoric acid.
 - iii) Explain isotope dilution analysis in ICP-MS.

SECTION-II

(Molecular Spectroscopic Methods)

Q4) a) Attempt any four of the following. **[8]**

- i) What is triplet state?
- ii) What is absorption spectrum? Give its analytical application?
- iii) Give the principle of X-ray photoelectron spectrometer.
- iv) Draw hyperfine splitted ESR spectrum of benzene free radical.
- v) Enlist the factors affecting on fluorescence intensity.

b) Al^{2+} was analysed by Fluorescence measurement. Al^{2+} solution of 1 ppm was used on standard. 5ml of this solution was extracted in CCl_4 in presence of 8-hydroxyquinoline and showed fluorescence intensity 9.3. Aluminium solution stock (100 ml) is used as source Aluminium sample. 1-ml of this solution was diluted to 100 ml and treated similarly to standard. Calculate conc. of Al stock solution if fluorescence intensity for sample is 14.2. **[3]**

Q5) a) Attempt any three of the following. **[9]**

- i) What is photometric titration? Explain its application with suitable example.
- ii) Which of the following nuclei are ESR active? Why ^{13}C , ^1H , ^{40}Ca .
- iii) Explain term 'g'-factor in ESR spectroscopy.
- iv) Explain Qualitative & Quantitative analysis in XPS and AES.

b) If an unpaired electron in a particular environment has a g-factor 2.015. Calculate the magnetic field required to cause the electron to resonate at frequency of 9.5 GHz.

[Given $\mu_B = 9.285 \times 10^{-34} \text{J/T}$, $h = 6.6226 \times 10^{-34} \text{Js}$] **[3]**

Q6) a) Attempt any two of the following. **[8]**

- i) What is phosphorescence? Give the difference between fluorescence and phosphorescence.
- ii) Explain construction & working of electron gun in electron spectrometer.
- iii) Explain selection rule for transition of electron in ESR spectroscopy with suitable example.

b) Attempt any two of the following. **[4]**

- i) Give the application of ESCA.
- ii) Explain the term Auger electron spectra with suitable example.
- iii) Give the application of ESR spectroscopy.



Total No. of Questions : 6]

SEAT No. :

PE4525

[Total No. of Pages : 3

[6510]-77

M.Sc. (Part-II)

ANALYTICAL CHEMISTRY

CHA-652 MJ : Chemical Methods of Pharmaceutical Quality Control
(2023 Credit Pattern) (Semester - IV)

Time : 3 Hours]

[Max. Marks : 70

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of scientific calculator is allowed.

SECTION- I

Q1) a) Attempt any four of the following. **[8]**

- i) What are Nasal Preparations?
- ii) Define Gel.
- iii) What is injection?
- iv) Write in brief about loss on ignition.
- v) What are barbiturates?

b) Explain in detail friability of uncoated tablet: **[3]**

Q2) a) Attempt any three of the following. **[9]**

- i) Give a detailed account of limit test for Iron.
- ii) What is ester value? Explain the principle & method for estimation of ester value.
- iii) Write a note on shelf life of pharmaceutical preparation.
- iv) Write a note on particulate contamination.

b) A sample of oil weighing 0.28g was treated with KI solution after 30 minutes, the iodine is liberated. The liberated iodine is titrated with 0.1m $\text{Na}_2\text{S}_2\text{O}_3$ and it required 8.5ml of titrant, if blank value was 25.0ml. Calculate the iodine value of oil. **[3]**

P.T.O.

- Q3) a)** Attempt any two of the following. **[8]**
- i) Discuss in detail the disintegration test for tablets and capsules with suitable diagram.
 - ii) Explain in detail the assay of vitamin A
 - iii) Give a detailed account of limit test for Arsenic.
- b)** Attempt any two of the following. **[4]**
- i) Define capsule. Enlist the types of capsules.
 - ii) Differentiate between ointment and cream.
 - iii) What is an assay?

SECTION- II

- Q4) a)** Answer the following (any 4) **[8]**
- i) Define 'Medicinal Product' and API.
 - ii) Enlist different parameters given in monograph of pharmaceutical product.
 - iii) What are functions of excipients?
 - iv) Describe identification by IR spectroscopy.
 - v) What is sulphated ash?
- b)** 0.26g of sample is dissolved according to procedure and titrated with 0.1M perchloric acid. The end point obtained was 9.3ml. The molar mass of metronidazole benzoate is 275.26g/mol. Find out amount of metronidazole benzoate in given sample comment on assay validity if acceptance criteria is 98-101% **[3]**
- Q5) a)** Attempt any three of the following. **[9]**
- i) Describe assay of omeprazole by acid. base titration.
 - ii) Why there is need to identify and characterize impurities in pharmaceutical products?
 - iii) Describe method for identification of flupentixol Decanoate in flupentixol decanoate by UV-Vis spectrophotometry.
 - iv) Explain non aqueous titration method for assay of pharmaceutical product.
- b)** The specific absorbance of paracetamol is 715. The 20 tablets of paracetamol has weight 12.52g. From this powder of 20 tablets 0.2g was dissolved in 200ml of 0.05M NaOH. From this 1ml sample was diluted to 100ml with 0.01M NaOH. Absorbance of this sample was observed to be 0.647. Calculate amount of Paracetamol per tablet. **[3]**

Q6) a) Attempt any two of the following. **[8]**

- i) Describe steps involved in development of new drugs.
- ii) Explain assay of hydrocortisone by HPLC method.
- iii) What is role of quality control in Pharmaceutical industry?

b) Attempt any two of the following. **[4]**

- i) Define related substances. Explain their determination by LC method.
- ii) Define residual solvent. Give its classification
- iii) Explain system suitability.



Total No. of Questions : 3]

SEAT No. :

PE4526

[Total No. of Pages : 2

[6510]-78

S.Y.M.Sc.

ANALYTICAL CHEMISTRY

**CHA 660 (A) MJ : Bio Analytical Chemistry
(2023 Credit Pattern) (Semester - IV)**

Time : 2Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*

Q1) a) Attempt any four of the following. **[8]**

- i) Define electro-osmosis.
 - ii) Give the difference between Hydrodynamic and electrokinetic Injection System.
 - iii) State the Kubelka-Munk equation.
 - iv) Give any two applications of capillary Electrophoresis.
 - v) Give the difference between direct ELISA and Indirect ELISA.
- b) What is zone electrophoresis? Explain the principle of capillary zone electrophoresis. **[3]**

Q2) a) Attempt any three of the following. **[9]**

- i) Write a short note on electroosmotic flow.
 - ii) Explain the basic principle of ELISA.
 - iii) Write a note on cellulose acetate as support media in electrophoresis.
 - iv) Explain in detail sandwich ELISA.
- b) Discuss in detail fluorescence detection in capillary electrophoresis. **[3]**

P.T.O.

Q3) a) Attempt any two of the following. **[8]**

- i) Explain the principle of capillary electrophoresis and explain its components.
- ii) Give general aspects for quantitative and qualitative analysis.
- iii) Write a note on amperometric detection in capillary electrophoresis.

b) Attempt any one of the following. **[4]**

- i) Explain in detail factors affecting on electrophoretic mobility.
- ii) Explain in detail Hydrodynamic Injection system.



Total No. of Questions : 3]

SEAT No. :

PE4527

[Total No. of Pages : 2

[6510]-79

M.Sc. - II

ANALYTICAL CHEMISTRY

CHA - 660(B) MJ : Automation and Sensor

(2023 Pattern) (Credit Pattern) (Semester - IV)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) *All questions are compulsory.*
- 2) *Figures to the right indicate full marks.*
- 3) *Use of log tables & calculators are allowed.*

Q1) a) Solve any four of the following : **[8]**

- i) Define chemical sensors.
- ii) What is Batch Flow Analysis?
- iii) Enlist different types of analysers.
- iv) What is Biosensor?
- v) What is serial integration?

b) Discuss the advantages and disadvantages of automation. **[3]**

Q2) a) Attempt any three of the following : **[9]**

- i) Explain the voltametric chemical sensors.
- ii) Discuss discrete sample analyser.
- iii) Explain electrochemical sensors and give its applications.
- iv) How would you design an optical Biosensor to measure the cholesterol?

b) Explain the miniaturized analytical system. **[3]**

P.T.O.

Q3) a) Attempt any two of the following : **[8]**

- i) Define microfabrication. Explain glass micromatching.
- ii) Explain role of biosensors in analysis.
- iii) Explain flow injection-Hydride Generation scheme.

b) Attempt any two of the following : **[4]**

- i) Write note on parallel integration.
- ii) Write note on Lab information management system.
- iii) Explain the polymer replication technology.

x x x

[6510]-80

M.Sc. - II

ANALYTICAL CHEMISTRY

CHA-660(C)-MJ : Analytical Techniques of Polymer Characterization
(2023 Credit Pattern) (Semester - IV)

Time : 2 Hours]

[Max. Marks : 35

Instructions to the candidates:

- 1) All questions are compulsory.
- 2) Figures to the right indicate full marks.
- 3) Use of Scientific calculator is allowed.

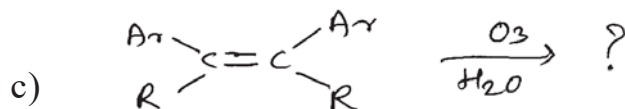
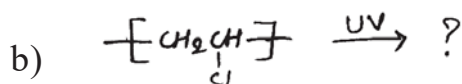
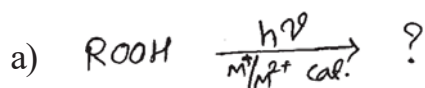
Q1) A) Attempt any four of the following.

[8]

- a) How a polymer can be identified by UV - Spectroscopy?
- b) What is the weight average molecular weight?
- c) What is tacticity of polymers?
- d) What is thermal degradation of polymer?
- e) What is Flexural Testing of polymer?

B) Identify the products for the following reactions.

[3]



P.T.O.

Q2) A) Attempt any Three of the following. [9]

- a) Write a note on Glass Transition Temperature (T_g).
 - b) Distinguish between Thermosets and Elastomers.
 - c) Explain the use of Mass spectrometry in structure elucidation of polymer.
 - d) A bar of rubber, consisting of 5×10^{20} chains between cross - links, is extended uniaxially at 20°C until its length is double the initial length (0.10m). What is the force required to double the length of this specimen.
- B) When a certain polymer sample contains 50 molecules with $MW = 104$, 100 molecules with $MW = 105$, 200 molecules with $MW = 103$ and 300 molecules with $MW = 107$. Calculate the $\overline{M}_n$ and $\overline{M}_w$ for the given polymer. [3]

Q3) A) Attempt any Two of the following. [8]

- a) Discuss the determination of Molecular weight of a polymer by viscosity technique.
 - b) Explain the terms
 - i) Stress relaxation
 - ii) Creep
 - c) Calculate the contour length and the root-mean-square end-to-end distance for a polyethylene sample with a molecular weight of 280kg/mol. Assume that the length of a c–c bond is 154 pm.
- B) Attempt any Two of the following. [4]
- a) What are Thermoplastic Elastomers?
 - b) Draw a schematic diagram of a typical FTIR-Spectrometer.
 - c) A sample of glass - filled nylon 6.6 composite is found to have a density of 1515 kg/m^3 . The densities of nylon 6.6 and glass are 1135 and 2500 kg/m^3 respectively. Calculate the volume fraction of glass fibre in the nylon.

