

1203

(90)

Roll No.

my 9095



Serial No. of Question Paper:

Unique Paper Code

: 32171401

Name of the Paper

: Core: Inorganic Chemistry III: Coordination Chemistry

Name of the Course

: B.Sc (H) Chemistry

Semester

: IV

Duration : 3 hours

Maximum marks: 75

(Write your Roll No. on the top immediately on receipt of this question paper)

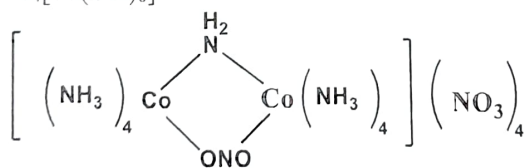
Attempt any six questions

1. (a) Give reasons for any five of the following

2.5 × 5 = 12.5 marks

- (i) All the octahedral complexes of Ni(II) must be outer orbital complexes.
- (ii) Higher oxidation states are more common for actinoids compared to lanthanoids
- (iii) The densities of third transition series are almost twice that of corresponding metals of second transition series.
- (iv) $[\text{Fe}(\text{CN})_6]^{3-}$ is a low spin complex whereas $[\text{FeF}_6]^{3-}$ is a high spin complex
- (v) Zinc(II) ions are colourless and diamagnetic while copper (II) ions are coloured and paramagnetic
- (vi) Transition elements can form complexes in zero or even negative oxidation states.

2. (a) Name the following complexes according to IUPAC system of nomenclature

i. $\text{Li}_4[\text{Fe}(\text{CN})_6]$ 

ii.

iii. $[\text{Ag}(\text{NH}_3)_2]_2 [\text{PtCl}_6]$

(b) Write the formulae of the following complexes

- (i) Hexaamminechromium(II) hexanitrochromate(III)
- (ii) Dichloridobis(ethylenediamine) platinum(IV) chloride
- (iii) Potassium dicyanidodioxalatonickelate(II)

(c) A solution containing 2.674 g of $\text{CoCl}_3 \cdot 6\text{NH}_3$ was passed through a cation exchanger. The solution obtained gave 4.305 g of AgCl precipitate with AgNO_3

solution. Determine the formula of the complex (Molar mass of the $\text{CoCl}_3 \cdot 6\text{NH}_3 = 267.4 \text{ g mol}^{-1}$)

(4.5, 4.5, 3.5 marks)

3 (a) What is Jahn Teller theorem. Discuss the Jahn Teller distortion in $[\text{Cu}(\text{NO}_2)_6]^{4-}$

(b) Using the valence bond method, i) assign the valence shell electronic configuration to the central metal atom, ii) predict the type of hybridization involved, and iii) the magnetic moment (in Bohr magnetons) for the following complex: $[\text{Cr}(\text{CN})_6]^{4-}$ and $[\text{Cr}(\text{H}_2\text{O})_6]^{2+}$

(c) For a complex $[\text{CoL}_6]^{3-}$ where L is a uninegative monodentate ligand, the values of Δ_0 and mean pairing energy are $15,000$ and $20,000 \text{ cm}^{-1}$ respectively. Calculate the crystal field stabilization (CFSE) of the complex

(4.5,4.5,3.5 marks)

4. (a) What happens when

(i) SO_2 is passed through acidified $\text{K}_2\text{Cr}_2\text{O}_7$

(ii) KI is added to KMnO_4 in acidic medium

(iii) $\text{K}_4[\text{Fe}(\text{CN})_6]$ is treated with H_2O_2

(b) Compare the molecular orbital diagram for the π - donor ligand with respect to pure σ -donor ligand. Explain the effect on the Δ_0

(c) On the basis of crystal field theory predict whether MnCr_2O_4 would adopt normal or inverse spinel structure. Explain

(4.5,4.5,3.5 marks)

5 (a) Giving reasons, explain which of the following pairs show higher value of the property mentioned.

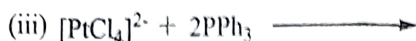
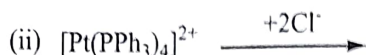
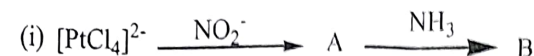
(i) Lability: $[\text{Cr}(\text{CN})_6]^{3-}$ or $[\text{Hg}(\text{CN})_4]^{2-}$

(ii) Higher value of Δ_0 : $[\text{Fe}(\text{CN})_6]^{3-}$ or $[\text{Fe}(\text{H}_2\text{O})_6]^{3+}$

(iii) Colourless ion: Ti^{3+} or Ti^{4+}

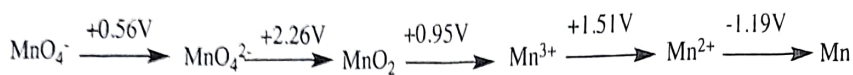
(b) An orange compound A on heating gives a green compound B and oxygen. On acidification of B, a compound C is formed which on treatment with zinc in the presence of dilute HCl gives a blue compound D. Compound D on treatment with sodium acetate gives a red compound E. Identify A, B, C, D and E. Discuss the structure and magnetic behaviour of Compound E.

(c) Using trans effect, predict the products of the following reactions



(4.5, 4.5, 3.5 marks)

6 (a) Consider the Latimer diagram for Manganese in acidic medium



Answer the following questions

- Calculate skip EMF for MnO_4^{2-} to Mn^{2+}
- Which oxidation state of Mn will disproportionate?
- Which is the most stable species

(b) Give all the possible geometrical isomers of

(i) $[Co(gly)_2(H_2O)_2]$ and (ii) $[Cr(H_2O)_3(py)_3]$. Also indicate which one of these will be optically active

(c) Arrange the following complex ions in the order of increasing Δ_0 giving reasons $[M(CN)_6]^{4-}$, $[MF_6]^{4-}$, $[M(H_2O)_6]^{2+}$, $[M(NH_3)_6]^{3+}$

(4.5,4.5,3.5 marks)

7(a) Which complex ion is more stable: $[M(en)_3]^{2+}$ or $[M(dien)_2]^{2+}$ and why where en = ethylene diamine and dien = diethylenetriamine.

(b) Compare and contrast the magnetic and spectral properties of elements of d- and f- block element.

(c) What are outer and inner orbital octahedral complexes. Explain giving one example of each

(4.5,4.5,3.5 marks)

8(a) A compound $Co(en)_2(NO_2)_2Cl$ has been prepared in a number of isomeric forms A, B, and C. A undergoes no reaction with $AgNO_3$ or ethylenediamine and is optically inactive, B reacts with $AgNO_3$ but not with ethylenediamine and is optically inactive. C is optically active and reacts with both $AgNO_3$ and ethylenediamine. Identify A, B and C and draw their structures.

(b) $Co(III)$ is stabilized in the presence of strong field ligands while $Co(II)$ is stabilised in the presence of weak field ligands. Explain with the help of crystal field theory

(c) Ce^{3+} ion with $4f^1$ electronic configuration is colourless while Ce^{4+} ion with $4f^0$ electronic configuration is red. Explain

(4.5,4.5,3.5 marks)



Sr No. Of the Question Paper.....**1204**

Your Roll No.: **23/5/258**

Unique Paper Code : 32171402

Name of the Paper : OC III-Heterocyclic Chemistry

Name of the Course : B.Sc. (Hons) Chemistry

Semester : IV

Duration : 3 hours

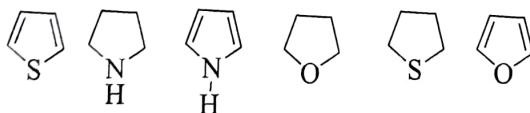
Maximum Marks : 75



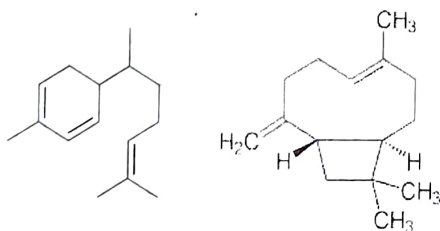
Instructions for Candidates

- Write your Roll No. on the top on receipt of this question paper.
- Attempt **six** questions in all.
- **Question No. 1 is compulsory** and carries **15** marks.
- All other questions are of **12** marks each.

- a. Three isomeric pyridine carboxylic acids X, Y, and Z are known. The following experiments were performed to decide their structures. Oxidation of quinoline with hot KMnO_4 gave a dicarboxylic acid which upon pyrolysis gave an acid X. similarly. Isoquinoline upon oxidation followed by pyrolysis of the resulting acid gave a mixture of acid X and Y. Assign structure to X, Y, and Z.
- b. Indicate the direction of the dipole moment of each compound and explain.



- c. What is the special isoprene rule? Indicate the isoprene units in the following compounds.



- d. Anthracene and phenanthrene are two isomeric polynuclear hydrocarbons with three ortho-fused benzene rings. Explain why phenanthrene is thermodynamically more stable than anthracene.

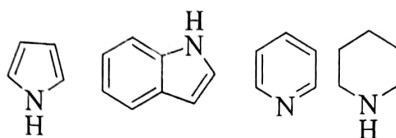
(6, 3, 3, 3)

2. a. Carry out the following conversions (any two):

- i) Quinoline to 8-Hydroxyquinoline
- ii) Furan to 2-Phenyl furan
- iii) Benzene to 1,3,5-tribromobenzene

- b. Oxidation of 1-nitronaphthalene yields 3-nitrophthalic acid while that of 1-aminonaphthalene yields phthalic acid. Why?

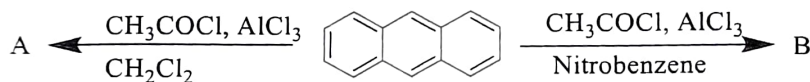
- c. Describe the correct order of the basicity of the following compound:



- d. How would you prepare 2-bromo-3-methylbenzoic acid which is otherwise very difficult to prepare by usual substitution reaction?

(3, 3, 3, 3)

3. a. What will be the structure of A and B? Give reason for the different product formation.



- b. Explain why 2-Ethyl-1-naphthol couples with Benzenediazonium chloride, whereas 1-ethyl-2-naphthol does not.
- c. Explain why phenanthrene undergoes electrophilic addition of dichlorocarbene in its C-9/C-10 position but anthracene does not.
- d. Pyridine-2-carboxylic acid upon heating gives pyridine. However, when this reaction is carried out in the presence of acetone, a tertiary alcohol is formed. Explain.

(3, 3, 3, 3)

4. a. Elucidate the structure of the citral with isomerism. Also, give a synthesis of citral and how many stereoisomers of citral are known to occur in nature.

- b. How *cis* and *trans*-citral can be converted into Geraniol?

- c. Using suitable reactions how will you indicate the position of linkage between pyridine and N-methyl pyrrolidine in nicotine?

d. What happens when:

- i) Citral is reacted with alkaline KMnO_4 followed by CrO_3
- ii) Nicotine is treated with Br_2/HBr followed by $\text{Ba}(\text{OH})_2$ in the presence of heat

(3, 3, 3, 3)

5. a. Outline the synthesis of 4-methylpentanamine using the Gabriel synthesis. Give the mechanism of synthesis involved.

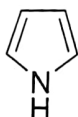
b. Arrange the following in increasing order of their reactivity towards electrophilic substitution reactions with suitable explanation.



(a)



(b)



(c)



(d)

c. Write the final products formed in the reaction of Isoquinoline using following reagents:

- i) Na in liq. NH_3
- ii) $\text{C}_2\text{H}_5\text{MgBr}$ /Ether
- iii) Alkaline KMnO_4 /heat

d. How would you distinguish between methyl cyanide and methyl isocyanide?

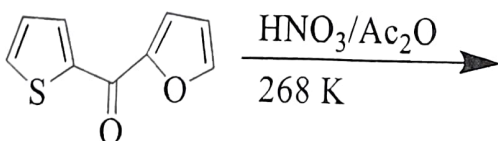
(3, 3, 3, 3)

6. a. N-ethyl-N-methylamine is chiral but non-resolvable however, 2-aminobutane is resolvable. Explain giving ~~of~~ all the structures involved.

b. How will primary, secondary, and tertiary nitroalkanes react with nitrous acid. Give the involved reactions.

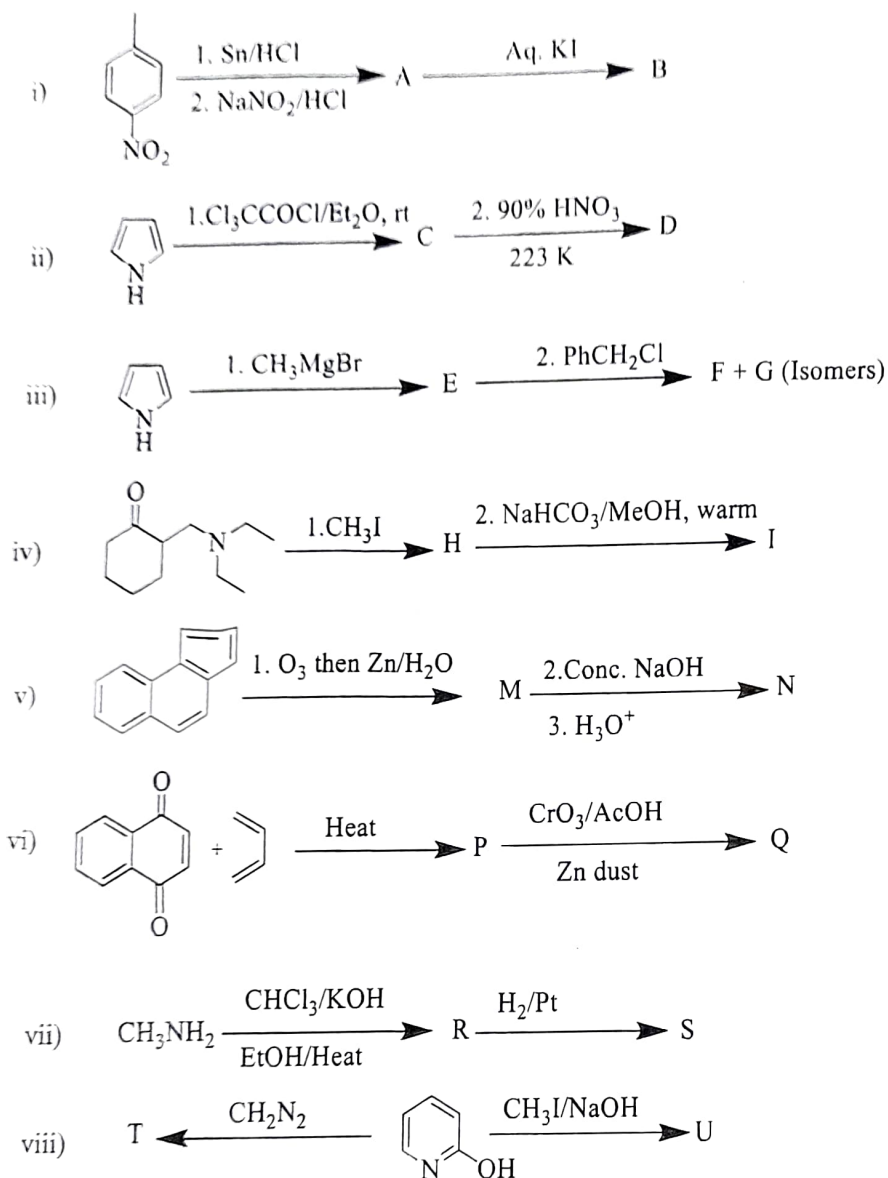
c. Between methyl cyanide and methyl isocyanide which one is more soluble in water and why?

d. Give the structure of the mononitration product of the following compound and explain why it is formed.



(3, 3, 3, 3)

7. Complete the following reactions (any 6):



(6 x 2)

8. Write a short note on the following (any three):

- Thorpe Nitrile Condensation
- Hantzsch synthesis for substituted pyridine
- Chichibabin reaction
- Paal-Knorr pyrrole synthesis

(3 x 4)

1205

27/5/25h

Roll No.

Unique Paper Code : 32171403

Name of Paper : Physical Chemistry IV: Conductance & Chemical Kinetics

Name of Course : B.Sc. (H) Chemistry

Semester : IV

Duration : 3 hours

Maximum Marks : 75



Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt *any six* Questions in all.
3. Question No.1 is compulsory.
4. Use of scientific calculator is permitted.

Q1. Answer any Five of the following:

(5× 3)

- (a) What is the difference between order and molecularity of a reaction? Explain.
- (b) H^+ ion and OH^- ions have abnormally high conductance values in aqueous solutions. Explain.
- (c) How does photochemical reactions differ from thermal reactions?
- (d) Elementary reactions with molecularity greater than three are unknown. Explain.
- (e) Write the difference between fluorescence and phosphorescence.
- (f) Explain conductometric titration curve of mixture of strong and weak acid against strong base.

Q2.

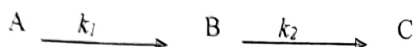
- (a) Kinetics of enzymes catalyzed reactions is studied by Michaelis- Menten mechanism. Using the Steady State approximation, relate enzyme and substrate concentration to rate of the reaction. Show that the enzyme reaction is 1st order and zero order with respect to substrate S at low and high concentration of S respectively.

(6)

- (b) At 380 °C, the half-life period for the first order decomposition of H_2O_2 is 360 min. The energy of activation of the reaction is 200 kJ mol^{-1} . Calculate the time required for 75% decomposition of H_2O_2 at 450 °C. (6)

Q3.

- (a) Consider two consecutive first order reactions:



Where $k_1 \neq k_2$ and at time $t = 0$ only A is present. Derive expressions for [A], [B] and [C] at time t in terms of the rate constants k_1 and k_2 . Show graphically the concentrations of A, B and C as function of time for the condition $k_2 \gg k_1$. (6)

- (b) The following table gives the kinetic data for the reaction between $\text{Na}_2\text{S}_2\text{O}_3$ and CH_3I at 298K, the concentration being expressed in arbitrary units.

Time (min.)	0	4.75	10	20	35	55
$\text{Na}_2\text{S}_2\text{O}_3$	35.35	30.5	27.0	23.2	20.3	18.6
CH_3I	18.25	13.4	9.9	6.1	3.2	1.5

Show that the reaction follows second order kinetics and calculate its rate constant.

(6)

Q4.

- (a) Discuss the collision theory of biomolecular gaseous reactions and derive the rate expression.

(6)

- (b) For the decomposition of acetone di-carboxylic acid, the rate constant is $2.46 \times 10^{-5} \text{ s}^{-1}$ at 273 K and $1.63 \times 10^{-3} \text{ s}^{-1}$ at 303 K. Calculate the activation energy of the reaction. (3)

- (c) In the reduction of nitric oxide 50% of the reaction was completed in 140 sec when initial pressure was 258 mm Hg and in 224 seconds when initial pressure was 202 mm Hg. Find the order of the reaction. (3)

Q5.

- (a) Discuss qualitatively the Debye-Hückel-Onsager's theory as applied to the variation with dilution of molar conductivity of a dilute solution of a strong electrolyte. (6)

- (b) The specific conductance of 0.011 M solution of acetic acid was found to be 0.016 S m^{-1} at 25°C.

Calculate the degree of dissociation of the acid. The molar conductance of acetic acid at infinite dilution is $391.0 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$ at 25°C . (3)

(c) Describe the moving boundary method for determining the transport number of ions. (3)

Q6.

(a). State and explain Kohlrausch Law of independent migration of ions. How does it help in determining the molar conductivity at infinite dilution of weak electrolyte? (6)

(b) A conductivity cell was filled with 0.01 M KCl which was known to have specific conductivity of 0.1413 S m^{-1} at 298 K. Its measured resistance at 298 K was 94.3 ohms. When the cell filled with 0.02 M AgNO_3 its resistance was 50.3 ohms. Calculate (i) the cell constant (ii) the specific conductance of AgNO_3 solution. (3)

(c) Explain Asymmetry effect and Electrophoretic effect. (3)

Q7.

(a) What is Quantum yield or quantum efficiency? Write down the reasons for high and low quantum yield. (6)

(b) State and derive Lambert-Beer's Law. (3)

(c) A certain substance in a cell of length 'L' absorbs 20 per cent of the incident light. What fraction of the incident light will be absorbed in a cell of length '4L'? (3)

Q8.

(a) Derive Stern-Volmer Equation. What is its significance? (6)

(b) The quantum yield for the photochemical reaction

$\text{H}_2(g) + \text{Br}_2(g) \longrightarrow 2\text{HBr}(g)$ is ~ 0.01 while that for the reaction

$\text{H}_2(g) + \text{Cl}_2(g) \longrightarrow 2\text{HCl}(g)$ is $\sim 10^4 - 10^6$.

Explain. (3)

(c) In the photochemical combination of $\text{H}_2(g)$, and $\text{Cl}_2(g)$, a quantum efficiency of about

2×10^6 is obtained with a wavelength of 480 nm. What amount of $\text{HCl}(g)$ would be produced

under these conditions per calories of radiant energy absorbed? (3)

[This question paper contains 8 printed pages.]

Your Roll No. May 2025

Sr. No. of Question Paper : 5526

Unique Paper Code : 2172012401

Name of the Paper : DSC 10: Coordination Chemistry
and Reaction Mechanism

Name of the Course : B.Sc. (Hons) Chemistry
(NEP-UGCF-2022)

Semester : IV

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **six** questions in all.
3. Question **1** is mandatory.
4. **All** questions carry equal marks.

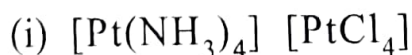
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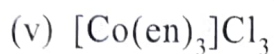
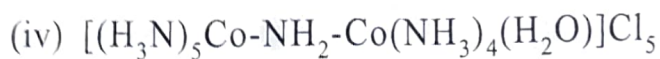
1. Explain the following giving appropriate reasoning :

- (a) 4d and 5d elements form low spin octahedral complexes.
- (b) Square planar complexes do not exhibit optical isomerism.
- (c) $[\text{PtF}_6]$ is stable, whereas NiF_6 does not exist.
- (d) Fe(II) and Fe(III) form complexes with CN^- but not with NH_3 .
- (e) The crystal field splitting in tetrahedral complexes is smaller than in octahedral complexes.

(3,3,3,3,3)

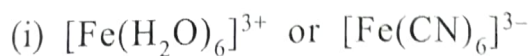
2. (a) Name the following complexes according to the IUPAC system of nomenclature.





(b) What is the chelate effect? Chelate effect is predominantly due to entropy change. Explain.

(c) Which of the following have higher Δ_0 value and why?



3. (a) Write the formulae of the following complexes according to the IUPAC system of nomenclature :

(i) pentaamminenitrito-O cobalt(III) sulphate

(ii) potassium amminedicyanidodioxidoperoxido-chromate(VI)

(iii) μ -amido - μ -hydroxido bis[tetraammine-cobalt(III)]

(iv) tetrapyridineplatinum(II) tetrachlorido-platinate(II)

(v) Potassium tetrafluoridoargentate(I)

(b) Define the terms transition state and intermediate state using reaction pathways.

(c) What is the effect of π acceptor ligand and π donor ligands on Δ_0 ? Explain on the basis of ligand field theory. (5,5,5)

- (a) Explain why square planar complexes of Pt(II) often undergo associative substitution mechanisms, while octahedral complexes of Cr(III) typically undergo dissociative mechanisms.
- (b) Draw and explain Crystal Field Splitting diagram for octahedral complexes.
- (c) How will you distinguish between the following pairs of isomers?
- (i) cis and trans $[\text{Pt}(\text{NH}_3)\text{Cl}_2]$
- (ii) $[\text{Co}(\text{NH}_3)_5\text{SO}_4]$ I and $[\text{Co}(\text{NH}_3)_5\text{I}] \text{SO}_4$
- (5,5,5)
- (a) Predict and sketch all the possible isomers of $[\text{Cr}(\text{gly})_3]$.

(b) Describe the factors responsible for strong distortion in the octahedral complexes. Square planar complexes are a special case of octahedral geometry. Justify your answer.

(c) (i) I^- and CO have higher trans effects than Cl^- . Explain.

(ii) Predict the products when $[\text{PtCl}_4]^{2-}$ is treated with NH_3 followed by C_2H_4 . (5,5,5)

6. (a) On the basis of VBT, account for the magnetic properties of $[\text{Ni}(\text{NH}_3)_6]^{2+}$ and $[\text{Cr}(\text{CN})_6]^{3-}$.

(b) Determine the CFSE of a d^6 octahedral complex having $10Dq = 25000 \text{ cm}^{-1}$ and $P = 15000 \text{ cm}^{-1}$ (mean pairing energy).

- (c) The formation of $[\text{CdBr}_4]^{2-}$ from $[\text{Cd}(\text{H}_2\text{O})_6]^{2+}$ exhibits the successive equilibrium constants K_1 , K_2 , K_3 and K_4 as 1.56, 0.54, 0.06 and 0.37, respectively. Explain why K_4 is larger than K_3 .

(5,5,5)

7. (a) Cr(II) fluoride and Mn(II) fluoride, both have a central metal ion surrounded by six F-ions. The Mn-F bond lengths are equidistant but four of the Cr-F distances are long and two are short. Explain.

- (b) What are labile and inert complexes? Explain giving one example each, on the basis of CFT.

- (c) Differentiate between inner orbital and outer orbital octahedral complexes.

(5,5,5)

8. Write short notes on (Any three) :

- (a) Crystal Field theory and its limitations

(b) Macrocyclic Effect

(c) Werner's theory of Coordination Compounds

(d) Factors affecting stability of the complexes

(5,5,5)

[This question paper contains 8 printed pages]

Your Roll No.

Sr. No. of Question Paper : 5586

Unique Paper Code : 2172012402

Name of the Paper : DSC: Carbohydrates, Lipids
and Heterocyclic Compounds

Name of the Course : B.Sc. (Hons)

Semester : IV

Duration : 3 Hours

Maximum Marks : 90

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt **six** questions in all.
3. **All** questions carry equal marks.

1. (a) An aldopentose(A) gives an optically active aldaric acid (B). (A) on Ruffs degradation gives an aldotetrose (C) which can be oxidised to an optically inactive aldaric acid (D). Give the reactions involved, structure and names of (A) (B) (C) and (D).
- (b) When crystals of pure α - D-glucose are dissolved in water, the specific rotation gradually changes from + 112.2 to + 52.7. When crystals of pure β -D-glucose are dissolved in water, the specific rotation gradually changes from + 18.7 to + 52.7. Name the phenomena involved and discuss its mechanism. Explain why this phenomenon is faster in 2-hydroxypyridine as compared to that in a mixture of phenol and pyridine.
- (c) Convert D-arabinose to D-glucose & D-mannose. Name the reaction involved in it. (5,5,5)

2. (a) Explain Inter-conversion of D-glucose, D-mannose and D-fructose in a basic solution.
- (b) Give Haworth proof (using Fisher Projection) for cyclic structure of D-glucose.
- (c) Carry out the following conversions (give complete reaction involved in it) :
- (i) D-glucose to n-hexane
 - (ii) D-glucose to sorbitol
 - (iii) D-fructose to 2-methyl hexanoic acid
- (5,5,5)
3. (a) An unknown disaccharide gives a positive Tollens' test. A glycosidase hydrolyses it to D-galactose and D-glucose. When the disaccharide is treated with methyl iodide (excess) and Ag_2O and then hydrolysed with dilute HCl , the products are 2,3,4,6-tetra-O-methylgalactose and 2,3,6-tri-O-methylglucose. Give structure and name of the disaccharide. Give complete reaction.

- (b) Compare the structure of sucrose & maltose based on composition, reducing nature, type of bonding, nature of anomeric carbon.
- (c) What are polysaccharides? Give two differences between starch and cellulose based on monosaccharide units present & glycosidic linkage? Write the Haworth projection of cellulose.
- (5,5,5)
4. (a) Define Iodine value of an oil. Draw the structure of glyceryl trioleate and calculate its iodine value.
- (b) What are glycolipids? Write the structure of a glycolipid derived from one molecule each of spingosine, palmitic acid and α -D-glucose.
- (c) Differentiate between :
- (i) fats and oils
- (ii) ω - 3 & ω - 6 fatty acids (give example)
- (5,5,5)

5. (a) Explain electrophilic substitution in quinoline takes place more readily at the benzene ring rather than the pyridine ring. At which position electrophilic substitution take place.
- (b) Explain Why is pyridine more reactive towards nucleophilic substitution compared to benzene? What product forms when pyridine reacts with sodamide? Explain using chemical reactions.
- (c) Explain the following :
- (i) Why nitration and sulphonation reactions of furan are carried out under mild conditions.
- (ii) Why pyridine does not show Friedel-Craft reactions. (5,5,2.5×2)
6. (a) Arrange pyrrole, furan and thiophene in order of their reactivity towards electrophilic substitution reactions. Explain and justify by drawing suitable structures.

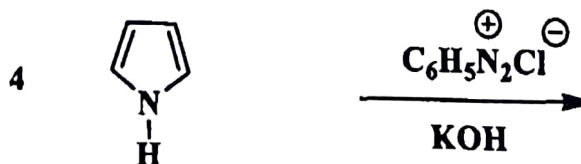
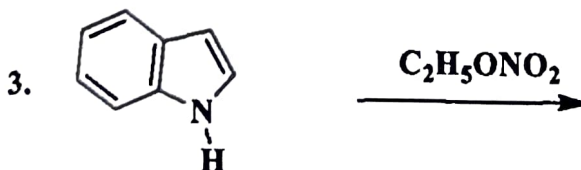
(b) How will you synthesise quinoline by Skraup synthesis? Explain with the help of a suitable mechanism.

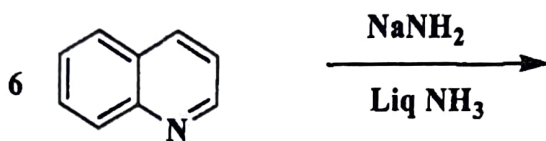
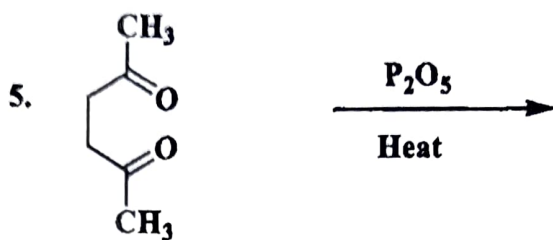
(c) Explain the following :

(i) Compare pyrrole and pyridine based on basicity.

(ii) Discuss the aromaticity of thiophene and compared it with benzene. (5,5,2.5×2)

7. (a) Complete the following reactions :





(b) How will you carry out the following conversions?

(i) 3-Bromopyridine from pyridine

(ii) Thiophane from acetylene

(iii) Piperidine from pyridine

(iv) Furfural from furan (1×7, 2×4)

8. Write short notes on (Any three):

(a) Paal-Knorr synthesis for thiophene

- (b) Friedlander synthesis for Quinoline
- (c) Hantzsch synthesis for pyrrole
- (d) Doebner-Miller synthesis of quinoline (5,5,5)

03/06/2025

[This question paper contains 8 printed pages]

Your Roll No. :
Sl. No. of Q. Paper : **5665**
Unique Paper Code : 2172012403
Name of the Paper : DSC : Electrochemical
Cells, Chemical
Kinetics and Catalysis
Name of the Course : **B. Sc. (Hons.) Chemistry**
Semester : IV

Time : 3 Hours

Maximum Marks : 90

Instructions for Candidates :

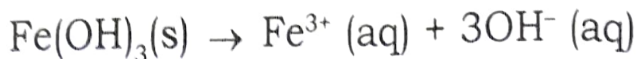
- Write your Roll No. on the top immediately on receipt of this question paper.
- Attempt **(SIX)** Questions in all. **First** question is Compulsory.
- Use of a Scientific calculator is permitted.
- Graph paper will be provided.

1. Attempt any **Five** parts.

- What is liquid junction potential ? Why is NH_4NO_3 salt a good choice for making a salt bridge ?

P.T.O.

- (b) Construct the cell in term of cell notation using the following cell reaction :



- (c) The standard redox potential of the water oxidation to dioxygen is -1.23 V.

$2\text{H}_2\text{O} \rightarrow \text{O}_2 + 4\text{H}^{+} + 4\text{e}^{-}$. Calculate the redox potential of the same reaction at pH = 7

- (d) The acid hydrolysis of the same quantity of ester is done separately with equal normal solutions of HCl & H_2SO_4 , it is given

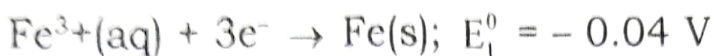
that $\frac{[\text{H}^{+}]_{\text{HCl}}}{[\text{H}^{+}]_{\text{H}_2\text{SO}_4}} = \frac{k_{\text{HCl}}}{k_{\text{H}_2\text{SO}_4}}$, explain whether the

value of $k_{\text{HCl}}/k_{\text{H}_2\text{SO}_4}$ is less than, equal or greater than one.

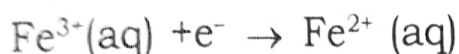
- (e) What are stationary and non-stationary chain reactions ? Discuss briefly.
- (f) Ionic reactions are fast while molecular reactions are slow. Why ?
- (g) Discuss, using potential energy barrier graph, the effect of catalyst on rates of the reaction.

5×3=15

2. (a) Given that :

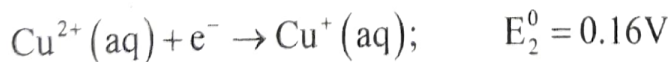
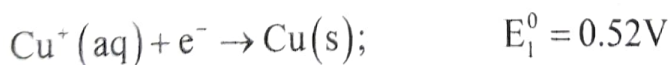


Determine the potential of the following half-cell reaction.

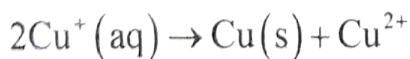


- (b) What is the basic principle of potentiometric titration ? How is it applied to acid - base titration ?
- (c) The standard potential of a cell "Pt | H₂(g) | HBr(aq) | Ag" was found to vary as $E^{\circ}(\text{volt}) = 0.01 - 1 \times 10^{-4}(T - 298) - 2 \times 10^{-6}(T - 298)^2$. Calculate the standard reaction entropy, ΔS° , and enthalpy, ΔH° , at 25°C.
- 3×5=15

3. (a) Given that the standard potential of the following half - cell reaction at 25°C



Calculate ΔG° (in kJ) for the following reaction :



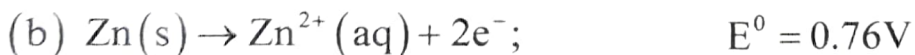
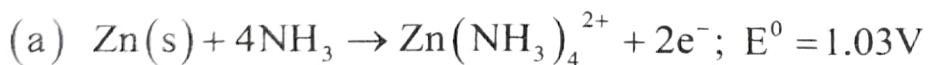
- (b) A platinum electrode is immersed in a solution containing 0.1 M Fe^{2+} and 0.1 M Fe^{3+} . Its potential is found to be 0.77 V against SHE. Under standard conditions, the activity coefficient is unity. What is the potential of the electrode when the concentration of Fe^{3+} is increased to 1 M at 25°C .
- (c) The cell constructed by the half cells.

$$E^0_{(\text{Cd}^{2+}|\text{Cd})} = -0.403\text{V} \quad \& \quad E^0_{(\text{I}^-|\text{AgI}|\text{Ag})} = -0.152\text{V}$$

has the potential of 0.29V at 25°C . Determine the activity of CdI_2 solution.

$$3 \times 5 = 15$$

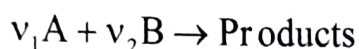
4. (a) Determine the formation of the complex, $\text{Zn}(\text{NH}_3)_4^{2+}$, Provided that



- (b) How do we use quinhydrone electrode for determination of pH of a given solution? What are advantages and disadvantages of quinhydrone electrode?

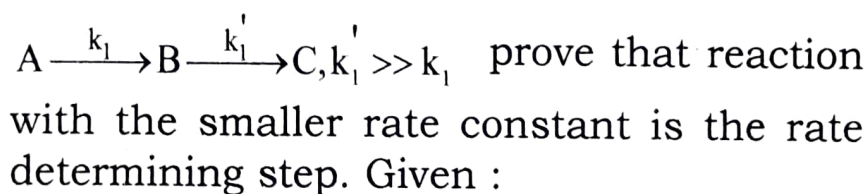
- (c) Construct a concentration cell without transference using silver – silver chloride electrode and derive the equation for determination of cell potential of the concentration cell. 3×5=15

5. (a) The reaction



is a first order reaction with respect to A & B. Write down its differential rate law & deduce from it the Integrated rate law. What is the unit of rate constant in this case ?

- (b) Suppose that in a consecutive reaction



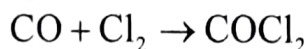
$$[C] = [A]_0 \left\{ 1 - \frac{1}{k_1' - k_1} \left(k_1' e^{-k_1 t} - k_1 e^{-k_1' t} \right) \right\}$$

- (c) Write a short note on Lindemann Mechanism. 3×5=15

6. (a) Compare the rate constants as given by Arrhenius equation & the collision theory and there by show that

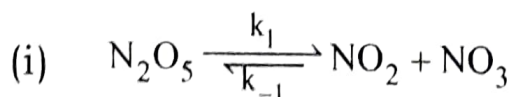
$$E_{\alpha} = E_0 + \frac{RT}{2} \quad \& \quad A = p N_A \frac{Z_{AB}}{N_A^* N_B^*} e^{1/2}$$

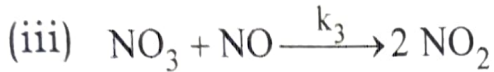
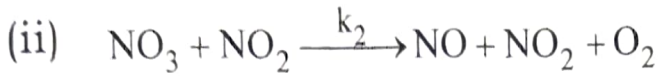
- (b) Using the following data, obtain the differential rate expression for the following reaction & the value of rate constant



Experiment No.	1	2	3	4
$[\text{CoCl}_2]_0 / \text{mol dm}^{-3}$	0.16	0.16	0.04	0.04
$[\text{Cl}_2]_0 / \text{mol dm}^{-3}$	0.16	0.04	0.16	0.04
$r_0 / \text{mol dm}^{-3} \text{ s}^{-1}$	1.92×10^{-2}	9.6×10^{-3}	4.8×10^{-3}	2.4×10^{-3}

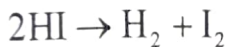
- (c) Discuss the conditions under which the equilibrium approximation & steady state approximation is used while elucidating the mechanisms of the complex reactions. Support your answer with any general reaction in each case 3×5=15
7. (a) The following mechanism has been proposed for the decomposition of N_2O_5 :





Show that rate law is $\frac{d[\text{O}_2]}{dt} = k[\text{N}_2\text{O}_5]$

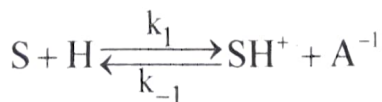
- (b) The bimolecular decomposition of Hydrogen Iodide is given by the equation

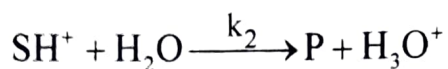


Assuming a collision diameter of 0.35×10^{-8} cm and an activation energy of $183.90 \text{ kJ mol}^{-1}$ for the reaction, calculate (i) the collision rate, (ii) the rate of reaction and (iii) the rate constant for the above reaction at 500 K and one atmosphere pressure.

- (c) Write a short note on Theory of Absolute Reaction rates. 3×5=15

8. (a) An acid, HA catalyses the substrate, S to products as follows :





Derive the rate law for the reaction. State when it becomes an example of "general acid catalysis" and it is "*specific hydrogen ion catalysis*".

- (b) Describe any five characteristics of catalyst.
- (c) The reaction rate of enzyme – catalysed reaction changes from first – order to zero – order as the substrate concentration is increased. Discuss the reason on the basis of active sites & Explain using the graph of rate versus substrate concentration.

$$3 \times 5 = 15$$

This question paper contains 3 printed pages]

Roll No.

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S. No. of Question Paper : 5696

Unique Paper Code : 2173012010

Name of the Paper : DSE : NUCLEAR AND ENVIRONMENTAL
CHEMISTRY

Name of the Course : B.Sc. (Hons.) Chemistry

Semester : IV

Duration : 3 Hours

Maximum Marks : 90

(Write your Roll No. on the top immediately on receipt of this question paper.)

Attempt six questions in all.

All questions carry equal marks.

1. (a) In what way is the mode of decay of a particular nucleus related to the ratio of neutrons to protons ? Explain on the basis of Stability Curve.
- (b) Calculate the energy released per fusion in MeV per fusion ${}^2\text{D}_1 + {}^1\text{H}_1 \longrightarrow {}^3\text{H}_1$. Given the atomic masses are ${}^2\text{D} = 2.01410$ amu, ${}^1\text{H} = 1.007825$ amu, ${}^3\text{H} = 3.01603$ amu.
- (c) The half-life period of ${}^{32}\text{P}$ is 8 days. What percentage of the original radioactive material will be present after 40 days ?

5,5,5

P.T.O.

2. Explain the following :
- (a) Disposal of nuclear waste and its management
 - (b) Different theories on the stability of nucleus.
 - (c) Nuclear fission and fusion reactions. 5,5,5
3. (a) Explain the construction and working principle of Geiger Muller Counter.
- (b) What are fast breeder reactors ? How are they different from conventional thermal reactors ? Describe the main components of a fast breeder reactor.
- (c) How are isotopes separated for use in nuclear reactors ? Explain using at least *three* different methods. 5,5,5
4. (a) What are air pollutants and how are they classified ? Elaborate on the major sources contributing to air pollution.
- (b) Discuss the major regions of Earth's atmosphere. Describe the characteristics of each region.
- (c) Explain different air pollution control methods. 5,5,5
5. (a) Discuss the chemistry and environmental consequences of photochemical smog. How is it formed and what are its main components ?
- (b) What is ozone depletion ? Explain the mechanisms involved, highlighting the role of chlorofluorocarbons (CFCs) and other ozone-depleting substances.

- (c) Describe the greenhouse effect and the role of greenhouse gases in global warming. Explain the chemical nature and environmental impact of major greenhouse gases. 5,5,5
6. (a) What is water pollution ? What are its impacts on the hydrological ecosystem ?
- (b) What are the key physicochemical parameters used to assess water quality ? Explain the significance of each parameter.
- (c) Explain the working principles and applications of *two* different water purification methods. 5,5,5
7. (a) Explain the sources and causes of water pollution.
- (b) Describe the various stages of the hydrological cycle and explain how each stage contributes to the continuous movement and transformation of water within the Earth's system.
- (c) Explain the effluent treatment process. How is the effluent from different industries treated ? 5,5,5
8. Write short notes on any *three* of the following : 5,5,5
- (a) α , β and γ
- (b) Chernobyl disaster
- (c) Nuclear reactors in India
- (d) Radioactive Series.