

2024

CHEMISTRY

(Theory)

Full Marks: 70

Pass Marks: 21

Time: Three hours

ALL the questions are compulsory.

The figures in the right margin indicate full marks for the questions.

Question Nos. 1-10 are Very short Answer (VSA) types of 1 mark each.

1. What are colligative properties of solutions ? 1
2. Electrolysis of water using platinum electrodes is generally facilitated by addition of a little amount of an electrolyte. But CuSO_4 cannot be used as the electrolyte. Why ? 1
3. How does a catalyst alter the speed of a chemical reaction ? 1
4. A reaction has a half-life of 20 s at the beginning but a half-life of 10s sometime later. Predict the order of the reaction. 1
5. Write the IUPAC name of the complex compound $\text{Na}_3[\text{Co}(\text{ONO})_6]$. 1
6. Cyclohexene on treatment with bromine in the presence of UV light gives a chiral molecule as product. Identify the chiral product. 1
7. Why is alkoxy group activating benzene ring towards electrophiles? 1
8. Formaldehyde dissolved in acetone on treatment with aqueous sodium hydroxide solution undergoes cross aldol condensation to form a product. Write the IUPAC name of the product. 1
9. Why aromatic diazonium salts cannot be generated in ethanol medium? 1
10. Why are water soluble vitamins needed to be supplied regularly in our diet? 1

Question Nos. 11-17 are Objective types carrying of 1 mark each. Choose and rewrite the best answer out of the given alternatives.

11. A solution is prepared by mixing together equimolar amounts of CH_2Cl_2 , CHCl_3 and CCl_4 (vapour pressure at 25°C being 415 mm, 200 mm and 143 mm respectively). At 50°C , the composition of the vapour over the solution will be 1
- A) richer in CH_2Cl_2 B) richer in CHCl_3
C) richer in CCl_4 D) of equal amounts of all components
12. An electrode constituted by passing hydrogen gas bubbles over platinum plate has the cell reaction $2\text{H}^+(\text{aq}) + 2\text{e}^- \rightleftharpoons \text{H}_2(\text{g})$. The electrode is represented as 1
- A) $\text{Pt}/\text{H}_2(\text{g})/\text{H}^+(\text{aq})$ B) $\text{H}^+(\text{aq})/\text{H}_2(\text{g})\text{Pt}$
C) $\text{Pt} / \text{H}_2(\text{g})$ D) $\text{H}^+(\text{aq}) / \text{Pt}$
13. The thermal decomposition of nitryl chloride, NO_2Cl is believed to follow the mechanism 1
- $\text{NO}_2\text{Cl}(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{Cl}(\text{g})$
 $\text{NO}_2\text{Cl}(\text{g}) + \text{Cl}(\text{g}) \rightarrow \text{NO}_2(\text{g}) + \text{Cl}_2(\text{g})$
In the reaction the intermediate species is
- A) NO_2 B) NO_2Cl
C) Cl_2 D) Cl
14. Which one of the following first row transition metals shows greatest number of oxidation states? 1
- A) Ti B) Mn
C) Cr D) Sc
15. The complex ion, $[\text{Fe}(\text{H}_2\text{O})_6]^{2+}$ is found to be paramagnetic. The number of unpaired electrons in the complex is 1
- A) 6 B) 5
C) 4 D) 2

16. Benzonitrile can be converted to Benzaldehyde by using 1
- A) (i) DIBAL-H (ii) H₂O B) LiAlH₄ (ii) H₂O
C) DNP D) PCC
17. Which of the following hormones is responsible for increasing blood glucose level? 1
- A) Insulin B) Glucagon
C) Epinephrine D) Thyroxine

Question Nos. 18 – 27 are Short Answer (SA-II) types and each carries 2 marks.

18. Define specific conductivity and molar conductivity of an electrolyte solution. 2
19. Daniel cell is expressed as Zn(s)|Zn²⁺(aq)||Cu²⁺(aq)|Cu(s). How will its emf change with change in concentration of (i) Zn²⁺ and (ii) Cu²⁺ ? 2
20. The electrolyte in automobile lead storage batteries is a 3.75 M sulphuric acid solution (density 1.23 g/mL). Calculate the mass percent of the sulphuric acid. 2
21. A pentoxide, A₂O₅ decomposes to dioxide and oxygen as
$$2 A_2O_5(g) \rightarrow 4AO_2(g) + O_2(g)$$
The reaction is studied by monitoring concentration of the reactant as a function of time and the following data was observed.

Time	[A ₂ O ₅]
500 s	$1.20 \times 10^{-2} M$
1200 s	$9.20 \times 10^{-3} M$

- Calculate the average rate of decomposition of A₂O₅. 2
22. Draw a potential energy profile diagram for an endothermic two step reaction (the first step being the rate determining step) and indicate the ΔH for the reaction. 2
23. Explain why is the second ionization enthalpy of copper higher than that of zinc. 2

24. Why do virtually all tetrahedral complex ions have high spin? 2
25. Two isomeric bromides of the molecular formula C_4H_9Br on treatment with sodium ethoxide give $C_4H_9OC_2H_5$ and C_4H_8 respectively as major product. Identify the two isomeric bromides. 2
26. Outline a scheme for the synthesis of propan-2-ol starting from ethanol. 2
27. Describe Gatterman-Koch reaction with an example. 2

Question Nos. 28 – 33 are Short Answer (SA-I) types and each carries 3 marks.

28. Either
- (a) At $25^\circ C$, the limiting molar conductance (Λ_m°) of NH_4Cl , $NaCl$ and $NaOH$ are 130, 109 and $217 S\ cm^2\ mol^{-1}$ respectively. Use Kohlrausch law of independent migration of ions to calculate the limiting molar conductivity (Λ_m°) of NH_4OH . 3
- Or
- (b) Given that the standard electrode potentials at $25^\circ C$ for I_2/I^- and Br_2/Br^- are 0.54 V and 1.09 V respectively. Calculate ΔG_{rxn}° for the following reaction under standard condition and predict whether it is spontaneous or not.
- $$I_2(s) + 2 Br^-(aq) \rightarrow Br_2(l) + 2 I^-(aq) \quad 3$$
29. Either
- (a) Discuss the synergic bonding between the ligand and the metal atom in the homoleptic metal carbonyls. 3
- Or
- (b) Explain with diagram the splitting of d-orbitals in an octahedral crystal field. 3
30. Outline a sequence of reactions to convert
- Either
- (a) Benzene to p-benzoquinone. 3
- Or
- (b) isopropylbenzene to anisole. 3

31. Write the mechanism of **any one** of the following reactions: 3
(a) Nucleophilic acyl substitution reaction of ethanoic acid with ethanol in the presence of concentrated sulphuric acid
(b) Nucleophilic addition-elimination reaction of propanone with hydroxylamine.

32. Either
(a) Illustrate with suitable examples how primary, secondary and tertiary amines can be distinguished by using p-toluenesulphonyl chloride. 3

- Or
- (b) Why do amines act as nucleophile? Write reaction in which CH_3NH_2 undergoes nucleophilic substitution at
(i) acyl carbon and (ii) saturated carbon. 3

33. Either
(a) Mention the three essential components of a nucleotide. 3
Or
(b) Classify carbohydrates based on their hydrolysis behaviour. 3

Question Nos. 34 -36 are Essay (E) types and each carries 5 marks.

34. Either
(a) A solution prepared by mixing 5.81 g acetone ($\text{C}_3\text{H}_6\text{O}$), and 11.9 g chloroform (CHCl_3) has a total vapour pressure of 260 mm Hg at 308 K. Show that the solution is not an ideal solution at this temperature? Give reason for its deviation from ideal behaviour.

(Given that the vapour pressures of pure acetone and pure chloroform at 308 K are 345 mm Hg and 293 mm Hg respectively).

- (b) For a saturated aqueous solution of glucose at 20°C , will the solubility increase, decrease, or remain unchanged when pressure is increased? Give reason 3+2=5

Or

- (c) Calculate the concentration of sodium chloride in water which is needed to produce an aqueous solution isotonic with blood (7.70 atm at 25°C).

(d) Oxygen gas obeys Henry's law in water but not in blood. Explain Why? 3+2=5

35.

Either

(a) Describe the preparation of potassium dichromate from iron chromite ore.

(b) Write two consequences of lanthanide contraction.

3+2=5

Or

(c) Write three characteristics of the transition elements that set them apart from the main-group elements?

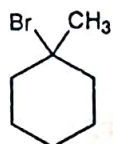
(d) Comment on the radioactivity and colour of the actinoids.

3+2=5

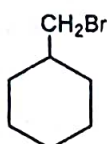
36.

Either

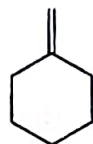
(a) Which one of the following alkyl halides (A) or (B), and what type of reagent should be used to prepare the alkene (C) in good yield by elimination of HBr? Give reason.



(A)



(B)



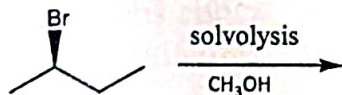
(C)

(b) An organic compound "A" on treatment with magnesium metal in dry ether gives methyl magnesium bromide which on exposure to atmospheric air liberates a gaseous product. Identify compound "A" and the gaseous product.

3+2=5

Or

(c) Predict the structures of substitution products with stereochemistry and identify the mechanism of the following reaction.



(d) Isobutane is subjected to monobromination gives a major product A. The major product (A) on heating with an equivalent amount of AgF gives compound B. Identify the compounds A and B.

3+2=5
