

General Instructions :

Read the following instructions carefully and follow them:

- (i) This question paper contains 33 questions. All questions are compulsory.
- (ii) This question paper is divided into five sections - Sections A, B, C, D and E.
- (iii) In **Section A** - Questions no. 1 to 16 are Multiple Choice type questions. Each question carries 1 mark.
- (iv) In **Section B** - Questions no. 17 to 21 are Very Short Answer type questions. Each question carries 2 marks.
- (v) In **Section C** - Questions no. 22 to 28 are Short Answer type questions. Each question carries 3 marks.
- (vi) In **Section D** - Questions no. 29 and 30 are case study-based questions. Each question carries 4 marks.
- (vii) In **Section E** - Questions no. 31 to 33 are Long Answer type questions. Each question carries 5 marks.
- (viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A
- (ix) Kindly note that there is a separate question paper for Visually Impaired candidates.
- (x) Use of calculators is not allowed.

You may use the following values of physical constants wherever necessary:

$$c = 3 \times 10^8 \text{ m/s}$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

$$\text{Mass of electron (m}_e\text{)} = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{Mass of neutron} = 1.675 \times 10^{-27} \text{ kg}$$

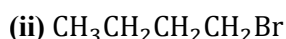
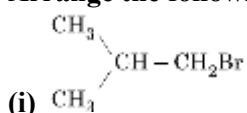
$$\text{Mass of proton} = 1.673 \times 10^{-27} \text{ kg}$$

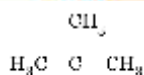
$$\text{Avogadro's number} = 6.023 \times 10^{23} \text{ per gram mole}$$

$$\text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

SECTION –A

1. In case of association, abnormal molar mass of solute will
 - (a) increase
 - (b) decrease
 - (c) remain same
 - (d) first increase and then decrease
2. Standard electrode potential for $\text{Sn}^{4+}/\text{Sn}^{2+}$ couple is +0.15 V and that for the Cr^{3+}/Cr couple is -0.74 V. The two couples in their standard states are connected to make a cell. The cell potential will be
 - (a) +1.19 V
 - (b) +0.89 V
 - (c) +0.18 V
 - (d) +1.83 V
3. The magnetic moment is associated with its spin angular momentum and orbital angular momentum. Spin only magnetic moment value of Cr^{3+} ion (Atomic no.: Cr = 24) is _____.
 - (a) 2.87 B.M.
 - (b) 3.87 B.M.
 - (c) 3.47 B.M.
 - (d) 3.57 B.M.
4. Acidified KMnO_4 oxidises sulphite to
 - (a) $\text{S}_2\text{O}_3^{2-}$
 - (b) $\text{S}_2\text{O}_8^{2-}$
 - (c) SO_2 (g)
 - (d) SO_4^{2-}
5. The correct IUPAC name of $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]^{2+}$ is
 - (a) Diamminedichloridoplatinum (II)
 - (b) Diamminedichloridoplatinum (IV)
 - (c) Diamminedichloridoplatinum (O)
 - (d) Diamminedichloridoplatinate (IV)
6. Arrange the following compounds in increasing order of their boiling points:





(iii) Br

The correct order is

(a)(ii) < (i) < (iii) (b)(i) < (ii) < (iii)

(c)(iii) < (i) < (ii) (d)(iii) < (ii) < (i)

7. Alkyl halides undergoing nucleophilic bimolecular substitution reaction involve

(a) retention of configuration

(b) formation of racemic mixture

(c) inversion of configuration

(d) formation of carbocation

8. Which is the correct order of acid strength from the following ?

(a) $\text{C}_6\text{H}_5\text{OH} > \text{H}_2\text{O} > \text{ROH}$ (b) $\text{C}_6\text{H}_5\text{OH} > \text{ROH} > \text{H}_2\text{O}$

(c) $\text{ROH} > \text{C}_6\text{H}_5\text{OH} > \text{H}_2\text{O}$ (d) $\text{H}_2\text{O} > \text{C}_6\text{H}_5\text{OH} > \text{ROH}$

9. The acid formed when propyl magnesium bromide is treated with CO_2 followed by acid hydrolysis is :

(a) $\text{C}_3\text{H}_7\text{COOH}$ (b) $\text{C}_2\text{H}_5\text{COOH}$

(c) CH_3COOH (d) $\text{C}_3\text{H}_7\text{OH}$

10. The best reagent for converting propanamide into propanamine is _____.

(a) excess H_2

(b) Br_2 in aqueous NaOH

(c) iodine in the presence of red phosphorus

(d) LiAlH_4 in ether

11. Which of the following statements is not true about glucose ?

(a) It is an aldohexose.

(b) On heating with HI it forms n-hexane.

(c) It exists in furanose form.

(d) It does not give Schiff's test.

12. An unripe mango placed in a concentrated salt solution to prepare pickle, shrivels because _____.

(a) it gains water due to osmosis

(b) it loses water due to reverse osmosis

(c) it gains water due to reverse osmosis

(d) it loses water due to osmosis

For questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below :

(a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).

(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).

(c) Assertion (A) is true, but Reason (R) is false.

(d) Assertion (A) is false, but Reason (R) is true.

13. Assertion (A): $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_2$ and $[\text{Fe}(\text{H}_2\text{O})_6]\text{Cl}_2$ are examples of homoleptic complexes.

Reason (R): All the ligands attached to the metal are the same.

14. Assertion (A): The boiling points of alkyl halides decrease in the order : $\text{RI} > \text{RBr} > \text{RCl} > \text{RF}$.

Reason (R): The boiling points of alkyl chlorides, bromides and iodides are considerably higher than that of the hydrocarbon of comparable molecular mass.

15. Assertion (A): The boiling point of ethanol is higher than that of methoxymethane.

Reason (R): There is intramolecular hydrogen bonding in ethanol.

16. Assertion (A): All naturally occurring α -amino acids except glycine are optically active.

Reason (R): Most naturally occurring amino acids have L-configuration.

SECTION –A

17. (a) Give reasons:

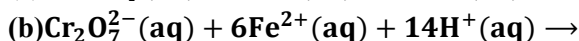
(a) Cooking is faster in pressure cooker than in an open pan.

(b) On mixing liquid X and liquid Y, volume of the resulting solution decreases. What type of deviation from Raoult's law is shown by the resulting solution? What change in temperature would you observe after mixing liquids X and Y?

OR

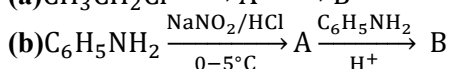
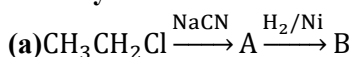
(b) Define Azeotrope. What type of Azeotrope is formed by negative deviation from Raoult's law? Give an example.

18. Complete and balance the following chemical equations:

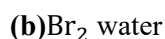


19. Would you expect benzaldehyde to be more reactive or less reactive in nucleophilic addition reactions than propanal? Justify your answer.

20. Identify A and B in each of the following reaction sequence:



21. Write the reactions involved when D-glucose is treated with the following reagents :



SECTION - C

22. A solution of glucose (molar mass = 180 g mol^{-1}) in water has a boiling point of 100.20°C . Calculate the freezing point of the same solution. Molal constants for water K_f and K_b are $1.86 \text{ K kg mol}^{-1}$ and $0.512 \text{ K kg mol}^{-1}$ respectively.

23. (a) State the following :

(i) Kohlrausch law of independent migration of ions and

(ii) Faraday's first law of electrolysis.

(b) Using E°_{values} of X and Y given below, predict which is better for coating the surface of iron to prevent corrosion and why?

Given $E^\circ_{\text{X}^{2+}/\text{X}} = -2.36 \text{ V}$,

$E^\circ_{\text{Y}^{2+}/\text{Y}} = -0.14 \text{ V}$,

$E^\circ_{\text{Fe}^{2+}/\text{Fe}} = -0.44 \text{ V}$

24. A certain reaction is 50% complete in 20 minutes at 300 K and the same reaction is 50% complete in 5 minutes at 350 K. Calculate the activation energy if it is a first order reaction.

$[R = 8.314 \text{ J K}^{-1} \text{ mol}^{-1}; \log 4 = 0.602]$

25. The elements of 3d transition series are given as:

Sc, Ti, V, Cr, Mn, Fe, Co, Ni, Cu, Zn

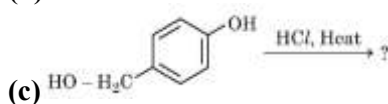
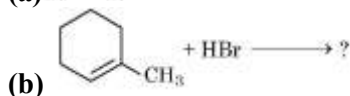
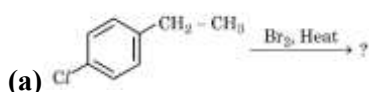
Answer the following :

(a) Copper has exceptionally positive $E^\circ_{\text{M}^{2+}/\text{M}}$ value, why?

(b) Which element is a strong reducing agent in +2 oxidation state and why?

(c) Zn^{2+} salts are colourless. Why?

26. (a) Draw the structure of the major monohalo product for each of the following reaction:



OR

(b) How do you convert:

- (a) Chlorobenzene to biphenyl
(b) Propene to 1-Iodopropane
(c) 2-bromobutane to but-2-ene.

27. (a) Arrange the following compounds in increasing order of their boiling point:
(CH₃)₂NH, CH₃CH₂NH₂, CH₃CH₂OH.
(b) Give plausible explanation for each of the following:
(i) Aromatic primary amines cannot be prepared by Gabriel Phthalimide synthesis.
(ii) Amides are less basic than amines.
28. (a) What is the difference between native protein and denatured protein?
(b) Which one of the following is a disaccharide ?
Glucose, Lactose, Amylose, Fructose
(c) Which vitamin is responsible for the coagulation of blood?

SECTION-D

The following questions are case based questions. Read the passage carefully and answer the questions that follow.

29. The rate of a chemical reaction is expressed either in terms of decrease in the concentration of reactants or increase in the concentration of a product per unit time. Rate of the reaction depends upon the nature of reactants, concentration of reactants, temperature, presence of catalyst, surface area of the reactants and presence of light. Rate of reaction is directly related to the concentration of reactant. Rate law states that the rate of reaction depends upon the concentration terms on which the rate of reaction actually depends, as observed experimentally. The sum of powers of the concentration of the reactants in the Rate law expression is called order of reaction while the number of reacting species taking part in an elementary reaction which must collide simultaneously in order to bring about a chemical reaction is called molecularity of the reaction.

Answer the following questions:

- (a)(i) What is a rate determining step?
(ii) Define complex reaction.
(b) What is the effect of temperature on the rate constant of a reaction?

OR

- (b) Why is molecularity applicable only for elementary reactions whereas order is applicable for elementary as well as complex reactions?
(c) The conversion of molecule X to Y follows second order kinetics. If concentration of X is increased 3 times, how will it affect the rate of formation of Y?

30. Phenols undergo electrophilic substitution reactions readily due to the strong activating effect of OH group attached to the benzene ring. Since, the OH group increases the electron density more to o – and p – positions therefore OH group is ortho, para-directing. Reimer-Tiemann reaction is one of the examples of aldehyde group being introduced on the aromatic ring of phenol, ortho to the hydroxyl group. This is a general method used for the ortho-formylation of phenols.

Answer the following questions:

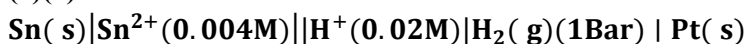
- (a) What happens when phenol reacts with
(i) Br₂/CS₂
(ii) Conc. HNO₃
(b) Why phenol does not undergo protonation readily?
(c) Which is a stronger acid - phenol or cresol ? Give reason.

OR

- (c) Write the IUPAC name of the product formed in the Reimer-Tiemann reaction.

SECTION-E

31. (a)(a) Write the cell reaction and calculate the e.m.f. of the following cell at 298 K:



(Given : E°_{Sn²⁺/Sn} = -0.14 V, E°_{H⁺|H₂(g),Pt} = 0.00 V)

- (b) Account for the following;
(i) On the basis of E° values, O₂ gas should be liberated at anode but it is Cl₂ gas which is liberated in the

electrolysis of aqueous NaCl .

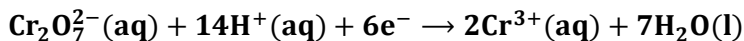
(ii) Conductivity of CH_3COOH decreases on dilution.

OR

(b) (a) Write the anode and cathode reactions and the overall cell reaction occurring in a lead storage battery during its use. (2 + 3 =

(b) Calculate the potential for half-cell containing 0.01 M $\text{K}_2\text{Cr}_2\text{O}_7(\text{aq})$, 0.01M $\text{Cr}^{3+}(\text{aq})$ and $1.0 \times 10^{-4}\text{M}\text{H}^+(\text{aq})$.

The half cell reaction is



and the standard electrode potential is given as $E^\circ = 1.33 \text{ V}$.

[Given: $\log 10 = 1$]

32. (a) Answer the following:

(a) Low spin tetrahedral complexes are not known.

(b) Co^{2+} is easily oxidised to Co^{3+} in the presence of a strong ligand [At. No. of Co = 27]

(c) What type of isomerism is shown by the complex $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$?

(d) Why a solution of $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is green while a solution of $[\text{Ni}(\text{CN})_4]^{2-}$ is colourless. (At. No. of Ni = 28)

(e) Write the IUPAC name of the following complex : $[\text{Co}(\text{NH}_3)_5(\text{CO}_3)]\text{Cl}$

OR

(b) (a) What is meant by 'Chelate effect'? Give an example. (2 + 2 + 1 =

(b) Write the hybridization and magnetic behaviour of $[\text{Fe}(\text{CN})_6]^{4-}$. (Atomic number: Fe = 26)

(c) If $\text{PtCl}_2 \cdot 2\text{NH}_3$ does not react with AgNO_3 , what will be its formula?

33. (a) (a) Carry out the following conversions:

(2 + 3 =

(i) Ethanal to But-2-enal

(ii) Propanoic acid to ethane

(b) An alkene A with molecular formula C_5H_{10} on ozonolysis gives a mixture of two compounds B and C. Compound B gives positive Fehling test and also reacts with iodine and NaOH solution. Compound C does not give Fehling solution test but forms iodoform. Identify the compounds A, B and C.

OR

(b) An organic compound (a) (molecular formula $\text{C}_8\text{H}_{16}\text{O}_2$) was hydrolysed with dilute sulphuric acid to get a carboxylic acid (b) and an alcohol (C). Oxidation of (c) with chromic acid produced (B). (c) on dehydration gives But-1-ene. Identify (A), (b) and (c) and write chemical equations for the reactions involved.

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 Mass of neutron = 1.675×10^{-27} kg
 Mass of proton = 1.673×10^{-27} kg
 Avogadro's number = 6.023×10^{23} per gram mole
 Boltzmann constant = 1.38×10^{-23} J K⁻¹

SECTION-A

34. The charge required for the reduction of 1 mol of MnO_4^- to MnO_2 is

- (a) 1 F (b) 3 F
(c) 5 F (d) 6 F

35. Which among the following is a false statement ?

- (a) Rate of zero order reaction is independent of initial concentration of reactant.
 (b) Half-life of a zero order reaction is inversely proportional to the rate constant.
 (c) Molecularity of a reaction may be zero.
 (d) For a first order reaction, $t_{1/2} = 0.693/k$.

36. The number of molecules that react with each other in an elementary reaction is a measure of the:

- (a) activation energy of the reaction
 (b) stoichiometry of the reaction
 (c) molecularity of the reaction
 (d) order of the reaction

37. The element having [Ar]3d¹⁰4s¹ electronic configuration is

- (a) Cu (b) Zn
(c) Cr (d) Mn

38. The complex ions $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]^{2+}$ and $[\text{Co}(\text{NH}_3)_5(\text{ONO})]^{2+}$ are called

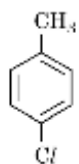
- (a) Ionization isomers
 (b) Linkage isomers
 (c) Co-ordination isomers
 (d) Geometrical isomers

39. The diamagnetic species is :

- (a) $[\text{Ni}(\text{CN})_4]^{2-}$ (b) $[\text{NiCl}_4]^{2-}$
 (c) $[\text{Fe}(\text{CN})_6]^{3-}$ (d) $[\text{CoF}_6]^{3-}$

[At. No. Co = 27, Fe = 26, Ni = 28]

40. Which is the correct IUPAC name for



- (a) Methylchlorobenzene
 (b) Toluene
 (c) 1-Chloro-4-Methylbenzene
 (d) 1-Methyl-4-Chlorobenzene

41. What will be formed after oxidation reaction of secondary alcohol with chromic anhydride (CrO_3) ?

- (a) Aldehyde (b) Ketone
 (c) Carboxylic acid (d) Ester

42. The conversion of phenol to salicylic acid can be accomplished by

- (a) Reimer-Tiemann reaction
 (b) Friedel-Crafts reaction
 (c) Kolbe reaction
 (d) Coupling reaction

43. Which of the following is/are examples of denaturation of protein?

- (a) Coagulation of egg white
- (b) Curdling of milk
- (c) Clotting of blood
- (d) Both (a) and (b)

44. Nucleotides are joined together by

- (a) Glycosidic linkage
- (b) Peptide linkage
- (c) Hydrogen bonding
- (d) Phosphodiester linkage

45. Scurvy is caused due to deficiency of

- (a) Vitamin B1 (b) Vitamin B2
- (c) Ascorbic acid (d) Glutamic acid

For question number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (c) and (d) as given below :

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- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Assertion (A) is false, but Reason (R) is true.

46. **Assertion (A):** In a first order reaction, if the concentration of the reactant is doubled, its half-life is also doubled.

Reason (R): The half-life of a reaction does not depend upon the initial concentration of the reactant in a first order reaction.

47. **Assertion (A):** Cu cannot liberate H₂ on reaction with dilute mineral acids.

Reason (R): Cu has positive electrode potential.

48. **Assertion (A):** Aromatic primary amines cannot be prepared by Gabriel Phthalimide synthesis.

Reason (R): Aryl halides do not undergo nucleophilic substitution reaction with the anion formed by phthalimide.

49. **Assertion (A):** Vitamin D cannot be stored in our body.

Reason (R): Vitamin D is fat soluble vitamin and is not excreted from the body in urine.

SECTION - B

50. (a) The rate constant for a zero order reaction $A \rightarrow P$ is $0.0030 \text{ mol L}^{-1} \text{ s}^{-1}$. How long will it take for the initial concentration of A to fall from 0.10 M to 0.075 M?

OR

(b) The decomposition of NH₃ on platinum surface is zero order reaction. What are the rates of production of N₂ and H₂ if $k = 2.5 \times 10^{-4} \text{ mol L}^{-1} \text{ s}^{-1}$?

51. Define the following terms:

- (a) Pseudo first order reaction
- (b) Half-life period of reaction ($t_{1/2}$)

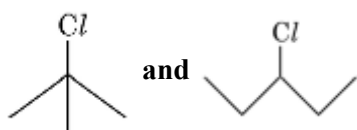
52. Examine the following observations:

- (a) Transition elements generally form coloured compounds.
- (b) Zinc is not regarded as a transition element.

53. Name the following coordination compounds according to IUPAC norms :

- (a) $[\text{Co}(\text{NH}_3)_4(\text{H}_2\text{O})\text{Cl}]\text{Cl}_2$
- (b) $[\text{CrCl}_2(\text{en})_2]\text{Cl}$

54. (a) In the following pair of halogen compounds, which compound undergoes S_N1 reaction faster and why?



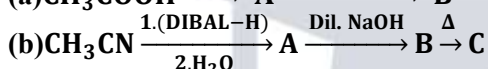
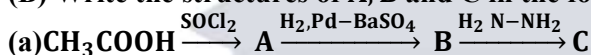
(b) Arrange the following compounds in increasing order of their reactivity towards S_N2 displacement: 2-Bromo-2-methylbutane, 1-Bromopentane, 2-Bromopentane.

SECTION - C

55. At 25°C the saturated vapour pressure of water is 24 mm Hg . Find the saturated vapour pressure of a 5% aqueous solution of urea at the same temperature. (Molar mass of urea = 60 g mol⁻¹)
56. The electrical resistance of a column of 0.05 M NaOH solution of area 0.8 cm² and length 40 cm is 5 × 10³ ohm. Calculate its resistivity, conductivity and molar conductivity.
57. Complete and balance the following chemical equations :
- $\text{MnO}_4^- + \text{C}_2\text{O}_4^{2-} + \text{H}^+ \rightarrow$
 - $\text{KMnO}_4 \xrightarrow[513\text{ K}]{\text{Heat}}$
 - $\text{Cr}_2\text{O}_7^{2-} + \text{H}_2\text{S} + \text{H}^+ \rightarrow$
58. Using valence bond theory, explain the hybridization and magnetic character of the following:
- $[\text{Co}(\text{NH}_3)_6]^{3+}$
 - $[\text{Ni}(\text{CO})_4]$
- [At. no. : Co = 27, Ni = 28]
59. (a) Define the following:
- Enantiomers
 - Racemic mixture
- (b) Why is chlorobenzene resistant to nucleophilic substitution reaction?
60. (A) Explain the following reactions and write chemical equation involved:
- Wolff-Kishner reduction
 - Etard reaction
 - Cannizzaro reaction

OR

(B) Write the structures of A, B and C in the following sequence of reactions:



61. Define the following terms:

- Glycosidic linkage
- Invert sugar
- Oligosaccharides

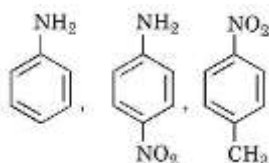
SECTION - D

62. The spontaneous flow of the solvent through a semipermeable membrane from a pure solvent to a solution or from a dilute solution to a concentrated solution is called osmosis. The phenomenon of osmosis can be demonstrated by taking two eggs of the same size. In an egg, the membrane below the shell and around the egg material is semipermeable. The outer hard shell can be removed by putting the egg in dilute hydrochloric acid. After removing the hard shell, one egg is placed in distilled water and the other in a saturated salt solution. After some time, the egg placed in distilled water swells-up while the egg placed in salt solution shrinks. The external pressure applied to stop the osmosis is termed as osmotic pressure (a colligative property). Reverse osmosis takes place when the applied external pressure becomes larger than the osmotic pressure.
- Define reverse osmosis. Name one SPM which can be used in the process of reverse osmosis.
 - (i) What do you expect to happen when red blood corpuscles (RBC's) are placed in 0.5% NaCl solution?
- OR
- (ii) Which one of the following will have higher osmotic pressure in 1 M KCl or 1 M urea solution. Justify your answer.
 - Why osmotic pressure is a colligative property?
63. Amines have a lone pair of electrons on nitrogen atom due to which they behave as Lewis base. Greater the value of K_b or smaller the value of $\text{p}K_b$, stronger is the base. Amines are more basic than alcohols, ethers, esters, etc. The basic character of aliphatic amines should increase with the increase of alkyl substitution. But it does not occur in a regular manner as a secondary aliphatic amine is unexpectedly more basic than a tertiary amine in aqueous solutions. Aromatic amines are weaker bases than ammonia and aliphatic amines. Electron releasing groups such as $-\text{CH}_3$, $-\text{OCH}_3$, $-\text{NH}_2$, etc., increase the basicity while electron-

withdrawing substituents such as $-\text{NO}_2$, $-\text{CN}$, halogens etc., decrease the basicity of amines. The effect of these substitute is more at p^- than at m^- position.

(a) Arrange the following in the increasing order of their basic character.

Give reason:



(b) Why pK_b of aniline is more than that of methylamine?

(c) (i) Arrange the following in the increasing order of their basic character in an aqueous solution:

$(\text{CH}_3)_3\text{N}$, $(\text{CH}_3)_2\text{NH}$, NH_3 , CH_3NH_2

OR

(c) (ii) Why ammonolysis of alkyl halides is not a good method to prepare pure amines?

SECTION-E

64. (a)(a) Give IUPAC name of $\text{CH}_3 - \text{CH} = \text{CH} - \text{CHO}$.

(b) Give a simple chemical test to distinguish between propanal and propanone.

(c) How will you convert the following:

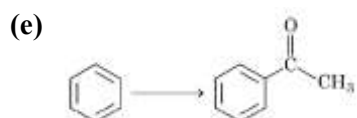
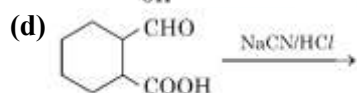
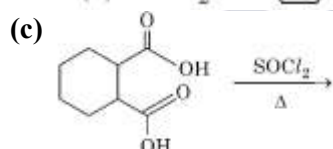
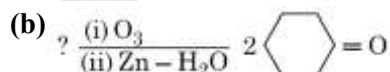
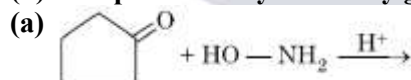
(i) Toluene to benzoic acid

(ii) Ethanol to propan-2-ol

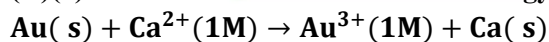
(iii) Propanal to 2-hydroxy propanoic acid

OR

(b) Complete each synthesis by giving missing starting material, reagent or products :



65. (A)(a) Calculate the standard Gibbs energy ($\Delta_r G^\circ$) of the following reaction at 25°C :



$$E_{\text{Au}^{3+}/\text{Au}}^\circ = +1.5\text{ V}, E_{\text{Ca}^{2+}/\text{Ca}}^\circ = -2.87\text{ V}$$

Predict whether the reaction will be spontaneous or not at 25°C .

$$[1\text{ F} = 96500\text{ C mol}^{-1}]$$

(b) Tarnished silver contains Ag_2S . Can this tarnish be removed by placing tarnished silverware in an aluminium pan containing an inert electrolytic solution such as NaCl ? The standard electrode potential for half reaction : $\text{Ag}_2\text{S(s)} + 2\text{e}^- \rightarrow 2\text{Ag(s)} + \text{S}^{2-}$ is -0.71 V and for $\text{Al}^{3+} + 3\text{e}^- \rightarrow 2\text{Al(s)}$ is -1.66 V

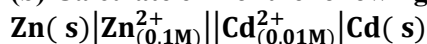
OR

(B)(a) Define the following:

(i) Cell potential

(ii) Fuel cell

(b) Calculate emf of the following cell at 25°C :



Given: $E_{\text{Cd}^{2+}/\text{Cd}}^{\circ} = -0.40 \text{ V}$

$E_{\text{Zn}^{2+}/\text{Zn}}^{\circ} = -0.76 \text{ V}$

$[\log 10 = 1]$

66. (A) An organic compound 'A', molecular formula $\text{C}_2\text{H}_6\text{O}$ oxidises with CrO_3 to form a compound 'B'. Compound 'B' on warming with iodine and aqueous solution of NaOH gives a yellow precipitate of compound 'C'. When compound 'A' is heated with conc. H_2SO_4 at 413 K gives a compound 'D', which on reaction with excess HI gives compound 'E'. Identify compounds 'A', 'B', 'C', 'D' and 'E' and write chemical equations involved.

OR

(B) (a) Write chemical equations of the following reactions:

(i) Phenol is treated with conc. HNO_3

(ii) Propene is treated with B_2H_6 followed by oxidation by $\text{H}_2\text{O}_2/\text{OH}^-$.

(iii) Sodium t-butoxide is treated with CH_3Cl .

(b) Give a simple chemical test to distinguish between butan-1-ol and butan-2-ol.

(c) Arrange the following in increasing order of acid strength : phenol, ethanol, water

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Read the following instructions carefully and follow them:

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(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A

(ix) Kindly note that there is a separate question paper for Visually Impaired candidates.

(x) Use of calculators is not allowed.

You may use the following values of physical constants wherever necessary:

$$c = 3 \times 10^8 \text{ m/s}$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

$$\text{Mass of electron (} m_e \text{)} = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{Mass of neutron} = 1.675 \times 10^{-27} \text{ kg}$$

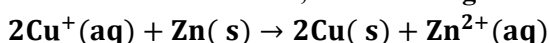
$$\text{Mass of proton} = 1.673 \times 10^{-27} \text{ kg}$$

$$\text{Avogadro's number} = 6.023 \times 10^{23} \text{ per gram mole}$$

$$\text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

SECTION-A

67. In an electrochemical cell, the following reaction takes place:



$$E_{\text{cell}}^{\circ} = 1.28 \text{ V}$$

As the reaction progresses, what will happen to the overall voltage of the cell ?

- (a) Voltage will remain constant.
 (b) It will decrease as $[\text{Zn}^{2+}]$ increases.
 (c) It will increase as $[\text{Cu}^+]$ increases.
 (d) It will increase as $[\text{Zn}^{2+}]$ increases.

68. Out of Fe^{3+} , Sc^{3+} , Cr^{3+} and Co^{3+} ions, the one which is colourless in aqueous solution is:

- (a) Sc^{3+} (b) Fe^{3+}

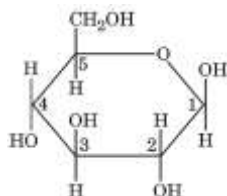
- (c) Cr^{3+} (d) Co^{3+}

[Atomic number : Fe = 26, Sc = 21, Cr = 24, Co = 27]

69. Hoffmann Bromamide degradation reaction is given by :

- (a) ArNO_2 (b) ArNH_2
(c) ArCONH_2 (d) ArCH_2NH_2

70. In the Haworth structure of the following carbohydrate, various carbon atoms have been numbered. The anomeric carbon is numbered as:



- (a) 1 (b) 2
(c) 3 (d) 5

71. The value of Henry's constant K_H is:

- (a) greater for gases with higher solubility
(b) greater for gases with lower solubility
(c) constant for all gases
(d) not related to the solubility of gases

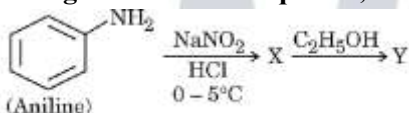
72. Out of the following statements, the incorrect statement is :

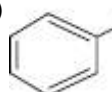
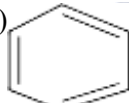
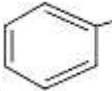
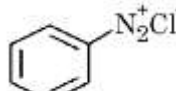
- (a) La is actually an element of transition series.
(b) Zr and Hf have almost identical atomic radii because of lanthanoid contraction.
(c) Ionic radius decreases from La^{3+} to Lu^{3+} ion.
(d) Lanthanoids are radioactive in nature.

73. Out of 2-Bromobutane, 1-Bromobutane, 2-Bromopropane and 1-Bromopropane, the molecule which is chiral in nature is:

- (a) 2-Bromobutane (b) 1-Bromobutane
(c) 2-Bromopropane (d) 1-Bromopropane

74. In the given reaction sequence, the structure of Y would be:



- (a)  (b) 
(c)  (d) 

75. The product of the oxidation of I^- with MnO_4^- in alkaline medium is :

- (a) IO_4^- (b) I_2
(c) IO^- (d) IO_3^-

76. Polyhalogen compounds have wide application in industries and agriculture. DDT is also a very important polyhalogen compound. It is a:

- (a) greenhouse gas
(b) fertilizer
(c) biodegradable insecticide
(d) non-biodegradable insecticide

77. What amount of electric charge is required for the reduction of 1 mole of MnO_4^- into Mn^{2+} ?

- (a) 1 F (b) 5 F
(c) 4 F (d) 6 F

78. Alkenes are formed by heating alcohols with conc. H_2SO_4 . The first step in the reaction is:

- (a) formation of carbocation
(b) formation of ester
(c) protonation of alcohol molecule
(d) elimination of water

For Questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

79. Assertion (A): Electrolysis of aqueous NaCl gives H_2 at cathode and Cl_2 at anode.

Reason (R): Chlorine has higher oxidation potential than H_2O .

80. Assertion (A): Cuprous salts are diamagnetic.

Reason (R): Cuprous ion has completely filled 3d-orbitals.

81. Assertion (A): n-Butyl chloride has higher boiling point than n-Butyl bromide.

Reason (R): C – Cl bond is more polar than C – Br bond.

82. Assertion (A): Acetanilide is less basic than aniline.

Reason (R): Acetylation of aniline results in decrease of electron density on nitrogen.

SECTION B

83. (a) Reactant 'A' underwent a decomposition reaction. The concentration of 'A' was measured periodically and recorded in the table given below:

Time / Hours	[A]/M
0	0.40
1	0.20
2	0.10
3	0.05

Based on the above data, predict the order of the reaction and write the expression for the rate law.

OR

(b) The reaction between H_2 (g) and I_2 (g) was carried out in a sealed isothermal container. The rate law for the reaction was found to be:

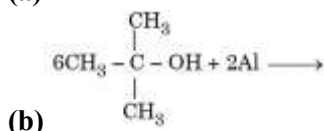
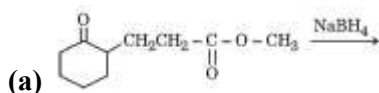
$$\text{Rate} = k[\text{H}_2][\text{I}_2]$$

If 1 mole of H_2 (g) was added to the reaction chamber and the temperature was kept constant, then predict the change in rate of the reaction and the rate constant.

84. $\text{PtCl}_4 \cdot 2\text{KCl}$ doesn't give precipitate of AgCl with AgNO_3 solution. Write the structural formula and IUPAC name of the complex.

85. Define fuel cell. Give two advantages of fuel cell over ordinary cell.

86. Write the structures of the main products of the following reactions:



87. What is meant by essential amino acids ? Why are amino acids amphoteric in nature?

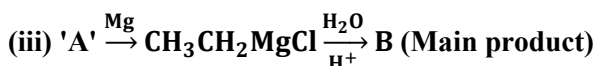
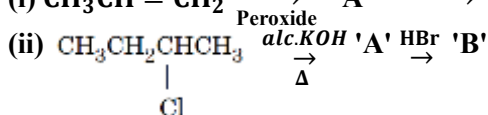
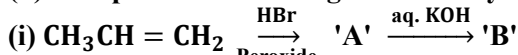
SECTION C

88. (a) Account for the following:

- Allyl chloride is hydrolysed more readily than n-propyl chloride.
- Isocyanides are formed when alkyl halides are treated with silver cyanide.
- Methyl chloride reacts faster with OH^- ion in $\text{S}_\text{N}2$ reaction than t-butyl chloride.

OR

(b) Complete the following reactions by writing the structural formulae of 'A' and 'B' :



89. Calculate the cell voltage of the voltaic cell which is set up by joining following half-cells at 25°C :

Al/Al³⁺ (0.001M) and Ni/Ni²⁺ (0.1M)

Given : $E^\circ_{\text{Ni}^{2+}/\text{Ni}} = -0.25 \text{ V}$, $E^\circ_{\text{Al}^{3+}/\text{Al}} = -1.66 \text{ V}$

90. Give explanation for each of the following observations:

- With the same d-orbital configuration (d^4), Mn³⁺ ion is an oxidising agent whereas Cr²⁺ ion is a reducing agent.
- Actinoid contraction is greater from element to element than that among lanthanoids.
- Transition metals form large number of interstitial compounds with H, B, C and N.

91. An aqueous solution of NaOH was made and its molar mass from the measurement of osmotic pressure at 27°C was found to be 25 g mol⁻¹. Calculate the percentage dissociation of NaOH in this solution.

[Atomic mass: Na = 23u, O = 16u, H = 1u]

92. Arrange the following compounds as asked:

- in decreasing order of pK_b values
 $\text{C}_2\text{H}_5\text{NH}_2$, $(\text{C}_2\text{H}_5)_2\text{NH}$, $\text{C}_6\text{H}_5\text{NHCH}_3$, $\text{C}_6\text{H}_5\text{NH}_2$
- increasing order of boiling point
 $\text{C}_2\text{H}_5\text{OH}$, $\text{C}_2\text{H}_5\text{NH}_2$, $(\text{CH}_3)_2\text{NH}$
- increasing order of solubility in water
 $\text{C}_6\text{H}_5\text{NH}_2$, $(\text{C}_2\text{H}_5)_2\text{NH}$, $\text{C}_2\text{H}_5\text{NH}_2$

93. An aromatic compound 'A' with molecular formula $\text{C}_8\text{H}_8\text{O}$ gives positive 2,4-DNP test. It gives yellow precipitate. of compound 'B' on treatment with sodium hypoiodite. Compound 'A' does not react with Tollen's or Fehling's reagent; on drastic oxidation with KMnO_4 it forms a carboxylic acid 'C'. Elucidate the structures of A, B and C. Also give their IUPAC names.

94. (a) Can sodium ethoxide and t-butyl chloride be used for the preparation of t-butyl ethyl ether? Give suitable explanation. Justify your answer by suggesting the appropriate starting material required for preparation of t-butyl ethyl ether.

(b) Give the IUPAC name of above mentioned ether.

SECTION D

The following questions are case-based questions. Read the case carefully and answer the questions that follow.

95. According to the generally accepted definition of the ideal solution there are equal interaction forces acting between molecules belonging to the same or different species. (This is equivalent to the statement that the activity of the components equals the concentration.) Strictly speaking, this condition is fulfilled only in exceptional cases for mixtures (optical isomers, isotopic mixtures of an element, hydrocarbon mixtures). It is still usual to talk about ideal solutions as limiting cases in reality since very dilute solutions behave ideally with respect to the solvent. This view is further supported by the fact that Raoult's law empirically found

for describing the behaviour of the solvent in dilute solutions can be deduced thermodynamically via the assumption of ideal behaviour of the solvent.

Answer the following questions:

(a) Give one example of miscible liquid pair which shows negative deviation from Raoult's law. What is the reason for such deviation?

(b)(i) State Raoult's law for a solution containing volatile components.

OR

(b)(ii) Raoult's law is a special case of Henry's law. Comment.

(c) Write two characteristics of an ideal solution.

96. Ribose and 2-deoxyribose have an important role in biology. Among the most important derivatives are those with phosphate groups attached at the 5 position. Mono-, di- and tri-phosphate forms are important, as well as 3-5 cyclic monophosphates. Purines and pyrimidines form an important class of compounds with ribose and deoxyribose. When these purine and pyrimidine derivatives are coupled to a ribose sugar, they are called nucleosides.

Answer the following questions:

(a) What products would be formed when DNA is hydrolysed? How is DNA different from RNA with reference to a structure?

(b) Differentiate between nucleotide and nucleoside.

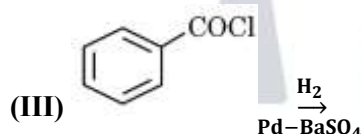
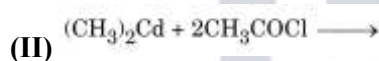
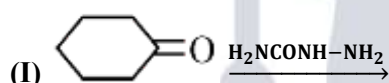
(c)(i) Mention two important functions of nucleic acid.

OR

(c)(ii) Name the linkage which joins two nucleotides. Name the base that is found in nucleotide of RNA but not in DNA.

SECTION E

97. (a)(i) Complete the following reactions by writing the structure of the main products :



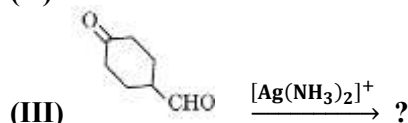
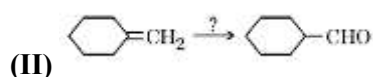
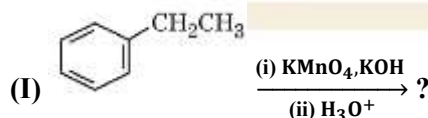
(ii) Give simple chemical test to distinguish between the following pairs of compounds:

(I) Ethyl benzoate and benzoic acid

(II) Propanal and propanone

OR

(b) (i) Complete each synthesis by giving missing starting material, reagent or products :



(ii) Carry out the following conversions:

(I) Benzaldehyde to Benzophenone

(II) Benzaldehyde to 3-phenyl propanol

98. (a) (i) Give reasons:

(I) $[\text{Ni}(\text{CO})_4]$ is diamagnetic whereas $[\text{NiCl}_4]^{2-}$ is paramagnetic. [Atomic number : Ni = 28]

(II) CO is a stronger complexing agent than NH_3 .

(III) The trans isomer of complex $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ is optically inactive.

(ii) Using Crystal Field theory, write the number of unpaired electrons in octahedral complexes of Fe^{3+} in the presence of :

(I) Strong field ligand

(II) Weak field ligand

[Atomic number : Fe = 26]

OR

(b) (i) Name the type of isomerism exhibited by the following compounds. Also draw their corresponding isomers.

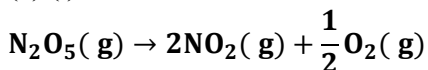
(I) $[\text{Co}(\text{NH}_3)_6][\text{Cr}(\text{CN})_6]$

(II) $[\text{Co}(\text{en})_3]^{3+}$

(III) $[\text{Co}(\text{NH}_3)_3(\text{NO}_2)_3]$

(ii) Differentiate between weak field and strong field ligands. How does the strength of the ligand influence the spin of the complex?

99. (a) (i) The initial concentration of N_2O_5 in the first order reaction:



was $1.2 \times 10^{-2} \text{ mol L}^{-1}$. The concentration of N_2O_5 after 60 minutes was $0.2 \times 10^{-2} \text{ mol L}^{-1}$. Calculate the rate constant of the reaction at 318 K.

[log 6 = 0.778]

(ii) Account for the following:

(I) We cannot determine the order of a reaction by taking into consideration the balanced chemical equation.

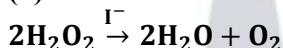
(II) A bimolecular reaction may become kinetically of first order under a specified condition.

OR

(b) (i) The rate of the chemical reaction doubles for an increase of 10 K in absolute temperature from 298 K. Calculate activation energy (E_a).

$[2 \cdot 303R = 19 \cdot 15 \text{ JK}^{-1} \text{ mol}^{-1}, \log 2 = 0.3]$

(ii) For a reaction:



the proposed mechanism is as given below :

(I) $\text{H}_2\text{O}_2 + \text{I}^- \rightarrow \text{H}_2\text{O} + \text{IO}^-$ (slow)

(II) $\text{H}_2\text{O}_2 + \text{IO}^- \rightarrow \text{H}_2\text{O} + \text{I}^- + \text{O}_2$ (fast)

(1) Write rate law for the reaction.

(2) Write the overall order and molecularity of the reaction.

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(vii) In **Section E** - Questions no. 31 to 33 are Long Answer type questions. Each question carries 5 marks.

(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A

(ix) Kindly note that there is a separate question paper for Visually Impaired candidates.

(x) Use of calculators is not allowed.

You may use the following values of physical constants wherever necessary:

$$c = 3 \times 10^8 \text{ m/s}$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

$$\text{Mass of electron (} m_e \text{)} = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{Mass of neutron} = 1.675 \times 10^{-27} \text{ kg}$$

$$\text{Mass of proton} = 1.673 \times 10^{-27} \text{ kg}$$

$$\text{Avogadro's number} = 6.023 \times 10^{23} \text{ per gram mole}$$

$$\text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

SECTION-A

100. The role of a catalyst is to change:

- (a) equilibrium constant
- (b) enthalpy of reaction
- (c) Gibbs energy of reaction
- (d) activation energy of reaction

101. Which of the following molecules is chiral in nature ?

- (a) 1-chloropropane (b) 2-chloropropane
- (c) 1-chlorobutane (d) 2-chlorobutane

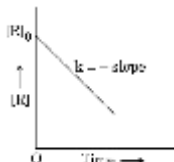
102. $\text{CH}_3\text{CH}_2\text{OH}$ can be converted to CH_3CHO by :

- (a) catalytic hydrogenation
- (b) treatment with LiAlH_4
- (c) treatment with PCC
- (d) treatment with KMnO_4

103. The IUPAC name for $\text{CH}_3 - \text{CH}_2 - \text{N}(\text{CH}_3) - \text{CH}_2 - \text{CH}_2 - \text{CH}_3$ is :

- (a) N-methylpentan-2-amine
- (b) N-ethyl-N-methylpropan-1-amine
- (c) N,N-diethylpropan-1-amine
- (d) N,N-dimethylpropan-1-amine

104. A plot between concentration of reactant $[R]$ and time 't' is shown below. Which of the given order of reaction is indicated by the graph ?



- (a) Third order (b) Second order
- (c) First order (d) Zero order

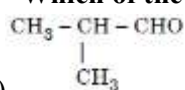
105. The treatment of ethyl bromide with alcoholic silver nitrite gives:

- (a) ethyl nitrite (b) nitroethane
- (c) nitromethane (d) ethene

106. Which of the following aqueous solutions will have the highest freezing point?

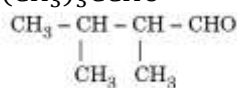
- (a) 1.0 M KCl (b) 1.0 M Na_2SO_4
- (c) 1.0 M Glucose (d) 1.0 M AlCl_3

107. Which of the following aldehydes will undergo Cannizzaro reaction?



(a)

(b) $(\text{CH}_3)_3\text{CCHO}$



(c) $\text{CH}_3 - \text{CH}_2 - \text{CHO}$

(d)

108. In which of the following groups are both ions coloured in aqueous solution?

I. Cu^+

II. Ti^{4+}

III. Co^{2+}

IV. Fe^{2+}

[Atomic number: Cu = 29, Ti = 22, Co = 27, Fe = 26]

- (a) I and II (b) II and III
(c) III and IV (d) I and IV

109. $\text{CH}_3\text{CH}_2\text{CHO}$ and $\text{CH}_3\text{CH}_2\text{COOH}$ can be distinguished by :

- (a) Sodium bicarbonate test
(b) Hinsberg test
(c) Iodoform test
(d) Lucas test

110. Match the type of cell given in Column I with their use given in Column II.

Column I	Column II
(I) Lead storage cell	(A) Wall clock
(II) Mercury cell	(B) Apollo Space Programme
(III) Dry cell	(C) Wrist watch
(IV) Fuel cell	(D) Inverter

- (a) I-A, II-B, III-C, IV-D (b) I-D, II-C, III-A, IV-B
(c) I-C, II-D, III-B, IV-A (d) I-B, II-A, III-D, IV-C

111. While doing qualitative analysis in chemistry lab, Abhishek added yellow coloured potassium chromate solution into a test tube. He was surprised to see the colour of the solution changing immediately to orange. He realised that the test tube was not clean and contained a few drops of some liquid. Which of the following substances will be the most likely liquid to be present in the test tube before adding potassium chromate solution?

- (a) Sodium hydrogen carbonate solution
(b) Methyl orange solution
(c) Sodium hydroxide solution
(d) HCl solution

For Questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

112. **Assertion (A):** For measuring resistance of an ionic solution an AC source is used.

Reason (R): Concentration of ionic solution will change if DC source is used.

113. **Assertion (A):** Henry's law constant (K_H) decreases with increase in temperature.

Reason (R): As the temperature increases, solubility of gases in liquids decreases.

114. **Assertion (A):** The solubility of aldehydes and ketones in water decreases with increase in size of the alkyl group.

Reason (R): Aldehydes and ketones have dipole-dipole interaction.

115. **Assertion (A):** The boiling points of alkyl halides decrease in the order

 $\text{RI} > \text{RBr} > \text{RCl} > \text{RF}$.

Reason (R): The van der Waals forces of attraction decrease in the order $\text{RI} > \text{RBr} > \text{RCl} > \text{RF}$.

SECTION B

116. (a) Calculate the elevation of boiling point of a solution when 3 g of CaCl_2 (Molar mass = 111 g mol^{-1}) was dissolved in 260 g of water, assuming that CaCl_2 undergoes complete dissociation. (K_b for water = $0.52 \text{ K kg mol}^{-1}$)

OR

- (b) Liquids 'X' and 'Y' form an ideal solution. The vapour pressure of pure 'X' and pure 'Y' are 120 mm Hg and 160 mm Hg respectively. Calculate the vapour pressure of the solution containing equal moles of 'X' and 'Y'.
- 117.

Concentration of KCl solution in mol/L	Conductivity at 298 – 15 K in Scm^{-1}	Molar Conductivity at 298.15 K in $\text{Scm}^2 \text{ mol}^{-1}$
1.000	0-1113	111.3
0-100	0.0129	$129 \cdot 0$
0.010	0-00141	141.0

Based on the data given above, give plausible reason for the variation of conductivity and molar conductivity with concentration.

118. (a) Write the rate law expression for the reaction $2\text{HI} \rightarrow \text{H}_2 + \text{I}_2$, if the order of the reaction is zero.
 (b) What is the effect of temperature on the rate of reaction? Write a mathematical expression for the same.
119. Explain the mechanism of acid catalysed hydration of ethene.
120. (a) How can acetaldehyde be prepared from acetyl chloride?
 (b) Propanal is more reactive than propanone towards nucleophilic addition reaction. Give reason.

SECTION C

121. (a) Shweta mixed two liquids A and B of 10 mL each. After mixing, the volume of the solution was found to be $20 - 2 \text{ mL}$.
 (i) Why was there a volume change after mixing the liquids?
 (ii) Will there be an increase or decrease of temperature after mixing?
 (iii) Give one example for this type of solution.

OR

- (b)(i) How does sprinkling of salt help in clearing the snow covered roads in hilly areas?
 (ii) What happens when red blood cells are kept in 0 – 5% (mass/vol) NaCl solution? Justify your answer.
 (iii) Write an application of reverse osmosis.
122. For the reaction $\text{A} + \text{B} \rightarrow \text{Products}$, the following initial rates were obtained at various initial concentrations of reactants:

	$[\text{A}]/\text{molLL}^{-1}$	$[\text{B}]/\text{molLL}^{-1}$	Initial rate / $\text{molLL}^{-1} \text{ s}^{-1}$
1	0.1	0.1	0.05
2	0.2	0.1	0.10
3	0.1	0.2	0.05

Determine the order of the reaction with respect to A and B and overall order of the reaction.

123. (a) What is meant by crystal field splitting energy? For a d^4 ion, write the configuration if (i) $\Delta_0 < P$, and (ii) $\Delta_0 > P$.
 (b) Explain why in tetrahedral coordination entities, low spin configurations are rarely observed.
124. Account for the following:
 (a) The C – Cl bond length in chlorobenzene is shorter than that in methyl chloride.
 (b) Grignard reagents should be prepared under anhydrous conditions.
 (c) In case of optically active alkyl halides, $\text{S}_\text{N}1$ reactions are accompanied by racemisation.

125. (a) Arrange the following compounds in the increasing order of their acidic strength :
3,5-dinitrophenol, 4-methylphenol, phenol, 2,4,6-trinitrophenol
(b) What happens when : (write equations)
(i) Phenol is distilled with Zn dust?
(ii) Anisole is treated with HBr ?
126. An organic compound 'A' (molecular formula C_8H_8O) gives 2,4-DNP test. It does not give Tollen's test, but gives a yellow precipitate 'B' with NaOH and I_2 . On drastic oxidation, it gives a carboxylic acid 'C' with formula $C_7H_6O_2$. Identify 'A', 'B', 'C' and write the reactions involved.
127. (a) Name the type of linkage responsible for the formation of proteins from α -amino acids.
(b) Write any two differences between DNA and RNA.

SECTION D

The following questions are case-based questions. Read the case carefully and answer the questions that follow.

128. Carbohydrates are polyhydroxy aldehydes or ketones that represent enormous structural diversity in terms of the arrangement of atoms in space, resulting in hundreds of stereoisomers. Although the chemical properties of most stereoisomers may not be very different, their metabolic rate and utilization in biological systems is significantly different and known to influence the overall carbohydrate metabolism. Structural variants, which arise due to a different arrangement of atoms in three-dimensional space are known as stereoisomers. The number of stereoisomers can be theoretically estimated by using the formula 2^n , where 'n' is the number of stereocenters or asymmetric (chiral) carbon atoms in a molecule. Out of these stereoisomers, there are some structures, which are mirror images of each other, and they are referred to as enantiomers.

Answer the following questions:

- (a) Give chemical reactions to show the presence of an aldehydic group and straight chain in glucose.
(b)(i) Define anomers.

OR

- (b)(ii) Draw the structure of β -D-Glucopyranose.
(c) Sucrose is known as invert sugar. Explain.

129. Werner's coordination theory in 1893 was the first attempt to explain the bonding in coordination complexes. It must be remembered that this theory was put forward before the electron had been discovered by J.J. Thomson in 1897, and before the electronic theory of valency. Werner did not have any of the modern instrumental techniques and all his studies were made using simple experimental techniques. Werner was able to explain the nature of bonding in complexes and he concluded that in complexes, the metal shows two different sorts of valency: primary and secondary. Primary valences are normally ionisable whereas secondary valences are non ionisable.

Answer the following questions:

- (a) One mole of $CrCl_3 \cdot 4H_2O$ precipitates one mole of AgCl when treated with excess of $AgNO_3$ solution. Write (i) the structural formula of the complex, and (ii) the secondary valency of Cr.
(b) What is the difference between a complex and a double salt ?
(c)(i) Arrange the following complexes in the increasing order of conductivity of their solution :
 $[Cr(NH_3)_3Cl_3]$, $[Cr(NH_3)_6]Cl_3$, $[Cr(NH_3)_5Cl_3]Cl_2$

OR

- (c)(ii) Write two differences between primary and secondary valences in coordination compounds.

SECTION E

130. (a)(i) For a galvanic cell, the following half reactions are given. Decide, which will remain as reduction reaction and which will be reversed to become an oxidation reaction. Give reason for your answer.
(II) $Fe^{2+} + 2e^- \rightarrow Fe(s)$; $E^\circ = -0.44 V$
(ii) Represent the cell in which the following reaction takes place:
 $Mg(s) + 2Ag^+(0.001M) \rightarrow Mg^{2+}(0.100M) + 2Ag(s)$
Calculate E_{cell}° if $E_{cell}^\circ = 3.17 V$. ($\log 10 = 1$)

OR

(b)(i) State Kohlrausch's law. Give any two applications of it.

(ii) $\Lambda_m^\circ \text{NH}_4\text{Cl}$, $\Lambda_m^\circ \text{NaOH}$ and $\Lambda_m^\circ \text{NaCl}$ are 129-8, 217-4, and 108.9 $\text{S cm}^2 \text{mol}^{-1}$ respectively. Molar conductivity of $1 \times 10^{-2} \text{M}$ solution of NH_4OH is 9.33 $\text{S cm}^2 \text{mol}^{-1}$. Calculate the degree of dissociation (α) of NH_4OH solution at this concentration.

131. (a) (i) In a chemistry practical class, the teacher gave his students an amine 'X' having molecular formula $\text{C}_2\text{H}_7\text{N}$, and asked the students to identify the type of amine. One of the students, Neeta, observed that it reacts with $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$, to give a compound which dissolves in NaOH solution. Can you help Neeta to identify the compound 'X'?

(ii) Arrange the following in the increasing order of their pK_b value in aqueous phase:

$\text{C}_6\text{H}_5\text{NH}_2$, $(\text{CH}_3)_2\text{NH}$, NH_3 , CH_3NH_2 , $(\text{CH}_3)_3\text{N}$

(iii) Aniline on nitration gives considerable amount of meta product along with ortho and para products. Why?

(iv) Convert aniline to:

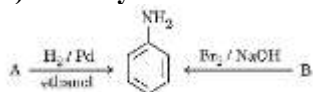
(I) p-bromoaniline

(II) phenol

OR

(b)(i) Arun heated a mixture of ethylamine and CHCl_3 with ethanolic KOH , which forms a foul smelling gas. Write the chemical equation involved.

(ii) Identify A and B in the following reactions:



(iii) Convert aniline to:

(I) benzene

(II) sulphanilic acid

132. (a) (i) When pyrolusite ore is fused with KOH , in presence of air, a dark green coloured product 'A' is obtained which changes to purple coloured compound 'B' in acidic medium.

(I) Write the formulae of 'A' and 'B'.

(II) Write the ionic equation for the reaction when compound 'B' reacts with Fe^{2+} in acidic medium.

(ii) Give reasons:

(I) Ce^{4+} in aqueous solution is a good oxidising agent.

(II) The actinoid contraction is greater from element to element than lanthanoid contraction.

(III) $E_{\text{Zn}^{2+}/\text{Zn}}^\circ$ value is more negative than expected, whereas $E_{\text{Cu}^{2+}/\text{Cu}}^\circ$ is positive.

OR

(b) (i) While studying the periodic properties, Arti came across an abnormal behaviour in the atomic size of Hf. She found that, even though Hf is placed below Zr in the same group, both have almost similar atomic sizes.

(I) Which phenomenon is responsible for the above behaviour? Define it.

(II) Mention any other consequence of the above phenomenon.

(ii) Give reasons for the following :

(I) Transition metals exhibit catalytic properties.

(II) Transition metals have high enthalpy of atomisation.

(III) Sc is a transition element, while Zn is not.

General Instructions:

Read the following instructions carefully and follow them:

(i) This question paper contains 33 questions. All questions are compulsory.

(ii) This question paper is divided into five sections - Sections A, B, C, D and E.

(iii) In Section A - Questions no. 1 to 16 are Multiple Choice type questions. Each question carries 1 mark.

(iv) In Section B - Questions no. 17 to 21 are Very Short Answer type questions. Each question carries 2 marks.

(v) In Section C - Questions no. 22 to 28 are Short Answer type questions. Each question carries 3 marks.

(vi) In Section D - Questions no. 29 and 30 are case study-based questions. Each question carries 4 marks.

(vii) In Section E - Questions no. 31 to 33 are Long Answer type questions. Each question carries 5 marks.

(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A

(ix) Kindly note that there is a separate question paper for Visually Impaired candidates.

(x) Use of calculators is not allowed.

You may use the following values of physical constants wherever necessary:

$$c = 3 \times 10^8 \text{ m/s}$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2 \text{ C}^{-2}$$

$$\text{Mass of electron (m}_e\text{)} = 9.1 \times 10^{-31} \text{ kg}$$

$$\text{Mass of neutron} = 1.675 \times 10^{-27} \text{ kg}$$

$$\text{Mass of proton} = 1.673 \times 10^{-27} \text{ kg}$$

$$\text{Avogadro's number} = 6.023 \times 10^{23} \text{ per gram mole}$$

$$\text{Boltzmann constant} = 1.38 \times 10^{-23} \text{ J K}^{-1}$$

SECTION-A

133. Williamson synthesis of preparing unsymmetrical ether is :

- S_N1 reaction
- S_N2 reaction
- Electrophilic addition reaction
- Elimination reaction

134. Which of the following compounds would be hydrolysed by aqueous KOH most easily?

- $\text{CH}_2 = \text{CH} - \text{Br}$
- $\text{CH}_3 - \text{CH}_2 - \text{Br}$
 $\text{CH}_3 - \text{CH}(\text{Br}) - \text{CH}_3$
- $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{Br}$

135. According to Werner's theory of coordination compounds :

- Primary valences are ionisable.
- Secondary valences are ionisable.
- Both primary and secondary valences are non-ionisable.
- Both primary and secondary valences are ionisable.

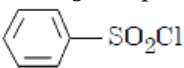
136. Which of the following complex ion is not optically active ?

- $[\text{Co}(\text{ox})_3]^{3-}$
- $\text{cis} - [\text{Co}(\text{en})_2\text{Cl}_2]^+$
- $\text{trans} - [\text{Co}(\text{en})_2\text{Cl}_2]^+$
- $[\text{Co}(\text{en})_3]^{3+}$

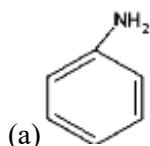
137. Which of the following is the softest metal?

- Zn
- Sc
- Cu
- Fe

138. In the Hinsberg's method for separation of primary, secondary and tertiary amines, the reagent used is:

- Nitrous acid
- $\text{CHCl}_3 + \text{aq. NaOH}$
- 
- HCl/ZnCl_2

139. Which one of the following amines gives an alcohol on reaction with HNO_2 ?



- $\text{C}_2\text{H}_5\text{NH}_2$

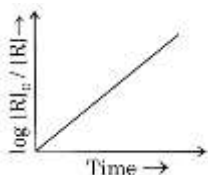
- (c) $(C_2H_5)_2NH$ (d) $(C_2H_5)_3N$
140. The freezing point of one molal KCl solution, assuming KCl to be completely dissociated in water, is : (K_f for water = $1.86 \text{ K kg mol}^{-1}$)
- (a) -3.72°C (b) $+3.72^\circ\text{C}$
(c) -1.86°C (d) $+2.72^\circ\text{C}$
141. A solution of acetone in ethanol:
- (a) obeys Raoult's law.
(b) forms an ideal solution.
(c) shows a positive deviation from Raoult's law.
(d) shows a negative deviation from Raoult's law.
142. Which of the following cell converts the energy of combustion of fuel into electrical energy?
- (a) Mercury cell (b) Fuel cell
(c) Dry cell (d) Lead storage cell
143. The unit of rate and rate constant are same for a :
- (a) First order reaction
(b) Second order reaction
(c) Zero order reaction
(d) Third order reaction
144. Pyranose ring of glucose is formed due to the reaction between :
- (a) C_1 and C_3 (b) C_1 and C_5
(c) C_1 and C_4 (d) C_1 and C_2

For Questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

- (A) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(B) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
(C) Assertion (A) is true, but Reason (R) is false.
(D) Assertion (A) is false, but Reason (R) is true.
145. **Assertion (A):** Actinoids show wide range of oxidation states.
Reason (R): Actinoids are radioactive in nature.
146. **Assertion (A):** Hydrolysis of an ester follows first order kinetics.
Reason (R): The concentration of water does not get altered much during the reaction.
147. **Assertion(A):** Boiling point of $(CH_3)_3N$ is higher than that of $CH_3CH_2CH_2NH_2$.
Reason (R): Hydrogen bonding is more extensive in $CH_3CH_2CH_2NH_2$.
148. **Assertion (A):** Phenol is strongly acidic as compared to ethanol.
Reason (R): Phenoxide ion is more stable than ethoxide ion.

SECTION B

149. State Henry's law. Why are aquatic species more comfortable in cold water as compared to warm water?
150. Observe the graph in the given figure and answer the following questions:



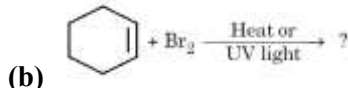
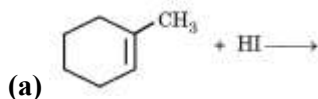
- (a) Predict the order of reaction.
(b) What is the slope of the curve?
151. (a) Write IUPAC names of the following coordination compounds:
- (i) $[CoCl_2(en)_2]SO_4$
(ii) $K_3[Fe(C_2O_4)_3]$

OR

(b) Differentiate between :

- (i) Double salt and Complex compound
- (ii) Didentate ligand and Ambidentate ligand

152. Draw the structures of major monohalo products in each of the following reactions:



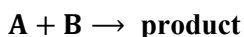
153. How do you explain the following?

- (a) Presence of an aldehydic group in glucose.
- (b) Presence of five -OH groups in glucose.

SECTION C

154. Vapour pressure of pure water at 298 K is 24 – 8 mmHg. Calculate the lowering in vapour pressure of an aqueous solution which freezes at -0.3°C . (K_f of water = $1.86\text{ K kg mol}^{-1}$)

155. The rate of a reaction:



is given below as a function of different initial concentrations of A and B.

Exp.	[A]/molL ⁻¹	[B]/molL ⁻¹	Initial Rate / molL ⁻¹ min ⁻¹
1	0.01	0.01	5×10^{-3}
2	0.02	0.01	1×10^{-2}
3	0.01	0.02	5×10^{-3}

Calculate the order of the reaction with respect to A and B. Determine the rate constant of the reaction.

156. Give reasons for the following:

- (a) The pH of aqueous NaCl increases when it is electrolysed.
- (b) Unlike dry cell, mercury cell has a constant cell potential through its lifetime.
- (c) Conductivity of solution decreases with dilution.

157. (a) Answer the following about the complexes



- (i) Write the hybridization involved in each case.
- (ii) Which of them is the outer orbital complex and which one is the inner orbital complex?
- (iii) Compare their magnetic behaviour.

[Atomic number : Fe = 26]

OR

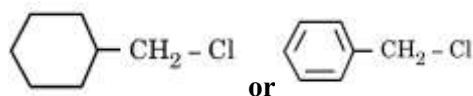
(b) (i) What happens to the colour of complex $[\text{Ti}(\text{H}_2\text{O})_6]^{3+}$ when heated gradually?

(ii) Write the electronic configuration for d^5 ion if $\Delta_0 < P$.

(iii) Write the hybridization and magnetic behaviour of the complex $[\text{Ni}(\text{CO})_4]$.

[Atomic number : Ni = 28]

158. Write any two differences between S_N1 and S_N2 reactions. Which of the following compounds would undergo S_N1 reaction faster and why?



159. A compound (A) with molecular formula $\text{C}_4\text{H}_5\text{N}$ on reduction with DIBAL-H followed by hydrolysis, gives a compound (B). Compound (B) gives positive Tollens' test but does not give iodoform test.

Compound (B) can also be obtained when ethanal is treated with dilute NaOH followed by heating. Identify (A) and (B). Write the reactions of (A) with DIBAL-H followed by hydrolysis.

160. How will you obtain the following from aniline? Give chemical equations only.

- (a) Sulphanilic acid
- (b) Phenylisocyanide
- (c) Acetanilide

SECTION D

The following questions are case-based questions. Read the case carefully and answer the questions that follow.

161. Alcohols undergo a number of reactions involving the cleavage of C – OH bond. However, phenols do not undergo reactions involving the cleavage of C – OH bond. Alcohols are weaker acids than water. Alcohols react with halogen acids to form the corresponding haloalkanes. Phenols are stronger acids than alcohols. A characteristic feature of phenols is that they undergo electrophilic substitution reactions such as halogenation, nitration, etc. Since -OH group is a strong activating group, phenol gives trisubstituted products during halogenation, nitration, etc.

(a) What happens when phenol is treated with the following ?

- (i) Br₂ water
- (ii) Conc. HNO₃

(b) (i) Write the mechanism of alcohol reacting as nucleophile in a reaction with CH₃⁺.

OR

(b) (ii) Why do phenols not undergo reactions involving cleavage of C – OH bond?

(c) How can you distinguish between Butan-1-ol and 2-Methylpropan-2-ol by using HCl in the presence of anhydrous ZnCl₂?

162. The α-amino acids are the building blocks of proteins. All α-amino acids exist as zwitter ion due to which they show amphoteric behaviour. All amino acids are joined through peptide bond. Proteins are broadly classified as globular proteins and fibrous proteins. Globular proteins are water soluble, whereas fibrous proteins are not. The complete structure of protein is discussed at four different levels i.e. primary, secondary, tertiary and quaternary structures. Protein loses its biological activity in denatured form.

(a) Define the following:

- (i) Peptide linkage
- (ii) Denatured protein

(b) Why do amino acids show amphoteric behaviour?

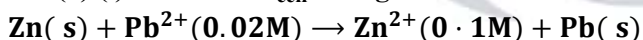
(c) (i) How can you differentiate between Fibrous protein and Globular protein?

OR

(c) (ii) Write the names of two different secondary structures of proteins.

SECTION E

163. (a) (i) Calculate E_{cell} of a galvanic cell in which the following reaction takes place at 25°C :



[Given : E_{Zn²⁺/Zn}^o = -0.76 V, E_{Pb²⁺/Pb}^o = -0.13 V;

log 2 = 0.3010, log 4 = 0.6021, log 5 = 0.6990].

(ii) State Faraday's first law of electrolysis. How much electricity, in terms of Faraday, is required to reduce one mol of MnO₄⁻ to Mn²⁺ ion?

OR

(b) (i) The resistance of a conductivity cell containing 0.001 M KCl solution at 298 K is 1000 ohm. What is the cell constant if conductivity of 0.001 M KCl solution at 298 K is 0.125 × 10⁻³ S cm⁻¹ ?

(ii) Calculate the E_{Mg²⁺/Mg} potential for the following half cell at 25°C :

Mg/Mg²⁺ (1 × 10⁻⁴ M); E_{Mg²⁺/Mg}^o = +2.36 V

[Given: log 10 = 1]

(iii) What is the effect of temperature on the electrical conductance of metallic conductor?

164. (a) (i) Account for the following:

(I) Orange colour of Cr₂O₇²⁻ ion changes to yellow when treated with an alkali.

(II) Zn, Cd and Hg are non-transition elements.

(III) E^o value for Mn³⁺/Mn²⁺ couple is highly positive (+1.57 V) as compared to Cr³⁺/Cr²⁺.

(ii) What happens when :

(I) Manganate ion undergoes disproportionation reaction in acidic medium?

(II) KMnO_4 is heated?

OR

(b) Answer the following questions:

(i) What is 'Misch metal'? Give its one use.

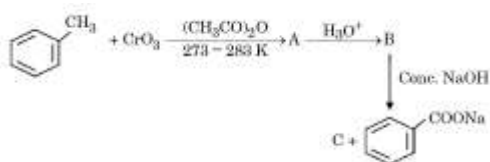
(ii) Write the formula of an oxoanion of chromium in which it shows the oxidation state equal to its group number.

(iii) Why does Vanadium pentoxide (V_2O_5) act as a catalyst?

(iv) Why do transition elements have high enthalpies of atomisation?

(v) How do you prepare $\text{Na}_2\text{Cr}_2\text{O}_7$ from Na_2CrO_4 ?

165. (a) (i) Identify A, B and C in the following reactions:



(ii) Give reasons for the following:

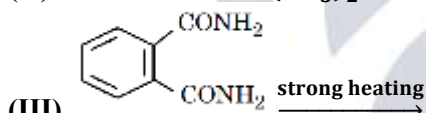
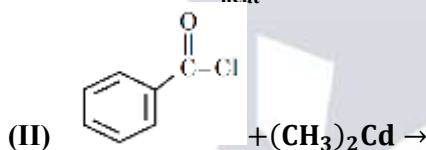
(I) Carboxylic acids do not give the characteristic reactions of carbonyl group.

(II) Ethanoic acid is a stronger acid than ethanol.

OR

(b) (i) Write the product(s) in the following reactions:

(I) $2\text{CH}_3\text{COOH} \xrightarrow[\text{heat}]{\text{P}_4\text{O}_{10}}$



(ii) Write the reaction involved in the following reactions:

(I) Wolff-Kishner Reduction

(II) Decarboxylation Reaction

General Instructions:

Read the following instructions carefully and follow them:

(i) This question paper contains 33 questions. All questions are compulsory.

(ii) This question paper is divided into five sections - Sections A, B, C, D and E.

(iii) In Section A - Questions no. 1 to 16 are Multiple Choice type questions. Each question carries 1 mark.

(iv) In Section B - Questions no. 17 to 21 are Very Short Answer type questions. Each question carries 2 marks.

(v) In Section C - Questions no. 22 to 28 are Short Answer type questions. Each question carries 3 marks.

(vi) In Section D - Questions no. 29 and 30 are case study-based questions. Each question carries 4 marks.

(vii) In Section E-Questions no. 31 to 33 are Long Answer type questions. Each question carries 5 marks.

(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the Sections except Section A

(ix) Kindly note that there is a separate question paper for Visually Impaired candidates.

(x) Use of calculators is not allowed.

You may use the following values of physical constants wherever necessary:

$$c = 3 \times 10^8 \text{ m/s}$$

$$h = 6.63 \times 10^{-34} \text{ Js}$$

$$e = 1.6 \times 10^{-19} \text{ C}$$

$$\mu_0 = 4\pi \times 10^{-7} \text{ T m A}^{-1}$$

$$\epsilon_0 = 8.854 \times 10^{-12} \text{ C}^2 \text{ N}^{-1} \text{ m}^{-2}$$

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \text{ N m}^2\text{C}^{-2}$$

Mass of electron (m_e) = 9.1×10^{-31} kg

Mass of neutron = 1.675×10^{-27} kg

Mass of proton = 1.673×10^{-27} kg

Avogadro's number = 6.023×10^{23} per gram mole

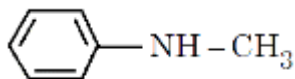
Boltzmann constant = $1.38 \times 10^{-23} \text{ JK}^{-1}$

SECTION-A

166. Which of the following transition metal ion is not coloured?
 (a) Cu^+ (b) Ni^{2+}
 (c) Co^{2+} (d) V^{3+}
167. Which of the following solutions will have the highest boiling point in water?
 (a) 1%KCl (b) 1% glucose
 (c) 1% urea (d) 1% CaCl_2
168. During electrolysis of dilute H_2SO_4 , using platinum electrodes, the gas evolved at the anode is:
 (a) H_2 gas (b) O_2 gas
 (c) SO_2 gas (d) SO_3 gas
169. The activation energy (E_a) of a reaction can be determined from the slope of which of the following plots?
 (a) $\ln k$ vs. T (b) $\frac{\ln k}{T}$ vs. T
 (c) $\ln k$ vs. $\frac{1}{T}$ (d) $\frac{T}{\ln k}$ vs. $\frac{1}{T}$
170. Which of the following represents the fraction of molecules with energies equal to or greater than E_a ?
 (a) $\frac{-E_a}{RT}$ (b) $e^{-E_a/RT}$
 (c) $e^{+E_a/RT}$ (d) $+\frac{E_a}{RT}$
171. The number of moles of AgCl precipitated when excess AgNO_3 solution is mixed with one mole of $[\text{Co}(\text{NH}_3)_3\text{Cl}_3]$ is :
 (a) 0 (b) 1
 (c) 2 (d) 3
172. Which of the following haloalkanes react with aqueous KOH most rapidly by $\text{S}_{\text{N}}1$ reaction?
 (a) 2-Chlorobutane
 (b) 1-Bromobutane
 (c) 2-Bromo-2-Methylpropane
 (d) 2,2-Dimethyl-1-Chloropropane
173. The reaction $\text{R}-\text{OH} + \text{Na} \rightarrow \text{RO}^-\text{Na}^+ + \frac{1}{2}\text{H}_2(\text{g})$ suggests that alcohols are:
 (a) Acidic (b) Basic
 (c) Neutral (d) Amphoteric
174. At low temperature, phenol reacts with Br_2 in CS_2 to form :
 (a) 2,4,6-tribromophenol
 (b) *p*-bromophenol
 (c) *o*-and *p*-bromophenol
 (d) 2,4-dibromophenol
175. When alkyl iodide is treated with large excess of ammonia, the major product obtained is:
 (a) Tertiary amine
 (b) Quaternary ammonium salt
 (c) Secondary amine
 (d) Primary amine

176. An amine 'X' reacts with Hinsberg reagent and the product obtained is soluble in alkali. The amine 'X' is:

- (a) $\text{CH}_3 - \text{NH}_2$
- (b) $(\text{CH}_3)_2\text{NH}$
- (c) $(\text{CH}_3)_8\text{N}$



(d)

177. α -helix structure refers to:

- (a) primary structure of protein
- (b) secondary structure of protein
- (c) tertiary structure of protein
- (d) quaternary structure of protein

For Questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below.

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
- (b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of the Assertion (A).
- (c) Assertion (A) is true, but Reason (R) is false.
- (d) Assertion (A) is false, but Reason (R) is true.

178. **Assertion (A):** A mixture of o-nitrophenol and p-nitrophenol can be separated by steam distillation.

Reason (R): o-nitrophenol is steam volatile due to intermolecular hydrogen bonding.

179. **Assertion (A):** Cooking time is reduced in pressure cooker.

Reason (R): Boiling point of water inside the pressure cooker is elevated.

180. **Assertion (A):** Actinoids show irregularities in their electronic configurations.

Reason (R): Actinoids are radioactive in nature.

181. **Assertion (A):** Vitamin K can be stored in our body.

Reason (R): Vitamin K is a water soluble vitamin.

SECTION B

182. What is meant by positive deviation from Raoult's law? Give an example. What type of azeotrope is formed by positive deviation?

183. State a condition under which a bimolecular reaction is kinetically first order reaction. Give an example. For which type of reactions, do order and molecularity have the same value?

184. (a) Write the IUPAC name of the complex $[\text{Pt}(\text{en})_2\text{Cl}_2]^{2+}$. Draw the structure of geometrical isomer of this complex which is optically inactive.

OR

(b) (i) Write the formula of the following coordination compound:

Pentaamminecarbonatocobalt (III)chloride

(ii) Write the IUPAC name of the linkage isomer of the complex $[\text{Co}(\text{NH}_3)_5(\text{NO}_2)]\text{Cl}_2$.

185. Why are haloarenes less reactive towards nucleophilic substitution reaction? How does the presence of nitro ($-\text{NO}_2$) group at ortho- and para-positions in haloarenes increase the reactivity towards nucleophilic substitution reaction?

186. The two strands in DNA are not identical but complementary. Explain. What products would be formed when DNA is hydrolysed?

SECTION C

187. 0.3 g of acetic acid (Molar mass = 60 g mol^{-1}) dissolved in 30 g of benzene shows a depression in freezing point equal to 0.45°C . Calculate the percentage association of acid if it forms a dimer in the solution. (Given : K_f for benzene = $5.12 \text{ K kg mol}^{-1}$)

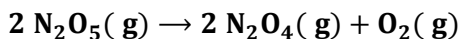
188. (a) Write the name of the cell which is generally used in inverters. Write the reactions taking place at anode and cathode of this cell, when it is in use.

OR

(b) Explain why electrolysis of an aqueous solution of NaCl gives H₂ gas at cathode and Cl₂ gas at anode? Write overall reaction.

(Given : $E_{\text{Na}^+/\text{Na}} = -2.71 \text{ V}$, $E_{\text{H}_2\text{O}/\text{H}_2} = -0.83 \text{ V}$, $E_{\text{Cl}_2/2\text{Cl}^-} = +1.36 \text{ V}$, $E_{\text{H}^+/\text{O}_2/\text{H}_2\text{O}} = +1.23 \text{ V}$)

189. The following data were obtained during the first order thermal decomposition of N₂O₅(g) at constant volume:



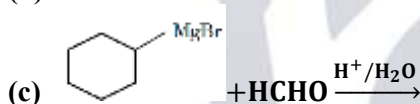
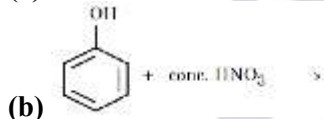
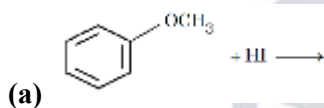
	Time/s	Total Pressure/atm
1	0	0.5
2	100	0.625

Calculate rate constant.

[Given: $\log 2 = 0.3010$, $\log 10 = 1$]

190. A compound (A) with molecular formula C₄H₉I which is a primary alkyl halide, reacts with alcoholic KOH to give compound (B). Compound (B) reacts with HI to give (C) which is an isomer of (A). When (A) reacts with Na metal in the presence of dry ether, it gives a compound (D), C₈H₁₈, which is different from the compound formed when n-butyl iodide reacts with sodium. Write the structures of (A), (B), (C) and (D). Write the chemical equation when compound (A) is reacted with alcoholic KOH.

191. Write structure of the products of the following reactions:



192. Give reasons for the following :

- Benzoic acid does not undergo Friedel-Crafts reaction.
- HCHO is more reactive than CH₃CHO towards addition of HCN.
- Vinyl group directly attached with carboxylic acid should decrease the acidity of corresponding carboxylic acid due to resonance, but on the contrary it increases the acidity.

193. Write the reaction of D-Glucose with the following :

- HCN
- Br₂ water
- (CH₃CO)₂O

SECTION D

The following questions are case-based questions. Read the case carefully and answer the questions that follow.

194. The Crystal Field Theory (CFT) of coordination compounds is based on the effect of different crystal fields (provided by the ligands taken as point charges) on the degeneracy of d-orbital energies of the central metal atom/ion. The splitting of the d-orbitals provides different electronic arrangements in strong and weak crystal fields. In tetrahedral coordination entity formation, the d-orbital splitting is smaller as compared to the octahedral entity.

Answer the following questions:

(a) On the basis of CFT, explain why [Ti(H₂O)₆]Cl₃ complex is coloured ? What happens on heating the complex [Ti(H₂O)₆]Cl₃ ?

Give reason.

[Atomic no.: Ti = 22]

(b) (i) What is crystal field splitting energy?

OR

(b) (ii) On the basis of Δ_0 and P (pairing energy), how can you differentiate between a strong field ligand and a weak field ligand?

(c) Why are low spin tetrahedral complexes rarely observed?

195. Amines are usually formed from amides, imides, halides, nitro compounds, etc. They exhibit hydrogen bonding which influences their physical properties. In alkyl amines, a combination of electron releasing, steric and H-bonding factors influence the stability of the substituted ammonium cations in protic polar solvents and thus affect the basic nature of amines. Alkyl amines are found to be stronger bases than ammonia. Amines being basic in nature, react with acids to form salts. Aryldiazonium salts, undergo replacement of the diazonium group with a variety of nucleophiles to produce aryl halides, cyanides, phenols and arenes.

Answer the following questions:

(a) How can you convert the following ?

(i) Ethanoic acid to methanamine

(ii) Propanenitrile to 1-aminopropane

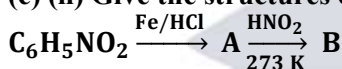
(b) Why is pK_b value of aniline more than that of methylamine?

(c) (i) Arrange the following in increasing order of their basic strength in aqueous solution :

$\text{CH}_3 - \text{NH}_2$, $(\text{CH}_3)_2\text{NH}$, $(\text{CH}_3)_3\text{N}$

OR

(c) (ii) Give the structures of A and B in the following reaction :



SECTION E

196. (a) (i) Account for the following:

(I) The $E_{\text{Mn}^{2+}/\text{Mn}}$ value for manganese is highly negative, whereas $E_{\text{Mn}^{3+}/\text{Mn}^{2+}}$ is highly positive.

(II) Actinoids show wide range of oxidation states.

(III) Transition metals have high melting points.

(ii) Complete the following ionic equations :

(I) $5\text{SO}_3^{2-} + 2\text{MnO}_4^- + 6\text{H}^+ \rightarrow$

(II) $2\text{MnO}_4^- + \text{H}_2\text{O} + \text{I}^- \rightarrow$

OR

(b) Answer the following questions:

(i) Name two elements of 3d series for which the third ionisation enthalpies are quite high.

(ii) Out of KMnO_4 and K_2MnO_4 , which one is paramagnetic and why?

(iii) Write any one consequence of lanthanoid contraction.

(iv) How do you prepare potassium manganate from pyrolusite ore?

(v) Why is the ability of oxygen more than fluorine to stabilise higher oxidation states of transition metals?

197. (a) (i) An organic compound (X) having molecular formula $\text{C}_5\text{H}_{10}\text{O}$ can show various properties depending on its structures. Draw each of the structures if it:

(I) shows Cannizzaro reaction.

(II) reduces Tollens' reagent and has a chiral carbon.

(III) gives positive iodoform test.

(ii) Write the reaction involved in the following :

(I) Clemmensen reduction

(II) Etard reaction

OR

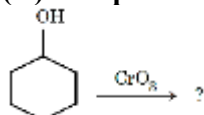
(b) Answer the following questions:

(i) Draw structure of the methyl hemiacetal of methanal.

(ii) There are two $-\text{NH}_2$ groups in semicarbazide. However only one is involved in the formation of semicarbazones. Give reason.

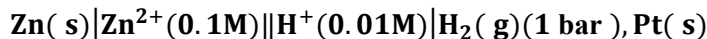
(iii) How will you convert ethanol to 3-hydroxybutanal?

(iv) Complete the following equation :



(v) Write the final product formed when phthalic acid is treated with NH_3 followed by strong heating.

198. (a) (i) Calculate the emf of the following cell at 25°C :



$$\left[\text{Given : } E_{\text{Zn}^{2+}/\text{Zn}}^\circ = -0.76\text{ V}, E_{\text{H}^+/\text{H}_2}^\circ = 0.00\text{ V}, \log 10 = 1 \right]$$

(ii) State Faraday's second law of electrolysis. How much electricity is required in terms of Faraday for the reduction of 1 mol of $\text{Cr}_2\text{O}_7^{2-}$ to Cr^{3+} ?

OR

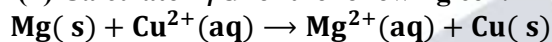
(b) Answer the following questions :

(i) The conductivity of 0.20 M solution of KCl is $2.48 \times 10^{-2}\text{ S cm}^{-1}$. Calculate its molar conductivity and degree of dissociation (α).

$$\left[\text{Given : } \lambda_{(\text{K}^+)}^\circ = 73.5\text{ S cm}^2\text{ mol}^{-1} \right]$$

$$\lambda_{(\text{Cl}^-)}^\circ = 76.5\text{ S cm}^2\text{ mol}^{-1}$$

(ii) Calculate $\Delta_r G^\circ$ of the following cell:



$$\left[\text{Given : } E_{\text{Mg}^{2+}/\text{Mg}}^\circ = -2.37\text{ V}, E_{\text{Cu}^{2+}/\text{Cu}}^\circ = +0.34\text{ V} \right]$$

$$1\text{ F} = 96500\text{ C mol}^{-1}$$

(iii) What type of cell is mercury cell ? Why is it more advantageous than dry cell?

General Instructions:

Read the following instructions carefully and follow them:

(i) This Question paper contains 33 questions. All questions are compulsory.

(ii) This Question paper is divided into five sections - Section **A**, **B**, **C**, **D** and **E**.

(iii) Section **A** - Question number 1 to 16 are multiple choice type questions. Each question carries 1 mark.

(iv) Section **B** - Question number 17 to 21 are very short answer type questions. Each question carries 2 marks.

(v) Section **C** - Question number 22 to 28 are short answer type questions. Each question carries 3 marks.

(vi) Section **D** - Question number 29 and 30 are case-based questions. Each question carries 4 marks.

(vii) Section **E** - Question number 31 to 33 are long answer type questions. Each question carries 5 marks.

(viii) There is no overall choice given in the question paper. However, an internal choice has been provided in few questions in all the sections except Section **A**.

(ix) Use of calculator is not allowed.

SECTION-A

199. Which of the following is a polysaccharide?

- (a) Maltose (b) Glucose
(c) Cellulose (d) Sucrose

200. The Gabriel Phthalimide Synthesis is used for the preparation of

- (a) Secondary amines
(b) Primary aromatic amines
(c) Tertiary amines
(d) Primary aliphatic amines

201. The compound which undergoes dehydration most easily is

- (a) 2-Methylpropan-2-ol
(b) Ethanol
(c) 2-Methylbutan-2-ol
(d) Propan-1-ol

202. The conversion of an alkyl halide into an alcohol by aqueous NaOH is classified as

- (a) an addition reaction
(b) a substitution reaction

- (c) a dehydrohalogenation reaction
(d) a dehydration reaction

203. Which of the following transition metals does not show variable oxidation states?

- (a) Cu (b) Sc
(c) Ti (d) Fe

204. An azeotropic mixture of two liquids has a boiling point higher than that of either of the two liquids when it

- (a) obeys Raoult's law.
(b) shows positive deviation from Raoult's law.
(c) shows negative deviation from Raoult's law.
(d) obeys Henry's law.

205. Kohlrausch gave the following relation for strong electrolytes at low concentration:

$$\Lambda_m = \Lambda_m^0 - A\sqrt{C}$$

Which of the following equality holds true?

- (a) $\Lambda_m = \Lambda_m^0$ as $C \rightarrow \sqrt{A}$
(b) $\Lambda_m = \Lambda_m^0$ as $C \rightarrow 0$
(c) $\Lambda_m = \Lambda_m^0$ as $C \rightarrow \infty$
(d) $\Lambda_m = \Lambda_m^0$ as $C \rightarrow 1$

206. The rate of reaction $X + Y \rightarrow \text{products}$, is given by the equation

$$\text{Rate} = k[X][Y]$$

If Y is taken in large excess, the order of the reaction would be

- (a) 0 (b) 1
(c) 2 (d) $\frac{1}{2}$

207. The synthesis of alkyl fluoride is best accomplished by

- (a) Sandmeyer reaction
(b) Finkelstein reaction
(c) Wurtz reaction
(d) Swarts reaction

208. Benzene diazonium chloride on hydrolysis gives

- (a) Chlorobenzene (b) Phenol
(c) Anisole (d) Aniline

209. Solubility of gases in liquid decreases with increase in

- (a) pressure
(b) volume
(c) number of solute particles
(d) temperature

210. $\Delta_r G^0$ and E_{cell}^0 for a spontaneous reaction will respectively be

- (a) positive and positive
(b) positive and negative
(c) negative and positive
(d) negative and negative

For question number 13 to 16, two statements are given, one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below :

- (a) Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of the Assertion (A).
(b) Both Assertion (A) and Reason (R) are true, but Reason (R) is not the correct explanation of Assertion (A).
(c) Assertion (A) is true, but Reason (R) is false.
(d) Assertion (A) is false, but Reason (R) is true.

211. Assertion (A): Zinc is not regarded as a transition element.

Reason (R): Zinc has completely filled 3d orbitals in its ground state as well as in its oxidised state.

212. **Assertion (A) :** In a first order reaction, if the concentration of the reactant is doubled, its half-life is also doubled.

Reason (R) : The half-life of a reaction does not depend upon the initial concentration of the reactant in a first order reaction.

213. **Assertion (A) :** $(\text{CH}_3)_3\text{C} - \text{O} - \text{CH}_3$ gives $(\text{CH}_3)_3\text{C} - \text{I}$ and CH_3OH on treatment with HI .

Reason (R) : The reaction occurs by $\text{S}_{\text{N}}1$ mechanism.

214. **Assertion (A) :** Nucleophilic substitution reaction of chlorobenzene is easier than that of chloroethane.

Reason (R) : $\text{C} - \text{Cl}$ bond in chlorobenzene has partial double bond character due to resonance.

SECTION - B

215. (a) Why does the cell potential of mercury cell remains constant throughout its life?

(b) Calculate the degree of dissociation (α) of CH_3COOH if Λ_{m} and Λ_{m}^0 of CH_3COOH are $50 \text{ S cm}^2 \text{ mol}^{-1}$ and $400 \text{ S cm}^2 \text{ mol}^{-1}$ respectively.

216. Using the E^0 values of P and Q, predict which one is better for coating the surface of iron [$E^0(\text{Fe}^{2+}/\text{Fe}) = -0.44 \text{ V}$] to prevent corrosion and why?

$E^0_{(\text{P}^{2+}/\text{P})} = -2.37 \text{ V}$, $E^0_{(\text{Q}^{2+}/\text{Q})} = -0.14 \text{ V}$

217. (a) A reaction is second order in 'A' and first order in 'B'. How is the rate affected when the concentrations of both 'A' and 'B' are doubled?

(b) Write the unit of 'k' for zero order reaction.

218. (a) How do you convert the following?

(i) Ethanenitrile to Ethanamine

(ii) Benzenediazonium chloride to benzonitrile

OR

(b) (i) Write a simple chemical test to distinguish between ethanamine and dimethylamine.

(ii) What happens when CH_3CONH_2 is heated with Br_2 and an aqueous solution of NaOH ?

219. What is the effect of denaturation on the structures of protein? Give one example each of fibrous protein and globular protein.

SECTION - C

220. What happens when

(a) Ethanal is treated with CH_3MgBr followed by hydrolysis?

(b) Phenol is treated with Zinc dust?

(c) Anisole is treated with HI ?

221. The rate constant of a first order reaction increases from 0.04 s^{-1} to 0.08 s^{-1} when the temperature increases from 27°C to 37°C . Calculate the energy of activation (E_{a}).

[Given : $2.303R = 19.15 \text{ JK}^{-1} \text{ mol}^{-1}$]

[$\log 2 = 0.3010$, $\log 3 = 0.4771$, $\log 4 = 0.6021$]

222. Give reactions for the following :

(i) Aniline does not undergo Friedel - Crafts reaction.

(ii) $(\text{CH}_3)_2\text{NH}$ is more basic than $(\text{CH}_3)_3\text{N}$ in an aqueous solution.

(iii) Ethyl amine is soluble in water whereas aniline is insoluble.

223. (a) When a co-ordination compound $\text{CoCl}_3 \cdot 6\text{NH}_3$ is mixed with excess of AgNO_3 solution, 3 moles of AgCl are precipitated per mole of the compound. Write

(i) Structural formula of the complex

(ii) IUPAC name of the complex

(iii) Hybridization of the complex using valence bond theory [Atomic number: $\text{Co} = 27$]

OR

(b) (i) Write IUPAC name of $[\text{Pt}(\text{NH}_3)_2\text{Cl}(\text{ONO})]$.

(ii) Why $[\text{Co}(\text{en})_3]^{3+}$ is more stable complex than $[\text{Co}(\text{NH}_3)_6]^{3+}$?

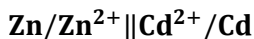
(iii) Predict the hybridization of $[\text{Ni}(\text{CO})_4]$ on the basis of valence bond theory. [Atomic number: $\text{Ni} = 28$]

3 × 1

224. Explain the following reactions:

- Rosenmund's Reduction
- Cannizzaro's reaction
- Hell-Volhard Zelinsky reaction

225. Calculate $\Delta_r G^\circ$ and $\log K_C$ for the following cell at 25°C :



Given that: $E_{\text{Zn}^{2+}/\text{Zn}}^0 = -0.76 \text{ V}$, $E_{\text{Cd}^{2+}/\text{Cd}}^0 = 0.40 \text{ V}$

$$1\text{F} = 96500 \text{ C mol}^{-1}.$$

226. Define Racemization. Out of S_N1 and S_N2 reactions, which is accompanied by racemization? Give reason in support of your answer.

SECTION - D

The following questions are case based questions. Each question has an internal choice and carries 4(2 + 1 + 1) marks each. Read the passage carefully and answer the questions that follow:

227. Carbohydrates are optically active polyhydroxy aldehydes or ketones or molecules which provide such units on hydrolysis. They are broadly classified into three groups monosaccharides, oligosaccharides and polysaccharides. Monosaccharides are held together by glycosidic linkage to form disaccharides like sucrose, maltose.

Another biomolecule: proteins are polymers of α -amino acids which are linked by peptide bonds. On the basis of number of amino group and carboxyl group, amino acids are classified as acidic, basic or neutral amino acids. Amino acids are amphoteric in nature.

- What is difference between glycosidic linkage and peptide linkage ? The pentacetate of glucose does not react with Hydroxyl amine. What does it indicate?
- Define Oligosaccharides with an example.

OR

- Why amino acids are amphoteric in nature?
- Define Acidic amino acids.

228. Werner proposed the concept of a primary valence and a secondary valence for a metal ion. The primary valences are normally ionisable and are satisfied by negative ions. The secondary valences are non-ionisable. These are satisfied by neutral molecules or negative ions. The secondary valency is equal to the co-ordination number and is normally fixed for a metal. The Valence Bond Theory (VBT) explains the formation, magnetic behaviour and geometrical shapes of co-ordination compounds whereas the Crystal Field Theory (CFT) is based on the effect of different crystal fields on the degeneracy of d-orbitals energies of the central metal atom / ion.

- $[\text{Cr}(\text{NH}_3)_6]^{3+}$ is paramagnetic while $[\text{Ni}(\text{CN})_4]^{2-}$ is diamagnetic. Explain why ? [Atomic number: Cr = 24, Ni = 28]
- Write one difference between a primary valence and a secondary valence.
- What is crystal field splitting energy?

OR

- On the basis of CFT, write the electronic configuration of d^4 orbitals when $\Delta_0 > P$.

SECTION - E

229. (A) (a) Account for the following:

- Transition metals and their compounds show catalytic activities.
- Mn^{3+} is a strong oxidising agent.
- Cu^+ is not stable in aqueous solution.

(b) Write the preparation of KMnO_4 from Pyrolusite ore (MnO_2).

(B) (i) Write the preparation of $\text{Na}_2\text{Cr}_2\text{O}_7$, from FeCr_2O_4 .

(ii) What is Lanthanoid contraction ? Write its two consequences.

(iii) Name two elements of 3d series which show anomalous electronic configuration.

230. (A) (a) 'A' and 'B' are two functional isomers of compound $\text{C}_4\text{H}_8\text{O}$. On heating with NaOH and I_2 , isomer 'B' forms yellow precipitate of iodoform whereas isomer 'A' does not form any precipitate.

- (i) Identify 'A' and 'B'.
- (ii) What happens when isomer 'A' is treated with Zn(Hg) in the presence of Conc. HCl?
- (iii) Write the reaction of isomer 'B' with NaOH and I₂.
- (b) Arrange the following in the increasing order of their property as indicated:
- (i) Ethanol, Ethanoic acid, Ethanal (boiling point).
- (ii) Ethanal, Methanal, acetone (reactivity towards addition of HCN).

OR

- (B) (a) Explain Aldol Condensation with an example. Why alpha (α) hydrogen of aldehydes and ketones are acidic in nature?
- (b) Give simple chemical test to distinguish between the following compounds:
- (i) Benzoic acid and Benzaldehyde
- (ii) Ethanal and Propanal

231. (A) (a) Calculate the boiling point of solution when 6 g of MgSO₄ (Molar mass = 120 g mol⁻¹) was dissolved in 200 g of water, assuming the complete dissociation of MgSO₄ · (K_b for water = 0.52 K kg mol⁻¹).

(b) State Raoult's law for a solution containing volatile components. How Raoult's law is a special case of Henry's law?

OR

(B) (a) The freezing point of a solution containing 5 g of benzoic acid (Molar mass = 122 g mol⁻¹) in 35 g of benzene is depressed by 2.94 K. Calculate the percentage association of benzoic acid if it forms a dimer in solution. (K_f for benzene = 4.9 K kg mol⁻¹)

(b) Define the following terms:

- (i) Ideal Solution
- (ii) Osmotic Pressure

