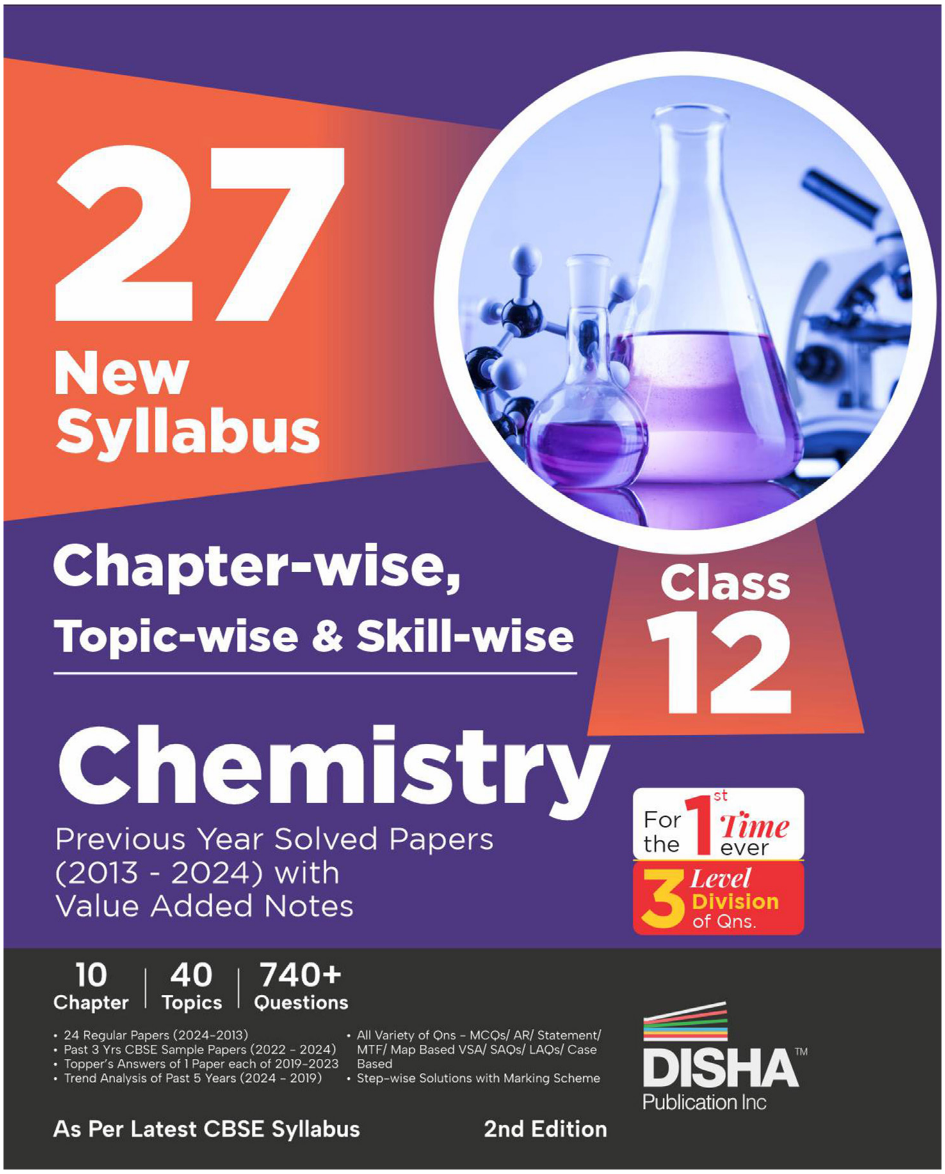
DISHA™
Publication Inc

All India 2024 Solved Paper

This sample is taken from the **"27 New Syllabus Chapter-wise, Topic-wise & Skill-wise CBSE Class 12 Chemistry Previous Year Solved Papers (2013 - 2024) with Value Added Notes 2nd Edition"**



27
New Syllabus
Chapter-wise,
Topic-wise & Skill-wise
Class 12
Chemistry
Previous Year Solved Papers (2013 - 2024) with Value Added Notes
For the 1st Time ever
3 Level Division of Qns.
10 Chapter | 40 Topics | 740+ Questions
- 24 Regular Papers (2024-2013)
- Past 3 Yrs CBSE Sample Papers (2022 - 2024)
- Topper's Answers of 1 Paper each of 2019-2023
- Trend Analysis of Past 5 Years (2024 - 2019)
- All Variety of Qns – MCQs/ AR/ Statement/ MTF/ Map Based VSA/ SAQs/ LAQs/ Case Based
- Step-wise Solutions with Marking Scheme

DISHA™ Publication Inc
As Per Latest CBSE Syllabus
2nd Edition

ISBN - 978-9362257475

Chapterwise Topicwise CBSE 2024
All India and Delhi Solved Paper

Chapter 1 : Solutions

Topic-4: Colligative Properties and Determination of Molar Mass, Abnormal Molar Masses

1 Multiple Choice Questions

1. Isotonic solutions have the same **[Delhi 2024, K]**
(a) density (b) refractive index
(c) osmotic pressure (d) volume

2. Van't Hoff factor for $Na_2SO_4.10H_2O$ solution, assuming complete ionization is **[Delhi 2024, Ap]**
(a) 1 (b) 3
(c) 13 (d) 2

5 Short Answer Questions (2 or 3 Marks)

3. 18 g of a non-volatile solute is dissolved in 200 g of H_2O freezes at 272.07 K. Calculate the molecular mass of solute (K_f for water = 1.86 K kg mol^{-1})
[All India 2024, Ap]

6 Long Answer Questions

4. (a) (i) Define reverse osmosis.
(ii) Why are aquatic species more comfortable in cold water in comparison to warm water?
(iii) A solution containing 2 g of glucose (M = 180 g mol^{-1}) in 100 g of water is prepared at 303 K. If the vapour pressure of pure water at 303 K is 32.8 mm Hg, what would be the vapour pressure of the solution? **[All India 2024, Ap]**

OR

(b) (i) Predict whether Van't Hoff factor will be less or greater than one, when Ethanoic acid is dissolved in benzene. **[All India 2024, Ap]**
(ii) Define ideal solution.
(iii) Calculate the mass of $CaCl_2$ (molar mass = 111 g mol^{-1}) to be dissolved in 500 g of water to lower its freezing point by 2K, assuming that $CaCl_2$ undergoes complete dissociation.
(K_f for water = 1.86 K kg mol^{-1})

5. (a) (i) Ishan's automobile radiator is filled with 1.0 kg of water. How many grams of ethylene glycol (Molar mass = 62 g mol^{-1}) must Ishan add to get the freezing point of the solution lowered to – 2.8 °C. K_f for water is 1.86 K kg. mol^{-1}.
(ii) What type of deviation from Raoult's law is shown by ethanol and acetone mixture? Give reason. **[Delhi 2024, Ap]**

OR

(b) (i) Boiling point of water at 750 mm Hg pressure is 99.68 °C. How much sucrose (Molar mass = 342 g mol^{-1}) is to be added to 500 g of water such that it boils at 100 °C? (K_b for water = 0.52 K kg mol^{-1}). **[Delhi 2024, Ap]**
(ii) State Henry's law and write its any one application.

Chapter 2 : Electrochemistry

Topic-1: Electrochemical Cells, Galvanic Cells

2 Assertion Reason/Two Statement Type Questions

6. **Assertion (A) :** For a Daniell cell, $Zn/Zn^{2+}(1M) \parallel Cu^{2+}(1M)/Cu$ with E°_{cell} = 1.1 V, if the external opposing potential is more than 1.1 V, the electrons flow from Cu to Zn. **[All India 2024, A]**
Reason (R) : Cell acts like a galvanic cell.
(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.

Topic-2: Nernst Equation

5 Short Answer Questions (2 or 3 Marks)

7. Calculate emf of the following cell at 25 °C:
Sn/Sn^{2+} (0.001 M) $\parallel$ H^+ (0.01 M) | $H_2(g)$ (1 bar) | Pt(s)
Given: $E^\circ(Sn^{2+}/Sn) = -0.14$ V, E° H^+/H_2 = 0.00 V (log 10 = 1) **[All India 2024, Ap]**

8. Calculate the emf of the following cell: **[Delhi 2024, Ap]**
$Ni(s) + 2Ag^+(0.01\ M) \longrightarrow Ni^{2+}\ (0.1\ M) + 2Ag(s)$
Given that E°_{cell} = 1.05 V, log 10 = 1

Topic-3: Conductance of Electrolytic Solutions

1 Multiple Choice Questions

9. The molar ionic conductivities of Ca^{2+} and Cl^- are 119.0 and 76.3 S cm^2 mol^{-1} respectively. The value of limiting molar conductivity of $CaCl_2$ will be:
[All India 2024, Ap]
(a) 195.3 S cm^2 mol^{-1} (b) 43.3 S cm^2 mol^{-1}
(c) 314.3 S cm^2 mol^{-1} (d) 271.6 S cm^2 mol^{-1}

10. Dilution affects both conductivity as well as molar conductivity. Effect of dilution on both is as follows: **[Delhi 2024, U]**

(a) both increase with dilution.
(b) both decrease with dilution.
(c) conductivity increases whereas molar conductivity decreases on dilution.
(d) conductivity decreases whereas molar conductivity increases on dilution.

5 *Short Answer Questions (2 or 3 Marks)*

11. State: **[Delhi 2024, K]**

(a) Kohlrausch law of independent migration of ions.
(b) Faraday's first law of electrolysis. **[Delhi 2024, K]**

12. Resistance of a conductivity cell filled with 0.2 mol L^{-1} KCl solution is 200 Ω. If the resistance of the same cell when filled with 0.05 mol L^{-1} KCl solution is 620 Ω, calculate the conductivity and molar conductivity of 0.05 mol L^{-1} KCl solution. The conductivity of 0.2 mol L^{-1} KCl solution is 0.0248 S cm^{-1}. **[Delhi 2024, Ap]**

Topic-4: Electrolytic Cells and Electrolysis

7 *Case Based Questions*

13. In a galvanic cell, chemical energy of a redox reaction is converted into electrical energy, whereas in an electrolytic cell the redox reaction occurs on passing electricity. The simplest galvanic cell is in which Zn rod is placed in a solution of $ZnSO_4$ and Cu rod is placed in a solution of $CuSO_4$. The two rods are connected by a metallic wire through a voltmeter. The two solutions are joined by a salt bridge. The difference between the two electrode potentials of the two electrodes is known as electromotive force. In the process of electrolysis, the decomposition of a substance takes place by passing an electric current. One mole of electric charge when passed through a cell will discharge half a mole of a divalent metal ion such as Cu^{2+}. This was first formulated by Faraday in the form of laws of electrolysis.

Answer the following questions: **[All India 2024, A]**

(a) What is the function of a salt bridge in a galvanic cell?
(b) When does galvanic cell behave like an electrolytic cell?
(c) Can copper sulphate solution be stored in a pot made of zinc? Explain with the help of value of E° cell.
($E° Cu^{2+}/Cu = 0.34$ V)
($E° Zn^{2+}/Zn = – 0.76$ V)

OR

(c) How much charge in terms of Faraday is required for the following:
(i) 1 mol of MnO_4^- to Mn^{2+}
(ii) 1 mol of H_2O to O_2

Topic-5: Batteries, Fuel Cells, Corrosion

1 *Multiple Choice Questions*

14. Which of the following cell was used in Apollo space programme? **[Delhi 2024, K]**

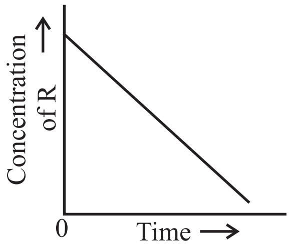
(a) Mercury cell	(b) $H_2 – O_2$ fuel cell
(c) Dry cell	(d) Ni-Cd cell

Chapter 3 : Chemical Kinetics

Topic-1: Rate of a Chemical Reaction

1 *Multiple Choice Questions*

15. In a given graph of zero order reaction, the slope and intercept are: **[All India 2024, A]**



(a) Slope = k, Intercept = $[R]_0$
(b) Slope = –k, Intercept = $[R]_0$
(c) Slope = k/2.303, Intercept = $\ln[R]_0$
(d) Slope = –k/2.303, Intercept = ln A

Topic-2: Factors Influencing Rate of a Reaction, Integrated Rate Equations

1 *Multiple Choice Questions*

16. The rate of a reaction increases sixteen times when the concentration of the reactant increases four times. The order of the reaction is **[Delhi 2024, A]**

(a) 2.5	(b) 2.0
(c) 1.5	(d) 0.5

2 *Assertion Reason/Two Statement Type Questions*

17. **Assertion (A):** The units of rate constant of a zero order reaction and rate of reaction are the same. **[Delhi 2024, A]**

Reason (R): In zero order reaction, the rate of reaction is independent of the concentration of reactants.

(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.

5 *Short Answer Questions (2 or 3 Marks)*

18. Show that the time required for 99.9% completion in a first order reaction is 10 times of half-life ($t_{1/2}$) of the reaction [log 2 = 0.3010, log 10 = 1].

[All India 2024, Ap]

19. Show that in case of a first order reaction, the time taken for completion of 99% reaction is twice the time required for 90% completion of the reaction. (log 10 = 1)

[Delhi 2024, Ap]

Topic-3: Temperature Dependence of the Rate of a Reaction and Collision Theory

1 *Multiple Choice Questions*

20. The correct Mathematical expression of Arrhenius equation is **[All India 2024, K]**

(a) $k = -A_e{}^{E_a/RT}$
(b) $k = e^{E_a/RT}$
(c) $k = A_e{}^{-E_a/RT}$
(d) $k = -Ae^{-E_a/RT}$

5 *Short Answer Questions (2 or 3 Marks)*

21. Define the following terms: **[All India 2024, K]**

(a) Order of a reaction
(b) Activation energy

22. The rate constant of a reaction quadruples when the temperature changes from 300 K to 320 K. Calculate the activation energy for this reaction. **[Delhi 2024, Ap]**
[log 2 = 0.30, log 4 = 0.60, 2.303 R = 19.15 J $K^{-1}mol^{-1}$]

Chapter 4 : The *d* and *f*-Block Elements

Topic-1: Position in the Periodic Table, Electronic Configurations of the d-Block Elements, General Properties of the Transition Elements (d-Block)

1 *Multiple Choice Questions*

23. From the elements of 3d series given below, which element shows the maximum number of oxidation states?

[All India 2024, A]

(a) Scandium
(b) Manganese
(c) Chromium
(d) Titanium

24. The general electronic configuration of d-block elements is: **[All India 2024, U]**

(a) $(n-1)\ d^{1-10}\ ns^{1-2}$
(b) $(n-1)\ d^{10}\ ns^{1-2}$
(c) $(n-1)\ d^{10}\ ns^{2-3}$
(d) $(n-1)\ d^{0}\ ns^{1-2}$

25. Transition metals are known to make interstitial compounds. Formation of interstitial compounds makes the transition metal **[Delhi 2024, U]**

(a) more hard
(b) more soft
(c) more ductile
(d) more metallic

Topic-2: Some Important Compounds of Transition Elements

6 *Long Answer Questions*

26. Attempt any **five** of the following:

(a) Why Zinc is not regarded as a transition element?

[All India 2024, U]

(b) What is Lanthanoid contraction? **[All India 2024, K]**

(c) Why is first ionization enthalpy of chromium lower than that of Zn? **[All India 2024, U]**

(d) Why are transition elements good catalysts?

[All India 2024, U]

(e) Compounds of transition metals are generally coloured. Give reason. **[All India 2024, U]**

(f) Out of $KMnO_4$ and K_2MnO_4, which one is paramagnetic and why? **[All India 2024, U]**

(g) Complete the following ionic equation:
$Cr_2O_7^{2-} + 14\ H^+ + 6e^- \longrightarrow$ **[All India 2024, Ap]**

27. Attempt any **five** of the following:

(a) Ce(III) is easily oxidised to Ce(IV). Comment.

[Delhi 2024, U]

(b) E°(Mn^{2+}/Mn) is –1.18 V. Why is this value highly negative in comparison to neighbouring d block elements? **[Delhi 2024, U]**

(c) Which element of 3d series has lowest enthalpy of atomisation and why? **[Delhi 2024, U]**

(d) What happens when sodium chromate is acidified?

[Delhi 2024, U]

(e) Zn, Cd and Hg are soft metals. Why?

[Delhi 2024, U]

(f) Why is permanganate titration not carried out in the presence of HCl? **[Delhi 2024, U]**

(g) The lower oxides of transition metals are basic whereas the highest are amphoteric/acidic. Give reason. **[Delhi 2024, U]**

Topic-3: The Lanthanoids, The Actinoids

2 *Assertion Reason/Two Statement Type Questions*

28. **Assertion (A):** Zr and Hf are of almost similar atomic radii. **[Delhi 2024, A]**

Reason (R): This is due to Lanthanoid contraction.

(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.

Chapter 5 : Coordination Compounds

Topic-2: Nomenclature of Coordination Compounds

5 Short Answer Questions (2 or 3 Marks)

29. Write the IUPAC names of the following coordination compounds (any three):

(a) $[Co(NH_3)_4Cl\,(NO_2)]Cl$ **[Delhi 2024, Ap]**
(b) $[Ni(NH_3)_6]Cl_2$ **[Delhi 2024, Ap]**
(c) $K_3[Cr(C_2O_4)_3]$ **[Delhi 2024, Ap]**
(d) $[Co(en)_2Br_2]^+$ **[Delhi 2024, Ap]**

Topic-3: Isomerism in Coordination Compounds

7 Case Based Questions

30. The oxidation number of the central atom in a complex is defined as the charge it would carry if all the ligands are removed along with the electron pairs that are shared with the central atom. Similarly the charge on the complex is the sum of the charges of the constituent parts i.e. the sum of the charges on the central metal ion and its surrounding ligands. Based on this, the complex is called neutral if the sum of the charges of the constituents is equal to zero. However, for an anion or cationic complex, the sum of the charges of the constituents is equal to the charge on the coordination sphere. **[Delhi 2024, A]**

Based on the above information, answer the following questions:

(a) Define ambidentate ligand with an example.
(b) What type of isomerism is shown by $[Co(NH_3)_5Cl]SO_4$ and $[Co(NH_3)_5SO_4]Cl$?
(c) Define Chelate effect. How it affects the stability of complex?

OR

(c) Find the coordination number and oxidation state of chromium in $Na_3[Cr(C_2O_4)_3]$.

Topic-4: Bonding in Coordination Compounds

5 Short Answer Questions (2 or 3 Marks)

31. (a) Draw the geometrical isomers of the given complex: $[Pt(en)_2Cl_2]^{2+}$ **[All India 2024, Ap]**
(b) Write the electronic configuration for d^4 ion if $\Delta_0 < P$ on the basis of crystal field theory. **[All India 2024, Ap]**
(c) What is meant by a unidentate ligand? Give an example. **[All India 2024, K]**

7 Case Based Questions

32. The nature of bonding, structure of the coordination compound can be explained to some extent by valence bond theory. The central metal atom/ion makes available a number of vacant orbitals equal to its coordination number. The appropriate atomic orbitals (s, p and d) of the metal hybridise to give a set of equivalent orbitals of definite geometry such as square planar, tetrahedral, octahedral and so on. A strong covalent bond is formed only when the orbitals overlap to the maximum extent. The d-orbitals involved in the hybridisation may be either inner d-orbitals i.e. (n–1) d or outer d-orbitals i.e. nd. The complexes formed are called inner orbital complex (low spin complex) and outer orbital complex (high spin complex) respectively. Further, the complexes can be paramagnetic or diamagnetic in nature. The drawbacks of this theory are that this involves number of assumptions and also does not explain the colour of the complex.

Answer the following questions: **[All India 2024, A]**

(a) Predict whether $[CoF_6]^{3-}$ is diamagnetic or paramagnetic and why?
[Atomic number : Co = 27]
(b) What is the coordination number of Co in $[Co(en)_2Cl_2]^+$?
(c) (i) Write the IUPAC name of the given complex: $[Pt(NH_3)_2Cl_2]^{2+}$
(ii) Explain $[Co(NH_3)_6]^{3+}$ is an inner orbital or outer orbital complex.

OR

(c) Using valence bond theory, deduce the shape and hybridisation of $[Ni(NH_3)_6]^{2+}$ [Atomic number of Ni = 28]

Chapter 6 : Haloalkanes and Haloarenes

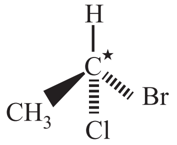
Topic-4: Physical Properties, Chemical Reactions

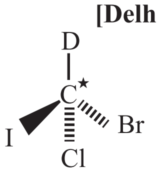
1 Multiple Choice Questions

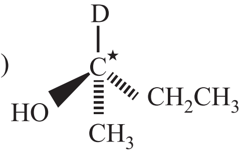
33. Which alkyl halide from the given options will undergo S_N1 reaction faster? **[All India 2024, A]**

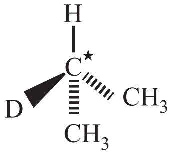
(a) $(CH_3)_3\,C–Br$ (b) $(CH_3)_2CH–Br$
(c) $CH_3–CH_2–Br$ (d) $(CH_3)_3C–CH_2–Br$

34. In which of the following molecules, C atom marked with asterisk is chiral? **[Delhi 2024, A]**

(I)


(II)


(III)


(IV)


(a) I, II, III (b) I, II, III, IV
(c) II, III, IV (d) I, III, IV

2 *Assertion Reason/Two Statement Type Questions*

35. **Assertion (A):** Inversion of configuration is observed in S_N2 reaction. **[Delhi 2024, A]**

Reason (R): The reaction proceeds with the formation of carbocation.

(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.

5 *Short Answer Questions (2 or 3 Marks)*

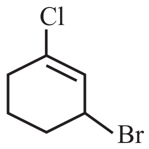
36. (a) Which compound in the given pair would undergo S_N2 reaction at a faster rate and why? **[All India 2024, A]**

$CH_3 – CH_2 – I$ and $CH_3 – CH_2 – Br$

OR

(b) Arrange the following compounds in the increasing order of their boiling points: **[All India 2024, Ap]**

37. (a) Write the IUPAC name of the given compound: **[All India 2024, Ap]**



(b) The presence of $–NO_2$ group at ortho or para position increases the reactivity of haloarenes towards nucleophilic substitution reactions. Give reason to explain the above statement. **[All India 2024, U]**

(c) What happens when ethyl chloride is treated with alcoholic potassium hydroxide? **[All India 2024, Ap]**

38. Account for the following:

(a) Haloalkanes react with AgCN to form isocyanide as main product. **[Delhi 2024, U]**

(b) Allyl chloride shows high reactivity towards S_N1 reaction. **[Delhi 2024, U]**

(c) Haloarenes are extremely less reactive towards nucleophilic substitution reactions. **[Delhi 2024, U]**

Topic-5: Polyhalogen Compounds

1 *Multiple Choice Questions*

39. Auto-oxidation of chloroform in air and light produces a poisonous gas known as **[Delhi 2024, A]**

(a) Phosphine (b) Mustard gas

(c) Phosgene (d) Tear gas

Chapter 7 : Alcohols, Phenols and Ethers

Topic-2: Alcohols and Phenols, Some Commercially Important Alcohols

1 *Multiple Choice Questions*

40. Nucleophilic addition of Grignard reagent to ketones followed by hydrolysis with dilute acids forms: **[All India 2024, Ap]**

(a) Alkene (b) Primary alcohol

(c) Tertiary alcohol (d) Secondary alcohol

41. Out of the following alkenes, the one which will produce tertiary butyl alcohol on acid catalysed hydration is

(a) $CH_3CH_2CH = CH_2$ **[Delhi 2024, A]**

(b) $CH_3 CH = CH_2$

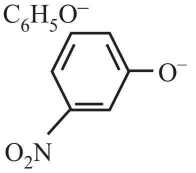
(c) $CH_3 – CH = CH – CH_3$

(d) $(CH_3)_2C = CH_2$

42. Which of the following species can act as the strongest base? **[Delhi 2024, A]**

(a) $OH^–$ (b) $C_6H_5O^–$

(c) $RO^–$ (d)



2 *Assertion Reason/Two Statement Type Questions*

43. **Assertion (A) :** *p*-nitrophenol is less acidic than phenol.

Reason (R) : Nitro group is electron withdrawing and helps in the stabilisation of *p*-nitrophenoxide ion. **[All India 2024, A]**

(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.

44. **Assertion (A):** p-methoxyphenol is a stronger acid than p-nitrophenol. **[Delhi 2024, A]**

Reason (R): Methoxy group shows +I effect whereas nitro group shows –I effect.

(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.

3 *Matching Based Questions*

45. Match the reagents required for the given reactions:

[All India 2024, A]

I.	Oxidation of primary alcohols to aldehydes	(p)	$NaBH_4$
II.	Butan-2-one to Butan-2-ol	(q)	85% phosphoric acid at 440 K
III.	Bromination of Phenol to 2, 4, 6-Tribromophenol	(r)	PCC
IV.	Dehydration of propan-2-ol to propene	(s)	Bromine water

(a) I - (r), II - (p), III - (s), IV - (q)
(b) I - (q), II - (r), III - (p), IV - (s)
(c) I - (s), II - (q), III - (p), IV - (r)
(d) I - (p), II - (s), III - (r), IV - (q)

5 *Short Answer Questions (2 or 3 Marks)*

46. Write chemical equations for the following reactions: (Do any **three**)
(a) Hydroboration - oxidation reaction **[All India 2024, A]**
(b) Williamson Synthesis **[All India 2024, A]**
(c) Friedel-Crafts Alkylation of Anisole **[All India 2024, A]**
(d) Reimer-Tiemann Reaction **[All India 2024, A]**

Chapter 8 : Aldehydes, Ketones and Carboxylic Acids

Topic-2: *Preparation of Aldehydes and Ketones*

1 *Multiple Choice Questions*

47. Rosenmund reduction is used for the preparation of Aldehydes. The catalyst used in this reaction is

[All India 2024, K]

(a) $Pd – BaSO_4$ (b) Anhydrous $AlCl_3$
(c) Iron (III) oxide (d) $HgSO_4$

Topic-3: *Physical Properties, Chemical Reactions, Uses of Aldehydes and Ketones*

1 *Multiple Choice Questions*

48. Consider the following reaction:

$$H_2C=O + H_2C=O + \text{Conc. KOH} \xrightarrow{\Delta} A + B$$

Identify A and B from the given options:

[All India 2024, Ap]

(a) A - Methanol, B - Potassium formate
(b) A - Ethanol, B - Potassium formate
(c) A - Methanal, B - Ethanol
(d) A - Methanol, B - Potassium acetate

5 *Short Answer Questions (2 or 3 Marks)*

49. (a) Write the stepwise mechanism of nucleophilic addition reactions in the carbonyl compounds.

[All India 2024, Ap]

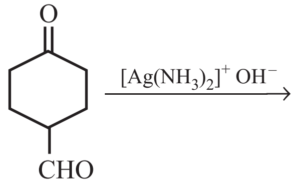
OR

(b) How will you convert the following:
(i) Toluene to benzoic acid. **[All India 2024, Ap]**
(ii) Ethanol to 3-Hydroxybutanal

50. Give the structure of the major product expected from the following reactions:
(a) Reaction of Ethanal with methyl-magnesium bromide followed by hydrolysis. **[Delhi 2024, Ap]**
(b) Hydration of But-1-ene in the presence of dilute sulphuric acid. **[Delhi 2024, Ap]**
(c) Reaction of phenol with bromine water.

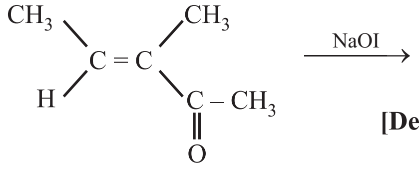
51. Draw the structures of major product(s) in each of the following reactions:

(a)



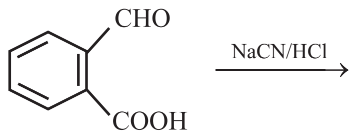
[Delhi 2024, Ap]

(b)



[Delhi 2024, Ap]

(c)



[Delhi 2024, Ap]

6 *Long Answer Questions*

52. (a) An organic compound (A) with the molecular formula $C_9H_{10}O$ forms 2, 4-DNP derivative, reduces Fehling solution and undergoes Cannizzaro reaction. On vigorous oxidation, it gives 1, 2-benzene dicarboxylic acid.
(i) Identify the compound (A) and write its IUPAC name. **[Delhi 2024, A]**

(ii) Write the reaction of compound (A) with

(1) 2, 4-Dinitrophenyl hydrazine and

(2) Fehling solution

(iii) Write the equation of compound (A) when it undergoes Cannizzaro reaction.

OR

(b) (i) Account for the following:

(1) The alpha (α)-hydrogens of aldehydes and ketones are acidic in nature.

(2) Oxidation of aldehydes is easier than ketones. **[Delhi 2024, Ap]**

(ii) Arrange the following in:

(1) Decreasing reactivity towards nucleophilic addition reaction propanal, acetone, benzaldehyde.

(2) Increasing order of boiling point:

Propane, Ethanol, Dimethylether, Propanal

(iii) Give simple chemical test to distinguish between Benzoic acid and Benzaldehyde.

Topic-5: Physical Properties, Chemical Reactions, Uses of Carboxylic Acids

2 Assertion Reason/Two Statement Type Questions

53. **Assertion (A) :** Benzoic acid does not undergo Friedel - Crafts reaction.

Reason (R) : Carboxyl group is deactivating and the catalyst aluminium chloride gets bonded to the carboxyl group. **[All India 2024, A]**

(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.

5 Short Answer Questions (2 or 3 Marks)

54. (a) Give chemical tests to distinguish between the following pairs of compounds: **[All India 2024, U]**

(i) Phenol and Benzoic acid

(ii) Propanal and Propanone

(b) Which one of the given compounds is a stronger acid and why? **[All India 2024, U]**

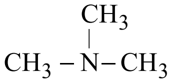
$CH_2FCH_2CH_2COOH$ or CH_3CHFCH_2COOH

Chapter 9 : Amines

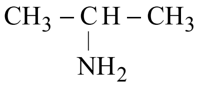
Topic-1: Structure of Amines, Classification, Nomenclature

1 Multiple Choice Questions

55. Identify the tertiary amine from the following: **[All India 2024, A]**

(a) 

$CH_3-\overset{\overset{CH_3}{|}}{N}-CH_3$

(b) 

$CH_3-\underset{\underset{NH_2}{|}}{C}H-CH_3$

(c) $CH_3-NH-CH_2-CH_3$

(d) $(C_2H_5)_2CHNH_2$

Topic-3: Physical Properties, Chemical Reactions

5 Short Answer Questions (2 or 3 Marks)

56. A compound 'X' with molecular formula C_3H_9N reacts with $C_6H_5SO_2Cl$ to give a solid, insoluble in alkali. Identify 'X' and give the IUPAC name of the product. Write the reaction involved. **[Delhi 2024, A]**

6 Long Answer Questions

57. (a) An amide 'A' with molecular formula C_7H_7ON undergoes Hoffmann Bromamide degradation reaction to give amine 'B'. B' on treatment with nitrous acid at 273-278 K form 'C' and on treatment with chloroform and ethanolic potassium hydroxide forms 'D'. 'C' on treatment, with ethanol gives 'E'. Identify 'A', 'B', 'C' 'D' and 'E' and write the sequence of chemical equations. **[All India 2024, A]**

OR

(b) (i) (1) What is Hinsberg's reagent?

(2) Arrange the following compounds in the increasing order of their basic strength in gaseous phase: **[All India 2024, U]**

$C_2H_5NH_2$, $(C_2H_5)_3$ N, $(C_2H_5)_2$ NH

(ii) Give reasons for the following:

(1) Methyl amine is more basic than aniline.

(2) Aniline readily reacts with bromine water to give 2, 4, 6- tribromoaniline.

(3) Primary amines have higher boiling points than tertiary amines.

Topic-4: *Method of Preparation of Diazonium Salts, Physical Properties, Chemical Reactions, Importance of Diazonium Salts in Synthesis of Aromatic Compounds*

1 *Multiple Choice Questions*

58. The correct name of the given reaction is

$$Ar - N_2^+X^- \xrightarrow{CuCN/KCN} Ar - CN + N_2$$

(a) Sandmeyer's reaction **[Delhi 2024, K]**
(b) Gabriel Phthalimide synthesis
(c) Carbyl amine reaction
(d) Hoffmann bromamide degradation reaction

5 *Short Answer Questions (2 or 3 Marks)*

59. (a) Carry out the following conversions:
(i) Nitrobenzene to Aniline **[Delhi 2024, Ap]**
(ii) Aniline to Phenol

OR

(b) (i) Write a chemical test to distinguish between Dimethyl amine and Ethanamine. **[Delhi 2024, Ap]**
(ii) Write the product formed when benzene diazonium chloride is treated with KI.

Chapter 10 : Biomolecules

Topic-1: *Carbohydrates*

2 *Assertion Reason/Two Statement Type Questions*

60. **Assertion (A) :** Fructose is a reducing sugar.
Reason (R) : Fructose does not reduce Fehling solution and Tollen's reagent. **[All India 2024, A]**
(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.

5 *Short Answer Questions (2 or 3 Marks)*

61. Classify the following sugars into monosaccharides and disaccharides: Galactose, Glucose, Lactose and Maltose **[Delhi 2024, A]**

Topic-2: *Proteins, Enzymes*

1 *Multiple Choice Questions*

62. The specific sequence in which amino acids are arranged in a protein is called its **[Delhi 2024, K]**
(a) Primary structure (b) Secondary structure
(c) Tertiary structure (d) Quaternary structure

5 *Short Answer Questions (2 or 3 Marks)*

63. Explain the following terms:
(a) Essential amino acids **[All India 2024, K]**
(b) Peptide bond **[All India 2024, K]**
(c) Denaturation **[All India 2024, K]**

Topic-3: *Vitamins, Nucleic Acids, Hormones*

1 *Multiple Choice Questions*

64. Which of the following acids represents Vitamin C? **[All India 2024, K]**
(a) Saccharic acid (b) Gluconic acid
(c) Ascorbic acid (d) Benzoic acid

5 *Short Answer Questions (2 or 3 Marks)*

65. (a) What happens when glucose reacts with bromine water? Write chemical equation. **[All India 2024, A]**
(b) Two bases are mentioned below, identify which is present in DNA and which one is present in RNA:
(i) Thymine, (ii) Uracil. **[All India 2024, A]**

7 *Case Based Questions*

66. Certain organic compounds are required in small amounts in our diet but their deficiency causes specific disease. These compounds are called vitamins. Most of the vitamins cannot be synthesized in our body but plants can synthesize almost all of them. So they are considered as essential food factors. However, the bacteria of the gut can produce some of the vitamins required by us. All the vitamins are generally available in our diet. The term 'vitamin' was coined from the words vital + amine, since the earlier identified compounds had amino group. Vitamins are classified into two groups depending upon their solubility in water or fat namely-fat soluble vitamins and water soluble vitamins. **[Delhi 2024, A]**

Answer the following questions:
(a) What is the other name of vitamin B_6?
(b) Name the vitamin whose deficiency causes increased blood clotting time.
(c) Xerophthalmia is caused by the deficiency of which vitamin? Give two sources of this vitamin.

OR

(c) Why can't vitamin C be stored in our body? Name the disease caused by the deficiency of this vitamin.

Solutions

Chapter 1 : Solutions

Topic-4: Colligative Properties and Determination of Molar Mass, Abnormal Molar Masses

1. **(c)** Isotonic solutions have equal osmotic pressure due to which there is no net flow of solvent / water across them.

2. **(b)** $Na_2SO_4 \cdot 10H_2O$ dissociates into $2Na^+$, SO_4^{2-} and $10H_2O$. The water of crystallization is not counted in the Van't Hoff factor as it is the solvent.

Thus, i = 2 + 1 = 3.

3. $$M_2 = \frac{K_f \times W_2 \times 1000}{\Delta T_f \times W_1} \quad \textbf{(1)}$$

$$= \frac{1.86 \times 18 \times 1000}{(273.15 - 272.07) \times 200} = 155 \text{ g mol}^{-1}. \quad \textbf{(1)}$$

4. (i) When the externally applied pressure on the impure water side becomes greater than the osmotic pressure, water flows into the pure form side against the natural osmotic flow and this is called reverse osmosis. **(1)**

(ii) In cold water, there is a greater concentration of oxygen for breathing due to higher solubility of gases at lower temperature.

Thus, aquatic species are more comfortable in cold water. **(1)**

(iii) Moles of H_2O :

$$n_{H_2O} = \frac{100 \text{ g}}{18 \text{ g mol}^{-1}} = 5.56 \text{ mol} \quad \textbf{(½)}$$

$$n_{C_6H_{12}O_6} = \frac{2 \text{ g}}{180 \text{ g mol}^{-1}} = 0.0111 \text{ mol} \quad \textbf{(½)}$$

$\Rightarrow$ Total moles = 5.56 + 0.0111 = 5.571 mol

$\Rightarrow$ Mole fraction of water $x_{H_2O} = \frac{5.56}{5.571} = 0.998$ **(1)**

Using Raoult's Law :

$P_{solution}$ (non-volatile solute) $= P^o_{H_2O} \times x_{H_2O}$

= 32.8 × 0.998

= 32.73 mm Hg **(1)**

OR

(b) (i) Ethanoic acid in benzene would undergo association or dimerization due to which the number of particles would be haved and thus i ≅ 0.5. **(1)**

> ***Note***
>
> *Acetic acid undergoes association in benzene but dissociates in water.*

(ii) An ideal solution is a solution that follows Raoult's law over an appreciable range of concentrations. **(1)**

(iii) $$\Delta T_f = iK_f m = iK_f \left[\frac{W_2 \times 1000}{M_2 \times W_1}\right] \quad \textbf{(1)}$$

$$\Rightarrow W_2 = \frac{\Delta T_f M_2 W_1}{1000 \times i \times K_f} = \frac{2 \times 111 \times 500}{1000 \times 3 \times 1.86}$$

= 19.89 g **(1 + 1)**

5. (a) (i) $$\Delta T_f = K_f \left[\frac{W_2 \times 1000}{M_2 \times W_1}\right] \quad \textbf{(1)}$$

$$2.8K = 1.86\left[\frac{W_2 \times 1000}{62 \times 1000}\right]$$

$= 0.03 \times W_2$ **(1)**

$\Rightarrow W_2 = 93.34$ g **(1)**

(ii) A mixture of ethanol and Acetone show positive deviation from Roult's law. **(1)**

This is so because addition of acetone breaks some hydrogen bonds and thus more ethanol molecule are evaporated. **(1)**

OR

(b) (i) $\Delta T_b = T_b' - T_b = 100 - 99.63 = 0.37^\circ$ C

$= 0.37$ K **(1)**

$$\text{Molality} = \frac{W_2 \times 1000}{M_2 \times W_1} = \frac{W_2 \times 1000}{342 \times 500}$$

$$= \frac{W_2}{171}$$ **(1)**

Now, $\Delta T_b = K_b \times$ molality

$$\Rightarrow 0.37 = 0.52 \times \frac{W_2}{171} \Rightarrow W_2 = 121.67 \text{ g}$$ **(1)**

(ii) According to Henry's law the solubility of gas in a liquid is directly proportional to the partial pressure of the gas present above the surface of the liquid or solution. **(1)**

Application :

To increase the solubility of CO_2 in soft drinks and soda water, the bottle is sealed under high pressure. **(1)**

Chapter 2 : Electrochemistry

Topic-1: *Electrochemical Cells, Galvanic Cells*

6. **(c)** When the external applied voltage is greater than standard cell potential, the cell becomes an electrolytic cell and current flows in the opposite direction

Thus, (A) is true but (R) is false.

Topic-2: *Nernst Equation*

7. According to nernst equation (at 25° C) :

$$E_{cell} = E^o_{cell} - \frac{0.0591}{n} \log \frac{[\text{Anode}]^n}{[\text{Cathode}]^m}$$ **(1)**

Now, $E^o_{cell} = E^o_{cathode} - E^o_{anode} = (0.00\text{V}) - (-0.14 \text{ V})$.

$= + 0.14$ V. **(½)**

Here, n = 2 (electrons transferred). **(½)**

$$\text{Thus, } E_{cell} = (0.14) - \frac{0.0591}{2} \log \frac{(0.001)}{(0.01)^2}$$

$= 0.14 - 0.02955 \log 10$

$= 0.14 - 0.02955 = 0.11045$ V. **(1)**

8. $$E_{cell} = E^o_{cell} - \frac{0.0591}{n} \log \frac{[\text{Anode}]^m}{[\text{Cathode}]^n}$$ **(½)**

$$= (1.05) - \frac{0.0591}{2} \log \frac{(0.1)}{(0.01)^2}$$ **(1)**

$= (1.05) - [0.02955 \times 3]$ **(1)**

$= + 0.961$ V **(½)**

Topic-3: *Conductance of Electrolytic Solutions*

9. **(d)** $CaCl_2 (s) \rightleftharpoons Ca^{2+} (aq) + 2Cl^- (aq)$

Thus, $\Lambda^0_m = \lambda^0_+ + \lambda^0_- = 119.0 + (2 \times 76.3)$

$= 271.6 \text{ S cm}^2 \text{ mol}^{-1}$

10. **(d)** Conductivity decreases upon dilution (decrease in concentration) due to a decrease in the number of ions per unit volume.

Molar conductivity increases on dilution due to an increase in the volume that contains one mole of ions.

11. (a) According to Kohlrausch law of independent migration of ions, the limiting molar conductivity of an electrolyte is the sum of the limiting molar conductivities of the cations and the anions. **(1)**

(b) The amount of chemical reaction which occurs at any electrode during electrolysis by a current is proportional to the quantity of electricity passed through the electrolyte. **(1)**

12. Cell constant $(G^*) = \kappa \times R = 0.0248 \times 200 = 4.96 \text{ cm}^{-1}$

(½)

$$\Rightarrow \text{Conductivity of 0.05 M KCl solution } (\kappa) = \frac{G^*}{R}$$

$$= \frac{496 \text{ m}^{-1}}{620 \ \Omega}$$

$= 0.8 \text{ Sm}^{-1}$ **(½)**

Now, concentration C = 0.05 mol L^{-1}

$= 1000 \times 0.05 \text{ mol m}^{-3} = 50 \text{ mol m}^{-3}$ **(½)**

$$\Rightarrow \Lambda_m = \frac{\kappa}{C} = \frac{0.8}{50} = 0.016 \text{ Sm}^2 \text{ mol}^{-1}$$

$= 160 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$ **(½)**

Topic-4: Electrolytic Cells and Electrolysis

13. (a) A salt bridge performes the following functions :

- Connects the two half-cells.
- Maintains electrical neutrality of the cells. **(1)**

(b) When the external voltage applied becomes greater than the EMF of the cell, a Galvanic cell becomes an electrolytic cell. **(1)**

(c) Since $E^o_{Cu^{2+}/Cu}$, > $E^o_{Zn^{2+}/Zn}$, Cu^{2+} will be reduced to Cu(s) by Zn in the pot and therefore we cannot store $CuSO_4$ in Zn pot. **(1)**

OR

(c) (i) $\overset{+7}{MnO_4^-} \longrightarrow \overset{+2}{Mn^{2+}}$

Thus, for one mole of MnO_4^- to be reduced to Mn^{2+}, we will need a change in oxidation state of +5 so we will need 5 moles or 5 Faraday of electricity. **(1)**

(ii) $H_2O \longrightarrow H_2 + \frac{1}{2}O_2$

This change involves release of two moles of electrons by oxidation of H_2O so 2F of electricity is involved.

(1)

Topic-5 Batteries, Fuel Cells, Corrosion

14. **(b)** $H_2 - O_2$ fuel cell was used in the Apollo space programme to provide electrical power.

Chapter 3 : Chemical Kinetics

Topic-1: Rate of a Chemical Reaction

15. **(b)** $y = mx + C \Rightarrow [R] = [-K]t + [R]_0$

Thus, slope = – k and y – intercept = $[R]_0$

Topic-2: Factors Influencing Rate of a Reaction, Integrated Rate Equations

16. **(b)** $r_1 = K[A]^n$ and $r_2 = K\,[4A]^n$

$= K \times 4^n \times [A]^n$

$= 4^n r_1 = 16$

$\Rightarrow \frac{r_2}{r_1} = 4^n = 16 \Rightarrow n = 2$

17. **(a)** Rate $= k[A]^n = k[A]^0 = k$

Thus, unit of Rate and k will be the same for a zero order reaction.

18. For a first order reaction:

$$t = \frac{2.303}{k}\log\frac{a}{a-x} \qquad \textbf{(½)}$$

Thus, for 99.9% completion :

$$t_{99.9} = \frac{2.303}{k}\log\frac{100}{100-99.9} = \frac{2.303}{k}\log\frac{100}{0.1}$$

$$= \frac{2.303}{k}\log(1000)$$

$$= \frac{2.303}{k}\times 3 \qquad \textbf{(1)}$$

For 50% completion (half lite) :

$$t_{50} = t_{1/2} = \frac{2.303}{k}\log\frac{100}{100-50} = \frac{2.303}{k}\log\frac{100}{50}$$

$$= \frac{2.303}{k}\log 2 = \frac{2.303}{k}\times 0.301 \qquad \textbf{(1)}$$

$$\Rightarrow \frac{t_{99.9}}{t_{50}} \cong 10 \text{ times} \qquad \textbf{(½)}$$

19. For a first order reaction:

$$t = \frac{k}{2.303}\log\frac{a}{a-x} \qquad \textbf{(½)}$$

$$\text{Thus, } t_{99\%} = \frac{k}{2.303}\log\frac{100}{100-99} = \frac{k}{2.303}\times 2 \qquad \textbf{(½)}$$

$$t_{90\%} = \frac{k}{2.303}\log\frac{100}{100-90} = \frac{k}{2.303}\times 1 \qquad \textbf{(½)}$$

$$t_{99\%} = 2 \times t_{90\%} \qquad \textbf{(½)}$$

Topic-3: Temperature Dependence of the Rate of a Reaction and Collision Theory

20. **(c)** Arrhenius equation : $k = A_e^{-E_a/RT}$

21. (a) The order of a reaction is the sum of the exponents of the reactants in the rate law expression, determined experimentally. **(1)**

(b) Activation energy is the minimum amount of energy required to initiate a chemical reaction.

It is denoted by E_a. **(1)**

> **Note**
>
> *Activation energy can be calculated from Arrhenius equation* $k = Ae^{-E_a/RT}$

22. From arrhenius equation :

$$\log\frac{k_2}{k_1} = \frac{E_a}{2.303\,R}\left[\frac{T_2 - T_1}{T_1\,T_2}\right] \quad \textbf{(½)}$$

$$\Rightarrow \log(4) = \frac{E_a}{2.303\times 19.15}\left[\frac{320-300}{300\times 320}\right]$$

$$0.60 = \frac{E_a}{2.303\times 19.15}\left[\frac{320-300}{300\times 320}\right] \quad \textbf{(1)}$$

$$\Rightarrow E_a = \frac{0.60\times 44.10}{2.08\times 10^{-4}} = \frac{26.46}{2.08\times 10^{-4}} \quad \textbf{(1)}$$

$= 127211.538$ J/mol

$= 127.211$ kJ/mol. **(½)**

Chapter 4 : The *d* and *f*-Block Elements

Topic-1: Position in the Periodic Table, Electronic Configurations of the d-Block Elements, General Properties of the Transition Elements (d-Block)

23. **(b)** Mn shows a maximum of +7 oxidation state from +2 to +7 Cr shows upto +6 Sc upto +3 and Ti upto +4.

24. **(a)** (n – 1) d can accommodate from 1 to 10 electrons while ns can hold from 1 to 2 electrons.

25. **(a)** Interstitial compounds have higher melting points are harder and retain the metallic conductivity.

Topic-2: Some Important Compounds of Transition Elements

26. (a) Zinc has completely-filled d-subshell and so it cannot exhibit characteristics properties of other transition elements. Therefore, it is not regarded as a transition element. **(1)**

(b) A gradual decrease in the atomic radii in the elements of the lanthanoid series (4f) from left to right is termed as 'lanthanoid contraction'. **(1)**

(c) Cr has a half-filled while Zn has a fully-filled d-subshell and a filled s-subshell.

Thus, removal of an electron would disturb a much more stable configuration of Zn and therefore its first ionization in enthalpy is higher than that of Cr. **(1)**

(d) Transition element act as good catalysts due to multiple oxidation states that they exhibit and a large surface area that they provide. **(1)**

(e) The colour of the compounds of transition metals are generally due to d – d transition of electrons is the d-subshell. **(1)**

> **Note**
>
> *The color of certain compounds like* $K_2Cr_2O_7$ *is due to charge transfer transition.*

(f) Mn in K_2MnO_4 is in + 6 state and has one unpaired electron due to which it is paramagnetic. **(1)**

(g) $Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7\,H_2O$ **(1)**

Topic-3: The Lanthanoids, The Actinoids

27. (a) Ce (III) is easily oxidized to Ce (IV) because loss of one electron from 4f subshell in Ce (III) would give a more stable $4f^{0}$ configuration in Ce (IV). **(1)**

(b) The $E^o_{Mn^{2+}/Mn}$ is highly negative due to the sum of the first and second ionization enthalpies is lower than its hydration enthalpy and the stable half-filled configuration of d^5 in Mn^{2+}. **(1)**

(c) Zinc (Zn) has the lowest enthalpy of atomisation (126 kJ/mol) in the 3d series. **(1)**

(d) $2Na_2CrO_4 + 2H^+ \rightarrow Na_2Cr_2O_7 + 2Na^+ + H_2O$ **(1)**

(e) Zn, Cd and Hg are soft metal due to lower atomisation enthalpy resulting in weaker metallic banding. **(1)**

(f) Permanganate titrations in the presence of HCl result in HCl getting oxidized to Cl_2 gas and affect the results. **(1)**

(g) Lower oxides of transition metals have lower oxidation states and the metal tend to lose some electrons to increase the charge and act as a base.

Opposite is the case with higher oxides having higher oxidation state and acidic / amphotenic behaviour. **(1)**

28. **(a)** Lanthanoid contraction results in the elements of 5th and 6th periods to have similar atomic radii in the same group due to addition of extra elements of *f*-block whose radii decrease only negligibly.

Chapter 5 : Coordination Compounds

Topic-2: *Nomenclature of Coordination Compounds*

29. (a) Tetraammine chloronitrocobalt (III) chloride. **(1)**

(b) Hexaammine nickel (II) chloride. **(1)**

(c) Potassium trioxalatechromate (III). **(1)**

(d) Dibromobis (ethylenediamine) cobalt (III). **(1)**

Topic-3: *Isomerism in Coordination Compounds*

30. (a) An ambidentate ligand has two donor atoms and either one of them can donate a lone pair of electrons.

e.g., NO_2^- (nitro) and ONO^- (nitrito) **(1)**

(b) The given pairs of coordination compounds show ionization isomerism as the complex switch between a charge of +2 with SO_4^{-2} and +1 with Cl^- outside the coordination sphere. **(1)**

(c) Binding of a bidentate or polydentate ligand to a metal gives extra stability to the coordination compound.

This is called 'chelate effect' and such ligands are called chelating ligands.

e.g., ethylenedimine (en), Oxalato ($C_2O_4^{2-}$), etc. **(2)**

OR

(c) Coordination number of Cr = Number of ligands × denticity of ligands

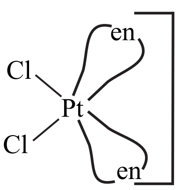
(for homoleptic complexes)

$= 3 \times 2 = 6$ **(1)**

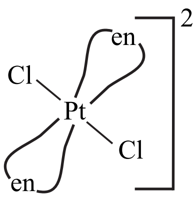
Oxidation state of Cr = + 3 **(1)**

Topic-4: *Bonding in Coordination Compounds*

31. (a)



cis – $[Pt(en)_2Cl_2]^{2+}$



trans – $[Pt(en)_2Cl_2]^{2+}$ **(1)**

(b) For a d^4 ion : $\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{}$

Since $\Delta_0 < P$, there will be no pairing of electrons as the ligand will be a weak-field ligand.

Thus, the configuration remains the same and

$d^4 = t_{2g}^3 e_g^1$ **(1)**

(c) A unidentate ligand has only one donor atom.

e.g.; Cl^-, Br^-, CO_3^{2-}, etc. **(1)**

Note

A species have more than one atom capable of donating but only one donates electron pair in monodentate ligands.

32. (a) $[CoF_6]^{3-} \Rightarrow Co^{3+} = [Ar]3d^6$ or $\underbrace{\boxed{\uparrow\downarrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}\boxed{\uparrow}}_{3d}$

Since F^- is a weak-field ligand, the electrons in the d-subshell remain unpaired and so we have four unpaired electrons.

Thus, it will be paramagnetic. **(1)**

(b) Co is bonded to two bidentate 'en' ligands and two monodentate Cl^- ligands.

Thus, coordination number = (2 × 2) + (2 × 1) = 6 **(1)**

(c) (i) The given complex is a cationic entity with Pt in +4 state, two ammine and two chloro ligands.

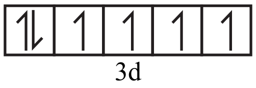
Thus, IUPAC name will be:

Diamminedichloro platinum (IV) cation. **(1)**

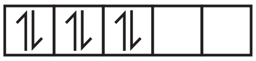
Note

Both, 'Chloro' and 'Chlorido' are acceptable for IUPAC name.

(ii) Co in $[Co(NH_3)_6]^{3+}$ is bonded to six strong-field ligands and is in +3 state.

Thus, Co^{3+} = [Ar] $3d^6$ or 

But, NH_3 causes pairing of electrons so



Thus, NH_3 ligands will occupy two inner 3d-orbitals and the complex will be inner-orbital complex. **(1)**

OR

(c) Ni is bonded to six NH_3 ligands and is in +2 state. Thus, hybridization will be sp^3d^2 (outer orbital) and the corresponding shape will be octahedral. **(1 + 1)**

Note

VBT allows us to predict the hybridization and the geometry from the number of ligands bonded.

Topic-5: Bonding in Metal Carbonyls, Importance and Applications of Coordination Compounds

Chapter 6 : Haloalkanes and Haloarenes

Topic-4: Physical Properties, Chemical Reactions

33. **(a)** A tertiary alkyl halide undergoes S_N1 reaction the fastest as it forms the most stable 3° carbocation in the first step.

Note

The order of stability of carbocation is 1° < 2° < 3° due to +I effect.

34. **(a)** A chiral carbon has all four different atoms or groups.

35. **(c)** S_N2 mechanism involves a single-step concerted pathway in which formation of a transition-state and not a carbocation, takes place. Stereo Chemically inversion of configuration takes place.

Thus, (A) is true but (R) is false.

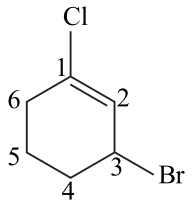
36. (a) $CH_3 - CH_2 - I$ would undergo S_N2 reaction at a faster rate because of weaker C – I bond. **(1)**

OR

(b) The correct order of boiling point is:

Butane < 1 – chlorobutane < 1 – bromobutane < 1 – iodobutane.

This is due to increasing strength of intermolecular forces because of increasing molecular mass.

37. (a) 

3-Bromo-1-Chlorocyclohex-1 ene **(1)**

(b) When the Nitro group is present at ortho– or para-positions, it withdraws the charge density from benzene ring and thus facilitates the attack of the nucleophile on haloarenes. **(1)**

(c) Ethyl chloride undergoes elimination with alcoholic potassium hydroxide and forms ethane.

$CH_3CH_2Cl \xrightarrow[\Delta]{\text{alc. KOH}} CH_2 = CH_2 + KCl + H_2O$ **(1)**

38. (a) AgCN is predominantly covalent so the C-atom in CN is bonded to Ag while N atom is free to bond.

Thus, haloalkanes react with AgCN in which N-atom bonds to C-atom of haloalkane to form isocyanide.

Note

AgCN is covalent and gives isocyanide while HCN is ionic that gives cyanide with haloalkanes.

(1)

(b) Allyl chloride forms a very stable carbocation

$CH_2 = CH - \overset{\oplus}{C}H_2$ that is resonance stabilized.

Thus, allyl chloride is very reactive towards S_N1 reactions as it would readily form a carbocation in the rate-determining step. **(1)**

(c) Haloarenes have their C–X bond having partial double-bond character and the α-carbon atom is sp^2 – hybridized making it more electronegative and the C – X bond stronger.

Thus, haloarenes are extremely less reactive towards S_N reactions. **(1)**

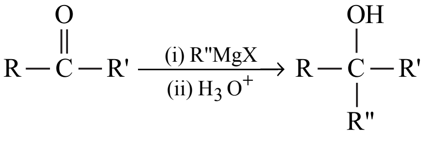
Topic-5: Polyhalogen Compounds

39. **(c)** $2CHCl_3 + O_2 \xrightarrow{\text{light}} \underset{\text{phosgene}}{2COCl_2} + 2HCl$

Chapter 7 : Alcohols, Phenols and Ethers

Topic-2: Alcohols and Phenols, Some Commercially Important Alcohols

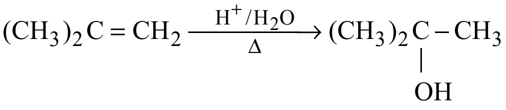
40. **(c)**



$$R-\overset{\overset{\large O}{\|}}{C}-R' \xrightarrow[\text{(ii) } H_3O^+]{\text{(i) } R''MgX} R-\underset{\underset{\large R''}{|}}{\overset{\overset{\large OH}{|}}{C}}-R'$$

3° alcohol

41. **(d)**



$$(CH_3)_2C=CH_2 \xrightarrow[\Delta]{H^+/H_2O} (CH_3)_2\underset{\underset{\large OH}{|}}{C}-CH_3$$

tert–Butyl alcohol

Note

Acid-catalysed hydration of alkenes follow Markovnikoff rule for addition in which H^+ adds to a less substituted doubly-bonded carbon atom.

42. **(c)** The strongest base will have the weakest conjugate acid. Thus, among H_2O, C_6H_5OH, ROH and $C_6H_5(NO_2)OH$, ROH is the weakest acid due to unstable RO^- ion which is the strongest base here.

43. **(d)** *p*-nitrophenol is more acidic than phenol due to the presence of electron – withdrawing – NO_2 group that stabilizes the corresponding phenoxide ion. Thus, (A) is false but (R) is true.

44. **(d)** *p*-Nitrophenol is a stronger acid than *p*-methoxyphenol due to –I effect of $–NO_2$ group and +I effect of $–OCH_3$ group.

Thus, (A) is false but (R) is true.

Note

+I groups increase basicity while –I groups increase acidity in organic compounds.

45. **(a)** Oxidation of 1° alcohols to aldehydes → PCC (mild oxidizing agent)

Butan – 2 – one to butan – 2 – ol → $NaBH_4$ (reducing agent)

Bromination of phenol to 2, 4, 6 – tribromophenol → Bromine water

Dehydration of proton – 2 – ol to propene → 85% phosphoric acid at 440 K.

46. (a) $3CH_3CH=CH_2 + (BH_3)_2 \longrightarrow$

$$(CH_3CH_2-CH_2)_3B$$

$$\big\downarrow H_2O,\ 3H_2O_2,\ OH^-$$

$$B(OH)_3 + 3CH_2CH_2CH_2-OH$$

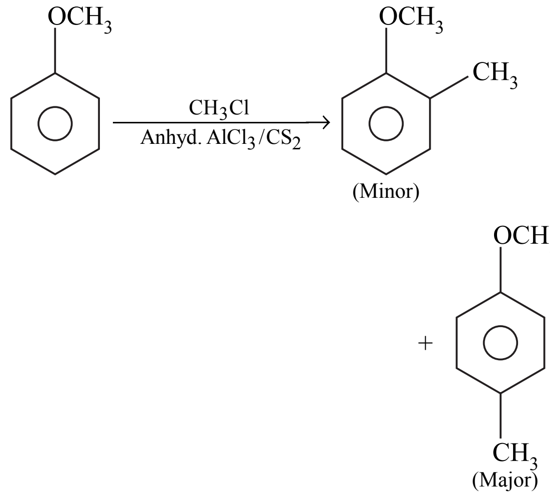
Note

Hydroboration-oxidation follows Anti-Markovnikoff Rule.

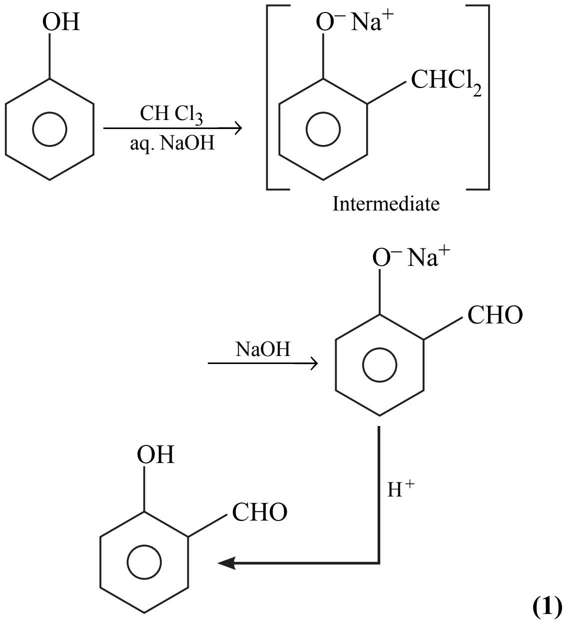
(1)

(b) $R-X + R'-ONa \longrightarrow R-O-R' + NaX$ **(1)**

(c)



(d)



(1)

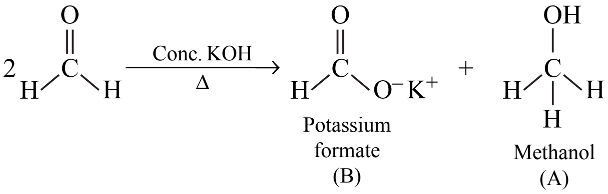
Chapter 8 : Aldehydes, Ketones and Carboxylic Acids

Topic-2: *Preparation of Aldehydes and Ketones*

47. **(a)** Catalyst for Rosenmond reaction = Pd – $BaSO_4$.

Topic-3: *Physical Properties, Chemical Reactions, Uses of Aldehydes and Ketones*

48. **(a)** Cannizzaro Reaction :

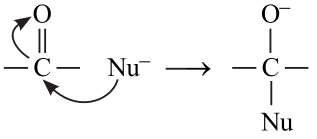


Note

Cannizzaro reaction takes place in carbonyl compounds with no α-Hydrogens.

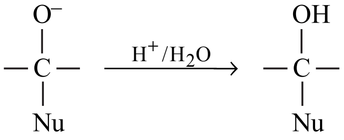
49. (a) Nucleophilic addition reaction :-

Step 1 : Addition of a nucleophile to Carbonyl carbon.



(1)

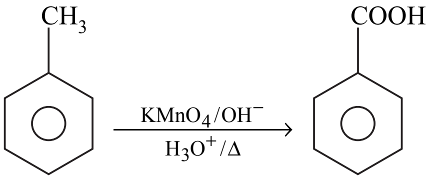
Step 2 : Hydrolysis



(1)

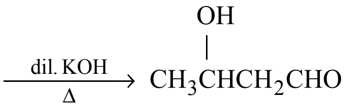
OR

(b) (i)



(1)

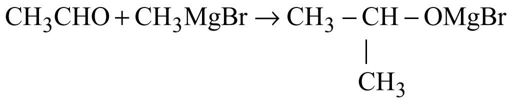
(ii) $2\,CH_2CH_2OH \xrightarrow[573\,K]{Cu} 2\,CH_3CHO$



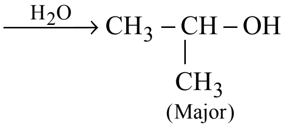
$$\xrightarrow[\Delta]{\text{dil. KOH}} CH_3\overset{\overset{\displaystyle OH}{|}}{C}HCH_2CHO$$

(1)

50. (a)



$$CH_3CHO + CH_3MgBr \rightarrow CH_3-\underset{\underset{\displaystyle CH_3}{|}}{CH}-OMgBr$$

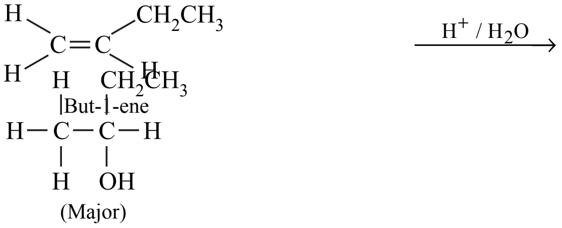


$$\xrightarrow{H_2O} CH_3-\underset{\underset{\displaystyle CH_3}{|}}{CH}-OH$$

(Major)

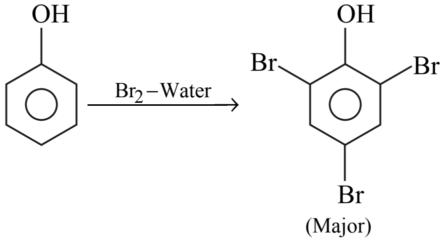
(1)

(b)

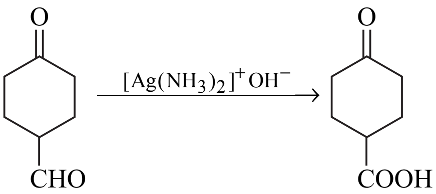


(1)

(c)

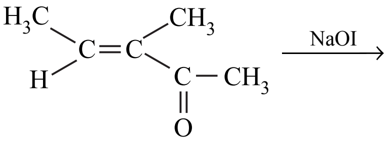


(1)

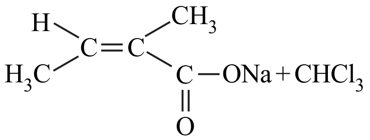
51. (a)  **(1)**

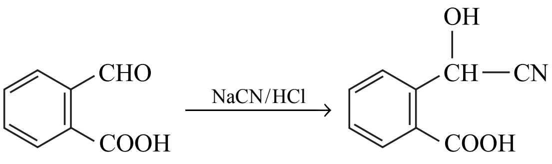
Note

Tollen's reagent is a mixture of $AgNO_3$ and NH_3 in an alkali that oxidizes aldehydes to carboxylic acid but not to ketones.

(b) 

(Haloform reaction)

 **(1)**

(c) 

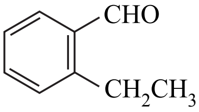
(1)

52. (a) (i) An organic compound that has the molecular formula $C_9H_{10}O$ forms 2, 4 – DNP derivative and also reduces Tollen's reagent.

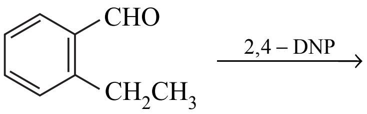
Thus, it is an aldehyde.

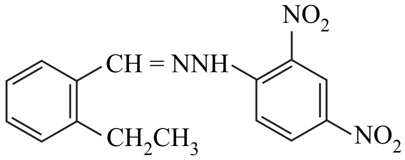
Since it undergoes Cannizzaro reaction, it does not have α-hydrogens.

Since it gives 1, 2-benzene dicarboxylic acid, the –CHO group must be directly attached to benzene ring and it must be ortho, di-substituted benzene. **(1)**

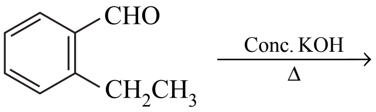
Thus, (A) =  **(1)**

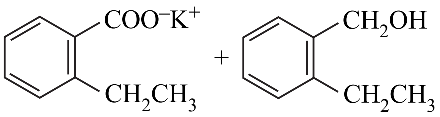
IUPAC name = 2-Ethylbenzaldehyde **(1)**

(ii) 



(1)

(iii) 



(1)

OR

(b) (i) (1) The α-hydrogens of aldehydes and ketones are acidic due to the presence of electron-withdrawing carbonyl groups that makes the C – H bond weaker. **(1)**

(2) Ketones are harder to oxidize because they do not have a hydrogen atom attached to the carbonyl carbon. They oxidized by only strong oxidizing agents. **(1)**

(ii) (1) Nucleophilic addition reactivity follows the order alphabetic aldehyde > aromatic aldehyde > ketones.

Thus, reactivity will be :

Propanal > benzaldehyde > acetone **(1)**

(2) Boiling point order :

Propane < Dimethyl ether < Propanal < Ethanol

This is due to dipole-dipole forces in propanol and H-bonding in ethanol. **(1)**

(iii) That two compounds can be differentiated by sodium bicarbonate test or Tollen's test.

Benzoic acid gives sodium bicarbonate test while benzaldehyde gives Tollen's test. **(1)**

Topic-5: Physical Properties, Chemical Reactions, Uses of Carboxylic Acids

53. **(a)** Benzoic acid does not undergo Friedel-Crafts reactions due to deactivating nature of – COOH group that also reacts with $AlCl_3$.

54. (a) (i) $FeCl_3$ test can be used to differentiate between phenol and benzoic acid as it gives a red / green / blue / purple coloured complex with phenol while it gives a buff-coloured precipitate with benzoic acid.

Sodium bicarbonate test can also be used as it gives effervescence with benzoic acid but not with phenol. **(1)**

(ii) Tollen's test can be used to differentiate between propanal and propanone.

Propanal is an aldehyde that gives a positive Tollen's test and gives a silver mirror while propanone does not. **(1)**

(b) CH_3CHFCH_2COOH is a stronger acid as the electron – withdrawing group – F is closer to the – COOH group which causes a greater stabilization of the conjugate base having – COO^- group. **(1)**

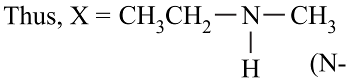
Chapter 9 : Amines

Topic-1: Structure of Amines, Classification, Nomenclature

55. **(a)** A tertiary amine (3°) has three alkyl groups attached to the amino nitrogen atom.

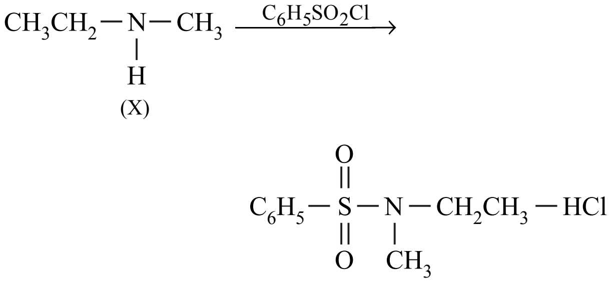
Topic-3: Physical Properties, Chemical Reactions

56. Since the compound reacts with $C_6H_5SO_2Cl$ (Hinsberg reagent) to give a solid insoluble in alkali, it has to be a secondary amine.



$$X = CH_3CH_2-\underset{\displaystyle H}{\underset{|}{N}}-CH_3$$

(N-methylethanamine) **(1)**



$$\underset{(X)}{CH_3CH_2-\underset{\displaystyle H}{\underset{|}{N}}-CH_3} \xrightarrow{C_6H_5SO_2Cl} C_6H_5-\underset{\displaystyle O}{\underset{||}{\overset{\displaystyle O}{\overset{||}{S}}}}-\underset{\displaystyle CH_3}{\underset{|}{N}}-CH_2CH_3-HCl$$

(1)

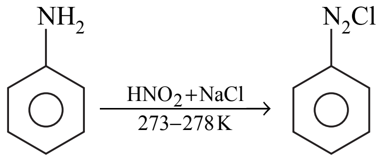
IUPAC name of the product = N-Methyl-N-ethylbenzene Sulphonamide **(1)**

57. (a) In Hoffman-Bromamide degradation reaction, an amide of the formula $RCONH_2$ gives a 1° amine of the formula $R-NH_2$, that is one carbon less than that in the amide.

Thus. 'A' is $C_6H_5CONH_2$ or benzamide.

'A' would give the amine $C_6H_5NH_2$ (aniline), which is 'B'.

Now,

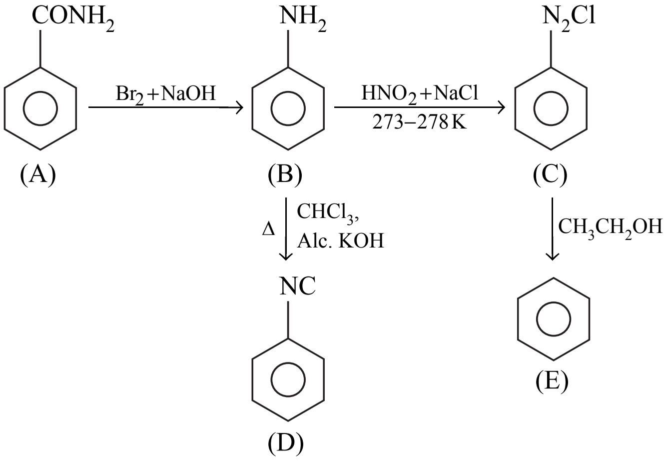


(B) (C)

(Benzenediazonium chloride)

Aniline with chloroform and ethanolic KOH gives an offensive smelling phenyl isocyanide (D) in this isocyanide test.

Benzenediazonium chloride (C) with ethanol, gives benzene (E) as the product.



(1 + 1 + 1 + 1 + 1)

OR

(b) (i)

(1) Hinsberg reagent is benzenesulphonyl chloride ($C_6H_5SO_2Cl$) **(1)**

(2) In the gaseous phase, amines basicity follows the order:

$1^\circ < 2^\circ < 3^\circ$

Thus, basicity order will be :

$C_2H_5NH_2 < (C_2H_5)_2NH < (C_2H_5)_3N$ **(1)**

(ii) (1) Methyl amine is more basic than aniline as the lone pair of electrons on nitrogen atom in aniline is delocalized due to resonance and hence not easily available for donation.

This is not the case with methyl amine. **(1)**

(2) The $-NH_2$ group is ortho – and para-directing and ring-activating group which increases charge density or benzene ring.

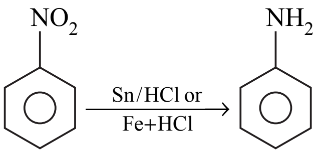
Thus, aniline readily reacts with bromine water. **(1)**

(3) Primary amines have higher boiling points than tertiary amines due to presence of hydrogen bonding in primary amines which is absent in tertiary amines. **(1)**

Topic-4: *Method of Preparation of Diazonium Salts, Physical Properties, Chemical Reactions, Importance of Diazonium Salts in Synthesis of Aromatic Compounds*

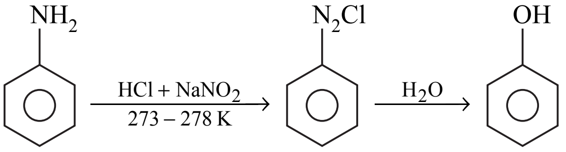
58. **(a)** The given reaction of the conversion of a diazonium salt to cyanobenzene / benzonitrile is called Sandmeyer's reaction.

59. (a) (i)



(1)

(ii)



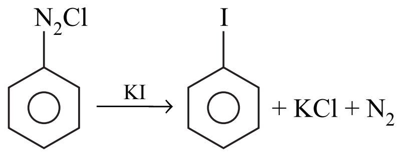
(1)

OR

(b) (i) Dimethyl amine and ethanamine are 2° and 1° amines that can be distinguished by isocyanide / carbylamine test.

Only ethanamine (1° amine) will give this test. **(1)**

(ii)



(1)

Chapter 10 : Biomolecules

Topic-1: *Carbohydrates*

60. **(c)** Fructose is a monosaccharide that gives positive Tollen's test and Fehling's test and is a reducing sugar.

Thus (A) is true but (R) is false.

61. **Monosaccharides :** Galactose, Glucose **(1)**

Disaccharides : Lactose, Maltose **(1)**

Topic-2: Proteins, Enzymes

62. **(a)** Primary structure of proteins is the sequence of amino acids bonded through peptide / amino bonds.

63. (a) Essential amino acid are those amino acid that are not produced in our body and therefore are to be taken in our diet.

e.g., Histidine, leucine, etc. **(1)**

> ***Note***
>
> *There are about nine essential and eleven non-essential amino acids.*

(b) A peptide bond is an amide bond that is formed between the carboxyl (C-terminal) and amino (N-terminal) terminal of two amino acids releasing a water molecule. **(1)**

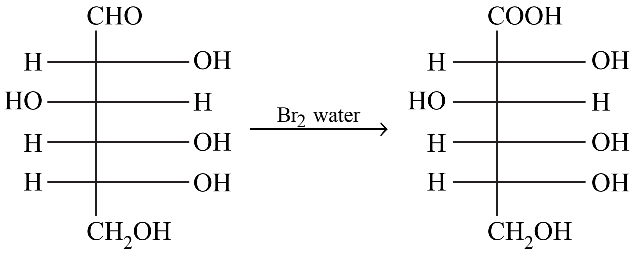
(c) When a protein is subjected to heating or acids and alkalies, the secondary tertiary and quaternary structures of the proteins are destroyed.

This is called denaturation of proteins. **(1)**

Topic-3: Vitamins, Nucleic Acids, Hormones

64. **(c)** Vitamin C = Ascorbic acid

65. (a)



Oxidation of glucose gives gluconic acid. **(1)**

(b) DNA has Thymine (T) while RNA was uracil (U) instead of Thymine.

66. (a) Vitamin B_6 = Pyridoxine **(1)**

(b) Vitamin K **(1)**

(c) Xerophthalmia caused by deficiency of vitamin A. **(1)**

Two sources of vitamin A :

• Fish liver oil • Carrots **(1)**

OR

(c) Vitamin C is water-soluble and therefore it is excreted through urine. **(1)**

Disease caused by its deficiency = Scurvy (bleeding gums). **(1)**