

CBSE EXAMINATION PAPER 2024

Chemistry (Theory)

Class-12th

(Solved)

(Delhi & Outside Delhi Sets)

Time : 3 Hours

Max. Marks : 70

General Instructions:

Read the following instructions carefully and follow them:

- This question paper contains 33 questions. All questions are compulsory.
- Question paper is divided into FIVE sections - Section A, B, C, D and E.
- Section A - question number 1 to 16 are multiple choice type questions. Each question carries 1 mark.
- Section B- question number 17 to 21 are very short answer type question.s. Each question carries 2 marks.
- Section C- question number 22 to 28 are short answer type questions. Each question carries 3 marks.
- Section D - question number 29 and 30 are case-based questions. Each question carries 4 marks.
- Section E - question number 31 to 33 are long answer type questions. Each question carries 5 marks.
- 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.
- Kindly note that there is a separate question paper for Visually Impaired candidates.
- Use of calculator is NOT allowed.

Delhi Set-1

56/5/1

SECTION A

Question No. 1 to 16 are Multiple Choice type questions carrying 1 mark each. $16 \times 1 = 16$

- The specific sequence in which amino acids are arranged in a protein is called its
(A) Primary structure (B) Secondary structure
(C) Tertiary structure (D) Quaternary structure
- The correct name of the given reaction is



- Sandmeyer's reaction
 - Gabriel Phthalimide synthesis
 - Carbyl amine reaction
 - Hoffmann bromamide degradation reaction
- Out of the following alkenes, the one which will produce tertiary butyl alcohol on acid catalysed hydration is
(A) $\text{CH}_3\text{CH}_2\text{CH} = \text{CH}_2$
(B) $\text{CH}_3\text{CH} = \text{CH}_2$
(C) $\text{CH}_3 - \text{CH} = \text{CH} - \text{CH}_3$
(D) $(\text{CH}_3)_2\text{C} = \text{CH}_2$
 - Auto-oxidation of chloroform in air and light produces a poisonous gas known as
(A) Phosphine (B) Mustard gas
(C) Phosgene (D) Tear gas

- Transition metals are known to make interstitial compounds. Formation of interstitial compounds makes the transition metal

(A) more hard (B) more soft
(C) more ductile (D) more metallic

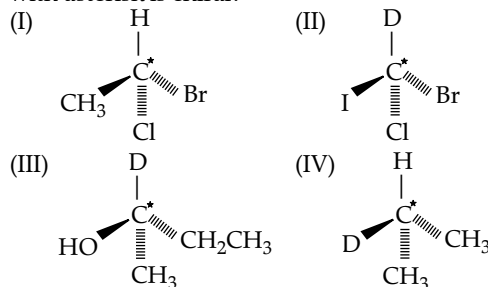
- Isotonic solutions have the same
(A) density (B) refractive index
(C) osmotic pressure (D) volume
- Which of the following cell was used in Apollo space programme ?

(A) Mercury cell (B) $\text{H}_2 - \text{O}_2$ fuel cell
(C) Dry cell (D) Ni-Cd cell

- The rate of a reaction increases sixteen times when the concentration of the reactant increases four times. The order of the reaction is

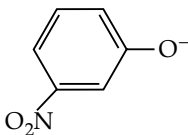
(A) 2.5 (B) 2.0
(C) 1.5 (D) 0.5

- In which of the following molecules, C atom marked with asterisk is chiral?



- (A) I, II, III (B) I, II, III, IV
 (C) II, III, IV (D) I, III, IV
10. Which of the following species can act as the strongest base ?

(A) OH^-
 (C) RO^-

(B) $\text{C}_6\text{H}_5\text{O}^-$
 (D) 

11. Dilution affects both conductivity as well as molar conductivity. Effect of dilution on both is as follows:
- (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.

12. Van't Hoff factor for $\text{Na}_2\text{SO}_4 \cdot 10\text{H}_2\text{O}$ solution, assuming complete ionization is

(A) 1 (B) 3
 (C) 13 (D) 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 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): Zr and Hf are of almost similar atomic radii.

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

14. Assertion (A): The units of rate constant of a zero order reaction and rate of reaction are the same.

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

15. Assertion (A): Inversion of configuration is observed in $\text{S}_{\text{N}}2$ reaction.

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

16. Assertion (A): *p*-methoxyphenol is a stronger acid than *p*-nitrophenol.

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

SECTION B

17. State:

(a) Kohlrausch law of independent migration of ions.
 (b) Faraday's first law of electrolysis. 1×2

18. Classify the following sugars into monosaccharides and disaccharides:

Galactose, Glucose, Lactose and Maltose 2

19. (a) Carry out the following conversions:

(i) Nitrobenzene to Aniline 1
 (ii) Aniline to Phenol 1

OR

(b) (i) Write a chemical test to distinguish between Dimethyl amine and Ethanamine. 1

(ii) Write the product formed when benzene diazonium chloride is treated with KI. 1

20. 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. ($\log 10 = 1$) 2

21. Resistance of a conductivity cell filled with 0.2 mol L^{-1} KCl solution is 200Ω . If the resistance of the same cell when filled with 0.05 mol L^{-1} KCl solution is 620 , 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} . 2

SECTION C

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

(a) $[\text{Co}(\text{NH}_3)_4\text{Cl}(\text{NO}_2)]\text{Cl}$ (b) $[\text{Ni}(\text{NH}_3)_6]\text{Cl}_2$
 (c) $\text{K}_3[\text{Cr}(\text{C}_2\text{O}_4)_3]$ (d) $[\text{Co}(\text{en})_2\text{Br}_2]^+$ 1×3

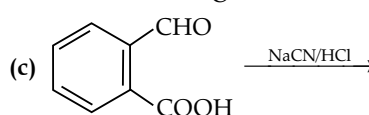
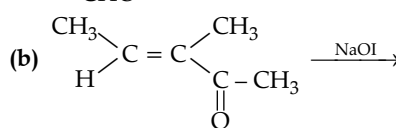
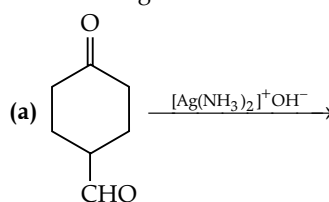
23. Give the structure of the major product expected from the following reactions: 1×3

(a) Reaction of ethanal with methyl-magnesium bromide followed by hydrolysis.

(b) Hydration of But-1-ene in the presence of dilute sulphuric acid.

(c) Reaction of phenol with bromine water.

24. Draw the structures of major product(s) in each of the following reactions: 1×3



25. Calculate the emf of the following cell:

$\text{Ni(s)} + 2\text{Ag}^+ (0.01 \text{ M}) \rightarrow \text{Ni}^{2+} (0.1 \text{ M}) + 2\text{Ag(s)}$
 Given that $E_{\text{cell}}^\circ = 1.05 \text{ V}$, $\log 10 = 1$ 3

26. Account for the following: 1×3

(a) Haloalkanes react with AgCN to form isocyanide as main product.

(b) Allyl chloride shows high reactivity towards $\text{S}_{\text{N}}1$ reaction.

(c) Haloarenes are extremely less reactive towards nucleophilic substitution reactions.

27. The rate constant of a reaction quadruples when the temperature changes from 300 K to 320 K. Calculate the activation energy for this reaction. 3
[$\log 2 = 0.30$, $\log 4 = 0.60$, $2.303 R = 19.15 \text{ J K}^{-1}\text{mol}^{-1}$]
28. A compound 'X' with molecular formula $\text{C}_3\text{H}_9\text{N}$ reacts with $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$ to give a solid, insoluble in alkali. Identify 'X' and give the IUPAC name of the product. Write the reaction involved. 3

SECTION D

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

29. 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.

Based on the above information, answer the following questions:

- (a) Define ambidentate ligand with an example. 1
(b) What type of isomerism is shown by $[\text{Co}(\text{NH}_3)_5\text{Cl}]\text{SO}_4$ and $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Cl}$? 1
(c) Define chelate effect. How it affects the stability of complex? 2

OR

- (c) Find the coordination number and oxidation state of chromium in $\text{Na}_3[\text{Cr}(\text{C}_2\text{O}_4)_3]$. 2
30. 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.

Answer the following questions:

- (a) What is the other name of vitamin B_6 ? 1
(b) Name the vitamin whose deficiency causes increased blood clotting time. 1
(c) Xerophthalmia is caused by the deficiency of which vitamin? Give two sources of this vitamin. 2

OR

- (c) Why can't vitamin C be stored in our body? Name the disease caused by the deficiency of this vitamin. 2

SECTION E

31. Attempt any five of the following: 1×5
- (a) Ce(III) is easily oxidised to Ce(IV). Comment.
(b) $E^\circ(\text{Mn}^{2+}/\text{Mn})$ is -1.18 V . Why is this value highly negative in comparison to neighbouring d block elements?
(c) Which element of $3d$ series has lowest enthalpy of atomisation and why?
(d) What happens when sodium chromate is acidified?
(e) Zn, Cd and Hg are soft metals. Why?
(f) Why is permanganate titration not carried out in the presence of HCl?
(g) The lower oxides of transition metals are basic whereas the highest are amphoteric/acidic. Give reason.
32. (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 $1.86 \text{ K kg mol}^{-1}$. 3
(ii) What type of deviation from Raoult's law is shown by ethanol and acetone mixture? Give reason. 2

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 = $0.52 \text{ K kg mol}^{-1}$).
(ii) State Henry's law and write its any one application. 3+2
33. (a) An organic compound (A) with the molecular formula $\text{C}_9\text{H}_{10}\text{O}$ 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.
(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. 2+2+1

OR

- (b) (i) Account for the following: 1×2
(1) The alpha (α)-hydrogens of aldehydes and ketones are acidic in nature.
(2) Oxidation of aldehydes is easier than ketones.
(ii) Arrange the following in: 1×2
(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. 1

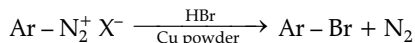
Delhi Set-2

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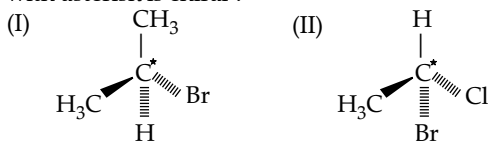
Note: Except these, all other question have been given in Delhi Set-1

SECTION A

6. The correct name of the given reaction is



- (A) Hoffmann Bromamide degradation reaction.
 (B) Gabriel Phthalimide synthesis
 (C) Carbyl amine reaction
 (D) Gatterman reaction
7. Visha took 4 test-tubes namely A, B, C & D containing $\text{CH}_3\text{CH}=\text{CH}_2$, $\text{CH}_3\text{CH}_2\text{CH}=\text{CH}_2$, $\text{CH}_3\text{CH}=\text{CH}-\text{CH}_3$ and $(\text{CH}_3)_2\text{C}=\text{CH}_2$ respectively and tried to convert them into tertbutylalcohol. She carried out acid catalysed hydration reaction on every alkene. Out of the four test-tubes, the one which will give desired result is
- (A) A (B) B
 (C) C (D) D
8. Van't Hoff factor for KCl solution assuming the complete dissociation is
- (A) 1 (B) 2
 (C) 0.5 (D) 1.5
9. Dilution affects both molar conductivity as well as conductivity. Effect of dilution on both is
- (A) molar conductivity decreases whereas conductivity increases on dilution.
 (B) molar conductivity increases whereas conductivity decreases on dilution.
 (C) both decrease with dilution.
 (D) both increase with dilution.
10. Which of the following cell is used in inverter?
- (A) Fuel cell (B) Mercury cell
 (C) Lead storage cell (D) Dry cell
11. In which of the following molecules, C atom marked with asterisk is chiral?



Delhi Set-3

56/5/3

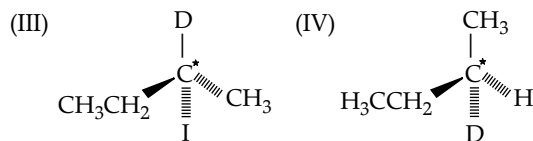
Note: Except these, all other question have been given in Delhi Set-1&2

SECTION A

6. Which of the following cell is used in hearing aids?
- (A) Mercury cell (B) $\text{H}_2 - \text{O}_2$ fuel cell
 (C) Dry cell (D) Ni-Cd cell

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



- (A) I, II, III (B) II, III, IV
 (C) I, II, III, IV (D) I, III, IV
12. For the reaction $\text{A} + 2\text{B} \rightarrow \text{C} + \text{D}$. The order of the reaction is
- (A) 1 with respect to A
 (B) 2 with respect to B
 (C) can't be predicted as order is determined experimentally.
 (D) 3

SECTION B

17. Define the following terms:
- (a) Faraday's second law of electrolysis
 (b) Corrosion 2
21. Classify the following sugars into monosaccharides and disaccharides.
- Fructose, Lactose, Glucose, Maltose 2

SECTION C

25. Write IUPAC names of the following coordination compounds: (any three)
- (a) $\text{K}_3[\text{Fe}(\text{CN})_6]$
 (b) $[\text{Pt}(\text{en})_2\text{Cl}_2]^{2+}$
 (c) $[\text{Co}(\text{NH}_3)_4\text{Cl}(\text{NO}_2)]\text{Cl}$
 (d) $[\text{Zn}(\text{OH})_4]^{2-}$ 1×3
28. Account for the following:
- (a) Haloalkanes react with NaCN to form both cyanides and isocyanides.
 (b) Haloarenes do not undergo nucleophilic substitution reaction easily.
 (c) Benzyl chloride gives $\text{S}_{\text{N}}1$ reaction. 1×3

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.
15. **Assertion (A):** *p*-methoxyphenol is a stronger acid than *m*-methoxy phenol.
Reason (R): Methoxy group exerts +R effect at both ortho and para position.
16. **Assertion (A):** Inversion of configuration is observed when 1-Bromobutane is hydrolysed.
Reason (R): The reaction is $\text{S}_{\text{N}}2$ and proceeds with the formation of transition state.

SECTION B

18. Define the following terms:
 (a) Limiting molar conductivity ($\wedge^{\circ}\text{m}$)
 (b) Fuel cell 1 × 2
19. Classify the following sugars into monosaccharides and disaccharides:
 Sucrose, Lactose, Glucose, Fructose 2
21. A first order reaction takes 40 min for 75% decomposition. Calculate rate constant.
 [Given: $\log 2 = 0.30$, $\log 4 = 0.60$] 2

SECTION C

27. Give the structure of the major product expected from the following reactions:
 (a) Reaction of propanal with methyl magnesium bromide followed by hydrolysis.
 (b) Reaction of phenol with Br_2 in CS_2 .
 (c) Reaction of propene with diborane followed by oxidation. 1 × 3
28. The rate constant of a reaction quadruples when the temperature changes from 700 K to 720 K. Calculate the activation energy for this reaction. 3
 [$\log 2 = 0.30$, $\log 4 = 0.60$, $2.303 R = 19.15 \text{ J K}^{-1} \text{ mol}^{-1}$]

SECTION D

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

29. 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.

Based on the above information, answer the following questions:

- (a) What is the secondary valence of Co in $[\text{Co}(\text{NH}_3)_4\text{Cl}_2]^+$? 1
- (b) What type of isomerism is shown by the complex $[\text{Cr}(\text{H}_2\text{O})_6]\text{Cl}_3$ and $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$? 1
- (c) Write the electronic configuration of d^4 ion on the basis of crystal field theory when
 (i) $\Delta_0 < P$
 (ii) $\Delta_0 > P$ 2

OR

- (c) Find the oxidation state and coordination number of the central metal ion in $[\text{Co}(\text{H}_2\text{O})(\text{CN})(\text{en})_2]^{2+}$ 2

Outside Delhi Set-1

56/4/1

SECTION A

Question No. 1 to 16 are Multiple Choice type questions carrying 1 mark each. 16 × 1 = 16

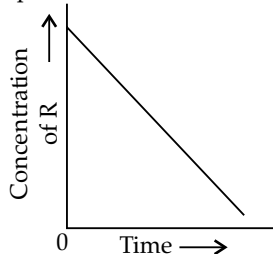
1. The molar ionic conductivities of Ca^{2+} and Cl^- are 119.0 and 76.3 $\text{S cm}^2 \text{ mol}^{-1}$ respectively. The value of limiting molar conductivity of CaCl_2 , will be
 (A) 195.3 $\text{S cm}^2 \text{ mol}^{-1}$ (B) 43.3 $\text{S cm}^2 \text{ mol}^{-1}$
 (C) 314.3 $\text{S cm}^2 \text{ mol}^{-1}$ (D) 271.6 $\text{S cm}^2 \text{ mol}^{-1}$
2. Consider the following reaction:

$$\begin{array}{c} \text{H} & & \text{H} \\ & \diagdown & / \\ & \text{C} = \text{O} & + \text{C} = \text{O} \\ & / & \diagdown \\ \text{H} & & \text{H} \end{array} + \text{Conc. KOH} \xrightarrow{\Delta} \text{A} + \text{B}$$

 Identify A and B from the given options
 (A) A-Methanol, B-Potassium formate
 (B) A-Ethanol, B-Potassium formate
 (C) A-Methanal, B-Ethanol
 (D) A-Methanol, B-Potassium acetate
3. Which of the following acids represents Vitamin C?
 (A) Saccharic acid (B) Gluconic acid
 (C) Ascorbic acid (D) Benzoic acid
4. Rosenmund reduction is used for the preparation of Aldehydes. The catalyst used in this reaction is
 (A) Pd-BaSO₄ (B) Anhydrous AlCl₃
 (C) Iron (III) oxide (D) HgSO₄

5. Which alkyl halide from the given options will undergo $\text{S}_{\text{N}}1$ reaction faster?
 (A) $(\text{CH}_3)_3\text{C}-\text{Br}$ (B) $(\text{CH}_3)_2\text{CH}-\text{Br}$
 (C) $\text{CH}_3-\text{CH}_2-\text{Br}$ (D) $(\text{CH}_3)_3\text{C}-\text{CH}_2-\text{Br}$
6. From the elements of 3d series given below, which element shows the maximum number of oxidation states?
 (A) Scandium (C) Chromium
 (B) Manganese (D) Titanium
7. The correct mathematical expression of Arrhenius equation is
 (A) $k = -Ae^{E_a/RT}$ (B) $k = e^{E_a/RT}$
 (C) $k = Ae^{-E_a/RT}$ (D) $k = -Ae^{-E_a/RT}$
8. Identify the tertiary amine from the following:
 (A) $\begin{array}{c} \text{CH}_3 \\ | \\ \text{CH}_3-\text{N}-\text{CH}_3 \end{array}$ (B) $\begin{array}{c} \text{CH}_3-\text{CH}-\text{CH}_3 \\ | \\ \text{NH}_3 \end{array}$
 (C) $\text{CH}_3-\text{NH}-\text{CH}_2-\text{CH}_3$ (D) $(\text{C}_2\text{H}_5)_2\text{CHNH}_2$
9. Nucleophilic addition of Grignard reagent to ketones followed by hydrolysis with dilute acids forms
 (A) Alkene (B) Primary alcohol
 (C) Tertiary alcohol (D) Secondary alcohol

10. In a given graph of zero order reaction, the slope and intercept are



- (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 = $\ln A$
11. Match the reagents required for the given reactions:

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) II-(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)
12. The general electronic configuration of d -block elements is:
- (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) $(n-1)d^0ns^{1-2}$
- 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.
13. **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.
14. **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.
15. **Assertion (A):** Fructose is a reducing sugar.
Reason (R): Fructose does not reduce Fehling solution and Tollen's reagent.
16. **Assertion (A):** For a Daniell cell, $\text{Zn}/\text{Zn}^{2+}(1\text{M}) \parallel$

$\text{Cu}^{2+}(1\text{M})/\text{Cu}$ with $E^\circ_{\text{cell}} = 1.1\text{ V}$, if the external opposing potential is more than 1.1 V, the electrons flow from Cu to Zn.

Reason (R): Cell acts like a galvanic cell.

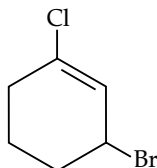
SECTION B

17. Define the following terms:
 (a) Order of a reaction
 (b) Activation energy 1 × 2
18. 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 = $1.86\text{ K kg mol}^{-1}$) 2
19. (a) Which compound in the given pair would undergo $\text{S}_{\text{N}}2$ reaction at a faster rate and why?
 $\text{CH}_3-\text{CH}_2-\text{I}$ and $\text{CH}_3-\text{CH}_2-\text{Br}$
 (b) Arrange the following compounds in the increasing order of their boiling points:
 Butane, 1-Bromobutane, 1-Iodobutane, 1-Chlorobutane 1 × 2
20. (a) Write the stepwise mechanism of nucleophilic addition the carbonyl compounds. reactions 2
OR
 (b) How will you convert the following:
 (i) Toluene to benzoic acid.
 (ii) Ethanol to 3-Hydroxybutanal 1 × 2
21. (a) What happens when glucose reacts with bromine water? Write chemical equation.
 (b) Two bases are mentioned below, identify which is present in DNA and which one is present in RNA:
 (i) Thymine, (ii) Uracil. 1 × 2

SECTION C

22. (a) Draw the geometrical isomers of the given complex:
 $[\text{Pt}(\text{en})_2\text{Cl}_2]^{2+}$
 (b) Write the electronic configuration for d^4 ion if $\Delta_0 < P$ on the basis of crystal field theory.
 (c) What is meant by a unidentate ligand? Give an example. 1 × 3
23. Calculate emf of the following cell at 25°C:
 $\text{Sn}/\text{Sn}^{2+}(0.001\text{ M}) \parallel \text{H}^+(0.01\text{ M}) \mid \text{H}_2(\text{g})(1\text{ bar}) \mid \text{Pt}_{(\text{s})}$
 Given: $E^\circ(\text{Sn}^{2+}/\text{Sn}) = -0.14\text{ V}$, $E^\circ\text{H}^+/\text{H}_2 = 0.00\text{ V}$
 $(\log 10 = 1)$ 3
24. Write chemical equations for the following reactions: (Do any three)
- (a) Hydroboration-oxidation reaction
 (b) Williamson Synthesis
 (c) Friedel-Crafts Alkylation of Anisole
 (d) Reimer-Tiemann Reaction 1 × 3
25. (a) Give chemical tests to distinguish between the following pairs compounds:
 (i) Phenol and Benzoic acid
 (ii) Propanal and Propanone
 (b) Which one of the given compounds is a stronger acid and why?
 $\text{CH}_2\text{FCH}_2\text{CH}_2\text{COOH}$ or $\text{CH}_3\text{CHFCH}_2\text{COOH}$

26. Explain the following terms:
 (a) Essential amino acids
 (b) Peptide bond
 (c) Denaturation 1×3
27. (a) Write the IUPAC name of the given compound:



- (b) The presence of $-\text{NO}_2$ group at ortho or para position increases the reactivity of haloarenes towards nucleophilic substitution reactions. Give reason to explain the above statement.
- (c) What happens when ethyl chloride is treated with alcoholic potassium hydroxide? 1×3
28. 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 [$\log 2 = 0.3010, \log 10 = 1$]. 3

SECTION D

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

29. The nature of bonding, structure of the coordination 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:

- (a) Predict whether $[\text{CoF}_6]^{3-}$ is diamagnetic or paramagnetic and why [Atomic number: Co = 27] 1
- (b) What is the coordination number of Co in $(\text{Co}(\text{en})_2\text{Cl}_2)^+$? 1
- (c) (i) Write the IUPAC name of the given complex:
 $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]^{2+}$
 (ii) Explain $(\text{Co}(\text{NH}_3)_6)^{3+}$ is an inner orbital or outer orbital complex. 1+1

OR

- (c) Using valence bond theory, deduce the shape and hybridisation of $[\text{Ni}(\text{NH}_3)_6]^{2+}$ (Atomic number of Ni = 28). 2

30. 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 :

- (a) What is the function of a salt bridge in a galvanic cell? 1
- (b) When does galvanic cell behave like an electrolytic cell? 1
- (c) Can copper sulphate solution be stored in a pot made of zinc? Explain with the help of the value of E° cell.
 $(E^\circ \text{Cu}^{2+} / \text{Cu} = 0.34 \text{ V})$
 $(E^\circ \text{Zn}^{2+} / \text{Zn} = -0.76 \text{ V})$ 2

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 2

SECTION E

31. Attempt any five of the following:
- (a) Why zinc is not regarded as a transition element?
 (b) What is Lanthanoid contraction?
 (c) Why is first ionization enthalpy of chromium lower than that of Zn?
 (d) Why are transition elements good catalysts?
 (e) Compounds of transition metals are generally coloured. Give reason.
 (f) Out of KMnO_4 and K_2MnO_4 , which one is paramagnetic and why?
 (g) Complete the following ionic equation:
 $\text{Cr}_2\text{O}_7^{2-} + 14 \text{H}^+ + 6\text{e}^- \rightarrow$ 1×5
32. (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 $M = 180 \text{ g mol}^{-1}$ 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? 1+1+3

OR

- (b) (i) Predict whether Van't Hoff factor will be less or greater than one, when ethanoic acid is dissolved in benzene.
 (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. $1+1+3$
(K_f for water = $1.86 \text{ K kg mol}^{-1}$)

33. (a) An amide 'A' with molecular formula $\text{C}_7\text{H}_7\text{ON}$ 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. 5

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 : $\text{C}_2\text{H}_5\text{NH}_2$, $(\text{C}_2\text{H}_5)_3\text{N}$, $(\text{C}_2\text{H}_5)_2\text{NH}$
(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. 2+3

Outside Delhi Set-2

56/4/2

Note: Except these, all other question have been given in Outside Delhi Set-1

SECTION A

1. The molar ionic conductivities of Mg^{2+} and SO_4^{2-} are $106.0 \text{ S cm}^2 \text{ mol}^{-1}$ and $160.0 \text{ S cm}^2 \text{ mol}^{-1}$ respectively. The value of limiting molar conductivity of MgSO_4 will be:
(A) $266 \text{ S cm}^2 \text{ mol}^{-1}$ (B) $622 \text{ S cm}^2 \text{ mol}^{-1}$
(C) $288 \text{ S cm}^2 \text{ mol}^{-1}$ (D) $822 \text{ S cm}^2 \text{ mol}^{-1}$
7. In effective collisions the colliding molecules must have.
(A) Proper orientation only
(B) A certain minimum amount of activation energy.
(C) Threshold energy only.
(D) Threshold energy and proper orientation both.
8. Identify the secondary amine from the given options:
(A) $(\text{CH}_3)_2\text{CHNH}_2$ (B) $\text{CH}_3\text{NHCH}(\text{CH}_3)_2$
(C) $(\text{CH}_3)_3\text{CNH}_2$ (D) $\text{CH}_3(\text{CH}_2)_2\text{NH}_2$

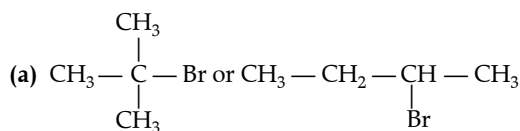
For questions number 13 to 16, two statements are given - one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below:

- (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.
13. **Assertion (A):** Bromination of Phenol can be carried out even in the absence of Lewis acid.
Reason (R): OH group of Phenol has the high activation effect.

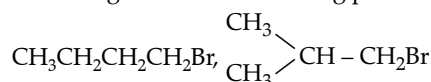
SECTION B

17. Define the following terms:
(a) Molecularity of reaction
(b) Complex reaction 2
18. Calculate the molar mass of a compound when 6.3 g of it is dissolved in 27 g of chloroform to form a solution that has a boiling point of 68.04°C . The boiling point of pure chloroform is 61.04°C and K_b for chloroform is $3.63^\circ\text{C kg mol}^{-1}$. 2

19. Which of the following compounds will react more rapidly by $\text{S}_{\text{N}}2$ reaction & why?



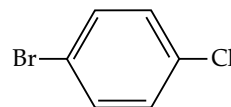
- (b) Arrange the following compounds in the increasing order of their boiling points:



21. (a) What happens when glucose reacts with HI? Write chemical equation.
(b) Which type of bond holds a DNA double helix together? 1×2

SECTION C

22. (a) Draw the geometrical isomers of the given complex:
 $[\text{Co}(\text{en})_2\text{Cl}_2]^+$
(b) Write the electronic configuration of d^4 ion if $\Delta_0 > P$.
(c) What is a didentate ligand? Give one example. 1×3
26. Define the following terms:
(a) Non essential amino acids.
(b) Monosaccharides
(c) Anomers 1×3
27. (a) Write the IUPAC name of the given compound:



- (b) Why are haloalkanes more reactive towards nucleophilic substitution reactions than haloarenes ?
(c) What happens when ethyl chloride is treated with aqueous KOH? 1×3

Outside Delhi Set-3

56/4/3

Note: Except these, all other question have been given in Outside Delhi Set-1&2

SECTION A

1. The molar ionic conductivities of Al^{3+} and SO_4^{2-} are $189 \text{ S cm}^2 \text{ mol}^{-1}$ and $160 \text{ S cm}^2 \text{ mol}^{-1}$ respectively. The value of limiting molar conductivity of $\text{Al}_2(\text{SO}_4)_3$ will be:
 (A) $198 \text{ S cm}^2 \text{ mol}^{-1}$ (B) $858 \text{ S cm}^2 \text{ mol}^{-1}$
 (C) $588 \text{ S cm}^2 \text{ mol}^{-1}$ (D) $891 \text{ S cm}^2 \text{ mol}^{-1}$
7. The fraction of molecules having energy equal to or greater than activation energy is:
 (A) A (B) $e^{-E_a/RT}$
 (C) K (D) $Ae^{-E_a/RT}$
8. Identify the primary amine from the given options:
 (A) $(\text{C}_2\text{H}_5)_3\text{N}$ (B) $(\text{C}_2\text{H}_5)_2\text{NH}$
 (C) $\text{C}_2\text{H}_5\text{NH}_2$ (D) $(\text{CH}_3)_3\text{N}$

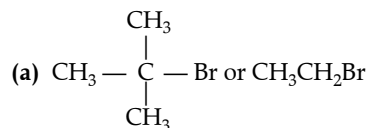
For questions number 13 to 16, two statements are given one labelled as Assertion (A) and the other labelled as Reason (R). Select the correct answer to these questions from the codes (A), (B), (C) and (D) as given below:

- (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):** Phenols are stronger acids than alcohols.
Reason (R): Alkoxide ion is more stable than phenoxide ion.

SECTION B

17. Define the following terms:
 (a) Half life period ($t_{1/2}$)
 (b) Effective collisions 1×2

18. A solution containing 60 g of a non-volatile solute in 250 g of water freezes at 270.67 K. Calculate the molar mass of the solute. (K_f of water = $1.86 \text{ K kg mol}^{-1}$). 2
19. Which of the following compounds will react more rapidly by $\text{S}_{\text{N}}1$ reaction and why?



- (b) Arrange the following compounds in the increasing order of their boiling points:
 Bromoform, Dibromomethane, Chloromethane, Bromomethane 1×2
21. (a) What happens when Glucose reacts with nitric acid? Write chemical equation.
 (b) Write one structural difference between DNA and RNA. 1×2

SECTION C

22. (a) Draw the geometrical isomers of the given complex:
 $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]^{2+}$
 (b) Write the electronic configuration of d^5 ion if $\Delta_0 < P$.
 (c) What is an ambidentate ligand? 1×3
26. Define the following terms:
 (a) Glycosidic linkage
 (b) Primary structure of protein
 (c) Disaccharides 1×3
27. (a) Write the IUPAC name of the given compound:
 $\text{CH}_2 = \text{CH} - \text{CH}_2 - \text{CH}_2 - \text{Cl}$
 (b) Why is thionyl chloride preferred for preparing alkyl halides from alcohols?
 (c) What happens when methyl bromide reacts with KCN? 1×3



ANSWERS

Delhi Set-1

56/5/1

SECTION A

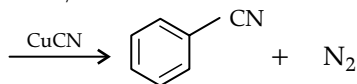
1. Option (A) is correct.

Explanation: The specific sequence in which amino acids are linked together to form a polypeptide chain is the primary structure of a protein.

2. Option (A) is correct.

Explanation: Benzene diazonium salts can be converted to different substituents by Sandmeyer's reaction.

Diazonium salt + CuCN/KCN

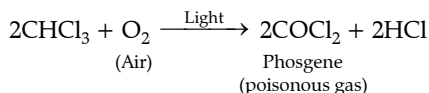


3. Option (D) is correct.

Explanation: The substituted alkene on acidic hydrolysis produces a tertiary alcohol according to Markownikoff's addition where the negative part of the addendum goes to the carbon atom having least number of hydrogen atoms.

4. Option (C) is correct.

Explanation: Chloroform undergoes auto oxidation as follows:



5. Option (A) is correct.

Explanation: Though the chemical properties do not change, when Transition metals form interstitial compounds they become more hard.

6. Option (C) is correct.

Explanation: Solutions having same osmotic pressure are known as isotonic solutions. They have the same concentration of the solute.

7. Option (B) is correct.

Explanation: It was chosen for its ability to generate electricity by combining hydrogen and oxygen from hydrogen peroxide, producing water as a byproduct. This type of fuel cell provided a reliable and efficient source of power for the spacecraft during the Apollo missions.

8. Option (B) is correct.

Explanation:

$$r = k[A]^n \quad \dots(i)$$

$n = \text{order of the reaction}$

$$16r = k[4A]^n \quad \dots(ii)$$

Dividing (ii) by (i):

$$16 = 4^n$$

$$n = 2$$

Order of the reaction = 2

9. Option (A) is correct.

Explanation: A chiral carbon has four different groups attached to it and is represented by C*. Structures I, II and III have such a carbon.

10. Option (C) is correct.

Explanation: The stronger base is a conjugate form of its weak acid. ROH is the weakest acid. Also, the positive Inductive effect of the alkyl group in RO⁻ increases the negative charge and makes it a very strong base.

11. Option (D) is correct.

Explanation: Conductivity depends on the concentration of ions per unit volume of the solution. On dilution this decreases.

Molar conductivity increases because with dilution the dissociation of the weak electrolyte increases, causing an increase in the number of active ions in solution.

12. Option (B) is correct.

Explanation: The molecule Na₂SO₄·10H₂O dissociates as follows:

- 2 Na⁺
- 1 SO₄²⁻
- 10 H₂O

Since water is a non-electrolyte, it does not ionize and does not contribute to the van't Hoff factor value.

13. Option (A) is correct.

Explanation: Both Zr and Hf have same atomic radii and this is due to the lanthanoid contraction.

14. Option (A) is correct.

Explanation: The rate of a zero-order reaction does not depend on the concentration of the reactants. Therefore, the rate of a zero-order reaction is always equal to the rate constant of that specific reaction.

15. Option (C) is correct.

Explanation: S_N2 mechanism proceeds via a concerted mechanism in which a pentavalent carbon is formed with half bonds in the transition state and no carbocation is formed. There is inversion of configuration due to the attack of the nucleophile from the back.

16. Bonus

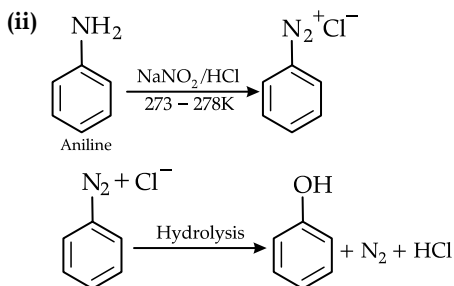
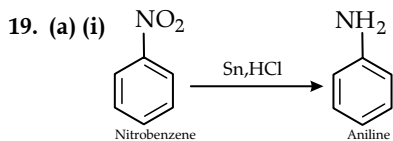
Explanation: *p*-nitrophenol is a more acidic than *p*-methoxyphenol. The nitro group present in para position exerts -R effect and increases acidic character. Methoxy group in para position exerts +R effect and decreases acidic character.

SECTION B

17. (a) Kohlrausch's law states that the equivalent conductivity of an electrolyte at infinite dilution is equal to the sum of the conductance of the anions and cations.

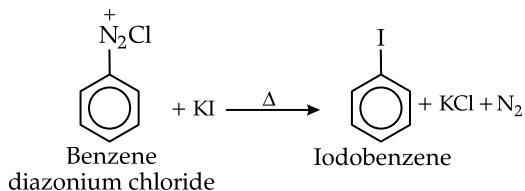
(b) Faraday's first law of electrolysis states, during electrolysis, the amount of substance produced at any electrode as a result of chemical reaction proportional to the quantity of electricity passed through the electrolyte.

18. **Galactose:** Monosaccharide
Glucose: Monosaccharide
Lactose: Disaccharide
Maltose: Disaccharide



OR

- (b) (i) Ethanamine reacts with alcoholic KOH and CHCl3 to form Carbylamine having a characteristic odour. Di-methyl amine does not respond to this test.
- (ii) Benzene diazonium chloride reacts with KI to form iodo benzene:



20. **Case 1:** If 't' is the time required for 99% completion 'a' is the initial concentration of reactant then,

$$x = 99\% \text{ of } a \Rightarrow (a - x) = 1\% \text{ of } a = \frac{1}{100} \times a = \frac{a}{100}$$

$$t = \frac{2.303}{k} \log \left(\frac{a}{a-x} \right)$$

$$= \frac{2.303}{k} \log \left(\frac{a \times 100}{a} \right)$$

$$= \frac{2.303}{k} \log 10^2$$

$$\therefore t = 2 \left[\frac{2.303}{k} \right]$$

- Case 2:** If 't' is the time required for 90% of completion then $x = 90\%$ of a $(a - x) = 10\%$ of a $= \frac{1}{10} \times a = \frac{a}{10}$

$$t = \frac{2.303}{k} \log \left(\frac{a}{a-x} \right)$$

$$= \frac{2.303}{k} \log \left(\frac{a \times 10}{a} \right)$$

$$= \frac{2.303}{k} \log 10$$

$$\therefore t = \left[\frac{2.303}{k} \right]$$

Comparing: case 1: case 2, 2:1

So, the time required for the completion of 99% of reaction is twice the time required for 90% completion in a first order reaction.

21. Cell constant = conductivity \times resistance
 $= 0.0248 \times 200 = 4.96 \text{ m}^{-1}$
 $= 0.0496 \text{ cm}^{-1}$

For 0.05 mol L^{-1} KCl solution:

Cell constant = conductivity \times resistance

Conductivity = cell constant / resistance

$$\text{Conductivity} = \frac{0.0496}{620}$$

$$= 8 \times 10^{-5} \text{ ohm}^{-1} \text{ cm}^{-1}$$

$$\text{Concentration} = 0.05 \times 10^{-3} \text{ mol cm}^{-3}$$

$$\text{Molar conductivity} = \frac{\text{conductivity}}{\text{concentration}}$$

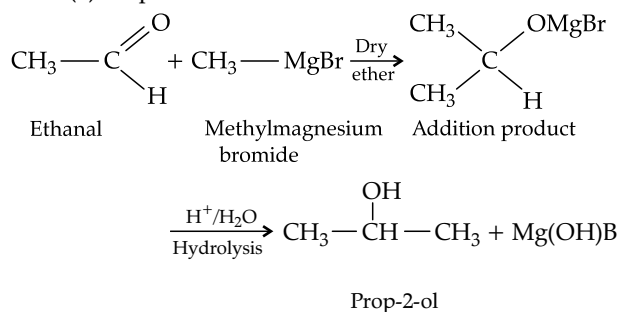
$$= \frac{8 \times 10^{-5}}{0.05 \times 10^{-3}}$$

$$= 160 \times 10^{-2}$$

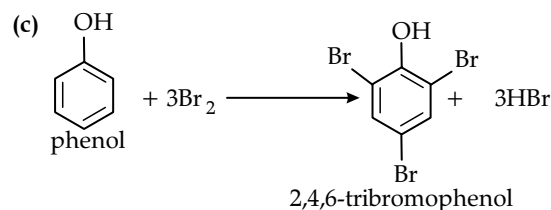
SECTION B

22. (a) Tetraamminechloridonitrocobalt (III)chloride
 (b) Hexaamminenickel(II)chloride
 (c) Potassiumtrioxalatochromate (III)
 (d) Dibromo bis(ethylenediamine)cobalt(III)ion

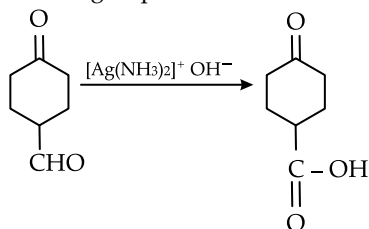
23. (a) Propan-2-ol is formed.



- (b) According to Markovnikov's Rule—
CH3CH2CH=CH2 + H2O $\xrightarrow{\text{dil. H}_2\text{SO}_4}$ CH3CH2CH(OH)CH3
 But-1-ene Butan-2-ol

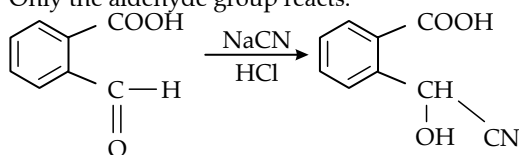


24. (a) Only the aldehyde group reacts to get oxidized to acid, the keto group remains unaffected.



- (b) $\text{CH}_3\text{CH} = \text{C}(\text{CH}_3)\text{COCH}_3 + \text{NaOI} \rightarrow$
 $\text{CH}_3\text{CH} = \text{C}(\text{CH}_3)\text{COOH} + \text{CHI}_3$

- (c) Only the aldehyde group reacts.



25. Using Nernst equation:

$$E_{\text{cell}} = E_{\text{cell}}^0 - \frac{0.0592}{n} \log \frac{[\text{Products}]}{[\text{Reactants}]}$$

$$= 1.05 - \frac{0.0592}{2} \log \frac{[\text{Ni}^{2+}]}{[\text{Ag}^+]^2}$$

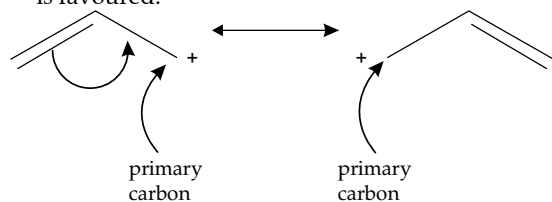
$$= 1.05 - 0.0291 \log \frac{0.1}{(0.01)^2}$$

$$= 1.05 - 0.0291 \log 10^3 \quad [\because \log 10 = 1]$$

$$= 1.05 - 0.0291 \times 3$$

$$E_{\text{cell}} = 1.05 - 0.0873 = 0.962 \text{ V}$$

26. (a) Cyanide ion is an ambident ion and it reacts with alkyl halides to form isocyanides. AgCN is covalent and replaces the halogen via a $\text{S}_{\text{N}}2$ mechanism, when the lone pair of nitrogen in AgCN is attached to the carbon bearing the halogen yielding isocyanide.
- (b) Allyl chloride undergoes heterolysis to form a carbocation. This carbocation is resonance stabilised and is stable. Hence $\text{S}_{\text{N}}1$ mechanism that involves the formation of a carbocation in the transition state is favoured.



- (c) Halogens are highly electronegative and draws the delocalized pi cloud of the benzene ring towards itself, which makes the ring electron deficient and do not undergo electrophilic attack.

27. By Arrhenius equation,

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303 \times R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

$$\log 4 = \frac{E_a}{2.303 \times 8.314} \left[\frac{1}{300} - \frac{1}{320} \right]$$

$$E_a = \log 4 \times 2.303 \times 8.314 \times 320 \times \frac{300}{20}$$

$$E_a = 0.60 \times 2.303 \times 8.314 \times 300 \times \frac{320}{20}$$

$$E_a = 55152 \text{ J/mol}$$

28. Since the compound formed on reaction with $\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$ is insoluble in alkali, the amine is a secondary amine. The structure of the compound X is $\text{CH}_3\text{NHCH}_2\text{CH}_3$. IUPAC is N-Methyl ethanamine.

SECTION D

29. (a) A ligand which has two different donor atoms and either of the two sites in the ligand can form coordinate bonds with the central atom is called an ambidentate ligand.

Ex: $-\text{O}-\text{N}=\text{O}$

- (b) Ionisation isomerism
- (c) When a ligand attaches to the metal ion in a manner that forms a ring, then a chelate is formed. A bidentate or a polydentate ligand contains donor atoms positioned in such a way that when they coordinate with the central metal ion, a 5- or 6-membered ring is formed, the effect is known as the chelate effect. The complex resulting from coordination with the chelating ligand is much more thermodynamically stable.

OR

- (c) Coordination no. = No. of ligands \times denticity of ligand
- $$= 3 \times 2$$
- $$= 6$$

Since overall charge of the ligand + metal ion is +3, the oxidation no. of Cr is +3

30. (a) Pyridoxine
 (b) Vitamin K
 (c) Vitamin A deficiency. Fish, dairy, eggs

OR

- (c) Since, vitamin C is soluble in water, so dissolves in water and can be eliminated out from the body through urine and hence cannot be stored. Dry, brittle, and coiled hair that hang in a spiral shape, bleeding around hair follicles, and gum bleeding are one of the most characteristic signs of vitamin C deficiency.

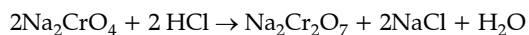
SECTION E

31. (a) Ce, having the configuration of $4f^1 5d^1 6s^2$. Ce(III) will have the configuration: $4f^1 5d^0 6s^0$, it can easily lose an electron to acquire the stable configuration of $4f^0 5d^0 6s^0$. This loss of an electron transforms it into Ce(IV), which has the noble gas configuration of xenon (Xe).
- (b) The electronic configuration of Mn: $\text{Mn } 1s^2 2s^2 2p^6 3s^2 3p^6 3d^5 4s^2$
 Mn^{2+} has a half-filled state of $3d^5$.
 Negative E° values of Mn^{2+}/Mn is because of the stabilities of half-filled ($3d^5$: Mn^{2+}) configuration.

- (c) The greater the number of unpaired electrons, the stronger is the resultant bonding and hence, higher is the enthalpy of atomisation. In the 3d series, from Sc to Zn, Zn has no unpaired electrons. Hence, it

exhibits weak interactions and thus possesses the least enthalpy of atomisation.

- (d) At acidic pH, sodium chromate converts to sodium dichromate:



- (e) Zinc, cadmium and mercury have a fully filled *d*-subshell, due to which metallic bonds are weak. That's why they are soft and have low melting point.

- (f) Permanganate titration is not carried out in the presence of hydrochloric acid because some of the hydrochloric acid gets oxidised to chlorine gas. Hence, we do not get the correct endpoint for any given titration.

- (g) In low oxidation state of the metal, some of the valence electrons of the metal atom are not involved in bonding. Hence it can donate electrons and behave as a base. On the other hand, in higher oxidation state of the metal, valence electrons are involved in bonding and are not available. , effective nuclear charge is high and hence it can accept electrons and behave as an acid.

$$32. \text{ (a) (i)} \quad \Delta T_f = 2.8 = K_f \times m \\ = \frac{K_f \times \text{moles}}{\text{Mass per kg of water}}$$

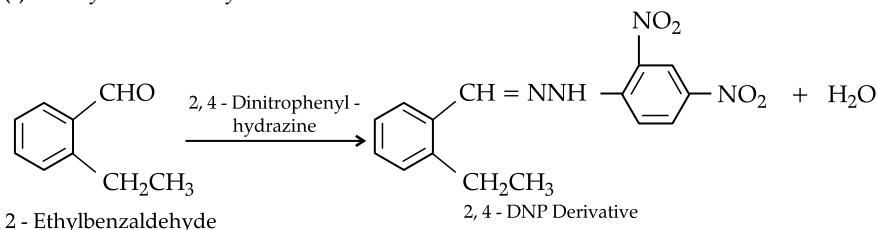
$$2.8 = \frac{1.86 \times m}{62 \times 1}$$

$$m = 93.3\text{g}$$

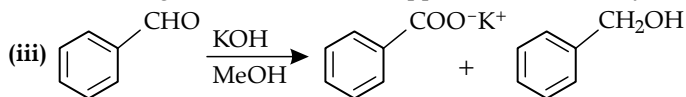
Mass of ethylene glycol required = 93.3g

33. (a) (i) 2-Ethyl benzaldehyde

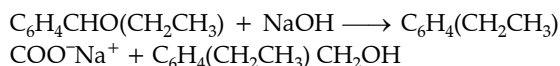
- (ii) (1)



- (2) Fehling's reaction does not happen with benzaldehyde.



Cannizzaro reaction does not affect the alkyl substituent. Same products are formed.



OR

- (b) (i) (1) The hydrogen at alpha position of carbonyl group is acidic as it experiences -I effect of the carbonyl group. The proton can be abstracted by a base and the resulting anion is stabilised by keto-enol tautomerism

- (ii) **Positive Deviation:** When a solution shows positive deviation, its vapor pressure is greater than what Raoult's law predicts.

In the case of ethanol-acetone mixtures, this positive deviation occurs. Pure ethanol possesses hydrogen bonding interactions. When acetone is introduced into the mixture, it disrupts some of the hydrogen bonds between ethanol molecules. The weakening of these interactions leads to the positive deviation from Raoult's law.

OR

$$\text{(b) (i)} \quad \Delta T_b = K_b \times m$$

$$0.32 = 0.52 \times W \times \frac{1000}{342 \times 500}$$

$$W = 0.32 \times 342 \times \frac{500}{0.52 \times 1000}$$

$$= 105.23 \text{ g}$$

Weight of sucrose to be added = 105.23 g

- (ii) Henry's law states that the solubility of the gas is directly proportional to the pressure of the gas at a constant temperature. This means that the more the pressure of the gas is, the more soluble the gas is.

Application: In soft drinks, to increase the solubility of carbon dioxide (CO_2) the bottles are sealed at a high pressure. This is why some of the gas escapes when we open a bottle of soft drink.

- (2) Aldehydes are more reactive than ketones and can be easily oxidized. Aldehydes ($-\text{CHO}$) have a hydrogen atom attached to carbonyl carbon which can easily be abstracted. Ketones lack this proton, hence they oxidise only under extreme conditions where C-C bonds are broken.

- (ii) (1) propanal > acetone > Benzaldehyde

(2) Propane < dimethyl ether < propanal < ethanol

- (iii) Benzoic acid reacts with ethanol in the presence of dilute sulphuric acid to form sweet smelling ester Ethyl benzoate. This reaction is not given by benzaldehyde.

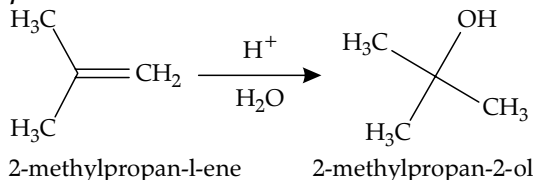
SECTION A

6. Option (D) is correct.

Explanation: This reaction is used for obtaining chlorobenzene or bromobenzene from benzenediazonium chloride by treating it with Cu/HCl or Cu/HBr respectively. It is a method of formylation of aromatic ring compounds. Hence, it is also known as Gatterman formylation.

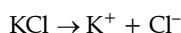
7. Option (D) is correct.

Explanation:



8. Option (B) is correct.

Explanation: Van't Hoff Factor = final moles / initial moles



Initial moles = 1; final moles = 2

Van't Hoff Factor = $2/1 = 2$

9. Option (B) is correct.

Explanation: When a solution is diluted, there are more ions and they have more space to move. On dilution as volume of solution increase, no. of ions per ml decrease and hence conductivity decreases. While molar conductivity is conductivity of 1 moles of ions. Hence on dilution ions move apart and mobility of ions increase which leads to increase in molar conductivity of the solution.

10. Option (C) is correct.

Explanation: Lead Storage Cell is used in inverters as it is a secondary storage cell which we can recharge again and use again.

11. Option (B) is correct.

Explanation: The carbon in which all four valencies of carbon is satisfied by different groups, is called chiral carbon.

12. Option (C) is correct.

Explanation: The order of reaction refers to the power dependence of the rate on the concentration of each reactant.

SECTION B

17. (a) **Faraday's second law of electrolysis:** When the same quantity of electricity is passed through the solutions of different electrolytes connected in series, the masses of substances liberated (or deposited) at the electrodes are directly proportional to their equivalent masses.

(b) **Corrosion:** It is a process of slow deterioration of metals which occurs when most or all of the atoms on the same metal surface are oxidized, damaging the entire surface. Most metals are easily oxidized: they tend to lose electrons to oxygen (and other substances) in the air or in water. As oxygen is reduced (gains electrons), it forms an oxide with the metal.

21. **Monosaccharide sugars:** Glucose and Fructose

Disaccharide sugars: Lactose and Maltose

SECTION C

25. (a) Potassium hexacyanidoferrate (III)

(b) Dichlorido bis(ethane-1, 2diammine) platinum (IV) ion

(c) Tetraamminechloronitrito-N-cobalt(III) chloride.

(d) Tetrahydroxidozincate(II) ion

28. (a) On reacting with NaCN, haloalkane form cyanide and isocyanide because of ionic character of NaCN.

(b) The partial double bond nature of C-X bond in a haloarene is resonance stabilised due to presence of aryl group than a haloalkane. Therefore, haloarenes can't be cleaved by a nucleophile easily and hence they are less reactive towards nucleophilic substitution reactions.

(c) Benzyl chloride gives S_N1 reaction because the intermediate carbocation formed in slowest step is stabilised through resonance.

SECTION A

6. Option (A) is correct.

Explanation: Mercury cells are used in the hearing aids due to their low self-discharge rate, stable and constant voltage output, long shelf life and small size.

15. Option (D) is correct.

Explanation: Due to the methoxy group or OCH_3 showing (-I)-effect at the *m*-position and (+R)-effect at the *p*-position, the *m*-methoxyphenol is a stronger acid than *p*-methoxyphenol.

16. Option (A) is correct.

Explanation: Hydrolysis of 1-bromobutane proceeds through the S_N2 reaction. Such reactions always proceed with an inversion of configuration.

SECTION B

18. (a) **Limiting molar conductivity:** It is defined as the measure of the ability of an electrolyte to conduct electricity at infinite dilution, where the concentration approaches zero. It is denoted by the symbol \wedge_m^0

(b) **Fuel cell:** A fuel cell is an electrochemical device that converts chemical energy directly into electrical energy by combining a fuel (usually hydrogen) and an oxidizing agent (usually oxygen or air) within an electrochemical cell.

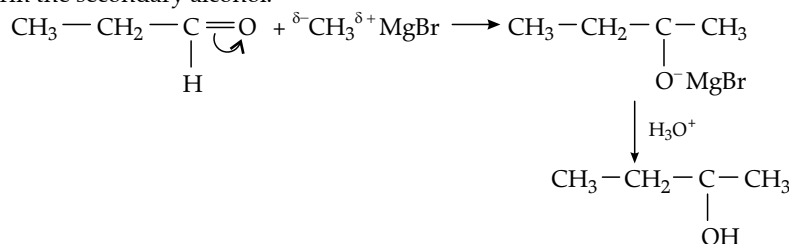
19. Monosaccharides – Glucose, Fructose
Disaccharides – Sucrose, Lactose

SECTION C

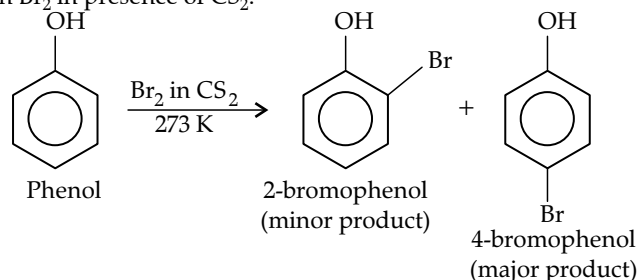
21. According to the first-order reaction

$$t = \frac{2.303}{k} \log \frac{100}{100-x}$$

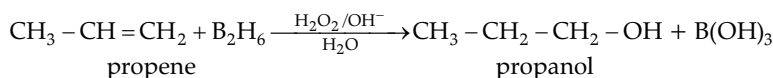
27. (a) The nucleophile MeMgBr attacks the carbonyl carbon of propanal to form the final product followed by hydrolysis to form the secondary alcohol.



- (b) Reaction of phenol with Br₂ in presence of CS₂:



- (c) Reaction of propene with diborane followed by oxidation:



28. The activation energy can be calculated by the equation as:

$$\log \frac{K_2}{K_1} = \frac{-E_a}{2.303R} \left(\frac{1}{T_1} - \frac{1}{T_2} \right)$$

Now, by substituting the values in the given equation:

$$\log 4 = \frac{-E_a}{19.15 \text{ JK}^{-1} \text{ mol}^{-1}} \left(\frac{1}{700\text{ K}} - \frac{1}{720\text{ K}} \right)$$

$$0.60 = \frac{-E_a}{19.15 \text{ JK}^{-1} \text{ mol}^{-1}} \left(\frac{20\text{ K}}{700\text{ K} \times 720\text{ K}} \right)$$

$$-E_a = \frac{0.60 \times 19.15 \text{ JK}^{-1} \text{ mol}^{-1} \times 700\text{ K} \times 720\text{ K}}{20\text{ K}}$$

$$= 289548 \text{ J/mol}$$

$$-E_a = 289.548 \text{ kJ/mol}$$

SECTION D

29. (a) The secondary valency refers to the number of ligands directly attached to the central metal ion.

$$k = \frac{2.303}{40 \text{ min}} \log \frac{100}{100-75}$$

$$k = \frac{2.303}{40 \text{ min}} \log \frac{100}{25}$$

$$k = \frac{2.303}{40 \text{ min}} \log 4$$

$$k = \frac{2.303}{40 \text{ min}} \times 0.60$$

$$k = 0.0345 \text{ min}^{-1}$$

The secondary valency of Co in [Co(NH₃)₄Cl₂]⁺ is 6 that means it forms six bonds with surrounding ligands that are 4 ammonia (NH₃) and 2 chloride ions (Cl⁻).

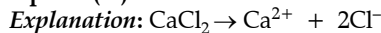
- (b) Solvate isomerism. In these complexes, water is exchanged by chloride ion. Thus, when two compounds having the same molecular formula differ by water or solvent molecules that are directly bonded to metal ion or present as free solvent molecules.
- (c) (i) If $\Delta_0 < P$, the electrons will occupy the higher energy orbitals first. The electron configuration becomes $t_{2g}^3 e_g^1$.
- (ii) If $\Delta_0 > P$, the electrons will occupy the lower energy t_{2g} orbitals first. The electron configuration becomes $t_{2g}^4 e_g^0$.

OR

- (c) The coordination number of cobalt is 6 and the oxidation state of cobalt (Co) in the complex is +3.

SECTION A

1. Option (D) is correct.



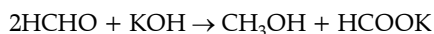
Limiting molar conductivity of CaCl_2 can be calculated as:

$$\begin{aligned}\Lambda^{\circ}m(\text{CaCl}_2) &= \Lambda^{\circ}\text{Ca}^{2+} + 2 \times \Lambda^{\circ}\text{Cl}^- \\ &= 119.0 + 2 \times 76.3 \\ &= 271.6 \text{ S cm}^2 \text{ mol}^{-1}\end{aligned}$$

2. Option (A) is correct.

Explanation: This is Cannizzaro reaction in which an aldehyde not containing α hydrogen undergoes self oxidation and self reduction in presence of concentrated alkali-NaOH or KOH.

So the reaction is:



3. Option (C) is correct.

Explanation: Vitamin C is ascorbic acid.

4. Option (A) is correct.

Explanation: Palladium and barium sulphate in boiling xylene acts as catalyst.

5. Option (A) is correct.

Explanation: Tertiary carbon compounds undergo $\text{S}_{\text{N}}1$ is a tertiary carbon halide.

6. Option (B) is correct.

Explanation: Manganese, show maximum oxidation ranging from -3 to $+7$. However, the most common oxidation states for are $+2$, $+3$, $+4$, $+6$, and $+7$ for manganese.

7. Option (C) is correct.

8. Option (A) is correct.

Explanation: Tertiary amine is a nitrogen atom bonded to three alkyl or aryl groups.

9. Option (C) is correct.

Explanation: Tertiary alcohol is formed by the following reaction:



10. Option (B) is correct.

Explanation: According to integrated rate law for zero order:

$$[\text{R}] = -kt + [\text{R}_0]$$

so the slope is equal to the negative of rate constant $-k$ and intercept is equal to the initial concentration R_0 .

11. Option (A) is correct.

Explanation:

- (i) Oxidation of primary alcohol to aldehyde takes place with PCC-Pyridinium chlorochromate as it is milder compared to other oxidising agents like potassium dichromate or chromic acid.
- (ii) For conversion of ketone to secondary alcohol, sodium borohydride is used.
- (iii) Bromine water forms white precipitate of 2,4,6-tribromophenol when treated with phenol.
- (iv) 85% phosphoric acid is used for removal of OH group from secondary alcohol to form an alkene.

12. Option (A) is correct.

Explanation: In d -block elements, the electrons are filled in the penultimate or second last shell i.e. $n-1$. the capacity of d subshell is 1-10. For completely filled and half filled shells, one electron is borrowed from s subshell.

13. Option (D) is correct.

Explanation: p -Nitrophenol is actually more acidic than phenol.

The reason for this lies in the electron-withdrawing nature of the nitro group ($-\text{NO}_2$) attached to the phenol ring in p -nitrophenol.

14. Option (A) is correct.

Explanation: The assertion is correct as Friedel Crafts reaction is a type of electrophilic aromatic substitution that involves the addition of an alkyl or acyl group to an aromatic ring. However, benzoic acid is not suitable substrate as the carboxyl group is strong electron withdrawing group that deactivates the aromatic ring.

15. Option (C) is correct.

Explanation: Reducing sugars are carbohydrates that contain free aldehyde or ketone functional groups capable of reducing other substances. Thus, fructose is a reducing sugar. The reaction of fructose with Fehling's solution is slower because fructose is a ketose sugar and does not contain a free aldehyde group in its cyclic form. However, under prolonged heating and acidic conditions, fructose can undergo mutarotation to convert to its open-chain form, which contains a carbonyl group and can react with Fehling's solution. Same is with Tollen's Reagent. Thus, reason is false.

16. Option (C) is correct.

Explanation: If the opposing potential (external potential) exceeds 1.10 volts in the Zn-Cu Daniel cell, the cell will no longer function as a galvanic cell, rather become an electrolytic cell and the direction of electron flow will reverse. Instead of the spontaneous flow of electrons from the zinc electrode to the copper electrode, the external potential will force the electrons to flow in the opposite direction—from the copper electrode to the zinc electrode.

SECTION B

17. (a) Order of reaction:

The order of a chemical reaction describes how the rate of the reaction depends on the concentration of reactants. It is determined experimentally and may be an integer, fractional, or zero.

- (b) **Activation Energy:** Activation energy is the minimum amount of energy required to initiate a chemical reaction by breaking the bonds of reactant molecules and forming the activated complex or transition state. It represents the energy barrier that must be overcome for a reaction to occur. Activation energy is usually denoted by E_a .

18. To solve this numerical we use formula:

$$\Delta T_f = K_f \times m$$

$$\text{Here: } \Delta T_f = T_{\text{pure}} - T_{\text{solution}}$$

Therefore, $\Delta T_f = 273.15 - 272.07\text{K} = 1.08\text{K}$
 now substituting the value of ΔT_f in the formula

$$\Delta T_f = k_f \times m$$

$$1.08 = 1.86\text{K kg/mol} \times m$$

$$m = \frac{\text{number of moles of solute}}{\text{mass of solvent}} \times 1000$$

or $T_f = \frac{K_f \times w_B \times 1000}{M_B \times W_A}$

$$1.08 = \frac{1.86 \times 18 \times 1000}{M_B \times 200}$$

$$M_B = \frac{1.86 \times 18 \times 1000}{1.08 \times 200}$$

$$M_B = 155.0120 \text{ g/mol}$$

19. (a) In general, for S_N2 reactions:

The stronger the nucleophile, the faster the reaction. Less steric hindrance around the electrophilic carbon favors a faster reaction.

When we look at the given pairs $\text{CH}_3\text{CH}_2\text{I}$ and $\text{CH}_3\text{CH}_2\text{Br}$:

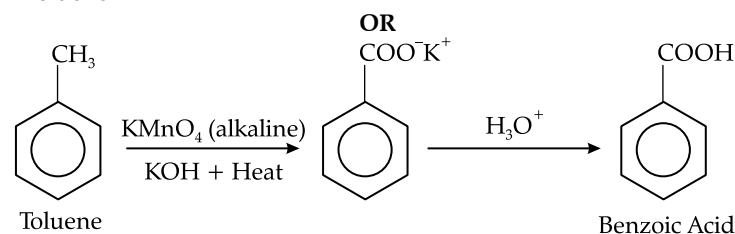
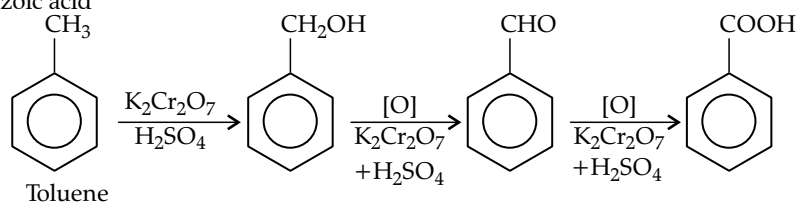
Iodide (I^-) is a better nucleophile than bromide (Br^-) because iodide is larger and has more electron density, making it more reactive in nucleophilic substitution reactions.

Under steric hindrance: Both molecules have the same alkyl group (ethyl), so there's no difference in steric hindrance between them.

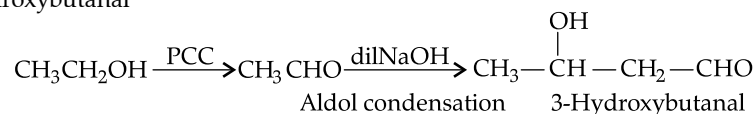
Therefore, $\text{CH}_3\text{CH}_2\text{I}$ undergoes the S_N2 reaction faster than $\text{CH}_3\text{CH}_2\text{Br}$ due to the stronger nucleophilicity of iodide compared to bromide.

OR

(b) (i) Toluene to benzoic acid

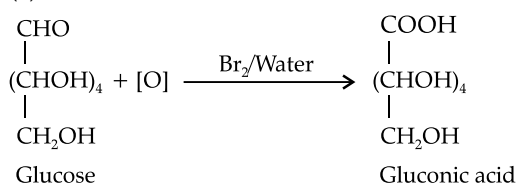


(ii) Ethanol to 3 hydroxybutanal



PCC = Pyridinechlorochromate

21. (a) Glucose decolourise bromine water.



(b) The increasing order of boiling points is: Butane < 1-Chlorobutane < 1-Bromobutane < 1-Iodobutane
Reason: Butane (C_4H_{10}) has only London dispersion forces, as it is nonpolar and the smallest molecule among the given compounds.

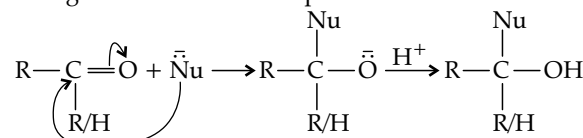
1-Chlorobutane ($\text{C}_4\text{H}_9\text{Cl}$) has a polar bond (C-Cl), which increases its boiling point compared to butane due to the presence of dipole-dipole interactions in addition to London dispersion forces.

Similarly, 1-bromobutane also has a polar bond (C-Br), leading to dipole-dipole interactions. Bromine is larger than chlorine, so the molecule might have slightly stronger dispersion forces as well.

1-Iodobutane ($\text{C}_4\text{H}_9\text{I}$) has the largest halogen atom (iodine), so it will have stronger London dispersion forces compared to the previous compounds due to its larger electron cloud.

20. (a) Generally, nucleophilic addition reaction of carbonyl compounds take place in three steps:

Step 1: Electrophilic carbonyl compound forms a sigma bond with nucleophilic.



Step 2: Carbon-oxygen pi bond is broken to form negative charged alkoxide.

Step 3: Protonation on alkoxide forming a derivative of alcohol.

25. (a) (i)

Reagent	Phenol	Benzoic acid
Neutral ferric chloride	When phenol is treated with ferric chloride there is change in colour, the product formed is either green, blue purple or red.	No change in colour of benzoic acid.

(ii)

Reagent	Propanal	Propanone
Tollen's Reagent	On heating with Tollen's reagent, silver mirror is formed on the inner walls of the test tube. Aldehyde group reduce the Tollen's reagent.	No change in propanone.

(b) 3-fluorobutanoic acid $\text{CH}_3\text{CHFCH}_2\text{COOH}$ is stronger than 4-fluorobutanoic acid $\text{CH}_2\text{FCH}_2\text{CH}_2\text{COOH}$ due to the distance, as in inductive effect, distance increases the strength decreases.

26. (a) Essential amino acids are a group of amino acids that cannot be synthesized by the human body in sufficient amounts or at all.

There are nine essential amino acids for humans: Histidine, isoleucine, leucine, lysine, methionine, phenylalanine, threonine, tryptophan and valine.

(b) A peptide bond is a type of covalent bond that forms between the amino group ($-\text{NH}_2$) of one amino acid and the carboxyl group ($-\text{COOH}$) of another amino acid, resulting in the formation of a peptide linkage.

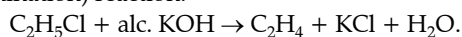
This process can be repeated multiple times, resulting in the formation of longer peptide chains known as polypeptides or proteins.

(c) Denaturation refers to the process by which the native structure of a biological molecule, such as a protein or nucleic acid, is disrupted, leading to the loss of its biological activity. Denaturation can occur due to various factors, including heat, pH extremes, organic solvents, detergents, and mechanical agitation.

27. (a) 3-Bromo-1-chlorocyclohexene

(b) The nitro group present on ortho or para position, increases the reactivity due to increased delocalization of negative charge involving nitro group. Or we can say that the nitro group present at ortho or para position, withdraw the electron density from the benzene ring, facilitating the nucleophile attack. The carbanion formed is stabilised through resonance and NO_2 group. **1**

(c) When ethyl chloride ($\text{C}_2\text{H}_5\text{Cl}$) reacts with alcoholic potassium hydroxide (alc. KOH), it undergoes an elimination reaction known as the E_2 (bimolecular elimination) reaction.



Ethene is formed

28. First order reaction $k = \frac{2.303}{t} \log \frac{a}{a-x}$

where

$$\begin{aligned} a &= \text{original amount} \\ a-x &= \text{amount left behind} \\ t &= \text{time period} \\ k &= \text{rate constant} \end{aligned}$$

We also know that

$$k = \frac{0.693}{t_{1/2}}$$

$$t_{1/2} = \text{half life period.}$$

Now, $x = 99.9\%$ and $x = 50\%$

$$\text{We can say } t = \frac{2.303}{k} \log \frac{a}{a-x}$$

$$\text{or } \frac{t_{99.9\%}}{t_{50\%}} = \frac{2.303 / k \log / 100 - 99.9}{2.303 / k \log / 100 - 50}$$

$$\text{or } \frac{t_{99.9\%}}{t_{50\%}} = \frac{\log \frac{100}{0.1}}{\log \frac{100}{50}} = \frac{-\log 1000}{\log 2}$$

$$\frac{t_{99.9\%}}{t_{50\%}} = \frac{-\log 1 \times 10^{-3}}{\log 2} = \frac{3}{0.3010}$$

$$\frac{t_{99.9\%}}{t_{50\%}} = \frac{3}{0.3}$$

thus, $t_{99.9\%} = 10 \times t_{50\%}$

SECTION D

29. (a) $[\text{CoF}_6]^{3-}$

$$\begin{aligned} \text{Co} &= 27 = 2, 8, 15, 2 \\ &= 1s^2 2s^2 2p^6 3s^2 3p^6 3d^7 4s^2 \end{aligned}$$

In $[\text{CoF}_6]^{3-}$

$$x + 6(-1) = -3$$

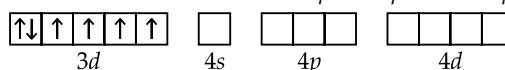
$$x - 6 = -3$$

$$x = -3 + 6$$

$$x = +3$$

Co^{+3} means

$$= 1s^2 2s^2 2p^6 3s^2 3p^6 3d^6 4s^0 4p^0$$



Fluorido is a weak ligand so it will undergo high spin, sp^3d^2 hybridisation.

So it will be paramagnetic due to 4 unpaired electrons.

(b) $[\text{Co}(\text{en})_2\text{Cl}_2]^+$

$\Rightarrow \text{en} = \text{ethylenediamine}$

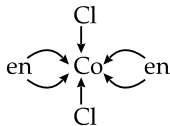
\Rightarrow It is a bidentate ligand, means it will provide two lone pairs.

So, cobalt has 2 ethylenediamine

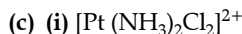
$$= 2 \times 2 + 2 \text{ Chlorine}$$

$$= 4 \text{ lone pair} + 2 \text{ chlorine} \\ = 6$$

The coordination number is six for cobalt as central metal atom.

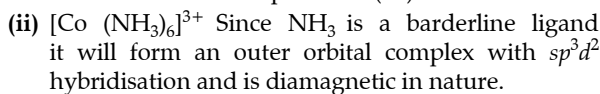


6 is the coordination number.



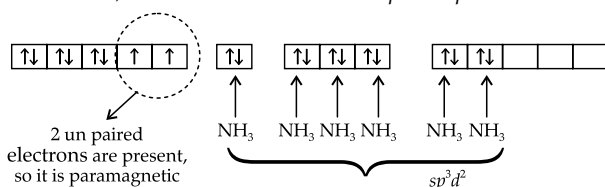
$$x + 2(0) + 2(-1) = +2 \\ x + 0 - 2 = +2 \\ x = +4$$

Diamminedichloridoplatinum (IV) ion

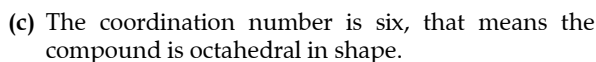


$$x + 6(0) = +2 \\ x = +2$$

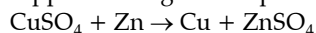
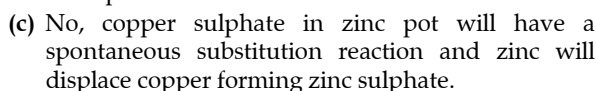
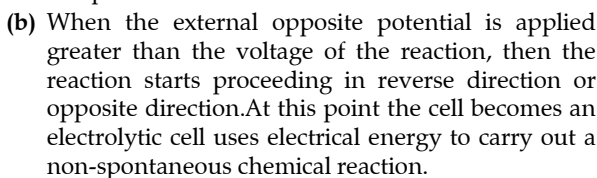
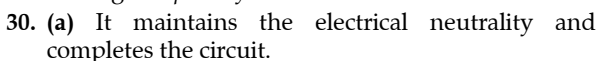
Thus, $\text{Ni}^{+2} = 1s^2 2s^2 2p^6 3s^2 3p^6 3d^8$



OR



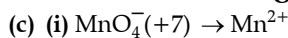
Since $[\text{Ni}(\text{NH}_3)_6]^{2+}$ is an outer orbital complex it undergoes sp^3d^2 hybridisation.



The reduction potential for Zinc is lower than copper, means it acts as anode. The oxidation will occur at anode and zinc will lose 2 electrons. and copper as cathode, with high reduction potential, it will accept electron or reduction will take place.

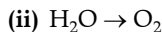
$$E^{\circ}_{\text{cell}} = E^{\circ}_{\text{cathode}} - E^{\circ}_{\text{anode}} \\ E^{\circ}_{\text{cell}} = 0.34 - (-0.76) \\ = 1.10 \text{ V}$$

OR



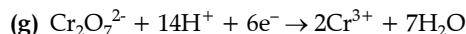
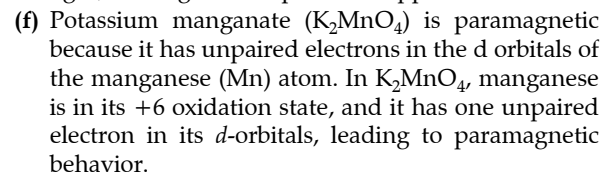
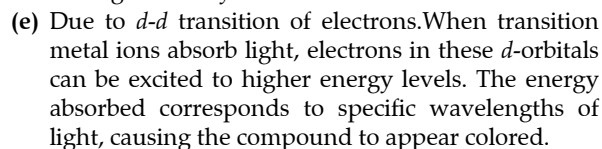
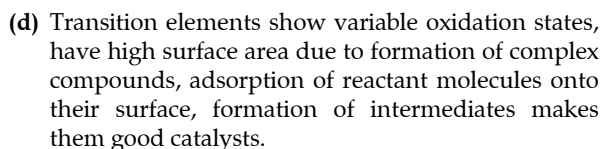
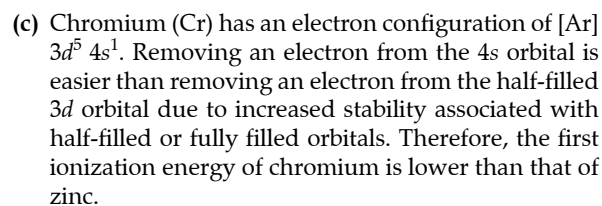
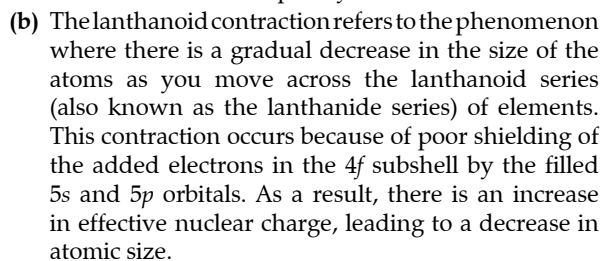
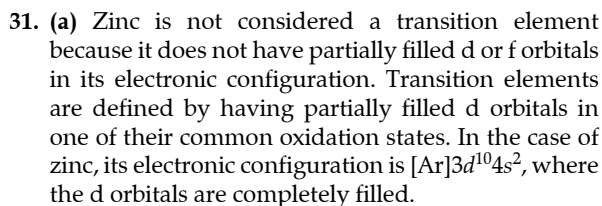
Faraday's number required = change in oxidation number

$$= 7 - 2 \\ = 5 \text{ F} \quad [\because \text{F} = 965000]$$



Change in oxidation Number is 2

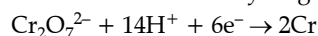
So, No. of faraday's required = 2 or 2F.



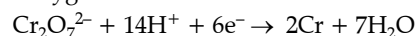
1. Write unbalanced reaction:



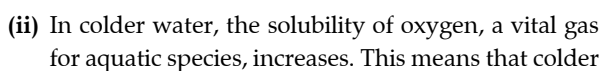
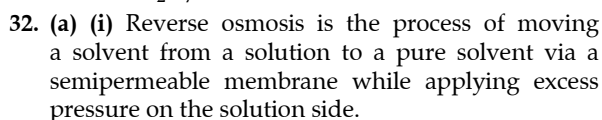
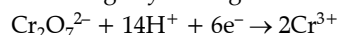
2. Balance the atoms other than hydrogen and oxygen



3. Balance the oxygen by adding water to the side that need oxygen



4. Balance the charge by adding electrons or charge



water can hold more dissolved oxygen compared to warmer water. As a result, aquatic species, particularly those with higher oxygen demands, find colder water more comfortable because it provides them with a greater supply of dissolved oxygen necessary for respiration and metabolic processes.

(iii) Number of moles of water

$$\begin{aligned} &= \frac{\text{Mass of water}}{\text{mol.mass of water}} \\ &= \frac{100}{18} \\ &= 5.55 \text{ moles} \end{aligned}$$

Number of moles of glucose

$$\begin{aligned} &= \frac{\text{Mass of glucose}}{\text{mol.mass of glucose}} \\ &= \frac{2}{180} \\ &= 0.0111 \end{aligned}$$

Total moles = 5.55 + 0.011

$$= 5.56 \text{ mol}$$

$$\chi_{\text{water}} = \frac{5.55}{5.56}$$

$$P_{\text{solution}} = \chi_{\text{water}} \times P_{\text{water}}$$

$$P_s = 0.99 \times 32.8$$

$$= 32.74 \text{ mm of Hg}$$

OR

(b) (i) In benzene, ethanoic acid molecules are more likely to associate with each other through hydrogen bonding and other intermolecular forces, rather than dissociate into ions. Thus, its van't Hoff factor is less than 1.

(ii) It is defined as the solution that obeys Raoult's Law, there is no interaction between the molecules. there is no volume change or heat change upon mixing.

(iii)

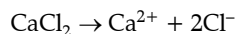
$$\Delta T_f = i k_f \text{ molality}$$

$$\Delta T_f = \frac{w \text{ of CaCl}_2}{\text{mol.mass of CaCl}_2}$$

$$\frac{1}{wt \text{ of water}} \times 1000$$

$$2k = i \times 1.86 \times \frac{w}{111} \times \frac{1}{500} \times 1000$$

here,

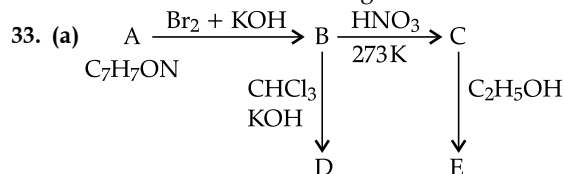


$$i = 3$$

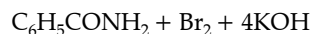
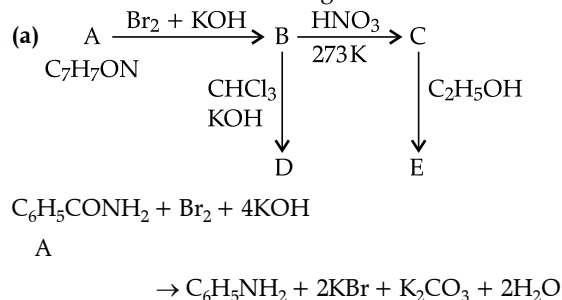
$$2k = 3 \times 1.86 \times \frac{w}{111} \times \frac{1000}{500}$$

$$w = \frac{2 \times 111 \times 500}{3 \times 1.86 \times 1000}$$

$$w = 19.89 \text{ g}$$



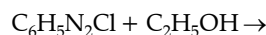
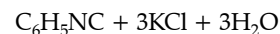
33. (a)



A



B



E

Answer:

A = $\text{C}_6\text{H}_7\text{CONH}_2$ Benzamide

B = $\text{C}_6\text{H}_5\text{NH}_2$ Aniline

C = Benzenediazonium Chloride

D = Bhenylisocyanide

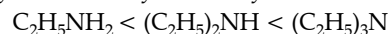
E = Benzene

OR

(b) (i) (1) The Hinsberg reagent is a chemical reagent used in organic chemistry for the identification and differentiation of primary, secondary, and tertiary amines. The Hinsberg reagent is typically composed of benzenesulfonyl chloride ($\text{C}_6\text{H}_5\text{SO}_2\text{Cl}$).

(2) The trend of basicity in the gaseous phase depends on the electron-donating property. Therefore, the increasing order is:

Primary < Secondary < Tertiary amine



This trend considers the relative availability of the lone pair of electrons on the nitrogen atom in the gaseous phase.

(ii) (1) In aniline the lone pair of electron remains delocalised in the pie electron ring and thus is not available on nitrogen. However, in methylamine, the lone pair is on NH_2 group of methyl and is the source of basicity.

(2) The benzene ring in aniline is highly activated due to strong mesomeric effect of amino group. This readily reacts with bromine water.

(3) In primary amines there are intermolecular hydrogen bonding, so more energy is required to break the attraction. Whereas in tertiary amines there is no intermolecular hydrogen bonding.

(All the three parts are 1 mark each)

SECTION A

1. Option (A) is correct.

Explanation: For a binary electrolyte like MgSO_4 , the formula is:

$$\lambda_m^0 = \lambda_+^0 + \lambda_-^0$$

$$\lambda_m^0 = \lambda_{\text{Mg}^{2+}}^0 + \lambda_{\text{SO}_4^{2-}}^0$$

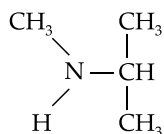
$$\lambda_m^0 = 106.0 \text{ Scm}^{-1} \text{ mol}^{-1} + 160.0 \text{ Scm}^{-1} \text{ mol}^{-1} \\ = 266.0 \text{ Scm}^{-1} \text{ mol}^{-1}$$

7. Option (D) is correct.

Explanation: In effective collisions, the colliding molecules must have sufficient energy called Threshold energy and the correct or proper orientation so that a reaction can take place.

8. Option (B) is correct.

Explanation:



13. Option (A) is correct.

Explanation: The bromination of phenol can be carried out in the absence of a Lewis acid because phenol is more reactive towards electrophilic aromatic substitution reactions as compared to benzene due to the presence of the hydroxy ($-\text{OH}$) group, which is an ortho-para directing group.

The hydroxy group activates the aromatic ring towards electrophilic attack. Thus, has high activating effect.

SECTION B

17. (a) Molecularity of the reaction: The molecularity of a chemical reaction refers to the number of molecules or ions participating as reactants in an elementary reaction. It is an integer value that represents the number of entities that come together to undergo a reaction.

(b) Complex reactions: Such reactions involve multiple elementary steps, each with its own reaction mechanism. These reactions can be broken down into simpler steps, often involving the formation and decomposition of intermediates. The overall reaction is a combination of these individual steps.

OR

The reaction in which molecularity of the reaction is not equal to order of reaction.

18. Mass of solute = 6.3 g

Mass of chloroform (solvent) = 27 g or 0.027 kg

Boiling point of the solution = 68.04°C

Boiling point of the chloroform (solvent) = 61.04°C

$$\Delta T_b = 68.04^\circ\text{C} - 61.04^\circ\text{C}$$

$$= 7.0^\circ\text{C}$$

$$\Delta K_b = 3.63^\circ\text{C mol}^{-1} \text{ kg}$$

Molality,

$$m = \frac{n_{\text{solute}}}{\text{Solvent in kg}}$$

$$= (6.3 \text{ g/M}) / (0.027 \text{ kg})$$

$$\Delta T_b = K_b \cdot m$$

$$7.0^\circ\text{C} = 3.63^\circ\text{C mol}^{-1} \text{ kg}^{-1}$$

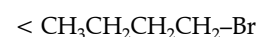
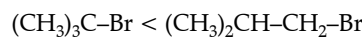
$$\times \frac{6.3 \text{ g}}{0.027 \text{ kg} \times M}$$

$$M = \frac{6.3 \text{ g} \times 3.63^\circ\text{C mol}^{-1} \text{ kg}^{-1}}{0.027 \text{ kg} \times 7.0^\circ\text{C}}$$

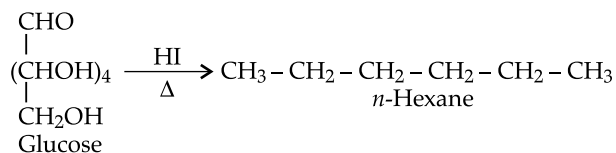
$$= 121 \text{ g/mol}$$

19. (a) The steric hindrance in tertiary halides makes it more difficult for the nucleophile to approach the reacting carbon atom in the rate-determining step of the $\text{S}_{\text{N}}2$ reaction. As a result, secondary halides typically undergo $\text{S}_{\text{N}}2$ reactions faster than tertiary halides. Therefore, 2-bromo-2methylpropane undergo $\text{S}_{\text{N}}2$ reaction slower than 2-bromobutane. **1**

(b) For isomeric alkyl halides, Boiling point decreases with an increase in branching due to less surface area and weak intermolecular forces. The increasing order is



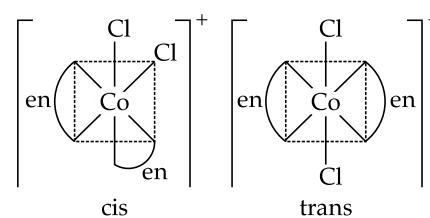
21. (a) The reaction of glucose with hydrogen iodide in the presence of heat involves its complete reduction to yield n-hexane. Hydrogen iodide acts as a reducing agent.



(b) A DNA helix is held together by hydrogen bonds between the complementary base pairs.

SECTION C

22. (a) The geometrical isomer of the complex $[\text{Co}(\text{en})_2\text{Cl}_2]^+$ are



- (b) If $\Delta_0 > P$, the electrons will occupy the lower energy t_{2g} orbitals first. The electron configuration becomes $t_{2g}^4 e_g^0$.
- (c) A didentate ligand, also known as a bidentate ligand, is a ligand that can form coordination bonds to a metal ion using two donor atoms. These donor atoms are typically separated by a specific number of atoms in the ligand's structure, forming a chelate complex. A common example of a bidentate ligand is ethylenediamine (en).
26. (a) **Non-essential amino acids:** The amino acids which can be synthesized in the body are known as non-essential amino acids. For e.g., glycine, alanine, glutamine, etc.
- (b) **Monosaccharides:** Monosaccharides include non-hydrolysable carbohydrates. They are soluble in water. Those containing an aldehydic group are called aldoses while others containing a ketonic group are called ketoses.
- (c) **Anomers:** The isomers which differ only in the configuration of the hydroxyl group at C-1 are called anomers and are referred to as α and β -forms.
27. (a) The IUPAC name of the compound is 1-bromo-4-chlorobenzene.
- (b) Haloalkanes are generally more reactive towards nucleophilic substitution reactions as compared to haloarenes because the carbon-halogen bond is generally weaker in haloalkanes as compared to haloarenes. The carbon-halogen bond strength influences the ease with which the leaving halide ion can be replaced by a nucleophile. As C-X bond in aryl halide acquires a partial double bond character due to resonance.
- (c) When ethyl chloride is treated with aqueous KOH it undergoes an elimination reaction known as dehydrohalogenation where a hydrogen atom and a halogen atom are eliminated from adjacent carbon atoms, resulting in the formation of an alkene.
- $$\text{CH}_3\text{CH}_2\text{Cl} + \text{aq. KOH} \rightarrow \text{CH}_2=\text{CH}_2 + \text{OH}^- + \text{KCl}$$

Outside Delhi Set-3

56/4/3

SECTION A

1. Option (B) is correct.

Explanation: Ionic molar conductivity or limiting molar conductivity $\Lambda_{\text{Al}^{3+}}^{\circ} = 189 \text{ S cm}^2 \text{ mol}^{-1}$

Ionic molar conductivity or limiting molar conductivity $\Lambda_{\text{SO}_4^{2-}}^{\circ} = 160 \text{ S cm}^2 \text{ mol}^{-1}$

So, limiting molar conductivity of a $\text{Al}_2(\text{SO}_4)_3$ compound $\Lambda_{\text{Al}_2(\text{SO}_4)_3}^{\circ}$

$$\begin{aligned} \Lambda_{\text{Al}_2(\text{SO}_4)_3}^{\circ} &= 2\lambda_{\text{Al}^{3+}}^{\circ} + 3\lambda_{\text{SO}_4^{2-}}^{\circ} \\ &= 2(189) + 3(160) \\ &= 858 \text{ S cm}^2 \text{ mol}^{-1} \end{aligned}$$

7. Option (B) is correct.

Explanation: When temperature of a substance increases the molecules collide with energy greater than activation energy. In Arrhenius equation the part $e^{-E_a/RT}$ corresponds to such molecules which has energy greater or equal to the activation energy.

8. Option (C) is correct.

Explanation: Primary, secondary and tertiary amines are formed by the substitution of 1, 2 and 3 hydrogen atoms in ammonia respectively by alkyl group. In $\text{C}_2\text{H}_5\text{NH}_2$ one hydrogen is substituted with alkyl group so it is primary amine.

13. Option (C) is correct.

Explanation: Phenol is more acidic than alcohols. However, it is because the phenoxide ion is more stable than alkoxide ion.

SECTION B

17. (a) **Half-life period ($t_{1/2}$):** Half-life period of a reaction is the time in which the concentration of a reactant is reduced to half of its initial concentration.

- (b) **Effective collision:** The effective collision is that in which molecules collide with sufficient kinetic energy and proper orientation. It leads to breaking of bonds of reactants and formation of new bonds of products.

$$18. \text{ Molar mass of solute } (M_B) = \frac{K_f \times W_B \times 1000}{\Delta T_f \times W_A}$$

$$W_B = \text{Weight of solute} = 60 \text{ g}$$

$$W_A = \text{Weight of solvent} = 250 \text{ g}$$

$$K_f (\text{Cryoscopic constant of water}) = 1.86 \text{ K kg/mol}$$

$$\Delta T_f = \text{Depression in freezing point} = T_f^{\circ} - T_f$$

$$= 273 - 270.67 = 2.33$$

$$\text{So, } M_B = \frac{1.86 \times 60 \times 1000}{2.33 \times 250}$$

$$= 191.58 \text{ g/mol}$$

19. (1) $(\text{CH}_3)_3\text{Br}$ undergoes $\text{S}_{\text{N}}1$ reaction more rapidly as compared to CH_3CH_2 .

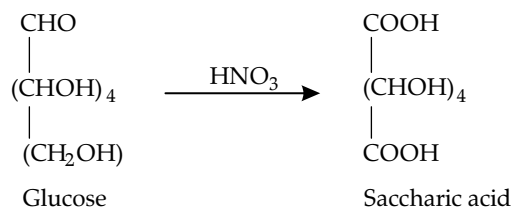
This is because the tertiary halides react more rapidly by $\text{S}_{\text{N}}1$ reaction as compared to primary halides because of high stability of tertiary carbocations.

(b) **Increasing order of boiling points:**

Chloromethane < Bromomethane < Dibromoethane < Bromoform

21. (a) When glucose reacts with nitric acid, it gets oxidised to saccharic acid.

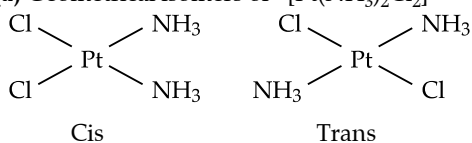
Chemical reaction



(b)

DNA	RNA
DNA has double strand helix structure.	RNA has single strand helix structure.

SECTION C

22. (a) Geometrical isomers of $[\text{Pt}(\text{NH}_3)_2\text{Cl}_2]^{2+}$ 

- (b) Electronic configuration of d^5 ion if $\Delta_0 < P$ is $t_{2g}^3 e_g^2$
- (c) The ligand which has two different donor atom is called ambidentate ligand.
26. (a) **Glycosidic linkage:** Linkage between two monosaccharides units through oxygen atom is called glycosidic linkage.
- (b) **Primary structure of protein:** The specific sequence of linkage of amino acids in each polypeptide chain of the protein is called primary structure of protein.
- (c) **Disaccharides:** The sugar formed when two monosaccharides units joined together through a glycosidic linkage is called disaccharide.
27. (a) 1-Chloro-But-3-ene
- (b) Thionyl chloride is preferred for the preparation of alkyl halide from alcohol because the byproducts formed in this reaction are gases (SO_2 and HCl).
- (c) These are easily separated from the desired product.
 $\text{CH}_3\text{Br} + \text{KCN} \rightarrow \text{CH}_3\text{CN} + \text{KBr}$
 Methyl cyanide or acetonitrile forms which on hydrolysis gives carboxylic acid.

