Class XII Session 2025-26
Subject - Chemistry
Sample Question Paper - 10

Time Allowed: 3 hours   **Maximum Marks: 70**

General Instructions:

Read the following instructions carefully.

1. There are **33** questions in this question paper with internal choice.

2. SECTION A consists of 16 multiple-choice questions carrying 1 mark each.

3. SECTION B consists of 5 very short answer questions carrying 2 marks each.

4. SECTION C consists of 7 short answer questions carrying 3 marks each.

5. SECTION D consists of 2 case-based questions carrying 4 marks each.

6. SECTION E consists of 3 long answer questions carrying 5 marks each.

7. **All questions are compulsory.**

8. **Use of log tables and calculators is not allowed.**

Section A

1. Decreasing order of reactivity of hydrogen halide acids in the conversion of ROH $\rightarrow$ RX is: **[1]**

   a) HI > HBr > HCl > HF   b) HF > HBr > HI > HCI

   c) HCI > HBr > HI > HF   d) HF > HCI> HBr > HI

2. ____ are joined together by phosphodiester linkage between 5′ and 3′ carbon atoms of the pentose sugar.   **[1]**

   a) Nucleic acids   b) Nucleotides

   c) Proteins   d) Nucleosides

3. The conversion of an alkyl halide into alcohol by aqueous NaOH is classified as   **[1]**

   a) a dehydrohalogenation reaction   b) a dehydration reaction

   c) an addition reaction   d) a substitution reaction

4. Pentan-2-one and Pentan-3-one can be distinguished by: **[1]**

   a) Tollens' test   b) Sodium bicarbonate test

   c) Fehling's test   d) Iodoform test

5. The unit of the rate of reaction is the same as that of the rate constant for a: **[1]**

   a) it cannot be same   b) second order reaction

   c) zero order reaction   d) first order reaction

6. Match the column and choose correct option   **[1]**

Vant'Hoff factor	Behaviour of compound

(a) i = 1	(i) Impossible
(b) i > 1	(ii) Association is the solution
(c) i < 1	(iii) Dissociation in the solution
(d) i = 0	(iv) No dissociation or association

a) (a) - (iv), (b) - (iv), (c) - (iii), (d) - (ii)   b) (a) - (iii), (b) - (iv), (c) - (ii), (d) - (i)

c) (a) - (iv), (b) - (iii), (c) - (i), (d) - (ii)   d) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)

7. Racemisation occurs in **[1]**

   a) Neither S_N1 nor S_N2 reactions   b) S_N2 reaction

   c) S_N1 reaction   d) S_N2 reaction as well as S_N1 reaction

8. The catalyst used in Deacon's process is: **[1]**

   a) Cu_2Cl_2 b) $CuCl_2$

   c) $FeCl_3$ d) $FeCl_2$

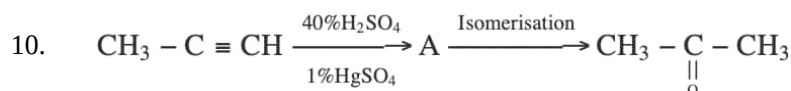9. The half-life for a zero order reaction equals: **[1]**
   where R is the initial concentration.

   a) $\frac{2k}{R}$ b) $\frac{R}{2k}$

   c) $\frac{1}{2}\frac{k}{R^2}$ d) $\frac{R^2}{2k}$

10. $CH_3 - C \equiv CH \xrightarrow[1\%HgSO_4]{40\%H_2SO_4} A \xrightarrow{\text{Isomerisation}} CH_3 - \underset{\underset{O}{||}}{C} - CH_3$ **[1]**

    The structure of A and type of isomerism in the above reaction are respectively.

    a) Prop-2-en-2-ol, geometrical isomerism   b) Prop–1–en–2–ol, metamerism

    c) Prop-1-en-2-ol, tautomerism   d) Prop-1-en-1-ol, tautomerism

11. The reaction $C_2H_5ONa + C_2H_5I \rightarrow C_2H_5OC_2H_5 + NaI$ is known as: **[1]**
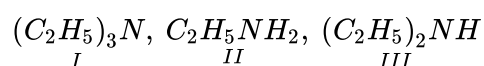
    a) Williamson's synthesis   b) Grignard's synthesis

    c) Kolbe's synthesis   d) Wurtz's synthesis

12. Three compounds are given below: **[1]**

    $\underset{I}{(C_2H_5)_3N}, \ \underset{II}{C_2H_5NH_2}, \ \underset{III}{(C_2H_5)_2NH}$

    Identify the correct decreasing order of their basic strength in gas phase:

    a) III > I > II   b) III > II > I

    c) II > III > I   d) I > III > II

13. **Assertion (A):** Fructose is a reducing sugar. **[1]**

    Reason (R): Fructose does not reduce Fehling solution and Tollen's reagent.

    a) Both A and R are true and R is the correct explanation of A.   b) Both A and R are true but R is not the correct explanation of A.

    c) A is true but R is false.   d) A is false but R is true.

14. **Assertion (A):** Acetaldehyde undergoes aldol condensation with dilute NaOH. **[1]**

Reason (R): Aldehydes which do not contain α-hydrogen undergo aldol condensation.

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

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

    c) A is true but R is false.

    d) A is false but R is true.

15. **Assertion (A):** 2-Chloro-3-methylbutane on treatment with alcoholic potash gives 2-methylbut-2-ene as major product. **[1]**

Reason (R): The reaction occurs according to Saytzeff rule.

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

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

    c) A is true but R is false.

    d) A is false but R is true.

16. **Assertion (A):** $(CH_3)_3C\text{-}O\text{-}CH_3$ gives $(CH_3)_3C\text{-}I$ and CH_3OH on treatment with HI. **[1]**

Reason (R): The reaction occurs by S_N1 mechanism.

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

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

    c) A is true but R is false.

    d) A is false but R is true.

Section B

17. At 300 K, 30 g of glucose present in a litre of its solution has an osmotic pressure of 4.98 bar. If the osmotic pressure of a glucose solution is 1.52 bar at the same temperature, what would be its concentration? **[2]**

OR

State any two characteristics of ideal solution?

18. Write the hybridization and magnetic character of the following complexes: **[2]**

  i. $[Fe(H_2O)_6]^{2+}$

  ii. $[Ni(CN)_4]^{2-}$

[Atomic number: Fe = 26, Ni = 28]

19. Though a transition element, scandium (Z = 21) does not exhibit variable oxidation states. Give reason. **[2]**

20. **Answer the following:** **[2]**

    (a)   Write the slope value obtained in the plot of ln[R] vs. time for a first order reaction. **[1]**

    (b)   Consider the following equation: **[1]**

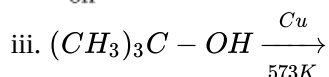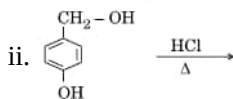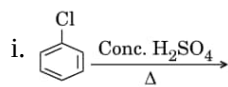$$2NO(g) + 2H_2(g) \rightarrow N_2(g) + 2H_2O(g)$$

The rate law for this reaction is first order with respect to H_2 and second order with respect to NO.

Write the rate law for this reaction.

21. Give the equations of reactions for the preparation of: (any **three**) **[2]**

  a. Phenol from chlorobenzene

  b. Salicylaldehyde from phenol

  c. 2-Methoxyacetophenone from anisole

  d. Picric acid from phenol

Section C

22. State Kohlrausch's law of independent migration of ions. Why does the conductivity of a solution decreases with **[3]**
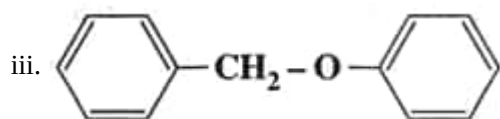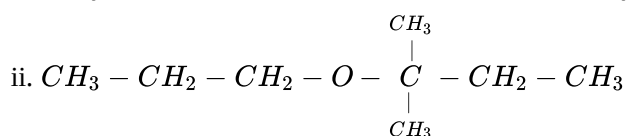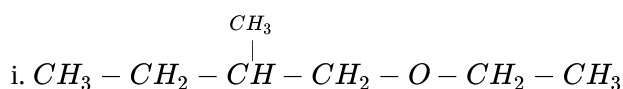
dilution?

23. A reaction is of first order in reactant A and of second order in reactant B. How is the rate of this reaction affected when **[3]**

    i. the concentration of B alone is increased to three times?

    ii. the concentrations of A as well as B are doubled?

24. Write the major product(s) of the following reactions: **[3]**

    i. $\xrightarrow[\Delta]{\text{Conc. H}_2\text{SO}_4}$

    ii. $\xrightarrow[\Delta]{\text{HCl}}$

    iii. $(CH_3)_3C - OH \xrightarrow[573K]{Cu}$

<div align="center">OR</div>

    Give the major products that are formed by heating each of the following ethers with HI.

    i. $CH_3 - CH_2 - \overset{\overset{\displaystyle CH_3}{|}}{C}H - CH_2 - O - CH_2 - CH_3$

    ii. $CH_3 - CH_2 - CH_2 - O - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}} - CH_2 - CH_3$

    iii.

25. Write the reactions involved in the following reactions: **[3]**

    i. Clemmensen reduction

    ii. Cannizzaro reaction

26. Determine the value of equilibrium constant $(K_c)\ and\ \Delta G^\theta$ for the following reaction. **[3]**
    $$Ni(s) + 2Ag^+(aq) \rightarrow Ni^{2+}(aq) + 2Ag(s)$$
    $$E^\theta = 1.05\,V\,(1\,F = 96500\,C\,mol^{-1})$$

27. An organic compound A on heating with NH_3 and cuprous oxide at high pressure gives compound B. The compound B on treatment with ice-cold solution of $NaNO_2$ and HCl gives C, which on heating with copper turning and HCl gives A again. Identify A, B & C. compound. **[3]**

28. Write the Nernst equation and calculate emf of the following cell at 298 K: **[3]**

    Cr | Cr^{3+} (0·1 M) || Fe^{2+} (0·01 M) | Fe

    Given : $E^\ominus_{Cr^{3+}/Cr}$ = -0·75 V

    $E^\ominus_{Fe^{2+}/Fe}$ = -0·45 V

    (log 10 = 1)

<div align="center">**Section D**</div>

29. **Read the following text carefully and answer the questions that follow:** **[4]**

    The d-block of the periodic table contains the elements of the groups 3 to 12 and are known as transition elements. In general, the electronic configuration of these elements is (n - 1)d$^{1-10}$ ns$^{1-2}$. The d-orbitals of the penultimate energy level in their atoms receive electrons giving rise to the three rows of the transition metals i.e. 3d, 4d and 5d series. However, Zn, Cd and Hg are not regarded as transition elements. Transition elements

exhibit certain characteristic properties like variable oxidation stables, complex formation, formation of coloured ions, alloys, catalytic activity etc. Transition metals are hard (except Zn, Cd and Hg) and have a high melting point.

   i. Why are Zn, Cd and Hg non-transition elements? (1)

   ii. Which transition metal of 3d series does not show variable oxidation state? (1)

   iii. Why do transition metals and their compounds show catalytic activity? (2)

     OR

   Why are melting points of transition metals high? (2)

30. **Read the following text carefully and answer the questions that follow:**   **[4]**

Many chemical and biological processes depend on osmosis, the selective passage of solvent molecules through the porous membrane from a dilute solution to a more concentrated one. The osmotic pressure π depends on molar concentration of the solution ($\pi = CRT$). If two solutions are of equal solute concentration and, hence, have the same osmotic pressure, they are said to be isotonic. If two solutions are of unequal osmotic pressures, the more concentrated solution is said to be hypertonic and the more diluted solution is described as hypotonic. Osmosis is the major mechanism, for transporting water upward in the plants. Transpiration is the leaves supports the transport mechanism of water. The osmotic pressure of seawater is about 30 atm; this is the pressure that must be applied to the seawater (separated from pure water using a semi-permeable membrane) to get drinking water.

   i. What will happen if a plant cell kept in a hypertonic solution? (1)

   ii. Blood cells are isotonic with 0.9% sodium chloride solution. What happens if we place blood cells in a solution containing in 1.2% sodium chloride solution? (1)

   iii. What happens when the external pressure applied becomes more than the osmotic pressure of solution? (2)

     OR

   Which mechanisms helps in the transportation of water in a plant? (2)

Section E

31. **Attempt any five of the following:**   **[5]**

   (a)   What type of linkage is present in polysaccharides?   **[1]**

   (b)   What type of protein is present in keratin?   **[1]**

   (c)   Write the name of the component of starch which is water-soluble.   **[1]**

   (d)   Differentiate between: **[1]**

     i. Peptide linkage and Glycosidic linkage

     ii. Nucleoside and Nucleotide

   (e)   Define the following terms: **[1]**

     a. Denaturation of protein

     b. Invert sugar

   (f)   Define the following terms: **[1]**

     i. Glycosidic linkage

     ii. Native protein

   (g)   i. How are carbohydrates stored in animal body? Mention any one organ where they are present.   **[1]**

     ii. What is the basic structural difference between starch and cellulose?

32. Explain with two examples each of the following: Coordination entity, ligand coordination number, coordination   **[5]**

polyhedron, homoleptic and heteroleptic.

OR

$CoSO_4Cl.5NH_3$ exists in two isomeric forms 'A' and 'B'. Isomer 'A' reacts with $AgNO_3$ to give white precipitate but does not react with $BaCl_2$. Isomer 'B' gives a white precipitate with $BaCl_2$ but does not react with $AgNO_3$. Answer the following questions.

  i. Identify 'A' and 'B' and write their structural formulas.

 ii. Name the type of isomerism involved.

iii. Give the IUPAC name of 'A' and 'B'.

33.   i. Give reasons: **[5]**

     a. Although $– NH_2$ group is o/p directing in electrophilic substitution reactions, yet aniline, on nitration

       gives good yield of m-nitroaniline.

     b. $(CH_3)_2 NH$ is more basic than $(CH_3)_3 N$ in an aqueous solution.

     c. Ammonolysis of alkyl halides is not a good method to prepare pure primary amines.

  ii. Distinguish between the following:

     a. $CH_3CH_2NH_2$ and $(CH_3CH_2)_2 NH$

     b. Aniline and CH_3NH_2

OR

Give one chemical test to distinguish between the following pairs of compounds:

  i. Methylamine and dimethylamine

 ii. Secondary and tertiary amines

iii. Ethylamine and aniline

iv. Aniline and benzylamine

 v. Aniline and N-methyl aniline

Solution

Section A

1. **(a)** HI > HBr > HCl > HF
   Explanation:
   As we move down the group 17, the size of atom increases as F<Cl<Br<I. Thus the bond strength of hydrogen halides reduces as HF>HCl>HBr>HI. So, it is easiest to break the H-I bond. Hence, the decreasing order of reactivity for the conversion of ROH to RX is HI>HBr>HCl>HF.

2.
   (b) Nucleotides
   Explanation:
   When nucleoside is linked to phosphoric acid at 5′-position of sugar moiety, we get a nucleotide and nucleotides are joined by a phosphodiester bond between 5′ and 3′ carbon atoms of the pentose sugar.

3.
   (d) a substitution reaction
   Explanation:
   Alkyl halides on alkaline hydrolysis (aqueous NaOH) get converted into alcohol. This takes place by a nucleophilic substitution reaction where the −X atom is substituted by a nucleophile i.e −OH group. The primary alkyl halides undergo nucleophilic substitution reaction by S_N2 substitution mechanism, while tertiary alkyl halides follow S_N1 substitution mechanism.

4.
   (d) Iodoform test
   Explanation:
   Iodoform test

5.
   (c) zero order reaction
   Explanation:
   Therefore, for a zero order reaction the units of rate of reaction and rate constants are same.

6.
   (d) (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)
   Explanation:
   (a) - (iv), (b) - (iii), (c) - (ii), (d) - (i)

7.
   (c) S_N1 reaction
   Explanation:
   Racemisation occurs in S_N1 reaction not in S_N2 reaction because in case of S_N1 a group (base/nucleophile) attack from (in front and back side) both sides.

8.
   (b) $CuCl_2$
   Explanation:
   $CuCl_2$ is used as a catalyst in Deacon's Process.
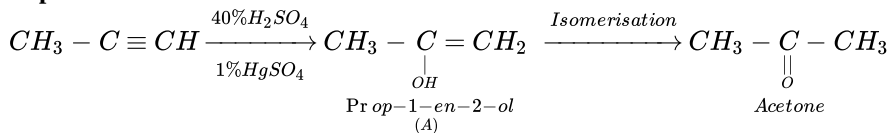
9.

(b) $\frac{R}{2k}$

Explanation:

$\frac{R}{2k}$ where [R]° is initial concentration of reactant and k is rate constant).
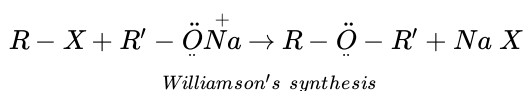
10.

(c) Prop-1-en-2-ol, tautomerism

Explanation:

$$CH_3 - C \equiv CH \xrightarrow[1\% HgSO_4]{40\% H_2SO_4} CH_3 - \underset{\underset{(A)}{\underset{Pr\,op-1-en-2-ol}{OH}}}{C} = CH_2 \xrightarrow{Isomerisation} CH_3 - \underset{\underset{Acetone}{O}}{C} - CH_3$$

Prop-1-en-2-ol (A) acetone are tautomers.

11. **(a)** Williamson's synthesis

Explanation:

Williamson's synthesis: When an alkyl halide reacts with sodium alkoxide, ether is formed. This reaction is known as Williamson's synthesis. The reaction generally follows the S_N2 mechanism for primary alcohols.

$$R - X + R' - \overset{+}{\ddot{O}Na} \rightarrow R - \ddot{O} - R' + Na\,X$$

$$\textit{Williamson's synthesis}$$

12.

(b) III > II > I

Explanation:

III > II > I

13.

(c) A is true but R is false.

Explanation:

A is true but R is false.

14.

(c) A is true but R is false.

Explanation:

Aldehydes which contain α-hydrogens undergo aldol condensation.

15. **(a)** Both A and R are true and R is the correct explanation of A.
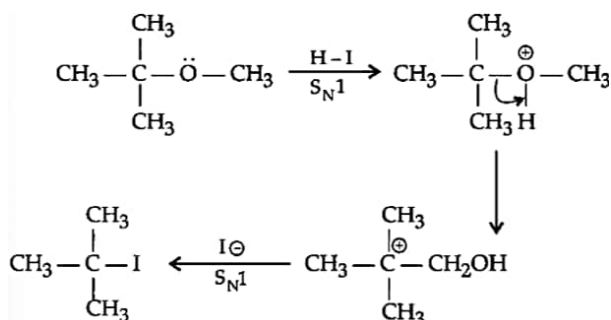
Explanation:

Both A and R are true and R is the correct explanation of A.

16. **(a)** Both A and R are true and R is the correct explanation of A.

Explanation:

$(CH_3)_3C$-O-CH_3 gives $(CH_3)_3C$-I and CH_3OH on treatment with HI. The reaction occurs by S_N1 mechanism.

Section B

17. $\pi = CRT$

   $4.98 = (30/180/1) \times RT$

   $4.98 = 0.166\, RT$ ...(i)

   $1.52 = CRT$ ...(ii)

   Divide eq. (ii) by (i)

   $0.305 = C/0.166$

   $C = 0.0506\ \text{mol}\ l^{-1}$

   Hence, its concentration would be $0.0506\ \text{mol}\ l^{-1}$

<center>OR</center>

   i. Ideal solutions follow Raoult's law exactly over the entire range of concentration. So $P_A = P^0_A.x_A$ and $P_B = P^0_B.x_B$

   ii. They can be separated by fractional distillation.

18. i. The hybridization and magnetic character of $[Fe(H_2O)_6]^{2+}$ are sp^3d^2 and paramagnetic.

   ii. The hybridization and magnetic character of $[Ni(CN)_4]^{2-}$ are dsp^2 and diamagnetic

19. Sc does not exhibit variable oxidation states because it contains only 3 electrons in its valence shell ($3d^14s^2$ configuration) and after losing them, it achieves inert gas configuration, i.e, highest stability.

20. Answer the following:

   (i) Slope = -k

   (ii) Rate = k $[NO]^2 [H_2]^1$

21. a.

   b.

   c.

   d.

<center>**Section C**</center>

22. Kohlrausch's law of independent migration of ions states that the limiting molar conductivity of an electrolyte can be expressed as the sum of the individual contributions of the anion and the cation of the electrolyte, e.g.

$$\Lambda^\circ_{m(CH_3COOH)} = \lambda^\circ_{CH_3COO^-} + \lambda^\circ_{H^+}$$

   The conductivity of a solution is related to the number of ions present per unit volume of the solution. When the solution is diluted, the number of ions per unit volume decreases. Hence, conductivity or specific conductance of the solution decreases.

23. Since, the reaction is of first order wrt A and second order wrt B, then the rate law can be given as,

   $(Rate)_1 = k\,[A]\,[B]^2$

   i. When the concentration of B is increased to three times (3B), the rate would be

   $(Rate)_2 = k\,[A]\,[3B]^2$
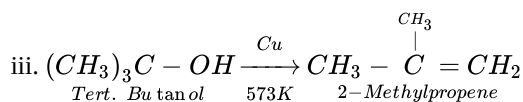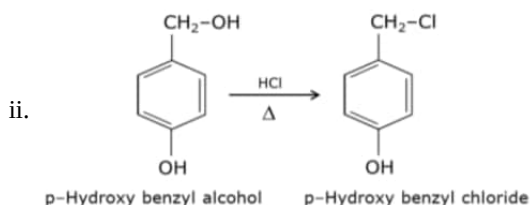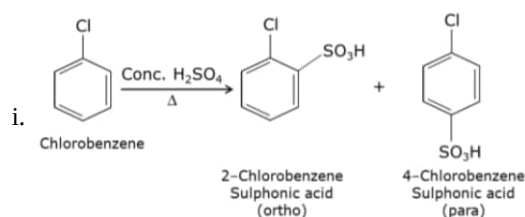
   $(Rate)_2 = 9\,k\,[A]\,[B]^2 = 9 \times (Rate\},$

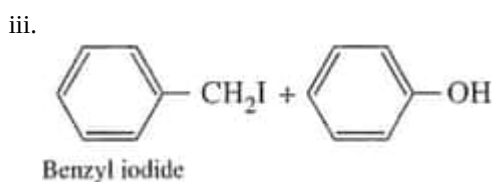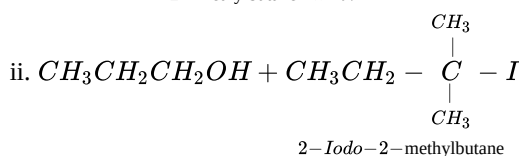 $\therefore$ Rate is increased by 9 times.

ii. $(Rate)_3 = k\,[2A]\,[2B]^2$
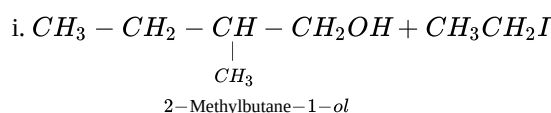
$(Rate)_3 = 2 \times 2 \times 2 \times k\,[A]\,[B]^2 = 8 \times (Rate)$

∴ Rate is increased by 8 times

24. The major project are:

i.

Chlorobenzene → 2-Chlorobenzene Sulphonic acid (ortho) + 4-Chlorobenzene Sulphonic acid (para)

ii.

p–Hydroxy benzyl alcohol → p–Hydroxy benzyl chloride

iii. $(CH_3)_3C - OH \xrightarrow[573K]{Cu} CH_3 - \overset{\overset{\displaystyle CH_3}{|}}{C} = CH_2$
Tert. Butanol, 2–Methylpropene

OR

i. $CH_3 - CH_2 - \overset{\overset{\displaystyle CH_3}{|}}{CH} - CH_2OH + CH_3CH_2I$
2–Methylbutane–1–ol

ii. $CH_3CH_2CH_2OH + CH_3CH_2 - \overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle CH_3}{|}}{C}} - I$
2–Iodo–2–methylbutane

iii.

Benzyl iodide
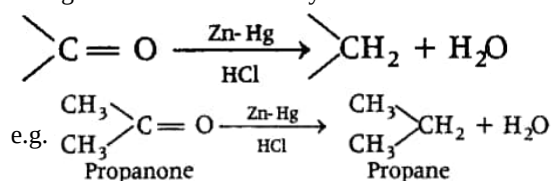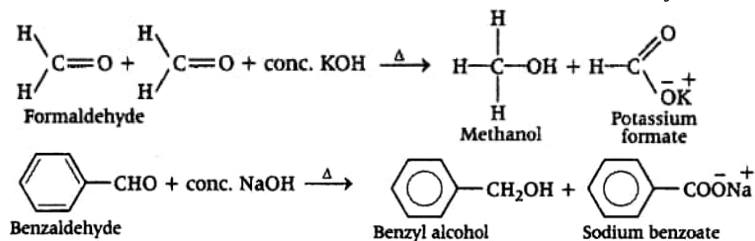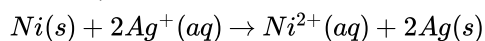
25. i. **Clemmensen reduction** The carbonyl group of aldehydes and ketones is reduced to - CH_2 group on treatment with zinc-amalgam and concentrated hydrochloric acid. This reaction is known as Clemmensen reduction.

ii. **Cannizzaro reaction** Aldehydes which do not have n-H atoms undergo self oxidation and reduction reaction on treatment with cone. alkali this reaction is known as Cannizzaro reaction. In this reaction, one molecule of aldehyde is reduced to alcohol while another molecule is oxidised to the salt of carboxylic acid.

26. We have,

$Ni(s) + 2Ag^+(aq) \rightarrow Ni^{2+}(aq) + 2Ag(s)$

For the reaction n = 2, E^θ_{cell} = 1.05 V

$\Delta G^\theta = -nFE^\theta$

$\Delta G^\theta = -2 \times 96500\,C \times 1.05\,V$

$\Delta G^\theta = -202.65\,kJ\,mol^{-1}$

For Equilibrium constant, we have,
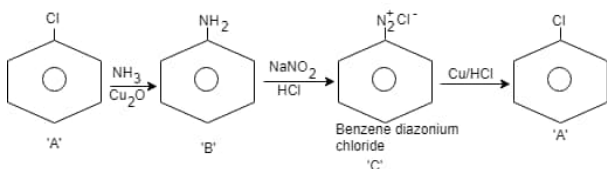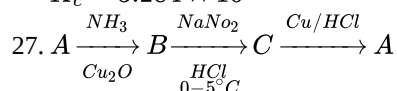
$\Delta G^\theta = -2.303\,RT\,\log K_c$

$\log K_c = -\frac{\Delta G^\Theta}{2.303RT}$

$= -\frac{202650}{2.303 \times 8.314 \times 298}$

$K_c = \text{Antilog}(35.5161)$

$K_c = 3.284 \times 10^{35}$

27. $A \xrightarrow[Cu_2O]{NH_3} B \xrightarrow[\substack{HCl \\ 0-5^\circ C}]{NaNo_2} C \xrightarrow{Cu/HCl} A$

28. $E_{cell} = E^0_{cell} - \frac{0.059}{6}\log\frac{\left[Cr^{3+}\right]^2}{\left[Fe^{2+}\right]^3}$

$E^0_{cell} = -0.45 - (-0.75)$

$= 0.30\ V$

$E_{cell} = 0.3 - \frac{0.059}{6}\log\frac{(0-1)^2}{(0.01)^3}$

$= 0\cdot 3 - .00985\log\frac{\left(10^{-1}\right)^2}{\left(10^{-2}\right)^3}$

$= 0.3 - .00985 \times 4\log 10$

$= 0.3 - 0.0394$

$= 0.2606\ V$

Section D

29.   i. It is because neither they nor their ions have incompletely filled d-orbitals.

ii. Scandium (Sc) and Zinc (Zn).

iii. It is because they show variable oxidation state, can form intermediate complexes and have large surface area for adsorption of gases.

OR

It is due to strong interatomic forces of attraction due to presence of unpaired electrons.

30.   i. A plant cell gets shrink when it is kept in a hypertonic solution.

ii. 1.2% sodium chloride solution is hypertonic with respect to 0.9% sodium chloride solution or blood cells. When blood cells are placed in this solution, water flows out of the cells and they shrink due to loss of water by osmosis.

iii. When the external pressure applied becomes more than the osmotic pressure of the solution, then the solvent molecules from the solution pass through the semipermeable membrane to the solvent side. This process is called reverse osmosis.

OR

In an upward direction, osmosis helps in the transportation of water in a plant.

Section E

31. Attempt any five of the following:

(i) Glycosidic linkage

(ii) Fibrous Proteins

(iii) The component of starch which is water-soluble - Amylose.

(iv)   i. **Peptide linkage:** A linkage formed when two amino acids are joined through -CONH- bond.

Glycosidic linkage: When two monosaccharides are joined through oxygen atom.

ii. **Nucleoside:** Base + Sugar

Nucleotide: Base + Sugar + Phosphate

(v)   a. When a protein in its native form, is subjected to physical change like change in pH, temperature etc it loses its biological activity. (Or destruction of secondary and tertiary structure.)

b. Hydrolysis of sucrose brings about a change in the sign of rotation, from dextro (+) to laevo (−) and the product is named an invert sugar.

(vi) i. A linkage between two monosaccharide units through oxygen atom.

   ii. Protein having a unique three-dimensional structure and biological activity.

(vii) i. Glycogen

   liver/muscles/brain

   ii. Starch is a polymer of α-Glucose whereas Cellulose is a polymer of β-Glucose.

32. **Coordination** entity: This entity usually constitutes a central metal atom or ion, to which are attached a fixed number of other atoms or ions or groups by coordinate bonds. Examples are $[Ni(CO)_4]$, $[COCl_3(NH_3)_3]$, etc.

Ligands: It is an ion having at least one lone pair of electrons and capable of forming a coordinate bond with central atom / ion in the coordination entity.

Examples are : Cl^-, $(OH)^-$, $(CN)^-$ etc.

Coordinate number: The total number of coordinate bonds with which central atom/ ion is linked to ligands in the coordination entity is called coordination number of central atom / ion.

Coordination polyhedron : The spatial arrangement of the ligands which are directly attached to the central atom / ion defines a coordination polyhedron about the central atom.

Examples are: $[Co(NH_3)_6]^{3+}$ is octahedral,

$[Ni(CO)_4]$ is tetrahedral.

Homoleptic and hedroleptic: Complexes in which a metal is bound to only one kind of donor groups are known as homoleptic.

Example $[CO(NH_3)_6]^{3+}$

Complex in which a metal is bound to more than one kind of donor groups are called hetroleptic. Example : $[Co(NH_3)_4Cl_2]^+$

OR

$CoSO_4Cl.5NH_3$:

   i. Isomer A reacts with $AgNO_3$ but not with $BaCl_2$, it shows that it has Cl ion outside the coordination sphere. Hence, A = $[CO(NH_3)_5SO_4]Cl$

   Isomer B reacts with $BaCl_2$ but not with $AgNO_3$, it shows that it has SO_4^- outside the coordination sphere

   Hence, B = $[CO(NH_3)_5Cl]SO_4$

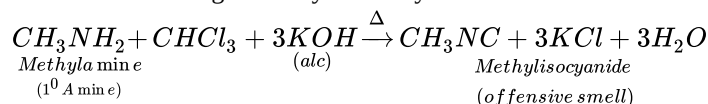 ii. Type of isomerism - Ionization isomerism.

 iii. IUPAC name of, A = Pentaamminesulphatocobalt (III) chloride and B = Pentaamminesulphatocobalt (III) sulphate.
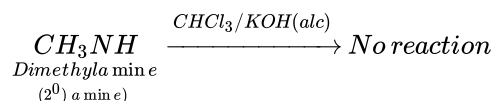
33. i. a. Nitration is carried out in acidic medium. In an acidic medium, aniline is protonated to form the anilinium ion which is meta directing. That is why besides the ortho and para derivatives, a substantial amount of meta derivative (m-nitroaniline) is also formed.

   b. $(CH_3)_2NH$ is a secondary amine and $(CH_3)_3N$ is a tertiary amine. Tertiary amine due to the presence of three alkyl groups is more hindered than secondary amine which has only two alkyl groups attached to it. Therefore formation of ammonium ion is easier in secondary amine than the tertiary amine. Therefore, it makes secondary amine less basic than the tertiary amine.

   c. The ammonolysis of alkyl halide leads to the formation of the mixture of primary, secondary and tertiary amine along with the formation of quaternary salt. It is very difficult to separate pure primary amine from this mixture.

  ii. a.

Test	$CH_3CH_2NH_2$	$(CH_3CH_2)_2NH$
Carbylamine test (add chloroform and alcoholic KOH to both the compounds separately in a test tube)	Forms a foul-smelling compound (gives positive test)	No reaction take place (gives negative test)

   b.

Azo dye Test	Aniline	Methyl Amine (CH_3NH_2)
Add a small amount of nitrous acid with aq. HCl	Forms a yellow coloured dye (gives positive test)	No dye is formed(gives negative test)

OR

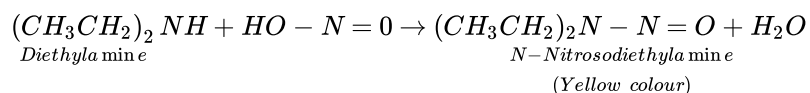   i. These can be distinguished by the carbylamine test.

$$CH_3NH_2 + CHCl_3 + 3KOH \xrightarrow{\Delta} CH_3NC + 3KCl + 3H_2O$$

$Methyla\min e$ (alc) $Methylisocyanide$

$(1^0 A\min e)$ $(offensive\,smell)$

$$\underset{\substack{Dimethyla\min e \\ (2^0)\,a\min e}}{CH_3NH} \xrightarrow{\quad CHCl_3/KOH(alc) \quad} No\;reaction$$

ii. Secondary and tertiary amines can be distinguished by Libermann nitrosoamine test. 2° amines react with nitrous acid to form N-nitrosamines while 3° do not.

$$\underset{Diethyla\min e}{(CH_3CH_2)_2\,NH} + HO-N=0 \rightarrow \underset{\substack{N-Nitrosodiethyla\min e \\ (Yellow\;colour)}}{(CH_3CH_2)_2N-N=O} + H_2O$$

iii. **Azo dye test:** Aniline and ethylamine can be distinguished by azo dye test. It involves the reaction of aniline with HNO_2 at 273-278 K followed by treatment with an alkaline solution of β-naphthol, which gives a brilliant yellow, orange or red coloured dye. Ethylamine under these condition gives a brisk evolution of N_2 gas with the formation of primary alcohol.

iv. **Nitrous acid test:** Benzylamine reacts with nitrous acid to form a diazonium salt which being unstable even at low temperature, decomposes with evolution of N_2 gas.

Aniline, on the other hand, reacts with nitrous acid to form benzene diazonium chloride which is stable at 273 - 278 K and hence does not decompose to evolve N_2 gas.

v. **Carbylamine test:** Aniline being a primary amine gives carbylamine test whereas N-methylamine being a secondary amine does not give this test. when aniline is heated with an alcoholic solution of KOH and $CHCl_3$, it gives the offensive smell of phenyl isocyanide.