ISC Solved Paper 2023

Chemistry

Class-XII

(Maximum Marks : 80)

(Time allowed : Three hours)

*Candidates are **allowed additional 15 minutes** for **only** reading the paper.*
They must NOT start writing during this time.

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*This paper is divided into **four** sections - A, B, C and D*
*Answer **all** questions.*
***Section A** consists of **one** question **having sub-parts** of **one** mark each.*
***Section B** consists of **ten** questions of **two** marks each*
***Section C** consists of **seven** questions of **three** marks each, and*
***Section D** consists of **three** questions of **five marks** each*
Internal choices have been provided in one question each in Section B.
Section C and Section D
All working, including rough work, should be done on the same sheet as, and adjacent to the rest of the answer.
The intended marks for questions or parts of questions are given in brackets []
Balanced equations must be given wherever possible and diagrams where they are helpful. When solving numerical problems, all essential working must be shown.
In working out problems, use the following data:
Gas constant $R = 1.987$ cal deg^{-1} mol^{-1} $= 8.314$ JK^{-1} mol^{-1}
$= 0.0821$ dm^3 atm K^{-1} mol^{-1}
1| atm = 1 dm^3 atm = 101.3. J 1 Faraday = 96500 coulombs.
Avogadro's number $= 6.023 \times 10^{23}$.

SECTION-A **[14 Marks]**

1. (A) Fill in the blanks by choosing the appropriate word(s) from those given in the brackets: **[4 × 1]**

[stable, low, aldehyde, unstable, 6, 4, ethane, Clemmensen's, 2, 3, carboxylic acid, high, propane, Rosenmund's]

(i) The primary alcohols are easily oxidised first into ________ and then into ____________.

(ii) The intermediate activated complex in a chemical reaction is highly ________ and then into ________.

(iii) The coordination number and oxidation state of the complex $K_4[Fe(CN)_6]$ ________ are ________ and ________ respectively.

(iv) Propanone on reaction with zinc-amalgam in presence of conc. HCl gives __________ and the reaction is known as __________ reduction.

(B) Select and write the correct alternative from the choices given below: **[4 × 1]**

(i) The reaction of a primary amine with chloroform and ethanolic KOH is called:

(a) Carbylamine reaction
(b) Kolbe's reaction
(c) Reimer-Tiemann reaction
(d) Wurtz-Fittig reaction

(ii) Which one of the following statements is TRUE for the Galvanic cell?

(a) Electrons flow from copper electrode to zinc electrode.
(b) Current flows from zinc electrode to copper electrode.
(c) Cations move towards copper electrode.
(d) Cations move towards zinc electrode.

(iii) Which one of the following compounds is diamagnetic and colourless?

(a) $K_2Cr_2O_7$
(b) $ZnSO_4$
(c) $KMnO_4$
(d) $Cr_2(SO_4)_3$

(iv) For a first order reaction, the half-life period ($t_{½}$) is:

(a) proportional to the initial concentration.

(b) inversely proportional to the initial concentration.

(c) proportional to the square root of the initial concentration.

(d) independent of the initial concentration.

(C) Match the following: **[4 × 1]**

(i)	Phenol	**(a)**	Hexane + heptane
(ii)	EDTA	**(b)**	Globular protein
(iii)	Ideal solution	**(c)**	Azo dye
(iv)	Insulin	**(d)**	Hexadentate ligand

(D) (i) Assertion: If a solution contains both H^+ and Na^- ions, the H^+ ions are reduced first at cathode.

Reason: Cations with higher E° value are reduced first at cathode.

(a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.

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

(c) Assertion is true but Reason is false.

(d) Assertion is false but Reason is true.

(ii) Assertion: Addition of bromine water to 1-butene gives two optical isomers.

Reason: The product formed contains two asymmetric carbon atoms.

(a) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.

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

(c) Assertion is true but Reason is false.

(d) Assertion is false but Reason is true.

Ans. (A) (i) Aldehyde, carboxylic acid

(ii) Unstable, high

(iii) 6, 2

(iv) Propane, Clemmensen's

(B) (i) Option (a) is correct.

(ii) Option (d) is correct.

(iii) Option (b) is correct.

(iv) Option (d) is correct.

(C) (i) Phenol — (c) Azodye

(ii) EDTA — (d) Hexadentate ligand

(iii) Ideal solution — (a) Hexane + Heptane

(iv) Insulin — (b) Globular Protein

(D) (i) Option (a) is correct.

(ii) Option (a) is correct.

SECTION-B [20 Marks]

2. Calculate the mass of ascorbic acid (molecular mass = 176 g/mol) that should be dissolved in 155g of acetic acid to cause a depression of freezing point by 1.15K. Assume that ascorbic acid does not dissociate or associate in the solution. (K_f for acetic acid = 3.9 K kg/mol) **[2]**

Ans. Mass of Acetic Acid (CH_3COOH) given (w_1) = 155g

Molecular Mass of ascorbic Acid ($C_6H_8O_6$), (M_2) = 176g/mol

K_f for acetic acid = 3.9 k kg/mol

Depression of freezing point ($\Delta T_f = 1.15\ k$)

According to the formula

$$\Delta T = \frac{K_b \times 1000 \times w_2}{M_2 \times w_1}$$

$$w_2 = \frac{\Delta T_b \times M_2 \times w_1}{K_b \times 1000}$$

$$w_2 = \frac{1.15 \times 176 \times 155}{3.9 \times 1000}$$

$$w_2 = 8.04\text{g}$$

Thus, the mass of ascorbic acid needed is 8.04g

3. Give a reason for the following: **[2]**

(i) Cu^{+2} salts are paramagnetic while Cu^+ salts are diamagnetic.

(ii) Mn^{+2} compounds are more stable than Fe^{+2} compounds.

Ans. (i) The salts of Cu^{+2} are paramagnetic in nature where as Cu^+ salts are diamagnetic because of the presence of unpaired electrons.

As Cu^{+2}, are paramagnetic in nature where as Cu^+ salts are diamagnetic because [Ar] $3d^9$ $4s°$ and for Cu^+, the electronic configuration is [Ar] $3d^{10}$ $4s°$

It shows their is presence of one unpaired electron in Cu^{+2}, thus show paramagnetic nature while in Cu^+, there is no unpaired electron, thus shows diamagnetic nature.

(ii) Mn^{+2} compounds are more stable than Fe^{+2} compounds because Mn^{+2} have half filled *d*-orbital that is [Ar] $3d^5$ whereas Fe^{+2} do not possesses half filled *d*-orbital due to presence of 6 electrons that is [Ar] $3d^6$.

4. Give chemical equations for each of the following: **[2]**

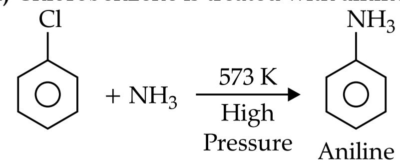
(i) Ethyl chloride is treated with aqueous KOH solution.

(ii) Chlorobenzene is treated with ammonia at 573K and high pressure.

Ans. Ethyl chloride treated with aq. KOH solution

$$C_2H_5Cl + aq.\ KOH \longrightarrow \underset{\text{Ethanol}}{CH_3CH_2OH}$$

(ii) Chlorobenzene is treated with ammonia at 573 K



5. State one reason for each of the following: [2]

(i) Alkylamine is soluble in water whereas arylamine is insoluble in water.

(ii) Methylamine is a stronger base than methyl alcohol.

Ans. (i) Alkyl amine is soluble in water due to the intermolecular hydrogen bonding where as in aryl amine, the large part is hydrophobic in nature that is hydrocarbon part, so the extent of hydrogen bonding is less or negligible, so it is insoluble in nature.

(ii) Methyl amine is stronger base than methyl alcohol because methyl amine consist of less electronegative. Nitrogen atom which makes it a stronger base whereas methyl alcohol contain more electronegative oxygen atom which makes it a strong acid.

6. Calculate the emf of the following cell at 298K. [2]

$Cu/Cu^{2+}_{(0.025M)} // Ag^{+}_{(0.005M)} /Ag$

Given $E°Cu^{2+}/Cu = 0.34V$, $E°Ag^{+}/Ag = 0.80V$,

1 Faraday = 96500 $Cmol^{-1}$

Ans. $E°_{cell} = E°_{Anode} - E°_{cathode}$

$$E°_{cell} = E°_{Ag/Ag^+} - E°_{Cu/Cu^{+2}}$$

$$E°_{cell} = 0.80\ V - 0.34\ V = 0.46\ V$$

According to Nernst equation

$$E_{cell} = E°cell - \frac{0.059}{2}\log\frac{[Cu^{+2}]}{[Ag^{+}]^2}$$

$$E_{cell} = 0.46\ V - \frac{0.059}{2}\log\frac{[0.025]}{[0.005]^2}$$

$$E_{cell} = 0.46\ V - \frac{0.059}{2}\log 3$$

$$E_{cell} = 0.46\ V - \frac{0.059}{2}\times 0.477$$

$$E_{cell} = 0.46\ V - 0.0140$$

$$E_{cell} = 0.446\ V$$

7. Complete and balance the following chemical equations: [2]

(i) $KMnO_4 + H_2SO_4 + KI \longrightarrow$ ________ + ________ + ________ + ________

(ii) $K_2Cr_2O_7 + H_2SO_4 + H_2S \longrightarrow$ ________ + ________ + ________ + ________

Ans. (i) $2KMnO_4 + 8H_2SO_4 + 10KI \longrightarrow 2MnSO_4 + 6K_2SO_4 + 5I_2 + 8H_2O$

(ii) $K_2Cr_2O_7 + 3H_2S + 4H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 3S + 7H_2O$

8. (i) How will the following be obtained? (Give chemical equation) [2]

(a) Ethanol from Grignard's reagent.

(b) Diethyl ether from sodium ethoxide.

OR

(ii) An organic compound [A] C_2H_6O, on heating with conc. H_2SO_4 at 413K gives a neutral compound [B] $C_4H_{10}O$. Compound [B] on treatment with PCl_5 gives a product, which on subsequent treatment with KCN yields compound [C] C_3H_5N. Compound [C] on hydrolysis gives an acid [D] $C_3H_6O_2$. Identify the compounds [A], [B], [C] and [D].

Ans. (i) (a) Ethanol from Grignard Reagent

$$\underset{\text{Methanal}}{H-\underset{\underset{H}{|}}{C}=O} + CH_3-MgBr \xrightarrow[\text{ether}]{\text{Dry}} H_3C-\underset{\underset{H}{|}}{\overset{\overset{H}{|}}{C}}-O\,MgBr \xrightarrow{H_2O} CH_3\,CH_2\,OH + Mg\,Br(OH)$$

(b) Diethyl ether from sodium ethoxide

$$\underset{\text{Sodium ethoxide}}{CH_3CH_2ONa} + CH_3CH_2Br \xrightarrow{\Delta} CH_5CH_2\,OCH_2\,CH_3 + NaBr$$

This reaction is called Williamson's synthesis.

OR

(ii) A = C_2H_6O

It can be alcohol CH_3CH_2OH

$$\underset{\underset{\text{Ethanol}}{(A)}}{CH_3CH_2OH} + H_2SO_4 \xrightarrow{413\ K} \underset{\underset{\text{Diethylether}}{(B)}}{CH_3CH_2OCH_2} + H_2O$$

$$\underset{(B)}{CH_3CH_2OCH_2 + CH_3} + PCl_5 \longrightarrow \underset{\text{Ethyl Chloride}}{2C_2H_5Cl} + POCl_3$$

$$2C_2H_5Cl + KCN \longrightarrow \underset{\underset{\text{Propane nitrile}}{(C)}}{C_2H_5CN}$$

$$\underset{(C)}{C_5H_5CN} + H_2O/H^+ \xrightarrow{\text{Hydrolysis}} \underset{\underset{\text{Propionic Acid}}{(D)}}{CH_3CH_2COOH}$$

9. The osmotic pressure of blood at 37°C is 8.21 atm. How much glucose in grams should be used per litre of aqueous solution for an intravenous injection so that it is isotonic with blood? (Molecular wt of glucose = 180g/mol) [2]

Ans. Osmotic Pressure; π = 8.21 atm

Temperature; T = 37 + 273 = 310 K

Volume; V = 1L

According to the formula

$$\pi = CRT$$

$$\pi = \frac{m \times R \times T}{M \times V} \qquad \left[\because \frac{m}{M} = n\right]$$

$$\pi V = nRT$$

$$n = \frac{\pi V}{RT}$$

$$n = \frac{8.21 \times 1.0}{0.0821 \times 310} = \frac{10}{31}$$

$$m = n \times M$$

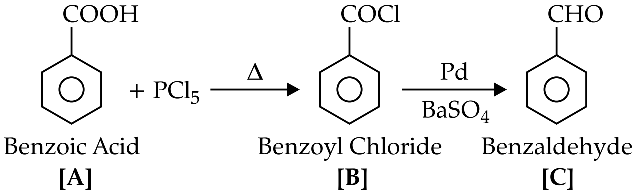
$$= \frac{10}{31} \times 180$$

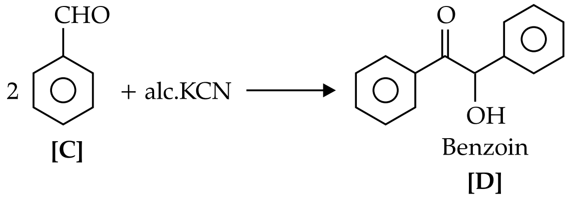
$$= 58.06 g$$

10. An aromatic carboxylic acid [A] which readily sublimes on heating, produces compound [B] on treatment with PCl_5. Compound [B], when reduced in the presence of Pd catalyst over $BaSO_4$ poisoned by sulphur in xylene solution gives compound [C]. When compound [C] is condensed in the presence of alcoholic KCN, it gives compound [D]. (Molecular formula of compound [D] is $C_{14}H_{12}O_2$)

Identify the compounds [A], [B], [C] and [D]. **[2]**

Ans. A = Aromatic carboxylic Acid. So, it can be benzoic Acid





It is an example of Benzoin condensation.

11. State a reason for each of the following: [2]

(i) $La(OH)_3$ is more basic than $Lu(OH)_3$.

(ii) Transition elements and their compounds act as catalyst.

Ans. (i) $La(OH)_3$ is more basic than $Lu(OH)_3$ because due to lanthanide contraction as the size of lanthanide increases from La^{+3} to Lu^{+3}, the covalent character of these hydroxides increases and the basic strength decreases.

(ii) Transition elements and their compounds acts as a catalyst because they are capable of exhibiting different oxidation states and thus, acts as both oxidising and reducing agents at same time.

SECTION-C **[21 Marks]**

12. 20% of a first order reaction is completed in five minutes. How much time will the 60% reaction take to complete? Calculate the half-life period ($t_{1/2}$) for the above reaction. [3]

Ans. According to 1st order Kinetics

$[A]_0$; Initial concentration = 100

[A]; Final concentration = 100 – 20 = 80

If reaction is 20% completed

t; time = 5 min

$$K = \frac{2.303}{t} \log \frac{[A]_0}{[A]}$$

$$K = \frac{2.303}{5} \log \frac{100}{80}$$

$$K = \frac{2.303}{5} \times 0.4$$

$$= 0.0446 \text{ min}^{-1}$$

Now, reaction is 60% complete

$$[A] = 100 - 60 = 40$$

$$t = \frac{2.303}{0.0446} \log \frac{100}{40}$$

$$t = 20.5 \text{ min}$$

13. Write the balanced chemical equations for the following name reactions: [3]

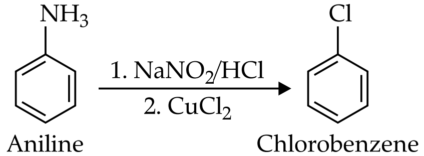
(i) Sandmeyer's reaction

(ii) Wurtz reaction

(iii) Finkelstein reaction

Ans.(i) Sandmeyer's reaction

It is used to synthesis aryl halide from aryl diazonium salt.



(ii) Wurtz Reaction

It is used to synthesis higher alkanes from alkyl halides when treated with metallic Na in dry ether presence

$$R-X + R-X \xrightarrow[\text{Dryether}]{\text{Na}} R-R + 2NaX$$

(iii) Finkelstein Reaction

It is a SN_2 mechanism which involves exchange of one halogen atom with another one

$$CH_3-X + NaI \xrightarrow{\text{Acetone}} CH_3\text{–}I + NaX$$

14. (i) Give an example each of reducing sugar and non-reducing sugar.

(ii) What is *denaturation of proteins*?

(iii) Give an example each of water soluble vitamin and fat soluble vitamin. [3]

Ans. (i) Reducing Sugar-Maltose, lactose etc

Non-R educing sugar—Sucrose, Trehalose, etc.

(ii) The process of breaking the molecular shape of the protein, molecule without breaking amide or peptide bond that is their primary structure is retained. This is called denaturation of protein.

(iii) Water soluble vitamin — Vitamin B and C

Fat soluble vitamin — Vitamin A, D, E, K, etc.

15. When 2g of benzoic acid is dissolved in 25g of benzene, it shows a depression in freezing point equal to 1.62K. Molal depression constant (K_f) of benzene is 4.9 K kg mol^{-1} and molecular weight of benzoic acid = 122g/mol. What will be the percentage association of the benzoic acid?

(Benzoic acid forms dimer when dissolved in benzene.) [3]

Ans. Mass of Benzoic Acid (W_2) = 2g

Mass of Benzene (W_1) = 25g

$$K_f = 4.9 \text{ K kg mol}^{-1}$$

$$\Delta T_f = 1.62 \text{ K}$$

$$\Delta T_f = k_f \times \frac{W_2 \times 100}{W_1 \times M_2}$$

$$M_2 = \frac{4.9 \times 2 \times 1000}{1.62 \times 25}$$

$$= 241.98 \text{g/ mol}$$

$$2C_6H_5COOH \rightleftharpoons (C_6H_5COOH)_2$$

$t = 0$	1	0
$t = t_{eq}$	$1 - x$	$\frac{x}{2}$

Total number of moles of particles at equilibrium

$$1 - x + \frac{x}{2} = 1 - \frac{x}{2}$$

Thus, Van't Hoff factor (i) = $\frac{\text{Normal M.M}}{\text{Abnormal M.M}}$

$$i = \frac{122 \text{ g mol}^{-1}}{241.98 \text{ g mol}^{-1}}$$

So, $1 - \frac{x}{2} = \frac{122}{241.98}$

$$\frac{x}{2} = \frac{1 - 122}{241.98}$$

$$1–0.504 = 0.496$$

$$x = 0.496 \times 2 \Rightarrow 0.992$$

$$x\% = 99.2$$

∴ Degree of association of Benzoic acid is 99.2%.

16. Account for the following: [3]

(i) Phenol is a stronger acid than aliphatic alcohols.

(ii) Ethanol gives iodoform reaction whereas methanol does not give iodoform reaction.

(iii) Ethers should not be distilled to dryness.

Ans. (i) Phenol is stronger acid that aliphatic alcohol because of the formation of stable phenoxide ion due to resonance whereas no resonance occurs in aliphatic alcohol so they form alkoxide ion that does not involve negative charge on oxygen atom. As a result phenol are acidic than aliphatic.

(ii) Ethanol gives iodoform reaction because it consist of methyl keto group ($CH_3 - \underset{\underset{O}{||}}{C} -$) whereas methanol do not oxidise into a compound that contain methyl keto group.

(iii) Ethers are not distilled to dryness because due to the formation of peroxides, explosion, take place. Thus, these peroxides are highly explosive and are quite sensitive. They are less volatile than ethers.

17. (i) Identify the compounds [A], [B] and [C] in the following reactions: **[3]**

(a) $CH_3COOH \xrightarrow[\Delta]{NH_3} [A] \xrightarrow{Br_2 + KOH} [B] \xrightarrow{CHCl_3 + NaOH_{(alc)}} [C]$

(b) $CH_3Br \xrightarrow{KCN} [A] \xrightarrow{LiAlH_4} [B] \xrightarrow[273K]{HNO_2} [C]$

OR

(ii) How will the following be converted? (Give chemical equation)

(a) Ethyl bromide to ethyl isocyanide.

(b) Aniline to benzene diazonium chloride.

(c) Benzene diazonium chloride to phenol.

Ans.(i) (a) $CH_3COOH \xrightarrow[\Delta]{NH_3} \underset{\text{Acetamide}}{\underset{[A]}{CH_3CONH_2}}$

$$\xrightarrow{Br_2 + KOH} \underset{\text{Primary Amine}}{\underset{[B]}{CH_3NH_2}} + 2KBr$$

$$\xrightarrow{CHCl_3 + alc.NaOH} \underset{\text{Isocyanide}}{\underset{[C]}{CH_3NC}} + 3KCl + 3H_2O$$

(b) $CH_3Br \xrightarrow{KCN} \underset{\text{[A] Acotoxitile}}{CH_3CN} \xrightarrow{LiAlH_4}$

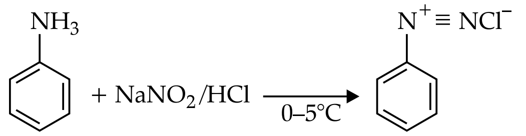
$\underset{\text{[B] Ethylamine}}{CH_3CH_2NH_2} \xrightarrow{HNO_2\ 273K} \underset{\text{[C] Ethylalcohol}}{CH_3CH_2OH}$

OR

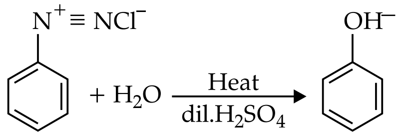
(ii) (a) Ethyl Bromide to ethyl isocyanide

$\underset{\text{Silver Cyanide}}{C_2H_5Br + AgCN} \longrightarrow \underset{\text{Ethyl Isocyanide}}{C_2H_5NC} + AgBr$

(a) Aniline to benzene diazonium chloride



(c) Benzene diazonium chloride to phenol



18. A first order reaction is 50% completed in 40 minutes at 300K and in 20 minutes at 320K. Calculate the activation energy of the reaction. **[3]**

Ans. According to First order Kinetics

$$\log \frac{K_2}{K_1} = \frac{Ea}{2.303} R\left[\frac{1}{T_1} - \frac{1}{T_2}\right]$$

$$t_{½} = \frac{0.693}{k} \text{ or } t_{½} \propto \frac{1}{K}$$

$$\log \frac{t_{½}}{t_{½}} = \frac{E_a}{2.303}\left[\frac{T_2 - T_1}{T_1 T_2}\right]$$

$$\log \frac{40}{20} = \frac{Ea}{2.303 \times 8.314} \left[\frac{320-300}{300 \times 320}\right]$$

$$0.3010 = \frac{E_a}{19.147} \times \frac{20}{300 \times 320}$$

$$E_a = 27664 \text{ J/mol}$$

SECTION-D [15 Marks]

19. (i) Write the chemical equations to illustrate the following name reactions: [5]

(a) Cannizzaro's reaction

(b) HVZ reaction

(c) Aldol condensation

(ii) How will the following be converted? (Give chemical equation)

(a) Acetaldehyde to acetone

(b) Formaldehyde to urotropine

Ans. (i) (a) Cannizzaro's Reaction

In presence of strong alkali, aliphatic and aromatic aldehyde (with no α-Hydrogen) undergo self oxidation and reduction to give a mixture of an alcohol and salt of carboxylic acid.

$$\underset{\text{Formaldehyde}}{2HCHO} \xrightarrow[H_3O^+]{NaOH} \underset{\text{Formate ion}}{HCOO^-} + \underset{\text{Methanol}}{CH_3OH}$$

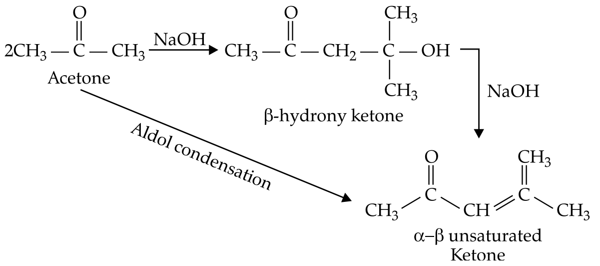
(b) HVZ reaction

The reaction in which carboxylic acid is converted into α-halo carboxylic acid in presence of Red phosphorous, halogen, and water is called HVZ reaction.

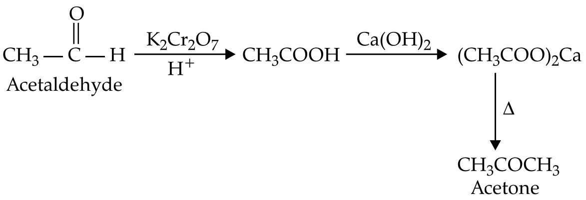
$$CH_3CH_2COOH + Br_2 \xrightarrow[H_2O]{\text{Red P}} \underset{\text{α-Bromo Propanoic acid}}{CH_3-\underset{\underset{Br}{|}}{CH}-COOH} + HBr$$

(c) Aldol condensation

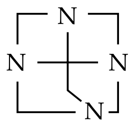
Reaction of an enol or an enolate ion with Carbonyl compound to form β-hydroxy aldehyde or β-hydroxy ketone, followed by dehydration to give conjugate enone.



(ii) (a) Acetaldehyde to acetone



(b) Formaldehyde to utropine

$6HCHO + 4NH_3 \longrightarrow$  $+ 6H_2O$

or

$(CH_2)_6NH$ (Utropine)

20. (i) Name the type of isomerism exhibited by the following pairs of compounds. [5]

(a) $[Co(NH_3)_5(ONO)]Cl_2$ and $[Co(NH_3)_5(NO_2)]Cl_2$

(b) $[Cr(H_2O)_5CI]Cl_2.H_2O$ and $[Cr(H_2O)_4Cl_2]Cl.2H_2O$

(c) $[Pt(NH_3)_4Cl_2]Br_2$ and $[Pt(NH_3)_4Br_2]Cl_2$

(ii) Write the IUPAC names of the following complexes:

(a) $[Co(NH_3)_4(H_2O)_2]Cl_3$

(b) $K_2\,[Ni(CN)_4]$

Ans. (i) (a) Linkage isomerism

(b) Hydration isomerism

(c) Ionization isomerism

(ii) (a) $[CO(NH_3)_4\,(H_2O_2]\,Cl_3$

Tetra amino diaqua Cobalt (II) chloride

(b) $K_2[Ni(CN)_4]$

Potassium Tetracyanonickelate (II)

21. (i) The specific conductance of 2.5×10^{-4} M formic acid is 5.25×10^{-5} ohm^{-1}cm^{-1}. Calculate its molar conductivity and degree of dissociation. Given $\lambda°_{(H^+)}$ = 349.5 ohm^{-1} cm^{-1} mol^{-1} and $\lambda°_{(HCOO^-)}$ = 50.5 ohm^{-1}cm^{-1}mol^{-1}

(ii) Calculate the time taken to deposit 1.27g of copper at cathode when a current of 2 amp. is passed through the solution of $CuSO_4$. (Atomic weight of Cu= 63.5 g mol^{-1}) [5]

OR

(i) The resistance of a conductivity cell with 0.1 M KCL solution is 200 ohm. When the same cell is filled with 0.02M NaCl solution, the resistance is 1100 ohm. If the conductivity of 0.1M KCl solution is 0.0129 ohm^{-1}cm^{-1}, calculate the cell constant and molar conductivity of 0.02M NaCl solution.

(ii) The emf (E°cell) of the following reaction is 0.89V:

$3Sn^{4+} + 2Cr \longrightarrow 3Sn^{2+} + 2Cr^{3+}$

Calculate the value of AG° for the reaction. Predict whether the above reaction will be spontaneous or not.

Ans.(i) Molar conductivity (λ_m) = $\dfrac{1000 \times k}{\text{conc.}}$

Specific conductivity (k) = $5.25 \times 10^{-5}\,\Omega^{-1}cm^{-1}$.

Conc. (c) = 2.5×10^{-4} M

$$\lambda_m = \frac{1000 \times 5.25 \times 10^{-5}}{2.5 \times 10^{-4}}$$

$$= 210 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\lambda^0_{CH_3COOH} = \lambda^0_{H^+} + \lambda^0_{CH_3COO^-}$$

$$= 50.5 + 34.9.5$$

$$= 400 \text{ S cm}^2 \text{ mol}^{-1}$$

$$\alpha = \frac{\lambda_m}{\lambda_0}$$

$$= \frac{210}{400} = 0.525$$

$$\alpha = 52.5\%$$

(ii) t = ?, I = 2A, At.wt of Cu = 63.5 g mol^{-1}

Mass given = 1.27 g

1F = 96500 C

According to 1st law of faraday

W =zit

$$Z = \frac{\text{atomic weight}}{\text{no. of electrons}} \times F = \frac{63.5}{2 \times 96500}$$

required for reduction

Putting the values in the formula

$$1.27 = \frac{63.5}{2 \times 96500} \times Z \times t$$

$$t = 1930 \text{ S}$$

OR

(i)

Cell 1	**Cell 2**
Resistance = 200 Ω Molarity = 0.1MKCl Conductivity (k) = 0.0129 Ω^{-1} cm^{-1}.	Resistance = 1100 Ω Molarity = 0.02 MNaCl

Cell constant = Conductivity × Resistance

(for 0.1MKCl) = 0.0129 × 200

= 2.5800

(For 0.02 M NaCl)

G = K × R

2.58 = K × 1100

$$K = \frac{2.58}{1100}$$

$$= 0.00234 S'cm^{-1}$$

or 2.34×10^{-3} S cm^{-2}.

Molar conductivity (λ_m) = $\dfrac{1000 \times k}{C}$

$$= \frac{2.34 \times 10^{-3} \times 1000}{0.02}$$

$= 117.25 \text{ S cm}^2 \text{ mol}^{-1}$

or $= 117.25 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$

$\lambda_m = 1.172 \times 10^{-2} \text{ S m}^2 \text{ mol}^{-1}$

(for NaCl)

(ii) $3Sn^{+4} + 2Cr \longrightarrow 3Sn^{+2} + 2Cr^{+3}$

$E^\circ_{Cell} = 0.89 \text{ V}$

$\Delta G^\circ = -nFE^\circ_{cell}$

$\boldsymbol{n} = 6 \text{ mol}$

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

$\Delta G^\circ = -6 \times 96500 \times 0.89$

$= -515310 \text{ J or } -515.310 \text{ KJ}$

Since, ΔG° is negative and E° is positive so the reaction is spontaneous.

■■