SAMPLE PAPER 6

CHEMISTRY PAPER 1
(THEORY)

Maximum Marks: 70

Time Allowed: Three Hours

*(Candidates are allowed **additional 15 minutes** for **only** reading the paper.*

*They must **NOT** start writing during this time.)*

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 L atm = 1 dm^3 atm = 101.3 J, 1 Faraday = 96500 coulombs,   Avogadro's number = 6.023×10^{23}

SECTION A – 14 MARKS

Question 1

(A)

(i)
Ans.: two, s^{-1}

(ii)
Ans.: tetrahedral, square planar

(iii)
Ans.: carbocations, transition state

(iv)
Ans.: phenol, methyl iodide

(B)

(i)

Ans.: (d) 5.49×10^7 C of electricity

Explanation:

$Al^{3+} + 3e^- \rightarrow Al$

$\qquad w = ZQ$

Where, w = amount of metal

$w = 5.12$ kg

$\quad = 5.12 \times 10^3$ g

Z = electrochemical equivalent

$$Z = \frac{\text{equivalent weight}}{96500} = \frac{\text{atomic mass}}{\text{electrons} \times 96500}$$

$$Z = \frac{27}{3 \times 96500}$$

$$5.12 \times 10^3 = \frac{27}{3 \times 96500} \times Q$$

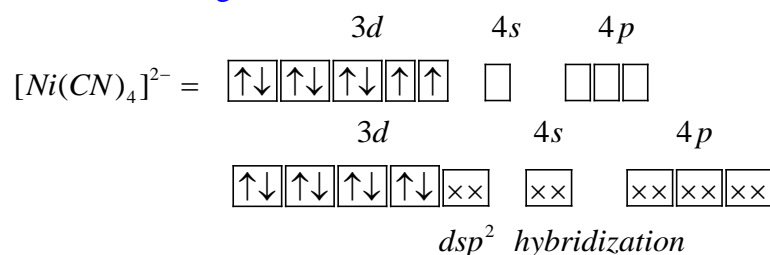$$Q = \frac{5.12 \times 10^3 \times 3 \times 96500}{27} C$$

$$\quad = 5.49 \times 10^7 C$$

(ii)

Ans.: (d) $[Ni(CN)_4]^{2-}$: Oxidation number of $Ni = +2$

Explanation:

Electronic configuration of $Ni^{2+} : 3d^8 4s^0$

dsp^2 $hybridization$

Pairing of electrons in d -orbital takes place due to the presence of strong field ligand $\left(CN^-\right)$

(iii)

Ans.: (d) They do not exhibit variable valency.

Explanation:

$_{30}Zn \rightarrow [Ar]3d^{10}4s^2$

∵ It d-orbital is complete

∴ It does not show variable valency

(iv)

Ans.: (b) RCH_2NH_2

Explanation: $RBr + KCN \rightarrow RCN \xrightarrow{\text{Reduction}} RCH_2NH_2$

(v)

Ans.: (d) 0.5 M Na_3PO_4

(vi)

Ans.: (d) Assertion is false but Reason is true.

(vii)

Ans.: **(a)** Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

(C)

Ans.:

(i) Osmotic pressure is directly proportional to the conentration of solute in solution $\pi \propto c$

(ii) Film of cellulose

(iii) This can be used for desalination of sea water.

SECTION B – 20 MARKS

Question 2

Ans.: (i) *Ortho*-nitrophenol is less acidic than *para*-nitrophenol due to intramolecular hydrogen bonding in the ortho isomer, which destabilizes the phenoxide ion, making it less likely to release a proton.

(ii) O and C bond of phenyl group has a double bond character due to resonance with the phenyl group. Due to the double bond character the O and C bond has more strength and difficult to cleave. So, O and C bond of methyl group cleaves and phenol and methyl iodide are formed.
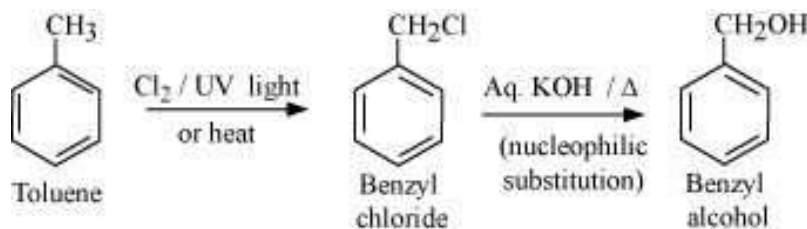
Question 3

Ans.: (i) The irregularities in the electronic configurations of actinoids are due to extra stabilities of the f^0, f^7 and f^{14} orbitals
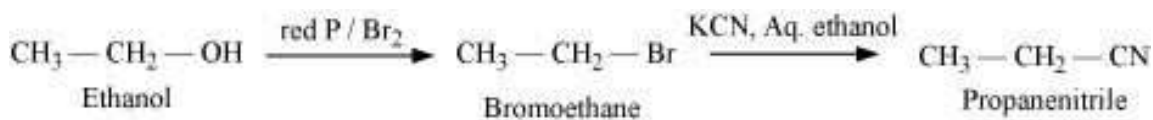
(ii) In case of Mn_2O_7, Mn exists in highest oxidation state and has d^0 electronic configuration. Therefore, it has the tendency to accept the electron. Hence it is acid whereas in case of Mn_2O_3, Mn exists is +3 oxidation state and has d^4 electronic configuration. Therefore, it has tendency to donate electron, hence it acts as base.
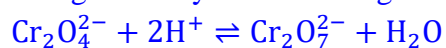
Question 4

Ans.: (i)

(ii)

$$CH_3-CH_2-OH \xrightarrow{\text{red P / Br}_2} CH_3-CH_2-Br \xrightarrow{\text{KCN, Aq. ethanol}} CH_3-CH_2-CN$$

Ethanol   Bromoethane   Propanenitrile

Question 5

Ans.: (i) Zn, Cd and Hg are soft and have low melting point because they have no unpaired electrons in their neutral and most stable oxidation states due to which metallic bonding is weaker and considered as transition elements.

(ii) When the pH of the solution of potassium dichromate is decreased, the colour of the solution changes from yellow to orange due to the conversion of $Cr_2O_4^{2-}$ ions into $Cr_2O_7^{2-}$ ions.
$$Cr_2O_4^{2-} + 2H^+ \rightleftharpoons Cr_2O_7^{2-} + H_2O$$

Question 6

Ans.: (i)

$$CH_3-\underset{\underset{Cl}{|}}{CH}-CH_2-CH_3$$

(ii) Dextro- and laevo-rotatory isomers of Butan-2-ol are enantiomers of each other and both have the same boiling point and hence they cannot be separated by fractional distillation.
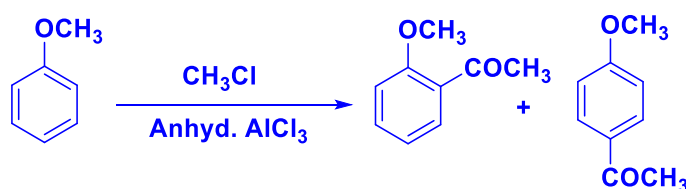
Question 7

Ans.: (i) A is strong electrolyte and B is weak electrolyte.

(ii) As seen from the graph, electrolyte 'A' is a strong electrolyte which is ionised almost completely almost completely in solutions. For strong electrolyte 'A' the number of ions does not increase appreciably on dilution and only mobility of ions increases due to decrease in interionic attraction. Therefore, molar conductivity increases a little as shown in graph by a straight line.
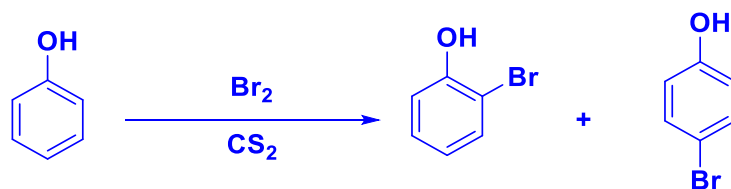
Question 8

Ans.:
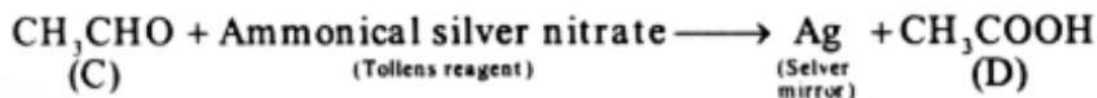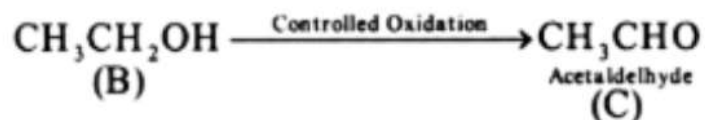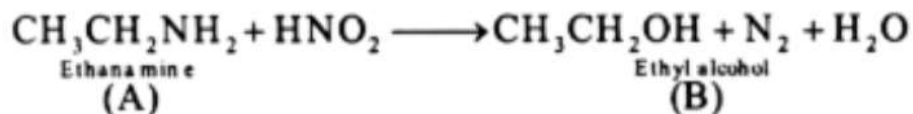**(a)** Acetyl group is introduced at *ortho* and *para* positions of anisole.

(b) 2-bromophenol and 4-bromophenol are formed.

OR

Ans.:

$$CH_3CH_2NH_2 + HNO_2 \longrightarrow CH_3CH_2OH + N_2 + H_2O$$

Ethanamine   Ethyl alcohol
(A)   (B)

$$CH_3CH_2OH \xrightarrow{\text{Controlled Oxidation}} CH_3CHO$$

(B)   Acetaldelhyde
                   (C)

$$CH_3CHO + \text{Ammonical silver nitrate} \longrightarrow Ag + CH_3COOH$$

(C)   (Tollens reagent)   (Selver   (D)
                                          mirror)

Question 9

Ans.:

$P_s = 80\%$ of $P_0 = 0.80$

Solute $= \dfrac{W}{40 gmol^{-1}}$

Solvent (octane) $= \dfrac{114g}{114 gmol^{-1}}$

(molar mass of $C_8H_{18} = 114 gmol^{-1}$)

Now $\dfrac{P_0 - P_s}{P_0} = x_2$

$\therefore \dfrac{P_0 - 0.80P_0}{P_0} = \dfrac{\frac{W}{40}}{\frac{W}{40} + 1}$

Or $\dfrac{0.8W}{40} = 0.2$

$\Rightarrow W = 10g$

Question 10

Ans.: (i) The phenoxide ion has lower resonance stabilization due to the negative charge being distributed over one oxygen atom and carbon atoms. In contrast, the carboxylate ion achieves higher stability by spreading the negative charge over two electronegative oxygen atoms, making it more stable than the phenoxide ion.

(ii) Oxidation of aldehyde is easier than ketones because in aldehyde there is one oxidisable-H present attached to the carbonyl carbon whereas ketones do not have the oxidisable-H atom. Also, the carbonyl carbon in ketone contains two alkyl groups attached it to which makes it less reactive compared to that of aldehyde.

Question 11

Ans.: (i) $2MnO_2 + 4KOH + O_2 \xrightarrow{\Delta} 2\ K_2MnO_4 + 2H_2O$

(ii) $Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$

SECTION C – 21 MARKS

Question 12

(i)
Ans.: Suppose order with respect to NO is *m* and order with respect to Cl₂ is *n*,

Then the rate will be:
Rate = $k\,[A]^m\,[B]^n$

$2.0 \times 10^{-3} = [1.0]^x[1.0]^y$

For experiment (ii) $4.0 \times 10^{-3} = [2.0]^x[1.0]^y$ ...(2)

For experiment (iii) $8.0 \times 10^{-3} = [4.0]^x[1.0]^y$

For experiment (iv) $2.0 \times 10^{-3} = [1.0]^x[2.0]^y$

For experiment (v) $2.0 \times 10^{-3} = [1.0]^x[4.0]^y$

Determination of x. In order to get the value of x, divide equation (2) by (1)

$$\frac{4.0 \times 10^{-3}}{2.0 \times 10^{-3}} = \frac{[2.0]^x[1.0]^y}{[1.0]^x[1.0]^y}, (2)^1 = (2)^x \text{ or } x = 1$$

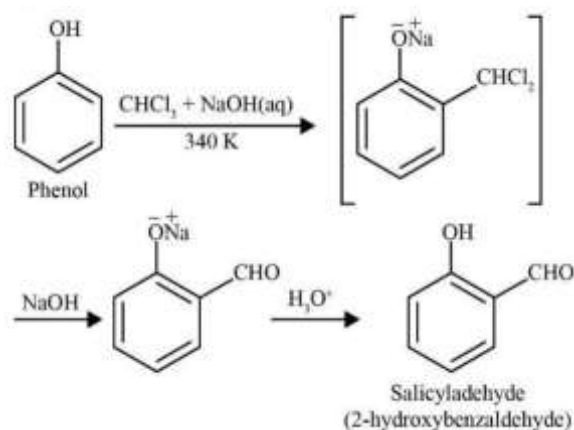Determination of y. In order to get the value of y, divide equation (4) by (1)

$$\frac{2.0 \times 10^{-3}}{2.0 \times 10^{-3}} = \frac{[1.0]^x[2.0]^y}{[1.0]^x[1.0]^y}, (1)^1 = [2.0]^y \text{ or } y = 0$$
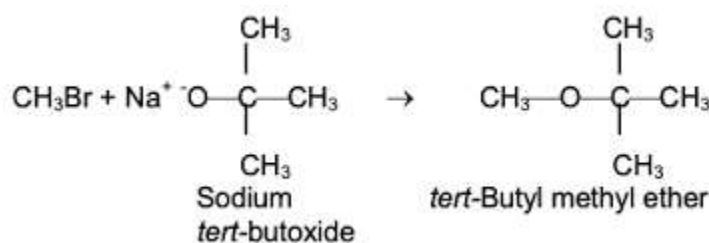
(i) Overall order of the reaction = 1 + 0 = 1

(ii) Rate Law equation, Rate = k[A]¹ [B]⁰ = k[A]

Question 13

Ans.: (i) Reimer - Tiemann reaction

(ii) Williamson ether synthesis:

Question 14

Ans.: (i) Proteins are sensitive to heat, pH changes, electrolytes, and short-wavelength radiation. Exposure to such conditions induces structural changes, disrupting the three-dimensional structure and causing permanent loss of protein activity. This process, known as protein denaturation, involves altering the native conformation due to changes in the protein's environment.

(ii) Water soluble vitamins are B and C.

Vitamin C cannot be stored in our body because it is water soluble. As a result, it is readily excreted in the urine.

(iii) Glycogen is a branched polymer of α-D glucose, with shorter chains (10-14 glucose units) and higher branching compared to amylopectin. Starch is a mixture of amylose (15-20%), a linear polymer of α-D glucose, and amylopectin (80-85%), which is also a branched polymer of α-D glucose with longer chains (20-25 glucose units).

Question 15

Ans.:

$W_2 = 2.56$ g, $W_1 = 100$ g, $\Delta T_f = 0.383$ K

$K_f = 3.83$ K kg mol^{-1}. $\Delta T_f = K_f \times m$

$$\Rightarrow \Delta T_f = K_f \times \frac{W_2}{M_2} \times \frac{1000}{W_1}$$

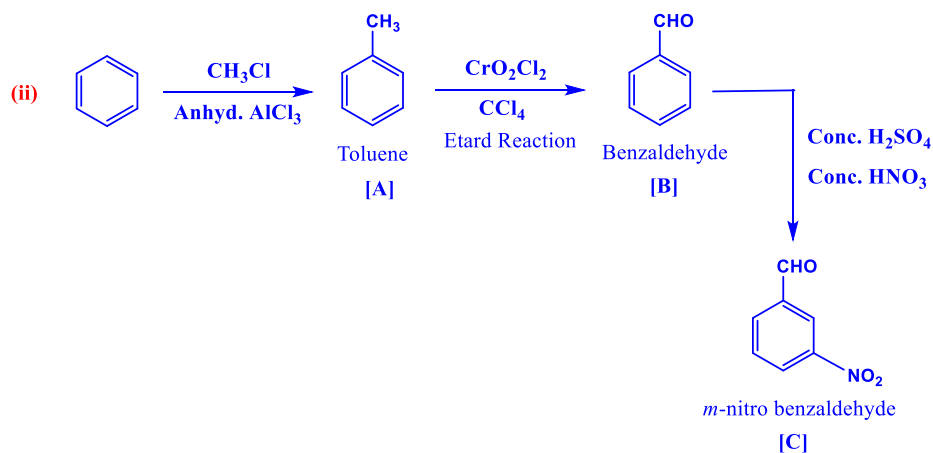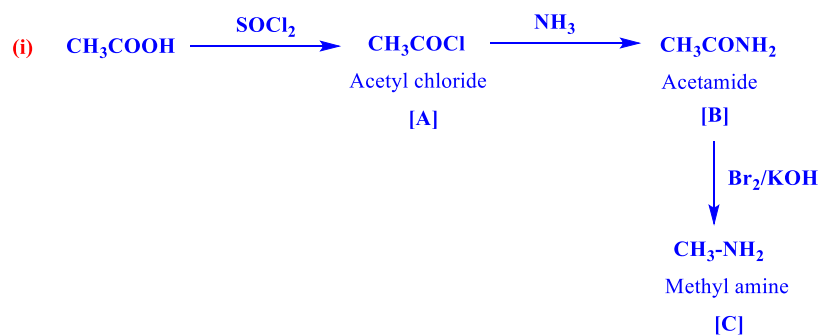$$\Rightarrow M_2 = \frac{W_2 \times 1000}{\Delta T_f \times W_1} \times K_f$$

$$= \frac{2.56 \times 1000}{0.383 \times 100} \times 3.83 = 256 \text{ g mol}^{-1}$$

$$\therefore i = \frac{\text{Normal atomic mass}}{\text{Observed atomic mass}} = \frac{32}{256} = \frac{1}{8}$$

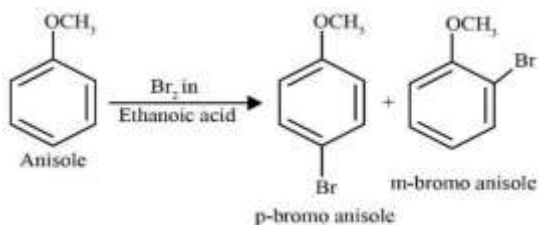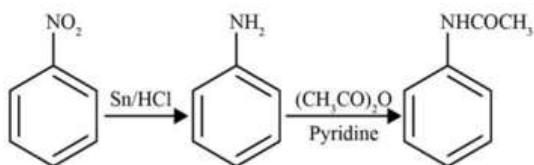Sulphur exists as S_8.

Question 16

Ans.:

(i) $CH_3COOH \xrightarrow{SOCl_2} CH_3COCl \xrightarrow{NH_3} CH_3CONH_2$

Acetyl chloride [A]   Acetamide [B]

[B] $\xrightarrow{Br_2/KOH}$ $CH_3\text{-}NH_2$ Methyl amine [C]

(ii) Benzene $\xrightarrow[\text{Anhyd. AlCl}_3]{CH_3Cl}$ Toluene [A] $\xrightarrow[\substack{CCl_4 \\ \text{Etard Reaction}}]{CrO_2Cl_2}$ Benzaldehyde [B] $\xrightarrow[\text{Conc. HNO}_3]{\text{Conc. H}_2\text{SO}_4}$ m-nitro benzaldehyde [C]

Question 17
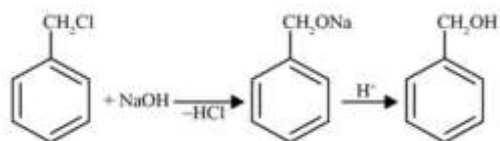
Ans.: (a)

(b)

(c)

<center>**OR**</center>

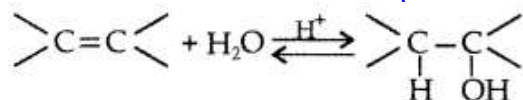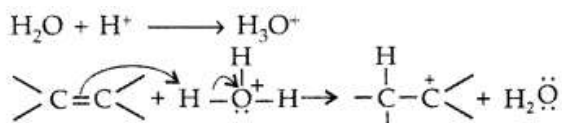**Ans.:**

Alkenes react with water in the presence of acid as catalyst to form alcohols
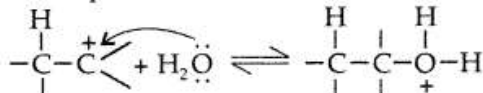

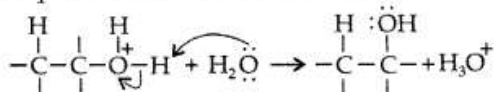**Mechanism** : It involves three steps :
(i) Protonation of alkene to form carbocation by electrophilic attack of H_3O^+

(ii) Nucleophilic attack of water on carbocation

(iii) Deprotonation to form an alcohol

Question 18

Ans.: (i)

$A + B \rightarrow C$

On doubling the concentration of A, rate of reaction increases by 4 times.

$\therefore$ rate $\propto [A]^2$ (w.r.t. A)

However, on doubling the concentration of B rate of reaction increases two times.

$\therefore$ rate $\propto [B]^2$ (w. r. t. B)

Thus, overall order of reaction $=2+1=3$

(ii)

$a = 100, \quad x = 25, \qquad t = 30$ min

$$k = \frac{2{\cdot}303}{t} \ \log_{10} \frac{a}{(a-x)} \qquad \text{or}$$

$$k = \frac{2{\cdot}303}{30} \ \log_{10} \frac{100}{(100-25)} \qquad \text{or}$$

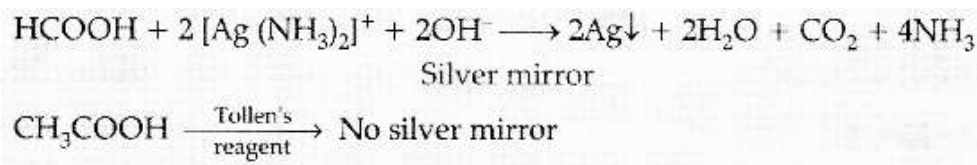$$k = \frac{2{\cdot}303}{30} \ \log_{10} \frac{100}{75}$$

$$k = 9{\cdot}59 \times 10^{-3} \text{min}^{-1}$$

$$t = \frac{2{\cdot}303}{k} \ \log \frac{100}{(100-90)} \quad \text{or} \quad = \frac{2{\cdot}303}{9{\cdot}59 \times 10^{-3}} \ \log_{10} \frac{100}{10}$$

$t = 240{\cdot}15$ min.

SECTION D – 15 MARKS

Question 19

Ans.:

(a) HCOOH gives silver mirror test with Tollen's reagent whereas ethanoic acid does not.

$$HCOOH + 2 \,[Ag\,(NH_3)_2]^+ + 2OH^- \longrightarrow 2Ag\!\downarrow + 2H_2O + CO_2 + 4NH_3$$

<div align="center">Silver mirror</div>

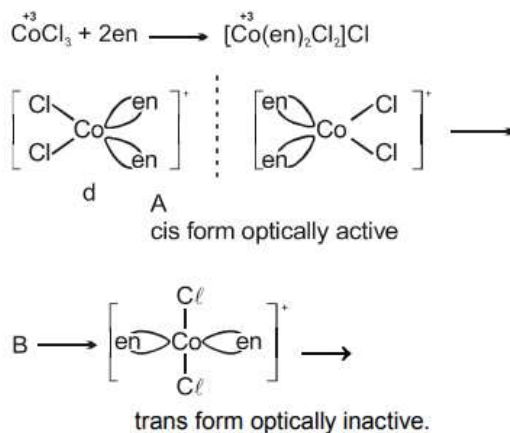$$CH_3COOH \xrightarrow[\text{reagent}]{\text{Tollen's}} \text{No silver mirror}$$

(b) Benzoic acid is weaker than formic acid due to the phenyl group's smaller electron-releasing effect compared to a methyl group. Resonance (+R) dominates over inductive (-I) effects when the carboxyl group is directly attached to the benzene ring, hindering proton release. The stronger acidity of benzoic acid versus acetic acid indicates that $[(-I) + R] < +I$ of the methyl group.

(c) It is because aldehydes get further oxidized to acids so, oxidation of alcohols to aldehydes needs to be controlled.
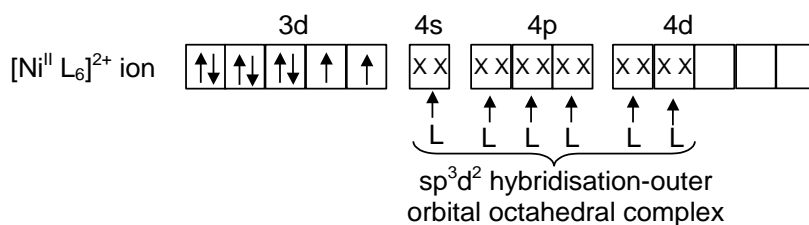
Question 20

Ans.: (i)

$$CoCl_3 + 2en \longrightarrow [Co(en)_2Cl_2]Cl$$

cis form optically active

trans form optically inactive.

A & B shows geometrical isomers.

(ii) The electric configuration of Ni^{2+} ion ($3d^8$) indicates that two inner d-orbitals (3d-orbitals) cannot be made available to allow d^2sp^3 hybridisation. However, by using two 4d-orbitals, sp^3d^2 hybridisation may be possible.

sp^3d^2 hybridisation-outer orbital octahedral complex

Question 21

Ans.:

**(a)** At anode oxidation takes place, and oxidation is defined as loss of electrons. So the reaction should be

$$2H_2O \rightarrow O_2 + 4H^+ + 4e^-$$
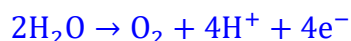
Since mobility of OH^- is greater than SO_4^{2-}

$\therefore$ oxidation of SO_4^{2-} will not occur.

(b) Specific conductance is the conductivity of all ions present in 1 cm^3 of a solution. When the solution is diluted the number of ions present in 1cm^3 of solution decrease and as a result specific conductance decreases.

(c) (1) Cell 'B' will act as an electrolytic cell because potential of B is less than that of A.

Following reaction can take place at cathode and anode.

At cathode: $Zn^{2+} + 2e^- \rightarrow Zn$

At anode: $Cu \rightarrow Cu^{2+} + 2e^-$
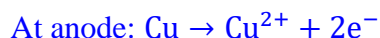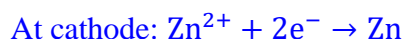
(2) Now the cell ' B ' has higher e.m.f and it will act as a galvanic cell.

At cathode: $Cu^{2+} + 2e^- \rightarrow Cu$

At anode: $Zn \rightarrow Zn^{2+} + 2e^-$
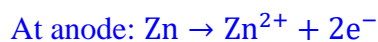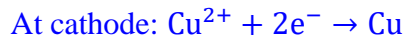
OR

Ans.: (ii) (a)

- High efficiency
- Pollution free.

(b) $(H_2 + 2AgCl \rightarrow 2Ag + 2H^+ + 2Cl^-)$

$\Delta G^o_{cell\ reaction} = 2(-130,79) - 2(-109.56)$

$= -42.46 \text{ kJ/mole} = -2\ F \times E^o_{cell}$

$\therefore E^o_{cell} = \dfrac{-42460}{-2 \times 96500} = +0.550 \text{ V}$

Now

$E_{cell} = +0.220 - \dfrac{0.059}{2} \log \dfrac{1}{(0.01)^4} = 0.456 \text{ V} = 456 mV$

(c) The degree of dissociation α is given by

$\alpha = \dfrac{\Lambda_m}{\Lambda_m^o}$

where Λ_m is the molar conductivity and Λ_m° is the limiting molar conductivity.

$\Lambda_m^{\circ}(CH_3COOH) = \lambda_{H^+}^{\circ} + \lambda_{CH_3COO^-}^{\circ}$

(b) $\Lambda_{m(NaCl)}^o = \lambda_{Na^+}^o + \lambda_{Cl-}^0$

$\Lambda_m^o(HCl) = \lambda_{H^+}^o + \lambda_{Cl^-}^o$

$\Lambda_m^o(NaCl) = \lambda_{Na^+}^o + \lambda_{Cl^-}^o$
$\Lambda_m^o(CH_3COONa) = \lambda_{CH_3COO^-}^C + \lambda_{Na^+}^o$
$\Lambda_m^o(CH_3COOH) = \lambda_{CH_3COO^-}^C + \lambda_{H^+}^o$
$= \lambda_{H^+}^o + \lambda_{Cl^+}^o + \lambda_{CH_3COO^-}^o + \lambda_{Na^+}^o - \lambda_{Cl^-}^o - \lambda_{Na^+}^o$
$= \Lambda_m^o(HCl) + \Lambda_m^o(CH_3COONa) - \Lambda_m^oNaCl$
$= 426 + 91 - 126 = 391 Scm^2\ mol^{-1}$