



SAMPLE PAPER 10

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 $R = 1.987 \text{ cal deg}^{-1} \text{ mol}^{-1} = 8.314 \text{ JK}^{-1} \text{ mol}^{-1} = 0.0821 \text{ dm}^3 \text{ atm K}^{-1} \text{ mol}^{-1}$

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

SECTION A – 14 MARKS

Question 1

(A)

Ans.: **does not, $k[R]^0$**

(ii)

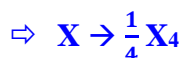
Ans.: **4, CN^-**

(iii)

Ans.: **ethanol, ethene**

(iv)

Ans.: **decreases, increases**

(B)**(i)****Ans.: (b) 1.42 h****(ii)****Ans.: (a) $[NiCl_4]^{2-}$** **(iii)****Ans.: (c) Nearly same atomic size****(iv)****Ans.: (c) $(CH_3)_3N$** **(v)****Ans.: (c) Acetone – Chloroform****(vi)****Ans.: (a) Both Assertion and Reason are true and Reason is the correct explanation of Assertion.****(vii)****Ans.: (d) Assertion is false but Reason is true.****(c)****Ans.: (i)** $i = \text{Moles of compound after association} / \text{Moles of compound before association}$ $i = 1/2 = 0.5$ **(ii) $4X \rightarrow X_4$**  $t=0 \quad 1 \quad 0$ $t=t' \quad 0 \quad \frac{1}{4}$ van't Hoff Factor (i) = $\frac{\text{Number of particles obtained after association}}{\text{Number of particles taken before association}}$

$$= \frac{0 + \frac{1}{4}}{1} \\ = 0.25$$

(iii) $i=2$ van't Hoff Factor (i) = $\frac{\text{Calculated Molar Mass}}{\text{Observed molar mass}}$ $\Rightarrow \text{Observed molar mass} = \frac{\text{Calculated Molar Mass}}{\text{van't Hoff Factor } (i)}$

$$= \frac{23 + 35.5}{2}$$

$$= 29.25 \text{ g mol}^{-1}$$

SECTION B – 20 MARKS

Question 2

Ans.: (i) Phenol < 4-nitrophenol < 2,4,6-trinitrophenol

(ii) In phenol, conjugation with the aromatic ring imparts partial double bond character to the carbon-oxygen bond. The oxygen is attached to an sp^2 hybridized carbon, leading to a more stable and shorter bond compared to methanol, where oxygen is attached to an sp^3 hybridized carbon.

Question 3

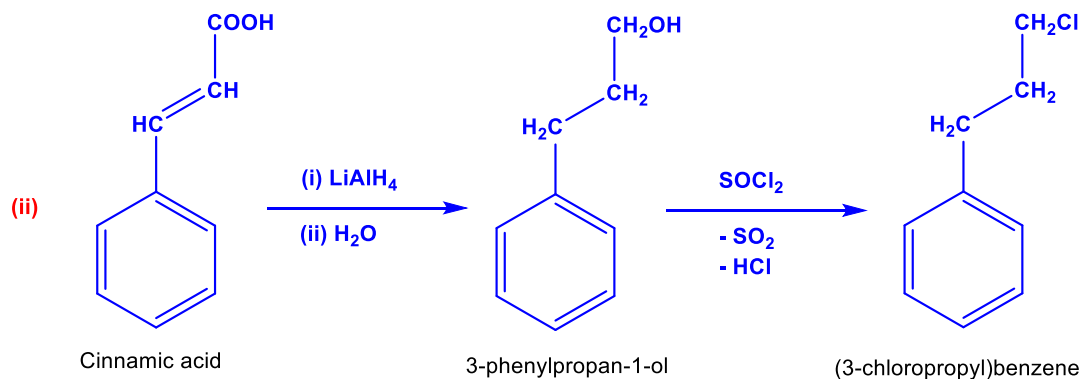
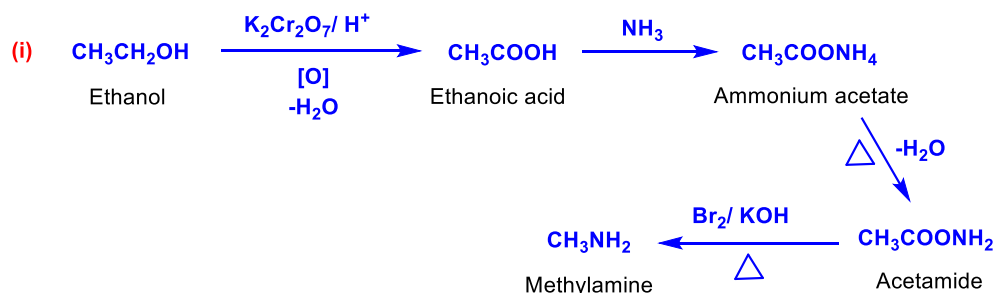
Ans.:

(i) Cu^+ ion has an electronic configuration $3d^{10}$ whereas Cu^{2+} ion has an electronic configuration $3d^9$. Hence an unpaired electron is present in Cu^{2+} which makes electronic transition feasible in case of Cu^{2+} ion, thus imparting color. Due to lack of unpaired electrons, Cu^+ is colorless.

(ii) As zinc atom has completely filled 3d-orbitals ($3d^{10}$) in its ground state as well as in its common oxidation state, therefore, it is not regarded as transition element.

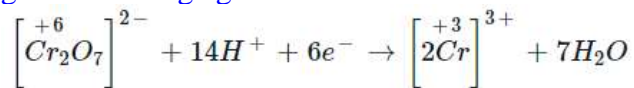
Question 4

Ans.:



Question 5

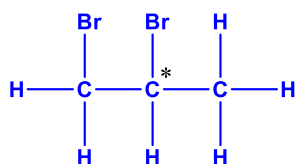
Ans.: (i) In acidic medium, Cr undergoes a decrease in oxidation state from +6 in $\text{Cr}_2\text{O}_7^{2-}$ ion to +3 in Cr^{3+} ion. Since +3 oxidation state is more stable than +6 oxidation state, therefore, $\text{K}_2\text{Cr}_2\text{O}_7$ is a good oxidizing agent in the acidic medium.



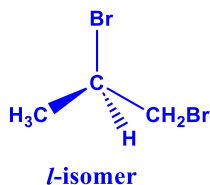
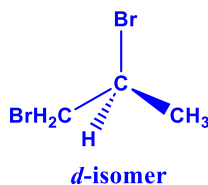
(ii) There are five unpaired electrons in Mn^{2+} ion and d -subshell can have maximum of 5 unpaired electrons. Thus, Mn(II) has maximum paramagnetic character.

Question 6

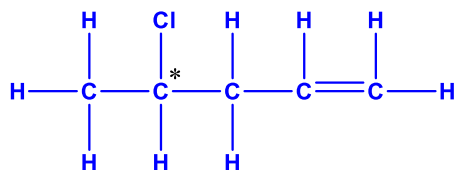
Ans.: (i) 1,2-dibromopropane has one centre of chirality denoted by * mark in the structure below:



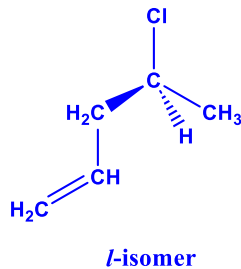
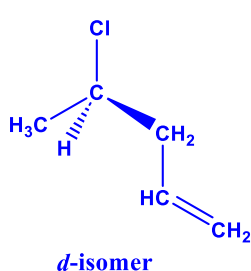
It has two stereoisomers as given below:



(ii) 4-chloro-pent-1-ene has one centre of chirality denoted by * mark in the structure below:



It has two stereoisomers as given below:



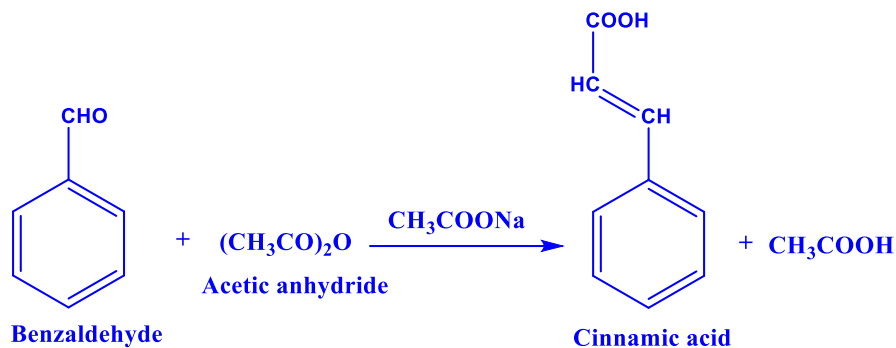
Question 7

Ans.: In rusting, impure iron, in the presence of water containing dissolved oxygen or carbon dioxide, forms a small electrochemical cell. Here, pure iron acts as the anode, and the impure iron surface acts as the cathode, with moisture serving as the electrolyte.

Question 10

Ans: (i) The higher acidic strength of *o*-toluic acid in comparison to benzoic acid is due to the ortho effect.

(ii)

**Question 11**

Ans.:

(i) The 5*f* orbitals provide less shielding compared to the 4*f* orbitals. Because of this, electrons in the outer shell of actinides feel a stronger pull from the nucleus than those in lanthanides. As a result, the contraction in size, known as the actinoid contraction, is greater than the contraction observed in lanthanides.

(ii) A transition metal exhibits higher oxidation state in oxides and fluorides because oxygen and fluorine are highly electronegative elements, small in size (and strongest oxidizing agents). For example, osmium shows an oxidation state of + 6 in OsF_6 and vanadium shows an oxidation state of + 5 in V_2O_5 .

SECTION C – 21 MARKS**Question 12**

Ans.:

Suppose order with respect to **A** is *a*, order with respect to **B** is *b* and order with respect to **C** is *c*.

Then the rate will be:

$$\text{Rate} = k [\text{A}]^a [\text{B}]^b [\text{C}]^c$$

Comparing exp. 1 and 2,

$$(\text{Rate})_1 = k (0.02)^a (0.02)^b (0.02)^c = 2.08 \times 10^{-3} \quad \dots(i)$$

$$(\text{Rate})_2 = k (0.01)^a (0.02)^b (0.02)^c = 1.04 \times 10^{-3} \quad \dots(ii)$$

Dividing eq. (i) by eq. (ii), we get

$$\frac{(\text{Rate})_1}{(\text{Rate})_2} = \frac{(0.02)^a}{(0.01)^a} = \frac{2.08 \times 10^{-3}}{1.04 \times 10^{-3}} = 2$$

$$\text{Or, } 2^a = 2$$

$$\therefore a = 1$$

Comparing exp. 1 and 3,

$$(\text{Rate})_1 = k (0.02)^a (0.02)^b (0.02)^c = 2.08 \times 10^{-3} \quad \dots(iii)$$

$$(\text{Rate})_3 = k (0.02)^a (0.04)^b (0.02)^c = 4.16 \times 10^{-3} \quad \dots(\text{iv})$$

Dividing eq. (iv) by eq. (iii), we get

$$\frac{(\text{Rate})_3}{(\text{Rate})_1} = \frac{(0.04)^b}{(0.02)^b} = \frac{4.16 \times 10^{-3}}{2.08 \times 10^{-3}} = 2$$

$$\text{Or, } 2^b = 2$$

$$\therefore b = 1$$

Comparing exp. 1 and 4,

$$(\text{Rate})_1 = k (0.02)^a (0.02)^b (0.02)^c = 2.08 \times 10^{-3} \quad \dots(\text{v})$$

$$(\text{Rate})_3 = k (0.02)^a (0.02)^b (0.04)^c = 8.32 \times 10^{-3} \quad \dots(\text{vi})$$

Dividing eq. (vi) by eq. (v), we get

$$\frac{(\text{Rate})_4}{(\text{Rate})_1} = \frac{(0.04)^c}{(0.02)^c} = \frac{8.32 \times 10^{-3}}{2.08 \times 10^{-3}} = 4$$

$$\text{Or, } 2^c = 4$$

$$2^c = 2^2$$

$$\therefore c = 2$$

(i) Order of the reaction with respect to A, B and C are 1, 1 and 2 respectively.

$$\text{Rate} = k [\text{A}] [\text{B}] [\text{C}]^2$$

(ii) Substituting the values from experiment 1, we get

$$2.08 \times 10^{-3} = k \times 0.02 \times 0.02 \times (0.02)^2$$

$$\therefore k = \frac{2.08 \times 10^{-3}}{(0.02)^4} = \frac{2.08 \times 10^{-3}}{16 \times 10^{-8}} = 1.3 \times 10^4 \text{ M}^{-3} \text{ min}^{-1}$$

(iii) Rate of reaction when concentration of all reactants = 0.01 M

$$\text{Rate} = 1.3 \times 10^4 \times (0.01) \times (0.01) \times (0.01)^2$$

$$= 1.3 \times 10^{-4} \text{ M min}^{-1}$$

Question 13

Ans.: (i)

Diethyl ether < Aniline < methylamine < ethylamine

Reasons-

a) + I effect of the alkyl groups

b) Steric effects of alkyl groups

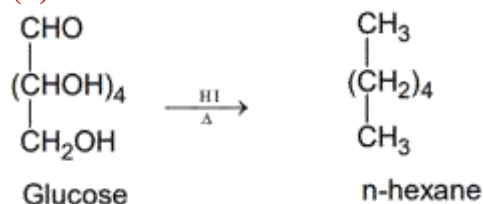
c) Aromatic amines are weaker bases than aliphatic amines.

(ii) Primary amines ($R - \text{NH}_2$) have two hydrogen atoms on nitrogen which can undergo intermolecular hydrogen bonding whereas no such hydrogen bonding is present in tertiary amines ($R_3\text{N}$). So, primary amines boil at a higher temperature than tertiary amines.

Question 14

Ans.: (i) Adenine (A), cytosine (C), uracil (U), and guanine (G) are the four bases found in RNA. The nitrogenous base uracil is absent from DNA.

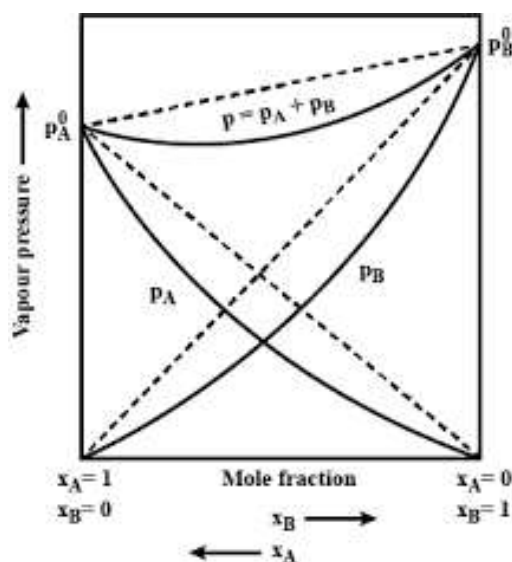
(ii)



(iii) Since water soluble vitamins are soluble in water and excreted in urine so, they must be supplied regularly.

Question 15

Ans.: (i) Negative Deviation is expected when phenol and aniline are mixed with each other. The net volume of the mixture will decrease, $\Delta V_{\text{mix}} < 0$ due to stronger intermolecular interactions.



P-X diagram for solutions showing negative deviation from Raoult's law

(ii)

$$\text{Relative lowering of vapour pressure} = (P^\circ - P) / P^\circ = x_2$$

$$x_2 = n_2 / n_1$$

$$n_2 = 0.1$$

$$n_1 = 100/18$$

$$x_2 = 0.1 / 5.55 + 0.1 = 0.1 / 5.65 = 0.018$$

$$P^\circ = 23.8 \text{ mm Hg}$$

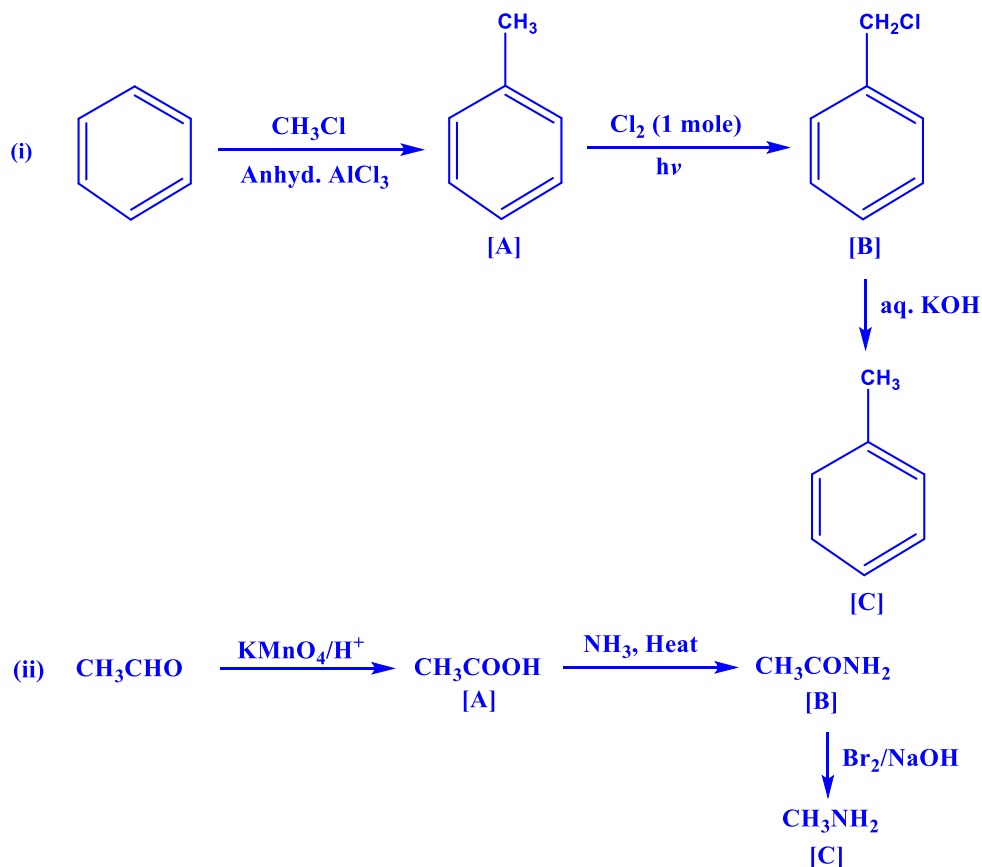
$$\text{Relative lowering of vapour pressure} = (23.80 - P) / 23.80 = 0.018$$

$$23.80 - P = 0.428$$

$$P = 23.80 - 0.428 = 23.37 \text{ mm Hg}$$

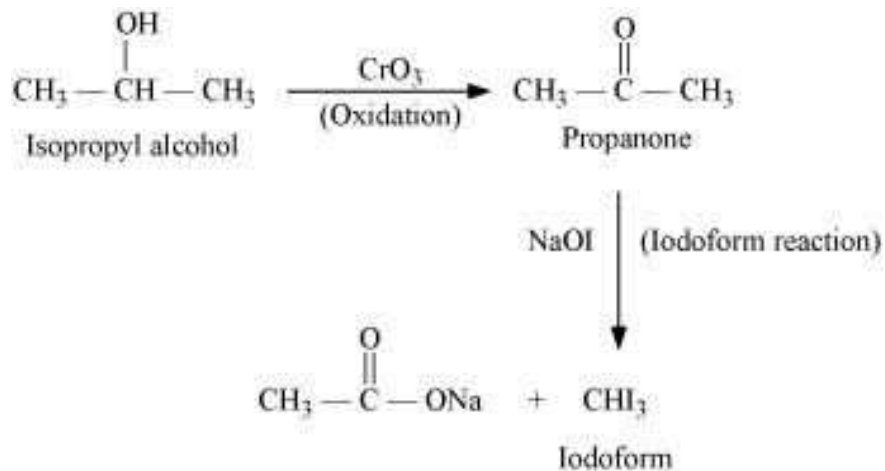
Question 16

Ans.:

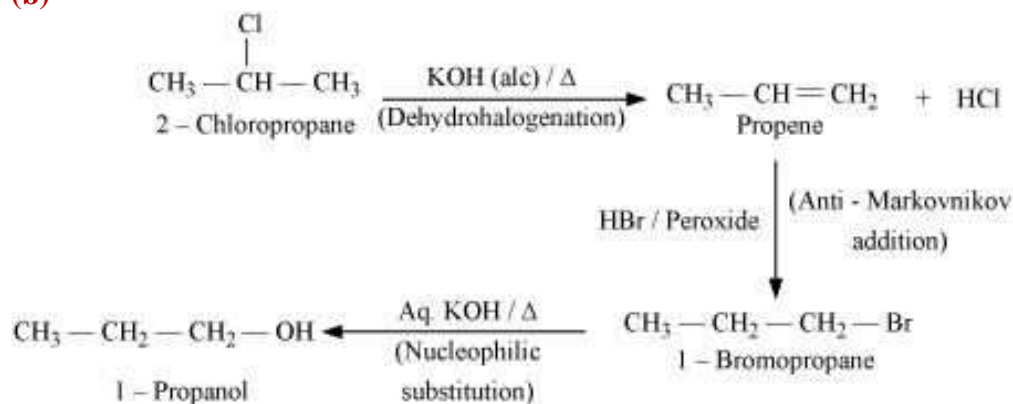


Question 17

Ans.: (a)



(b)



(c)



Question 18

Ans.: (i)

$$t_{1/2} = 28.1 \text{ years}$$

$$K = \frac{0.693}{t_{1/2}} = \frac{0.693}{28.1} = 2.47 \times 10^{-2} \text{ years}^{-1}$$

$$[A]_0 = 2.47 \times 1 \mu\text{g}$$

For 10 years

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

$$10 = \frac{2.303}{2.47 \times 10^{-2}} \log \frac{1 \times 10^{-6}}{[A]}$$

$$\log \frac{[A]_0}{[A]} = 0.1071$$

$$\frac{[A]_0}{[A]} = 1.28 = \frac{1 \times 10^{-6}}{[A]}$$

$$[A] = 0.78 \times 10^{-6} \text{ g} = 0.78 \mu\text{g}$$

The amount of ^{90}Sr that will remain in the child's body after 10 years is $0.78 \mu\text{g}$.

(ii)

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303 \times R} \left[\frac{T_2 - T_1}{T_1 \times T_2} \right]$$

$$\log 2 = \frac{E_a}{2.303 \times 8.314} \left[\frac{410 - 400}{400 \times 410} \right]$$

$$0.310 = \frac{E_a}{19.147} \left[\frac{10}{164000} \right]$$

$$E_a = \frac{0.301 \times 19.147 \times 164000}{10}$$

$$= 94517 \text{ J mol}^{-1}$$

$$= 94.517 \text{ kJ mol}^{-1}$$

SECTION D – 15 MARKS

Question 19

Ans.: (i) (a) This is so because dialkyl cadmium can only reduce acids to ketones, but Grignard's reagent reduces ketones further to tertiary alcohols.

(b) Because of the electron-withdrawing nature of the "-COOH" group in benzoic acid, it directs reactions to the meta position. When benzoic acid undergoes nitration, it forms meta nitrobenzoic acid due to this meta-directing effect.

Ans.: (ii)

Given, MF = C₇H₇NO₂

$$\text{Double bond Equivalence} = C + 1 - \frac{H}{2} - \frac{X}{2} + \frac{N}{2}$$

$$= 7 + 1 - \frac{7}{2} - \frac{0}{2} + \frac{1}{2}$$

$$= 8.5 - 3.5 = 4$$

Where,

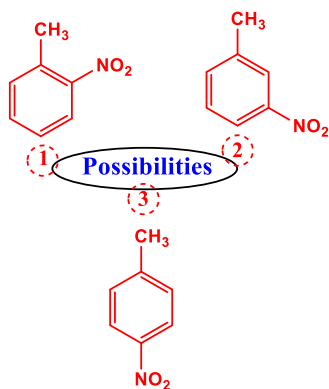
C= Number of carbon atoms present

H= Number of hydrogen atoms present

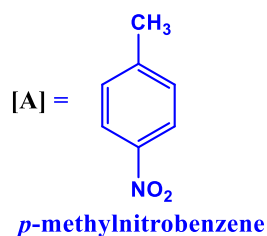
X= Number of halogen atoms present

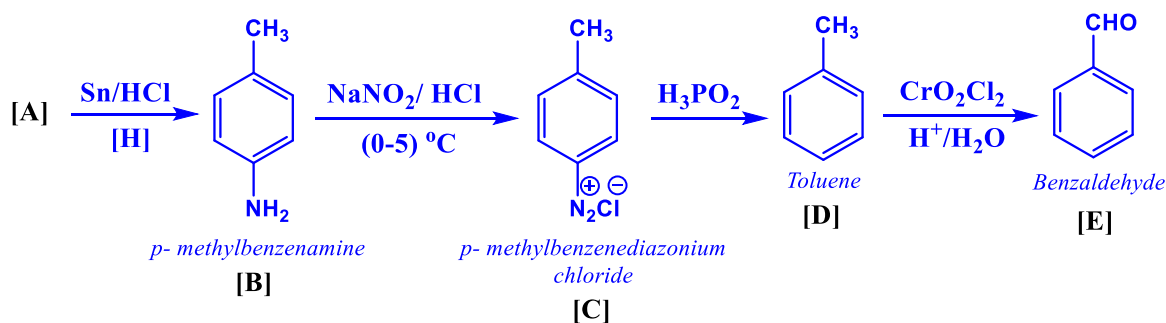
N= Number of Nitrogen atom present

Since, benzene has DBE =4, there is a presence of benzene ring in the given compound. So, with the given molecular formula, we have three possibilities as follows:



Among the three possibilities, **possibility 3** is **Compound A** because it is the highly symmetric molecule and therefore has the maximum melting point.



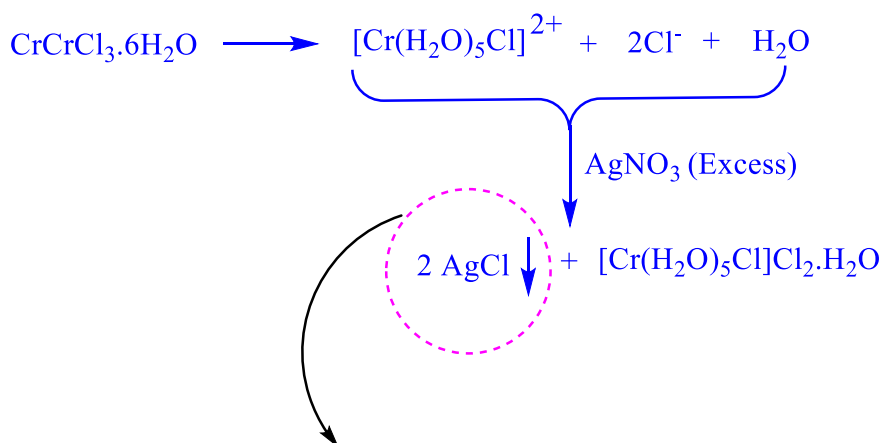
**Question 20**

Ans.: (i) (a) The complex, $\text{Na}_2[\text{Ni}(\text{CN})_4]$, is diamagnetic in nature.

(b) The state of hybridization of Ni^{2+} ion in the complex is dsp^2 .

(ii) The electronic configuration of d^4 under the given conditions is $t_{2g}^4 e_g^0$

(iii) (a)



Number of ionizable Cl^- anions = Number of moles of AgCl precipitated

The structural formula of the given complex is $[\text{Cr}(\text{H}_2\text{O})_5\text{Cl}]\text{Cl}_2 \cdot \text{H}_2\text{O}$

(b) IUPAC name of the complex is Pentaaquachloridochromium(III) chloride monohydrate.

Question 21

(i) (a) Calculate the degree of dissociation of 0.0024 M CH_3COOH if conductivity of the solution

Ans.: (i) (a) Molar conductance, $\Lambda_m = \frac{1000 k}{c}$

$$= \frac{1000 \times 8.0 \times 10^{-5} \text{ S cm}^{-1}}{0.0024}$$

$$= 33.33 \text{ S cm}^2 \text{ mol}^{-1}$$

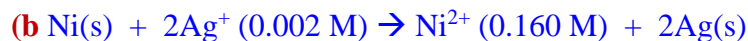
$$\text{Again, } \Lambda_m^0(\text{CH}_3\text{COOH}) = \lambda_{\text{CH}_3\text{COO}^-}^0 + \lambda_{\text{H}^+}^0$$

$$= (349.6 + 40.9) \text{ S cm}^2 \text{ mol}^{-1}$$

$$= 390.5 \text{ S cm}^2 \text{ mol}^{-1}$$

Now, Degree of dissociation, $\alpha = \frac{\Lambda_m}{\Lambda_m^\circ}$

$$= \frac{33.33}{390.5} = 0.0853 = 8.53\%$$



$$E_{\text{cell}}^\circ = E_{\text{cathode}}^\circ - E_{\text{anode}}^\circ$$

$$= E_{\text{Ag}^+/\text{Ag}}^\circ - E_{\text{Ni}^{2+}/\text{Ni}}^\circ$$

$$= [0.80 - (-0.25)] \text{ V} = 1.05 \text{ V}$$

Using Nernst equation,

$$E_{\text{cell}} = 1.05 - \frac{0.0591}{2} \log \frac{[\text{Ni}^{2+}]}{[\text{Ag}^+]^2}$$

$$E_{\text{cell}} = 1.05 - \frac{0.0591}{2} \log \frac{0.160}{(0.002)^2}$$

$$= 1.05 - (0.059/2) \times 4.60$$

$$= 1.05 - 0.1475 = 0.914 \text{ V}$$

$$\Delta G = -nFE_{\text{cell}} = -2 \times 96500 \times 0.914 = -176402 \text{ J} = -176.402 \text{ kJ}$$

OR

Ans.: (ii)

(a) Cell constant, $G^* = \frac{1}{A} = \frac{1.8}{5.4} = 0.333 \text{ cm}^{-1}$

Specific conductance, $k = \frac{G^*}{R} = \frac{0.333}{50} = 6.666 \times 10^{-3} \text{ ohm}^{-1} \text{ cm}^{-1}$

(b) Two functions of a salt bridge are as follows:

1. It connects the solutions in two half-cells and completes the cell circuit.
2. It maintains the electrical neutrality of solutions in the two half-cells by diffusion of ions through it.

(c)

$$E = E_{\text{cell}}^\circ - \frac{0.0591}{n} \log \frac{[\text{Sn}^{2+}][\text{Zn}^{2+}]}{[\text{Sn}^{4+}]}$$

$$= 0.89 - \frac{0.0591}{2} \log \frac{(0.5)(2.0)}{1.5} = 0.895 \text{ V}$$

if $[\text{Sn}^{4+}]$ is increased, the second factor will decrease or E_{cell} will increase.

***** The End *****