



# Rao IIT Academy

Symbol of Excellence and Perfection

## XII - ISC BOARD

Date: 20.03.2015

## CHEMISTRY - SOLUTIONS

### PART I

#### Question 1:

- (a)
- positive, lesser
  - efficient, 74
  - decreases, common-ion effect
  - Cannizzaro, no  $\alpha$  - hydrogen
  - paramagnetic, diamagnetic
- (b)
- (2)  $-0.372^{\circ}\text{C}$
  - (3) 1155
  - (2) Secondary Alcohol
  - (4) Octahedral and  $sp^3d^3$
  - (1) +3 and +4
- (c)
- As temperature increases, concentration of  $\text{H}^+$  and  $\text{OH}^-$  increases and hence pH value decreases.

At 298 K.

$$[\text{H}^+][\text{OH}^-] = 10^{-14}$$

$\therefore$  for neutral solution

$$\text{pH} = 7$$

and at high temperature pH will be less than 7.

- $$\text{Fe}^{3+} + e^- \rightarrow \text{Fe}^{2+}$$

$\therefore$  for 1 mole of  $\text{Fe}^{3+}$ , 1 mole of  $e^-$  is required

$\therefore$  for 3 moles of  $\text{Fe}^{3+}$ , 3 moles of  $e^-$  are required

$$\therefore 3e^- = 3F = 3 \times 96500 \text{ C}$$

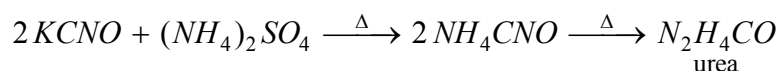
$$Q = I \times t$$

$$3 \times 96500 = 2 \times t$$

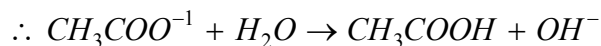
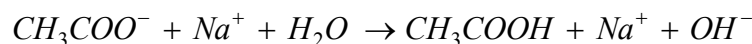
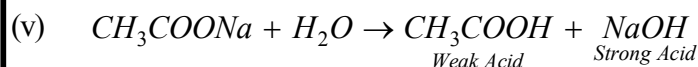
$$\therefore t = \frac{3 \times 96500}{2 \times 3600}$$

$$t = 40.2 \text{ hrs}$$

- (iii) Mixture containing potassium cyanate and ammonium sulphate on heating gives ammonium cyanate which further gives urea



- (iv) Yes



$\therefore OH^-$  are left in the solution

$\therefore$  Sodium acetate on hydrolysis gives basic solution.

- (d) (i)  $\rightarrow d$  ; (ii)  $\rightarrow c$  (iii)  $\rightarrow b$  (iv)  $\rightarrow e$  (v)  $\rightarrow a$

## PART II

### SECTION A

#### Question 2:

- (a)

(i)  $w_2 = 0.5 \text{ g}$

$$w_1 = 100 \text{ g}$$

$$M_1 = 18 \text{ g.mol}^{-1}$$

$$\Delta T_f = 0 - (-0.24) = 0.24^\circ\text{C}$$

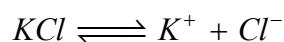
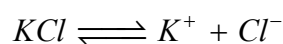
$$M_2 = \frac{1000 k_f w_2}{\Delta T_f \times w_1} = \frac{1000 \times 1.86 \times 0.5}{0.24 \times 100} = 38.75 \text{ g/mol}$$

Calculated (theoretical) mol mass of  $KCl = 39 + 35.5$

$$= 74.5 \text{ g mol}^{-1}$$

$$i = \frac{\text{Calculated molar mass}}{\text{The observed molar mass}} = \frac{74.5}{38.75} = 1.92$$

$$i = 1.92$$



Initial	1	0	0
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Equilibrium	$1-\alpha$	$\alpha$	$\alpha$
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$$\text{total number of moles after dissociation} = (1 - \alpha) + \alpha + \alpha$$

$$= 1 + \alpha$$

$$i = \frac{1 + \alpha}{1} \text{ or } \alpha = i - 1$$

$$\alpha = 1.92 - 1 = 0.92$$

$\therefore$  degree of dissociation = 0.92



(ii) **Given:**

$$\text{mass of sugar} = 1.71 \text{ g}$$

$$\text{molar mass} = 342 \text{ g}$$

$$\text{volume of solution} = 500 \text{ ml}$$

$$\text{temperature} = 300 \text{ K}$$

Formula used

$$\text{number of moles} = \frac{\text{mass of sugar}}{\text{molar mass}}$$

$$\text{Molarity} = \frac{\text{number of moles of solute}}{\text{volume of the solution in litres}}$$

$$\text{Osmotic pressure} \Rightarrow \pi = CRT$$

**Solution:**

$$\begin{aligned} \text{number of moles} &= \frac{1.71}{342} \\ &= 0.005 \end{aligned}$$

$$\begin{aligned} \text{Molarity (C)} &= \frac{0.005 \times 1000}{500} \\ &= 0.01 \text{ M} \end{aligned}$$

$$\begin{aligned} \text{Osmotic Pressure} &= CRT \\ &= 0.01 \times 0.083 \times 300 \\ &= 0.249 \text{ bar} \end{aligned}$$

(iii) **Given**

$$\text{Mass of solute} = 0.70 \text{ g } (w_2)$$

$$\text{Mass of solvent} = 32 \text{ g } (w_1)$$

$$\Delta T_b = 0.25 \text{ }^\circ\text{C}$$

$$K_b = 1.72 \text{ K.kg mol}^{-1}$$

**To find** =  $M_2$  (molecular mass of organic compound)

$$\text{Formula} \Rightarrow M_2 = \frac{1000 K_b w_2}{w_1 \Delta T_b}$$

$$M_2 = \frac{1000 \times 1.72 \times 0.70}{32 \times 0.25}$$

$$M_2 = 150.5 \text{ g}$$

(b)

(i)

	Order	Molecularity
1.	Order of a reaction is an experimental quantity. It can be zero and even a fraction.	Molecularity of a reaction is number of species (atoms, ions or molecules) taking part in elementary reaction. It cannot be zero or non integer
2.	Order is applicable to elementary as well as complex reactions.	Molecularity is applicable only for elementary reactions.
3.	For complex reaction, order is given by slowest step.	Molecularity of the slowest step is equal to the order of over all reaction.

(ii) **Given :** Following is a 1st order reaction. $(t_{1/2})$  half life of a reaction = 120 min**To Find :**

Time required to complete 90% of the reaction.

**Solution:**

Let the reaction constant be K

Initial concentration  $[R_0]$ 

Now calculating constant K

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

$$K = \frac{0.693}{120}$$

$$K = 0.0058 \text{ min}^{-1}$$

Now time required to complete 90% of the reaction

$$\begin{aligned} \text{Final concentration} &= [R_0] - 0.9 [R_0] \\ &= 0.1 [R_0] \end{aligned}$$

Now,

$$K = \frac{2.303}{t} \log \frac{[R_0]}{0.1[R_0]}$$

$$t = \frac{2.303}{0.0058} \log \left[ \frac{1}{0.1} \right]$$

$$t = \frac{2.303}{0.0058}$$

$$t = 397.06 \text{ min}$$

time required to complete 90% of reaction = 397.06 min.

(c) Crystal structure of Cu metal is FCC or CCP

[Face centered cubic or cubic closed packed]

**Question 3:****(a)****(i) Given :**

Crystal structure of Cr = BCC

Edge length (a) = 287 pm

**To find**Atomic radius =  $r$ Density =  $\rho$ **Solution:**

For BCC crystal system

$$\text{Edge length (a)} = \frac{4r}{\sqrt{3}}$$

$$\therefore r = \frac{\sqrt{3} a}{4}$$

$$= 0.433 \times 287 \text{ pm}$$

$$r = 124.27 \text{ pm}$$

Now density of a crystal :

$$\rho = \frac{zM}{a^3 N_A}$$

Where

 $z$  = number of atom in BCC unit cell = 2 $M$  = Molar mass of Cr = 52.99 g

$$a^3 = (287 \text{ pm})^3$$

$$= (287 \times 10^{-12} \text{ m})^3$$

$$= (287 \times 10^{-10} \text{ cm})^3$$

$$= 2.37 \times 10^{-23} \text{ cm}^3$$

$$N_A = 6.022 \times 10^{23} \text{ atoms}$$

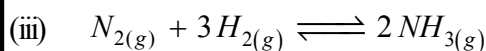
$$\text{Density} = \frac{zM}{a^3 N_A}$$

$$= \frac{2 \times 52.99}{2.37 \times 10^{-23} \times 6.022 \times 10^{23}}$$

$$= \frac{105.98}{14.27}$$

Density of crystal = 7.42 g/cm<sup>3</sup>

- (ii) NaCl show metal excess defect due to anionic vacancies. When crystals of NaCl are heated in an atmosphere of sodium vapour, the sodium atoms are deposited on the surface of the crystal. The  $Cl^-$  ions diffuse to the surface of the crystal and combine with Na atoms to give NaCl. This happens by loss of electrons by sodium atoms to form  $Na^+$  ions. The released electrons diffuse into the crystal and occupy anionic sites. As a result crystal now has excess  $Na^+$  ions. The anionic sites occupied by unpaired electrons are called F-centres. They impart yellow colour to the crystals of NaCl. The colour results by excitation of these electrons when they absorb energy from visible light falling on the crystal.



$$K \text{ (equilibrium constant)} = 6.0 \times 10^{-2} \text{ mol L}^{-1}$$

$$\text{Temperature (T)} = 715 \text{ K}$$

$$[H_2] = 0.25 \text{ mol L}^{-1}$$

$$[NH_3] = 0.06 \text{ mol L}^{-1}$$

$$[N_2] = ?$$

$$K = \frac{[NH_3]^2}{[N_2] \times [H_2]^3}$$

$$[N_2] = \frac{[NH_3]^2}{K \times [H_2]^3}$$

$$= \frac{(0.06)^2}{6.0 \times 10^{-2} \times (0.25)^3}$$

$$= \frac{0.0036}{6.0 \times 10^{-2} \times 0.015625}$$

$$[N_2] = 3.84 \text{ mol L}^{-1}$$

(iv)  $[H^+] = 6.2 \times 10^{-2} \text{ mol L}^{-1}$

$$[H^+] \times [OH^-] = 10^{-14}$$

Now putting the value of  $[H^+]$

$$[OH^-] = \frac{10^{-14}}{6.2 \times 10^{-2}}$$

$$[OH^-] = 1.61 \times 10^{-13} \text{ mol L}^{-1}$$

- (v) **Le-Chatelier's principle :** The principle states that if an external stress is applied to a reacting system at equilibrium, the system will adjust itself in such a way that the effect of the stress is reduced.

- (b)
- (i) NaCl crystallises in FCC lattice
- (ii) Each  $\text{Na}^+$  ion is surrounded by six  $\text{Cl}^-$  ions and each  $\text{Cl}^-$  ion is surrounded by six  $\text{Na}^+$  ions.
- (iii) Number of  $\text{Cl}^-$  ions = 4  
 Number of  $\text{Na}^+$  ions = 4
- (iv) In the NaCl crystal,  $\text{Cl}^-$  ions occupy all the FCC positions and  $\text{Na}^+$  ions occupy the octahedral voids.
- (c)
- (i) Increase in temperature – forward reaction  
 Decrease in temperature – backward reaction
- (ii) Increase in pressure – forward reaction  
 Decrease in pressure – backward reaction
- (iii) Increase in conc. of  $[\text{N}_2\text{O}_4]$  – forward reaction  
 Decrease in conc. of  $[\text{N}_2\text{O}_4]$  – backward reaction
- (iv) Removal of  $\text{NO}_2$  causes decrease in  $[\text{NO}_2]$  – forward reaction

**Question 4:**

(a)  $K = 1.65 \times 10^{-4} \Omega^{-1} \text{cm}^{-1}$

$$\lambda_{\text{H}^+}^0 = 349.1 \Omega^{-1} \text{cm}^2 \text{mol}^{-1}$$

$$\lambda_{\text{CH}_3\text{COO}^-}^0 = 40.9 \Omega^{-1} \text{cm}^2 \text{mol}^{-1}$$

$$C = 0.01 \text{ M.}$$

(i)  $\wedge = \frac{1000 K}{C} = \frac{1000 \times 1.65 \times 10^{-4}}{10^{-2}} = 16.5 \Omega^{-1} \text{cm}^2 \text{mol}^{-1}$

$$\therefore \boxed{\wedge = 16.5 \Omega^{-1} \text{cm}^2 \text{mol}^{-1}}$$

(ii)  $\wedge^\circ = \lambda^\circ \text{H}^+ + \lambda^\circ \text{CH}_3\text{COO}^- = 349.1 + 40.9 = 390.0$

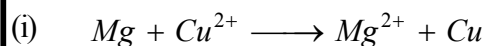
$$\alpha = \frac{\wedge}{\wedge^\circ} = \frac{16.5}{390} = 0.0423$$

$$\boxed{\alpha = 0.0423}$$

(iii)  $K = \frac{\wedge^2 C}{\wedge^\circ(\wedge^\circ - \wedge)} = \frac{(16.5)^2 \times 0.01}{390(390 - 16.5)}$

$$\boxed{K = 1.86 \times 10^{-5}}$$

(b)



$$Q = \frac{[Mg^{2+}]}{[Cu^{2+}]} = \frac{10^{-3}}{10^{-4}} = 10 \quad \boxed{n = 2}$$

$$\begin{aligned} E_{cell} &= E_{cell}^0 - \frac{0.0592}{n} \log_{10} Q \\ &= 2.71 - \frac{0.0592}{2} \log_{10} 10 \\ &= 2.71 - 0.0296 \end{aligned}$$

$$\boxed{E_{cell} = 2.68 V}$$

(ii) In pure water

$$K_{sp} = [Ba^{2+}][SO_4^{2-}]$$

$$1.5 \times 10^{-9} = S^2$$

$$S = \sqrt{1.5 \times 10^{-9}}$$

$$= \sqrt{15 \times 10^{-10}}$$

$$\boxed{S = 3.87 \times 10^{-5} M}$$

$$\text{in } 0.1 M BaCl_2 \quad [Ba^{2+}] = x + 0.1$$

$$[Cl^-] = x$$

$$K_{sp} = [Ba^{2+}][Cl^-]^2$$

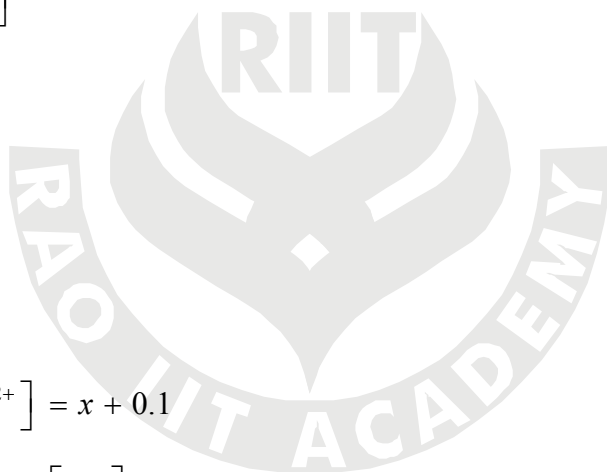
$$1.5 \times 10^{-9} = (x + 0.1) x^2$$

$$\therefore 1.5 \times 10^{-9} = x^2 \times 0.1 \quad (x \text{ is very small})$$

$$\therefore x^2 = 1.5 \times 10^{-8}$$

$$x = \sqrt{1.5 \times 10^{-8}}$$

$$\boxed{x = 1.224 \times 10^{-4} M}$$





- (c)
- (i)  $\text{NH}_4\text{OH} \rightleftharpoons \text{NH}_4^+ + \text{OH}^-$   
 $\text{NH}_4\text{Cl} \rightarrow \text{NH}_4^+ + \text{Cl}^-$   
 $\text{Fe}^{3+} + 3\text{OH}^- \rightarrow \text{Fe}(\text{OH})_3$   
 $\text{Ca}^{2+} + 2\text{OH}^- \rightarrow \text{Ca}(\text{OH})_2$   
 $\therefore K_{sp}[\text{Fe}(\text{OH})_3]$  is very less compared to  $K_{sp}[\text{Ca}(\text{OH})_2]$  hence  $\text{Fe}(\text{OH})_3$  will be precipitated and  $\text{Ca}(\text{OH})_2$  remains in solution.
- (ii)  $\text{H}_2\text{S} \rightleftharpoons 2\text{H}^+ + \text{S}^{2-}$  when strong acid is added  $\text{HCl} \rightarrow \text{H}^+ + \text{Cl}^-$ . Due to common ion effect, concentration of  $\text{H}^+$  is suppressed. Therefore dissociation of  $\text{H}_2\text{S}$  suppressed.

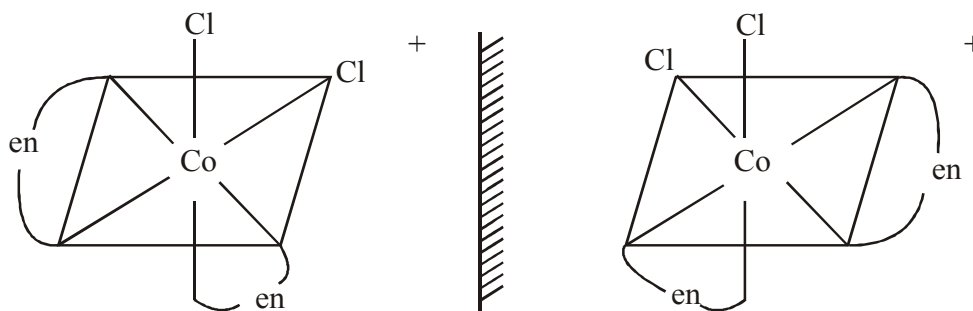
### SECTION B

#### Question 5:

- (a) IUPAC Name
- (i)  $[\text{Cr}(\text{NH}_3)_4(\text{H}_2\text{O})_2]\text{Cl}_3$   
 Tetra ammine diaqua chromium (III) chloride
- (ii)  $[\text{PtCl}_2(\text{NH}_3)_4][\text{PtCl}_4]$   
 Tetraamminedichloro platinum (IV) tetrachloro platinate (II)
- (b)  $[\text{Fe}(\text{CN})_6]^{3-}$   
 hybridisation =  $d^2sp^3$   
 magnetic property = paramagnetic
- (c)
- (i)  $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4 \rightarrow [\text{Co}(\text{NH}_3)_5\text{Br}]^{2+} + \text{SO}_4^{2-}$   
 $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br} \rightarrow [\text{Co}(\text{NH}_3)_5\text{SO}_4]^{1+} + \text{Br}$   
 Both are ionisation isomers.
- $[\text{Co}(\text{NH}_3)_5\text{Br}]\text{SO}_4 + \text{BaCl}_2 \rightarrow \text{red violet ppt of } (\text{BaSO}_4)$   
 $[\text{Co}(\text{NH}_3)_5\text{SO}_4]\text{Br} + \text{AgNO}_3 \rightarrow \text{red ppt of } (\text{AgBr})$



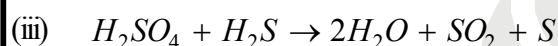
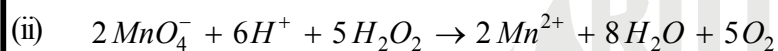
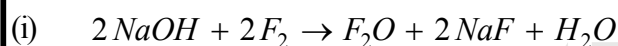
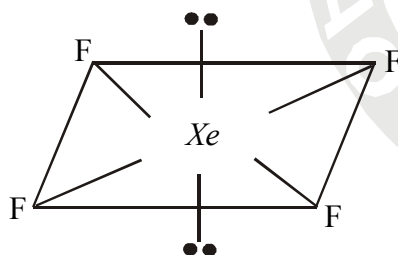
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Non super imposable mirror image structure

**Question 6:**

(a)

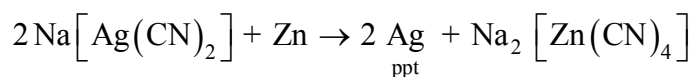
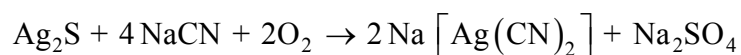
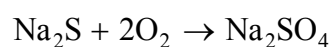
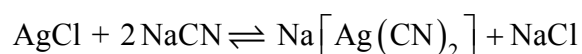
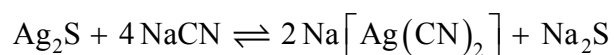

 (b)  $\text{XeF}_4$ 

 Hybridisation =  $sp^3d^2$ 

Geometry = square planar

**Question 7:**

(a) Silver :

- Argentite or silver glance ( $\text{Ag}_2\text{S}$ )

**Leaching Process:**
**Steps:**


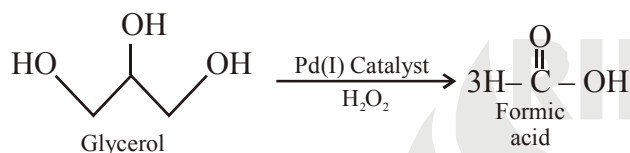
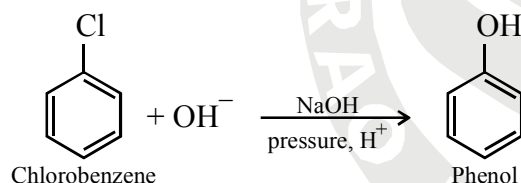
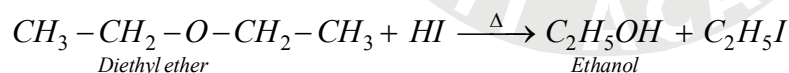
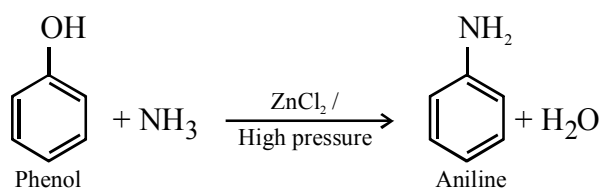
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- (b)
- (i)
- Due to small size of transition metal atoms or their cations and high effective nuclear charge, they have a high positive charge density on them. This high positive charge density makes the atoms or cations to attract the lone pairs of  $e^-$  from the ligands.
  - The transition metal cation or atoms have vacant d-orbital in which they can accommodate the lone pairs of  $e^-$  donated by ligands and thus can form  $L \rightarrow M$  coordinate bonds.
- (ii) Paramagnetic character increases with the increase in the number of unpaired electrons. The larger is the number of unpaired  $e^-$  in central atom or ion greater is the paramagnetic character.
- Hence from Sc to Mn number of unpaired  $e^-$  increases and then from Fe to Zn decreases. Hence paramagnetic character also increases from Sc to Mn and then decreases from Fe to Zn.

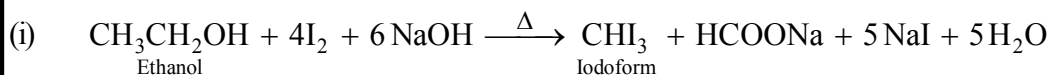
## SECTION C

**Question 8:**

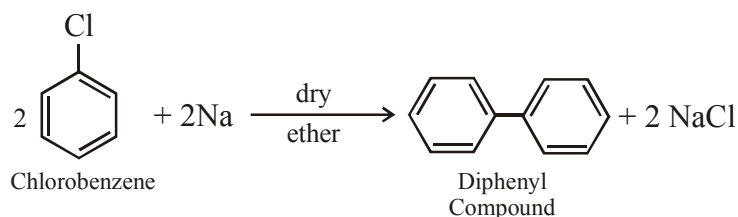
(a)

 (i) **Glycerol to formic acid**

 (ii) **Chlorobenzene to phenol**

 (iii) **Diethyl ether to ethanol**

 (iv) **Phenol to aniline**


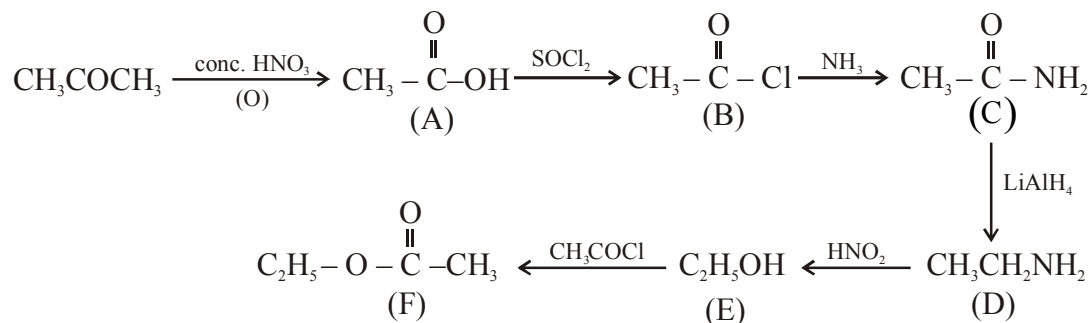
(b)



(ii) Chlorobenzene is heated with sodium metal in presence of dry ether gives diphenyl compound.



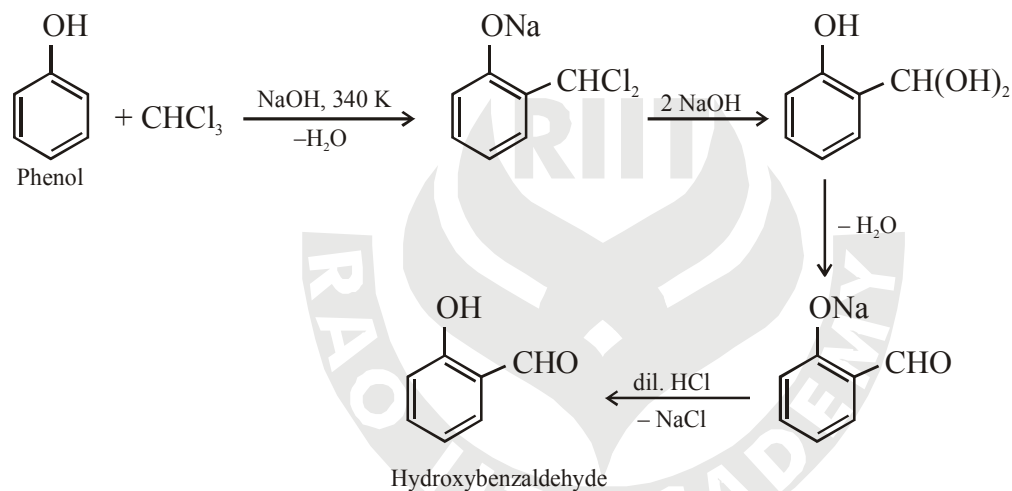
(c) Identifying compounds :



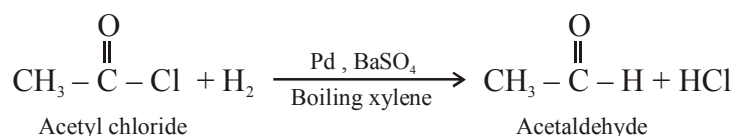
**Question 9:**

(a)

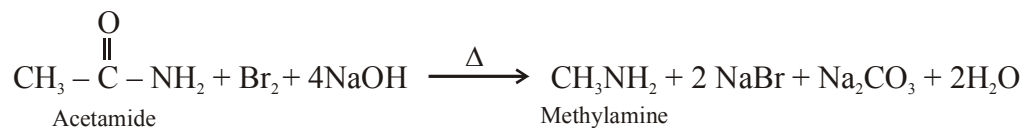
(i) Reimer – Tiemann reaction :



(ii) Rosemund Reaction :



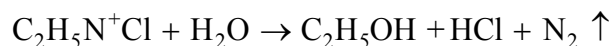
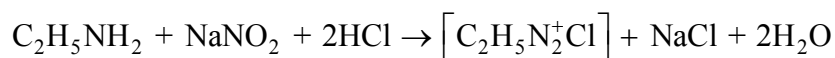
(iii) Hoffmann's degradation reaction :



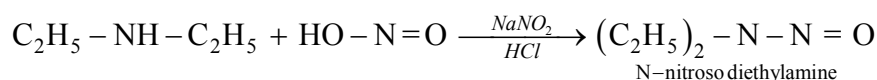
(b)

 (i) **Ethylamine and diethylamine**

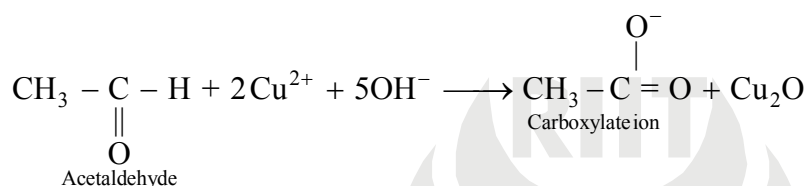
Ethylamine reacts with Nitrous acid in cold condition to form unstable diazonium salt and which decomposes to give alcohol with liberation of  $N_2$  gas.

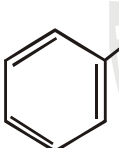


diethylamine reacting with Nitrous acid give yellow oily N-Nitrosoamines


 (ii) **Acetaldehyde and benzaldehyde**

Acetaldehyde reacts as reducing agent which reduces Fehling solution. The aldehyde gets oxidized to carboxylate ion and  $Cu^{2+}$  is reduced to Cuprous oxide



Benzaldehyde  (aromatic aldehyde) are not oxidised by Fehling solution.

(c)

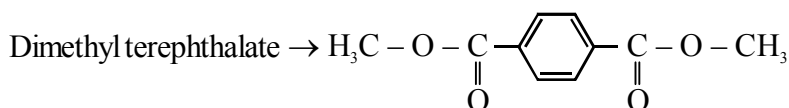
 (i) Compounds in ascending order of their basic strength:  
 diethylether < Aniline < Methylamine < ethylamine

In aliphatic amines, due to presence of electron donating alkyl group, electron density on nitrogen increases. Hence lone pair is easily available for protonation.

In aniline the lone pair of nitrogen is in conjugation with benzene and less available for protonation hence aniline is less basic than aliphatic amine and ethers are inert in nature due to stable C-O-C bond.

 (ii) (a) **Polyester :**

Monomer used :

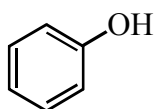


Type of Polymerization : Condensation polymerization.

 (b) **Bakelite :**

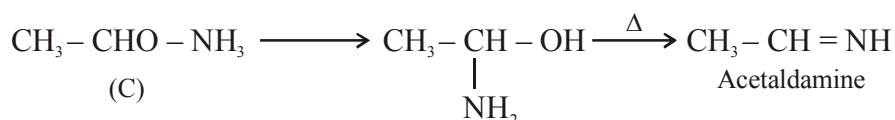
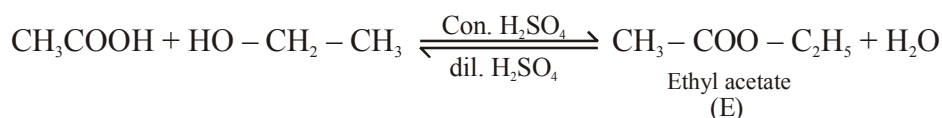
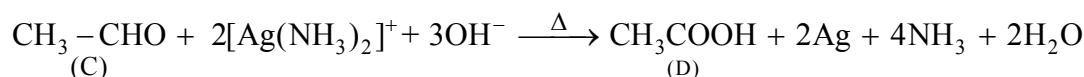
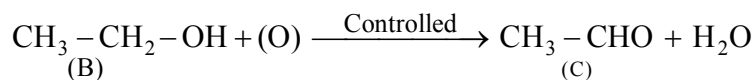
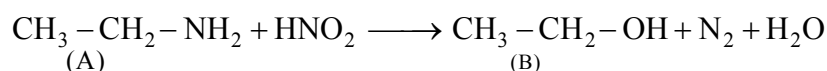
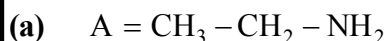
Monomer used :

Phenol :

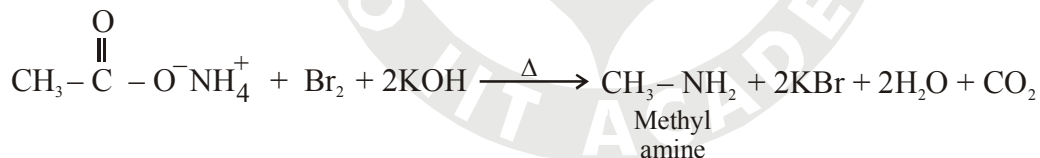
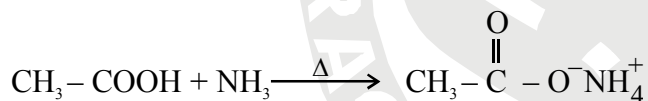
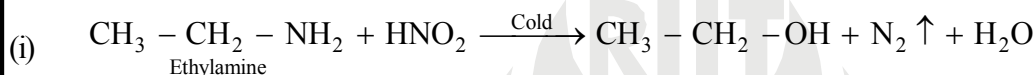


Formaldehyde - HCOOH

Type of Polymerization : Condensation polymerization.

**Question 10:**


(b)

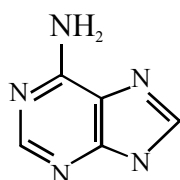


(ii) When globular proteins undergo coagulation or precipitation to give fibrous proteins, due to coagulation the native shape of protein is destroyed and biological activity is lost. That is why coagulated proteins so formed are called denaturated proteins.

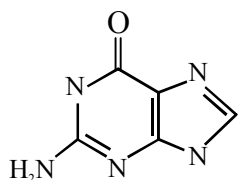
During denaturation, secondary and tertiary structures are destroyed but primary structure remains intact.

(iii)

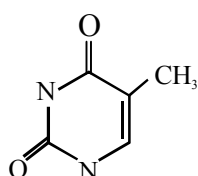
Adenine (A)



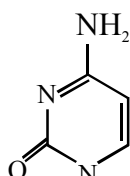
Guanine (G)



Thymine (T)



Cytosine (C)



(c)

