+2 CHEMISTRY MATERIAL & QBANK 2024-25

CLASS 12 VOLUME 1 & II (WITH TEXT BOOK PAGE NUMBER)

8. IONIC EQUILIBRIUM

(Note: Acid – H^+ = Conjugate base; base + H^+=Conjugate acid)

(e.g., Conjugate acid of NH_3 isNH_4^+ while the conjugate base of NH_3 is NH_2^-**)**

TEXT BOOK EVALUATION

II. Answer the following questions:

1. What are Lewis acids and bases? Give two examples for each.

Lewis Acids:

i. Lewis acid is a species that **accepts an electron pair.**

ii. Lewis acid is a positive ion (or) an electron deficient molecule.

iii. **Example,** Fe^{2+}, CO_2, BF_3, SiF_4 etc…

Lewis Bases:

i. Lewis base is a species that **donates an electron pair.**

ii. Lewis base is an anion (or) neutral molecule with atleast one lone pair of electrons.

iii. **Example,** NH_3, F^-, $CH_2{=}CH_2$, CaO etc……

2. Discuss the Lowery – Bronsted concept of acids and bases.

According to their concept,

- An acid is defined as a substance that has a tendency to **donate a proton** to another substance. (a Proton donor)
- Base is a substance that has a tendency to **accept a proton** form other substance. (a proton acceptor)

When **hydrogen chloride** is dissolved in water, HCl behaves as an acid and H_2O is base.

Conjugate acid - base pair

$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

Proton donar (acid) — Proton acceptor (Base) — Proton donar (acid) — Proton acceptor (Base)

Conjugate acid - base pair

Limitations of Lowry – Bronsted theory:

Substances like BF_3, $AlCl_3$ etc., that do not donate protons are known to behave as acids.

3. Identify the conjugate acid base pair for the following reaction in aqueous solution

i) $HS^-(aq) + HF \leftrightarrow F^-(aq) + H_2S(aq)$ **ii) $HPO_4^{2-} + SO_3^{2-} \leftrightarrow PO_4^{3-} + HSO_3^-$**

iii) $NH_4^+ + CO_3^{2-} \leftrightarrow NH_3 + HCO_3^-$

i) **$HS^-(aq) + HF \leftrightarrow F^-(aq) + H_2S(aq)$**

Conjugate acid - base pair

$HS^- + HF \rightleftharpoons F^- + H_2S$

Proton acceptor (base) — Proton donor (acid) — Proton acceptor (Base) — Proton donor (acid)

Conjugate acid - base pair

- HF and F^-, HS^- and H_2S are two conjugate acid – base pairs.
- F^- is the conjugate base of the acid HF (or) HF is the conjugate acid of F^-
- H_2S is the conjugate acid of HS^- (or) HS^- is the conjugate base of H_2S

ii) $HPO_4^{2-} + SO_3^{2-} \leftrightarrow PO_4^{3-} + HSO_3^-$

Conjugate acid - base pair

$HPO_4^{2-} + SO_3^{2-} \rightleftharpoons PO_4^{3-} + HSO_3^-$

Proton donor (acid) — Proton acceptor (Base) — Proton acceptor (Base) — Proton donor (acid)

Conjugate acid - base pair

- HPO_4^{2-} and PO_4^{3-}, SO_3^{2-} and HSO_3^- are two conjugate acid – base pairs.
- PO_4^{3-} is the conjugate base of the acid HPO_4^{2-} (or) HPO_4^{2-} is the conjugate acid of PO_4^{3-}.
- HSO_3^- is the conjugate acid of SO_3^{2-} (or) SO_3^{2-} is the conjugate base of HSO_3^-

iii) $NH_4^+ + CO_3^{2-} \leftrightarrow NH_3 + HCO_3^-$

Conjugate acid - base pair

NH_4^+ + CO_3^{2-} ⇌ NH_3 + HCO_3^-

Proton donor (acid) Proton acceptor (Base) Proton acceptor (Base) Proton donor (acid)

Conjugate acid - base pair

- NH_4^+ and NH_3, CO_3^{2-} and HCO_3^- are two conjugate acid – base pairs.
- HCO_3^- is the conjugate of acid CO_3^{2-} (or) CO_3^{2-} is the conjugate bases of HCO_3^-.
- NH_3 is the conjugate base of NH_4^+ (or) NH_4^+ is the conjugate acid of NH_3.

4. Account for the acidic nature of $HClO_4$. In terms of Bronsted – Lowry theory, identify its conjugate base.

- According to Lowry – Bronsted concept, a strong acid has weak conjugate base and a weak acid has a strong conjugate base.
- $HClO_4$ having the tendency to donate a proton. Hence it is acidic in nature.

Conjugate acid - base pair

$HClO_4$ + H_2O ⇌ H_3O^+ + ClO_4^-

Proton donar (acid) Proton acceptor (Base) Proton donar (acid) Proton acceptor (CBase)

Conjugate acid - base pair

- Thus ClO_4^- will be weakest base and its conjugate acid $HClO_4$ is the strongest acid.
- **ClO_4^- is the conjugate base** of the acid $HClO_4$.

5. When aqueous ammonia is added to $CuSO_4$ solution, the solution turns deep blue due to the formation of tetramminecopper (II) complex, $[Cu(H_2O)_4]_{(aq)}^{2+} + 4NH_{3(aq)} \leftrightarrow [Cu(NH_3)_4]_{(aq)}^{2+}$ among H_2O and NH_3 Which is stronger Lewis base.

Answer:

NH_3 is stronger Lewis base than H_2O.

- Ammonia was added to the aqueous $CuSO_4$ solutions and forms tetrammine Cu(II) Complex.
- Water present in the coordination sphere was replaced by NH_3 and the complex formed.

- Moreover the higher electronegativity of oxygen also responsible for less availability of lone pair of electrons on the oxygen atom.

- $[Cu(H_2O)_6]^{2+}_{(aq)} + 4\,NH_{3(aq)} \rightleftharpoons [Cu(NH_3)_4]^{2+}_{(aq)} + H_2$
- Nitrogen less electronegative than oxygen and donates its lone pair of electrons readily. Hence NH_3 is a stronger Lewis base.
- If a better Lewis base (ligand) is available, a Lewis acid (central metal ion) will react (Ligand exchange reaction)
- In this reaction, H_2O is exchanged with NH_3.
- The Lewis acid Cu^{2+} exchanges the Lewis base H with better Lewis base N-H_3 to form $[Cu(NH_3)_4]^{2+}$
- Hence NH_3 is a stronger Lewis base than H_2O in this reaction.

6. The concentration of hydroxide ion in a water sample is found to be 2.5 ×10^{-6}M. Identify the nature of the solution.

The concentration of OH^- ion in a water sample is found to be 2.5 ×10^{-6}M

$pOH = -\log_{10}[OH^-]$

$pOH = -\log_{10}[2.5 \times 10^{-6}]$

$pOH = -\log_{10}[2.5] - \log_{10}[10^{-6}]$

$= -0.3979 - (-6) = -0.3979 + 6$

$pOH = 5.6$

We know that,

$pH + pOH = 14$

$pH + 5.6 = 14$

$pH = 14 - 5.6$

$pH = 8.4$

pH = 8.4, shows the nature of the solution is basic.

(OR)

$[H_3O^+]\,[OH^-] = 10^{-14}$ **Given:** $[OH^-] = 2.5 \times 10^{-6}$M

$$[H_3O^+] = \frac{10^{-14}}{2.5 \times 10^{-6}} = 0.4 \times 10^{-8}$$

2.5 ×10^{-6}M > 0.4×10^{-8}. $[OH^-] > [H_3O^+]$ Hence the water sample is basic in nature.

7. A lab assistant prepared a solution by adding a calculated quantity of HCl gas 25°C to get a solution with $[H_3O^+] = 4\times10^{-5}$M . Is the solution neutral (or) acidic (or) basic.

$[H_3O^+] = 4\times10^{-5}$M

$pH = -\log_{10}[H_3O^+]$

$pH = -\log_{10}(4\times10^{-5})$

$pH = -\log_{10}(4) - \log_{10}(10^{-5})$

$pH = -0.6020 - (-5) = -0.6020 + 5$

$pH = 4.398$

pH value is lower than 7 . **The solution is Acidic.**

8. Calculate the pH of 0.04 M HNO_3 Solution.

Concentration of $HNO_3 = 0.04M$

$[H_3O^+] = 0.04 \text{ mol dm}^{-3}$

$pH = -\log[H_3O^+]$

$= -\log(0.04)$

$= -\log(4\times10^{-2}) = 2 - \log 4 = 2 - 0.6021$

$pH = 1.3979 = 1.40$

9. Define solubility product.

It is defined as the product of the molar concentration of the constituent ions, each raised to the power of its stoichiometric co-efficient in a balanced equilibrium equation.

$$X_mY_{n\,(s)} \overset{H_2O}{\Longleftrightarrow} m\,X^{n+}\,(aq) + nY^{m-}{}_{(aq)}$$

$$K_{sp} = [X^{n+}]^m\,[Y^{m-}]^n$$

10. **Define ionic product of water. Give its value at room temperature.**

i. The product of concentration of H^+ and OH^- ions in water at a particular temperature is known as ionic product.

ii. The ionic product of water at room temperature (25°C)is,

$K_w = [H^+][OH^-]$

$K_w = [H_3O^+][OH^-]$

$K_w = (1\times10^{-7})\,(1\times10^{-7})$

$K_w = 1\times10^{-14}\text{mol}^2\text{ dm}^{-6}$

11. Explain common ion effect with an example.

When a salt of a weak acid is added to the acid itself, the dissociation of the weak acid is suppressed further.

Example: Addition of sodium acetate to acetic acid solution.

- Acetic acid is a weak acid. It is not completely dissociated in aqueous solution and hence the following equilibrium exists.

$$CH_3COOH_{(aq)} \rightleftharpoons H^+_{(aq)} + CH_3COO^-_{(aq)}$$

- However, the added salt, sodium acetate, completely dissociated in aqueous solution and hence the following equilibrium exits.

$CH_3COONa_{(aq)} \rightleftharpoons Na^+_{(aq)} + CH_3COO^-_{(aq)}$

- Hence, the overall concentration of CH_3COO^- is increased, and the acid dissociation equilibrium is disturbed.
- Le chatelier's principle that when a stress is applied to a system at equilibrium, the system adjusts itself to nullify the effect produced by that stress.
- So, in order to maintain the equilibrium, the excess CH_3COO^- ions combines with H^+ ions to produce much more unionized CH_3COOH i.e., the equilibrium will shift towards the left.
- In other words, the dissociation of CH_3COOH is suppressed. Thus, ***the dissociation of a weak acid (CH_3COOH) is suppressed in the presence of a salt (CH_3COONa) containing an ion common to the weak electrolyte. It is called the common ion effect.***

12. Derive an expression for Ostwald's dilution law

Law: ***It relates the dissociation constant of the weak acid (K_a) with its degree of dissociation (α) and the concentration (C).***

"when dilution increases, the degree of dissociation of weak electrolyte also increases".

Degree of dissociation (α) is the fraction of the total number of moles of a substance that dissociates at equilibrium.

$$\alpha = \frac{number\ of\ moles\ dissociated}{total\ number\ of\ moles}$$

Considering a weak acid, acetic acid. The dissociation of acetic acid can be represented as,

$$CH_3COOH \rightleftharpoons H^+ + CH_3COO^-$$

The dissociation constant of acetic acid is ,

$$K_a = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]}$$

	CH_3COOH	H^+	CH_3COO^-

Initial number of moles	1	–	–
Degree of dissociation of CH_3COOH	α	–	–
Number of moles at equilibrium	1−α	α	α
Equilibrium concentration	(1−α)C	α C	α C

Substituting the equilibrium concentration in equation

$$K_a = \frac{(\alpha C)(\alpha C)}{(1-\alpha)C} \Rightarrow K_a = \frac{\alpha^2 C^2}{(1-\alpha)C}$$

$$K_a = \frac{\alpha^2 C}{(1-\alpha)C} \quad \text{---------- (1)}$$

We know that weak acid dissociation only to very small extent compared to one, α is so small.

i.e., equation (1) becomes,

$$K_a = \alpha^2 C$$

$$\alpha^2 = \frac{K_a}{C} \Rightarrow \alpha = \sqrt{\frac{K_a}{C}} \quad \text{---------- (2)}$$

Similarly, for a weak base,

$$K_b = = \alpha^2 C$$

$$\alpha^2 = \frac{K_b}{C} \Rightarrow \alpha = \sqrt{\frac{K_b}{C}} \quad \text{---------- (3)}$$

The concentration of H^+ can be calculated using the Ka value as below,

$$[H^+] = \alpha C$$

$$\alpha = \frac{[H^+]}{C}$$

Substituting α value in equation (2),

$$\frac{[H^+]}{C} = \sqrt{\frac{K_a}{C}} \Rightarrow [H^+] = \sqrt{\frac{K_a}{C}} . C$$

$$[H^+] = \sqrt{\frac{K_a . C^2}{C}} \Rightarrow [H^+] = \sqrt{K_a C}$$

For weak base,

$$[OH^-] = \sqrt{K_b C}$$

13. Define pH.

pH of a solution is defined as the negative logarithm of base 10 of the molar concentration of the hydronium ions present in the solution.

$$pH = -\log_{10}[H_3O^+] \quad \text{(or)} \quad pH = -\log_{10}[H^+]$$

14. Calculate the pH of 1.5×10^{-3}M solution of $Ba(OH)_2$

$Ba(OH)_2 \rightarrow Ba^{2+} + 2OH^-$

1.5×10^{-3}M $\quad 2 \times 1.5\times10^{-3}$M

$[OH^-]$ = Acidity x molarity

$[OH^-] = 3\times10^{-3}$M

[pH + pOH = 14]

pH = 14 – pOH

pH = 14 – $(-\log[OH^-])$

pH = 14 + $\log[OH^-]$

pH = 14 + $\log(3 \times 10^{-3})$

pH = 14 + log3 + log 10^{-3}

pH = 14 + 0.4771 – 3

pH = 11 + 0.4771

pH = 11.48

15. 50ml of 0.05M HNO_3 is added to 50ml of 0.025M KOH . Calculate the pH of the resultant solution.

Number of moles of $HNO_3 = 0.05 \times 50 \times 10^{-3} = 2.5 \times 10^{-3}$

Number of moles of KOH $= 0.025 \times 50 \times 10^{-3} = 1.25 \times 10^{-3}$

Number of moles of HNO_3 after mixing $= (2.5 \times 10^{-3}) - (1.5 \times 10^{-3}) = 1.25 \times 10^{-3}$

Concentration of $HNO_3 = \frac{Number\ of\ moles\ of\ HNO_3}{Volume\ in\ litre}$

After mixing, total volume = 100 ml = 100×10^{-3}L

$[H^+] = \frac{1.25\times10^{-3} moles}{100\times10^{-3} L} = 1.25 \times 10^{-2}$ moles L^{-1}

pH = – $\log[H^+]$

pH = $-\log(1.25 \times 10^{-2}) = 2 - 0.0969$

pH = 1.9031

16. The K_a value for HCN is 10^{-9} . What is the pH of 0.4M HCN solution?

$K_a = 10^{-9}$ $\quad$ c = 0.4M

pH = – $\log[H^+]$

$[H^+] = \sqrt{K_a \times c}$

$[H^+] = \sqrt{10^{-9} \times 0.4}$

$[H^+] = 2 \times 10^{-5}$

$pH = -\log(2 \times 10^{-5})$

$pH = -\log 2 - \log(10^{-5}) = -0.3010 + 5$

$pH = 4.699$

17. Calculate the extent of hydrolysis and the pH of 0.1 M ammonium acetate Given that $K_a = K_b = 1.8 \times 10^{-5}$

$$h = \sqrt{K_h} = \sqrt{\frac{K_w}{K_a K_b}} = \sqrt{\frac{1 \times 10^{-14}}{1.8 \times 10^{-5} \times 1.8 \times 10^{-5}}} = \sqrt{\frac{1}{1.8} \times 10^{-14}} = \sqrt{0.5555 \times 10^{-14}}$$

$= 0.7453 \times 10^{-2}$

$pH = \frac{1}{2} pK_w + \frac{1}{2} pK_a - \frac{1}{2} pK_b$

Given that $K_a = K_b = 1.8 \times 10^{-5}$

If $K_a = K_b$, then, $pK_a = pK_b$

$pH = \frac{1}{2} pK_w = \frac{1}{2}(14) = 7$

(OR)

$K_a = K_b = 1.8 \times 10^{-5}$

Ammonium acetate => Salt of weak acid and weak base

$pH = 7 + \frac{1}{2} pK_a - \frac{1}{2} pK_b$ Data: $K_a = K_b = 1.8 \times 10^{-5}$

$pH = 7$ $pK_a = pK_b$

18. Derive an expression for the hydrolysis constant and degree of hydrolysis of salt of strong acid and weak base

Let us consider the reactions between a strong acid, HCl, and a weak base, NH_4OH, to produce a salt, NH_4Cl, and water

$HCl_{(aq)} + NH_4Cl_{(aq)} \rightleftharpoons NH_4Cl_{(aq)} + H_2O_{(l)}$

$NH_4Cl_{(aq)} \rightarrow NH_4^+ + Cl^-_{(aq)}$

NH_4^+ is a strong conjugate acid of the weak base NH_4OH and it has a tendency to react with OH^- from water to produce unionized NH_4OH shown below.

$NH_4^+{}_{(aq)} + H_2O_{(l)} \rightleftharpoons NH_4OH_{(aq)} + H^+_{(aq)}$

There is no such tendency shown by Cl^- and therefore $[H^+] > [OH^-]$; the solution is acidic and the pH is less than 7.

As discussed in the salt hydrolysis of strong base and weak acid. In this case also, we can establish a relationship between the K_h and k_b as

$K_h.K_b = K_w$

Let us calculate the K_h value in terms of degree of hydrolysis (h) and the concentration of salt

$K_h = h^2C$ and $[H^+] = \sqrt{K_h.C} = \sqrt{\frac{K_w}{K_b}.C}$

$pH = -\log[H^+] = -\log\left(\frac{K_w}{K_b}.C\right)^{\frac{1}{2}}$

$= -\frac{1}{2}\log K_w - \frac{1}{2}\log C + \frac{1}{2}\log K_b$

$pH = 7 - \frac{1}{2} pK_b - \frac{1}{2}\log C$

19. Solubility product of Ag_2CrO_4 is 1×10^{-12}. What is the solubility of Ag_2CrO_4 in 0.01M $AgNO_3$ solution?

$Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + CrO_4^{2-}{}_{(aq)}$

(s) 2(s) (s)

$K_{sp} = \frac{[Ag^+]^2[CrO_4^{2-}]}{[Ag_2CrO_4]}$ Data: $K_{sp} = 1\times10^{-12}$; $[Ag^+]^2 = 2s$; $[CrO_4^{2-}] = s$

$K_{sp} = \frac{[2s]^2[s]}{[1]}$ $[Ag_2CrO_4] = 1$

$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$ ---------- (1)

The solubility of Ag_2CrO_4 in 0.01M $AgNO_3$ solution

$AgNO_{3(s)} \rightleftharpoons Ag^+_{(aq)} + NO_3^-{}_{(aq)}$

0.01M 0.01M 0.01M

$[Ag^+] = (2s + 0.01) \Rightarrow (2s << 0.01)$

$[Ag^+] = 0.01$ & $[CrO_4^{2-}] = s$

Substitute the above value in eq (1)

$[Ag^+]^2 [CrO_4^{2-}] = K_{sp}$

$(0.01)^2 \times s = 1\times10^{-12}$

$S = \frac{1\times10^{-12}}{(0.01)^2} = \frac{1\times10^{-12}}{1\times10^{-4}}$

$S = 1 \times 10^{-8}M$

20. Write the expression for the solubility product of $Ca_3(PO_4)_2$

$Ca_3(PO_4)_2 \rightleftharpoons 3Ca^{2+} + 2PO_4^{3-}$

(s) 3(s) 2(s)

$K_{sp} = [Ca^{2+}]^3 [PO_4^{3-}]^2$

$K_{sp} = [3s]^3 [2s]^2$

$K_{sp} = 27s^3.4s^2$

$K_{sp} = 108s^2$

21. A saturated solution, prepared by dissolving CaF_2 (s) in water, has $[Ca^{2+}] = 3.3 \times 10^{-4}$ M What is the K_{sp} of CaF_2 ?

$CaF_2(s) \rightleftharpoons Ca^{2+}{}_{(aq)} + 2F^-{}_{(aq)}$

(s) (s) 2(s)

$K_{sp} = [Ca^{2+}][F^-]^2$ Data: $[Ca^{2+}] = 3.3 \times 10^{-4}$ M

$[F^-] = 2\,[Ca^{2+}] = (2 \times 3.3 \times 10^{-4}) = 6.6 \times 10^{-4}$

$K_{sp} = 3.3 \times 10^{-4} \times (6.6 \times 10^{-4})^2$

$K_{sp} = 1.437 \times 10^{-10}$

22. K_{sp} of AgCl is 1.8×10^{-10} . Calculate molar solubility in 1 M $AgNO_3$

$AgCl(s) \rightleftharpoons Ag^+{}_{(aq)} + Cl^-{}_{(aq)}$

(s) (s) (s)

$K_{sp} = \frac{[Ag^+]^2[Cl^-]}{[AgCl]}$ Data: $K_{sp} = 1.8 \times 10^{-10}$; $[Ag^+] = s$; $[Cl^-] = s$

$K_{sp} = \frac{[s][s]}{[1]}$ $[AgCl] = 1$

$K_{sp} = [Ag^+][Cl^-]$ -------- (1)

The solubility of AgCl in 1M $AgNO_3$ solution

$AgNO_{3(s)} \rightleftharpoons Ag^+{}_{(aq)} + NO_3{}^-{}_{(aq)}$

1M 1M 1M

$[Ag^+] = (s + 1) \Rightarrow (s << 1)$

$[Ag^+] = 1$ & $[Cl^-] = s$

Substitute the above value in eq (1)

$[Ag^+]\,[Cl^-] = K_{sp}$

$(1)^2 \times s = 1.8 \times 10^{-10}$

$S = 1.8 \times 10^{-10}$M

23. A particular saturated solution of silver chromate Ag_2CrO_4 has $[Ag^+] = 5 \times 10^{-5}$ and $[CrO_4]^{2-} = 4.4 \times 10^{-4}$ M. What is the value of K_{sp} for Ag_2CrO_4?

$Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + CrO_4^{2-}{}_{(aq)}$

$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$ Data: $[Ag^+] = 5 \times 10^{-5}$M ; $[CrO_4^{2-}] = 4.4 \times 10^{-4}$ M;

$K_{sp} = (5 \times 10^{-5})^2 \times (4.4 \times 10^{-4})$ K_{sp} = ?

$K_{sp} = 1.1 \times 10^{-12}$

24. Write the expression for the solubility product of Hg_2Cl_2 .

$Hg_2Cl_2 \rightleftharpoons Hg_2^{2+} + 2Cl^-$

s s 2s

$K_{sp} = [Hg_2^{2+}][Cl^-]^2$

$K_{sp} = (s)\,(2s)^2$

$K_{sp} = 4s^3$

25. K_{sp} of Ag_2CrO_4 is 1.1×10^{-12}. What is solubility of Ag_2CrO_4 in 0.1M K_2CrO_4.

$Ag_2CrO_{4(s)} \rightleftharpoons 2Ag^+_{(aq)} + CrO_4^{2-}{}_{(aq)}$

(s) 2(s) (s)

$K_{sp} = \frac{[Ag^+]^2[CrO_4^{2-}]}{[Ag_2CrO_4]}$ Data: $K_{sp} = 1.1 \times 10^{-12}$; $[Ag^+]^2 = 2s$; $[CrO_4^{2-}] = s$

$K_{sp} = \frac{[2s]^2[s]}{[1]}$ $[Ag_2CrO_4] = 1$

$K_{sp} = [Ag^+]^2[CrO_4^{2-}]$ ---------- (1)

The solubility of Ag_2CrO_4 in 0.1M K_2CrO_4 solution

$K_2CrO_{4(s)} \rightleftharpoons 2K^+_{(aq)} + CrO_4^{2-}{}_{(aq)}$

0.1M 2×0.1M 0.1M

$[CrO_4^{2-}] = (s + 0.1) \Rightarrow (s << 0.1)$

$[CrO_4^{2-}] = 0.1$ & $[Ag^+]^2 = 2s$

Substitute the above value in eq (1)

$[Ag^+]^2\,[CrO_4^{2-}] = K_{sp}$

$(2s)^2 \times (0.1) = 1 \times 10^{-12}$

$$4s^2 = \frac{1\times10^{-12}}{(0.1)} = 1.1\times10^{-11}$$

$$s^2 = \frac{1\times10^{-11}}{4}$$

$$s = \sqrt{\frac{1.1\times10^{-11}}{4}} = \sqrt{2.75\times10^{-12}}$$

$s = 1.65 \times 10^{-6}$M

26. Will a precipitate be formed when 0.150 L of 0.1M $Pb(NO_3)_2$ and 0.100L of 0.2 M NaCl are mixed? K_{sp} ($PbCl_2$) =1.2 ×10 $^{-5}$.

$Pb(NO_3)_{2\,(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2NO_3^{-}{}_{(aq)}$

0.1M 0.1M 0.1M

Number of moles of Pb^{2+} ions = Molarity of the solution × Volume (in litre)

$= 0.1 \times 0.150 = 0.015$

Total volume = 0.150L + 0.100L = 0.250L

$$[Pb^{2+}] = \frac{[No.of\ moles\ of\ Pb^{2+}ions]}{[Total\ volume]} = \frac{0.015}{0.250}$$

$[Pb^{2+}] = 0.06$M

$NaCl_{\,(s)} \rightleftharpoons Na^{+}_{(aq)} + Cl^{-}_{(aq)}$

0.2M 0.2M 0.2M

No. of moles of Cl^- ions = Molarity of the solution × Volume (in litre)

$= 0.2 \times 0.1 = 0.02$

Total volume = 0.150L + 0.100L = 0.250L

$$[Cl^-] = \frac{[No.of\ moles\ of\ Cl^-ions]}{[Total\ volume]} = \frac{0.02}{0.250}$$

$[Cl^-] = 0.08$M

$PbCl_2$ is precipitated because

$PbCl_{2(s)} \rightleftharpoons Pb^{2+}_{(aq)} + 2Cl^{-}_{(aq)}$

$[Pb^{2+}][Cl^-]^2 = 0.06 \times (0.08)^2$

$[Pb^{2+}][Cl^-]^2 = 3.84 \times 10^{-4}$

$[Pb^{2+}][Cl^-]^2 > K_{sp}\ (PbCl_2) = 1.2 \times 10^{-5}$

Since ionic product of $[Pb^{2+}][Cl^-]^2 > K_{sp}\ (PbCl_2)$, $PbCl_2$ is precipitated

27. Ksp of $Al(OH)_3$ is 1×10^{-15}M. At what pH does 1.0×10^{-3}M Al^{3+}precipitate on the addition of buffer of NH_4Cl and NH_4OH solution?

$Al(OH)_{3(s)} \rightleftharpoons Al^{3+}_{(aq)} + 3OH^-_{(aq)}$

$K_{sp} = [Al^{3+}]\,[OH^-]^3$ Data: $K_{sp} = 1\times 10^{-15}M$; $[Al^{3+}] = 1.0 \times 10^{-3}M$ &$[OH^-] = ?$

$$[OH^-]\,\frac{K_{sp}}{[Al^{3+}]} = \frac{1\times 10^{-15}}{1.0\times 10^{-3}} = 10^{-12}$$

$[OH^-] = 10^{-4}$

$pOH = -\log [OH^-]$

$pOH = -\log 10^{-4}$

$pOH = 4$

$pH = 14 - pOH = 14 - 4 = 10$

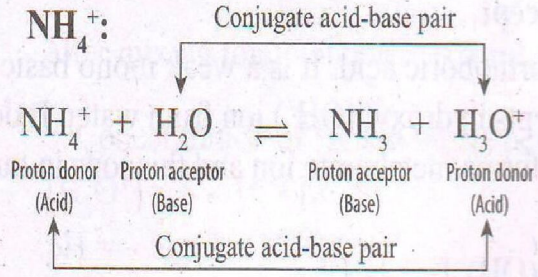
$pH = 10$

$Al(OH)_3$ is precipitates at a pH of 10

2. Write a balanced equation for the dissociation of the following in water and identify the conjugate acid –base pairs.

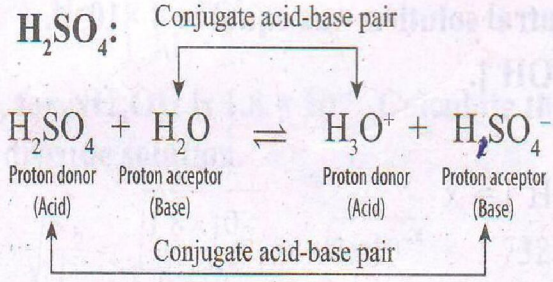
(*i*) NH_4^+ (*ii*) H_2SO_4 (*iii*) CH_3COOH.

(*i*) NH_4^+:



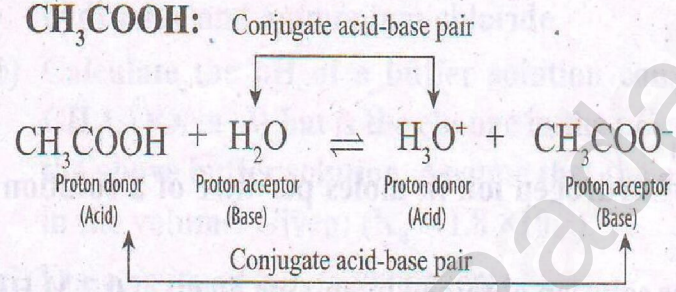
NH_4^+ and NH_3, H_2O and H_3O^+ are two conjugate acid-base pairs.

(*ii*) H_2SO_4:



H_2SO_4 and HSO_4^-, H_2O and H_3O^+ are two conjugate acid-base pairs.

(*iii*) CH_3COOH:

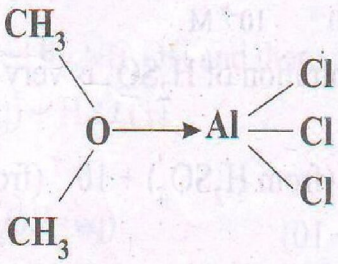


CH_3COOH and CH_3COO^-, H_2O and H_3O^+ are two conjugate acid-base pairs.

3. Identify the Lewis acid and the Lewis base in the following reactions.

(*i*) $CaO + CO_2 \rightarrow CaCO_3$

(*ii*) $CH_3 - O - CH_3 + AlCl_3 \longrightarrow$



⇒ CH_3OCH_3 ⇒ Lewis Base (Electron rich species)

$AlCl_3$: Lewis acid (Electron deficient molecules)

(*i*) $CaO + CO_2 \rightarrow CaCO_3$

(*a*) CaO - Lewis base ; All metals oxides are Lewis bases

(*b*) CO_2 - Lewis acid ; CO_2 contains a polar double bond.

1. Mention the Arrhenius concept of acid and base (2)
2. What are the limitations of Arrhenius concepts? (3) **M22 2M**
3. Classify acid or base using Arrhenius concept. HNO_3, CH_3COOH, $Ba(OH)_2$, H_3PO_4(3)
4. Define Lowery - Bronsted concept of acids and bases (3)
5. 0.1 M Solution of HF is weak acid. But 5M solute ion of HF is stronger acid. Why? **PTA3M**
6. What are conjugate acid – base pairs? Give example. (3) **PTA5M ii M23 2M**
7. Write a balanced equation for the dissociation of the following in water and identify the conjugate acid-base pairs. i)NH_4^+ ii)H_2SO_4 iii) CH_3COOH iv)HCl v) HF (4)
8. Classify the following into Lewis acids and Lewis bases. (5) **S20 5Mi**

   A)BF_3 (B) CO_2 (C) MgO (D) CH_3^-
9. What are Lewis acids and bases? Give two example (4) **M20 2M, J22 2M, J24 3M**
10. Difference between Lewis acids and Lewis base. (5)
11. Identify the Lewis acid and the Lewis base in the following reactions. (5)

    $Cr^{3+} + 6H_2O \rightarrow [Cr(H_2O)_6]^{3+}$
12. Identify the Lewis acid and Lewis base in the following reactions.(5)

    i) $CaO + CO_2 \rightarrow CaCO_3$ ii) $CH_3\text{-}O\text{-}CH_3 + AlCl_3 \rightarrow (CH_3)_2O \rightarrow AlCl_3$
13. H_3BO_3 accepts hydroxide ion from water as shown below. (6)

    $H_3BO_{3(aq)} + H_2O \rightleftharpoons B(OH)_4^- + H^+$

    Predict the nature of H_3BO_3 using Lewis concept.
14. Identify the conjugate Acid Base pair for the following reactions in aqueous solution.(30)BB **J20 5Mii**

    (A) $HS^-_{(aq)} + HF \rightleftharpoons F^-_{(aq)} + H_2S_{(aq)}$

    B) $HPO_4^{2-} + SO_3^{2-} \rightleftharpoons PO_4^{3-} + HSO_3^-$
15. How will you measure the strength of an acid? (6)
16. Define ionic product of water. Give its value at room temperature (7) **S20, PTA 3MARK**
17. Calculate the concentration of OH^- in a fruit juice which contains 2 x 10^{-3}M, H_3O^+ ion. Identify the nature of the solution. (8) **J23 2M COMPULSORY**
18. Derive the relationship between pH and pOH. (9,10)**PTA 5M i**
19. Define pH (9) **M22 5Mi, J24 2M**
20. Write the pH value of the following substances: **M20 5Mi**

A) Vinegar B) Black coffee C) Baking Soda D) Soapy Water

21. Calculate the pH of 10^{-7} M HCl.(11) **PTA3M**

22. State Oswald's dilution law. Derive an expression Ostwald's dilution law. (12) **J20 3MARK, PTA 3MARK, M23 5M.**

23. A solution of 0.10M of a weak electrolyte is found to be dissociated to the extent of 1.20% at 25°C. Find the dissociation constant of the acid.(14)

24. Calculate the pH of 0.1M CH_3COOHsolution. Dissociation constant of acetic acid is 1.8×10^{-5} . (15)

25. Define common Ion effect with an example (15)**J20 2M, PTA 2M, M22 5M ii, M24 2M**

26. What are buffer solutions? Give an example (16) **J22 3M**

27. What are the two types of buffer solution? Give example for each type.(16) **PTA5M ii**

28. Explain the buffer action of a solution (16) **J20 2MARK**

29. Explain buffer action of acidic buffer. (16) **PTA 3M**

30. Define Buffer capacity and buffer index. (18) **M24 5Mi (buffer index)**

31. Derive Henderson-Hasselbalch equation(Derive Henderson equation) (18) **M20,GM 3M**

32. Find the pH of a buffer solution containing 0.20 mole per litre sodium acetate and 0.18 mole per litre acetic acid. Ka for acetic acid 1.8×10^{-5}. (19) **A21 3MARK**

33. Calculate the pH of 0.1M CH_3COONa solution (pKa for CH_3COOH is 4.74)(20) **S20 2MARK**

34. Derive expression for hydrolysis constant and pH of salt of weak acid and strong base. (21)**5M**

35. Derive expression for hydrolysis constant and pH of salt of strong acid and weak base. (22)

36. Define solubility product (25)

37. Give a condition for a compound to be precipitated (25)

38. How will you calculate solubility product from molar solubility? (26) **PTA 5M ii**

39. Write the expression for the solubility product of $Ca_3(PO_4)_2$, $BaSO_4$. (26)

40. Define solubility product of a compound.(25) **2M**

41. The K_a value of HCN is 10^{-9}. What is the pH of 0.4M HCN solution? (31) **PTA5M**

42. 50ml of 0.05M HNO_3 is added to 50ml of 0.025M KOH. Calculate the pH of the resultant solution. ($BBQ_{15}31$)**GM2MC**

43. K_{SP} of Ag_2CrO_4 is $1.1x10^{-12}$. What is the solubility of Ag_2CrO_4 in 0.1M K_2CrO_4? ($BBQ_{25}31$)

GM5Mii

ALL INSIDE PROBLEM & Revise Book Back (Evaluation) Question Answer

9. ELELCTROCHEMISTRY

TEXTBOOK EVALUATION

Short Answer

1. Define anode and cathode

Anode:

- The electrode at which the ***oxidation*** occurs is called anode.
- It sends electrons into the outer circuit.
- It has a negative charge and in shown as (-) in cell diagram.

Cathode:

- The electrode at which the ***reduction*** occurs is called cathode.
- The electrode at which electrons are received from the outer circuit.
- It has a positive charge and is shown as (+) in cell diagram.

2. Why does conductivity of a solution decrease on dilution of the solution?

- ***The conductivity of solution is directly proportional to the number of ions present in unit volume of the solution.***
- On dilution, the ion concentration decreases per unit volume and hence conductivity decreases.

3. State Kohlrausch's Law. How is it useful to determine the molar conductivity of weak electrolyte at infinite dilution?

Kohlrausch's law:

At infinite dilution, the limiting molar conductivity of an electrolyte is equal to the some of the limiting molar conductivities of its constituent ions.

Calculation of molar conductance at infinite dilution of a weak electrolyte:

It is impossible to determine the molar conductance at infinite dilution for weak electrolytes experimentally. However, the same can be calculated using Kohlraush's Law.

For example, the molar conductance of CH_3COOH, can be calculated using the experimentally determined molar conductivities of strong electrolytes HCl, NaCl and CH_3COONa.

$$\Lambda^\circ_{CH_3COONa} = \lambda^\circ_{Na^+} + \lambda^\circ_{CH_3COO^-} \quad \ldots\ldots\ldots\ldots(1)$$

$$\Lambda^\circ_{HCl} = \lambda^\circ_{H^+} + \lambda^\circ_{Cl^-} \quad \ldots\ldots\ldots\ldots(2)$$

$$\Lambda^\circ_{NaCl} = \lambda^\circ_{Na^+} + \lambda^\circ_{Cl^-} \quad ----------(3)$$

Equation (1) + Equation (2) – Equation (3) gives

$$\left(\Lambda^\circ_{CH_3COONa}\right) + \left(\Lambda^\circ_{HCl}\right) - \left(\Lambda^\circ_{NaCl}\right) = \lambda^\circ_{H^+} + \lambda^\circ_{CH_3COO^-}$$

$$= \Lambda^\circ_{CH_3COOH}$$

4. **Describe the electrolysis of molten NaCl using inert electrodes**.

- Electrolysis is a process in which the electrical energy is used to cause a ***non-spontaneous*** chemical reaction to occur; the energy is often used to decompose a compound into elements.
- The device which is used to carry out the electrolysis is called the electrolytic cell.
- The electrochemical process occurring in the electrolytic cell and galvanic cell are the reverse of each other.
- The electrolytic cell consists of two electrodes one is **cylindrical steel cathode** and another one is **graphite anode**. They are dipped in molten sodium chloride.
- They are connected to an external DC power supply via a key.
- The electrode which is attached to the negative end of the power supply is called the cathode, and the one which attached to the positive end is called the anode.
- Once the key is closed, the external DC power supply drives the electrons to the cathode and at the same time pull the electrons from the anode.

Cell reactions:

Na^+ ions are attached towards cathode, where they combine with the electrons and reduced to liquid sodium.

Cathode(-) (reduction)

$$Na^+_{(l)} + e^- \rightarrow Na_{(l)} \qquad E^o = -2.71\ V$$

Similarly, Cl^- ions are attracted towards anode where they losses their electrons and oxidised to chlorine gas.

Anode (+) (oxidation)

$$2Cl^-_{(l)} \rightarrow Cl_{2(g)} + 2e^- \qquad E^\circ = -1.36V$$

The **overall reaction** is,

$$2Na^+_{(l)} + 2Cl^-_{(l)} \rightarrow 2Na_{(l)} + Cl_{2(g)} \qquad E^\circ = -\ 4.07V$$

The ***negative E° value*** shows that the above reaction is a ***non-spontaneous one***.

Hence, we have to supply a voltage greater than 4.07V to cause the electrolysis of molten NaCl.

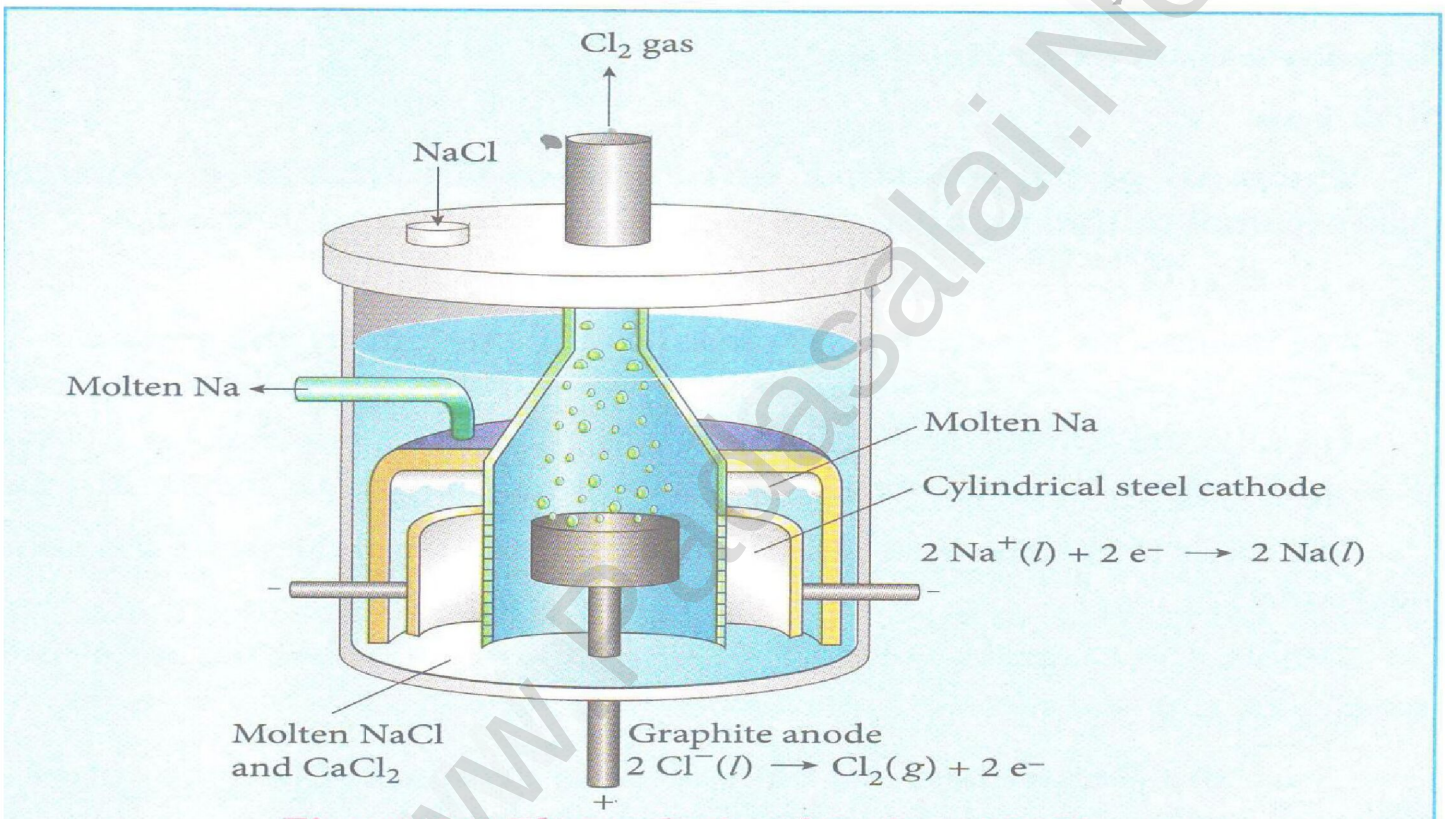


Figure 9.8 Electrolysis of molten NaCl

5. State Faraday's Laws of electrolysis

First law:

The mass of the substance (m) liberated at an electrode during electrolysis is directly proportional to the quantity of change (Q) passed through the cell.

$$m \propto Q$$

$$m \propto It \ \text{(or)} \ m = Z\,It$$

Where is Z is known as the electro chemical equivalent of the substance produced of the electrode.

Second Law:

When the same quantity of charge is passed through the solutions of different electrolytes, the amount of substances liberated at the respective electrodes is directly proportional to their electrochemical equivalents.

When Q coulomb charge is passed through the electrolytic cells the masses of silver, zinc and copper deposited at the respective electrodes be m_{Ag}, m_{Zn} and m_{Cu}, respectively. According to Faraday's second Law,

$m_{Ag} \alpha Z_{Ag}$, m_{Zn} and $m_{Cu} \alpha Z_{Cu}$ (or) $\frac{m_{Ag}}{Z_{Ag}} = \frac{m_{Zn}}{Z_{Zn}} \frac{m_{Cu}}{Z_{Cu}}$

6. Describe the construction of Daniel cell. Write the cell reaction.

Construction of Daniel Cell:

The separation of half reaction is the basis for the construction of Daniel cell. It consists of two half cells.

Oxidation half cell

A metallic zinc strip that dips into an aqueous solution of zinc sulphate taken in a beaker,

Reduction half cell

A copper strip that dips into an aqueous solution of copper sulphate taken in a beaker

Joining the half cells

The zinc and copper strips are externally connected using a wire through a switch (k) and a load (example: volt meter). The electrolytic solution present in the cathodic and anodic compartment are connected using an inverted U tube containing a agar-agar gel mixed with an inert electrolyte such as KCl, Na_2SO_4 etc.,

Cell Reaction;

Anodic oxidation: The electrode at which the oxidation occur is called the anode.

Electrons are liberated at zinc electrode and hence it is negative (- ve).

$Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^-$ (loss of electron-oxidation)

Cathodic reduction

The electrons flow through the circuit from zinc to copper, where the Cu^{2+} ions in the solution accept the electrons, get reduced to copper amd the same get deposited on the electrode. Here, the electrons are consumed and hence it is positive (+ve).

$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$ (gain of electron-reduction)

Salt bridge

The electrolytes present in two half cells are connected using a salt bridge.

To maintain the electrical neutrality in both the compartments, the non-reactive anions Cl^- (from KCl taken in the salt bridge) move from the salt bridge and enter into the anodic compartment, at the same time some of the K^+ ions move from the salt bridge into the cathodic compartment.

7. Why is anode in galvanic cell considered to be negative and cathode positive electrode?

Anodic oxidation: The electrode at which the ***oxidation*** occur is called the anode. In Daniel cell, the oxidation take place at zinc electrode, i.e., zinc is oxidised to Zn^{2+} ions and the electrons. The Zn^{2+} ions enters the solution and the electrons enter the zinc metal, then flow through the external

wire and then enter the copper strip. Electrons are liberated at zinc electrode and hence it is negative (- ve).

$$\mathbf{Zn_{(s)} \rightarrow Zn^{2+}_{(aq)} + 2e^- \text{ (loss of electron-oxidation)}}$$

Cathodic reduction

The electrons flow through the circuit from zinc to copper, where the Cu^{2+} ions in the solution accept the electrons, get reduced to copper amd the same get deposited on the electrode. Here, the electrons are consumed and hence it is positive (+ve).

$$\mathbf{Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)} \text{ (gain of electron-reduction)}}$$

8. The conductivity of a 0.01M solution of a 1 :1 weak electrolyte at 298K is 1.5×10^{-4} S cm^{-1}.

i) molar conductivity of the solution

ii) degree of dissociation and the dissociation constant of the weak electrolyte

Given that $\lambda^\circ_{cation} = 248.2$ S cm^2 mol^{-1} $\lambda^\circ_{anion} = 51.8$ S cm^2 mol^{-1}

Given:

C = 0.01M $\lambda^\circ_{cation} = 248.2$ S cm^2 mol^{-1}

K = 1.5×10^{-4} S cm^{-1} $= 51.8$ S cm^2 mol^{-1}

i) molar conductivity of the solution

$$\Lambda^\circ_m = \frac{^\circ(sm^{-1}) \times 10^{-3}}{C(in\ M)}\ mol^{-1}\ m^3$$

$^\circ = 1.5 \times 10^{-4}$ S cm^{-1}

$= \frac{1.5 \times 10^2 \times 10^{-3}}{0.01}$ S mol^{-1} m^2

1cm^{-1} = 10^2 m^{-1}

= 1.5 × 10^{-3} S m^2 mol^{-1}

= 1.5 × 10^2

ii) degree of dissociation $\alpha = \frac{\Lambda^{o}}{\Lambda^{\circ}_{\infty}}$

$\Lambda^{\circ}_{\infty} = \lambda^{\circ}_{cation} + \lambda^{\circ}_{anion}$

= (248.9 + 51.8) S cm^2 mol^{-1}

= 300 S cm^2 mol^{-1}

= 300 × 10^{-14} S m^2 mol^{-1}

$\alpha = \frac{1.5 \times 10^{-3}\ Sm^2mol^{-1}}{300 \times 10^{-4} Sm^2mol^{-1}}$

α = 0.05.

9. Which of 0.1M HCl and 0.1 M KCl do you expect to have greater Λ^{o}_{m} and why?

- The Concentration of HCl and KCl are same but molar conductivity of HCl is higher.
- Since smaller the cation higher the molar conductivity.
- H^+ ions are smaller when compared to K^+ ions.
- 0.1 M HCl will have greater molar conductivity (Λ_m).

10. Arrange the following solutions in the decreasing order of specific conductance.

i) 0.01M KCl ii) 0.005M KCl iii) 0.1M KCl iv) 0.25 M KCl v) 0.5 M KCl

- Specific conductivity decreases with decreases in concentration of the solution.
- So the decreasing order of specific conductance is

0.5 M KCl > 0.25 M KCl > 0.1M KCl > 0.01M KCl > 0.005M KCl

11. Why is AC current used instead of DC in measuring the electrolytic conductance?

- When DC current through the conductivity cell, it will lead to the electrolysis of the solution taken in the cell.
- So, AC current is used for this measurement to **prevent electrolysis.**

12. 0.1M NaCl solution is placed in two different cells having cell constant 0.5 and 0.25cm^{-1} respectively. Which of the two will have greater value of specific conductance?

Specific conductance $\frac{1}{\rho}$ *is directly proportional to cell constant* $\frac{l}{A}$

The cell with higher cell constant has greater value of specific conductance.

i.e., The cell with **0.5 cm^{-1}** cell constant will have greater value of specific conductance.

13. A current of 1.608A is passed through 250 mL of 0.5M solution of copper sulphate for 50 minutes. Calculate the strength of Cu^{2+} after electrolysis assuming volume to be constant and the current efficiency is 100%.

Given:

I = 1.608; t = 50min = 50 × 60 = 3000S V = 500mL C = 0.5M η = 100%

Calculate the number of faradays of electricity passed through the $CuSO_4$ solution

⇒ Q = It

Q = 1.608 × 3000

Q = 4824C

Number of Faradays of electicity = $\frac{4824C}{96500\ C}$ = 0.5 F

Electrilysis of $CuSO_4$

$Cu^{2+}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$

The above equation shows that 2F electricity will deposit 1 mole of Cu^{2+} to.

0.5F electricity will.

Deposit $\frac{1\ mol}{2F}$ × 0.5F = 0.025mol

Initial number of molar of Cu^{2+} in 250 ml of solution = $\frac{0.5}{1000\ mL}$ × 250mL

= 0.125 mol

Number of molar of Cu^{2+} after electrolysis = 0.125 – 0.025 = 0.1 mol.

Concentration of Cu^{2+} = $\frac{0.1mol}{250mL}$ × 1000mL = 0.4M.

14. Can Fe^{3+} oxidises Bromide to bromine under standard conditions?

Given: $E^{\circ}_{Fe3+\,|\,Fe2+}$= 0.771 $E^{\circ}_{Br_2/Br^-}$ = 1.09V.

Required half- cell reaction

$2Br^- \rightarrow Br_2 + 2e^-$ (E°_{ox}) = -1.09V

$2Fe^{3+} + 2e^- \rightarrow 2Fe^{2+}$ (E°_{red}) = +0.771V

$2Fe^{3+} + 2Br^- \rightarrow 2Fe^{2+} + Br_2$ (E°_{cell}) = ?

$E^{\circ}_{Cell} = (E^{\circ}_{ox}) + (E^{\circ}_{red})$

= - 1.09 +0.771 = -0.319 V.

$E°_{Cell}$ is –ve; ΔG is +ve and the cell reaction is non-spontaneous.

Hence Fe^{3+} cannot oxidizes Br^- to Br_2.

15. Is it possible to store copper sulphate in an iron vessel for a long time?

Given : $E^{\circ}_{Cu^{2+}/Cu}$ = 0.34V and $E^{\circ}_{Fe^{2+}/Fe}$ = - 0.44V.

No, we can

- $(E°_{ox})_{Fe/Fe^{2+}}$= 0.44V and $(E°_{red})_{Cu^{2+}/Cu}$ = 0.34V
- $E°_{Cell} = (E°_{ox}) + (E°_{red})$
  =0.44+0.34= 0.78V
- These +ve emf values shows that iron will oxidize and copper will get reduced i.e., the vessel will dissolve.
- Hence it is **not possible** to store copper sulphate in an iron vessel.

16. Two metals M_1 and M_2 have reduction potential values of -*x*V and +yV respectively. Which will liberate H_2 and H_2SO_4?

- Metals having negative reduction potential acts as powerful reducing agent. Since M_1 easily liberate H_2 in H_2SO_4
- Metals having higher oxidation potential will liberate H_2 from H_2SO_4.
- Hence, the metal M_1 having + xV, oxidation potential will liberate H_2 from H_2SO_4.

17. Reduction potential of two metals M_1 and M_2 are $E^{\circ}_{M_1^{2+}/M_1}$ = -2.3V and $E^{\circ}_{M_1^{2+}/M_2}$ = 0.2V Predict which one is better for coating the surface of iron. Given : $E^{\circ}_{Fe^{2+}/Fe}$ = -0.44V

Oxidation potential of M_1 is more +ve than the oxidation potential of Fe which indicates that it will prevent iron from rusting.

18. Calculate the standard emf of the cell: Cd | Cd^{2+} ‖Cu^{2+} | Cu and determine the cell reaction. The standard reduction potentials of Cu^{2+} | Cu and Cd^{2+}| Cd are 0.34V and -0.40 volts respectively. Predict the feasibility of the cell reaction.

Oxidation at anode : Cd(s) → Cd^{2+}(aq) 2e-

$(E°_{ox})_{Cd/Cd^{2+}}$ = 0.4V

Oxidation at cathode = $Cu^{2+}{}_{(aq)} + 2e^- \rightarrow Cu_{(s)}$

$(E^{\circ}_{red})_{Cu^{2+}/Cu} = 0.34V$

$E^{\circ}_{Cell} = (E^{\circ}_{ox}) + (E^{\circ}_{red})_{cathode}$

$= 0.4 + 0.34$

$= 0.74V.$

Emf is +ve, so ΔG is (-)ve, the reaction is feasible

20. The same amount of electricity was passed through two separate electrolytic cells containing solutions of nickel nitrate and chromium nitrate respectively. If 2.935g of Ni was deposited in the first cell. The amount of Cr deposited in the another cell? Give : molar mass of Nickel and chromium are 58.74 and 52gm^{-1} respectively.

$Ni^{2+}_{(aq)} + 2e^{-} \rightarrow Ni_{(s)}$

$Cr^{2+}_{(aq)} + 3e^{-} \rightarrow Cr_{(s)}$

The above reaction indicates that 2F charge is required to deposit 58.7g of Nickel form nickel nitrate and 3F charge is required to deposit 52g of chromium.

Given that 2.935gram of Nickel is deposited

∴ The amount of charge passed through the cell $= \frac{2F}{58.7g} \times 2.935\ g = 0.1\ F$

If 0.1F charge is passed through chromium nitrate the amount of chromium deposited

$= \frac{52g}{3F} \times 1F = 1.733g$

21. 0.1M copper sulphate solution in which copper electrode is dipped at 25°C . Calculate the electrode potential of copper. [Given: $E^{\circ}_{Cu^{2+}/Cu} = 0.34$]

Given that

$[Cu^{2+}] = 0.1\ M$

$E^{\circ}_{Cu2+}\,|\,Cu = 0.34$

$E_{cell} = ?$

Cell reaction is

$Cu^{2+}_{(aq)} + 2e^{-} \rightarrow Cu_{(s)}$

$E_{cell} = E^{\circ} - \frac{0.0591}{n} \log \frac{[Cu]}{[Cu^{2+}]}$

$= 0.34 - \frac{0.0591}{2} \log \frac{1}{0.1}$

$= 0.34 - 0.0296$

$= 0.31V$

22. For the cell Mg (s)| Mg^{2+}(aq) ||Ag^{+} (aq)| Ag (s), calculate the equilibrium constant at 25°C and maximum work that can be obtained during operation of cell. Given : $E^{\circ}_{Mg^{2+}/Mg}$ =-2.37V and $E^{\circ}_{Ag^{2+}/Ag}$ = 0.80V

Oxidation at anode

$Mg \rightarrow Mg^{2+} + 2e^{-}$ ……(1)

$(E^{\circ}_{ox}) = 2.37V$

Reduction at cathode

$Ag^{+} + e^{-} \rightarrow Ag$ ……(2)

$(E^{\circ}_{red}) = 0.80V$

$\therefore E^{\circ}_{cell} = (E^{\circ}_{ox})_{anode} + (E^{\circ}_{red})_{cathode}$

$= 2.37 + 0.80$

$= 3.17V$

Overall reaction

Equation (1) +2 x equation (2) ⇒

$Mg + 2Ag^{2+} \rightarrow Mg^{2+} + 2Ag$

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

$= -2 \times 96500 \times 3.17 = 611.810J$

$\Delta G^{\circ} = -6.12 \times 10^{5}J$

$W = 6.12 \times 10^{5}J$

$\Delta G^{\circ} = -2.803\ RT \log K_c$

$\Rightarrow \log K_c = \frac{6.12\ X\ 10^{5}}{2.803\ X\ 8.314\ X\ 298}$

K_c = Antilog of (107.2).

23. 8.2 ×10^{12} litres of water is available in a lake. A power reactor using the electrolysis of water in the lake produces electricity at the rate of 2 ×10^{6} Cs^{-1} at an appropriate voltage. How many years would it like to completely electrolyse the water in the lake. Assume that there is no loss of water except due to electrolysis.

Hydrolysis of water

At anode:

$2H_2O \rightarrow 4H^{+} + O_2 + 4e^{-}$ ……(1)

At cathode:

$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

Overall reaction

$6H_2O \rightarrow 4H^+ + 4OH^- + 2H_2 + O_2$

(or)

Equation (1) + (2) x 2 $\Rightarrow 2H_2O \rightarrow 2H_2 + O_2$

∴According to Faradays Law of electrolysis, to electrolysis two mole of Water (36g ≅36mL of H_2O), 4F charge is required alternatively, when 36 mL of water is electrolyzed, the charge generated = 4 x 96500 C

∴When the whole water which is available on the lake is completely electrolysed the amount of charge generated is equal to

$= \frac{4\ X\ 96500C}{36mL}$ x $9x10^{12}$L

$= \frac{4\ X\ 96500\ X\ 9\ X\ 10^{12}}{36\ X\ 10^{-3}} C$

$= 96500 \times 10^{15}$ C

∴Given that in 1 second, 2×10^6 C is generated therefore, the time required to generate 96500×10^{15}C is $= \frac{1S}{2\ X\ 106\ X\ C} \times 96500 \times 10^{15}$ C

$= 48250 \times 10^9$ S

Number of years $= \frac{48250\ X\ 109}{365\ X\ 24\ X\ 60\ X\ 60}$

$= 1.5299 \times 10^6$ years

1 year = 365 days

= 365 x 24 hours

= 365 x 24 x 60 min

= 365 x 24 x 60 x 60 sec.

24. Derive an expression for Nernst equation

Nernst equation is the one which relates the cell potential and the concentration of the species involved in an electrochemical reaction.

Let us consider an electrochemical cell for which the overall redox reaction is,

$xA + yB \leftrightarrow lC + mD$

The reaction quotient Q for the above reaction is given below

$$Q = \frac{[C]^l[D]^m}{[A]^x[B]^y} \quad \ldots\ldots\ldots\ldots(1)$$

We have already learnt that,

$$\Delta G = \Delta G + RT \ln Q \quad \ldots\ldots\ldots\ldots(2)$$

The Gibbs free energy can be related to the cell emf as follows (equation (1) and (2))

$$\Delta G = - nFE_{Cell} \; ; \; \Delta G^\circ = - nFE^\circ_{Cell}$$

Substitute these values and Q from (1) in the equation (2)

$$(2) \Rightarrow - nFE_{Cell} = - nFE^\circ_{Cell} + RT \ln \frac{[C]^l[D]^m}{[A]^x[B]^y} \quad ----------(3)$$

Divide the whole equation (3) by (-nF)

$$(4) \Rightarrow E_{Cell} = E_{Cell} - \frac{RT}{nF} \ln \frac{[C]^l[D]^m}{[A]^x[B]^y}$$

$$(\text{or}) \; E_{Cell} = E_{Cell} - \frac{2.303RT}{nF} \log \frac{[C]^l[D]^m}{[A]^x[B]^y} \quad ----------(4)$$

The above equation (4) is called the Nernst equation

At 25°C (298K), the above equation (4) becomes,

$$E_{Cell} = E^\circ_{Cell} - \frac{2.303 \times 8.314 \times 298}{n(96500)} \log \frac{[C]^l[D]^m}{[A]^x[B]^y}$$

$$E_{Cell} = E^\circ_{Cell} - \frac{2.303 \times 8.314 \times 298}{n(96500)} \log \frac{[C]^l[D]^m}{[A]^x[B]^y}$$

27. Ionic conductance at infinite dilution of Al^{3+} and SO_4^{2-} are 189 and 160 mho cm^2 $equiv^{-1}$. Calculate the equivalent and molar conductance of the electrolyte $Al_2(SO_4)_3$ at infinite dilution.

The electrolyte $Al_2(SO_4)_3$

Equivalent conductance at infinite dilution

$$\Lambda \quad Al_2(SO_4)_3 = \frac{1}{3}\lambda_\infty Al^3 + \tfrac{1}{2}\lambda_\infty SO_4^{2-}$$

$$\Lambda \, Al_2(SO_4)_3 = \frac{189}{3} + \frac{160}{2} = 63 + 80$$

$$= 143 \text{ mho } cm^2 \text{ gm } equ^{-1}$$

Molar conductance at infinite dilution

$$\Lambda Al_2(SO_4)_3 = 2 \times 189 + 3 \times 160$$

$$= 858 \text{ mho } cm^2 \text{ } mol^{-1}$$

IMPORTANT QUESTION

1. Define electrochemistry. (34)
2. State Ohm's law. (34)
3. A conductivity cell has two platinum electrodes separated by a distance 1.5 cm and the cross sectional area of each electrode is 4.5sq cm. Using this cell, the resistance of 0.5N electrolytic solution was measured 15Ω. Find the specific conductance of the solution. (36) **M20 2M**
4. Define molar conductivity. (36)
5. Define molar conductance and specific conductance How they are related? (36) **PTA5M i**
6. Define Equivalent conductance. (37) **A21 2M**
7. What are the factors affecting electrolytic conductance.(37) **A21 2M, M22 3M**
8. Explain measurement of conductivity of ionic solutions.(38)
9. Why is AC current used instead of DC in measuring the electrolytic conductance? (38) ($BBQ_{11}66$) **PTA 5Mii**
10. Explain variation of molar conductivity with concentration.(39)
11. Write Debye – Huckel and Onsager equation for a uni-univalent electrolyte. (41) **GM 5M ii**
12. State Kohlrausch's law and applications. (41) **J20 5MARK, GM 5Mii**
13. Describe the construction of Daniel cell and write its cell reaction. **(45) G3M**
14. What is the role of salt bridge in Galvanic cell? (46) **PTA5M ii**
15. What are the conventions used in Galvanic cell notation. (46) **PTA 5M i**
16. Explain about Galvanic cell notation. **(46) M24 5Mi**
17. Write note on standard hydrogen electrode(SHE). (48)**PTA3 3M & PTA5 5M i**
18. Explain Thermodynamics of cell reactions. (50)
19. Derive Nernst equation. (51) **S20 5M, M22 5M, J22 5M**
20. Explain Electrolytic cell and electrolysis. (53)
21. State Faraday's law of electrolysis First law, Second law. (54) **A21 3M, GM 3M, M23 3M**
22. A solution of silver nitrate is electrolyzed for 30 minutes with a current of 2 amperes. Calculate the mass of silver deposited at the cathode.(55) **S20 3MARK COM, J22 2M COM**
23. Write note on Leclanche cell. (56)
24. Write note on Mercury button cell. (57)

25. Write note on secondary batteries. (58)
26. Write note on fuel cell. (59)
27. Explain electrochemical mechanism of corrosion (60)
28. Write note on Electrochemical series.(62)
29. What are electrochemical series? How is it useful to predict corrosion?(62) **PTA3M**
30. How are metals protected from corrosion by cathodic protection method? (61) **M20 3M**
31. The reaction $Zn(s) + Co^{2+} \leftrightarrow Co(s) + Zn^{2+}$ occurs in a cell. Compute the standard emf of the cell. Given that $E°_{Zn/Zn2+} = +0.76V$ and $E°_{Co/Co^{2+}} = +0.28V$. **PTA2MC**
32. Reduction potential of two metals M_1 and M_2 are $E°_{M_1^{2+}/M_1}$ = -2.3 V and $E°_{M_2^{2+}/M_2}$=0.2 V. Predict which one is better for coating the surface of iron. Given: $E°_{Fe^{2+}/Fe}$ = -0.44 V ($BBQ_{17}66$) **PTA5M ii, J23 3M**
33. Is it possible to store copper sulphate in an iron vessel for a long time? Given $E°_{Cu^{2+}/Cu}$ = 0.34 V and $E°_{Fe^{2+}/Fe}$= -0.44V ($BBQ_{15}66$) **PTA2M**
34. Calculate $\Lambda°$ CH_3COOH using appropriate molar conductance of the electrolytes listed below at infinite dilution at 25°C ($BBQ_5$63) **PTA5M i**

Electrolyte	NaCl	HCl	CH_3COONa
$\Lambda°$ (S cm^2 mol^{-1})	126.5	426.2	91.0

35. The equivalent conductance of M/36 solution of a weak monobasic acid is 6 mho cm^2 $equiv^{-1}$ and at infinite dilution is 400 mho cm^2 $equiv^{-1}$. Calculate the dissociation constant of this acid. (BBQ_{17}64) **PTA2MC**

36. Can Fe^{3+} oxidise bromide to bromine under standard conditions? Given: $E°_{Fe^{3+}/Fe^{2+}}$=0.771V $E°_{Br2/Br^-}$=1.09V . **M24 2M**

ALL INSIDE PROBLEM & Revise Book Back (Evaluation) Question Answer

10. SURFACE CHEMISTRY

1. Give two important characteristics of physisorption.

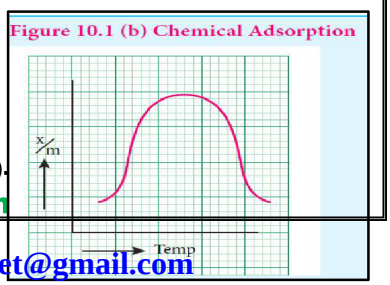
- Physisorption decreases with increase in temperature.
- No transfer of electrons.
- Multilayer of the adsorbate is formed on the adsorbent.
- It is reversible.

- It has low heat of adsorption.

2. Differentiate physisorption and chemisorptions.

	Chemical adsorption or Chemisorption or Activated adsorption	**Physical adsorption or Vanderwaals adsorption or Physisorption**
1	It is **very slow**	It is instantaneous. (fast)
2	It is **very specific** depends on nature of adsorbent and adsorbate.	It is **non-specific**
3	Chemical adsorption is **fast with increase pressure, it cannot alter the amount.**	In Physisorption, when **pressure increase the extent (amount) of adsorption increases**.
4	When **temperature is raised chemisorption first increases and then decreases**.	**Physisorption decreases with increase in temperature**
5	Chemisorption involves **transfer of electrons** between the adsorbent and adsorbate.	**No transfer of electrons**
6	**Heat of adsorption is high** i.e., from 40-400kJ/mole.	**Heat of adsorption is low** in the order of 40kJ/mole.
7	**Monolayer of the adsorbate** is formed.	**Multilayer of the adsorbate** is formed on the absorbent.
8	Adsorption occurs at fixed sites called active centres. It **depends on surface area.**	It occurs **on all sides**
9	Chemisorption involves the formation of activated complex with **appreciable activation energy.**	**Activation energy is insignificant. (no appreciable)**
10	It is **irreversible.**	It is **reversible.**
11	It is caused by **chemical bond** formation.	It arises because of **Vander Waals forces.**
12	**Example:** Adsorption of H_2 on Nickel.	**Example:** Adsorption of N_2 on mica.

3. In case of chemisorption, why adsorption first increases and then decreases with temperature?



- Chemisorption involves **high activation energy**, so also referred to as activated adsorption.
- It is found in chemisorption that it first increases and then decreases with increase in temperature. When adsorption is plotted, the graph first increases and then decrease with temperature.
- The initial increase illustrates the requirement of activation of the surface for adsorption is due to fact that formation of activated complex requires certain energy. But later it decreases at high temperature is due to desorption as the kinetic energy of the adsorbate increases (exothermic nature). **(or)**
- Increase in temperature will provide the molecule necessary activation energy for chemical bond formation hence the rate of adsorption increases.
- At a certain temperature all bonds are formed and now further increase in temperature will favours desorption.

4. Which will be adsorbed more readily on the surface of charcoal and why; NH_3 or O_2?

- NH_3 easily liquefiable have greater Vander Waal's force of attraction.
- Permanent gases O_2 Cannot be liquefied easily. These permanent gases are having low critical temperature and adsorbed slowly, while gases with high critical temperature are adsorbed readily.

5. Heat of adsorption is greater for chemisorptions than physisorption. Why?

- Chemisorption has higher enthalpy (from 40 - 400kJ) of adsorption because in chemisorption the chemical bonds are much stronger.
- In adsorbed state the adsorbate is held on the surface of adsorbent by attractive forces (bond).

6. Peptising agent is added to convert precipitate into colloidal solution. Explain with an example.

- By addition of suitable electrolytes, **precipitated particles** can be brought into **colloidal state.** The process is termed as peptisation.
- **Electrolyte** added is called peptising or **dispersing agent.**
- Silver chloride can be converted into a sol by adding hydrochloric acid.

$$AgCl \xrightarrow{HCl} AgCl$$

Precipitate Colloid

Silver chloride $AgCl$ is peptized by HCl giving negative sol of $(AgCl)Cl^-$

7. What happens when a colloidal sol of $Fe(OH)_3$ and AS_2S_3 are mixed?

$Fe(OH)_3$ sol has positive charge due to absorption Fe^{3+} ions while **AS_2S_3 sol has negative charge** due to absorption of S^{2-} ions.

When these sols are mixed with each other, due to Fe^{3+} and S^{2-} neutralization of charges will happen and precipitate will be formed.

$$Fe(OH)_3 + As_2S_3 \rightarrow Fe_2S_3 + As(OH)_3$$

8. What is the difference between a sol and a gel?

Sol	Gel
In sol, dispersion medium is liquid and the dispersed phase is solid.	In gel, dispersion medium is solid and the dispersed phase is liquid.
Definition: The liquid state of a colloidal solution is called Sol	**Definition:** The solid or semi-solid (Jelly like) stage of a colloidal solution is called gel
The sol **does not** have a definite structure.	The gel possesses **honeycomb** like structure
The dispersion medium of the sol may be water (hydrosol) or alcohol (alcosol)	The dispersion medium of gel will be hydrated colloid particles.
The sol can be converted to gel by **cooling**	The gel can be converted to sol by **heating.**
The sol can be easily **dehydrated.**	The gel **cannot** be dehydrated.
The **viscosity** of the sol is **very low.**	The viscosity of the gel is **very high.**
Sol is categorized into lyophobic and lyophilic sols.	There is no such classification of gel.
Example: Blood, Ink, paints, colloidal gold	Example: Butter, cheese

9. Why lyophilic colloidal sols are more stable than lyophobic colloidal sol.

- In lyophilic colloids or sols definite attractive force of affinity exists between dispersion medium and dispersed phase. **Examples:** sols of protein and starch.

  They are **more stable and will not get precipitated easily.**

- In lyophobic colloids, no attractive force exists between the dispersed phase and dispersion medium.
- They are less stable and precipitated.

  Example: sols of gold, silver, platinum and copper.

10. Addition of Alum purifies water. Why?

Alum containing a Al^{3+} when added to water, coagulates the colloidal impurities present in water. These impurities settle down and are removed by decantation or filtration, thus purifying the water.

1. What are the factors which influence the adsorption of a gas on a solid?

Factors affecting adsorption of gases on solids are:

i)Surface area of adsorbent

ii)Nature of adsorbate

iii) Effect of temperature

iv) Effect of pressure

1. Surface area of adsorbent:

- As the adsorption is a surface phenomenon it depends on the surface area of adsorbent. i.e., higher the surface area, higher is the amount adsorbed.

$$Rate\ of\ Adsorption \propto Surface\ area$$

2. Nature of adsorbate

- The nature of adsorbate can influence the adsorption.
- Gases like SO_2, NH_3, HCl and CO_2 are easily liquefiable as have greater van der waal's force of attraction.
- On the other hand, permanent gases like H_2 ,N_2 and O_2 cannot be liquefied easily.

- These permanent gases are having low critical temperature and adsorbed slowly, while gases with high critical temperature are adsorbed readily.
- (For liquefaction of a gas certain minimum temperature called critical temperature)

3. Effect of temperature

- When temperature is raised chemisorption first increases and then decreases.
- Whereas physisorption decreases with increase in temperature.

Amount of gas adsorbed $\propto 1/Temerature$

4. Effect of pressure:

- Chemical adsorption is fast with increase pressure, it cannot alter the amount of adsorption.
- In Physisorption, when pressure increases the amount of adsorption increases.

Rate of Adsorption $\propto$ Pressure

2. What are enzymes? Write a brief note on the mechanism of enzyme catalysis.

Enzymes are complex protein molecules with three dimensional structures. They catalyse the chemical reaction in living organism. They are often present in colloidal state and extremely specific in catalytic action.

Mechanism of enzyme catalysed reaction:

The following mechanism is proposed for the enzyme catalysis

$E+S \rightleftharpoons ES \rightarrow P+E$

Where E is the enzyme, S the substrate(reactant), ES represents activated complex and P the products.

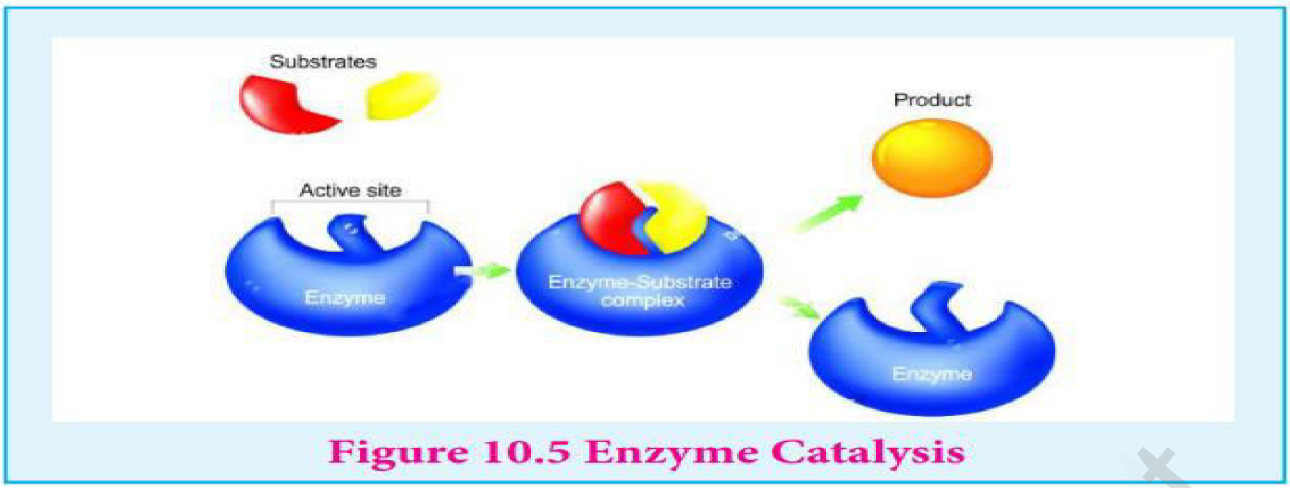


Figure 10.5 Enzyme Catalysis

1. What do you mean by activity and selectivity of catalyst?

Activity of catalyst:

Activity of a catalyst is the ability of a catalyst to increase the rate a particular reaction.

Chemisorption is the main factor in deciding the activity of a catalyst.

Selectivity of a catalyst:

The ability of the catalyst to direct a reaction to yield a particular product is referred to as the selectivity of the catalyst.

(i) $CO_{(g)} + 3H_{2(g)} \xrightarrow{Ni} CH_{4(g)} + H_2O_{(g)}$

(ii) $CO_{(g)} + 2H_{2(g)} \xrightarrow{Cu/ZnO-CrO_3} CH_3OH_{(g)}$

(iii) $CO_{(g)} + H_{2(g)} \xrightarrow{Cu} HCHO_{(g)}$

For Eg: We can get different products for the reaction between H_2 and CO by using different catalyst.

14. Describe some feature of catalysis by Zeolites.

i. Zeolites are microporous, crystalline, hydrated, alumino silicates, made of silicon and aluminium tetrahedra.

ii. There are about 50 natural zeolites and 150 synthetic zeolites.

iii. As silicon is tetravalent and aluminium is trivalent, the zeolite matrix carries extra negative charge.

iv. To balance the negative charge, there are extra framework cations for example, H^+ orNa^+ ions.

v. Zeolites carrying protons are used as solid acides, catalysis and they are extensively used in the petrochemical industry for cracking heavy hydrocarbon fractions into gasoline, diesel, etc., Zeolites carring Na^+ ions are used as basic catalysis.

vi. One of the most important applications of zeolites is their shape selectivity.

vii. In zeolites, the active sites namely protons are lying inside their pores.

viii. So, reactions occur only inside the pores of zeolites.

15. Give three uses of emulsions.

- It is used in making of medicines.
- (ii) Digestion of fats in intestine takes place by the process of emulsification.
- The cleansing action of soap is due to the formation of emulsion of soap molecules with dirt and grease.
- Antiseptics and disinfectants when added to water form emulsion.

16. Why does bleeding stop by rubbing moist alum.

Blood is a colloidal sol. Moist alum is a coagulating agent. When we rub the injured part with moist alum, coagulation of blood takes place, thus arrests bleeding.

17. Why is desorption important for a substance to act as good catalyst?

Desorption is very important for a substance to act as a good catalyst since after the reaction, the products formed on the surface must be removed (desorbed) so as to create free surface again for other reactant molecules to approach the surface and react.

If desorption does not occur then other reactants are left with no space on the catalysts surface for adsorption and reaction will stop.

18. Comment on the statement: Colloid is not a substance but it is a state of substance.

- ***A colloid is formed when the size of the solute particle lies between 1nm to 200nm.***
- ***Any particle is present between this size are behaves as colloid.***
- ***Hence it is a state of substance and not a substance.***

(Colloid: Colloid is a homogeneous mixture of two substances in which one substance is dispersed in another substance. Colloidal substance does not represent a separate class of substance. It is a state of a substance which is dependent on the size of the particle.

Example: Soap dissolves in water to form colloidal soap solution. Whereas it dissolves in alcohol to form a true solution. This shows that a substance can be brought into a colloidal state by methods.)

19.Explain any one method for coagulation.

The flocculation and setting down of the sol particles is called **coagulation.**

Various method of coagulation are given below

i) Electrophoresis

ii) Addition of electrolytes

iii) By mixing appositively charged sols.

iv) Boiling.

Electrophoresis:

- Electrophoresis is the one of the methods of coagulation.
- Here, charged particles migrate to the electrode of opposite sign.
- It is the due to neutralization of the charge of the colloids.
- The particles are discharged and so they get precipitated.

20. Write a note on electro osmosis.

- A sol is electrically neutral Hence the medium carries an equal but opposite charge to that of dispersed particles.
- When sol particles are prevented from moving, under the influence of electric field the medium moves in a direction opposite to that of the sol particles.

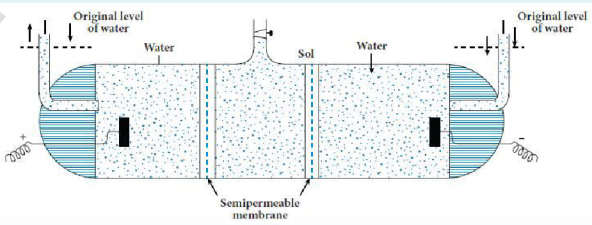


Figure 10.16 Electro osmosis

- This movement of dispersion medium under the influence of electric potential is called electro-osmosis.

21.Write a note on catalytic poison.

Certain substances when added to a catalysed reaction decreases or completely destroys the activity of catalyst and they often known as catalytic poisons.

For example: In the reaction, $2SO_2 + O_2 \rightarrow 2SO_3$ with a Pt catalyst, the **poison is As_2O_3**

Haber's process - manufacture of ammonia, the Fe catalyst is poisoned by the presence of **H_2S.**

22. Explain intermediate compound formation theory of catalysis with an example The intermediate compound formation theory:

- A catalyst acts by providing a new path with low energy of activation.
- In homogeneous catalysed reactions a catalyst may combine with one or more reactant to form an intermediate which reacts with other reactant or decompose to give products and the catalyst is regenerated.

Consider the reactions:

$$A + B \xrightarrow{C} AB \quad (1)$$

$$A + C \rightarrow AC \text{ (intermediate)} \quad (2)$$

C is the catalyst

$$AC + B \rightarrow AB + C \quad (3)$$

Activation energies for the reactions (2) and (3) are lowered compared to that of (1). Hence the formation and decomposition of the intermediate accelerate the rate of the reaction.

Example:1 The mechanism of Fridel crafts reaction is given below

$$C_6H_6 + CH_3Cl \xrightarrow{\text{anhydrous AlCl3}} C_6H_5CH_3 + HCl$$

Benzene methylchloride toluene

The action of catalyst is explained as follows

$$CH_3Cl + AlCl_3 \rightarrow [CH_3]^+ [AlCl_4]^-$$

It is an intermediate.

$$C_6H_6 + [CH_3^+] [AlCl_4]^- \rightarrow C_6H_5CH_3 + AlCl_3 + HCl$$

This theory describes

(i) the specificity of a catalyst and

(ii) the increase in the rate of the reaction with increase in the concentration of a catalyst.

Limitations

(i) The intermediate compound theory fails to explain the action of catalytic poison and activators (promoters).

(ii) This theory is unable to explain the mechanism of heterogeneous catalysed reactions.

23. What is the difference between homogenous and heterogeneous catalysis?

Homogenous Catalysis	**Heterogeneous Catalysis**
In a catalysed reaction, the reactants, products and catalyst are present in the **same phase.**	In a reaction, the catalyst is present in a **different phase.** i.e., It is not present in the same phase as that of reactants or products.
Example: $2SO_{2(g)}+O_{2(g)} \xrightarrow{NO(g)} 2SO_{3(g)}$	**Example** In the manufacture of sulphuric acid by contact process. $2SO_{2(g)}+O_{2(g)} \xrightarrow{Pt(s)} 2SO_{3(g)}$

24. Describe adsorption theory of catalysis.

Langmuir explained the action of catalyst in heterogeneous catalysed reactions based on adsorption.

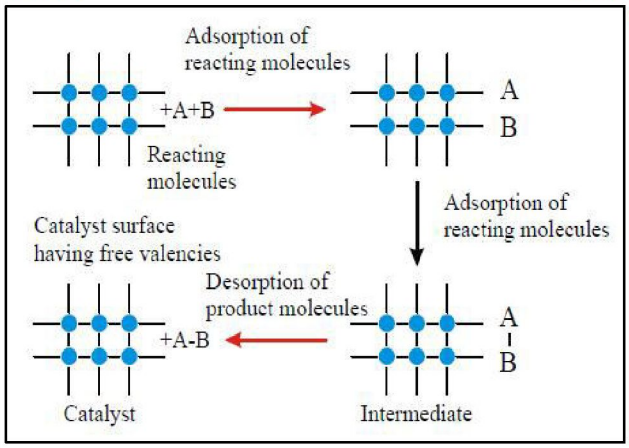
The reactant molecules are adsorbed on the catalyst surfaces, so this can also be called as **contact catalysis.**

According to this theory, the reactants are adsorbed on the catalyst surface to form an activated complex which subsequently decomposes and gives the product.

The various steps involved in a heterogeneous catalysed reaction are given as follows:

1. Reactant molecules **diffuse** from bulk to the catalyst surface.
2. The reactant molecules are **adsorbed** on the surface of the catalyst.
3. The adsorbed reactant molecules are activated and form **activated complex** which is decomposed to form the products.
4. The product molecules are **desorbed**.
5. The product **diffuses away** from the surface of the catalyst.

Example: $CH_2{=}\ CH_{2\,(g)} + H_{2(g)} \xrightarrow{Ni(s)} CH_3\text{-}\ CH_{3\,(g)}$



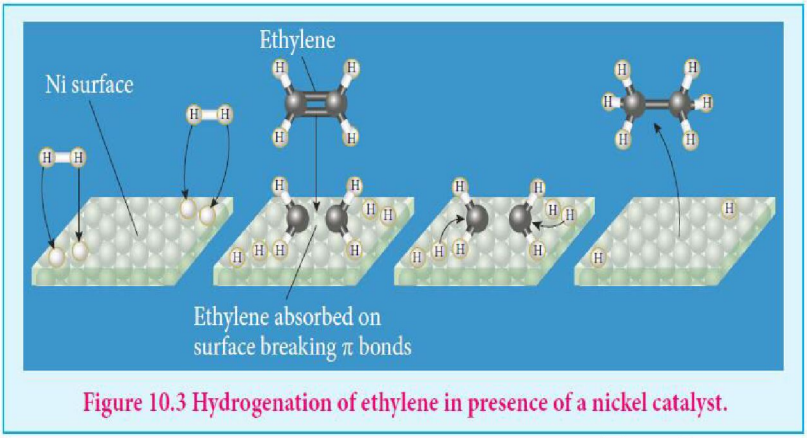


Figure 10.3 Hydrogenation of ethylene in presence of a nickel catalyst.

(OR)

$$A + B \xrightarrow{CATALYST} C + D$$

Step - 1. Adsorption of reactant molecules

The reactant molecules A and B strike the surface of the catalyst. They are held up at the surface by weak vanderwaal's forces or by partial chemical bonds.

Step - 2. Formation of Activated complex

The particles of the reactants adjacent to one another join to form an intermediate complex (A-B). The activated complex is unstable.

Step - 3. Decomposition of Activated complex

The activated complex breaks to form the products C and D. The separated particles of the products hold to the catalyst surface by partial chemical bonds.

Step - 4. Desorption of Products

The particles of the products are desorbed or released from the surface.

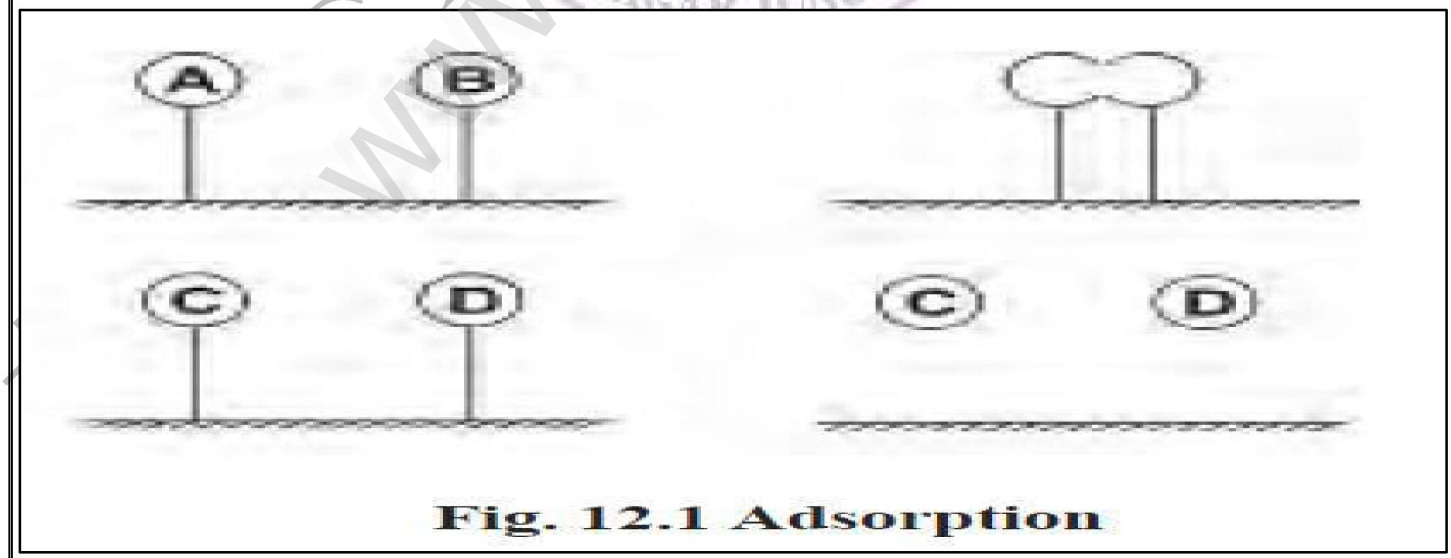


Fig. 12.1 Adsorption

1. Define adsorption and absorption. (70)
2. Characteristics of adsorption. (71) **PTA 2M**
3. Distinction between chemical and physical adsorption. (71) **PTA 5Mi**
4. Explain the effect of temperature and pressure on physisorption and chemisorption. (72) **M24 3M**
5. Give two important characteristics of physisorption. **(71) J23 2M**
6. Explain Factors affecting adsorption. (72)
7. Write note on Adsorption and isobars. (73)
8. Explain Freundlich adsorption isotherm and limitations. (73)
9. Explain applications of adsorption. (75)
10. Define catalyst and catalysis. (77)
11. Define positive catalysis. (77)
12. Define homogenous catalysis & example (77) **M22 3M**
13. Define heterogeneous catalysis & example (77) **J22 3M**
14. What are the characteristics of catalysis? (78) **J20 5MARK, PTA 5Mi, M22 5M**
15. Define promoters, catalytic poison with suitable example (79) **PTA 2M M23 2M, J24 2M**
16. Define auto catalysis and example (79)
17. Identify the auto catalyst in the following reaction. (79) **J20 5Mi**

    A) $CH_3COOC_2H_5 + H_2O \rightarrow CH_3COOH + C_2H_5OH$ B) $2AsH_3 \rightarrow 2As + 3H_2$
18. Define negative catalysis and example (79)
19. Explain intermediate compound formation theory of catalysis with an example & limitations. (80) **GM 5Mi J23 5M**
20. Explain adsorption theory of catalysis. (81) **A21 5MARK J22 5M**
21. What is the role of adsorption in the heterogeneous catalysis? (81) **PTA 3M**
22. What are active centres? (82) **PTA 2M**
23. Define, Mechanism, characteristics of Enzyme Catalysis. (83)
24. Explain Zeolite catalysis.(84)
25. What is Nano Catalysis? Give example.(86)**GM 5M i**
26. Define colloid & particle size.(86)
27. Define dispersed phase and dispersing medium. (86)

28. Define lyophilic colloids & example(87)
29. Define lyophobic colloids & example (87)
30. Why are lyophilic colloidal sols are more stable than lyophobic colloidal sols? (87) **J23 3M**
31. Explain the classification of colloids based on the physical state.(87)
32. Write the dispersed phase and dispersion medium of butter. (88) **M20 2MARK**
33. Write note on preparation of Colloids- mechanical dispersion.(88)
34. Write note on preparation of Colloids- electro dispersion.(89)
35. Write note on preparation of Colloids- Ultrasonic dispersion.(89)
36. Peptising agent is added to convert precipitate into colloidal solution. Illustrate with an example. 90 (BB103) **PTA 2M (**Write note on preparation of Colloids- peptisation.)
37. Write any three condensation methods of preparation of colloids. (Chemical method) (90) **PTA5M i**
38. What happens when hydrogen sulphide gas is passed through a solution of arsenic oxide? Name the chemical method. (90) **PTA 2M**
39. Write note on Dialysis. (91)
40. Write note on Electrodialysis. (91)
41. Write note on Ultrafiltration. (91) **GM5Mii**
42. Mention the shapes of the following colloidal particles. (93) **M20 3MARK**

    i) As_2S_3 ii) Blue gold sol iii) Tungstic acid sol
43. Define Tyndall effect. (93) **J20 2M**
44. Define Brownian movement. (94)
45. What is the significance of Brownian movement? (94) **PTA 5M ii**
46. Write note on Helmholtz double layer. (94) **PTA 3M M23 3M**
47. Explain Electrophoresis. (94) **PTA 5Mi, M22 2M**
48. Define electroosmosis. (95)
49. Define coagulation. Various method of coagulation. (96) (Explain any one method for coagulation) **J24 3M**
50. What is flocculation value? (96) **PTA 2M**
51. Define Gold number.(96) **M24 5Mii**
52. Explain types, identification of Emulsions. (97)

53. What is inversion of phase? Give an example. (98) **S20 3M**

54. Explain various application of colloids (98)

55. How colloids are used in tanning of leather and in Rubber industry? **M23 5Mii**

& Revise Book Back (Evaluation) Question Answer

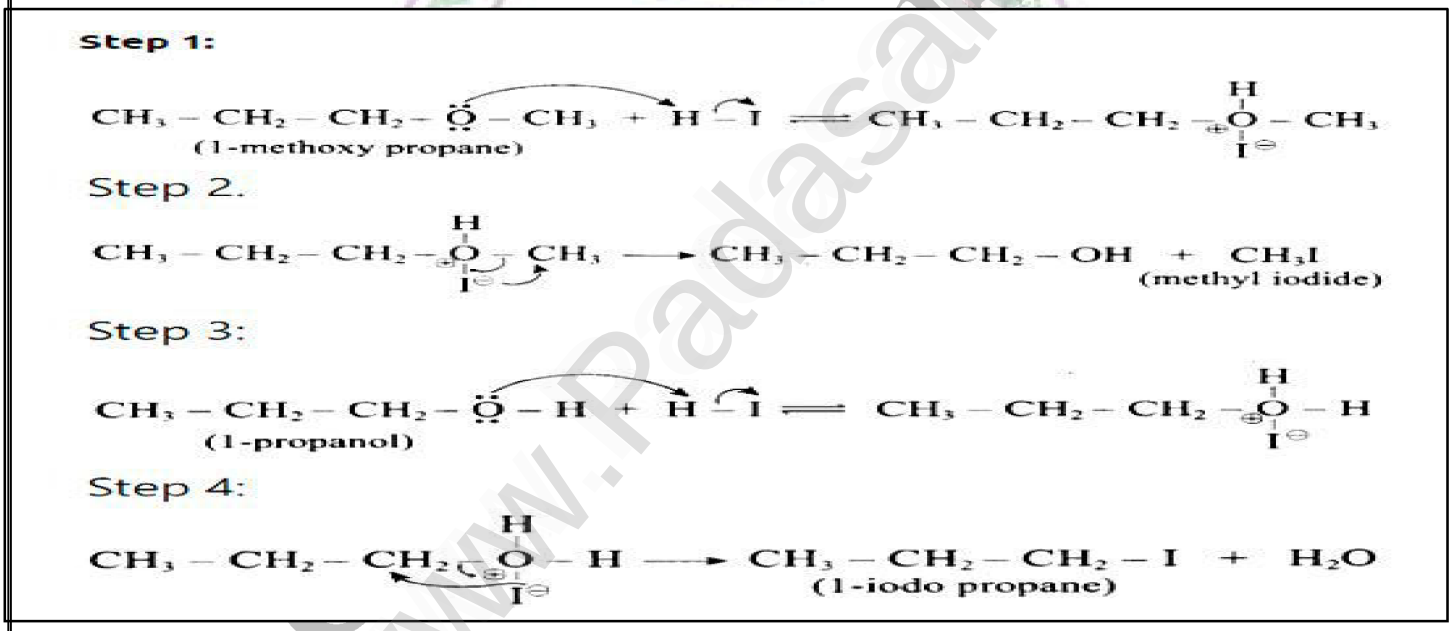
Lesson 11 Alcohol, phenol and Ether

Text Book Evaluation

1. Identify the product(s) is / are formed when 1-methoxy propane is heated with excess HI. Name the mechanism involved in the reaction.

$CH_3\text{-}O\text{-}CH_2CH_2CH_3 + 2HI \rightarrow CH_3I + CH_3CH_2CH_2I + H_2O$

1-methoxy propane — Methyl Iodide — n- Propyl iodide



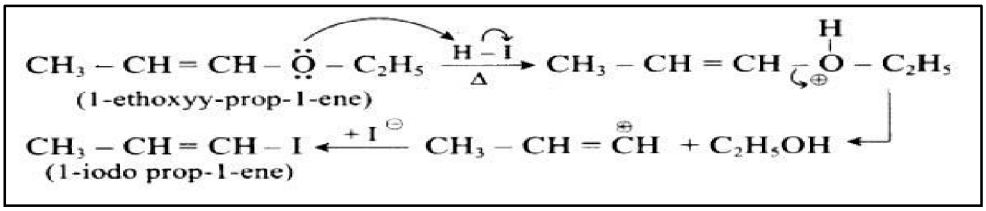
Ethers undergo **Nucleophilic substitution reaction mechanism (SN^1)** with HBr or HI

2. Draw the major product formed when 1-ethoxyprop-1-ene is heated with one equivalent of HI.

$C_2H_5 - O - CH = CH - CH_3 + HI \rightarrow C_2H_5OH + CH_3\text{-}CH{=}CHI$

1-ethoxy prop-1-ene — Ethanol — 1- **iodo propene**

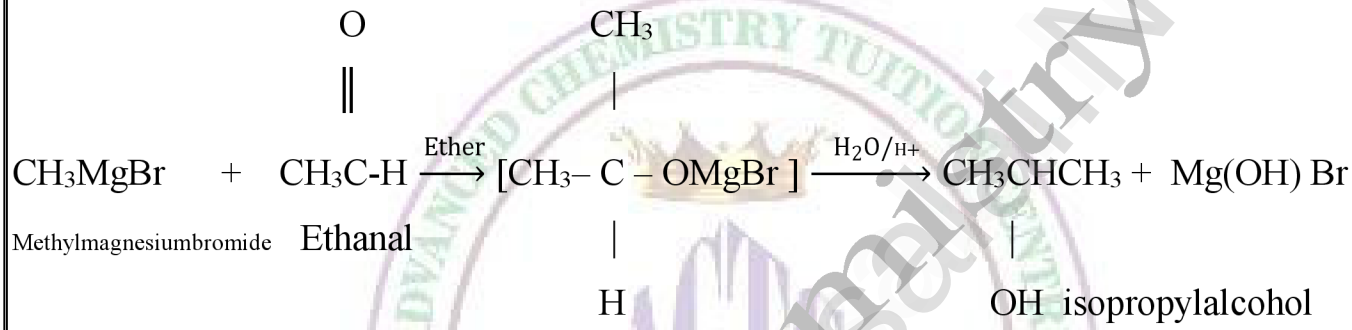
This reaction follows **SN^1 mechanism** because in this reaction the more stable



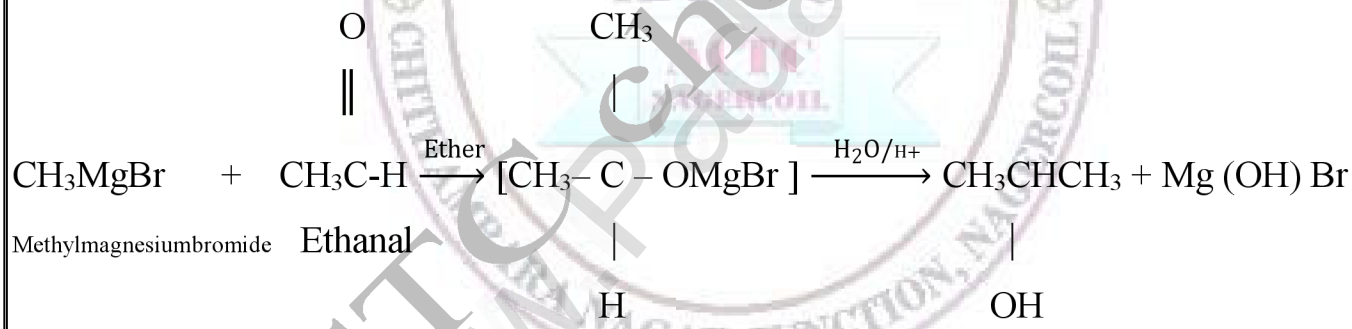
carbocation is formed that is double bonded carbocation. Therefore, the given molecule reacts with HI to form ethanol and 1- iodo prop – 1 – ene.

3. Suggest a suitable reagent to prepare secondary alcohol with identical group using Grignard reagent. (PgNo 108)

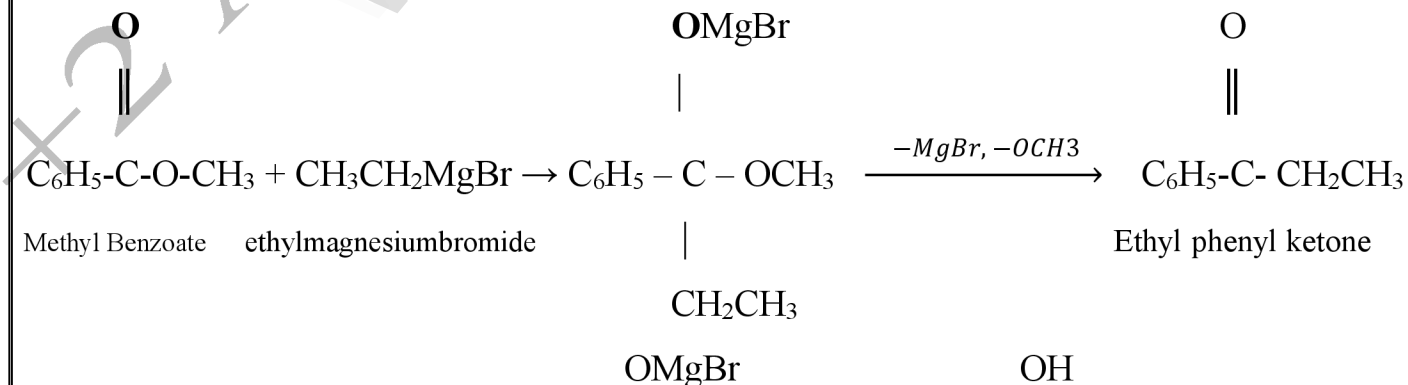
1. From ethyl formate (ethyl methanoate)

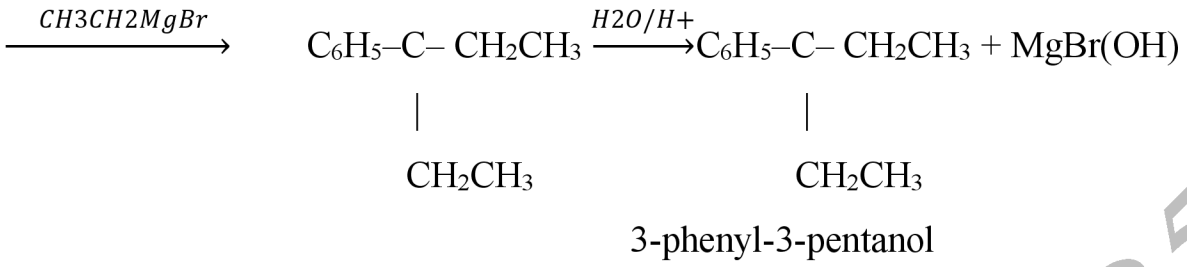


2. The suitable reagent used to prepare secondary alcohol using Grignard reagent is ethanal.



4. What is the major product obtained when two moles of ethyl magnesium bromide is treated with methyl benzoate followed by acid hydrolysis.

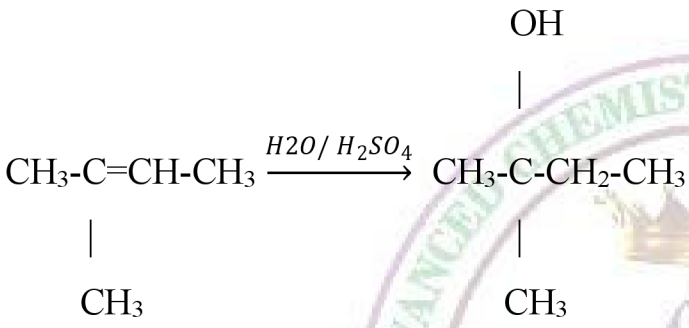




3-phenyl-3-pentanol

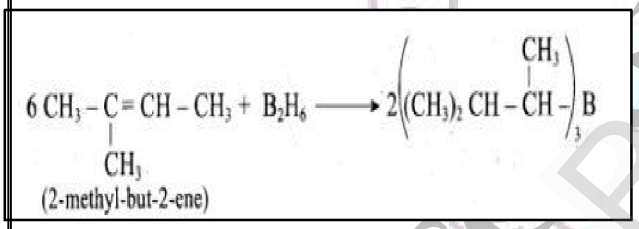
5. Predict the major product, when 2-methyl but-2-ene is converted into an alcohol in each of the following methods.

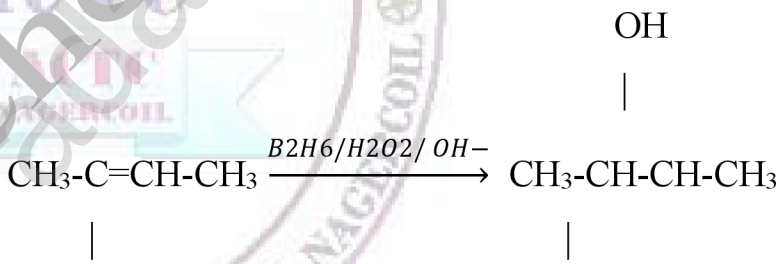
i)Acid catalysed hydration



2-methylbut-2-ene 2-methylbutan-2-ol

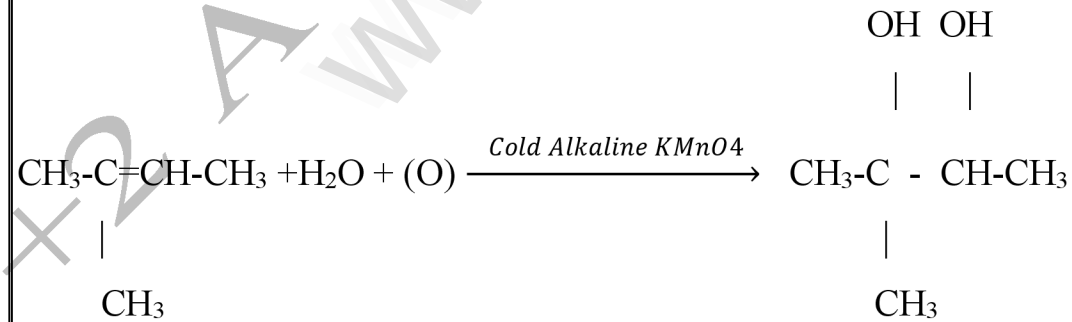
ii)Hydroboration





2-methylbut-2-ene 3-methylbutan-2-ol

iii) Hydroxylation using Bayer's reagent



2-methylbut-2-ene 2-methyl butan – 2,3-diol

6. Arrange the following in the increasing order of their boiling point and give a reason for your ordering i)Butan -2-ol,Butan -1-ol,2-methylpropan-2-ol

2-Methylpropan-2-ol < Butan-2-ol < Butan-1-ol,

Boiling point decrease with **increase of branching** because the Vander Waals force decreases with decrease of surface area.

ii)Propan -1-ol, propan-1,2,3-triol,propan-1,3-diol,propan-2-ol

propan-2-ol < Propan -1-ol < propan-1,3-diol < propan-1,2,3-triol

The boiling point of the alcohol also increases when the number of –OH group increases due to strong hydrogen bonding.

7. Can we use Nucelophiles such as NH_3,CH_3O^- for the nucleophilic substitution of alcohols.

No, In activating an alcohol for nucleophilic substitution by protonation, strong basic nucleophiles (lewis base) such as NH_3, RNH_2,CH_3O-etc cannot be used since they too would be protonated in the acidic solution.

(1. Increasing order of nucelophilicity, $NH_3 < -OH^{\oplus} < CH_3O^{\ominus}$

2. Higher electron density will increase the nucelophilicity.

3. Negatively charged species are almost always more nucelophiles than neutral species.

4. $RO^{\ominus}$ has an alkyl group attached, allowing a greater amount of polarizability. This means oxygen's lone pairs will be more readily available to reach in $RO^{\ominus}$ than in $OH^{\ominus}$. Hence CH_3O^- is the better nucelophile for the nucleophilic substitution of alcohols. NH_3 cannot act as nucelophile for the nucleophilic substitution of alcohols.)

8. Is it possible to oxidize t – butyl alcohol using acidified dichromate to form a carbonyl compound.

Tertiary alcohols ***do not undergo oxidation reaction*** under normal condition, but at elevated temperature, under strong oxidising agent cleavage of C-C bond takes place to give a mixture of carboxylic acid.

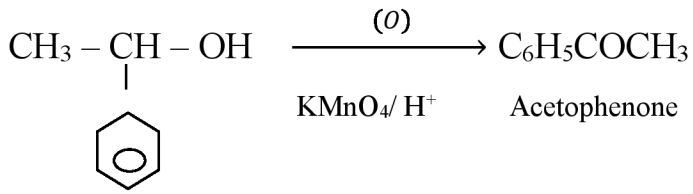
Yes. It is possible. Cleavage of C- C bond takes place to give a ketone and then mixture of carboxylic acids.

$$CH_3\text{-}\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{C}}}}\text{-}OH \xrightarrow{H^+} CH_3\text{-}C{=}CH_2 \xrightarrow[K_2Cr_2O_7]{(O)} CH_3COCH_3 + HCOOH \xrightarrow{(O)} CH_3COOH$$

Isobutylene Acetone Formic acid Acetic acid

CH_3

9. What happens when 1-phenyl ethanol is treated with acidified $KMnO_4$.



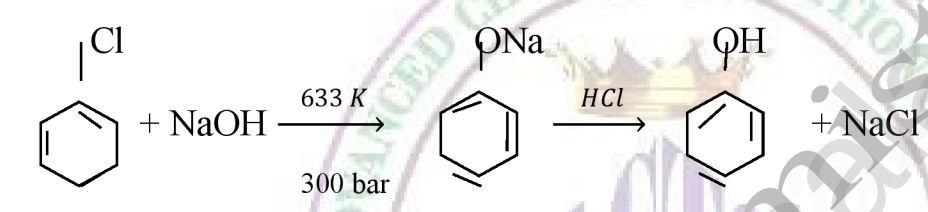
(Sec alcohol oxidized to form ketone)

1 – Phenyl ethanol

11. How is phenol prepared form

i) chloro benzene

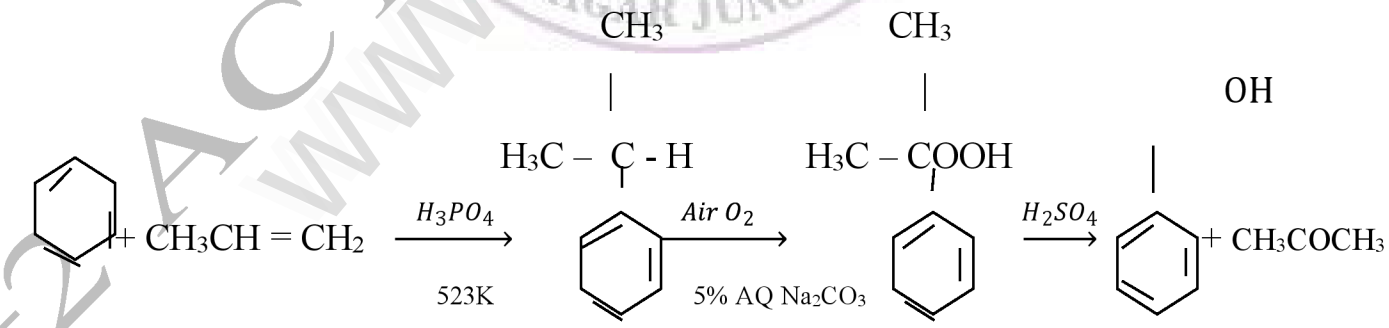
When Chlorobenzene is hydrolysed with 6 – 8% NaOH at 300 bar and 633K in a closed vessel, sodium phenoxide is formed which on treatment with dilute HCl gives phenol.



Chlorobenzene Sodium phenoxide Phenol

ii) isopropyl benzene

A mixture of benzene and propane is heated at 523K in a closed vessel in presence of H_3PO_3 catalyst gives cumene (isopropylbenzene). On passing air to a mixture of cumene and 5% aqueous sodium carbonate solution, cumene hydro peroxide is formed by oxidation. It is treated with dilute acid to get phenol and acetone. Acetone is also an important byproduct in this reaction.

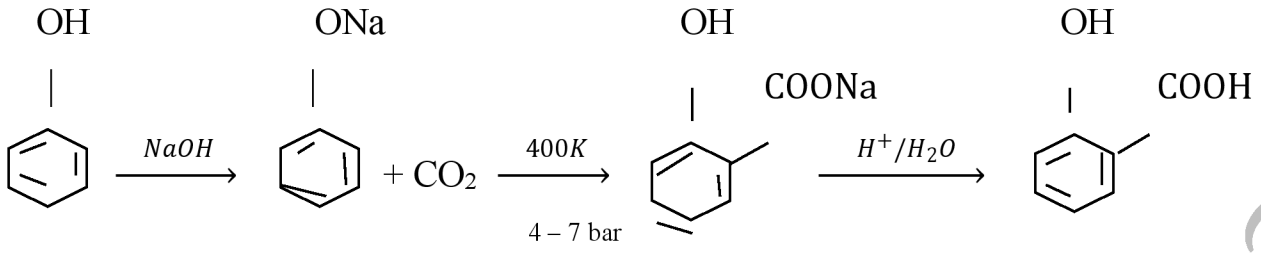


Benzene Propene Cumene Cumene Hydroperoxide Phenol acetone

12. Explain Kolbe's reaction

In this reaction, phenol is first converted into sodium phenoxide which is more reactive than phenol towards electrophilic substitution reaction with CO_2. Treatment of sodium

phenoxide with CO_2 at 400K, 4 – 7 bar pressure followed by acid hydrolysis gives salicylic acid.



Phenol sodium phenoxide Sodium salicylate Salicyclic acid

13. Writes the chemical equation for Williamson synthesis of 2-ethoxy – 2- methyl pentane starting from ethanol and 2 – methyl pentan-2-ol.

From ethanol and 2 – methyl pentan-2-ol:

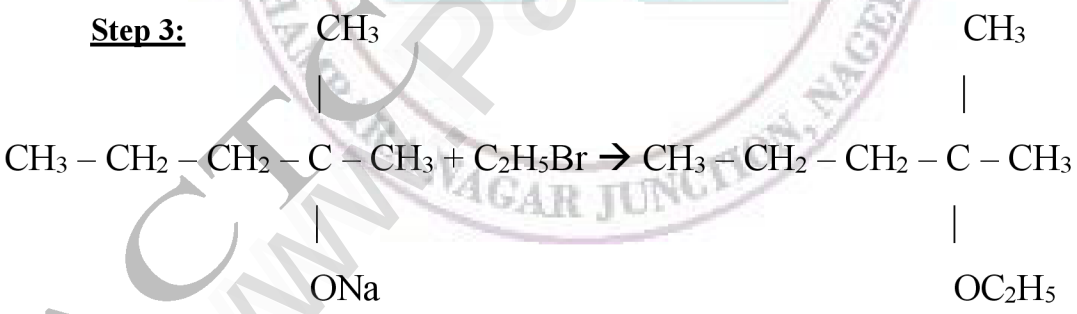
Step 1: $C_2H_5OH + HBr \rightarrow C_2H_5Br + H_2O$

Ethyl bromide

Step 2:

2-methyl -2-Pentanol Sodium salt of 2-methyl pentane (sodium alkoxide)

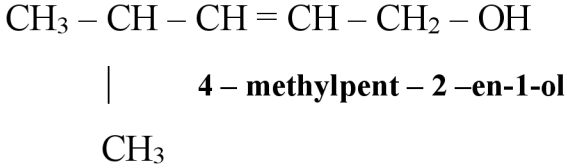
Step 3:



Sodium salt of 2-methyl pentane 2-ethoxy-2-methyl pentane

Williamsons synthesis occurs by SN2 – mechanism and primary alkyl halides are more reactive in SN2 reactions. Therefore ethanol is converted into ethyl bromide.

14. Write the structure of the aldehyde, carboxylic acid and ester that yield 4- methylpent -2-en-1-ol.



4 – methylpent – 2 –en-1-ol

The structure of aldehyde, carboxylic acid and ester that would yield the above compound are

(i) Aldehyde : $CH_3 - CH(CH_3) - CH = CH - CHO$ — **4 – methylpent – 2 –en-1-al**

(ii)Acid: $CH_3 - CH(CH_3) - CH = CH - COOH$ — 4 – methylpent – 2 –en-1-oic acid

iii)Ester: $CH_3 - CH(CH_3) - CH = CH - COOR$

15. What is metamerism? Give the structure and IUPAC name of metamers of 2 – methyoxy Propane

Metamerism is a special isomerism in which molecules with same formula, same functional group, differing only in the nature of the alkyl group attached to oxygen.

$CH_3 - O - CH(CH_3) - CH_3$	$CH_3 - O - CH_2 - CH_2 - CH_3$	$CH_3 - CH_2 - O - CH_2 - CH_3$
2-methoxy propane	1-methoxy propane	Ethoxy ethane

16. How are the following conversions effected

i) benzylchloride to benzylalcohol

$$C_6H_5 - CH_2Cl \xrightarrow{NaOH} C_6H_5CH_2OH + NaCl$$

Benzyl chloride — Benzyl alcohol

ii) benzyl alcohol to benzoic acid

$$C_6H_5 - CH_2OH \xrightarrow{K_2Cr_2O_7/H^+} C_6H_5COOH$$

Benzyl alcohol — Benzoic acid

17. Complete the following reactions

i) $CH_3 - CH_2 - OH \xrightarrow{PBr_3} A \xrightarrow{aq.NaOH} B \xrightarrow{Na} C$

$$CH_3 - CH_2OH \xrightarrow{PBr_3} CH_3CH_2Br \xrightarrow{NaOH} 2CH_3CH_2OH \xrightarrow{2Na} 2CH_3CH_2ONa + H_2$$

Ethanol — Bromo ethane (A) — ethanol (B) — Sodium ethoxide (C)

A – Bromoethane B – Ethanol C – Sodium ethoxide

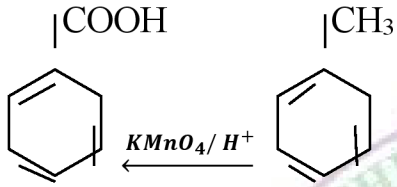
ii) C_6H_5 - OH $\xrightarrow{Zn\ dust}$ **A** $\xrightarrow[Anhydrs\ AlCl_3]{CH_3Cl}$ **B** $\xrightarrow{acid\ KMnO_4}$ **C**

C_6H_5 - OH $\xrightarrow{Zn\ dust}$ C_6H_6 + ZnO

Phenol Benzene

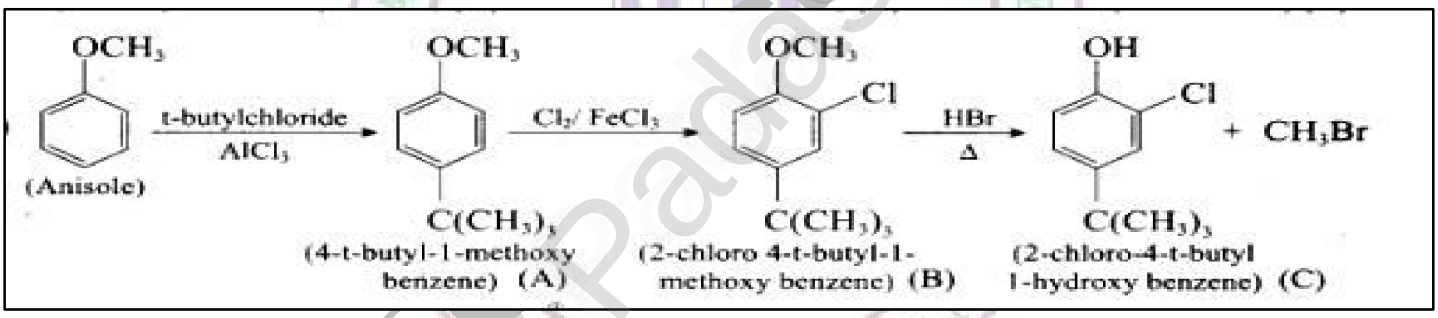
(A)

Anhydrs $AlCl_3$ | CH_3Cl

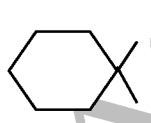


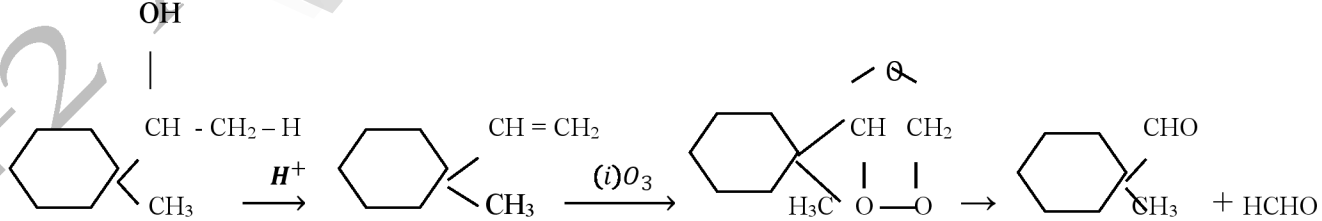
Benzene acid Toluene

A – Benzene; B – Toluene; C – Benzoic acid



iii) Anisole $\xrightarrow{t-butylchloride}$ **A** $\xrightarrow{Cl_2/FeCl_3}$ **B** $\xrightarrow{HBr}$ **C**

iv)  **CHOHCH$_3$** $\xrightarrow{H^+}$ **A** $\xrightarrow[ii)\ H_2O]{i)\ O_3}$ **B**



(ii) H_2O

18. 0.44g of a monohydric alcohol when added to methyl magnesium iodide in ether liberates at STP 112 cm^3 of methane with PCC the same alcohol form a carbonyl compound that answers silver mirror test. Identify the compound.

$$R\text{-}OH + CH_3MgI \rightarrow CH_4 + Mg\begin{matrix} I \\ \diagup \\ \diagdown \\ OR \end{matrix}$$

$$CH_3 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} - CH_2OH$$

$22400cm^3$ at STP is $112cm^3$

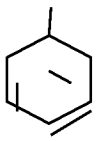
Mass of alcohol $= \frac{0.44 \times 22400}{112} = 88g$

$C_5H_{12}O$ Molecular formula has mass number 88 and it shows **8 possible isomers.**

- The alcohol must be a **primary alcohol** which on oxidation gives aldehyde with mass of 88g.
- Primary alcohol (n-pentyl Alcohol, neopentyl alcohol)reacts with PCC to give a carboxyl compound which answers silver mirror test.
- primary alcohol (5 carbon)= ***n-pentyl Alcohol, neopentyl alcohol, 3-methyl-1-butanol, 2-methyl-1-butanol***

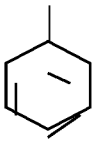
19. Complete the following reactions

i) **OH**



$$\xrightarrow[OH^-]{C_6H_5COCl} \mathbf{A} \xrightarrow{Nitration} \mathbf{B}$$ **(Major product)**

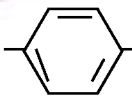
OH



$\xrightarrow{C_6H_5COCl}$

$OCOC_6H_5$

$\xrightarrow{Nitration}$ NO_2



$O - C - C_6H_5$

$\|$

O

Phenol Phenyl benzoate p-nitro phenyl benzoate (major)

A – Phenyl benzoate B – 4 – nitro phenyl benzoate

ii) $C_6H_5 - CHCH(OH)CH(CH_3)_2 \xrightarrow{Con\ H_2SO_4}$

$$C_6H_5 - CH_2 - CH(OH)CH(CH_3)_2 \xrightarrow[H_2SO_4]{Conc} C_6H_5 - CH = CH - CH(CH_3)_2$$

1-phenyl-3-methyl Butant-2-ol 1-phenyl-3-methyl but-2-ene

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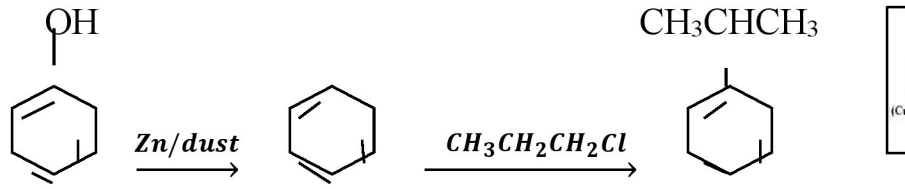
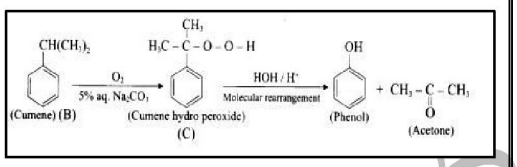
PLAN! PREPARE!! PRESENTATION!!!

20. Phenol is distilled with Zn dust followed by Friedel – crafts alkylation with propyl chloride to give a compound A, A on oxidation gives (B) Identify A and B.

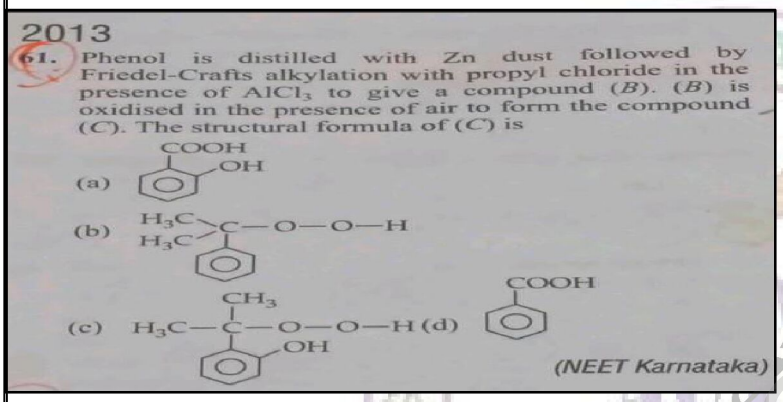


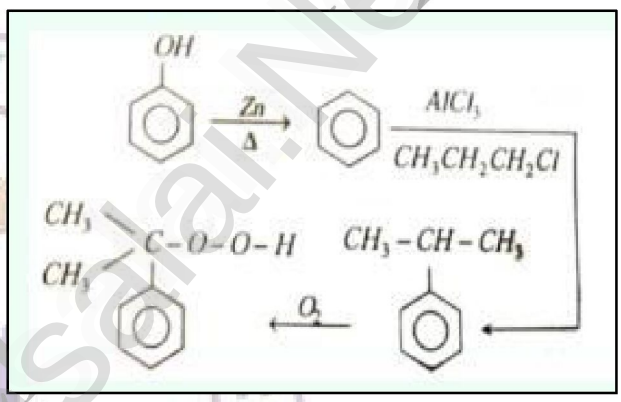
Phenol — Benzene — Anhydrs $AlCl_3$ — IsoPropyl benzene(cumene)

(Friedel Craft alkylation) (A)



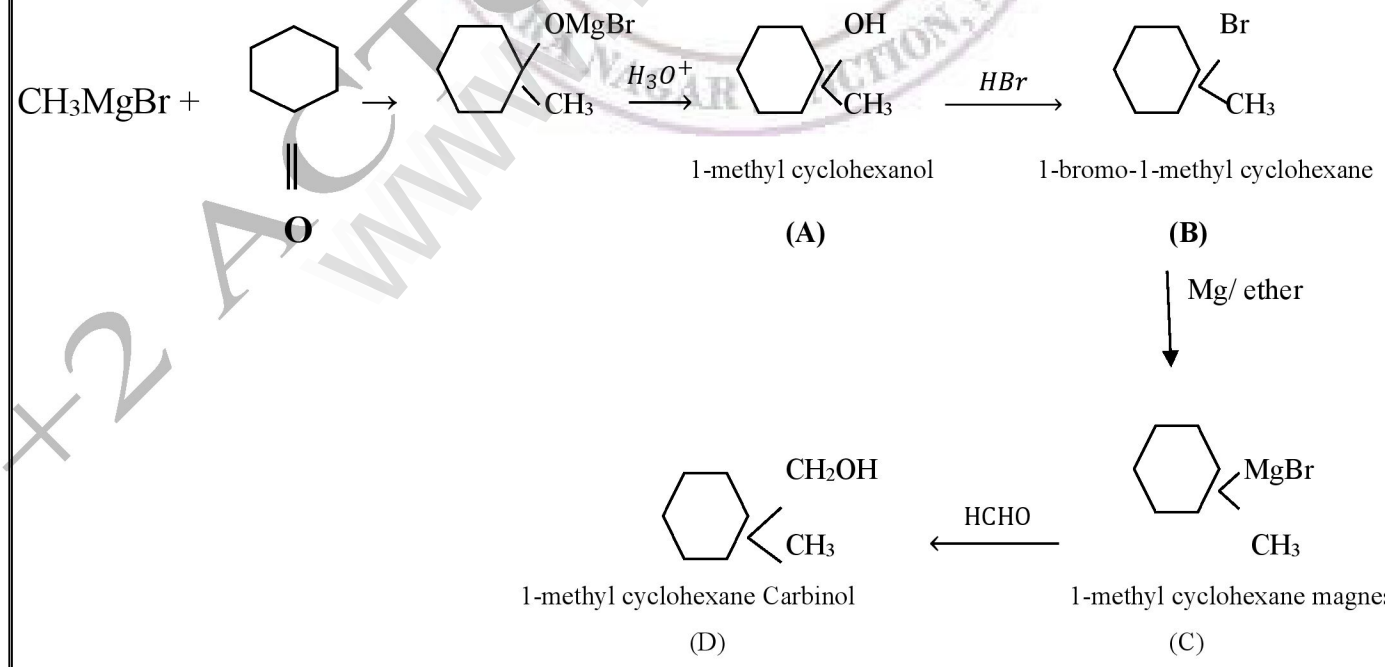
A– Isopropyl benzene (cumene) B- Cumene hydroperoxide





21.CH_3MgBr +  $\xrightarrow{H_3O^+}$ **A** $\xrightarrow{HBr}$ **B** $\xrightarrow{Mg/\,ether}$ **C** $\xrightarrow{HCHO\,/\,H_3O^+}$ **D**

O Identify A,B,C,D and write the complete equation:



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A – 1-methyl cyclohexanol B – 1-bromo-1- methyl cyclohexane

C – 1-methyl cyclohexane magnesium bromide D – 1-methyl cyclohexane carbinol

22. What will be the product for the following reaction

acetylchloride $\xrightarrow[\text{ii) } H_3O^+]{\text{i) } CH_3MgBr}$ **X** $\xrightarrow{acid\ K_2Cr_2O_7}$ **A Identify X and A**

$$CH_3C(=O)Cl + CH_3MgBr \rightarrow CH_3-C(Cl)(OMgBr)-CH_3 \xrightarrow{HOH} CH_3-C(=O)-CH_3 \xrightarrow[H^+]{K_2Cr_2O_7} CH_3COOH$$

Acetyl chloride — Methyl Magnesium Bromide — Acetone (X) — Acetic Acid (A)

X – CH_3COCH_3 – Acetone

A – CH_3COOH – Acetic Acid

23. How will you convert acetylene into n-butyl alcohol.

$$CH{\equiv}CH \xrightarrow{H_2} CH_2=CH_2 \xrightarrow[H_2SO_4]{353K} CH_3CH_2OH \xrightarrow{HBr} CH_3CH_2Br \xrightarrow[\text{(Wurtz reaction)}]{CH_3CH_2Br,\ Na} CH_3CH_2CH_2CH_2 \xrightarrow{Cl_2} CH_3CH_2CH_2CH_2Cl \xrightarrow{NaOH} CH_3CH_2CH_2CH_2OH$$

Acetylene — Ni — ethene — ethanol — ethyl bromide — n-butane — n-butyl chloride — n-butanol

24. Predict the product A,B,X and Y in the following sequence of reaction

butan - 2- ol $\xrightarrow{SOCl_2}$ **A** $\xrightarrow[\text{ether}]{Mg}$ **B**

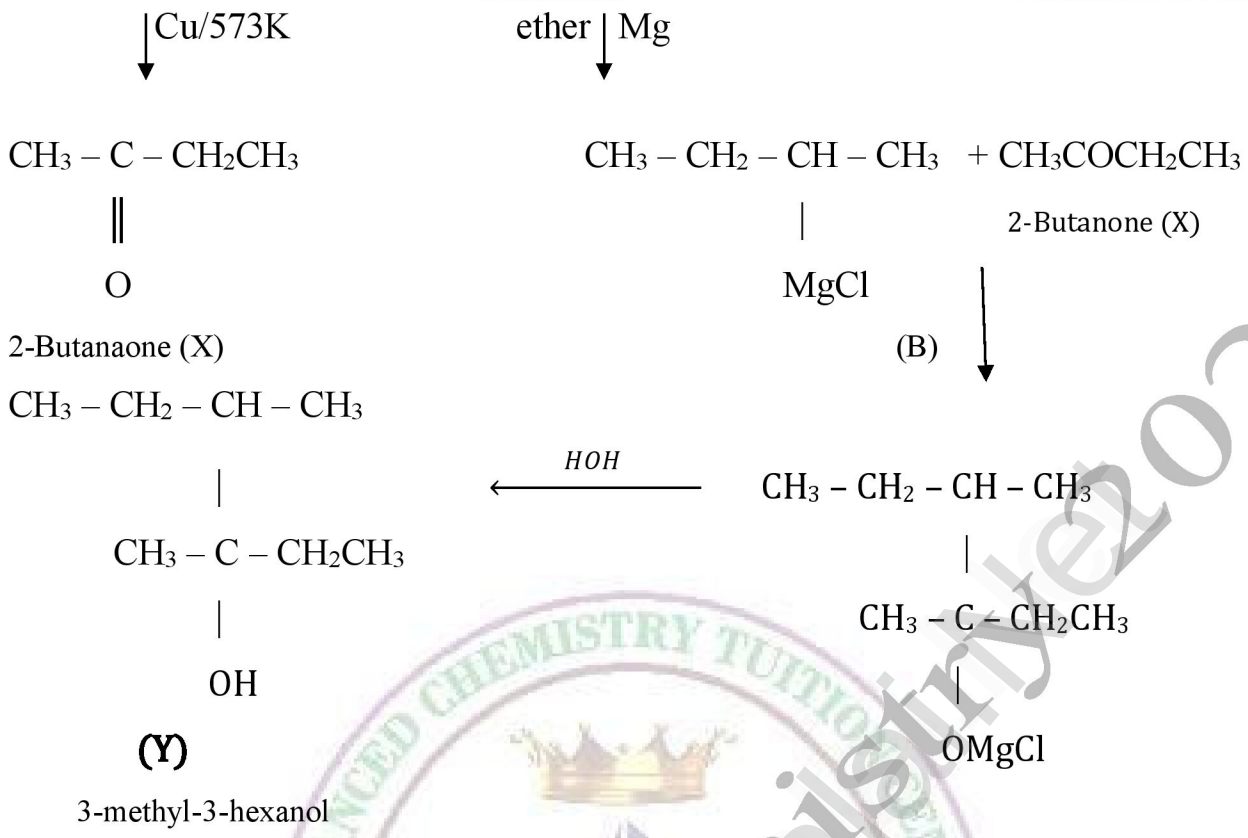
butan - 2- ol $\xrightarrow{Cu\ /\ 573K}$ **X**

B $\rightarrow$ **Y**

X **Y**

$$CH_3-CH_2-CH(OH)-CH_3 \xrightarrow{SOCl_2} CH_3-CH_2-CH(Cl)-CH_3$$

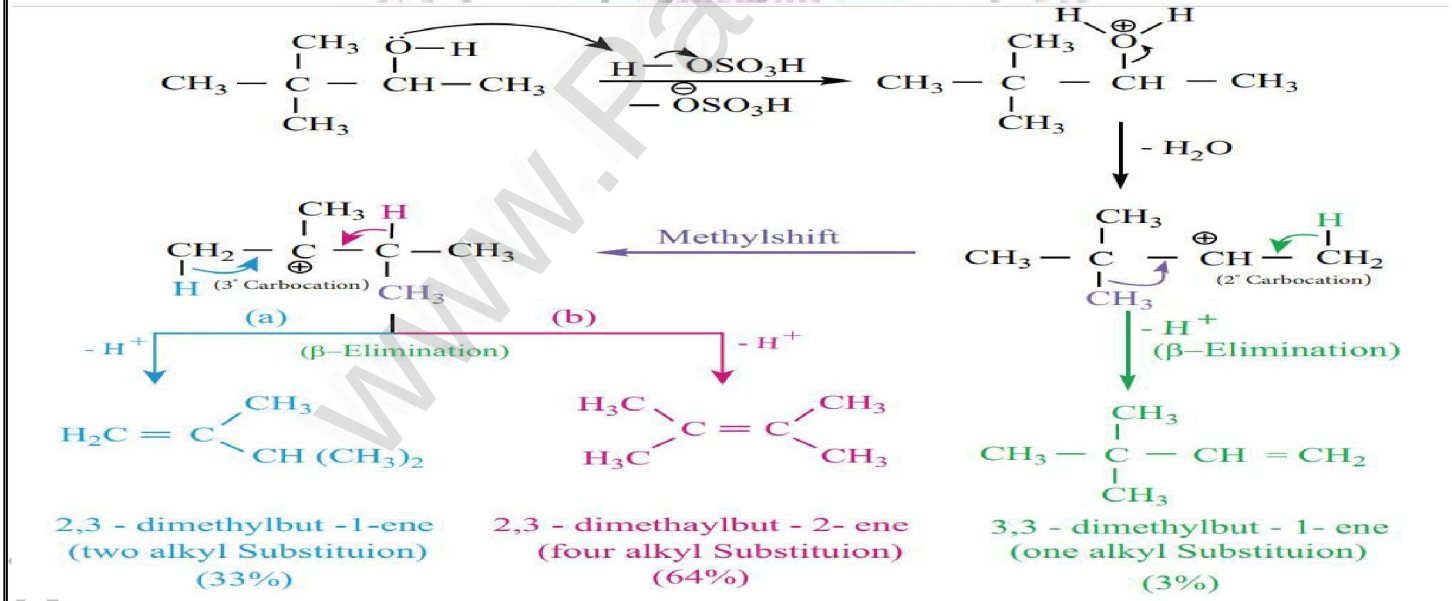
2-butanol — 2-Chloro butane (A)



A – 2-chloro butane B – Magnesium chloride X– 2-Butanone Y – 3-methyl-3-hexanol

25. 3,3 – dimethylbutan -2-ol on treatment with conc. H_2SO_4 to give tetramethyl ethylene as a major product. Suggest a suitable mechanism (BOOK Page number:116)

When 3,3-dimethyl-2-butanol is heated conc H_2SO_4, the elimination occurs after carbocation rearrangement resulting in the formation of 2,3-dimethyl but-2-ene.



IMPORTANT QUESTIONS

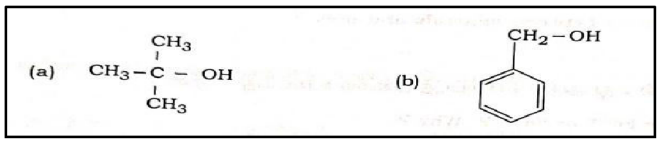
1. Classification of alcohol.(105)
2. Write the IUPAC names of the following compounds. **PTA2M**

i) $C_6H_5 – O – CH_2 – CH – CH_3$ (134M) ii) $CH_2 = CH – CH_2 – CH_2OH$ (107M)

CH_3

iii) Neopentyl alcohol (106) iv) Glycerol (107)

3. Give the IUPAC names: **M22 2M**



4. Write all the possible isomers of an alcohol having molecular formula $C_5H_{12}O$.(107)
5. Structure of alcohol.(107)
6. Preparation of primary, secondary, Tertiary alcohol(108)
7. Propene to 2-propanol.(107)
8. Formaldehyde to primary alcohol (Formaldehyde to ethanol).
   (Formaldehyde + $C_6H_5MgBr \rightarrow ?$) (108)
9. Acetaldehyde to secondary alcohol (Acetaldehyde to isopropyl alcohol)
   (Acetaldehyde + $CH_3CH_2MgBr \rightarrow ?$)(108)
10. Acetone to Tertiary alcohol (Acetone to tert-butyl alcohol)
    (Acetone + $CH_3CH_2CH_2CH_2MgBr \rightarrow ?$) (108)
11. Ethyl methanoate to isopropyl alcohol. (108)
12. How will you prepare the following by using Grignard reagent? **M20 5M ii**
    A)Propan-1-ol B) propan-2-ol
13. Write note on Hydroboration.(109)
14. Crotonaldehyde to crotyl alcohol. (109)
15. Benzyl alcohol to benzaldehyde(109)
16. What is Baeyer's reagent? How it is useful to convert ethane to ethane-1, 2-diol?**S20 5Mi**
    (What happens when ethylene reacts with cold dilute alkaline $KMnO_4$?) (110)
17. Write note on saponification. (110)
18. Lucas test for primary, secondary, tertiary alcohol. (110) **J20 5MARK, S20 5M I, J23 5M, M24 5M**
19. Victor Meyer test for primary, secondary, tertiary alcohol. (111)
20. State Saytzeff's rule.(2, 3-dimethylpentan-3-ol)114
21. Swern oxidation.(117) **PTA 5M i**

22. Biological oxidation(118)

23. Esterification.(118)

24. Oxidation primary, secondary alcohol, Tertiary alcohol. (117)

25. Is it possible to oxidize t-butyl alcohol using acidified dichromate to form a carbonyl compound? (BB142) **PTA2M**

26. Cu/573K of primary, secondary alcohol, Tertiary alcohol. (118)

27. Glycol to ethene, Glycol to dinitroglycol. (119)

28. Glycol to oxirane, glycol to acetaldehyde. **A21 3M i** (119)

29. Write the reaction of ethylene glycol with Con H_2SO_4? (120)

Ethylene glycol $\xrightarrow{Con\ H2SO4}$ X. Identify X. **J23 2M**

30. Oxidation of Ethylene glycol. (120)

31. Write the chemical equation for oxidation of ethylene glycol with periodic acid.(120) **PTA 2M**

32. Glycerol to TNG. (121)

33. What happens when glycerol react $KHSO_4$? (121)(Glycerol to Acrolein)**A21 3Mi GM 3M PTA5Mi**

34. Oxidation of glycerol(121)

35. What is meant by glycerose.(121)

36. Uses of glycerol.(122) **J22 2M**

37. Preparation of phenol

From chlorobenzene – dow process, From benzene sulphonic acid, From aniline, From benzene or cumene

38. **Chemical properties of phenol**

Zn, NH_3 /Anhydrous $ZnCl_2$, CH_3COCl, C_6H_5COCl, NaOH/ CH_3I, Oxidation - Acidified $K_2Cr_2O_7$, Reduction – Ni/160°C, Nitrosation – HNO_2/278K, 20% HNO_3/298K, Conc HNO_3/Conc H_2SO_4, Sulphonation –Conc.H_2SO_4, Br_2/H_2O, Br_2/CCl_4 /278K, Kolbe (or) Kolbe schmit reaction **M24 2M**

39. Riemer-tiemann reaction, **PTA 5M i** Pthalein reaction.

40. Schotten – Baumann reaction. (127) **PTA 5M i**

41. Test to differentiate alcohol and phenols, Uses of phenol

42. Give the coupling reaction of phenol. (131) **M20 5Mi**

43. How the following conversions are effected? **GM 5M**

i) phenol to salicyaldehyde (130)

ii) phenol to phenolthalein (131)

iii) Glycol to 1,4 dioxane (120)

44. Acidity of phenol. (124)

45. Why is C – O – C bond angle in ether slightly greater than the tetrahedral bond angle?(133) **M20 2MARK COMPULSORY**

46. Preparation of ether(134) Write any one method of preparation for diethyl ether? **M22 3M**

47. Chemical properties of ether.(136)

48. Explain auto oxidation of ethers. (137) **S20 5M ii**

49. Mention the mechanism in the following reactions: (137) **J20 3MARK**

(a) One mole of HI reacts with methoxy ethane **ANS: SN^2**

(b) One mole of HI reacts with 2-methoxy 2-methyl propane **ANS: SN^1**

50. Electrophilic substitution reactions. (137)

51. Give the uses of diethyl ether. (138) **A21 5Mii**

52. A ether (A) $C_6H_{12}O$ when heated with excess of hot concentrated HI, produced two alkyl halides, which on hydrolysis forms compound (B) and (C). Oxidation Of (B) gives an acid (D) where as oxidation of (C) gives ketone (E). Identify A, B, C, D and E and write the chemical equation. **PTA 5M**

53. Anisole $\xrightarrow{t-butylchloride\ AlCl3}$ A $\xrightarrow{Cl_2/FeCl_3}$ B $\xrightarrow{HBr}$ C. Complete the above reaction and Find A,B,C. (BB142) **PTA3M**

54. dehydration of glycerol (121) **5M ii**

55. How will you prepare 2-methyl hexan -2-ol form Grignard reagent? (108) **3M**

56. Write the mechanism of acid catalysed dehydration of ethanol to give ethene.(115) **5M i**

57. What are the tests to differentiate ethanol and phenols? (131) **3M**

58. An organic compound (A) – $C_3H_8O_3$ used a sweetening agent, which on oxidation with Fenton's reagent gives a mixture of compounds B and C. Identify A, B and C. Write Possible reactions. **3MC(121,122)**

59. Give four uses of diethyl ether. (138)**2M**

60. What will be the product (X and A) for the following reaction? **5M ii** ($BBQ_{22}143$)

Acetyl chloride $\xrightarrow{CH_3MgBr/H3O+}$ X $\xrightarrow{acidic/K2Cr2O7}$ A

61. The major product formed when 1- ethoxy prop-1-ene is heated with one equivalent of HI (BBQ_2142)**PTA 3Mi**

62. What happens when 1-phenyl ethanol is treated with acidified $KMnO_4$?(BBQ_9142) **PTA 3Mii**

63. An organic compound C_2H_6O (A) heated with Con H_2SO_4 at 443K to give an unsaturated hydrocarbon C_2H_4 (B), which on treatment with Bayer's reagent to give compound $C_2H_6O_2$ (C) which is used as antifreeze in automobile radiator. Compound (C) distilled with con H_2SO_4 to give cyclic compound $C_4H_8O_2$ (D). Compound (A) is heated with Con H_2SO_4 at 413K to give compound $C_4H_{10}O$ (E). Identify Compounds (A) to (E) and write equations. **PTA5M**

64. How the following conversions are effected? **G5M**

i) phenol to salicyaldehyde (130)

ii) phenol to phenolthalein (131)

i) Glycol to 1,4 dioxane (120)

LESSON 12 CARBONYL COMPOUNDS AND CARBOXYLIC ACIDS

Short Answer Questions

1. How is propanoic acid is prepared starting from

(a) an alcohol

$$CH_3 - CH_2 - CH_2 - OH \xrightarrow{H^+/K_2Cr_2O_7} CH_3 - CH_2 - COOH$$

(propan – 1 – ol) (Propanoicacid)

(b) an alkyl halide

$$CH_3 - CH_2 - Br \xrightarrow{Mg/ether} CH_3 - CH_2 - MgBr \xrightarrow{(i)CO_2} CH_3CH_2COOH + MgBr(OH)$$

(Ethyl bromide) (Ethyl magnesium bromide) (ii) H^+/H_2O (propanoic acid)

(Or)

$$CH_3 - CH_2 - CH_2 - Cl \xrightarrow{NaCN} CH_3 - CH_2 - CN \xrightarrow{H^+/H_2O} CH_3CH_2COOH$$

(n-Propyl chloride) -NaCl (Ethyl cyanide) Excess (Propanoic acid)

(c) an alkene

$$CH_2 = CH_2 \xrightarrow{HCl} CH_3 - CH_2 - Cl \xrightarrow{NaCN} CH_3 - CH_2 - CN \xrightarrow{H^+/H_2O} CH_3CH_2COOH$$

(Ethene) (Ethyl chloride) -NaCl (Ethyl cyanide) Excess (Propanoic acid)

2. A Compound (A) with molecular formula C_2H_3N on acid hydrolysis gives(B) which reacts with thionyl chloride to give compound(C). Benzene reacts with compound (C) in presence of anhydrous $AlCl_3$ to give compound(D). Compound (D) on reduction with Zn/Hg and Conc. HCl gives (D). Identify (A), (B), (C), (D) and E. Write the equations.

(i) Compound (A) with molecular formula C_2H_3N is methyl cyanide. (CH_3CN)

(ii) Methyl cyanide (A) on hydrolysis gives acetic acid (B)

$$CH_3CN \xrightarrow{H^+/H_2O} CH_3COOH$$

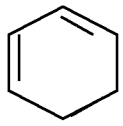
(Methyl cyanide) (A) Excess (Acetic acid) (B)

(iii) Acetic acid (B) with thionyl chloride to give acetyl chloride (C)

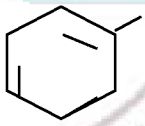
$$CH_3COOH \xrightarrow{SOCl_2} CH_3COCl + SO_2 + HCl$$

(Acetic Acid) (B) (Acetyl chloride) (C)

(iv) Benzene reacts with acetyl chloride (C) in the presence of anhydrous $AlCl_3$ to give acetophenone (D)


(Benzene)

$+ CH_3COCl \xrightarrow{Anhydrous\ AlCl_3}$



(Acetophenone) (D)

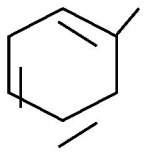
$+ HCl$

(Acetyl chloride) (C)

(v) Acetyl chloride (D) on reduced in the presence of **Zn/Hg and Conc. HCl**, to gives Ethylbenzene (E).

$$C_6H_5COCH_3 + 4(H) \xrightarrow{\frac{Zn}{Hg}\ conHCl} C_6H_5CH_2CH_3$$

COMPOUND	FORMULA	NAME
A	CH_3CN	Methyl cyanide
B	CH_3COOH	Acetic acid
C	CH_3COCl	Acetyl chloride

D		Acetophenone
E	$C_6H_5CH_2CH_3$	Ethyl benzene

3. Identify X and Y. $CH_3COCH_2CH_2COOC_2H_5 \xrightarrow{CH_3MgBr} X \xrightarrow{H_3O^+} Y$

$CH_3 - \overset{O}{\overset{\|}{C}} - CH_2 - CH_2 - COOC_2H_5 \xrightarrow{CH_3MgBr} CH_3 - \overset{OMgBr}{\overset{|}{C}}(CH_3) - CH_2 - CH_2 - COOC_2H_5$

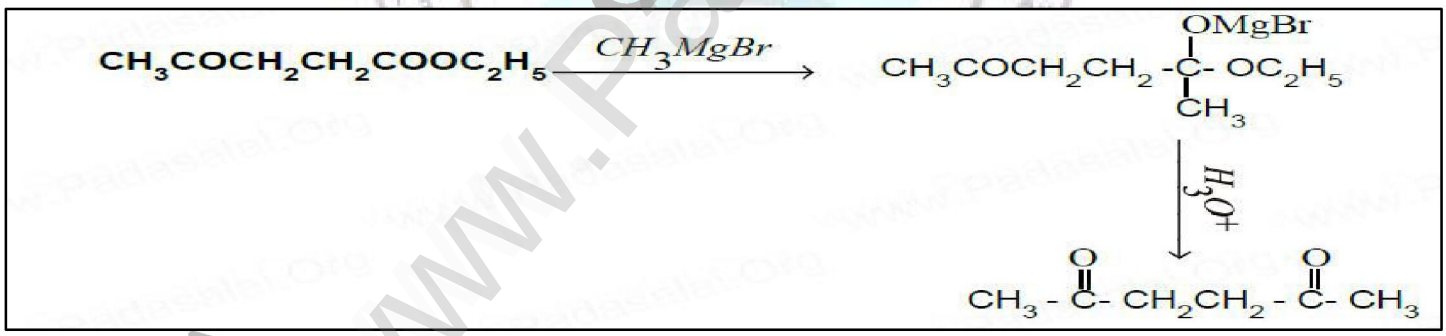
Butan – 2 – one – propionate (X)

Adduct

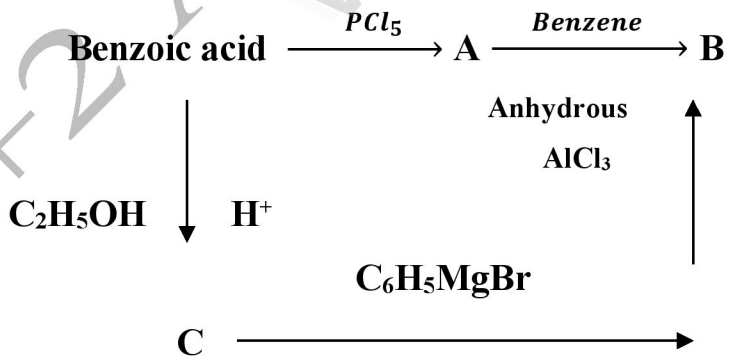
$\xrightarrow{H_3O^{(+)}}$

$CH_3 - \overset{OH}{\overset{|}{C}}(CH_3) - CH_2 - CH_2 - COOC_2H_5$ (Y)

2-methyl –butan -2 –hydroxy propionate



4. Identify A, B and C



$$C_6H_5COOH \xrightarrow{PCl_5} C_6H_5COCl \xrightarrow[\text{Anhydrous } AlCl_3]{C_6H_6} C_6H_5COC_6H_5 + HCl$$

(Benzoic acid) (Benzoyl chloride) (A) (Benzophenone) (B)

$$C_6H_5COOC_2H_5 \xrightarrow[H^+]{C_2H_5OH} C_6H_5MgBr$$

(Ethyl benzoate) (C) $- MgBr(OC_2H_5)$

COMPOUND	FORMULA	NAME
A	C_6H_5COCl	Benzoyl chloride
B	$C_6H_5COC_6H_5$	Benzophenone
C	$C_6H_5COOC_2H_5$	Ethyl benzoate

5. Identify A, B, C and D

ethanoic acid $\xrightarrow{SOCl_2}$ **A** $\xrightarrow{Pd/BaSO_4}$ **B** $\xrightarrow{NaOH}$ **C** $\xrightarrow[\Delta]{}$ **D**

$$CH_3COOH \xrightarrow{SOCl_2} CH_3COCl \xrightarrow[H_2]{Pd/BaSO_4} CH_3CHO + HCl$$

(Ethanoic acid) (Acetyl chloride) (A) (Acetaldehyde) (B)

$\downarrow$ NaOH

$$CH_3 - CH = CH - CHO \xleftarrow[-H_2O]{\Delta} CH_3 - CH(OH) - CH_2 - CHO$$

(Crotonaldehyde)

(D) OH

Aldol (3 – hydroxyl butanal) (C)

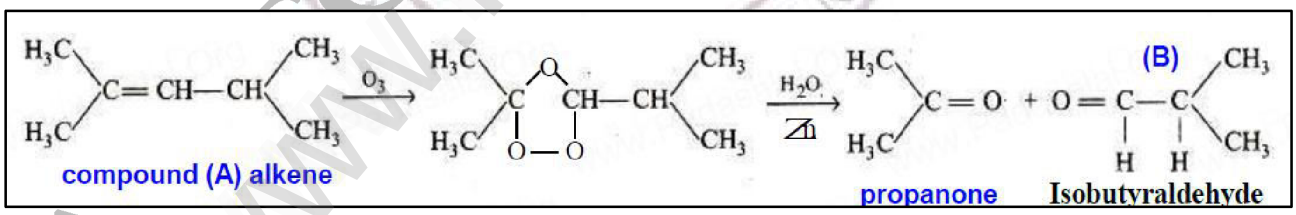
COMPOUND	FORMULA	NAME
A	CH_3COCl	Acetyl chloride
B	CH_3CHO	Acetaldehyde
C	$CH_3 - CH(OH) - CH_2 - CHO$	3 – Hydroxy butanal (aldol)
D	$CH_3 - CH = CH - CHO$	Crotonaldehyde

6. An alkene (A) on ozonolysis gives propanone and aldehyde (B). When (B) is oxidised (C) is obtained. (C) is treated with Br_2/P gives (D) which on hydrolysis gives (E). When propanone is treated with HCN followed by hydrolysis gives (E). Identify A, B, C, D,E.

(i) 2 –methyl –but -2 –ene (A) on ozonolysis gives propanone and Isobutyraldehyde (B)

$$CH_3 - C(CH_3) = CH - CH(CH_3) - CH_3 \xrightarrow[Zn\,/\,H_2O]{O_3} CH_3CHCHO + CH_3 - C(=O) - CH_3$$

2,4-dimethyl pent-2-ene (A) → Isobutyraldehyde (B) + (Propanone)



(ii) Isobutyraldehyde (B) is oxidised to give Isobutyric acid (C), which on further treated with Br_2/P give 2-bromo-2-methylpropanoic acid(D) which on hydrolysis gives 2-methyl-2-hydroxypropanoicacid(E).

$$CH_3CHCHO \xrightarrow{H^+/K_2Cr_2O_7} CH_3CHCOOH \xrightarrow{Br_2/P} CH_3CCOOH \xrightarrow{with\ aqueous\ NaOH} CH_3CCOOH$$

(O) Excess Br OH

(isobutyraldehyde) (B) (Isobutyric acid) (C) (2-Bromo-2-methyl propanoic acid) (D) (2-methyl-2-hydroxypropanoicacid) (E)

(iii) Propanone is treated with HCN followed by hydrolysis to gives 2-methyl-2-hydroxy propanoic acid (E)

$$CH_3 - \underset{\underset{O}{\|}}{C} - CH_3 \xrightarrow[(ii)\ H+/\ H_2O]{(i)HCN} CH_3 - \underset{\underset{OH}{|}}{\overset{\overset{COOH}{|}}{C}} - CH_3$$

(Propanone) (2-methyl-2-hydroxy propanoic acid)

COMPOUND	FORMULA	NAME
A	$CH_3 - \underset{\underset{CH_3}{|}}{C} = CH\overset{\overset{CH_3}{|}}{CH} - CH_3$	2,4-dimethyl pent-2-ene
B	$CH_3\overset{\overset{CH_3}{|}}{CH} - CHO$	Isobutraldehyde
C	$CH_3\overset{\overset{CH_3}{|}}{CH} - COOH$	Isobutyric acid
D	$CH_3C(Br)(COOH)CH_3$	2-bromo-2-methyl propanoic acid
E	$CH_3C(OH)(COOH)CH_3$	2-methyl-2-hydroxy propanoic acid

7. How will you convert benzaldehyde into the following compounds?

(i) benzophenone

Conversion of benzaldehyde into benzophenone.

$$C_6H_5CHO \xrightarrow{OH^{\ominus}/KMnO_4} C_6H_5COOH \xrightarrow[\Delta]{NaOH/CaO} C_6H_6 \xrightarrow[\text{Anhydrous } AlCl_3]{C_6H_6COCl} C_6H_5COC_6H_5 + HCl$$

(Benzaldehyde) (O) (Benzoic acid) (Benzene) Benzoylation (Benzophenone)

(ii) benzoic acid

Conversion of benzaldehyde into benzoic acid:

$$C_6H_5CHO \xrightarrow{OH^{\ominus}/KMnO_4} C_6H_5COOH$$

(Benzaldehyde) (O) (Benzoic acid)

(iii)α -hydroxyphenylaceticacid.

Conversion of benzaldehyde into 2-hydroxy phenyl acetic acid:

$$C_6H_5CHO \xrightarrow{HCN} C_6H_5-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-CN \xrightarrow[\text{Excess}]{H^+/H_2O} C_6H_5-\underset{\underset{OH}{|}}{\overset{\overset{H}{|}}{C}}-COOH$$

(Benzaldehyde) (Phenyl Cyanohydrin) (2-hydroxy phenyl acetic acid) (Mandelic acid)

8. What is the action of HCN on

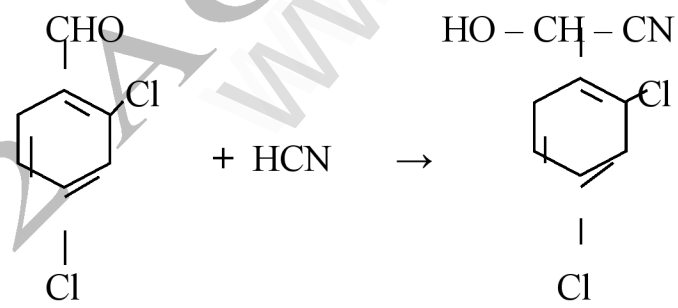
(i) propanone

Propanone reacts with HCN:

$$CH_3-\underset{\underset{O}{\|}}{C}-CH_3 + HCN \rightarrow CH_3-\underset{\underset{OH}{|}}{\overset{\overset{CN}{|}}{C}}-CH_3$$

(Propanone) (Acetone) (Acetone Cyanohydrin)

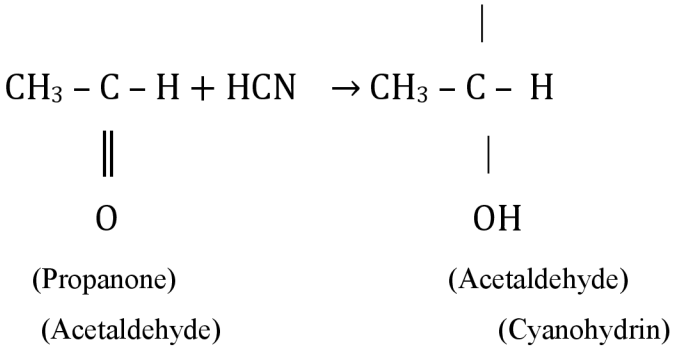
(ii) 2,4-dichlorobenzaldehyde.



2,4-dichlorobenzaldehyde (2,4-dichlorobenzaldehyde cyanohydrin)

(iii) ethanal

CN

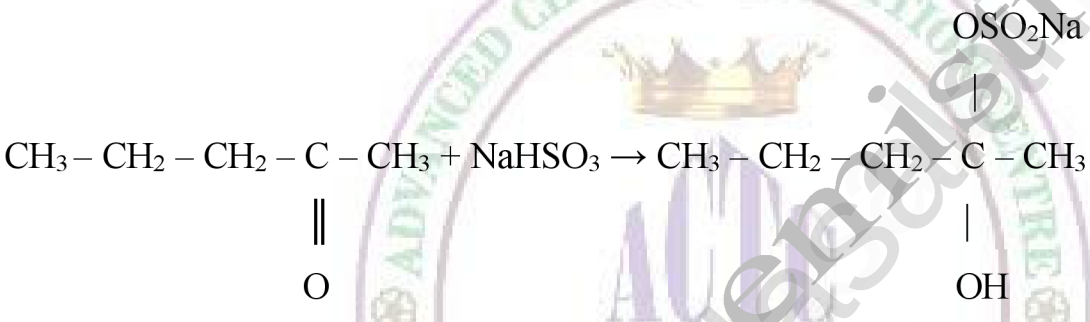


(Propanone) (Acetaldehyde)

(Acetaldehyde) (Cyanohydrin)

9. A carbonyl compound A having molecular formula $C_5H_{10}O$ forms crystalline precipitate with sodium bisulphate and gives positive iodoform test. A does not reduce Fehling solution. Identify A.

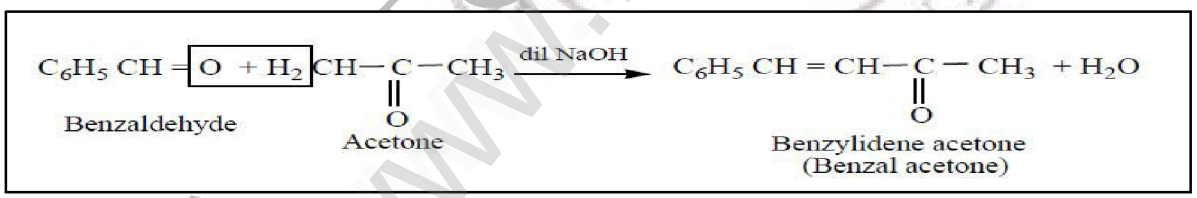
A carbonyl compound having molecular formula $C_5H_{10}O$ giving positive iodoform test and does not reduce Fehling solution is 2- pentanone.



2-pentanone Pentanone bi sulphite

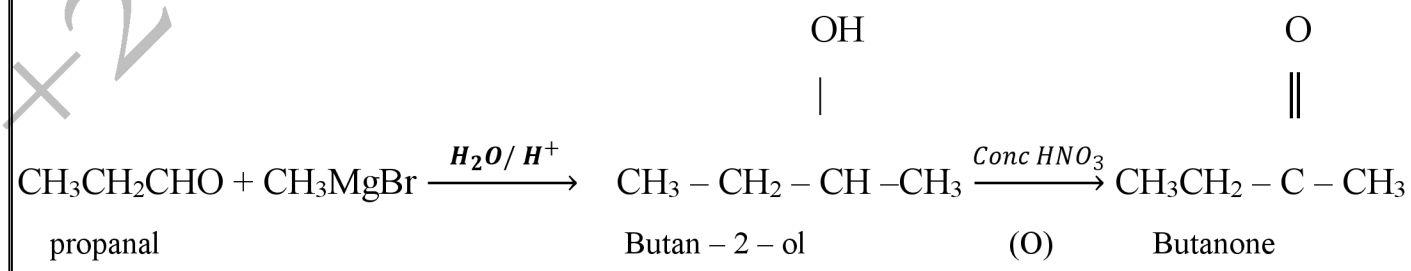
Compound (A) is 2-pentanone.

10. Write the structure of the major product of the aldol condensation of benzaldehyde with acetone.



11. How are the following conversions effected

(a) propanal into butanone



propanal Butan – 2 – ol Butanone

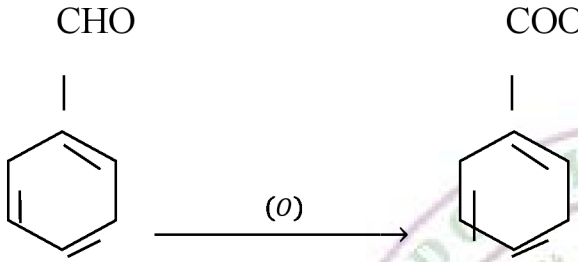
(b) Hex-3-yne into hexan- 3-one.

$$CH_3 - CH_2 - C \equiv CH_2 - CH_2 - CH_3 + H_2O \xrightarrow[H_2SO_4]{HgSO_4} CH_3CH_2 - \underset{\underset{O}{\|}}{C} - CH_2 - CH_2CH_3$$

Hex – 3 - yne Hexan – 3 - one

Hydration of alkyne in 42% sulphuric acid containing $HgSO_4$ as catalyst

(c) phenyl methanal into benzoic acid



Phenyl methanal Alk $KMnO_4$ Benzoic acid

(or)

Benzaldehyde

(d) phenyl methanal into benzoin

$$C_6H_5CH = O + H - CO - C_6H_5 \xrightarrow{alc} C_6H_5CHOH - CO - C_6H_5$$

Phenyl methanal KCN Benzoin

(or)

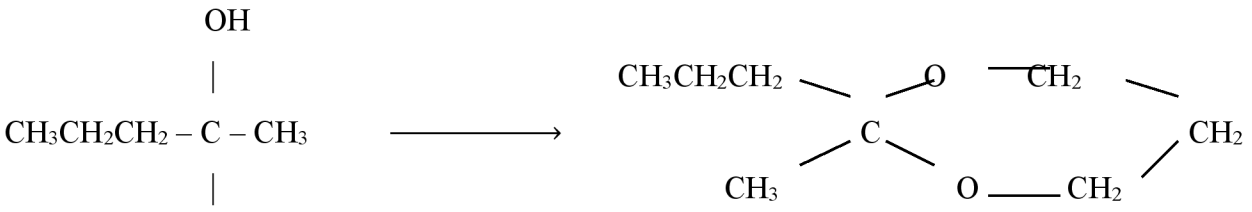
Benzaldehyde

12. **Complete the following reaction.** $CH_3\text{-}CH_2\text{-}CH_2\text{-}\underset{\underset{O}{\|}}{C}\text{-}CH_3 \xrightarrow[H^+]{HO-CH_2-CH_2-CH_2-OH}$ **?**

$$CH_3 - CH_2 - CH_2 - \underset{\underset{O}{\|}}{C} - CH_3 + HO - CH_2 - CH_2 - CH_2 - OH$$

Pentanone 1,3 - propanediol

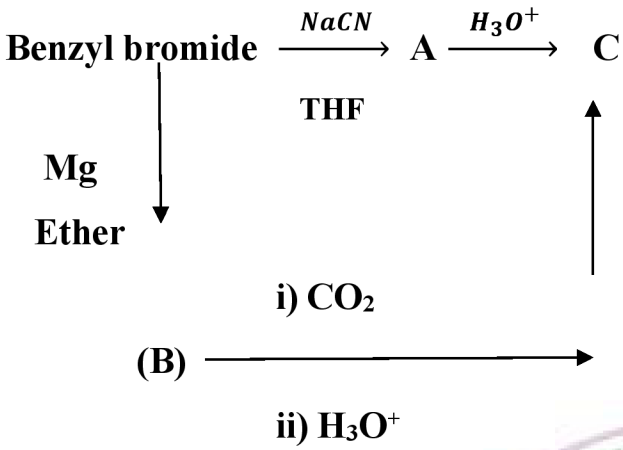
H^+

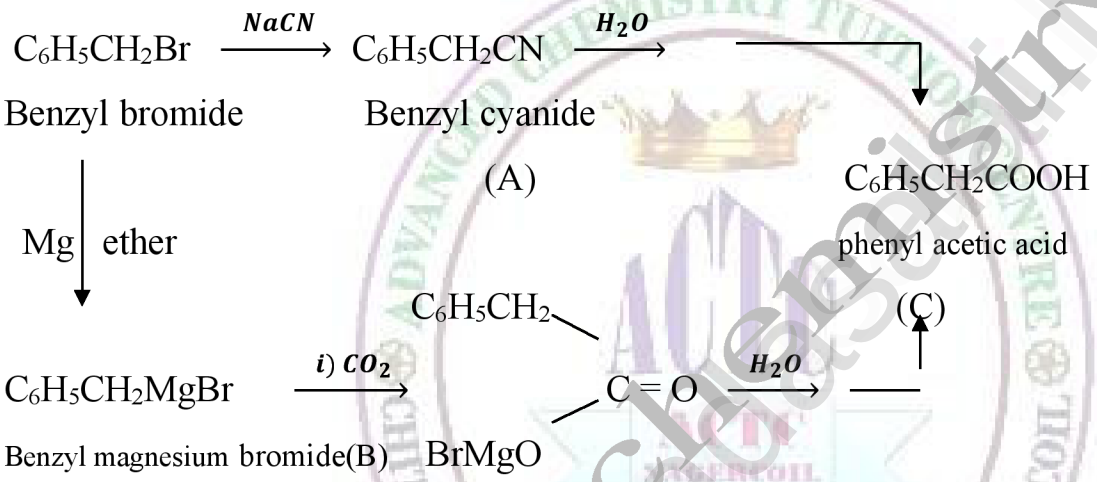


$OCH_2CH_2CH_2OH$ Cyclic ketal

Hemi ketal

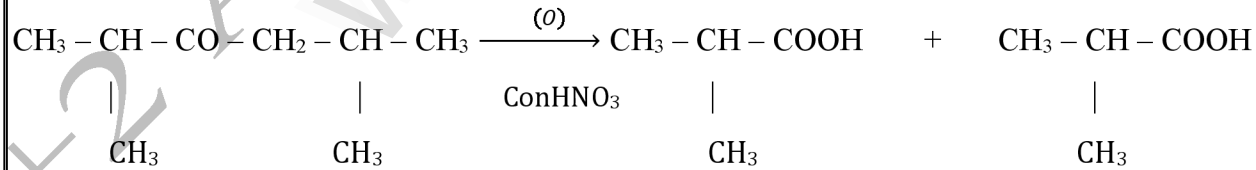
13.Identify A, B and C





COMPOUND	FORMULA	NAME
A	$C_6H_5CH_2CN$	Benzyl cyanide
B	$C_6H_5CH_2MgBr$	Benzyl magnesium bromide
C	$C_6H_5CH_2COOH$	Phenyl acetic acid

14.Oxidation of ketones involves carbon - carbon bond cleavage. Name the product (s) is / are formed on oxidizing 2,5 – dimethyhexan - 3– one using strong oxidizing agent.



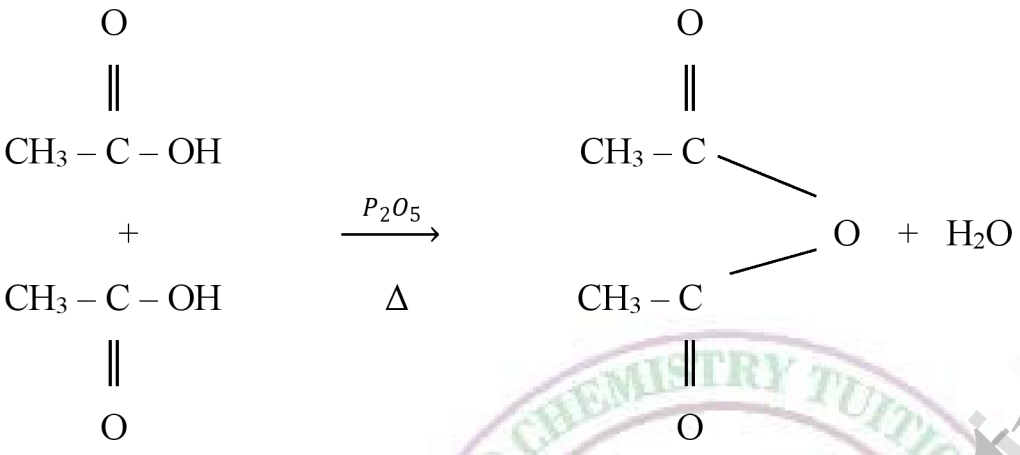
2,5-dimethyl hexan -2-one 2-methyl propanoic acid 2-methyl propanoic acid

The oxidation of unsymmetrical ketones is governed by Popoff's rule. It states that during ***the oxidation of an unsymmetrical ketone, a (C-CO) bond is cleaved in such a way that the keto group stays with the smaller alkyl group.***

15.How will you prepare

i. Acetic anhydride from acetic acid

Carboxylic acid on heating in the presence of a strong dehydrating agent such as P_2O_5 forms acid anhydride.



Acetic acid Acetic anlydride

ii. Ethylacetate from methylacetate

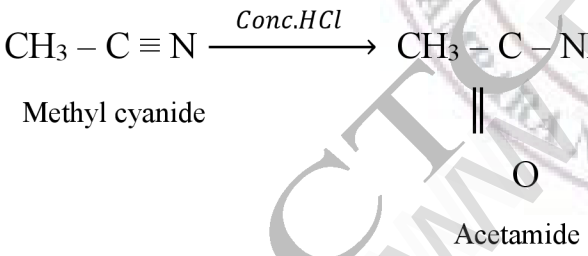
Presence of a little acid, methyl acetate is cleaved by ethyl alcohol to form ethyl acetate.

$$CH_3COOCH_3 + C_2H_5OH \xrightarrow{H^+} CH_3COOC_2H_5 + CH_3OH$$

This is called 'trans esterification '.

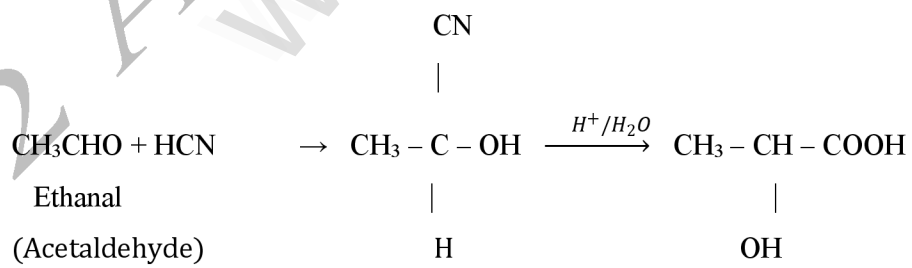
iii. Acetamide from methylcyanide

Partial hydrolysis of alkyl cyanides with cold con HCl gives amides



Methyl cyanide Acetamide

iv. Lactic acid from ethanal

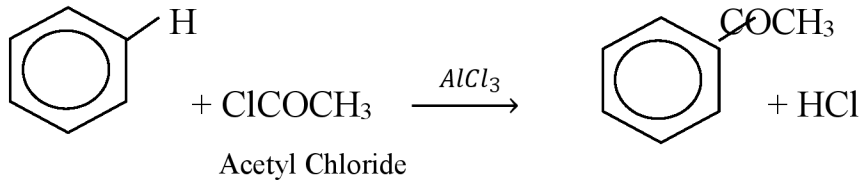


Acetaldehyde

Cyanohydrin Lactic acid

v. Acetophenone from acetylchloride

Friedel Crafts acetylation of benzene with CH_3COCl/ $AlCl_3$



Acetyl Chloride

Benzene Acetophenone

vi. Ethane from sodium acetate

$$2CH_3COONa + 2H_2O \xrightarrow{Electrolysis} CH_3 - CH_3 + 2CO_2 + H_2 + 2NaOH$$

Sodium acetate Ethane

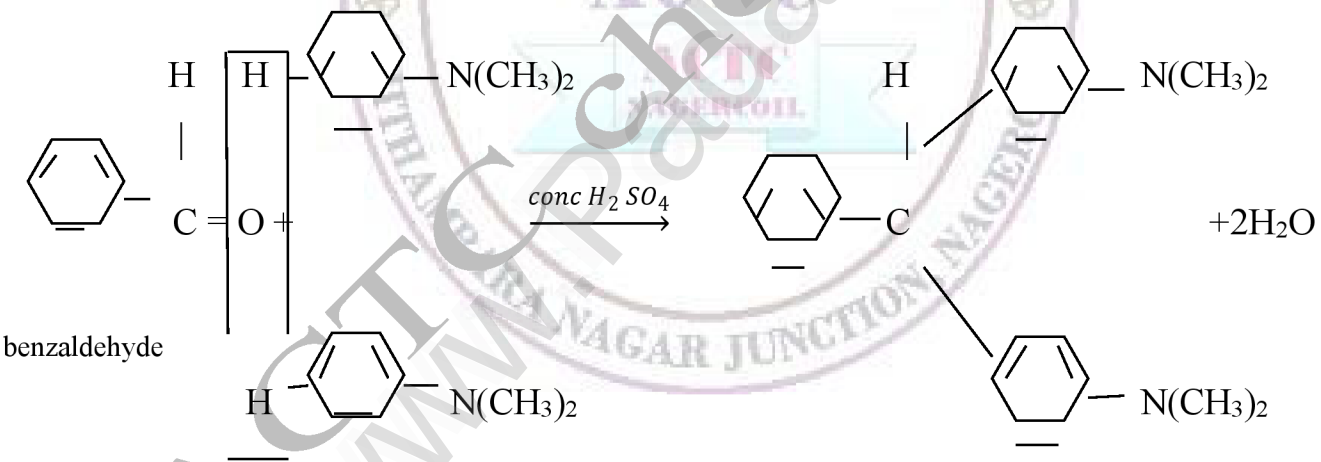
vii. Benzoic acid from toluene

Toluene is oxidised by acidified $KMnO_4$.

$$C_6H_5CH_3 \xrightarrow{H^+/KMnO_4} C_6H_5COOH$$

viii) Malachitegreen from benzaldehyde

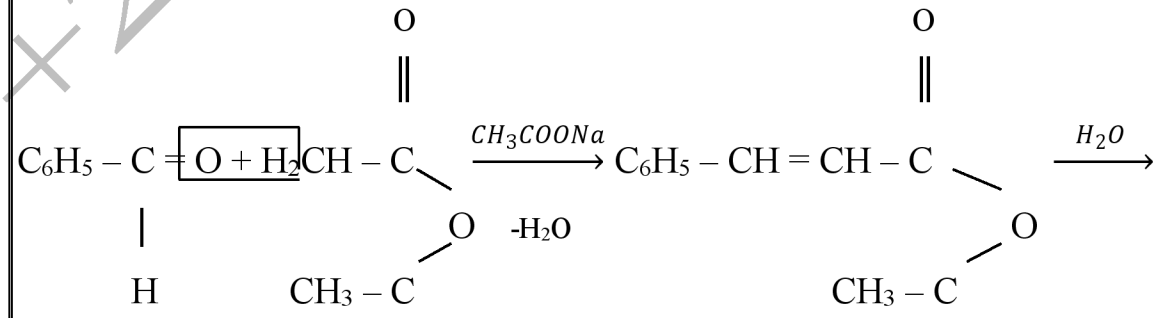
Benzaldehyde condenses with tertiary aromatic amines like N, N – dimethyl aniline in the presence of strong acids to from triphenyl methane dye.



benzaldehyde

N,N-Dimethyl aniline Malachite green dye

ix) Cinnamic acid from benzaldehyde



benzaldehyde + Acetic anhydride

$C_6H_5\ CH = CH - COOH + CH_3COOH$

Cinnamic acid Acetic acid

x) Acetaldehyde from ethyne

$$HC \equiv CH + H - OH \xrightarrow{HgSO_4\ /H_2SO_4} \left[\begin{array}{c} H\ \ H \\ /\ \ / \\ H - C = C - OH \end{array} \right] \xrightarrow{isomeries} CH_3 - CHO$$

Ethyne ethanal

1. How will you prepare ethanal by ozonolysis? (149) Ethene, propene, 1-butene, 2-butene
2. What happens when isobutylene is subjected to reductive ozonolysis? (149) **J23 3M**
3. How are the following conversions effected? **PTA2M**
   i) Hex-3-yne → hexan-3-one (150 model)
   ii) benzaldehyde → 2-hydroxy phenyl acetic acid. ($BBQ_8$193)
4. Rosenmund reduction (151) **J22 2M**
5. Name the catalyst used in Rosenmund reduction and state its importance.(151) **M20 2M**
6. How is the following conversion affected? Hex-4-enitrile → hex-4-enal (151)**PTA5M ii**
7. Stephen's reaction (151)
8. Etard reaction (151) **PTA 3M**
9. Gattermann Koch reaction (151)
10. Friedel crafts acylation (151)
11. How is benzaldehyde manufactured commercially? (152)
12. How are the following conversions affected? **5M ii**
    (X) Benzene → acetophenone (153) (Y) Benzaldehyde → hydrobenzamide (159)
13. How will you prepare aldimine? (158)
14. What is Urotropine? How it is prepared? and uses (158) **J20 2M**
15. Popoff's rule (159)
16. Clemmensen reduction (160) How will you c
17. Wolf kishner reduction (161)
18. Haloform reaction (161) **M22 3M**
19. Crossed aldol condensation (162)

20. What happens on heating of aldol? (161)

21. Explain Aldol condensation with mechanism (161) **S20 5M GM 3M**

22. Explain Cannizaro reaction with mechanism (163) **PTA 3M**

23. Claisen Schmidt condensation (163)

24. Crossed cannizaro reaction (164)

25. Perkin's reaction (165)

26. Knoevenagal reaction (165) **PTA 3Mi, M24 3M**

27. How will you convert benzaldehyde into the following compounds? (165) **A21 5M**

(i) Benzoin **J22 5Mii** (ii) Cinnamic acid (iii) Malachite green **PTA 2M**

28. Note on Schiff's base (165)

29. Test for aldehyde (166)

30. Explain Benedict's solution test. (167) **S20 3M**

31. What is Formalin? What is its use? (167) **M20 5Mi J23 2M**

32. How acetic acid is prepared from Grignard reagent? (170) **M24 5Mi**

33. How will you prepare benzoic acid from toluene?(171) **PTA 3M I, J24 2M**

34. What happens when ethanoic acid reacts with ethanol in the presence of con H_2SO_4. Give its complete mechanism. (173) **5M i**

35. How does sodium salt react with soda lime? (175)

36. HVZ reaction (176)

37. Formic acid reduces Tollens reagent whereas acetic acid does not reduce. (177) **M20 3M**

Explain the reducing action of formic acid with example. (177) **M22 5M**

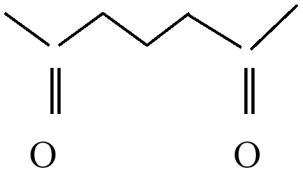
38. Test for carboxylic acid (177) **J20 3M, A21 3M, J22 5Mi**

39. Why formic acid act as strong reducing agent? Give one equation to show its reducing property. (177) **2M**

40. Benzoic acid $\xrightarrow{PCl5}$ A $\xrightarrow{benzene/\ anhydrous\ AlCl_3}$ B **J24 3M**

41. Identify A and B (by bond line structure) **J20 5Mi**

(i) HO OH $\xrightarrow{SOCl_2}$ A $\xrightarrow{2NH_3}$ B



42. Effect of substituents on the acidity of carboxylic acid. (178)

43. Complete the reaction **PTA5M ii**

(x) $CH_3 - CH = \underset{\displaystyle CH_3}{\overset{\displaystyle |}{C}} - CH_3 \xrightarrow{(i)O_3 \ /(ii)\ Zn/H2O}$? **(149)** (y) $CH_3COCH_3 \xrightarrow{Mg-Hg/H2O}$? **(161)**

44. Arrange the following in the increasing order of relative reactivity of acid derivatives and mention the reason alone. $CH_3COOC_2H_5$, CH_3COCl, CH_3CONH_2, $CH_3COOCOCH_3$ (180) **J20 5Mii**

45. How will you covert Ethylacetate into Ethylaceto acetate? (Claisen Condensation) (186) **M23 3M**

46. Uses of formic acid(188)

47. A carbonyl compound A having molecular formula $C_5H_{10}O$ forms crystalline precipitate with sodium bisulphate and gives positive iodoform test. A does not reduce Fehlings solution. Identify 'A'. (BBQ$_{10}$193) **PTA 5M ii**

48. An organic compound C_3H_4(A) on hydration with Hg^{2+} / H_2SO_4 gives compound (B) which gives positive iodoform test. Compound (B) heated with $NH_2 - NH_2$ / C_2H_5ONa to give hydrocarbon (C). (B) also treated with HCHO in the presence of dil NaOH gives compound (D). Identify A, B, C and D. Write the chemical reactions involved. **5M**

49. An organic Compound (A)-C_2H_4O reduces Tollen's and fehling's solution. A-react with methanol and HCl to give compound (B) – $C_4H_{10}O_2$. A-on reaction with Methanal in the presence of dilute NaOH to give compound (C) – $C_3H_6O_2$. Identify Compounds A, B and C with necessary reactions.(155,163) **PTA5M ii**

50. An organic Compound C_2H_5Br (A) on treatment with Mg in dry ether gives (B) which on treatment with CO_2 followed by acidification gives (C). Identify (A), (B) & (C) and write possible equations. **PTA3MC**

51. Compound A of molecular formula C_7H_6O reduces Tollen's reagent when A reacts with 50% NaOH gives compound B of molecular formula C_7H_8O and C of molecular formula $C_7H_5O_2Na$. compound C on treatment with dil HCl gives compound D of molecular formula $C_7H_6O_2$. When D is heated with soda lime gives compound E. identify A,B,C,D & E. Write the corresponding equations.(163) **GM 5M**

13. ORGANIC NITROGEN COMPOUNDS

TEXT BOOK EVALUATION

1. Write down the possible isomers of the $C_4H_9NO_2$ give their IUPAC names

The compounds with molecular formula $C_4H_9NO_2$ are,

(i) $CH_3CH_2CH_2CH_2 - NO_2$

1-nitrobutane

ii) $CH_3CHCH_2 - NO_2$

CH_3

2-methyl -1-nitropropane

iii) NO_2

$CH_3CHCH_2CH_3$

2-nitrobutane

iv) CH_3

$CH_3 - C - NO_2$

CH_3

2-methyl -2-nitropropane

v) $CH_3CH_2CH_2CH_2 - O - N = O$

n-butyl nitrite (1-nitrito butane)

vi) $CH_3CHCH_2 - O\text{-}N{=}O$

CH_3

2-methyl -1-nitritopropane

vii) CH_3

$CH_3 - C - O\text{-}N{=}O$

CH_3

2-methyl -2-nitritopropane

viii) O-N=O

$CH_3CHCH_2CH_3$

2-nitritobutane

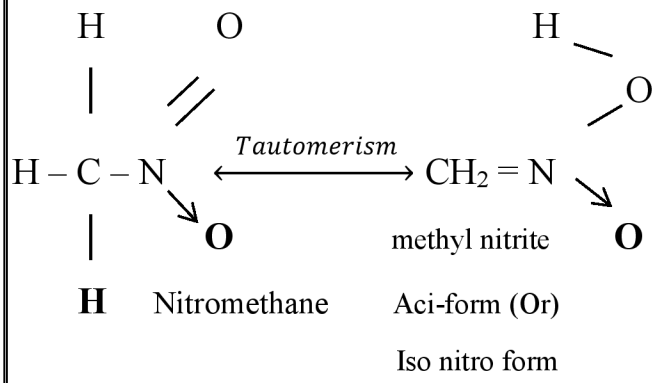
2. There are two isomers with the formula CH_3NO_2. How will you distinguish between them?

The two possible isomers with the formula CH_3NO_2 are

(i) $CH_3 - NO_2$ and ii) $CH_3 - O\text{-}N{=}O$

Nitro methane **methyl nitrite**

Tautomerism: Primary and secondary nitroalkanes, having α – H, also show an equilibrium mixture of two tautomers namely nitro – and aci – form



	Nitro methane (Nitro form)	Methyl nitrite (Aci-form)
1	Less acidic in nature	More acidic and also called pseudoacids or nitronic acids.
2	Dissolves in NaOH slowly.	Dissolves in NaOH instantly.
3	Decolourises $FeCl_3$ solution.	With $FeCl_3$ gives reddish brown colour
4	Electrical conductivity is low.	Electrical conductivity is high.

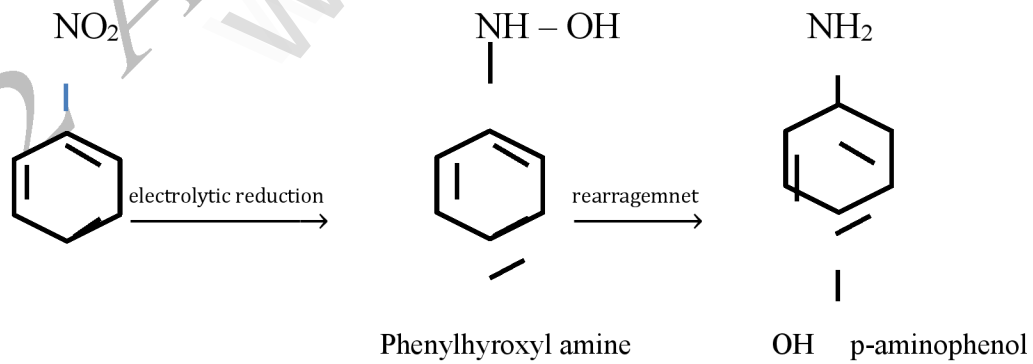
3. What happends when

i. 2 – Nitropropane boiled with HCl

$$(CH_3)_2CH - NO_2 \xrightarrow{HCl/H2O\ BOIL} CH_3COCH_3 + N_2O + H_2O$$

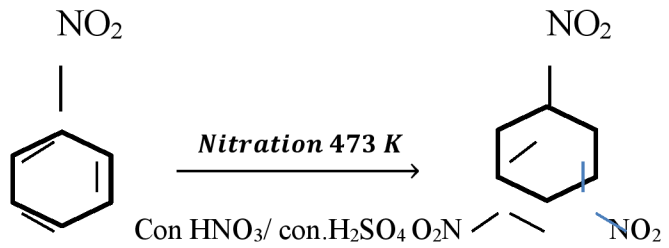
2-nitro propane — Acetone — Nitrous oxide

ii. Nitrobenezene electrolytic reduction in strongly acidic medium.



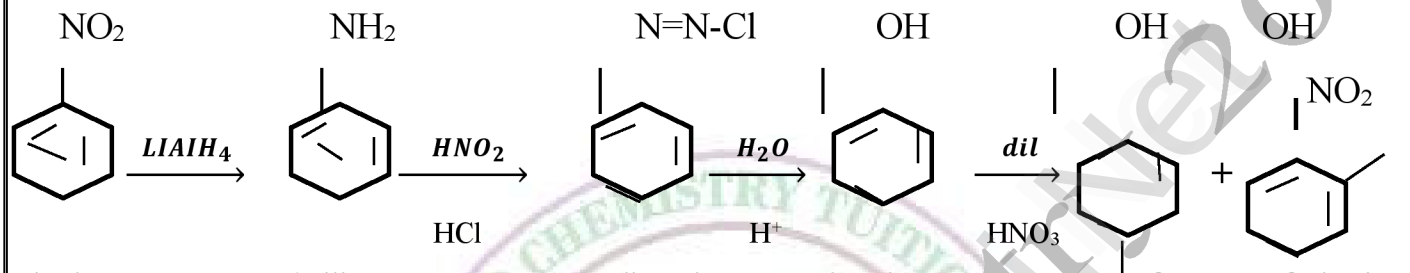
4. How will you convert nitrobenzene into

i. 1,3,5 – trinitrobenzene



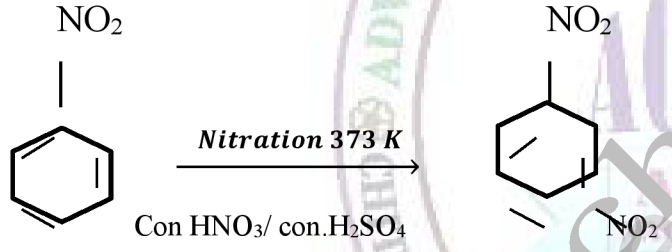
Nitrobenzene 1,3,5 – trinitrobenzene(TNB)

ii. o and p- nitrophenol



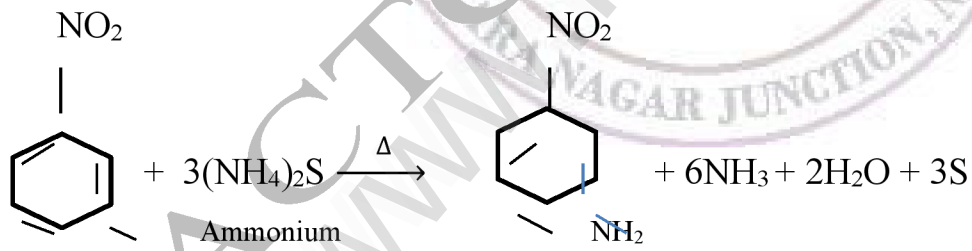
Nitrobenzene Aniline Benzene diazonium Chloride Phenol Para nitro Phenol Orthonitro Phenol

iii. m – nitro aniline



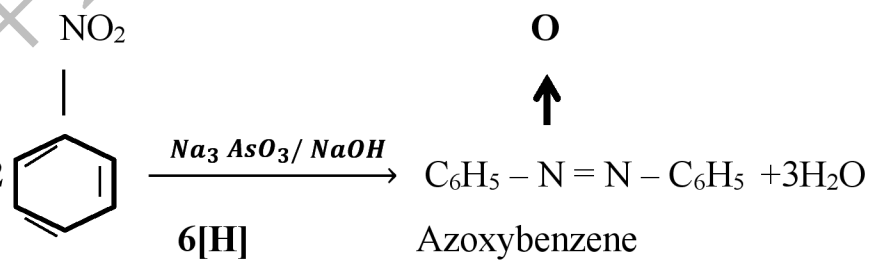
Nitrobenzene m-dinitro benzene (1,3-dinitrobenzene)

Selective reduction of polynitro compounds



m-dinitro benzene m – nitro aniline

iv. Azoxybenzene



nitrobenzene

v. hydrozobenzene

$$2C_6H_5 - NO_2 \xrightarrow{Zn/\ NaOH} [C_6H_5 - N = N - C_6H_5] \xrightarrow{2(H)} C_6H_5 - NH - NH - C_6H_5$$

Hydrazobenzene

vi. N – phenylhydroxylamine

$$C_6H_5 - NO_2 \xrightarrow[4(H)]{Zn/\ NH_4Cl} C_6H_5 - NH - OH + H_2O$$

(neutral medium)

N-Phenyl hydroxylamine

vii. Aniline

Nitrobenzene reduction with Ni (Or) Pt, (or) $LiAlH_4$ to give aniline

$$C_6H_5 - NO_2 + 6[H] \xrightarrow[(or)\ LiAH_4]{Ni(or)Pt\ /\ H_2} C_6H_5 - NH_2 + 2H_2O$$

Aniline

5. Identify compounds A,B and C in the following sequence of reactions.

i) $\mathbf{C_6H_5NO_2} \xrightarrow{Fe\ /\ HCl} \mathbf{A} \xrightarrow[273K]{HNO_2} \mathbf{B} \xrightarrow{C_6H_5OH} \mathbf{C}$

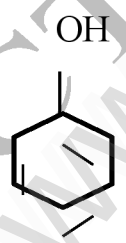
$$C_6H_5NO_2 \xrightarrow[6(H)]{Fe/\ HCl} C_6H_5NH_2$$

(A) Aniline

$$C_6H_5NH_2 + HNO_2 \xrightarrow[273K]{HCl} C_6H_5N = N - Cl + 2H_2O$$

(A) Aniline — Nitrrous Acid — (B) Benzene Diazonium

The reaction is known as chloride diazotization



$$C_6H_5N = N - Cl + \text{(Phenol)} \rightarrow HO - C_6H_4 - N = NC_6H_5$$

(B) Benzene diazonium Chlordie — Phenol — P- hydroxyl azo benzene (C) (Red orange dye)

The reaction is known as coupling reaction.

iii) $\mathbf{CH_3CH_2I} \xrightarrow{NaCN} \mathbf{A} \xrightarrow[\text{Partial hydrolysis}]{OH^-} \mathbf{B} \xrightarrow{NaOH\ /\ Br_2} \mathbf{C}$

$$CH_3CH_2I \xrightarrow{NaCN} CH_3CH_2CN$$

Iodoethane (Ethyl Iodide) → Ethyl Cyanide (A)

$CH_3CH_2CN \xrightarrow{OH^-} CH_3CH_2CONH_2$

Ethyl cyanide (A) — Partial Hydrolysis — (B) Propanamide

$CH_3CH_2CONH_2 \xrightarrow{Br_2} CH_3CH_2NH_2 + CO_2$

(B) Propanamide — NaOH — (C) Ethyl amine

The above reaction is Hoffmann's reaction.

iv) $CH_3NH_2 \xrightarrow{CH_3Br} A \xrightarrow{CH_3COCl} B \xrightarrow{B_2H_6} C$

$CH_3NH_2 \xrightarrow{CH_3Br} CH_3 - NH - CH_3$

Methyl Amine → (A) N-methylmethanamine

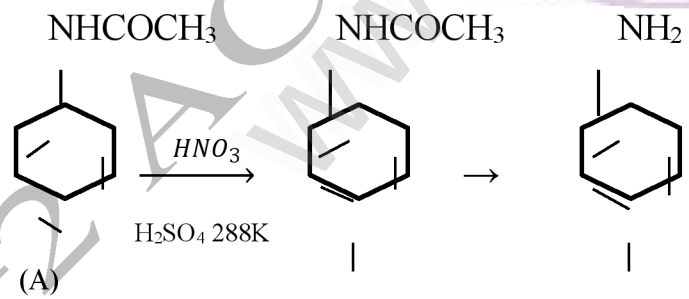
$CH_3 - NH - CH_3 + CH_3COCl \rightarrow CH_3 - \underset{\underset{COCH_3}{|}}{N} - CH_3 \xrightarrow{B_2H_6} CH_3 - \underset{\underset{CH_2CH_3}{|}}{N} - CH_3$

(A) N-methylmethanamine — N,N dimethyl Acetamide — (Reduction) — N,N imethyl ethanamine

v) $C_6H_5NH_2 \xrightarrow[\text{pyridine}]{(CH_3CO)_2O} A \xrightarrow[H_2SO_4,288K]{HNO_3} B \xrightarrow{H_2O/H^+} C$

$C_6H_5NH_2 \xrightarrow{(CH_3CO)_2O} C_6H_5NHCOCH_3 + CH_3COOH$

Aniline — pyridine — (A) Acetanilide

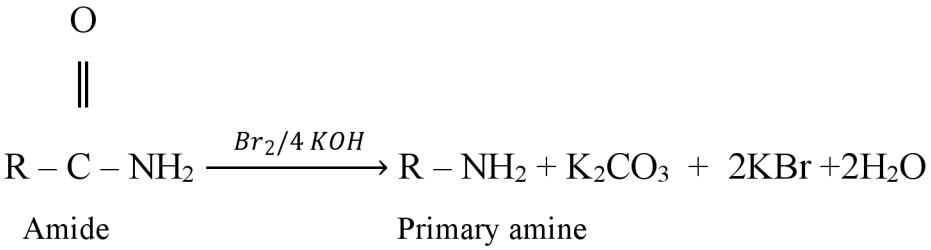


(A) Acetanilide — (B) p-nitroacetanilide — (C) p-nitro aniline

6. Write short notes on the following

i. Hofmann's bromide reaction

When Amides are treated with bromine in the presence of aqueous or ethanolic solution of KOH, primary amines with one carbon atom less than the parent amides are obtained.

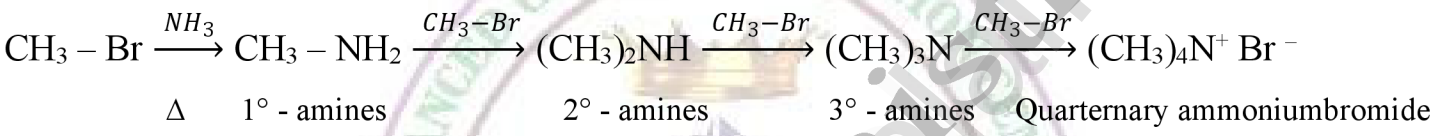


Amide Primary amine

R = Alkyl (or) Aryl

ii. Ammonolysis

When Alkyl halides (or) benzylhalides are heated with alcoholic ammonia in a sealed tube, mixtures of 1°, 2° and 3° amines and quaternary ammonium salts are obtained.

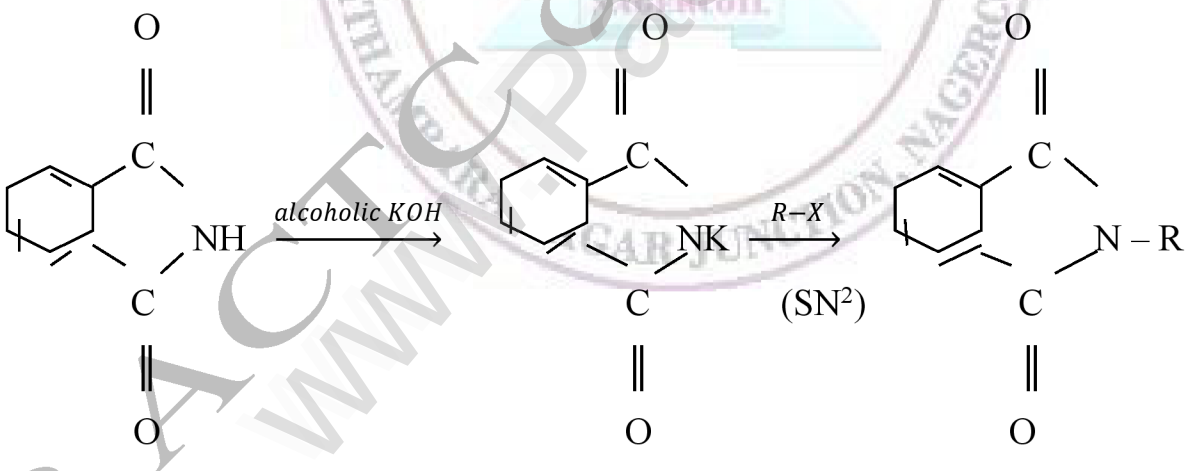


Δ 1° - amines 2° - amines 3° - amines Quarternary ammoniumbromide

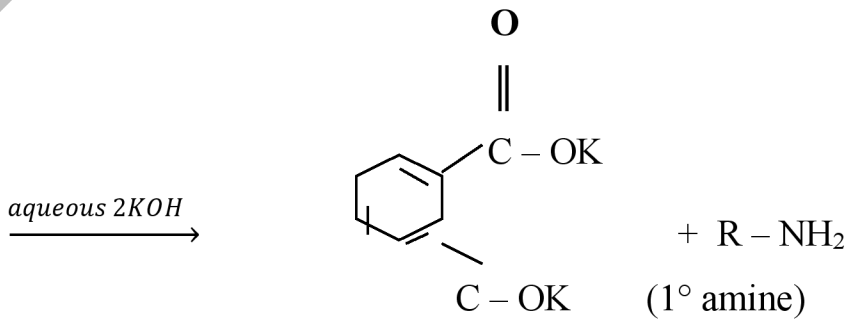
iii. Gabriel phthalimide synthesis

Gabriel synthesis is used for the preparation of Aliphatic primary amines.

Phthalimide on treatment with ethanolic KOH forms potassium salt of phthalimide which on heating with alkyl halide followed by alkaline hydrolysis gives primary amine.



Phthalimide Potassium phthalimide N – alkyl phthalimide



O phthalic acid

iv. Schotten – Baumann reaction

Aniline reacts with benzoylchloride (C_6H_5COCl) in the presence of NaOH to give N-phenyl benzamide. This reaction is known as Schotten – Baumann reaction. The acylation and benzoylation are Nucleophilic substitutions.

$$C_6H_5 - NH_2 + C_6H_5 - \overset{\overset{O}{\|}}{C} - Cl \xrightarrow{NaOH} C_6H_5 - NH - \overset{\overset{O}{\|}}{C} - C_6H_5 + HCl$$

(Aniline) (Benzoylchloride) (N – phenyl benzamide)

v. Carbylamine reaction

Aliphatic (or) aromatic primary amines react with chloroform and alcoholic KOH to give isocyanides (carbylamines), which has an unpleasant smell. This reaction is known as carbylamines test. This test used to identify the primary amines.

$$C_2H_5 - NH_2 + CHCl_3 + 3KOH \rightarrow C_2H_5 - NC + 3KCl + 3H_2O$$

Ethylamines Chloroform Ethylisocyanide

vi. Mustard oil reaction

When primary amines are treated with carbon disulphide (CS_2), N – alkyldithio carbonic acid is formed which on subsequent treatment with $HgCl_2$, give an alkyl isothiocyanate.

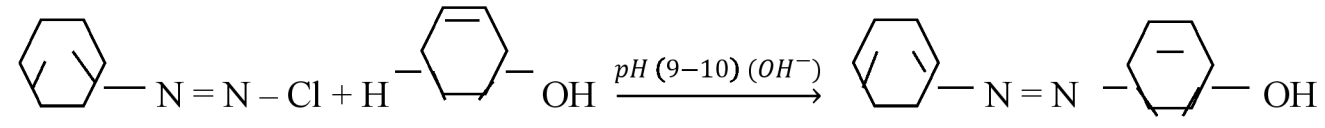
$$CH_3 - \underset{\underset{H}{|}}{N} - H + \overset{\overset{S}{\|}}{C} = S \rightarrow CH_3 - NH - \overset{\overset{S}{\|}}{C} - SH \xrightarrow{HgCl_2} CH_3 - N = C = S + HgS + 2HCl$$

Methylamine N – methyl dithiocarbamic acid Methyl isothiocyanate

vii. Coupling reaction

Benzene diazonium chloride reacts with electron rich aromatic compounds like phenol, aniline to form brightly coloured azo compounds. Coupling generally occurs at the para position. If para position is occupied then coupling occurs at the ortho position. Coupling

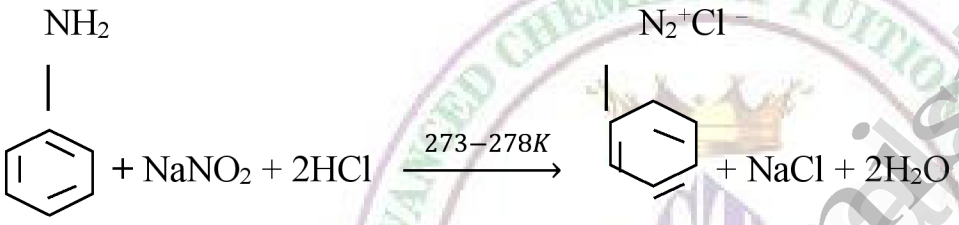
tenency is enhanced if an electron donating group is present at the para – position to $-N_2^+Cl^-$ group. This is an electrophilic substitution.



(benzene diazonium Chloride) (Phenol) 273 – 278K (P – hydroxyl azobenzene) (Red – orange dye)

viii. Diazotisation

Aniline reacts with nitrous acid at low temperature (273 – 278K) to give benzene diazonium chloride which is stable for a short time and slowly decompose seven at low temperatures. This reaction is known as diazotization.



Aniline benzenediazonium chloride

7. How will you distinguish between primary secondary and tertiary alphatic amines.

	Primary amine RNH_2	**Secondary amine R_2NH**	**Tertiary amine R_3N**
i.	With HNO_2 forms alcohol.	Forms N-nitroso amine	Forms salt
ii.	With $CHCl_3$/ KOH forms carbylamines	No reaction	No reaction
iii.	With acetyl chloride forms N-alkyl acetamide.	Form N,N-dialkyl acetamide	No reaction
iv.	With CS_2 and $HgCl_2$ alkyl isothiocyanate is formed.	No reaction	No reaction

v	With three molar proportion of alkyl halide, quarternary ammonium salt. $3RX + RNH_2 \rightarrow R_4N^+X^-$	With Two molar proportion of alkyl halide, quarternary ammonium salt. $2RX + R_2NH \rightarrow R_4N^+X^-$	With only one molar proportion of alkyl halide, quarternary ammonium salt. $RX + R_3N \rightarrow R_4N^+X^-$

8. Account for the following

i. Aniline does not undergo Friedel – Crafts reaction

Answer: ***Aniline is basic in nature and its lone pair to the Lewis acid $AlCl_3$ to form an adduct which inhibits further the electrophilic substation reaction.***

(Aniline being a Lewis base reacts with Lewis acid $AlCl_3$ to form a salt.

$$C_6H_5NH_2 + AlCl_3 \rightarrow C_6H_5\overset{+}{N}H_2\ \overset{-}{AlCl_3}$$

Due to the presence of a positive charge on N – atom in the salt the group - $^+NH_2AlCl_3^-$ acts as a strongly deactivating group.

As a result, it reduces the electron density in the benzene ring and which inhibits the electrophilic substitution reaction. Therefore aniline does not undergo Friedel – Crafts reaction.)

iii. pK_b of aniline is more than that of methylamine

- In aniline, the lone pair of electrons on the N-atom is delocalized over the benzene ring.
- As a result electron density on the nitrogen decreases.
- In contrast in CH_3NH_2, +I effect of CH_3 increases the electron density on the N – atom.
- Therefore, aniline is a weaker base than methylamine and hence its pK_b value is more than that of methylamine.

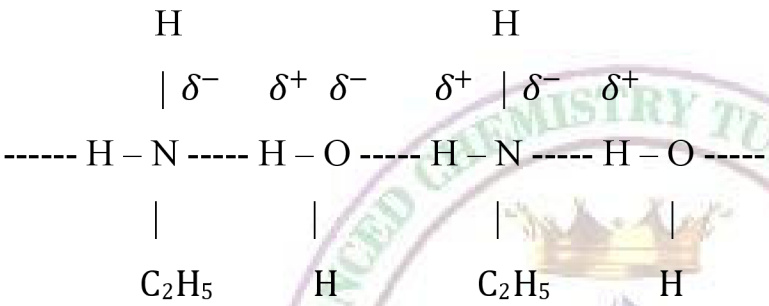
iv. Gabriel phthalimide synthesis is preferred for synthesising primary amines.

- Gabriel phthalimide reaction gives pure 1° - amine without any contamination of 2° and 3° - amines.
- ***Gabriel phthalimide synthesis involves SN^2 Nucleophilic substitution of alkyl halide by the anion formed by the phthalimide.***

Therefore it is preferred for synthesizing primary amines .

v. Ethylamine is soluble in water whereas aniline is not

- Ethylamine when added to water forms **intermolecular H – bonds** with water.
- And therefore it is soluble in water.
- But aniline does not form H – bond with water to a very large extent due to ***the presence of a large hydrophobic – C_6H_5 group.*** Hence, aniline is insoluble in water.



(Ethylamine – water Hydrogen bonding diagram)

vi. Amines are more basic than amides

- In simple amines, **the lone pair of electrons is on nitrogen** and hence available for protonation.
- In amides on the other hand, ***the electron pair on nitrogen is delocalized to the carboxyl oxygen through resonance and thus it is not available for protonation.***
- So amines are more basic than amides.

(Amide resonance structures)

vii. Although amino group is o – and p – directing in aromatic electrophilic substitution reactions, aniline on nitration gives a substantial amount of m – nitroaniline.

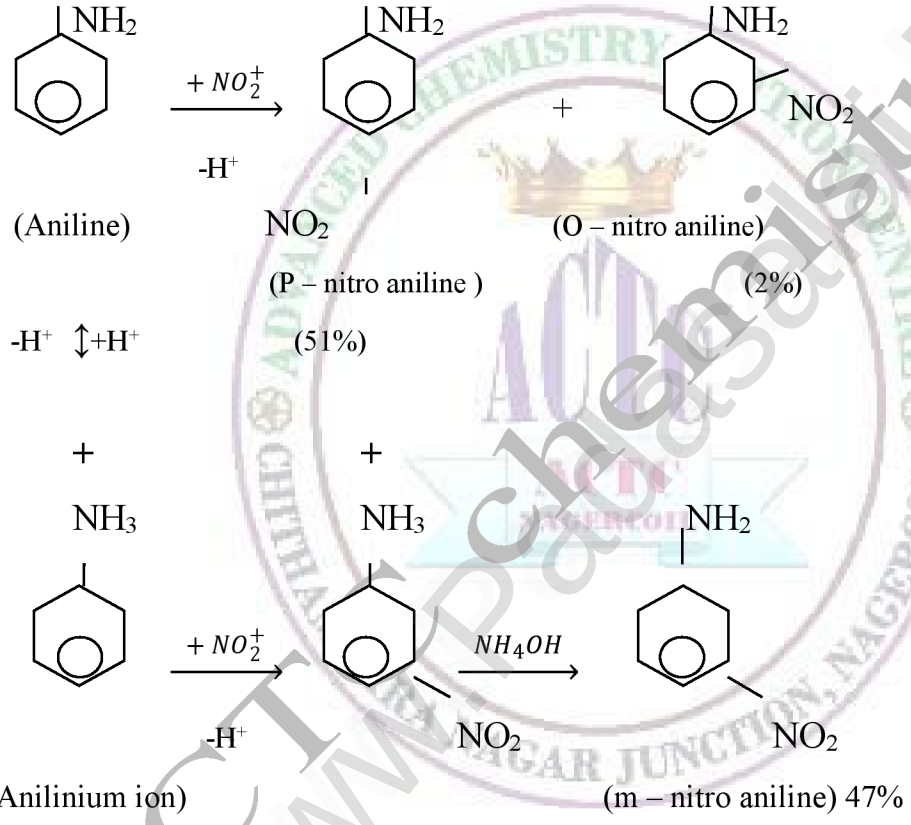
Answer:

- ***Direct nitration of aniline gives o and p –nitro aniline .***
- ***In strong acid medium aniline is protonated to form anilinium ion which is m-directing and hence m-nitro aniline is also formed.***

Nitration is usually carried out with a mixture of cone HNO_3 and conc H_2SO_4. In the presence of these acids, most of aniline gets protonated to form anilinium ion.

Therefore , in the presence of these acids, the reaction mixture consists of aniline and anilinium ion.

Now $-NH_2$ group in aniline is O, P – directing and activating while the $-NH_3^+$ group is anilinium ion is meta – directing and deactivating. Whereas nitration of aniline (due to steric hindrance at o – position) mainly gives p – nitroaniline, the nitration of anilinium ion gives m – nitro aniline. In actual practice, approximately a 1:1 mixture of P and m – nitroaniline is formed.



9. Arrange the following

i. In increasing order of solubility in water, $C_6H_5NH_2$,$(C_2H_5)_2$ NH,$C_2H_5NH_2$

The solubility increases in the order in which molecular mass decreases.

Answer: $C_6H_5NH_2 < (C_2H_5)_2NH < C_2H_5NH_2$

ii. In increasing order of basic strength

a) aniline, p- toludine and p – nitroaniline

The electron – donating groups increases the basic strength of amines while the electron – withdrawing groups decrease the basic strength of amines. Therefore p- nitroaniline is the weakest base followed by aniline while p – toluidine, which has methyl group and therefore it is the strongest base.

Base strength increases in the order:

P – nitro aniline < aniline < p - toluidine

b) **$C_6H_5NH_2$,$C_6H_5NHCH_3$,$C_6H_5NH_2$,p-Cl-C_6H_4-NH_2**

p – Cl $C_6H_4 – NH_2 < C_6H_5NH_2 < C_6H_5NHCH_3 < C_2H_5NH_2$

iii. In decreasing order of basic strength in gas phase $(C_2H_5)NH_2$,$(C_2H_5)NH$, $(C_2H_5)_5N$ and NH_3

Since the +I effect increases with the number of alkyl groups, therefore ***the basic strength of the amines decreases as the number of ethyl groups decreases.***

$(C_2H_5)_3N > (C_2H_5)_2N > C_2H_5NH_2 > NH_3$

iv. In increasing order of boiling point C_6H_5OH, $(CH_3)_2NH$, $C_2H_5NH_2$

$(CH_3)_2NH < C_2H_5NH_2 < C_2H_5OH$

v. In decreasing order of the pK_b values $C_2H_5NH_2$, $C_6H_5NHCH_3$,$(C_2H_5)_2NH$ and CH_3NH_2

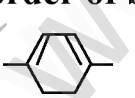
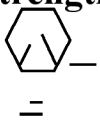
$C_6H_5NHCH_3 > CH_3NH_2 > C_2H_5NH_2 > (C_2H_5)_2NH$

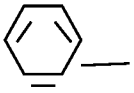
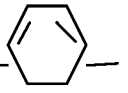
vi. Increasing order of basic strength $C_5H_5NH_2$,$C_6H_5N(CH_3)$,$(C_2H_5)_2NH$ and CH_3NH_2

- Due to delocalization of lone pair of electrons of the N – atom over the benzene ring, all aromatic **amines are less basic than alkylamines i.e.,** CH_3NH_2

$(C_6H_5)_2NH < C_6H_5NH_2 < C_6H_5N(CH_3)_2 < CH_3NH_2$

vii. In decreasing order of basic strength

$CH_3CH_2NH_2$, O_2N  **NH_2,**  **NH_2 , CH_3 - NH_2**

$CH_3CH_2NH_2 >$ $CH_3NH_2 >$  $NH_2 > O_2N$  NH_2

Ethylamine > Methylamine > Aniline > P – nitro aniline

10. How will you prepare propan – 1- amine from

i) butane nitrile

Butane nitrile treated with acid hydrolysis followed by Hoffmann's bromamide degradation gives propan – 1 – amine

$$CH_3 - CH_2 - CH_2 - CN \xrightarrow{H^+/H_2O} CH_3 - CH_2 - CH_2 - CONH_2 \xrightarrow{Br_2/KOH} CH_3 - CH_2 - CH_2 - NH_2$$

(Butane nitrile) (Butanamide) (Propane - 1 – amine)

ii) propanamide

When propanamide is treated with $LiAlH_4$ in the presence of water gives propan -1 – amine

$$CH_3CH_2CONH_2 \xrightarrow{LiAlH_4} CH_3CH_2CH_2NH_2$$

(Propanamide) (Propan – 1 – amine)

iii) 1- nitropropane

$$CH_3 - CH_2 - CH_2 - NO_2 \xrightarrow{Fe/HCl} CH_3 - CH_2 - CH_2 - NH_2 + 2H_2O$$

(1-nitropropane) 6(H) (Propan – 1 – amine)

Reduction of 1 – nitropropane using H_2/Ni or Fe/HCl gives propan – 1 – amine

11. Identify A,B,C and D $CH_3 - NO_2 \xrightarrow{LiAlH_4} A \xrightarrow{2CH_3CH_2Br} B \xrightarrow{H_2SO_4} C$

$$CH_3\,NO_2 \xrightarrow[6(H)/\,-2H_2O]{LiAlH_4} CH_3NH_2 \xrightarrow[-2HBr]{2CH_3CH_2Br} (CH_3CH_2)_2\,NCH_3 \xrightarrow{H_2SO_4} [(CH_3CH_2)_2NH^+]\,HSO_4^-$$

(Nitro methane) (Methylamine) (N,N – diethyl methylamine) | CH_3

(A) (B) (Quarternary Salt) (C)

12. How will you convert diethylamine into

i) N, N – diethylacetamide

$$(C_2H_5)_2NH + CH_3COCl \xrightarrow{Pyriine} (C_2H_5)_2\,N - CO - CH_3 + HCl$$

(diethylamine) (Acetyl chloride) (N,N-diethyl acetamide)

Diethylamine react with acetylchloride in the presence of pyridine to form N,N – diethyl acetamide.

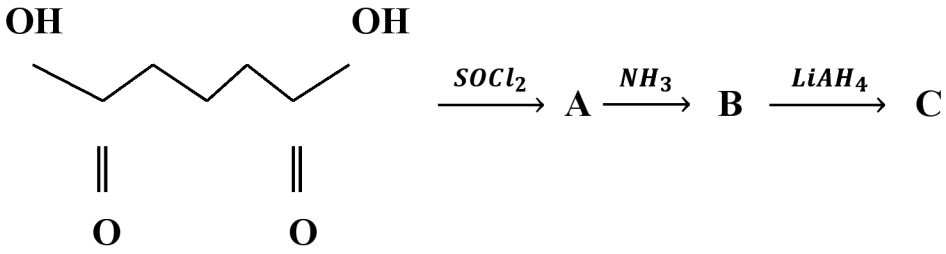
ii) N – nitrosodiethylamine

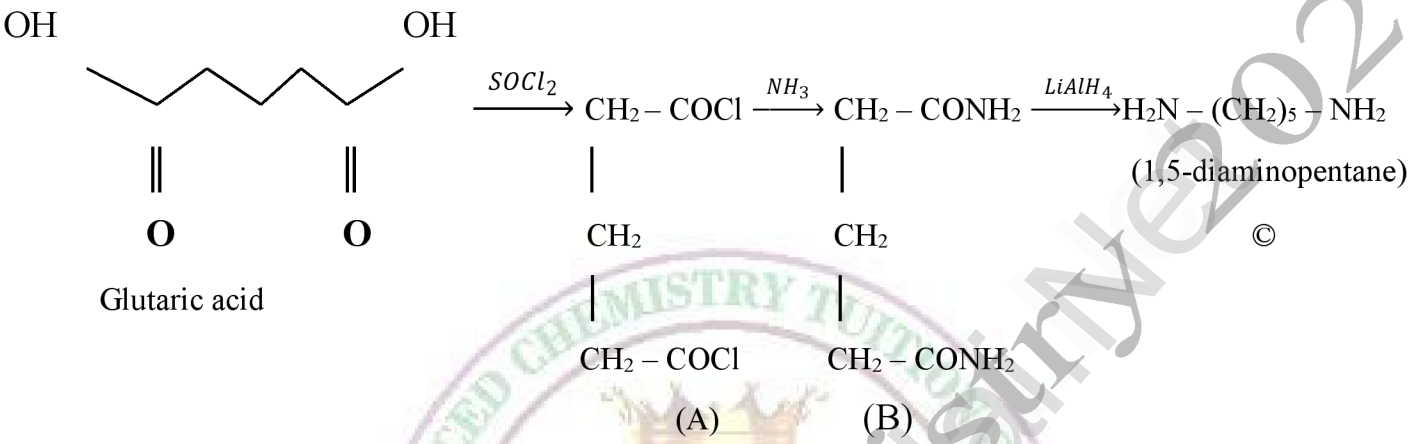
$$(C_2H_5)_2NH \xrightarrow{NaNO_2\,/\,Con\,HCl} (C_2H_5)_2\,N - N = O$$

(Diethylamine) (or) HNO_2 (N-nitrosodiethylamine)

Diethylamine react with nitrous acid to give N-nitrosodiethylamine .

13. Indentify A,B and C





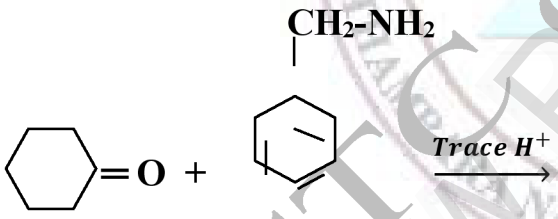
14. Identify A **Aniline + benzaldehyde → A**

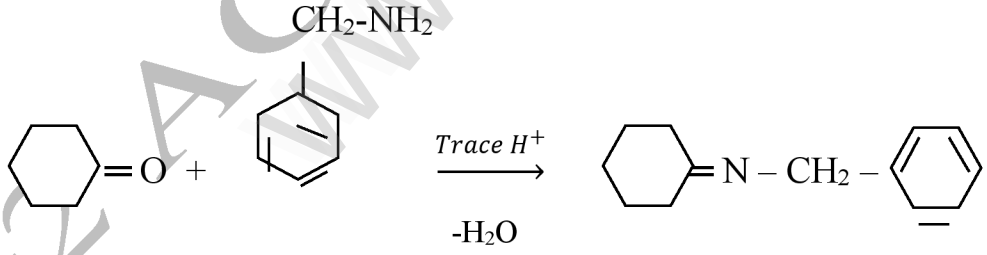
$C_6H_5NH_2 + C_6H_5CHO \rightarrow C_6H_5N = CH - C_6H_5$

(Benzal aniline)

(Schiff's base)(A)

15. Complete the following reaction

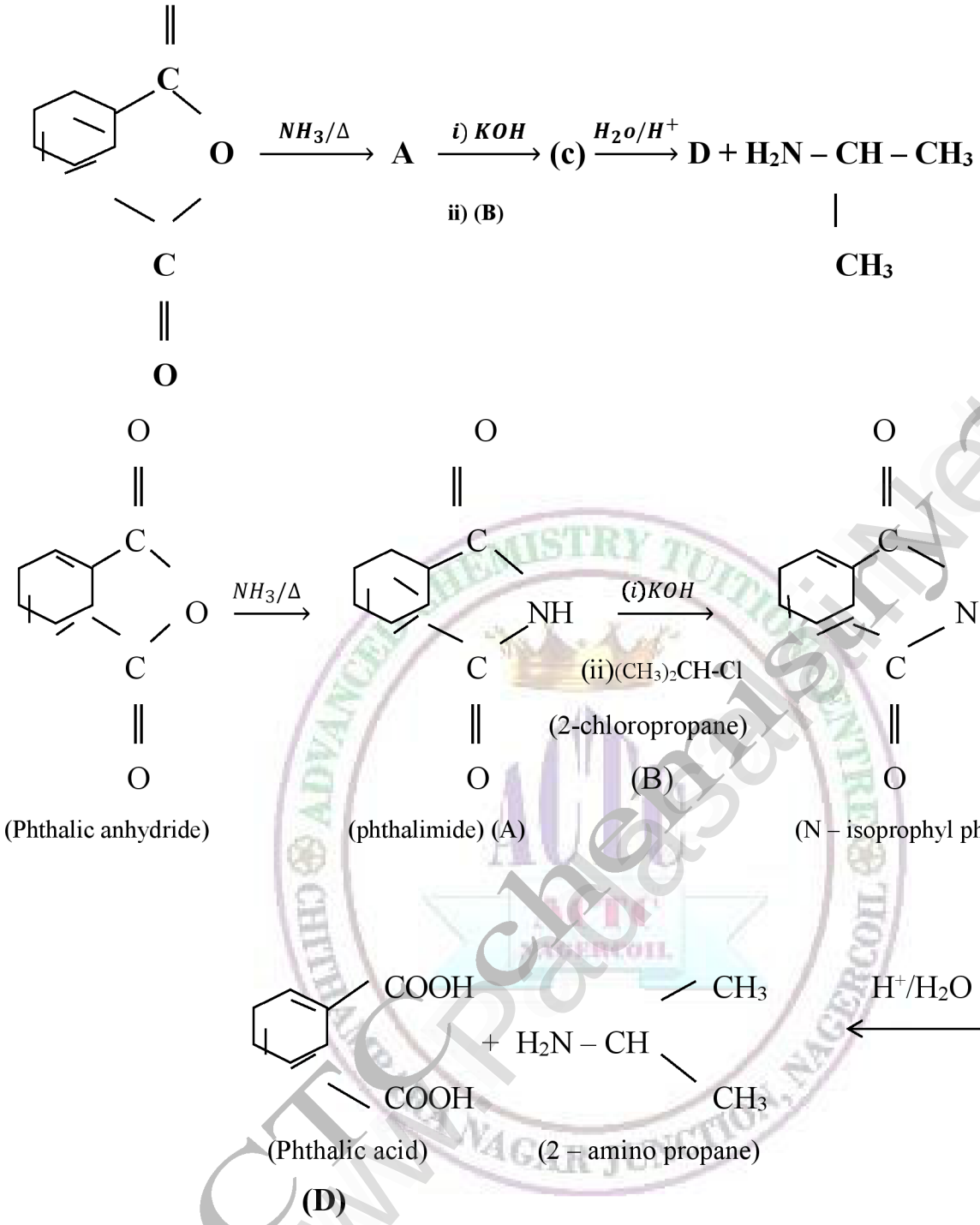




(Cyclohexanone) (Bezyl amine) (N-benzyl cyclo hexane imine)

16. Predict A,B,C and D for the following reaction

O



17. A dibromo derivative (A) on treatment with KCN followed by acid hydrolysis and heating gives a monobasic acid (B) along with liberation of CO_2 . (B) on heating with liquidammonia followed by treating with Br_2 /KOH gives (c) which on treating with $NaNO_2$ and HCl at low temperature followed by oxidation gives a monobasic acid (D) having molecular mass 74. Identify A to D.

(i) $CH_3 - CH_2 - CH(Br) - CH_2(Br) \xrightarrow{KCN} CH_3 - CH_2 - CH(CN) - CH_2(CN) \xrightarrow{(i)H^+/H_2O} CO_2 + CH_3 - CH_2 - CH_2 - COOH$

(ii) Heat (Butanoic acid) (B)

(1,2 – dibromobutane) (1,2-dicyanobutane)

(ii) $CH_3 - CH_2 - CH_2 - COOH \xrightarrow{liq\ NH_3} CH_3 - CH_2 - CH_2 - CONH_2 \xrightarrow{Br_2/KOH} CH_3 - CH_2 - CH_2 - NH_2$

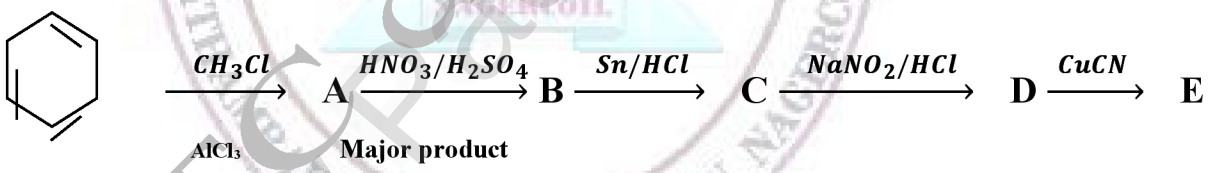
(Butanoic acid) Δ (Butanamide) (1-Aminopropane)

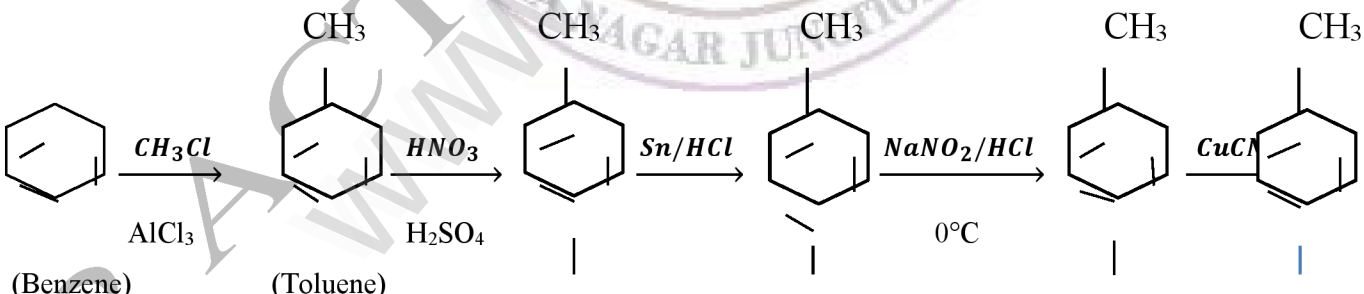
(A) (C)

(iii) $CH_3 - CH_2 - CH_2 - NH_2 \xrightarrow{NaNO_2\ /\ HCl} CH_3 - CH_2 - CH_2 - OH \xrightarrow{K_2Cr_2O_7\ /\ H^+} CH_3 - CH_2 - COOH$

(1-Aminopropane) (C) Low temperature (1-propanol) 2(O) (Propanoic acid) (D)

18. Identify A to E in the following frequency of reactions.





(Benzene) (Toluene) (A) NO_2 (p-nitrotoluene) (B) NH_2 (p-toluidine) (C) $N \equiv N - Cl$ (p-toluene diazonium chloride) (D) CN (p-Cyanotoluene) (E)

IMPORTANT QUESTIONS

1. There are two isomers with the formula CH_3NO_2 . How will you distinguish between them? (199) **PTA3M, J24 2M COMPULSORY**
2. How is Chloropicrin prepared (203) **M20 2 MARK**
3. Hofmann's bromide reaction (209)
4. Gabriel phthalimide synthesis (209) **J20 3M, M22 5Mii**
5. Hoffmann's ammonolysis (209)
6. Sabatier – Mailhe method (210)
7. Schotten – Baumann reaction (214) **J23 5Mi**
8. Diazotisation (215)
9. Libermann's nitroso test. (215)
10. Carbylamine reaction (216) **M22 5Mi**
11. Mustard oil reaction (216) **S20 5Mii, J22 5Mii, J23 5Mii**
    (write the reaction of primary amine with carbon disulphide (CS_2). **M24 3M**
12. Hofmann-Mustard oil reaction. (216)
    (How will you prepare phenyl mustard oil?)
13. How does aniline react with Br_2/H_2O (Bromination of aniline)? (217) **J22 5Mi**
14. Why aniline does not undergo Fridel Crafts reaction. (218)**J20 2M**
15. Identify A and B. (208) **M20 5Mii**

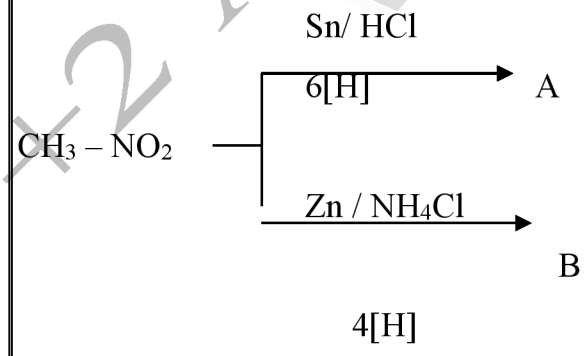
$$A \xrightarrow[4[H]]{Na(Hg)/C_2H_5OH} CH_3 - CH_2 - NH_2$$

$$B \xrightarrow[4[H]]{Na(Hg)/C_2H_5OH} CH_3 - NH - CH_3$$

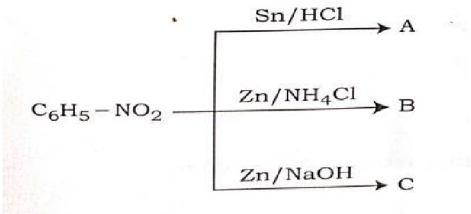
16. Identify A and B. (208) **M22 2M Compulsory**

$$CH_3Br \xrightarrow{NaN3} A \xrightarrow{LiAlH4} B + N_2$$

17. From the following reaction, identify A and B. (202) **A21 2M Compulsory**



18. From the following reaction, identify A, B and C. (203) **J22 3M Compulsory**



19. $CH_3CH_2NO_2 \xrightarrow{Sn/HCl} A \xrightarrow{CH3COCl} B$. **M23 2M COMPULSORY**

20. How will you convert nitrobenzene into (203)

Aniline, Phenyl hydroxyl amine, Nitrosobenzene, Azo benzene, azoxybenzene, hydrozobenzene, m – nitro aniline (204), 1,3,5 - trinitrobenzene (204), 3-nitro benzene sulphonic acid, 3-chloro nitro benzene.

21. Name the reducing agent used in the reduction of nitrobenzene to the following compounds. (203)

S20 5Mi (A) Aniline (B) Phenyl hydroxylamine (C) Nitrosobenzene

22. How will you distinguish between primary secondary and tertiary aliphatic amines?

23. Arrange the following: (212BB234) **PTA2M**

(i) In decreasing order of the pKb values: $C_2H_5NH_2$, $C_6H_5N(CH_3)_2$, $(C_2H_5)_2NH$, CH_3NH_2

(ii) Increasing order of basic strength : $C_2H_5NH_2$, $C_6H_5N(CH_3)_2$, $(C_2H_5)_2NH$, CH_3NH_2

24. How the following conversion are effected? **PTA5M**

(i) Nitro benzene → N – phenyl hydroxyl amine (203)

(ii) Propanamide → Propan – 1 – amine (209) (iii) Aniline → p – nitroaniline (218)

25. An organic compound (A) on reduction gives compound (B). (B) on treatment with $CHCl_3$ and alcoholic KOH gives (C). (C) on catalytic reduction gives N – methyl aniline. Identify A,B,C and write its equation. (216 Carbylamine) **PTA3M**

26. Account the following **PTA3M (BBQ$_8$234)**

i) Aniline does not undergo Friedel – crafts reaction. **M23 5Mi**

ii) Ethylamine is soluble in water whereas aniline is not

iii) Amines are more basic than amides.

27. An organic compound (A) – C_7H_7NO on treatment with Br_2 and KOH gives an amine (B), which gives carbylamines test. (B) upon diazotization to give (C). (C) on coupling with P. cresol to give compound (D). Identify A,B,C and D with necessary reaction. (209) **PTA5M**

28. An organic compound (A) – CNCl react with methyl magnesium Bromide to give compound B – (C_2H_3N). B-upon catalytic reduction to give compound C – (C_2H_7N). C gives carbylamine test. Identify compound A,B and C and write the reactions. (224, 225)**3MC**

29. An aromatic nitro compound (A) on reduction with Sn/HCl gives compound (B) C_6H_7N, which on treatment with Benzoyl chloride in the presence of pyridine to give compound (C). Compound (B) on treatment with CH_3Br to give compound (D) which further reacts with $NaNO_2$/HCl to give compound (E) with yellow oil liquid. Identify (A) to (E) and write the reactions. **PTA 5M**

30. Identify A and B in the following sequence of reactions.(210) **M22 2M COMPULSORY**

$$CH_3CH_2Br \xrightarrow{NaN3} A \xrightarrow{LiAlH4} B + N_2$$

31. Write a note on Sabatier – mailhe method?(210) **PTA 2M**

32. Identify Compounds A, B and C in the following sequence of reaction.($BBQ_{5vii}233$)**3MC**

$$CH_3CH_2NC \xrightarrow{HgO} A \xrightarrow{H_2O} B \xrightarrow[HCl]{NaNO_2}/H2O C$$

33. Write the uses of nitroalkanes. (228) **PTA 5M ii**

34. Identify A to C in the following sequence? ($BBQ_{5i}233$)**GM 3MC**

$$C_6H_5NO_2 \xrightarrow{Fe/HCl} A \xrightarrow{HNO3/\ 273k} B \xrightarrow{H2O} C$$

35. Identify Compounds A, B and C in the following sequence of reaction(203,215,222) **J23 3MC**

$$C_6H_5NO_2 \xrightarrow{Sn/HCl} A \xrightarrow{NaNO2+HCl/273k} B \xrightarrow{C6H5OH} C$$

36. write short notes on **GM 5M** a)Mustard oil reaction (216) b)Carbylamines reaction (216) c)Gabriel phthalimide synthesis. (209)

14. BIOMOLECULES

SHORT ANSWER QUESTIONS: Book Evaluation page: 270

1. What type of linkages hold together monomers of DNA?

- Monomers of DNA are linked together by ***phosphodiester bond*** **between 5'OH group of one nucleotide and 3'OH group on another nucleotide.**
- The sugar-phosphate linkage forms the backbone of each strand of DNA.
- The DNA double helix or duplex is held together by two forces,

(i) Hydrogen bonding between complementary base pairs.

(ii) Base- stacking interactions.

- The complementary between the DNA strands is attributable to the hydrogen bonding between base pairs but the base stacking interactions are largely non-specific, make the major contribution to the stability of the double helix.

2. Give the differences between primary and secondary structure of proteins.

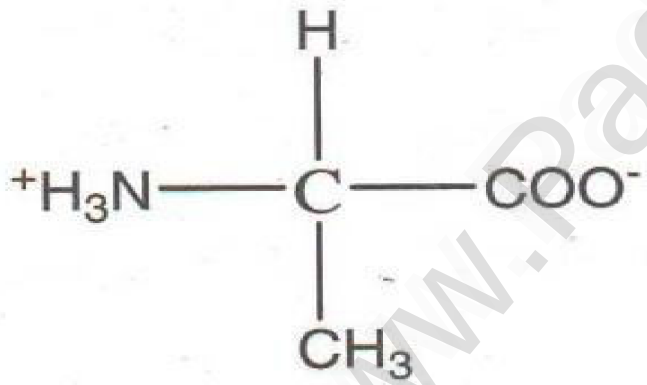
Primary structure	Secondary structure
Linear sequence of amino acids	Folding of the peptide chain into an α- Helix and β- strands.
The relative arrangement of the amino acids in the polypeptide chain.	The amino acids in the polypeptide chain forms highly regular shapes (α- Helix and β- strands)
Primary structure of a protein is started from the amino terminal (N) end to the carboxyl terminal (C) end.	Sub structures are formed through the hydrogen bond between the carbonyl oxygen and the neighboring amine hydrogen.

3. **Name the Vitamins whose deficiency cause. I)Rickets ii)Scurvy**

Diseases	Deficiency
i) Rickets	Vitamin D
ii) Scurvy	Vitamin C

4. Write the Zwitter ion structure of alanine.

Zwitter ion structure of alanine



5. Give any three difference between DNA and RNA.

DNA	RNA
It is mainly present in nucleus, mitochondria and chloroplast	It is mainly present in cytoplasm, nucleolus and ribosomes
It contains deoxyribose sugar	It contains ribose sugar
Base pair A=T.G≡C	Base pair A= U.C≡G
Double stranded molecules	Single stranded molecules

It's life time is high	It is short lived
It is stable and not hydrolyzed easily by alkalis	It is unstable and hydrolyzed easily by alkalis
It can replicate itself	It cannot replicate itself. It is formed from DNA.

6. Write a short note on peptide bond.

(i) The amino acids are linked covalently by peptide bonds.

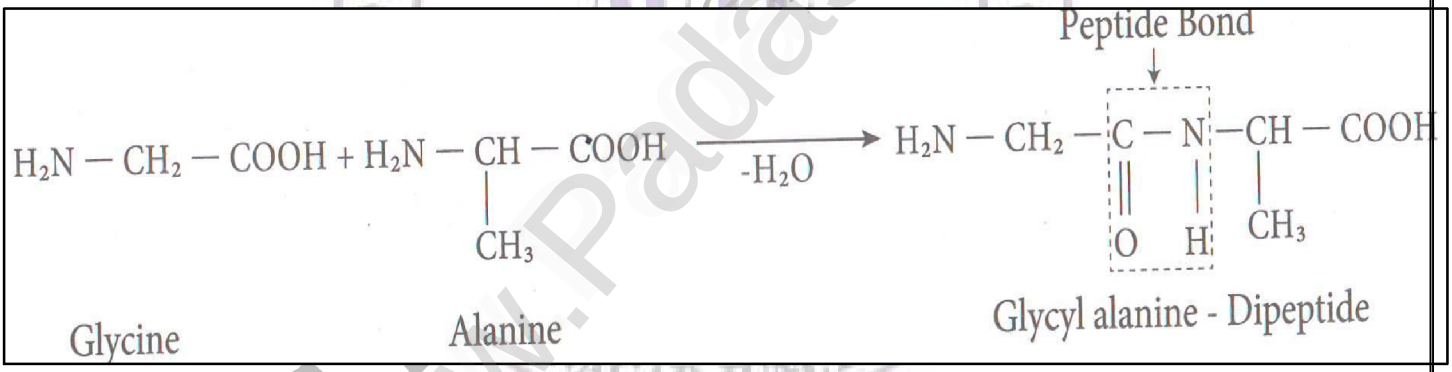
(ii) The carboxyl group of the first amino acid reacts with the amino group of the second amino acid to give an amide linkage between these amino acids.

(iii) This amide linkage is called **peptide bond.** The resulting compound is called a **dipeptide.**

(iv) Addition of another amino acid this dipeptide by a second peptide bond results in tripeptide.

(v) When number of amino acids are linked there is a formation of polypeptide.

(vi) If formation of the number of amino acids are less it is called as a polypeptide, if it has large number of amino acids (and preferably has a function) then it is called a **protein.**



7. Give two difference between Hormones and vitamins.

Hormone	Vitamin
Hormone is an organic substance ***secreted by one tissue into the blood stream*** and induces a physiological response in other tissues.	Vitamins are small organic compounds that ***cannot be synthesized by our body*** but are essential for certain function.
They are produced in the **ductless glands** (endocrine) Eg. Testes of males and ovaries of females	They are not produced in the body but have to **be supplied through diet.**
Hormones have **no catalytic action**	Vitamins have **catalytic action**

Deficiency causes metabolic disorders.	Their deficiency or excess causes disease.
Example: Insulin	**Example:** Vitamin A, B,C,D, E and K

8. Write a note on denaturation of proteins.

(i) Each protein has a unique three- dimensional structure formed by interaction such as disulphide bond, hydrogen bond, hydrophobic and electrostatic interactions.

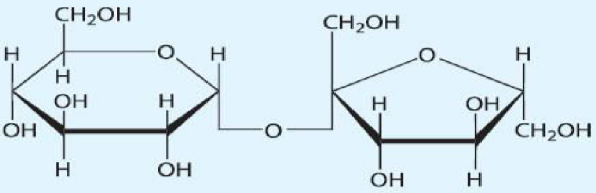
(ii) These interactions can be disturbed when the protein is exposed to a higher temperature, certain chemicals such as urea, alteration of pH, ionic strength etc., It leads to the loss of the three- dimensional structure partially or completely.

(iii) The process of a protein- losing its higher order structure without losing the primary structure, it called denaturation.

(iv) When a protein denatures, its biological function is also lost.

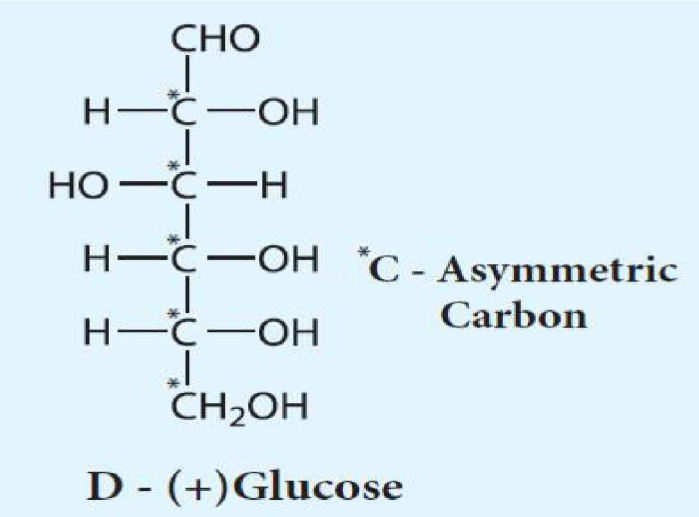
(v) **Example:** coagulation of egg white by action of heat.

9. What are reducing and non- reducing sugars?

Reducing sugars	**Non-reducing sugars**
A reducing sugar is a sugar has a **free aldehyde or ketone** that can act as a reducing agent. ***Eg: Glucose, Fructose, Lactose.***	A non- reducing sugar **does not have a free aldehyde or Ketone,** so it cannot act as a reducing agent. ***Eg: Sucrose.***
A reducing sugar also **reduces Fehling's solution** to **red cuprous oxide**. A reducing sugar contains an aldehyde group and it **reduces an ammoniacal solution of (Tollen's reagent) to metallic silver**. $C_6H_{12}O_6$- Glucose contains an aldehyde group and so it reduces Tollen's reagent to silver mirror. $C_6H_{12}O_6 + Ag_2O \rightarrow 2Ag + 6CO_2 + 6H_2O$ Tollen's reagent silver mirror	A non- reducing sugar **does not reduce Tollen's reagent or Fehling's solution.**  Sucrose *(α-D-glucopyranosyl-β-D-fructofuranoside)*

10.Why carbohydrates are generally optically active?

- Almost all carbohydrates are optically active as they have **one or more chiral carbon**.
- Chirality results in optical active.



11.Classify the following into monosaccharides, oligosaccharides and polysaccharides.

i)Starch ii)Fructose iii)Sucrose iv) Lactose v)Maltose

(i) Starch - Polysaccharide

(ii) Fructose- monosaccharide

(iii) Sucrose - oligosaccharide

(iv) Lactose - oligosaccharide

(v) Maltose - oligosaccharide

12.How are vitamins classified?

Vitamins are classified into two groups based on their ***solubility in water and in fat.***

i) **Fat soluble vitamins**: A, D, E and K.

- These vitamins absorbed best when taken with fatty food and are stored in fatty tissues and livers.
- These vitamins do not dissolve in water. Hence they are called fat soluble vitamins.
- Vitamin ***A, D, E & K are fat soluble vitamins.***

ii) **Water soluble vitamins:** Vitamins B (B_1, B_2, B_3,B_5, B_6, B_7,B_9 & B_{12}) and C are readily soluble in water. These vitamins can't be stored.

13.What are hormones? Give examples.

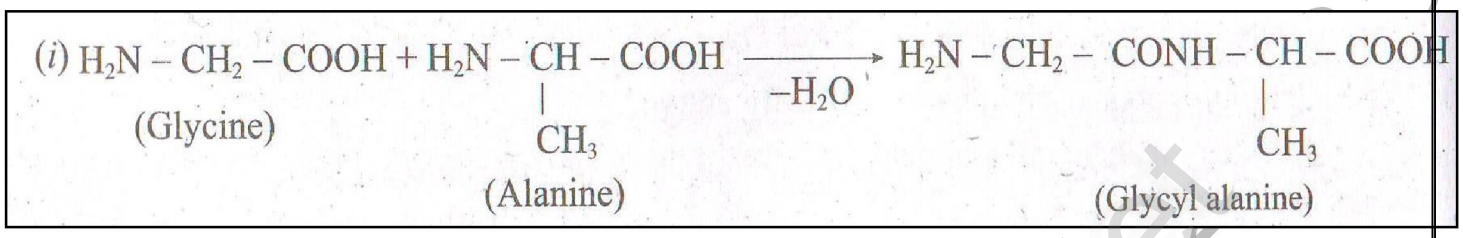
(i) Hormone is an organic substance (e.g. a peptide or a steroid) that is secreted by one tissue into the blood stream and induces a physiological response (e.g. growth and metabolism) in other tissues.

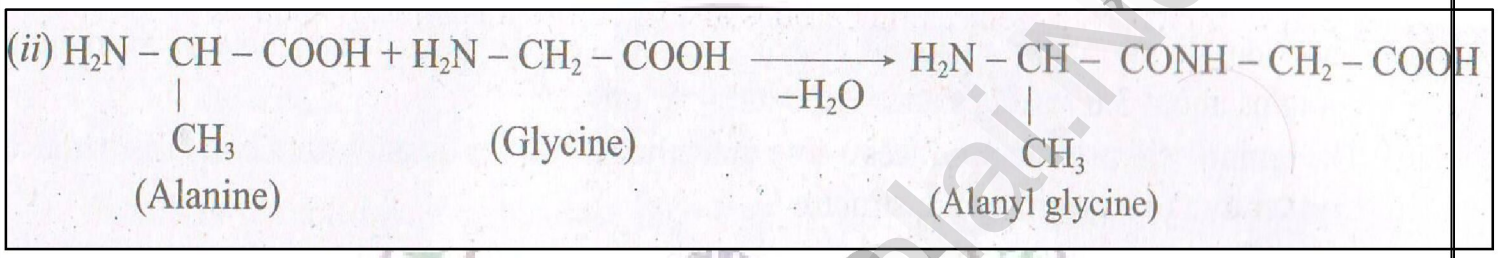
(ii) It is an intercellular signaling molecule.

(iii) **Example:** insulin, epinephrine.

(iv) Hormones are classified into Endocrine, Paracrine and Autocrine hormones.

14. Write the structure of all possible dipeptides which can be obtained form glycine and alanine.





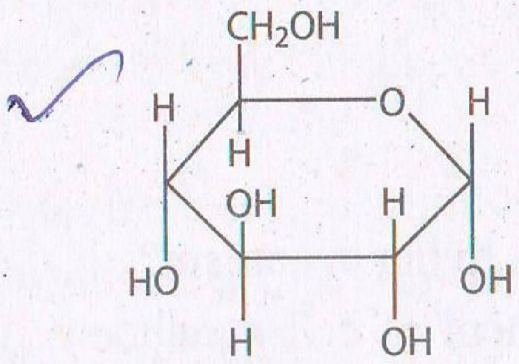
Therefore two dipeptides structures are possible from glycine and alanine.

They are (i) glycyl alanine and (ii) Alanyl glycine

15. Define enzymes.

- Enzymes are macromolecular biological catalyst.
- All biochemical reactions that occur in living cells are catalyzed by special proteins called enzymes.
- They are more specific in their action.
- **Example:** Invertase, zymase, maltase.

16. Write the structure of α- D (+) glucopyranose.



(α-D(+) glucopyranose)

α-D Glucose

Right side down.

17. What are different types of RNA which are found in cell?

RNA molecules are classified according to their structure and function into three major types,

(i) Ribosomal RNA (r-RNA)

(ii) Messenger RNA (m-RNA)

(iii) Transfer RNA (t-RNA)

i) Ribosomal RNA (r-RNA):

- It is mainly found in cytoplasm and in ribosomes, which contain 60% RNA and 40% protein.
- Ribosomes are the sites at which protein synthesis takes place.

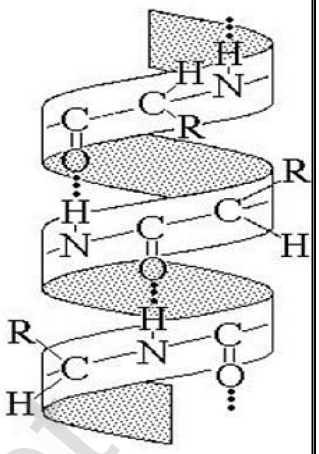
ii) Messenger RNA:

- It is present in small quantity and very short lived.
- They are single stranded, and their synthesis takes place on DNA.
- The synthesis of m-RNA from DNA strand is called transcription.
- m-RNA carries genetic information from DNA to the ribosomes for protein synthesis. This process is known as translation.

iii) Transfer RNA (t-RNA):

- t-RNA molecules have lowest molecular weight of all nucleic acids.
- They consist of 73-94 nucleotides in a single chain.
- The function of tRNA is to carry amino acids to the sites of protein synthesis on ribosomes.

18.Write a note on formation of α- helix.



The amino acids in the polypeptide chain forms highly regular shapes (sub- structures) through the hydrogen bond between the carbonyl oxygen (-C=O) and the neighboring amine hydrogen (-NH) of the main chain. α-Helix and β-strands or sheets are two most common sub structures formed by proteins.

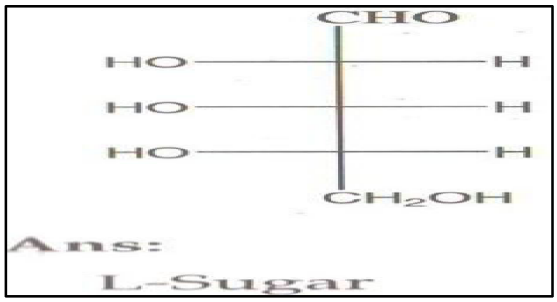
α-helix:

- In the α-helix sub-structure, the amino acids are arranged in a right-handed helical (spiral) structure and are stablished by the hydrogen bond between the carbonyl oxygen one amino acid (nth residue) with amino hydrogen of the fifth residue (n + 4th residue).
- The side chains of the residues protrude outside of the helix.
- Each turn of an α-helix contains about ***3.6 residues*** and is about ***5.4A° long.***
- The amino acid proline produces a kink in the helical structure and often called as a helix breaker due to its rigid cyclic structure.

19.What are the functions of lipids in living organism?

- Lipids are the integral component of cell membrane. They are necessary of structural integrity of the cell.
- The main function of triglycerides in animals is as an energy reserve. They yield more energy than carbohydrates and proteins.
- They act as protective coating in aquatic organisms.
- Lipids of connective tissue give protection to internal organs.
- Lipids help in the absorption and transport of fat soluble vitamins.
- They are essential for activation of enzymes such as lipases.
- Lipids act as emulsifier in fat metabolism.

20. **Is the following sugar, D-Sugar or L-Sugar.**



ADDITIONAL QUESTIONS AND ANSWER

1)What are monosaccharides? Give example.

➢ Monosaccharides are carbohydrates that cannot be hydrolysed further and are also called simple sugars.

➢ General formula $C_n(H_2O)_n$. ➢ Eg: glucose, fructose

2) What are disaccharides? Give example.

➢ Disaccharides are sugars that yield two molecules of monosaccharides on hydrolysis catalysed by dilute acid or enzyme.

➢ General formula $C_n(H_2O)_{n-1}$.

➢ Eg: Sucrose, Lactose

3) What is polysaccharide? Give example.

➢ Polysaccharide consists of large number of monosaccharide units bonded together by glycosidic bonds. Since, they do not have sweet taste polysaccharides are called as non-sugars.

➢ Eg: starch, cellulose

4) What is mutarotation

➢ The specific rotation of pure α- and β-(D) glucose are 112° & 18.7°

➢ When a pure form of any one of these sugars is dissolved in water, slow interconversion of α-D glucose and β-D glucose via open chain form occurs until equilibrium is established giving a constant specific rotation + 53°

➢ This phenomenon is called mutarotation.

5) What is epimerization.

➢ Sugar differing in configuration at an asymmetric centre is known as epimers.

- The process by which one epimer is converted into other is called epimerisation and it requires the enzymes epimerase.
- Galactose is converted to glucose by this manner in our body.

6) Sucrose is called as invert sugar? Why?

- Sucrose (+66.6°) and glucose (+52.5°) are dextrorotatory compounds while fructose is levo rotatory (-92.4°).
- During hydrolysis of sucrose the optical rotation of the reaction mixture changes from dextro to levo.
- Hence, sucrose is also called as invert sugar.

7) Write a short note on the structure of sucrose (or) sucrose is a non-reducing sugar. Justify.

- In sucrose, C1 of α-D-glucose is joined to C2 of β-D-fructose.
- The glycosidic bond thus formed is calledα-1,2glycosidic bond.
- Since, both the carbonyl carbons (reducing groups) are involved in the glycosidic bonding, sucrose is a non-reducing sugar.

8) What is glycosidic linkage?

- In disaccharides two monosaccharide's are linked by oxide linkage called 'glycosidic linkage'.
- It is formed by the reaction of the anomeric carbon of one monosaccharide with a hydroxyl group of another monosaccharide.

9) Lactose is a reducing sugar? Justify.

- In lactose the β-D–galactose and β-D–glucose are linked by β-1,4glycosidicbond.
- The aldehyde carbon is not involved in the glycosidic bond
- It retains its reducing property and is called a reducing sugar.

10) Maltose acts as a reducing sugar justify.

- Maltose consists two molecules of α-D-glucose units linked by an α-1,4glycosidic bond between

anomeric carbon of one unit and C-4 of the other unit.

- Since one of the glucose has the carbonyl group intact, it also acts as a reducing sugar.

11) **Write a note on a starch.**

- Starch is used for energy storage in plants.
- It is a polymer of glucose in which glucose molecules are linked by α(1,4) glycosidic bonds
- They are separated into two fractions,
- 1. water soluble amylose - 20 %
- 2. water insoluble amylopectin - 80%

12. What is isoelectric point.

- At a specific pH the net charge of an amino acid is neutral and this pH is called isoelectric point.
- At a pH above the isoelectric point the amino acid will be negatively charged and positively

charged at pH values below the isoelectric point.

13) **What are Zwitter ions?**

- In aqueous solution the proton from carboxyl group can be transferred to the amino group of an

amino acid leaving these groups with opposite charges.

- Despite having both positive and negative charges this molecule is neutral and has amphoteric behaviour.
- These ions are called zwitter ions. $^{+}H_3N - CH_2 - COO^{-}$ Zwitter ions.

14. Elucidate the structure of glucose.

Experiment	Observation	Inference
Elemental analysis and molecular weight determination of fructose	$C_6H_{12}O_6$.	Determine Molecular formula
With concentrated HI and red phosphorus	It gives n-hexane	Six carbon atoms are bonded **linearly**
With water	It gives Neutral solution	Absence of –COOH group
With acetic anhydride in the presence of pyridine	It form penta acetate	Presence of five hydroxyl (– OH) groups.
With NH_2OH and HCN	To give Oxime and Cynohydrin respectively	Presence of a carbonyl (-CO-) group.
With bromine water	It gives gluconic acid	Presence of Aldehyde (-CHO) group
With Tollens Reagent and Fehlings solution	Reduce both solutions	Presence of Aldehyde (_CHO) group
With con nitric acid	It gives glucaric acid (saccharic acid)	Presence of Primary alcohol ($-CH_2-OH$)group at the other end

15. Elucidate the structure of fructose.

Experiment	Observation	Inference
Elemental analysis and molecular weight determination of fructose	$C_6H_{12}O_6$.	Determine Molecular formula
With concentrated HI and red phosphorus	It gives n-hexane	Six carbon atoms are bonded linearly
With water	It gives neutral solution	Absence of **–COOH** group
With acetic anhydride in the presence of pyridine	It form penta acetate	Presence of five hydroxyl **(-OH)** groups
With NH_2OH and HCN	It gives Oxime and Cynohydrin respectively	Presence of a carbonyl **(-CO-)** groups
With bromine water	No reaction	Absence of Aldehyde **(-CHO)** group
With sodium amalgam	It Produce mixtures of Sorbitol and Mannitol	Presence of a keto **(-CO-)** group.
With Tollens Reagent and Fehlings solution	No reaction	Absence of Aldehyde **(-CHO)** group
With nitric acid	It gives glycolic acid and tartaric acids	This shows that a keto group **(-CO-)** is present in C-2.

1. Outline the classification of carbohydrates giving example for each (239)
2. What are the different types of monosaccharides. (240)
3. Elucidate the structure of glucose (241)
4. Draw the cyclic structure of glucose (243) (Write the structure of α – D(+) Glucopyranose., ß-D-glucopyranose)(243) **PTA 2M, M24 2M**
5. Define anomer. Give example. (243)
6. Define mutarotation. (244)
7. Define epimers and epimerization. (244) What are epimers? Give an example. **M22 3M**
8. Explain the structure of Fructose. (245) **GM5M**
9. Draw the structure of D(+) Fructose. (246) **J22 2M**
10. What are reducing and non-reducing sugars? Give an example. (BB) **J24 3M**
11. What happens when fructose is partially reduced with sodium amalgam and water? (245) **PTA 5M ii**
12. Draw the cyclic structure of fructose.(246)
13. Write about the structure of sucrose (247)
14. Explain the structure of lactose (247)
15. Explain the structure of maltose (248)
16. What is glycosidic linkage? (247) **M20 5Mi**

17. Mention the importance of Carbohydrates (250)
18. Define isoelectric point (252)
19. What is Called Zwitter ion? Give an example (252) **J22 3M** **M23 3M** Give the structure of a Zwitter ion.
20. Write a short note on peptide bond. (252) **PTA 5M i, M24 3M**
21. Write the Zwitter ion structure of alanine. (252) **2M**
22. Write a note on denaturation of proteins. (256) **S20 2M**
23. Mention the importance of proteins in living organisms. **(256) J23 5M**
24. Write any three biological importance of lipids. (258) **S20 3M**
25. How are vitamins classified? **(259) J24 2M**
26. Name the vitamins whose deficiency causes. (a) Rickets (b) Scurvy (259) **J20 2M**
27. Explain composition and structure of nucleic acids. (260)
28. Explain types of RNA molecules (264) **J20 5Mi**
29. Give any four differences between DNA and RNA. (264) **A21 3M GM2M**
30. Write note on DNA finger printing. (265)
31. Explain Hormones (266). What are Hormones? Give example. (166) **M23 2M**

LESSON 15 CHEMISTRY IN EVERYDAY LIFE

SHORT QUESTION ANSWERS

1. **What are antibiotics?**

- The medicines that have the ability to kill the pathogenic bacteria are grouped as antibiotics.
- Antibiotics is a chemical substance produced by one microorganism, that selectively inhibits the growth of another microorganism.
- **Examples:** Amoxicillin, ampicillin, cefixime, cefpodoxime, erythromycin, tetracycline etc.

2. **Name one substance which can act as both analgesic and antipyretic.**

Aspirin (acetyl salicylic acid) it is substance which lowers body temperature (to normal) and also reduces body pain. Therefore, its act as both analgesic and antipyretic.

3. **Write a note on synthetic detergents.**

- Synthetic detergents are ***products containing either sodium salts of alkyl hydrogen sulphate or sodium salts of long chain alkyl benzene sulphuric acids***.

There are three types of detergents.

- **Detergents type** **example**
  - Anionic detergent Sodium Lauryl sulphate (SLS)
  - Cationic detergent n-hexadecyltrimethyl ammonium chloride
  - Non-ionic detergent Pentaerythrityl stearate.

- Synthetic detergents can be used even in hard water, while soaps cannot be used in hard water.

4. **How do antiseptics differ from disinfectants?**

(i) Antiseptics and disinfectants are chemicals which kill or present the growth of microorganisms.

(ii) The difference between them is antiseptic are applied to living tissues , such as wound cuts etc, whereas disinfectants floors, drainage etc.

Antiseptics	Disinfectants
Antiseptics are chemical substances which prevent the growth of micro organism and may even kill them but are not harmfuk to living tissues.	Disinfectants are chemical substances which kill microorganism or stop their growth but harmful to human tissues.
They are generally applied to living tissues such as wounds ,cuts bulks and diseased surface.	Disinfectants are applied to inanimated objects such as floors ,drainage system,instruments etc.
All the antiseptics are disinfectants.	All the disinfectants are not antiseptics.
~~They are not injected or swallowed~~	~~They can be injected or swallowed~~
Example : Povoidone -iodine Benzalkonium-Chloride	**Example:**Alochol ,Chloribe compounds.

5. **What are food preservatives?**

(i) Preservatives are capable of inhibiting retarding or arresting the process of fermentation, acidification or other decomposition of food by growth of microorganisms.

(ii) Organic acids such as benzoic acid, sorbic acid and their salts are potent inhibitors of a number of fungi, yeast and bacteria.

Examples:

- ***Sodium meta sulphite*** is used as preservatives for fresh vegetables and fruits.
- ***Acetic acid*** is used as preservative for preparation of pickles.
- ***Sodium benzoate*** is used as preservatives for juices.

6. **What are drugs? How are they classified.**

- A drug is a substance that is used to modify or explore physiological systems or pathological states for the benefit of the recipient.

- It is used for the purpose of diagnosis, prevention, cure/relief of a disease.
- Drugs are classified based on their properties such as chemical structure, pharmacological effect, target system, site of an action etc.

7. **How the tranquilizers work in body?**

Tranquilizers: Thet are neurologically active drugs. They act on the central nervous system by blocking the neurotransmitter dopamine in the brain

E.g. Haloperidol, clozapine.

8. **Write the structure formula of asprin.**

Structural formula of asprin (Acetyl salicylic acid) $C_9H_8O_4$

9. **Explain the mechanism of cleaning action of soaps and detergents.**

(i) Let us consider sodium palmitate an example of a soap. The cleansing action of soap is directly related to the structure of carboxylate ions present in a soap. The structure of palmitate exhibits dual polarity. The hydrocarbon portion is non polar and carboxyl portion is polar.

(ii) The nonpolar portion is hydrophobic while the polar end is hydrophilic.

(iii) The hydrophobic hydrocarbon portion is soluble in oils and greases, but not in water. The hydrophilic carboxylate group is soluble in water.

(iv) The dirt in the cloth is due to the presence of dust oarticles intact or grease which stick.

(v) When the soap is added to an oily or greasy part of the cloth, the hydrocarbon part of the soap dissolve in grease, leaving the negatively charged carboxylate groups are strongly attracted by water thus leading to the formation of the small droplets called micelles and grease is floated away from the solid object.

(vi) When the water is rinsed away, grease goes with it . As a result the cloth gets free from dirt and the droplets are washed away with water.

(vii) The cleansing ability of a soap depends upon its tendency to act as a emulsifying agent between water and water insoluble greases.

10. **Which sweetening agents are used to prepare sweets for a diabetic patient?**

Synthetic compounds which imprint a sweet sensation and possess no or negligible nutritional value are called artificial sweeteners.

Examples: Saccharin, Aspartame, Sucralose, Alitame etc.

11. What are narcotic and non-narcotic drugs?

(i) Analgesics (Non-narcotic):

- Analgesics reduce the pain without causing impairment of consciousness.
- They alleviate pain by reducing local inflammatory responses
- **Example:** paracetamol, Ibuprofen, Asprin.
- **Uses:** Used for short-term pain relief and for modest painlike headache, muscle strain, bruising, or arthritis.

(ii) Opioids (Narcotic Analgesics):

- Relive pain and produce sleep. These drugs are addictive. In poisonous dose, these produces coma and ultimately death.
- **Example:** Morphine, codeine
- **Uses:** Used for either short-term or long-term relief of severe pain. Mainly used for post operative pain, pain of terminal cancer.

12. What are anti fertility drugs? Give examples.

- Antifertility drugs: These are synthetic hormones that suppresses ovulation/ fertilization.
- **Example:** Synthetic oestrogen – Ethynylestradiol, Menstranol
- **Uses:** Used in birth control pills.

13. Write a note on co-polymer.

- A polymer containing two or more different kinds of monomer units is called a copolymer.
- For example, SBR rubber (Buna-S) contains styrene and butadiene monomer units.
- Co-polymers have properties quite different from the homopolymers.

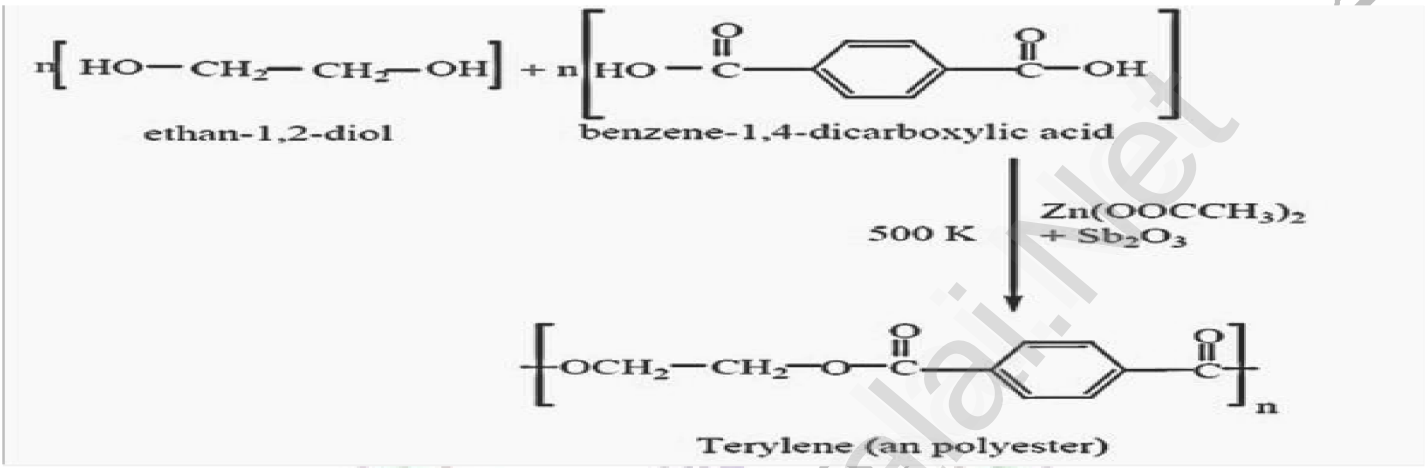
14. What are bio degradable polymers? Give examples.

- The materials that are readily decomposed by microorganisms in the environment are called biodegradable.
- **Examples:** Polyhydroxy butyrate (PHB), Polyhydroxy butyrate-co-hydroxyl valerate (PHBV)

- Biodegradable polymers are used in medical field such as surgical sutures, plasma substitute etc…these polymers are decomposed by enzyme action and are either metabolized or excreted from the body.

15.How is terylene prepared?

- When ethylene glycol and terepathalic acid (or) dimethylterephthalate are mixed and heated at 500K in the presence of zinc acetate and antimony trioxide catalyst, terylene is formed.



- It is used in blending with cotton or wool fibres and as glass reinforcing materials in safety helmets.

16. Write a note on vulcanization of rubber.

(i) The process of mixing natural rubber with sulphur is called **vulcanization**.

(ii) Natural rubber is mixed with 3-5% sulphur and heated at 100-150°C causes cross linking of the cis-1,4-polyisoprene chains through disulphide (-S-S-) bonds.

(iii) The physical properties of rubber can be altered by controlling the amount of sulphur that is used for vulcanization.

(iv) In sulphur rubber, made with about 1 to 3% sulphur is soft and stretchy.

(v) When 3 to 10% sulphur is used the resultant rubber is somewhat harder but flexible.

17. Classify the following as linear, branched or cross-linked polymers

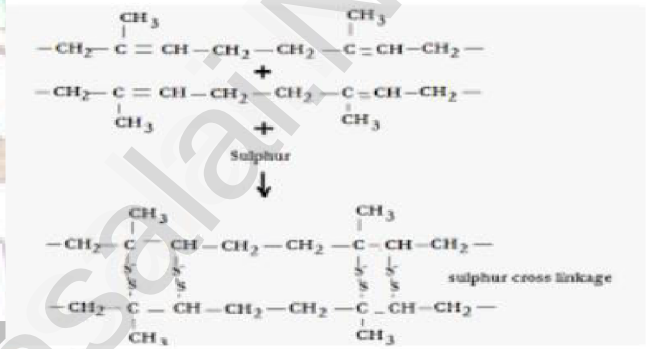
(a) Bakelite b) Nylon c) LDPE d) HDPE

(a) Bakelite – Cross linked polymer

b) Nylon – Linear polymer

c)LDPE – Branched polymer

d)HDPE – Linear polymer



1. What are antibiotics? BB 274 **M24 2M**
2. Give a brief account on Antioxidants. (283) **J20 5Mi**
3. How do you classify the following into various class of drugs? (277-282) **J20 5Mii**

(A) Milk of Magnesia (B) Aspirin (C) Penicillin (D) Procaine

4. How do antiseptics differ from disinfectants? (282) **S20 5Mi**
5. What are bio degradable polymers? Give two examples.(293) PTA**3M, J23 2M, M24 5Mii**
6. How the transquilizers work in body? 277 (BB 296) PTA **2M**
7. Write a note on TFM value. ((284) PTA **5M ii**
8. How nylon -6 is prepared? (289) PTA **2M**
9. Write the made of action and uses of antacids. Give an example (279) PTA **5M ii**
10. What are food preservatives? Give two examples. (283) PTA **2MC M23 3M**
11. Define food additives. (282) State any three advantages of food additives. (283) **M20 3M**
12. Define the term therapeutic index. How is it related to the safety of the drug? **(273) PTA 5M ii**
13. How is terylene prepared? (290) PTA **2M**

14. Explain the mechanism of cleaning action of soaps and detergents. (284) PTA **5M i**

15. What are Antiseptics? Give an example (282) PTA **2M**

16. How polymers are classified on the basis of structure and molecular forces, give examples of each one. **(286) PTA 5M**

17. Write short notes on Antioxidants. **(283) G2M**

18. Explain the preparation of Nylon-6,6 and Buna-S. (289, 292)**G3M**

19. How Nylon-2-Nylon-6 is prepared? **M23 5Mii**

20. What is Vulcanization?(292)**M20 5Mii** Write note on Vulcanization of rubber. **(292) J23 3M**

21. How is neoprene prepared? **S20 3M**

2M- 2 marks; 2MC- 2 marks Compulsory; 3M- 3 marks; 5M- 5 marks; GM2M- Govt model question paper 2 marks;

ALL THE BEST SCORE MORE MARKS

NAME REACTIONS ORGANIC CHEMISTRY

LESSON 11

1. Markonikoff's rule. (108)
2. Grignard reagent (108)
3. Hydroboration (109)
4. Bayer's reagent. (110)
5. Saponification (110)
6. Lucas test (111) **J20 5M, S20 5M I, J23 5M, M24 5M**
7. Victor Meyer test for primary, secondary, tertiary alcohol. (111)
8. Victor meyer's test (111)
9. Saytzeff's rule.(116)
10. Swern oxidation. (117)
11. Esterification (118)
12. Biological oxidation (118)
13. TERYLENE 3m J24 unit 15

14. TNG(121)
15. Acrolein (121)
16. Dows process(127)
17. Schotten- baumann reaction (128)
18. Williamson ether synthesis(128)
19. Kolbe's (or) Kolbe's schmit reaction(131) **M24 2M**
20. Riemer tiemann reaction(131)
21. Phthalein reaction(132)
22. Coupling reaction(132)
23. Friedel craft's reaction(139)

LESSON 12

24. Ozonolysis(149)
25. Rosenmund reduction(151)
26. Stephen's reaction(151)
27. Etard reaction (152)
28. Gattermann-koch reaction(152)
29. Friedel crafts acylation (152)
30. Urotropine(158)
31. Popoff's rule (159)
32. Clemmensen reduction(160) acetone to propane **M23 2M, M24 5M problem**
33. Wolfkishner reduction(161)
34. Aldol condensation(162)
35. Crossed aldol condensation(163)
36. Claisen-schmidt condensation(163)
37. Cannizaro reaction(164)
38. Crossed cannizaro reaction(164)
39. Benzoin condensation(164)
40. Penkins reaction(165)
41. Knoevenagal reaction(165) **M24 3M**
42. Schiffs base(165)

43.Malachite green dye(165) **M23 5Mi**

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45.Fehlings solution test(166)

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49.Kolbs electrolytic(175)

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52.Claisen condensation(186)

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54.Chloropicrin (203)

55.Mendius reaction (208)

56.Gabriel phthalimide systhesis(209)

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58.Sabatier –Mailhe method(210)

59.Schotten –baumann reaction(214,215) **M23 2m complete reaction J23 5Mi**

60.Libermanns nitroso test(215)

61.Carbylamine reaction(216)

62.Mustard oil reaction(216) **J23 5Mi, M24 3M**

63.Gattermann reaction(220)

64.sandmeyer reaction(220)

65.Baltz –schiemann reaction(221)

66.Gomberg reaction(221)

67.Coupling reaction(222)

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69.Carbylamins reaction(226)

70.Levine and hauser acetylation(225)

ORGANIC PROBLEM

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1. An organic compound (A) of molecular formula C_3H_8O gives turbidity within 5-10 minutes on reaction with anhydrous $ZnCl_2$/HCl. Compound (A) on treatment with PCC (Pyridinium chloro chromate) gives a carbonyl compound(B) which on further chlorination gives compound (C) of molecular formula $C_3H_3OCl_3$. Identify (A),(B) and (C) and explain the reactions. (117)
2. An organic compound (A) C_2H_6O liberates hydrogen on treatment with metallic sodium. (A) on mild oxidation gives (B) C_2H_4O which answers iodoform test. (B) when treated with CH_3OH/HCl to give (C) ($C_4H_{11}O_2$). Identify (A), (B) and (C) and explain the reactions. (155)
3. An organic compound A of molecular formula C_6H_6O gives a violet colourisation with neutral $FeCl_3$. Compound A on treatment with NaOH gives compound B. Compound B on treatment with CO_2 at 400 K under pressure gives C. This product on acidification gives compound D($C_7H_6O_3$) which is used in medicine. Identify A, B, C and D and explain the reactions. (130 Kolbe reaction)
4. An organic compound (A) of molecular formula C_6H_6O gives a purple colourisation with neutral $FeCl_3$. Compound (A) on treatment with ammonia to gives compound (B). Compound (B) and it also reacts with Zn dust to give compound (C). Identify A, B, C explain the reactions. **M23 5M**
5. An organic compound A of molecular formula C_3H_6O on reduction with $LiAlH_4$ gives B. Compound B gives blue colour in Victor Mayer's test and also forms a chloride C with $SOCl_2$. (A) reacts with NH_3 to form D($C_6H_{13}NO$). Identify A, B, C and D and explain the reactions.(158)
6. An organic compound (A) C_3H_8O answers Lucas test-within 5-10 minutes and on oxidation forms B(C_3H_6O). This on further oxidation forms C($C_2H_4O_2$) which gives effervescence with Na_2CO_3. B also undergoes iodoform reaction. Identify A, B, and C,. Explain the conversion of A to B and C.
7. An organic compound (A) of molecular formula C_6H_6O gives violet colour with neutral $FeCl_3$. (A) react with $CHCl_3$/aq.NaOH to gives B. (A) also reacts with $C_6H_5N_2Cl$ to give the compound (C) which is a red orange dye. Identify (A),(B) and (C). Explain with suitable reactions. (130)

8. Compound (A) of molecular formula C_3H_8O liberates hydrogen with sodium metal. (A) with P/I_2 gives (B). Compound (B) on treatment with silver nitrite gives (C) which gives blue colour with nitrous acid. Identify (A),(B),(C) and explain the reactions. (112)
9. Compound (A) with molecular formula C_6H_6O gives violet colour with neutral $FeCl_3$, reacts with $CHCl_3$ and NaOH gives (B) with molecular formula $C_7H_6O_2$. Compound (A) reacts with Ammonia at 473 K in the presence of $ZnCl_2$ and gives compound (C) with molecular formula C_7H_7N. Compound (D) undergoes carbylamine test. Identify (A), (B), and (C). Explain the reactions. 127
10. An organic compound C_2H_6O (A) reacts with H_2SO_4 at 443 K and gives (B) of molecular formula C_2H_4. (B) Reacts with cold alkaline $KMnO_4$ (Baeyer's reagent) to give (C) of molecular formula $C_2H_6O_2$. Identify (A). (B), (C). Explain the reactions. (115 & 110)
11. An organic compound A (C_2H_6O) liberates hydrogen with sodium metal. A when heated with alumina at 620 K gives an alkene B which when passed through Bayer's reagent gives C($C_2H_6O_2$). C reacts with PI_3 and gives back B. Identify A, B and C. Write the reactions. (110, 115, 119)
12. A ether (A) $C_5H_{12}O$ when heated with excess of hot concentrated HI, produced two alkyl halides, which on hydrolysis forms compound (B) and (C). Oxidation Of (B) gives an acid (D) where as oxidation of (C) gives ketone (E). Identify A, B, C, D and E and write the chemical equation.
13. An organic compound (A) on reduction gives compound (B). (B) on treatment with $CHCl_3$ and alcoholic KOH gives (C). (C) on catalytic reduction gives N – methyl aniline. Identify A,B,C.
14. An organic compound C_3H_4(A) on hydration with Hg^{2+} / H_2SO_4 gives compound (B) which gives positive iodoform test. Compound (B) heated with $NH_2 - NH_2$ / C_2H_5ONa to give hydrocarbon (C). (B) also treated with HCHO in the presence of dil NaOH gives compound (D). Identify A, B, C and D. Write the chemical reactions involved.
15. An organic compound (A) – $C_3H_8O_3$ used a sweetening agent, which on oxidation with Fenton's reagent gives a mixture of compounds B and C. Identify A, B and C. Write Possible reactions.

16. An organic compound (A) – C_7H_7NO on treatment with Br_2 and KOH gives an amine (B), which gives carbylamines test. (B) upon diazotization to give (C). (C) on coupling with P. cresol to give compound (D). Identify A,B,C and D with necessary reaction.
17. An organic Compound (A)-C_2H_4O reduces Tollen's and fehling's solution. A-react with methanol and HCl to give compound (B) – $C_4H_{10}O_2$. A-on reaction with Methanal in the presence of dilute NaOH to give compound (C) – $C_3H_6O_2$. Identify Compounds A, B and C with necessary reactions.
18. An organic Compound C_2H_5Br (A) on treatment with Mg in dry ether gives (B) which on treatment with CO_2 followed by acidification gives (C). Identify (A), (B) & (C) and write possible equations.
19. An aromatic nitro compound (A) on reduction with Sn/HCl gives compound (B) C_6H_7N, which on treatment with Benzoyl chloride in the presence of pyridine to give compound (C). Compound (B) on treatment with CH_3Br to give compound (D) which further reacts with $NaNO_2$/HCl to give compound (E) with yellow oil liquid. Identify (A) to (E) and write the reactions.
20. An organic compound C_2H_6O (A) heated with Con H_2SO_4 at 443K to give an unsaturated hydrocarbon C_2H_4 (B), which on treatment with Bayer's reagent to give compound $C_2H_6O_2$ (C) which is used as antifreeze in automobile radiator. Compound (C) distilled with con H_2SO_4 to give cyclic compound $C_4H_8O_2$ (D). Compound (A) is heated with Con H_2SO_4 at 413K to give compound $C_4H_{10}O$ (E). Identify Compounds (A) to (E) and write equations.
21. Compound A of molecular formula C_7H_6O reduces Tollen's reagent when A reacts with 50% NaOH gives compound B of molecular formula C_7H_8O and C of molecular formula $C_7H_5O_2Na$. compound C on treatment with dil HCl gives compound D of molecular formula $C_7H_6O_2$. When D is heated with soda lime gives compound E. identify A, B, C, D & E. (163) **GM5M**
22. An organic compound (A) – C_7H_7NO on treatment with Br_2 and KOH gives an amine (B), which gives carbylamines test. (B) upon diazotization to give (C). (C) on coupling with P. cresol to give compound (D). Identify A,B,C and D with necessary reaction. (209) **PTA5M**

23. An organic compound (A) – CNCl react with methyl magnesium Bromide to give compound B – (C_2H_3N). B-upon catalytic reduction to give compound C – (C_2H_7N). C gives carbylamine test. Identify compound A,B and C and write the reactions. (224, 225)**3MC**

24. An organic compound (A) of molecular formula C_2H_4O reacts with Zn-Hg/Conc.HCl to give compound (B) which reacts with HNO_3 forming compound (C) (as major product) and Compound (D). Compound (C) reacts with conc.HCl to give compound (E) (Table vinegar) and hydroxylamine. Identify A,B,C,D and E with suitable reactions. **M24 5M**

Compulsory questions: ORGANIC

1. C_6H_6O (A) $\xrightarrow{NH3}$ (B) (A) $\xrightarrow{Zn}$ (C)
2. C_7H_6O (A) $\xrightarrow{50\%\ NaOH}$ (B) C_7H_8O + $C_7H_5O_2Na$ (C). (C) $\xrightarrow{HCl}$ (D) $\xrightarrow{Sodalime}$ (E)
3. C_2H_6O (A) $\xrightarrow{\text{conc. H2SO4 at 443 K}}$ (B) $\xrightarrow{Bayer's\ reagent}$ (C) $C_2H_6O_2$ $\xrightarrow{\text{anhydrous ZnCl2}}$ C_2H_4O (D)
4. CH_4O (A) $\xrightarrow{Tollens\ reagent}$ (B) CH_2O $\xrightarrow{CH3MgBr}$ (C) C_2H_6O
5. C_2H_6O (A) $\xrightarrow{Cu/573K}$ (B) C_2H_4O $\xrightarrow{CH3MgBr}$ (C) C_3H_8O $\xrightarrow{Cu/573k}$ (D) C_3H_6O
6. C_6H_5Cl (A) $\xrightarrow{NaOH}$ (B) C_6H_6O $\xrightarrow{NH3—anhydrous\ ZnCl2}$ (C) C_6H_7N
7. C_6H_5Cl (A) $\xrightarrow{NaOH}$ (B) C_6H_6O $\xrightarrow{NaOH}$ (C) C_6H_5ONa $\xrightarrow{CO2}$ (D) $C_7H_6O_3$
8. $C_6H_5N_2Cl$ (A) $\xrightarrow{H2O}$ (B) C_6H_6O $\xrightarrow{Zn}$ (C) simplest aromatic hydrocarbon $\xrightarrow{Methyl\ chloride}$ (D) C_7H_8
9. C_6H_6 (A) $\xrightarrow{H3PO4\ 523\ K}$ (B) C_9H_{12} $\xrightarrow{Air\ O2}$ (C) $C_9H_{12}O_2$ $\xrightarrow{H2SO4}$ (D) C_6H_6O
10. C_3H_8O (A) $\xrightarrow{P/I2}$ (B) C_3H_7I $\xrightarrow{AgNO2}$ (C) $C_3H_7NO_2$ $\xrightarrow{Nitrous\ acid}$ (D) $C_3H_6N_2O_3$ Blue colour
11. C_2H_6O (A) $\xrightarrow{Al2O3/620K}$ (B) alkene $\xrightarrow{\text{Bayer's reagent}}$ (C) $C_2H_6O_2$
12. C_6H_6O (A) $\xrightarrow{\text{CHCl3 and NaOH}}$ (B) $C_7H_6O_2$ (A) $\xrightarrow{\overset{NH3}{\underline{\quad}}\ Anhydrous\ chloride}$ (C) C_6H_7N
13. Organic compound (A) $\xrightarrow{reduction}$ (B) $\xrightarrow{\text{CHCl3 alc KOH}}$ (C) $\xrightarrow{\text{catalytic reduction}}$ (D) N – methyl aniline
14. C_3H_4 (A) $\xrightarrow{\text{Hg2+ / H2SO4}}$ (B) (Positive iodoform test) $\xrightarrow{\text{NH2 – NH2 / C2H5ONa}}$ (C)

(B) $\xrightarrow{\overset{\text{HCHO /dil NaOH}}{\underline{\quad}}}$ (D)

15. $C_3H_8O_3$ (A) $\xrightarrow{\text{Fenton's reagent}}$ (B) and (C)

16. C_7H_7NO (A) $\xrightarrow{\text{Br2 and KOH}}$ (B) $\xrightarrow{\text{diazotization}}$ (C) $\xrightarrow{\text{coupling with p−cresol}}$ (D)

17. C_2H_4O (A) $\xrightarrow{\text{Methanol/HCl}}$ (B) $C_4H_{10}O_2$ (A) $\xrightarrow{\text{Methanal in the presence of dilute NaOH}}$ (C) $C_3H_6O_2$

18. C_2H_5Br (A) $\xrightarrow{\text{Mg dry ether}}$ (B) $\xrightarrow{CO2}$ (C)

19. (A) $\xrightarrow{\text{Sn/HCl}}$ (B) C_6H_7N $\xrightarrow{\text{Benzoyl chloride /pyridine}}$ (C) (B) $\xrightarrow{\text{CH3Br}}$ (D) $\xrightarrow{\text{NaNO2/HCl}}$ (E)

20. C_2H_6O (A) $\xrightarrow{\text{Con H2SO4 at 443K}}$ (B) C_2H_4 $\xrightarrow{\text{Bayer's reagent}}$ $C_2H_6O_2$ (C). (A) $\xrightarrow{\text{Conc H2SO4}}$ $C_4H_{10}O$ (E).

21. Identify A and B in the following sequence of reactions.(210) **M22 2M C**

$$CH_3CH_2Br \xrightarrow{NaN3} A \xrightarrow{LiAlH4} B + N_2$$

22. Identify Compounds A, B and C in the following sequence of reaction.($BBQ_{5vii}233$)**3MC**

$$CH_3CH_2NC \xrightarrow{HgO} A \xrightarrow{H_2O} B \xrightarrow[HCl]{NaNO_2}{}/H2O \; C$$

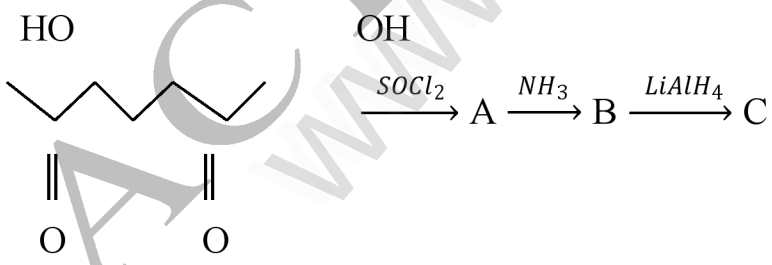
23. Identify A to C in the following sequence? ($BBQ_{5i}233$)**GM 3MC**

$$C_6H_5NO_2 \xrightarrow{Fe/HCl} A \xrightarrow{HNO3/\ 273k} B \xrightarrow{H2O} C$$

24. Identify Compounds A, B and C in the following sequence of reaction(203,215,222) **J23 3MC**

$$C_6H_5NO_2 \xrightarrow{Sn/HCl} A \xrightarrow{NaNO2+HCl/273k} B \xrightarrow{C6H5OH} C$$

25. Identify A,B and C ($BBQ_{13}235$) **PTA5M i**



$$\xrightarrow{SOCl_2} A \xrightarrow{NH_3} B \xrightarrow{LiAlH_4} C$$

26. Identify A and B. (208) **M20 5Mii**

$$A \xrightarrow{Na(Hg)/C_2H_5OH} CH_3 - CH_2 - NH_2$$

4[H]

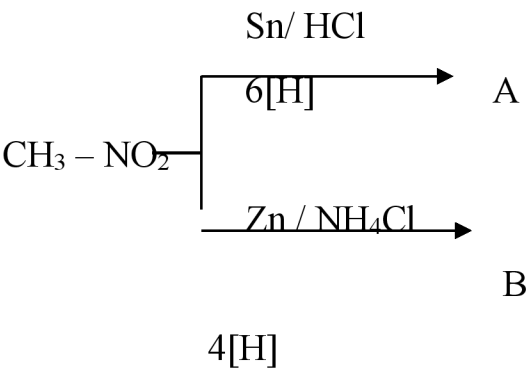
$$B \xrightarrow{Na(Hg)/C_2H_5OH} CH_3 - NH - CH_3$$

4[H]

27. Identify A and B. (208) **M22 2M Compulsory**

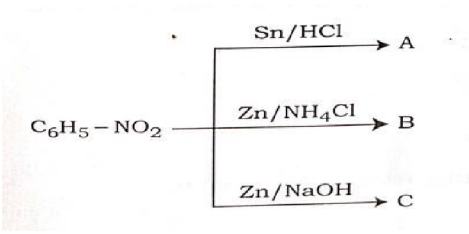
$$CH_3Br \xrightarrow{NaN3} A \xrightarrow{LiAlH4} B + N_2$$

28. From the following reaction, identify A and B. (202) **A21 2M Compulsory**



4[H]

29. From the following reaction, identify A, B and C. (203) **J22 3M Compulsory**



30. $CH_3CH_2NO_2 \xrightarrow{Sn/HCl} A \xrightarrow{CH3COCl} B$. **M23 2M COMPULSORY**

- **"NO PAIN, NO GAIN".**

Never Dreamed about success, Worked for it.

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"May God's guidance be with you during the Exam and may you be able to answer each question correctly. My prayers and Blessings are with you".- ACTC EMS

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