PRACTICE PAPER – 4

ANSWERS

SECTION – A

1. Calculate the mass of a non-volatile solute (molar mass 40g mol^{-1}) which should be dissolved in 114g Octane to reduce its vapour pressure to 80%.

Ans. Raoult's law formula $\frac{P_0 - P_S}{P_0} = x_s$

$$= \frac{n_s}{n_0 + n_s} = \frac{\frac{w}{m}}{\frac{W}{m} + \frac{w}{m}}$$

Given vapour pressure reduced to 80%, when non-volatile solute is dissolved in octane.

P_0 = 1 atm	m = 40 gms/mole
P_s = 0.8 atm	$\frac{1-0.8}{1} = \frac{w/40}{w/40+1}$
W = 114 gms	$0.2 = \frac{w}{w+40}$
M = 144 gm/mole	0.2 W + 8 = W
w = ?	W = 10 gms.

2. What are complex reactions ? Name one Complex reaction.

Ans. A sequence of elementary reactions, reactants give the products, the reactions are called complex reactions.

Eg : Oxidation of Ethane to CO_2 and H_2O passes through a series of intermediate steps in which alcohol, aldehyde and acid are formed.

3. What are the limitations of Ellingham diagram ?

Ans. Limitations of Ellingham diagram :

→ Ellingham diagram is based only on the thermodynamic concepts. It does not explain the kinetics of the reduction

process. The graph simply indicates whether a reacton is possible or not but not the kinetics of the reaction.

→ The interpretation of ΔG° is depends on K [$\Delta G^\circ = -RT\mathit{l}.nK$]
It is presumed that the reactants and products are in equilibrium.

$M_xO + A_{red} \rightleftharpoons x\,M + AO_{ox}$

This is not always true because the reactant or product may be solid.

4. The highest Mn fluoride is MnF_4 where as the highest oxide is Mn_2O_7. Why ?

Ans. The ability of oxygen to stabilize the high oxidation states exceeds that of fluoride. Thus the highest Mn fluoride is MnF_4 where as highest oxide is Mn_2O_7.

5. What is Ziegler – Natta catalyst ?

Ans. A mixture of Tri alkyl aluminium and titanium chloride is called Ziegler – Natta catalyst

E.g. : $(C_2H_5)_3\,Al + TiCl_4$

6. What are elastomers ? Give example.

Ans. Elastomers : These are rubber like solids with elastic properties. In elastomers the polymer chains are held together by the weak inter molecular forces. **E.g. :** Buna – S, Buna – N etc.

7. Why cannot vitamin C be stored in our body ?

Ans. Vitamin C (ascorbic acid) is water soluble. Therefore, it is regularly excreted in urine from the body and cannot be stored.

8. What are the expected products of hydrolysis of lactose ?

Ans. Lactose forms two molecules of monosaccharides on hydrolysis – One molecule of D–(+) – glucose and one molecule of D – (+) – galactose.

$$\underset{\text{Lactose}}{C_{12}H_{22}O_{11}} + H_2O \xrightarrow[\text{Lactase}]{H_3O^+ \text{ or}} \underset{\text{D — (+) — Glucose}}{C_6H_{12}O_6} + \underset{\text{D– (+) Galactose}}{C_6H_{12}O_6}$$

(A disaccharide)

9. When are the drugs called medicines ?

Ans. When the biological response of a drug is therapeutic and useful then the chemical substances (drugs) are called medicines.

10. What are antacids ? Give example.

Ans. Antacids : Chemicals that remove the excess of acid in the stomach and maintain the pH to normal level are antacids.

E.g. : Omeprozole, Lansoprozole etc.,

SECTION – B

11. Define mass percentage, volume percentage and mass to volume percentage solutions.

Ans. i) Mass percentage : The mass percentage of a component of a solution is defined as the

$$\text{mass \%} = \frac{\text{Mass of the component in the solution}}{\text{Total mass of the solution}} \times 100$$

ii) Volume percentage $\left(\frac{\mathbf{v}}{\mathbf{V}}\right)$ **:** It is defined as the volume % of a component $= \frac{\text{Volume of the component}}{\text{Total volume of solution}} \times 100$

iii) Mass to volume percentage $\left(\frac{\mathbf{w}}{\mathbf{V}}\right)$ **:** It is defined as the mass of solute dissolved in 100 m*l* of the solution.

$\rightarrow$ It is commonly used in medicine and pharmacy.

12. What is Schottky defect ? What is Frenkel defect ?

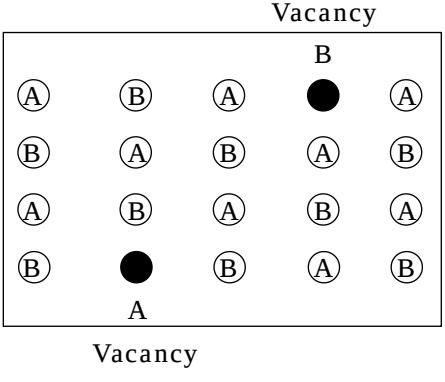
Ans. Schottky defect :

1) "It is a point defect in which an atom or ion is missing from its normal site in the lattice".
2) In order to maintain electrical neutrality, the number of missing cations and anions are equal.
3) This sort of defect occurs mainly in highly ionic

compounds, where cationic and anionic sizes are similar. In such compounds the co-ordination number in high.

Ex. : NaCl, CsCl etcUY

4) **Illustration :**



5) This defect decreases the density of the substance.

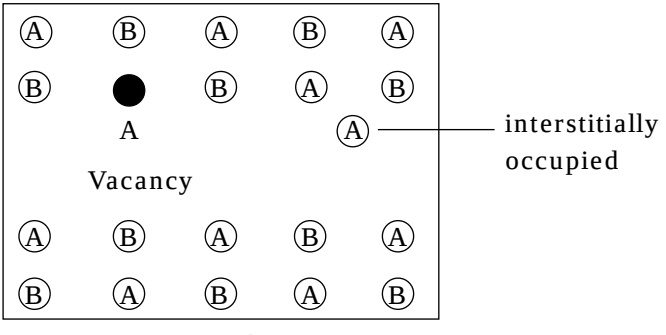
Frenkel defect :

1) "It is a point defect in which an atom or ion is shifted from its normal lattice position". The ion or the atom now occupies an interstitial position in the lattice.

2) This type of a defect is favoured by a large difference in sizes between the cation and anion. In these compounds co-ordination number is low.

E.g. : Ag – halides, ZnS etc.

3) **Illustration :**



4) Frenkel defect do not change the density of the solids significantly.

13. What are lyophilic and lyophobic sols ?

Ans. Lyophilic colloid : The colloidal solution in which the dispersed phase has great affinity to the dispersion medium is called a *Lyophilic colloid or Lyophilic solution*. **Ex :** Starch solution.

The starch paste when dissolved in hot water, with stirring, the starch solution is formed. The starch particles (dispersed phase) has great affinity to water molecules (dispersion medium). So starch solution is a lyophilic solution or lyophilic colloid.

Lyophobic colloid : The colloidal solution in which there exists not much affinity between the dispersed phase and dispersion medium, it is called a *Lyophobic colloid* or *Lyophobic solution*.

Ex : Gold solution.

Gold rods are placed in water containing alkali. Electric arc is applied between gold rods. The gold particles dissolves in water, to give gold solution.

Gold particles (dispersed phase) have not much affinity towards water (dispersion medium). So this is a *Lyophobic solution* or *Lyophobic colloid*.

14. Explain zone refining.

Ans. Zone refining :

→ Zone refining is based on the principle that the impurities are more soluble in the melt than in the solid state of the metal.

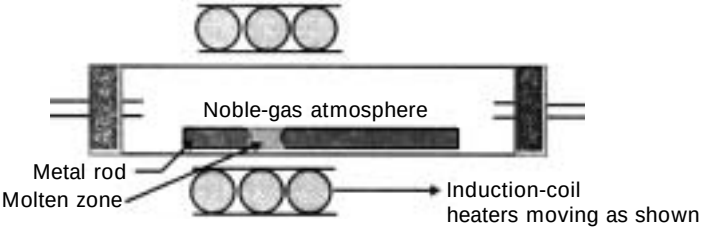
→ A circular mobile heater is fixed at one end of a rod of impure metal.

→ The molten zone moves along with the heater moves forward the pure metal crystallises out of the melt and the impurities pass into the adjacent molten zone.

→ The above process is repeated several times and the heater is moved in the same direction form one end to the other end. At one end impurities get concentrated. This end is cut off.

→ This method is very useful for producing semiconductor grade metals of very high purity.

Eg : Ge, Si, B, Ga etc...



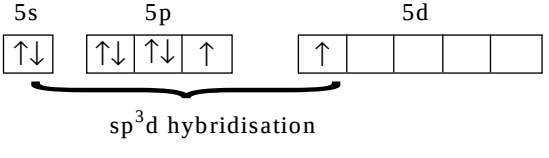
Zone refining process

15. Explain the structures of a) XeF_2 and b) XeF_4

Ans. a) Structure of XeF_2 :

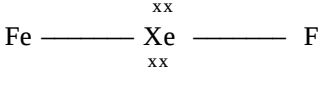
1) In XeF_2 central atom is 'Xe'.

2) 'Xe' undergoes sp^3d hybridisation in it's 1^{st} excited state



3) Shape of molecule is linear

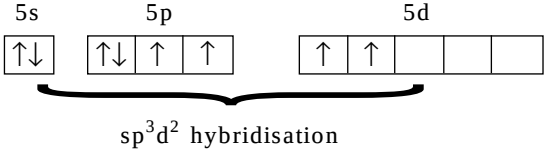
4) Xe form two σ – bonds with two fluorines ($sp^3 - 2p_z$ overlap)



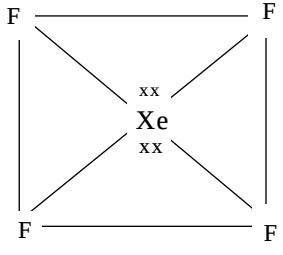
b) Structure of XeF_4 :

1) Central atom in XeF_4 is 'Xe'.

2) Xe undergoes sp^3d^2 hybridisation in it's 2^{nd} excited. state.



3) Shape of the molecule is square planar with bond angle 90° and bond length 1.95Å.



4) Xe – forms four σ - bonds by the overlap of sp^3d^2 – $2p_z$ (F) orbitals.

16. Explain Werner's theory of coordination compounds with suitable examples.

Ans. Werner's theory :

Postulates :

1) Every complex compound has a central metal atom (or) ion.

2) The central metal shows two types of valencies namely primary valency and secondary valency.

A) Primary valency : The primary valency is numerically equal to the oxidation state of the metal. Species or groups bound

by primary valencies undergo complete ionization. These valencies are identical with ionic bonds and are non-directional. These valencies are represented by discontinuous lines (.....)

Eg. : $CoCl_3$ contains Co^{3+} and $3Cl^-$ ions. There are three Primary Valencies or three ionic bonds.

B) Secondary Valency : Each metal has a characteristic number of Secondary Valencies. They are directed in space around the central metal.

The number of Secondary Valencies is called Coordination numbe (C.N.) of the metal. These valencies are directional in Nature.

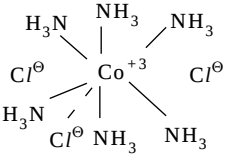
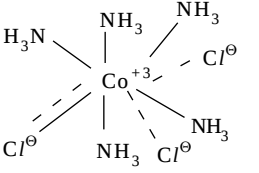
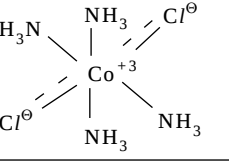
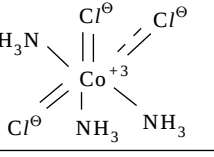
For example in $CoCl_3 . 6NH_3$

Three Cl^- ions are held by primary Valencies and $6NH_3$ molecules are held by Secondary Valencies. In $CuSO_4 . 4NH_3$ complex SO_4^{2-} ion is held by two Primary Valencies and $4NH_3$ molecules are held by Secondary Valencies.

3) Some negative ligands, depending upon the complex, may satisfy both primary and secondary valencies. Such ligands, in a complex, which satisfy both primary as well as secondary valencies do not ionize.

4) The primary valency of a metal is known as its outer sphere of attraction or ionizable valency while the Secondary valencies are known as the inner sphere of attraction or coordination sphere. Groups bound by secondary valencies do not undergo ionization in the complex.

Example to Clarify Wener's Theory

S.No.	Molecular formula of the compound	Co-ordination number	Werner's Structure	Information
1.	$CoCl_3.\ 6NH_3$	6		Octahedral The ligand NH_3 satisfies only Secondary Valencies.
2.	$CoCl_3.\ 5NH_3$	6		Octahedral One Cl^- satisfies secondary valency. As well as primary valency. The remaining Secondary Valencies are satisfied by NH_3.
3.	$CoCl_3.\ 4NH_3$	6		Octahedral Two Cl^- ions and $4NH_3$ molecules satisfy secondary valencies.
4.	$CoCl_3.\ 3NH_3$	6		Octahedral Three Cl^- ions and three NH_3 molecules satisfy

17. Define the following :

i) Racemic mixture ii) Retention of configuration

iii) Enantiomers.

Ans. i) Racemic mixture : Equal portions of Enantiomers combined to form an optically inactive mixture. This mixture is called racemic mixture.

1) Here rotation due to one isomer will be exactly cancelled by the rotation of due to other isomer.

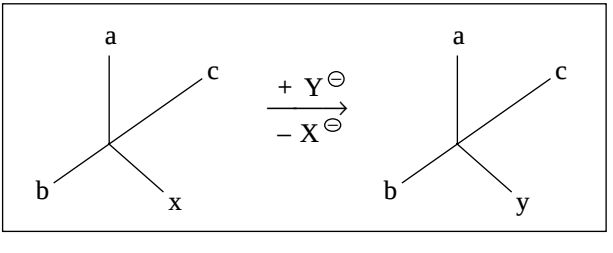
2) The process of conversion of enantiomer into a racemic mixture is called as racemisation.

Eg : (+) Butan-2-ol + (–) Butan-2-ol $\longrightarrow$ (±) Butan-2-ol

Enantiomers Racemic mixture

ii) Retention of configuration : The preservation of integrity of the spatial arrangement of bonds to an asymmetric centre during a chemical reaction (or) transformation is called Retention of configuration.

General Eg : Conversion of XC_{abc} chemical species into YC_{abc}.



Eg : (–) 2 – Methyl 1 – butanol conversion into (+) 1 – chloro 2. Methyl butane

Enantiomers : The stereo isomers related to each other as non-superimposable mirror images are called enantiomers.

→ These have identical physical properties like melting point, boiling points refractive index etc.

→ They differ in rotation of plane polarised light.

18. Write the equations involved in the reaction of Nitrous acid with Ethylamine and aniline.

Ans. Reaction of Ethylamine with nitrous acid : Ethyl amine reacts with nitrous acid to form highly unstable diazonium salt which gives nitrogen gas and Ethyl alcohol after decomposition.

$$CH_3 - CH_2 - NH_2 \xrightarrow{NaNO_2 + HCl} CH_3 - CH_2 - N_2^+ Cl^-$$

$$\text{unstable} \xrightarrow{H_2O} CH_3 - CH_2 - OH + N_2 + HCl$$

Ethyl alcohol

Reaction of Aniline with nitrous acid : Aniline reacts with nitrous acid at low temperatures (0 – 5°C) to form diazonium salts. (Benzene diazonium salt)

$$C_6H_5NH_2 \xrightarrow[0-5°C]{NaNO_2 + HCl} C_6H_5N_2^+ Cl^- + NaCl + H_2O$$

Benzene diazonium chloride

SECTION – C

19. How is Gibbs energy (G) related to the cell emf (E) mathematically ?

Ans. Relation between Gibb's energy (G) and emf (E) mathematically

$\Delta G^0 = - nFE_{(cell)}$

ΔG = change in Gibb's energy

n = number of electrons involved

F = Faraday = 96500 C mol^{-1}

a) Calculate K_c for the reaction at 298 K

$$Zn_{(s)} + Cu^{2+}_{(aq)} \rightleftharpoons Zn^{2+}_{(aq)} + Cu_{(s)}$$

$$E^0_{Zn^{2+}/Zn} = -0.76\,V;\ E^0_{Cu^{2+}/Cu} = +0.34\,V.$$

b) What is "molecularity" of a reaction ? How is it different from the 'order' of a reaction ?

Sol. Given $Zn_{(s)} + Cu^{+2}_{(aq)} \quad Zn^{+2}_{(aq)} + Cu_{(s)}$

E^0 of $Zn^{+2}/Zn = -0.76$ V

E^0 of $Cu^{+2}/Cu = -0.34$ V

E^0 of cell $= E_{RHS} - E_{LHS} = 0.34 - (-0.76) = 1.1$ V

$$\Delta G^0 = -RT\ln K_c = -2.303\,RT \log K_c$$

$$-212300 = -2.303 \times 8.314 \times 298 \times \log K_c$$

$$\log K_c = \frac{212300}{2.303 \times 8.314 \times 298} = 37.207$$

$$K_c = 1.6 \times 10^{37}$$

b) The number of reacting species (atoms, ions or molecules) taking parts in an elementary reaction, which must colloid simultaneously to bring about a chemical reaction is called molecularity of a reaction.

$NH_4NO_2 \longrightarrow N_2 + 2H_2O$ (Unimolecular)

$2HI \longrightarrow H_2 + I_2$ (Bimolecular)

$2NO + O_2 \longrightarrow 2NO_2$ (Trimolecular)

→ Molecularity has only integer values (1, 2, 3 .....)

→ It has non zero, non fraction values while order has zero, 1, 2, 3 ..... and fractional values.

→ It is determined by reaction mechanism, order is determined experimentally.

20. a) How is ozone prepared ? How does it react with the following ?

i) PbS ii) KI iii) Hg iv) Ag

Ans. Preparation of Ozone :

A slow dry stream of oxygen under silent electric discharge to form ozone (about 10%). The product obtained is known as ozonised oxygen.

$3O_2 \longrightarrow 2O_3 \quad \Delta H° = 142kJ/mole$

→ The formation of ozone is an endothermic reaction.

→ It is necessary to use silent electric discharge in the preparation of O_3 to prevent its de- composition

i) Reaction with PbS : Black lead sulphide oxidised to white lead sulphate in presence of ozone.

$PbS + 4O_3 \longrightarrow PbSO_4 + 4O_2$

ii) Reaction with KI : Moist KI is oxidised to Iodine in presence of ozone.

$2KI + H_2O + O_3 \longrightarrow 2KOH + I_2 + O_2$

iii) Reaction with Hg : Mercury loses it's lustreness, meniscus and consequently sticks to the walls of glass vessel when it reacts with ozone. This phenomenon is called tailing of mercury.

$2Hg + O_3 \longrightarrow Hg_2O + O_2$

It is removed by shaking it with water which dissolves Hg_2O.

iv) Reaction with Ag : Ag metal oxidised to Ag_2O (Ag metal is tarnished).

$2Ag + O_3 \longrightarrow Ag_2O + O_2$

b) Explain the reactions of Cl_2 with NaOH.

Ans. i) Reaction with cold dilute NaOH : Chlorine reacts with cold dilute NaOH to give sodium hypochlorite and sodium chloride.

$$2\,NaOH + Cl_2 \longrightarrow NaCl + NaOCl + H_2O$$
(cold, dil.)

ii) Reaction with hot concentrated NaOH : Chlorine reacts with hot concentrated NaOH to give sodium chlorate and sodium chloride.

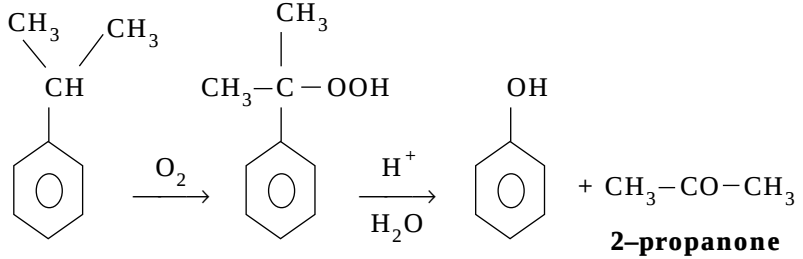
$$3\,Cl_2 + 6\,NaOH \longrightarrow 5\,NaCl + NaClO_3 + 3\,H_2O$$
(hot, Conc.)

21. a) Give the equations for the preparation of phenol from Cumene.

Ans. Phenol is prepared from Cumene as follows.

i) Oxidation of Cumene to Cumene hydroperoxide.

ii) Cumene hydroperoxide on acidic hydrolysis to form phenol.



Cumene **Cumene hydroperoxide** **Phenol** **2–propanone**

b) Describe the following :

i) Cross aldol condensation ii) Decarboxylation

Ans. i) Cross Aldol Condensation : When aldol condensation is carried out between two different aldehydes and (or) ketones, it is called cross aldol condensation.

→ If both the reactants contain α–hydrogen atoms, it gives a mixture of four products.

$$CH_3CHO \xrightarrow[2.\ \Delta]{1.\ NaOH} CH_3-CH=CH-CHO + CH_3CH_2-CH=C(CH_3)-CHO$$

CH_3CH_2CHO

But-2-enal

from two molecules of ethanal

2 – Methylpent-2-enal from two molecules of propanal

Simple or self aldol products

+

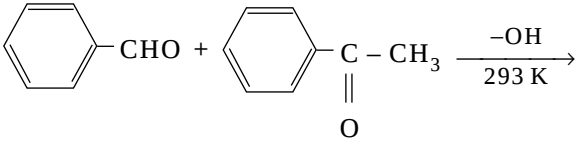
$CH_3-CH=C(CH_2)-CHO$ + $CH_3CH_2-CH=CHCHO$

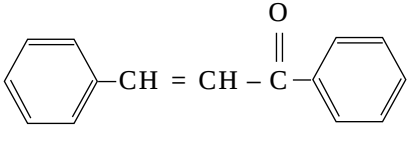
Pent-2-enal

2 – Methylbut-2-enal from one molecule of ethanal and one molecule of propanal

cross aldol products

Ketones can also be used as one component in the cross aldol reactions





1, 3 – Diphenylprop–2–en–1–one (Benzalacetophenone)

(Major product)

ii) Decarboxylation : Carboxylic acids lose carbon dioxide molecule to produce hydrocarbons on heating their sodium salts with sodalime (a mixutre of NaOH & CaO in ratio 3 : 1)

→ This reaction is called decarboxylation

$$CH_3COONa + NaOH \xrightarrow[\text{Heat}]{CaO} CH_4 + Na_2CO_3$$

Sodium ethanoate — Sodium hydroxide — Methane — Sodium carbonate

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