1 . METALLURGY

1)What is the difference between minerals and ores?

SNo.	Minerals	Ores
1	Naturally occuring substances obtained by mining which contain the metals in free state or in the form of compounds like oxides, sulphides etc. are called minerals.	Minerals that contain high percentage of metal from which it can be extracted conveniently and economically are called ores.
2	All the minerals are not ores	All the ores are minerals
3	Mineral of Al is Bauxite and Clay	Ore of Al is Bauxite

## 2)What are the various steps involved in extraction of pure metals from their ores?

Steps involved in extraction of pure metals from their ores are

(i) Concentration of the ore

(ii) Extraction of crude metal

(iii) Refining of crude metal

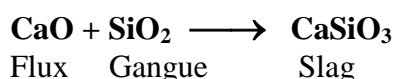## 3)What is the role of limestone in the extraction of iron from its oxide Fe_2O_3?

Lime stone ($CaCO_3$) is used as a **basic flux**

Limestone decomposes to form CaO

$$CaCO_3 \xrightarrow{\Delta} CaO + CO_2$$
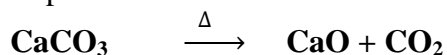
Impurity silica (SiO_2) react with CaO form fusible **slag calcium silicate**.

$$CaO + SiO_2 \longrightarrow CaSiO_3$$
$$\text{Flux} \quad \text{Gangue} \quad \quad \text{Slag}$$

4)Which type of ores can be concentrated by froth flotation method? Give two examples for such ores.

❖ *Sulphide ores* can be concentrated by froth flotation method.

❖ Eg. Galena(PbS) and zinc blend (ZnS).

5) Out of coke and CO which is better reducing agent for the reduction of ZnO? Why?

❖ Coke is better reducing agent,

❖ because the ΔG of formation of CO or CO_2 from Coke is lower than that of CO_2 from CO.
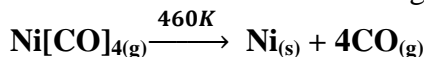
$$ZnO + C \longrightarrow Zn + CO$$
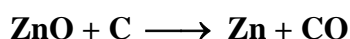
6) Describe a method for refining nickel.

Nickel is refined by Mond process.

Impure nickel is heated in a stream of carbon monoxide at around 350K to form a highly volatile nickel tetracarbonyl.($Ni[CO]_4$)

$$Ni_{(s)} + 4CO_{(g)} \xrightarrow{350K} Ni[CO]_{4(g)}$$

The solid impurities are left behind. On heating from vapour of $Ni(CO)_4$ nickel is got as follows.

$$Ni[CO]_{4(g)} \xrightarrow{460K} Ni_{(s)} + 4CO_{(g)}$$

7) Explain zone refining process with an example

❖ This method is based on **Fractional Crystallisation**.

❖ The impure metal is taken in the form of a rod

❖ When the metal rod is heated with a heater, the metal melts,

❖ The heater is slowly moved from one end to the other end.

❖ The impurity dissolves in the molten zone.

❖ When the heater moves the molten zone also moves.

❖ This process is repeated again and again to get the pure metal.

❖ This process is carried out in an inert gas atmosphere to prevent the oxidation of metals.

❖ Eg.**Germanium, Silicon and Gallium** which are used as semiconductor are refined by this process.

8) Using the Ellingham diagram given below.
(A) Predict the conditions under which
i) Aluminium might be expected to reduce magnesia.
ii) Magnesium could alumina.
B) Carbon monoxide is more effective reducing agent than carbon below 983K but, above this temperature, the reverse is true - Explain.
C) It is possible to reduce Fe₂O₃ by coke at a temperature around 1200K

A. (i) According to Ellingham diagram *below 1550K* magnesium can reduce alumina.
   (ii) According to *ellingham diagram about 1550K* aluminium can reduce magnesia.

B. Below 983K *theΔG of formation CO₂ from 'CO' is lower than that CO₂ from carbon*.

C. In Ellingham diagram **above 1000K carbon line lies below the iron *line***. Hence it is possible to reduce Fe₂O₃ by coke at a temperature around 1200K.

9) Give the uses of zinc.

Metal / Compunds	Uses
Metallic Zinc	Galvanizing metals such as iron and steel to protect them from rusting and corrosion. Electrical Industries
Zinc sulphide	To produce luminous paints, fluorescent lights and x-ray screens.
Zinc oxide	Prepare Paints, rubber,Plastics, and Ink
Brass an alloy of zinc	Water valves and communication equipment

10) Explain the electro metallurgy of Aluminium
Aluminium is extracted by Hall – Herold process
> Cathode :- **Iron tank** coated with Carbon
> Anode :- **Carbon** rod
> Electrolyte :- Calcium Chloride + Alumina + Cryolite
> Temperature :- 1270K

Pure Aluminium is deposited at the cathode
> Ionization of aluminia: $Al_2O_3 \longrightarrow 2\ Al^{3+} + 3O^{2-}$
> Reaction At cathode:- $2Al^{3+}(melt) + 6e^- \longrightarrow 2Al_{(l)}$
>
> Reaction At anode :- $6O^{2-}(melt) \longrightarrow 3O_2 + 12e^-$
>
> Reaction in Carbon rod :-
>
> $$C_{(s)} + O^{2-}(aq) \longrightarrow CO + 2\ e^-$$
> $$C_{(s)} + 2O^{2-}(aq) \longrightarrow CO_{2(g} + 4\ e^-$$

The pure aluminium is formed at the cathode and settles at the bottom.
   The net electrolysis reaction can be written as follows. .
$$4Al^{3+}(melt) + 6O^{2-}(melt) + 3C_{(s)} \longrightarrow 2Al_{(l)} + 3CO_{2(g)}$$

11) Explain the following terms with suitable examples.a)Gangueb) slag
   ❖ **Gangue**: The Rocky**Nonmetallic impurity** associated with ore.
   ❖ **Slag**:The **fusible product**formed when flux react with gangue.

> Eg. $\quad CaO + SiO_2 \longrightarrow CaSiO_3$
> $\qquad\qquad$ Flux $\quad$ Gangue $\qquad$ Slag
>
> $SiO_2 \Rightarrow$ Gangue ; $CaSiO_3 \Rightarrow$ Slag & $CaO \Rightarrow$ Flux

12)Give the basic requirements for vapour phase refining.
   ❖ The metal should form a volatile compound with the reagent.
   ❖ The volatile compound decomposes to give the pure metal

13) Describe the role of the following in the process mentioned.
   (i) Silica in the extraction of copper
   (ii) Cryolite inthe extraction of aluminium
   (iii) Iodine in the refining of zirconium
   (iv) Sodium cyanide in froth flotation.

(i) Silica in the extraction of copper	Silica is an acidic flux, used to react with basic gangue iron oxide (FeO) $$FeO+ SiO_2 \rightarrow FeSiO_3$$
(ii) Cryolite inthe extraction of aluminium	As $Al_2O_3$is a poor conductor Cryolite improves the electrical conductivity. Cryolitelowers the melting point and acts as solvent
(iii) Iodine in the refining of zirconium	To form of volatile compound so as to give pure metal on decomposition
(iv) Sodium cyanide in froth flotation	To depress the flotation property of zinc sulphide

14) Explain the principle of electrolytic refining with an example.
   Principle:
   ❖ Crude metal is refined by electrolysis carried out in an electrolytic cell.
   ❖ Pure metal is cathode, impure metal as anode aretaken.because of electrolysis there is the deposit of pure metal from the electrolyte at cathode.
   ❖ **Example**:Refining of silver

   Anode: Impure silver $Ag \longrightarrow Ag^+ + e^-$
   Cathode: Pure silver $Ag^+ + e^- \longrightarrow Ag$
   Electrolyte: Acidified silver nitrate solution On passing current the following reactions will take place. Pure Silver is deposited at the cathode.

15) The selection of reducing agent depends on the thermodynamic factor: Explain with an example.
   ❖ he reduction of metal oxide with a given one reducing agent can occur only if the free energy change for the reaction is negative.
   ❖ Example: $2FeO + 2e^- \longrightarrow 2Fe^+ 2CO$ $\Delta G = -130$ KJ mol-1

16) Give the limitations of ellingham diagram.
   ❖ It explains feasibility of reaction, but does not explain rate of reaction.
   ❖ No explanation on other reactions that might occur.
   ❖ ΔG is assume at equilibrium condition, but it is not always true.

17) Write short note on electrochemical principles of metallurgy.
   ❖ The less active element cannot reduce the more active element.
   ❖ That is the electrode potential of reductant should be lower than that of oxidant.
   ❖ For example zinc whose E° is - 0.77V is lower than copper whose E° is 0.34V.
   ❖ So zinc reduces copper.
   ❖ Gibbs free energy is given by
$$\Delta G = -nFE$$
   n = number of electrons,   F = faraday and   E = Emf
   ❖ If ΔG is negative and E is positive then the reaction is spontaneous

ADDITIONAL QUESTIONS & ANSWERS

1) Mention the uses of Aluminium

Metal / Compunds	Uses
Aluminium foil	Packing food items
Aluminium	Electric cable , Make cooking vessles and Gas pipes

2) Mention the uses of Iron

Metal / Compunds	Uses
Cast Iron	Make pipes, valves and pumps
Iron	Make magnets, Make Bridges and cycle chain Make surgical instruments, automobiles and aeroplane parts

3) Mention the uses of Copper

Metal / Compunds	Uses
Copper	Make coins & Make wires and water pipes
Copper and Gold	Make ornaments

4) Mention the uses of Gold

Metal / Compunds	Uses
Copper and Gold	Make ornaments
Gold nanoparticles	Increasing the efficiency of solar cells
Gold	Electro plating of watches Make coins

5) Define concentration (or) Ore dressing

The process of *removal of the gangue* from the impure ore is called as concentration

6) Define Anode mud

During electrolysis *the less electropositive impurities* settles at the bottom of the container. These are called as Anode mud.

7) What are the Observations of Ellingham diagram

❖ The formation metal oxides gives a positive slope. The value of S value is negative and the randomness decreases.

❖ The formation of Carbon monoxide gives a negative slope. The value of S value is positive. So Carbon monoxide is more stable at high temperature

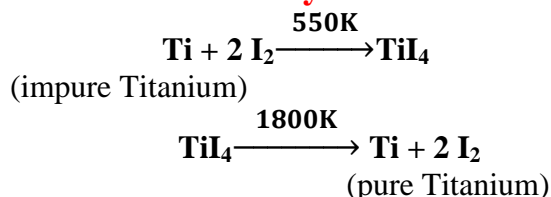❖ For MgO, due to phase transition, there is a sudden change in the slope at a particular temperature.

8) What are the applications of Ellingham diagram

❖ The Ellingham diagram for the formation of Ag_2O and HgO is at the upper part of the diagram. So, these oxides are unstable and decompose on heating.

❖ Ellingham diagram is used to predict the thermodynamic feasibility of reduction of metal oxides by another metal.

❖ Ex. Aluminium can be reduce Chromic oxide.

❖ Carbon line cuts the line of many metal oxides. Hence it can reduce all metal oxides a high temperature

9) What are the limitations of Ellingham's diagram

❖ It does not explains the rate of the reaction

❖ It does not explain the possibility of other reactions taking place.

❖ When the reactants and the products are in equilibrium, the value of ΔG is not true value.

10) How Titanium is refined by the Van-Arkel method

$$Ti + 2 I_2 \xrightarrow{550K} TiI_4$$
(impure Titanium)

$$TiI_4 \xrightarrow{1800K} Ti + 2 I_2$$
(pure Titanium)

11) Explain the Gravity separation or Hydraulic wash process

❖ The ore is finely powdered and washed with a current of water.

❖ The lighter gangue particles are washed away by water.
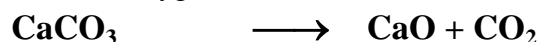
❖ Example: Oxides ores like Tin Stone

12) Define Roasting

The Ore is oxidised by heated in the presence of Oxygen in a furnace below the melting point of the metal.

$$2\ ZnS + 3\ O_2 \longrightarrow 2\ ZnO + 2\ SO_2$$
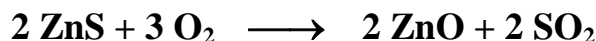
13) Define Calcination

The ore is heated in the absence of oxygen in a furnace. The water molecules are removed as moisture.

$$CaCO_3 \longrightarrow CaO + CO_2$$

14) Define Smelting

The ore is heating above the melting point in the presence of Flux and reducing agents like Carbon in a smelting furnace. The water molecules are removed as moisture.

$$Fe_2O_3 + 3CO_2 \longrightarrow Fe + 3CO_2$$
$$CaO + SiO_2 \longrightarrow CaSiO_3$$

15) Give example for the following

1. Frothing agent ,
2. Collector
3. Depressing agent

Frothing agent	Pine oil , eucalyptus oil
Collector	Sodium ethyl xanthate
Depressing agent	Sodium cyanide , sodium carbonate

## 16) Explain Cyanide leaching (or) Explain Extraction of Gold by Cyanide leaching)

Gold is treated with dilute potassium cyanide solution. It is converted into a cyanide complex.

$$4Au + 8KCN + O_2 + 2H_2O \longrightarrow 4K[Au(CN)_2] + 4KOH$$
$$2K[Au(CN)_2] + Zn \longrightarrow 2Au + K_2[ZN(CN)_4]$$
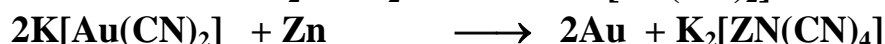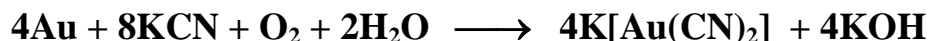
Gold is reduced to elemental Gold. This is called as **cementation**.

17) Define Cementation

Gold is reduced to elemental Gold. This is called as cementation.

$$2K[Au(CN)_2] + Zn \longrightarrow 2Au + K_2[ZN(CN)_4]$$
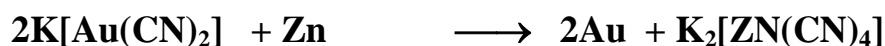
18) Define Blister Copper

When metallic copper is solidified, SO_2 gas is evolved and gives a Blister like appearance. This is called as Blister Copper

19) Explain the Alumino thermic process

❖ Chromic oxide is mixed with Aluminium powder and heated in a fire clay crucible.
❖ A ignation mixture of barium peroxide and Mg powder is placed over it
❖ When ignited large amount of heat is produed and Aluminium reduces Chromic oxide.

$$Cr_2O_3 + 2Al \longrightarrow 2Cr + Al_2O_3$$
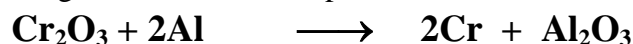
20) What is Leaching

❖ The ore is crushed and dissolved in the suitable solvent.
❖ The metal is converted into a complex
❖ And insoluble Gangue particles are removed.

21) Why Fe, Pb , Cu are reduced by hydrogen ?

The oxides of metal Fe ,Pb , Cu having less electropositive character than hydrogen , these metal oxide can be reduced by hydrogen.

$$Fe_2O_3 + 4H_2 \longrightarrow 4Fe + 4H_2O$$
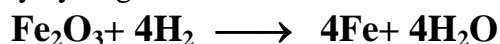
22) Explain the Auto reduction reaction

❖ The use ofreducing agents is not necessary.
❖ Mercury is obtained by roasting of its ore Cinnabar (HgS)

$$HgS + O_2 \longrightarrow Hg + SO_2$$
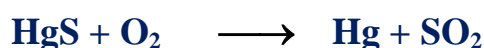
23) Define Distillation

In this method the impure metal is heated evaporated and the **pure vapours are condensed**. Eg.**Zinc** is distilled at **1180K**.

24) Explain Liquation

❖ This method is used to remove **high melting point impurities from low melting point metals.**Eg. **Lead**
❖ The impure metal is heated in the absence of air in a sloping furnace.
❖ Pure metal melts and flows down and collected separately
❖ The impurities remain on the slope.

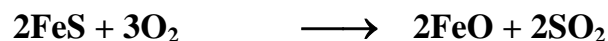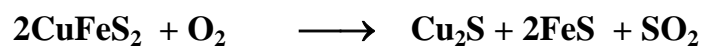## 25) Explain the reduction using carbon
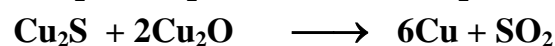
The ore is heated with coke in a blast furnace

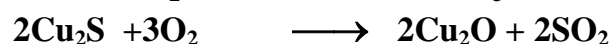$$ZnO + C \longrightarrow Zn + CO$$
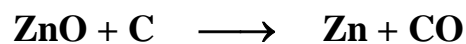
26) Explain the Extraction of Copper

❖ Ore → copper pyrites
❖ Concentration → Froth Flotation process
❖ Roasting

$$2CuFeS_2 + O_2 \longrightarrow Cu_2S + 2FeS + SO_2$$
$$2FeS + 3O_2 \longrightarrow 2FeO + 2SO_2$$

❖ Smelting

$$FeO + SiO_2 \longrightarrow FeSiO_3$$
$$2Cu_2S + 3O_2 \longrightarrow 2Cu_2O + 2SO_2$$
$$Cu_2S + 2Cu_2O \longrightarrow 6Cu + SO_2$$

27) Explain the Froth Floatation process

❖ Frothing agent → **Pine oil Diagram**.
❖ Collector → **Sodium Ethyl Xanthate**
❖ Depressing agent → **Sodium cyanide**
❖ Example → Sulphide ore → **Galena**
❖ The ore is finely powdered and mixed with water and pine oil.
❖ When air is passed, it produces froth.
❖ The *ore particles rise to the surface and collected separately*.
The Impurities settles at the bottom of the container
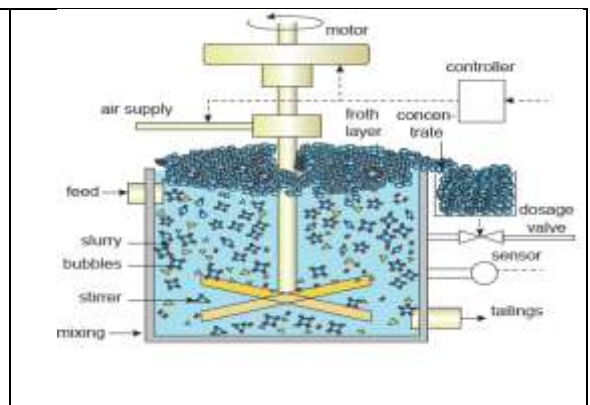
28) Explain the Magnetic separation process (or) Ferro magnetic ores are concentrated

❖ This method is used to concentrate *Ferro magnetic* ore
❖ Example *Tin Stone and Chromite ore*
❖ The powdered ore is added on an electro magnet containing a moving belt on a magnetic rollers.
❖ The *magnetic ore falls near the magnet*.
❖ The *non magnet impurities fall away from the magnet.*
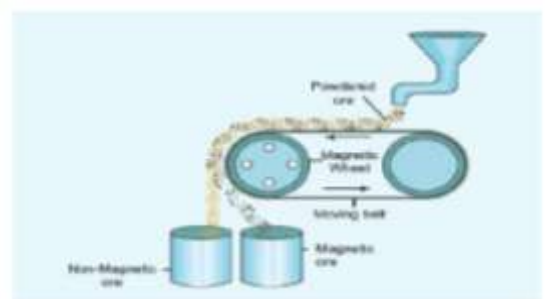

29) Expalin Ammonia leaching

❖ When a crushed ore containing nickel, copper and cobalt is treated with aqueous ammonia under suitable pressure, ammonia selectively leaches these metals by forming their soluble complexes.
❖ From the ore leaving behind the gangue, iron(III) oxides/hydroxides and aluminosilicate.

30) Expalin Alkali leaching

❖ Bauxite, an important ore of aluminum
❖ It is heated with a solution of sodium hydroxde in the temperature range 470 - 520 K at 35 atm to form soluble sodium meta-aluminate
❖ Leaving behind the impurities, iron oxide andtitanium oxide.

$$Al_2O_3 + 2NaOH + 3H_2O \longrightarrow 2Na[Al(OH)_4]$$

❖ The hot solution is decanted, cooled, and diluted. This solution is neutralised by passing CO_2 gas, to the form hydrated Al_2O_3 precipitate.

$$2Na[Al(OH)_4] + CO_2 \longrightarrow Al_2O_3.3H_2O + 2NaHCO_3$$
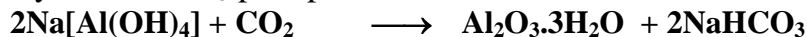
31) Expalin Acid leaching

❖ Leaching of sulphide ores such as ZnS, PbS etc., can be done by treating them with hot aqueous sulphuric acid.
❖ In this process the insoluble sulphide is converted into soluble sulphate and elemental sulphur

$$2ZnS + 2H_2SO_4 + O_2 \longrightarrow 2ZnSO_4 + 2S + H_2O$$
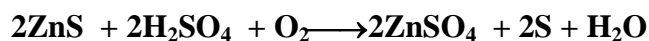
2. p – Block Elements – I

1) Write a short note on anamolous properties of the first element of p-block.
   - ❖ Small size
   - ❖ High ionisation enthalpy and high electronegativity
   - ❖ Absence of d-orbitals.

2) Describe briefly allotropism in p-block elements with specific reference to carbon.
   - ❖ Some elements exist in more than one form in the same physical state. This is allotropism.
   - ❖ **Allotropes of carbon**

Graphite	sp^2 carbon	Soft, conduct electricity
Diamond	sp^3 carbon	Hard , do not conduct electricity
Fullerenes	sp^2 carbon	Bucky ball, conduct electricity
Carbon nano tubes	sp^2 carbon	Strong than steel , Conduct electricity
Graphene	sp^2 carbon	Single planar sheet of haoney comb crystal lattice

3) Boron does not react directly with hydrogen. Suggest one method to prepare diborane from BF3.

$$2BF_3 + 6\,NaH \xrightarrow{\ 450K\ } B_2H_6 + 6NaF$$
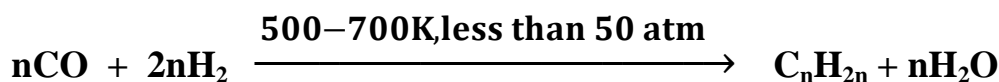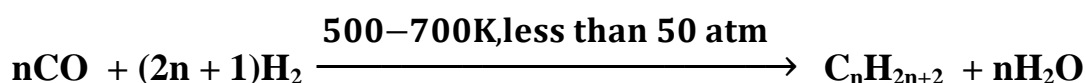
4) Give the uses of Borax.
   - ❖ To identify coloured metal ions.
   - ❖ Acts as preservative.
   - ❖ To manufacture optical and borosilicate glass, enamels.
   - ❖ As flux in metallurgy.

5) What is catenation ? Describe briefly the catenation property of carbon.
   Catenation is an ability of an element to form chain of atoms.
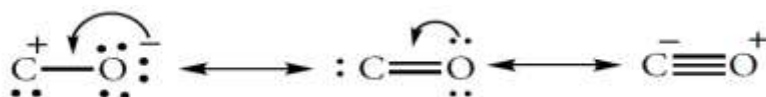   - ❖ Valency of element is greater than or equal to two,
   - ❖ Ability to bond with itself
   - ❖ Self bond must be strong
   - ❖ Kinetic inertness of catenated compound

6) Write a note on Fischer Tropsch synthesis

$$nCO + (2n+1)H_2 \xrightarrow{500-700K,\text{less than 50 atm}} C_nH_{2n+2} + nH_2O$$

$$nCO + 2nH_2 \xrightarrow{500-700K,\text{less than 50 atm}} C_nH_{2n} + nH_2O$$
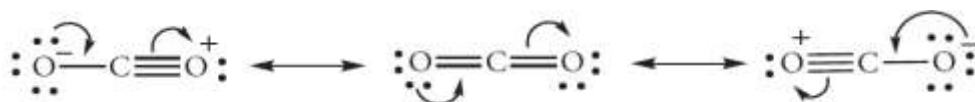
7) Give the structure of CO and CO_2
   Structure of CO :-

Structure of CO_2 :-

8) Give the uses of silicones.
   - ❖ Low temperature vaccuum pumbs.
   - ❖ Lubricants

- ❖ High temperature oil baths
- ❖ water proof cloths
- ❖ Mixed with paints to make them resistance towards high temperature, sun light etc..,

9) Why $AlCl_3$ acts as Lewis acid?

It is an electron deficient compound. So it acts as an electron acceptor

10) Write a short note on hydroboration?

$$B_2H_6 + 6RCH=CHR \longrightarrow 2(RCH_2\text{-}CHR)_3B$$

11) Give one example for each of the following

(i) Icosogens	Boron
(ii) Tetragen	Carbon
(iii) Pnictogen	Nitrogen
(iv) Chalcogen	Oxygen

12) Write a note on metallic nature of p-block elements.

- ❖ The tendency of an element to form a cation by loosing electrons is known as electropositive metallic character.
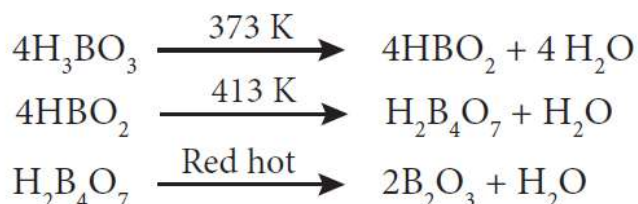- ❖ This character depends on the ionisation energy.

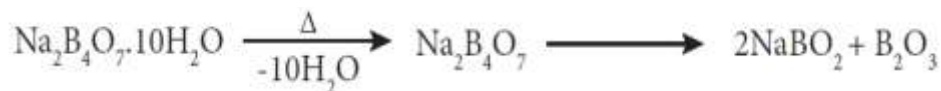| Group	Non-metal	Metalloid	Metal
13	-	B	Al, Ga, In, Tl
14	C	Si, Ge	Sn, Pb
15	N, P	As, Sb	Bi
16	O, S, Se	Te	Po
17	All elements	-	-
18	All elements	-	-

13) How will you identify borate radical ?

Flame test : When Borates are added with ethanol and exposed to flame gives green flame .

$$H_3BO_3 + 3C_2H_5OH \xrightarrow[H_2SO_4]{Conc.} B(OC_2H_5)_3 + 3H_2O$$

14) What is the action of heat on Boric acid

$$4H_3BO_3 \xrightarrow{373\ K} 4HBO_2 + 4H_2O$$

$$4HBO_2 \xrightarrow{413\ K} H_2B_4O_7 + H_2O$$

$$H_2B_4O_7 \xrightarrow{Red\ hot} 2B_2O_3 + H_2O$$

15) Write a note on Borax bead test.

$$Na_2B_4O_7.10H_2O \xrightarrow[-10H_2O]{\Delta} Na_2B_4O_7 \longrightarrow 2NaBO_2 + B_2O_3$$

16) How will you prepare propanal by oxo process?

$$CO + C_2H_4 + H_2 \longrightarrow CH_3CH_2CHO$$

17) What is inorganic benzene? How to prepare it?

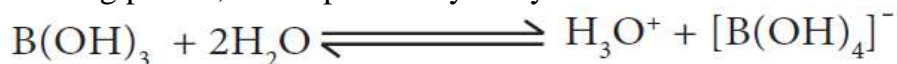Inorganic benzene $\Rightarrow B_3H_6N_3$– Borazole (or) Borazine

$$3B_2H_6 + 2NH_3 \xrightarrow[Clossed\ vessel]{High\ temp} 2B_3N_3H_6 + 12H_2$$
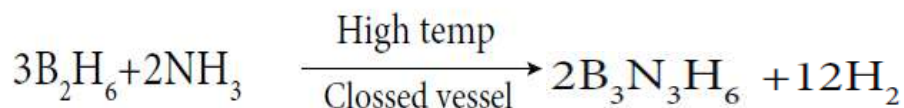
18) What are the uses of Boron

Boron	Used as Rocket fuel igniter
	Present in cell wall of plants.
	(B-10) Neutron absorbers in nuclear reactor

19) H_3BO_3 is a mono basic acid why?

Instead of donating proton, it accepts one hydroxyl ion.

$$B(OH)_3 + 2H_2O \rightleftharpoons H_3O^+ + [B(OH)_4]^-$$

20) How will you convert Boric acid to Boron nitride?

$$B(OH)_3 + NH_3 \longrightarrow BN + 3H_2O \text{ (Boron nitride)}$$

21) Write a note on Zeolites?

❖ Hydrated sodium alumino silicates.

❖ Monovalent sodium ions and water molecules are loosely held.

❖ Porous structure, consisting of a network of inter connected tunnels and cages like a honey comb.

❖ Water molecules moves freely in and out of these pores.

❖ Por sizes are uniform.

❖ Acts as a sieve, for the removal of permanent hardness.

22) From Aluminium to Thalium only a marginal difference in ionization enthalpy why?

❖ Presence of inner d and f electrons which has poor shielding effect.

❖ Effective nuclear charge on valency electrons increases.

23) What is inert pair effect?

In p-block elements the outer s-electrons have a tendency to remain inert and shows reluctance to take part in the bonding.
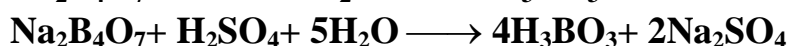
24) Boron form co-valent compounds why?

❖ Small size

❖ High ionization energy.

❖ Similarty in electronegativity with carbon and hydrogen.

25) How to prepare Borax?

$$2\,Ca_2B_6O_{11} + 3Na_2CO_3 + H_2O \xrightarrow{\Delta} 3Na_2B_4O_7 + 3CaCO_3 + Ca(OH)_2$$
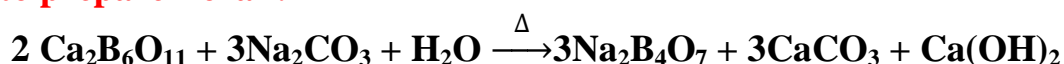
26) How is boric acid prepared from borax?

Boric acid can be extracted from borax by treating with HCl or H_2SO_4

$$Na_2B_4O_7 + 2HCl + 5H_2O \longrightarrow 4H_3BO_3 + 2NaCl$$
$$Na_2B_4O_7 + H_2SO_4 + 5H_2O \longrightarrow 4H_3BO_3 + 2Na_2SO_4$$

27) Give the uses of Diborane?

Diborane	❖ High energy fuel propellant,
	❖ Reducing agent
	❖ Welding torches.

28) Give an account of McAfee process?

$$2Al_2O_3 + 3C + 6Cl_2 \longrightarrow 4AlCl_3 + 3CO_2$$

29) Write the uses of Aluminium chloride?

Aluminium Chloride	❖ Catalyst inFridel Craft reaction
	❖ Manufacture of petrol by cracking of mineral oils
	❖ Catalyst in the manufacture of dyes, drugs and perfumes.

30) What are the uses of Potash Alum

Potash Alum	❖ For purification of water ❖ For water proofing and textiles ❖ In dyeing, paper and leather tanning industries ❖ Employed as a styptic agent to arrest bleeding.

31) What is burnt alum?
❖ At 475K potash alum loses water of hydration and swells up.
❖ The swollen mass is known as burnt alum.

$$K_2SO_4.Al_2(SO_4)_3 .24H_2O \longrightarrow K_2SO_4.Al_2(SO_4)_3 + 24H_2O$$
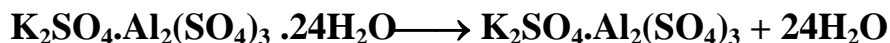
32) How Potash alum is prepared?
❖ When alunite (or) alum stone is treated with excess of sulphuric acid, the aluminium hydroxide is converted to aluminium sulphate.
❖ A calculated quantity of potassium sulphate is added and the solution is crystallised to generate potash alum.
❖ It is purified by recrystallization.

$$K_2SO_4.Al_2(SO_4)_3.4Al(OH)_3 + 6H_2SO_4 \longrightarrow K_2SO_4.Al_2(SO_4)_3 + 12H_2O$$
$$K_2SO_4.Al_2(SO_4)_3 + 24H_2O \longrightarrow K_2SO_4.Al_2(SO_4)_3 .24H_2O$$

33) Differentiate Diamond and Graphite

GRAPHITE	DIAMOND
1, Soft	1, Very hard
2, Sp^2 hybridised carbon atoms	2, Sp^3 hybridised carbon atom
3, C-C bond length is $1.41A^0$	3, C-C bond length is $1.54A^0$
4, π-electrons are delocalized over the entire sheet and responsible for electrical conductivity	4, There is no free electrons for conductivity
5, Used as a lubricant either on its own or as a graphite oil	5, Used for sharpening hard tools, cutting glasses, making bores and rock drilling

34) Write a short note on fullerences.
❖ Have cage like structure. The C_{60} molecules have a soccer ball like structure and is called **buckminister fullerences or buckyballs**.
❖ Has a fused ring structure consists of 20 six membered rings and one delocalised π - bond giving aromatic character.
❖ Each carbon atom has sp2 hybridised and forms 3σ bonds and one deloclised π-bond giving aromatic character.
❖ C–C bond distance is $1.44A^0$ and C=C bond distance is $1.38A^0$

35) Write the uses of Carbon nano tubes

| Carbon nano tubes	Nanoscale electronics Catalysts Polymers Medicine

36) Write a short note on graphene
❖ It has a single planar sheet of sp^2 hybridised carbons atoms
❖ That are densely packed in a honeycomb crystal lattice.

37) Describe the structure of Diborane
❖ In diborane two BH_2 unitsare linked by two bridged hydrogens.
❖ It has eight B-H bonds.
❖ It has only 12 valance electrons and are not sufficient to form normal covalent bonds
❖ The four terminal B-H bonds are normal covalent bonds (two centre – two electron bond (or)2c-2e⁻ bond).
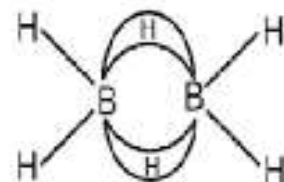
- The remaining four electrons have to be used by two B – H – B bonds $(3C - 2e^-)$
- In diborane, the boron is sp^3 hybridised, B–H–B bond formed by overlapping the half filled hybridised orbital of one boron, the empty hybridised orbital of the other boron and the half filled 1s orbital of hydrogen.

38) Complete the following reactions :-

a,

$B(OH)_3 + NH_3 \longrightarrow$

$B(OH)_3 + NH_3 \longrightarrow BN + 3H_2O$ (Boron nitride)

$Na_2B_4O_7 + H_2SO_4 + H_2O \longrightarrow$

$Na_2B_4O_7 + H_2SO_4 + H_2O \longrightarrow 4H_3BO_3 + Na_2SO_4$ (Boric acid)

$B_2H_6 + 2\ NaOH + 2H_2O \longrightarrow$

$B_2H_6 + 2\ NaOH + 2H_2O \longrightarrow 2NaBO_2 + 6H_2$
(Sodium meta borate)

$B_2H_6 + CH_3OH \longrightarrow$

$B_2H_6 + 6CH_3OH \longrightarrow 2B(OCH_3)_3 + 6H_2$ (Trimethyl borate)

$BF_3 + 9H_2O \longrightarrow$

$BF_3 + 9H_2O \longrightarrow 9HF + 3H_3BO_3$ (Boric acid)

$HCOOH + H_2SO_4 \longrightarrow$

$HCOOH + H_2SO_4 \longrightarrow H_2SO_4 + H_2O + CO$

$SiCl_4 + NH_3 \longrightarrow$

$2SiCl_4 + NH_3 \longrightarrow Cl_3Si\ \text{-}NH\text{-}SiCl_3 + 2HCl$ (Chlorosilazanes)

$SiCl_4 + C_2H_5OH \longrightarrow$

$SiCl_4 + C_2H_5OH \longrightarrow Si(OC_2H_5)_4 + 4HCl$ (Tetraethoxy silane)

$B + NaOH \longrightarrow$

$2B + 6NaOH \longrightarrow 2Na_3BO_3 + 3H_2$ (Sodium borate)

$H_2B_4O_7 \xrightarrow{\text{Red Hot}}$

$H_2B_4O_7 \xrightarrow{\text{Red Hot}} 2B_2O_3 + H_2O$ (Boron trioxide (or) Boron anhydride)

39) Solution of Borax is alkaline in nature why?

Borax solution is alkaline in hot water as it dissociates into boric acid and sodium hydroxide.

$$Na_2B_4O_7 + 7\ H_2O \longrightarrow 4H_3BO_3 + 2NaOH$$
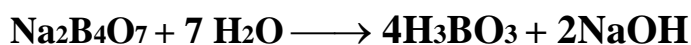
40) Explain the types of Silicates with example

| Name of the Silicate	Molecular formula	Examples
1, Ortho (or) Neso Silicates	$[SiO_4]^{4-}$ Single tetrahedral	Phenacite, Olivine
2, Pyro (or) Soro Silicates	$[Si_2O_7]^{6-}$	Thortveitite
3, Cyclic (or) Ring Silicates	$(SiO_3)^{2n-}$	Beryl
4, Inosilicates a) Chain Silicates (or) Pyroxenes b) Double chain Silicates (or) Amphiboles	$(SiO_3)_n^{2n}$ $[Si_4O_{11}]_n^{6n}$	Spodumene Asbestos
5, Sheet (or) Phyllo Silicates	$(Si_2O_5)_n^{2n}$	Talc, Mica
6, Three dimensional Silicates (or) Tecto Silicates	$(SiO_2)_n$	Quartz

41)   Explain the types of Silicones

(1) **Linear Silicones:**	Obtained by the hydrolysis & subsequent condensation of dialkyl or diaryl siliconchlorides.
(a) Silicone Rubbers:	Bridged together by methylene or similar groups
(b) Silicone Resins:	Obtained by blending Silicones with organic resins such as acrylic esters.
(2) **Cyclic Silicones:**	Obtained by the hydrolysis of R_2SiCl_2
(3) **Cross linked Silicones:**	Obtained by the hydrolysis of $RSiCl_3$

42)   Aluminium(III)chloride is stable whereas Thalium(III)chloride is highly unstable why?

❖ Thallium the stable lower oxidation state corresponds to the loss of np electrons only and not
❖ ns electrons. it is due to the inert pair effect.

43)   Explain the structure of Boric acid

❖ Two dimensional layered structure
❖ It consists of $(BO_3)^{3-}$ units linked by **hydrogen bonds**
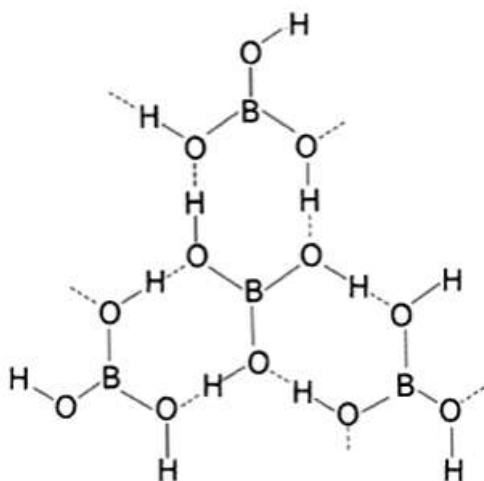
3 . p-BLOCK ELEMENTS - II

1. **What is inert pair effect?**
   - ❖ As we move down the group in p–block elements the outer ns^2 electrons become inert and do not involve in chemical combination.
   - ❖ Only np electrons take part in chemical combination.
   - ❖ his is known as inert pair effect.

2. **Chalcogens belongs to p–block. Give reason.**
   - ❖ Because their outer electronic configuration is ns^2np^4.
   - ❖ In these elements the last electron enters np orbital.
   - ❖ Hence they belong to p–block elements.

3. **Explain why fluorine always exhibit an oxidation state of –1?**
   - ❖ Since fluorine is the most electronegative element it exhibits only a negative state of –1.
   - ❖ Electronic configuration of fluorine is $1s^2 2s^2 2p^5$.
   - ❖ To attain noble gas configuration it gains 1 electron and exhibit -1 oxidation state.

4. **Give the oxidation state of halogen in the following.**
      a) OF_2 b) O_2 F_2 c) Cl_2O_3 d) I_2O_4

a) OF_2	b) O_2F_2	c) Cl_2O_3	d) I_2O_4
-1	-1	+6	+4

5. **Write the reason for the anamolous behavior of Nitrogen.**
   - ❖ Smallsize
   - ❖ Highelectronegativity
   - ❖ Non–availabilityofd–orbitalsinvalencyshell
   - ❖ Chemicallyinertduetohighbondingenergy
      High ionization energy

6. **What are inter halogen compounds? Give examples**
   - ❖ Each halogen combines with other halogensto form a series of compounds calledinter halogen compounds.
   - ❖ Ex : IF_7.

7. **Give the uses of helium.**
   - ❖ Helium and oxygen mixture is used by divers in place of air oxygen mixture.This Prevents the painful dangerous condition called bends.
   - ❖ Helium is used to provide inert atmosphere in electric arc welding of metals.
   - ❖ Helium has lowest boiling point hence used in cryogenics
   - ❖ Helium is much less denser than air and hence used for filling air balloons.

8. **Give the uses of argon.**
   - ❖ Argon prevents the oxidation of hot filament and prolongs the life in filamentbulbs.
   - ❖ Argon is used in radio valves and tubes.

9. **What is the hybridisation of iodine in IF_7?Give its structure.**

Interhalogen	Hybridisation	Structure
IF_7	Sp^3d^3	Pentagonalbipyramidal

10. **What are the uses of Nitric acid?**
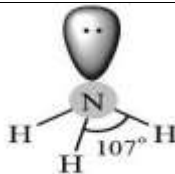   - ❖ In the preparation of Aqua regia
   - ❖ Used in photography and Manufacture of explosives

11. **List the uses of Phosphine (PH_3)**
   - ❖ Formation of Smoke screen
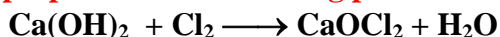   - ❖ Used in Holmes signal

12. **Explain the structure of Ammonia molecule**

❖ Shape of Ammonia is pyramidal ❖ Bond length of N – H is $1.016A^0$ ❖ Bond Angle = 107^0 ❖ It has lone pair of electrons	

13. Write the preparation of Bleaching powder

$$Ca(OH)_2 + Cl_2 \longrightarrow CaOCl_2 + H_2O$$

14. What are the Allotropic forms of Sulphur?

| Crystalline	Amorphous
i. Rhombic Sulphur	i, Plastic Sulphur
ii. Monoclinic Sulphur	ii, Milk of sulphur
	iii, Colloidal Sulphur

15. What are the uses of Sulphur dioxide

❖ Sulphur dioxide is used in bleaching hair, silk, wool etc...
❖ It can be used for disinfecting crops and plants in agriculture

16. Explain the Structure and Hybridisation of interhalogen compounds

Type	Structure	Hybridization	Bond pairs / lone pairs
AX	Linear	sp^3	1 /3
AX_3	'T' shape	sp^3d	3 / 2
AX_5	Square pyramidal	sp^3d^2	5 / 1
AX_7	Pentagonal bipyramidal	sp^3d^3	7 / 0

17. What happens when ammonia reacts with excess of chlorine?

With excess of chlorine ammonia reacts to give an explosive substance nitrogen trichloride

$$2NH_3 + 6Cl_2 \longrightarrow 2NCl_3 + 6HCl$$
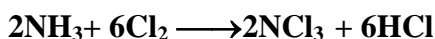
18. What is phosphorescence?

White phosphorous undergoes spontaneous slow oxidationin air giving a greenish yellowglow which is visible in the dark. This is known as phosphorescence.

19. How is phosphine prepared?

Phosphine is prepared by the action of sodium hydroxide with white phosphorous in an inert atmosphere of carbon dioxide

$$P_4 + NaOH + H_2O \longrightarrow 3NaH_2PO_2 + PH_3\uparrow$$
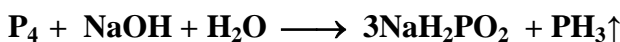
20. Write a short note on Holmes signal

❖ In a ship, a pierced container with a mixture of calcium carbide and calcium phosphide, liberates phosphine and acetylene when thrown into sea.
❖ The liberated phosphine catches fire and ignites acetylene.
❖ These burning gases serves as a signal to the approaching ships.
❖ This is known as **Holmes signal**.

21. Write about the bleaching action of chlorine.

Chlorine is a strong oxidising and bleaching agent since it produces nascent oxygen.

$$H_2O + Cl_2 \longrightarrow HCl + HOCl$$
$$HOCl \longrightarrow HCl + [O] \text{ (Nascent oxygen)}$$
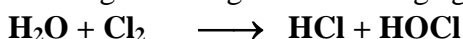
Colouring matter + Nascent oxygen $\longrightarrow$ Colourless oxidation product.

The bleaching of *chlorine is permanent*.

22. Explain the manufacture of chlorine by Deacon's process

Deacon's process

In this process a mixture of air and hydrochloric acid is passed up a chamber containing a number of shelves, pumice stones soaked in cuprous chloride are placed. Hot gases at about 723K are passed through a jacket that surrounds the chamber.

$$4HCl + O_2 \xrightarrow{400^0C / Cu_2Cl_2} 2H_2O + Cl_2$$
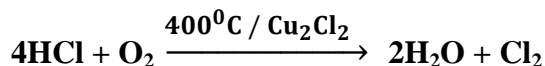
23. Write about the bleaching action of sulphur dioxide.

❖ In presence of water, sulphurdioxide bleaches coloured wool, silk, sponges and straw intocolourless due to its reducing property
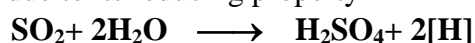
$$SO_2 + 2H_2O \longrightarrow H_2SO_4 + 2[H]$$
$$X + 2[H] \longrightarrow XH_2$$
Coloured   colourless

24. Write about the reducing property of sulphur dioxide

❖ SO_2reduces chlorine into hydrochloric acid

$$SO_2 + 2H_2O + Cl_2 \longrightarrow H_2SO_4 + 2HCl$$

25. Show that sulphuric acid is an oxidising agent

❖ Sulphuric acid oxidises carbon into carbondioxide
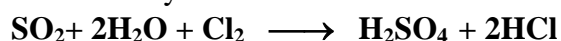
$$C + 2H_2SO_4 \longrightarrow 2SO_2 + 2H_2O + CO_2$$
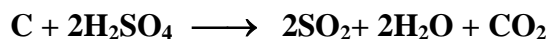
26. What are the uses of Oxygen ?

❖ Oxygen is one of the essential component for the survival of living organisms.
❖ It is used in welding (oxyacetylene welding)
❖ Liquid oxygen is used as fuel in rockets etc...

27. What are the properties of inner halogen compounds?

❖ The central atom will be the larger one
❖ It can be formed only between two halogen and not more than two halogens.
❖ Fluorine can't act as a central metal atombeing the smallest one
❖ They can undergo the auto ionization.
❖ They are strong oxidizing agents

28. Provethat nitric acid is an oxidising agent & nitrating agent.

❖ Non metals like carbon, sulphur are oxidised by nitric acid.

$$C + 4HNO_3 \longrightarrow CO_2 + 4 NO_2 + 2H_2O$$

❖ Nitric acid replaces hydrogen atom from organic compounds with nitronium ion NO_2^+
This is called nitration.

$$C_6H_6 + HNO_3 \longrightarrow C_6H_5–NO_2 + H_2O$$
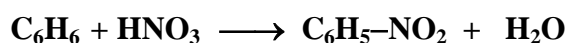
29. Whattypeof hybridization occurina)BrF$_5$ b)BrF$_3$

S.NO	Inter Halogen Compound	Hybridisation
a)	BrF	sp^3
b)	BrF$_3$	sp^3d
c)	BrF$_5$	sp^3d^2

30. Deduce the oxidation number of oxygen in hypofluorous acid – HOF.

H O F
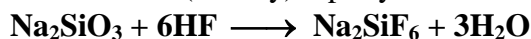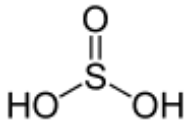1+ x -1 = 0
x = 0
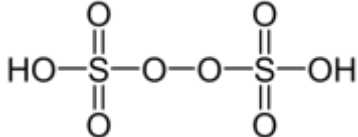
The oxidation number of oxygen in hypofluorous acid is **Zero**

31. Why HF cannot be stored in glass bottles?

Moist hydrofluoric acid **HF** (not dry) rapidly react with sodium silicate in glass.

$$Na_2SiO_3 + 6HF \longrightarrow Na_2SiF_6 + 3H_2O$$

32. Write the molecular formula and draw the structure of sulphurous acid and Marshall's acid.

Sulphurous acid	H_2SO_3	
Marshall's acid	$H_2S_2O_8$	

33. Sulphuric Acid is a dibasic acid. Prove it

It forms two types of salts namely bisulphates and sulphates.

$$H_2SO_4 + NaOH \longrightarrow NaHSO_4 + H_2O$$
sodium bisulphate

$$H_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2H_2O$$
sodium sulphate
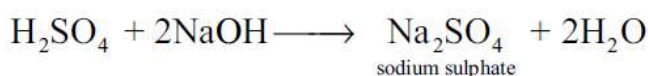
34. Write the balanced equation for the overall of Chlorine with cold NaOH and hot NaOH

With cold NaOH : To give hypochlorite and chloride

$$Cl_2 + 2NaOH \longrightarrow NaOCl + NaCl + H_2O$$

With hot NaOH : To give chlorides and chlorates

$$3Cl_2 + 6NaOH \longrightarrow NaClO_3 + 5NaCl + 3H_2O$$

35. Complete the following reactions :-

Reaction	Completed
$NaCl + MnO_2 + H_2SO_4 \longrightarrow$	$4NaCl + MnO_2 + 4H_2SO_4 \longrightarrow Cl_2 + MnCl_2 + 4NaHSO_4 + 2H_2O$
$NaNO_2 + HCl \longrightarrow$	$NaNO_2 + HCl \longrightarrow NaCl + HNO_2$
$P_4 + NaOH + H_2O \longrightarrow$	$P_4 + NaOH + H_2O \longrightarrow 3NaH_2PO_2 + PH_3$
$AgNO_3 + PH_3 \longrightarrow$	$6AgNO_3 + PH_3 + 3H_2O \longrightarrow 6Ag + 6HNO_3 + H_3PO_3$
$Mg + HNO_3 \longrightarrow$	$Mg + HNO_3 \longrightarrow 4Mg(NO_3)_2 + NH_4NO_3 + 3H_2O$
$KClO_3 \xrightarrow{\Delta}$	$2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$
$Cu + conc\ H_2SO_4 \longrightarrow$	$Cu + 2H_2SO_4 \longrightarrow CuSO_4 + SO_2 + H_2O$
$Sb + Cl_2 \longrightarrow$	$2Sb + 3Cl_2 \longrightarrow 2SbCl_3$
$HBr + H_2SO_4 \longrightarrow$	$HBr + H_2SO_4 \longrightarrow H_2O + Br_2 + SO_2$
$XeF_6 + H_2O \longrightarrow$	$XeF_6 + 3H_2O \longrightarrow XeO_3 + 6HF$
$XeO_6^{4-} + Mn^{2+} + H^+ \longrightarrow$	$5XeO_6^{4-} + 2Mn^{2+} + 14H^+ \longrightarrow 2MnO_4^- + 5XeO_3 + 7H_2O$
$XeOF_4 + SiO_2 \longrightarrow$	$2XeOF_4 + SiO_2 \longrightarrow 2XeO_2F_2 + SiF_4$
$Xe + F_2 \xrightarrow{\text{Ni / 200 atm / 400}^0\text{C}}$	$Xe + 3F_2 \xrightarrow{\text{Ni / 200 atm / 400}^0\text{C}} XeF_6$
$Cu + conc\ H_2SO_4 \longrightarrow$	$Cu + 2\ H_2SO_4 \longrightarrow CuSO_4 + SO_2 + 2H_2O$

4 .TRANSITION AND INNER TRANSITION ELEMENTS

1. **What are transition metals? Give four examples.**
   - ❖ Transition metals occupy from group 3 to group 12.
   - ❖ Metals with incomplete filled d-orbital
   - ❖ Positive ions formed by these elements have unfilled d-orbitals
   - ❖ Elements placed between s and p-block
   - ❖ Example : Fe , Cu , Ni , CO

2. **What are interstitial compounds?**
   - ❖ An interstitial compound is formed when small atoms like hydrogen, boron, carbon or nitrogenare trapped in the interstitial holes in a metal lattice.
   - ❖ They are usually non-stoichiometric compounds
   - ❖ Example : TiC, Mn₄N

3. **Write the electronic configuration of Cr and Cu**
   Electronic Configuration of Cr $\Rightarrow$ [Ar] $4s^1 3d^5$
   Electronic Configuration of Cu $\Rightarrow$ [Ar] $4s^1 3d^{10}$

4. **Write the electronic configuration of Ce^{4+} and Co^{2+}**
   Electronic Configuration of $Ce^{4+} \Rightarrow$ [Xe] $4f^0 5d^0 6s^0$
   Electronic configuration of $Co^{2+} \Rightarrow$ [Ar]$3d^7 4s^0$

5. **Among Fe^{2+} and Fe^{3+} which one is more stable why?**
   - ❖ The electronic configuration of $Fe^{2+} \Rightarrow$ [Ar]$3d^6$
   - ❖ The electronic configuration of $Fe^{3+} \Rightarrow$ [Ar]$3d^5$
   - ❖ Fe^{3+} is more stable , since it has half filled orbitals

6. **Explain why Cr^{2+} is strongly reducing while Mn^{3+} is strongly oxidizing.**
   - ❖ E_0 value for Cr^{2+} is negative (-0.41V),
   - ❖ If E_0 of a metal is large and negative, the metal is a powerful reducing agent.
   - ❖ Where as E_0 Value for Mn^{3+} is positive (+1.57V).
   - ❖ On the other hand, Mn^{3+} acts as oxidising agent.

7. **Transition metals have high melting point why?**
   - ❖ High attractive forces between the atoms
   - ❖ Strong metallic bond.

8. **Which metal in the 3d series exhibits +1 oxidation state most frequently and why?**
   - ❖ Cu is only metal in the 3d series exhibits +1 oxidation state
   - ❖ Cu has electronic configuration **[Ar] $3d^{10} 4s^1$** and after losing one electron it acquires a **stable $3d^{10}$** configuration which is more stable.

9. **Why 'd' block elements exhibit variable oxidation state ?**
   The energies of (n – 1)d and ns orbitals are fairly close to each other

10. **Explain Hume-Rothery rule for alloy formation**
    - ❖ Both the solvent and the solute must have the same crystal structure.
    - ❖ The difference between the atomic radii of solvent and solute is less than 15%
    - ❖ Their electronegativity difference must be close to zero.

11. **What is the reason for d-block elements to form alloys?**
    - ❖ Their atomic sizes are similar and one metal atom can be easily replaced by another metal atom fromits crystal lattice to form an alloy.
    - ❖ The alloys formed are hard and often have high melting points
    - ❖ Eg: Gold-Copper alloy.

12. **Why do transition elements form more number of complexes?**
    - ❖ Transition elements have a tendency to form coordination complexes with ligands.
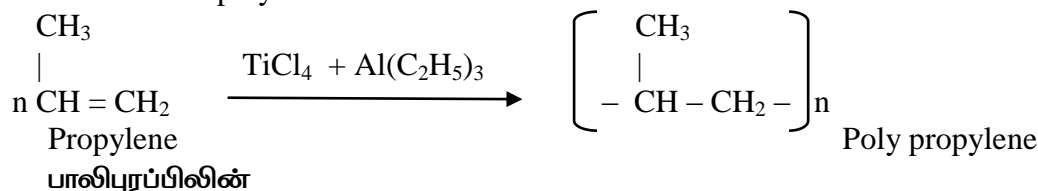
    Reasons for complex formation are
    - ❖ Small size
    - ❖ High positive charge density.
    - ❖ Availability of low energy vacant orbitals to accept an electron pairs.

13. List the properties of interstitial compounds?

❖ Hard and show electrical and thermal conductivity.
❖ Have high melting points higher than those of pure metals.
❖ The hydrides are used as powerful reducing agents.
❖ Metallic carbides are chemically inert.

14. What is Zeigler- Natta catalyst? Mention its use.

❖ Mixture of $TiCl_4$ and Trialkyl aluminium is called a Zeigler nattacatalyst,
❖ It is used for polymerization

$$n\ CH = CH_2 \overset{TiCl_4\ +\ Al(C_2H_5)_3}{\longrightarrow} \left[- CH - CH_2 - \right]n$$

Propylene   Poly propylene

(with CH_3 groups on the CH carbons)

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15. Explain variable oxidation states of 3d series elements?

❖ These elements have several $(n-1)d$ and ns electrons
❖ The energies of $(n-1)d$ and ns orbital are fairly close to each other
❖ Eg:- Fe^{2+}, Fe^{3+} and Mn^{2+}, Mn^{3+}

16. $[Sc(H_2O)_6]^{3+}$ is colorless – Explain.

❖ Sc^{3+} ion in this complex is colourless, because of vacant $3d^0$ orbital.
❖ hence there is no d-d transaction.

17. Complete the following equation.

i) $Cr_2O_7^{2-} + I^- + H^+ \longrightarrow ?$	$Cr_2O_7^{2-} + 6I^- + 14H^+ \longrightarrow 2Cr^{3+} + 3I_2 + 7H_2O$
ii) $MnO_2 + KOH + O_2 \longrightarrow ?$	$2MnO_2 + 4KOH + O_2 \longrightarrow 2K_2MnO_4 + 2H_2O$

18. What is the role of V_2O_5 in the manufacture of H_2SO_4?

V_2O_5 is used as a catalyst to oxidize SO_2.

19. Calculate the number of unpaired electrons in Ti^{3+}, Mn^{2+} and calculate the spin only magnetic moment.

Ions	Unpaired electrons	Magnetic moment $\sqrt{n(n+2)}$(BM)
Ti^{3+}	$[Ar]3d^1 = 1$	$= \sqrt{1(1+2)} = \sqrt{3} = 1.75$
Mn^{2+}	$[Ar]3d^5 = 5$	$= \sqrt{5(5+2)} = \sqrt{35} = 5.96$

20. Most of the transition metals and their compounds have catalytic activity why?

❖ Transition metal has energetically available 'd' orbitals.
❖ It can accept electrons from reactant molecule (or) metal.
❖ It can form bond with reactant molecule using its 'd' electrons.

21. Why do Zirconium and Hafnium exhibit similar properties?

❖ Zirconium and Hafnium exhibit similar properties due to lanthanoid contraction.
❖ Similar ionic radius and hence exhibits similar properties.

Series	Element	Atomic radius
4d series	Zr	145 pm
5d Series	Hf	144 pm

22. What are inner transition elements?

❖ Electrons are filled in $(n-2)f$ orbitals
❖ They form a transition series within the transition elements.
❖ 4f series – Lanthanoids – Ce to Lu (14 elements)
❖ 5f series – Actinoids – Th to Lr (14 elements).

23. Write the electronic configuration of lanthanoids and Actinoids

❖ Electronic configuration of lanthanoids $\Rightarrow$ **[Xe] 4f $^{0-14}$ 5d$^{0-1}$ 6s^2**
❖ Electronic configuration of Actinoids $\Rightarrow$ a

24. Write the Oxidation states of lanthanoids and Actinoids

Oxidation state	Lanthanoids	Actinoids
Common Oxidation state	**+3**	**+3**
Other Oxidation states	**+2 & +4**	**+2, +4, +5, +6 & +7**

25. Write the uses of $K_2Cr_2O_7$.
- ❖ Strong oxidisiong agent
- ❖ Dyeing and printing
- ❖ Leather tanneries for chrome tanning

26. Write chromyl chloride test.

$$K_2Cr_2O_7 + 4NaCl + 6H_2SO_4 \longrightarrow 2KHSO_4 + 4NaHSO_4 + 2CrO_2Cl_2 + 2H_2O$$

CrO_2Cl_2 - orange red vapours of chromyl chloride.

27. Write any three uses of $KMnO_4$.
- ❖ Strong oxidizing agent.
- ❖ The treatment of various skin infections and fungal infections of the foot.
- ❖ It is used as Water treatment industries to remove iron and hydrogen sulphide from well water.
- ❖ It is used as Bayer's reagent for detecting unsaturation in an organic compound.

**28. Classify the following elements into d-block and f-block elements.**

   i) Tungsten   **ii) Ruthenium**   **iii) Promethium**   **iv) Einstenium**

|	
Tungsten & Ruthenium	d- block elements
Promethium & Einstenium	f- block elements

29. Describe the preparation of potassium dichromate
- ❖ **Ore :** - Chromate ($FeCr_2O_4$)
- ❖ **Concentration**: By Gravity separation
- ❖ **Formation of Sodium Chromate:**

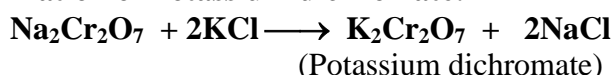   Ore is then mixed with excess sodium carbonate and lime and roasted in a reverbratory furnace.

$$4FeCr_2O_4 + 8Na_2CO_3 + 7O_2 \xrightarrow{900-1000^0C} 2Fe_2O_3 + 8Na_2CrO_4 + 8CO_2$$
$$\text{(yellow)}$$
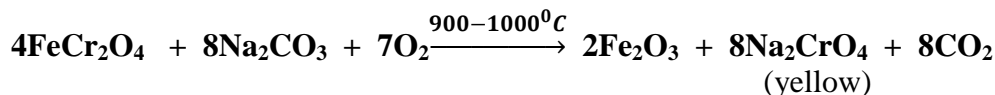
    The roasted mass is treated with water to separate soluble sodium chromate from insoluble iron oxide.

- ❖ **Formation of sodium dichromate:**

$$2Na_2CrO_4 + H_2SO_4 \longrightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$$
   Sodium chromate   Sodium dichromate (orange red)

- ❖ **Formation of Potassium dichromate:**
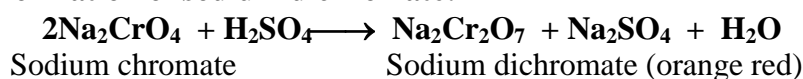
$$Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$$
                 (Potassium dichromate)

30. What is Lanthanide contration ? List the consequences of Lanthanide contraction.

    As we move across 4f series, the atomic and ionic radii of Lanthanoids show gradual decrease with increase in atomic number. This decrease in ionic size is called Lanthanoid contraction.

Consequences of Lanthanoid contraction:
- ❖ Size and radius of ions decreses
- ❖ Basicity decreases
- ❖ In the complete f - series very small change in radii of lanthanoids is observed and their chemical properties are quite similar.
- ❖ The elements of the second and third transition series resemble each other more closely than the elements of the first and second transition series.

31. Compare Lanthanoids and Actinoids

Sl.No	Lanthanoids	Actinoids
1.	Differentiating electrons enters in 4f orbital.	Differentiating electrons enters in 5f orbital.
2.	Binding energy of 4f orbitals are higher.	Binding energy of 5f orbitals are lower
3.	They show less tendency to form Complexes.	They show greater tendency to form complexes.
4.	Most of the lanthanoids are colourless	Most of the actinoids are coloured. For Eg. U^{3+} (Red), U^{4+}(Green),UO_2^{2+} (Yellow)
5.	They do not form oxocations	They do not form oxocations such UO_2^{2+},NpO_2^{2+}
6.	Oxidation states **+2 ,+3 & +4**	Oxidation states **+3, +4, +5, +6 & +7**

5 . COORDINATION CHEMISTRY

1. **Give the difference between double salts and coordination compounds.**

Sl.No	Double salt	Co-ordination compound
1,	**dissociating into ions** their constituent simple ions in solutions.	Never dissociates to give simple ions in Solutions.
2,	Loose their identity	Does not loose its identity
3,	Positive and negative ions are present	Simple and complex ions are present
4,	Example: Potash alum $K_2SO_4.Al_2(SO_4)_3.24H_2O$	Example: $K_4[Fe(CN)_6]$

2. **Define central atom / ion**
   - ❖ The central atom / ion is the one that occupies the central position in a coordination entity.
   - ❖ Binds the ligands to itself by coordinate bonds.
   - ❖ Referred to as a Lewis acid
   - ❖ Ex: - In $K_4[Fe(CN)_6]$ the central metal ion is Fe^{2+}

3. **Define coordination sphere (or) complex ion.**
   - ❖ The complex ion , the central metal atom and the ligands are enclosed in the square bracket with its net charge. This is called coordination sphere.
   - ❖ Ex :- In $K_4[Fe(CN)_6]$ the coordination sphere is $[Fe(CN)_6]^{4-}$

4. **Define coordination number**
   - ❖ The number of ligand donor atom bonded to a central metal in a complex is called the coordination number.
   - ❖ Ex :- In $K_4[Fe(CN)_6]$ the coordination number of Fe^{2+} is **6**.

5. **Define coordination polyhedron**
   - ❖ The three dimensional special arrangement of ligands that are directly bonded to the central metal atom is called Coordination polyhedron.
   - ❖ Ex :- In $K_4[Fe(CN)_6]$ the coordination polyhedron is **octahedral**.

6. **Define oxidation state (number)**
   - ❖ If all the ligands were removed along with the electron pair that were shared with the central atom, the result charge is called Oxidation number.
   - ❖ Net charge = (oxidation state of the central metal) + [(no of ligands) x (charge on the ligand)]
   - ❖ Ex :- In $[Fe(CN)_6]^{4-}$ the oxidation number of Fe is **+2**.

7. **Explain the classification of complexes based on kind of ligands**

a) **Homoleptic complex : -**
   - ❖ The central metal ion / atom is coordinated to only one kind of ligand
   - ❖ Example: $[Co(NH_3)_6]^{3+}$; $[Fe(H_2O)_6]^{2+}$

b) **Heteroleptic complex : -**
   - ❖ The central metal ion / atom is coordinated to more than one kind of ligand.
   - ❖ Example: $[Co(NH_3)_5Cl]^{2+}$; $[Pt(NH_3)_2Cl_2]$

8. **Define Ligands**.
   - ❖ Atoms or group of atoms bound to the central atom / ion
   - ❖ Referred to as Leis base
   - ❖ Ex : - In $K_4[Fe(CN)_6]$ the ligand is CN^- ion

| Ligands	Example
Neutral Ligand	H_2O aqua CO carbonyl NH_3 ammine NO nitrosyl
Negative Ligand	Cl^- chloro SO_4^{2-} sulphato CN^- cyanido
Positive Ligand	$NH_2 - NH_3^+$ hydrazinium

9. Write the postulates of Werner's theory

There are two type of valencies namely
a, Primary and b, Secondary valency

PRIMARY VALENCY	SECONDARY VALENCY
1, oxidation number of the central metal ion	1, Coordination number of the central metal ion.
2, Ionisable valency	2, Non ionisable valency
3, Always satisfied by negative ions	3, Satisfied by negative ions (or) neutral molecules (or) positive ions.
4, It is non directional	4, It is directional
Ex :- $[Ni(NH_3)_4]^{2+}$ primary valency is 2	Ex :- $[Ni(NH_3)_4]^{2+}$ secondary valency is 4 tetrahedral

❖ The inner sphere is called the coordination sphere and the groups present in this sphere are firmly attached to the central metal ion.

❖ The outer sphere is called the ionsation sphere. The groups present in this sphere are loosely attached to the central metal ion.

❖ **Structure of compound $[Co(NH_3)_6]Cl_3$**
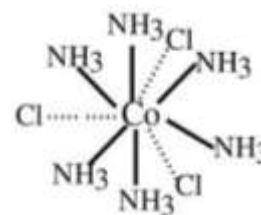
❖ **Limitation of Werner's theory :-**

It does not explain the colour and magnetic properties of coordination compounds.

10. Discuss the types of structural isomerism.

Structural isomerism :

Complexes having same molecular formula, but different connections between the ligand atoms are called structural isomerism.

a) Linkage isomerism :

❖ When an ambidentate ligand is bonded to two different donor atoms by the central metal ion are called linkage isomers.

❖ **Ex : -** $[Cr(H_2O)_5NO_2]Br$ $[Cr(H_2O)_5ONO]Br$
           (Nitro)   (Nitrito)

b) Coordination isomerism:

❖ Coordination compounds having both the cation and anion as complex ions givs coordination isomerism.

❖ The ligands are interchange between the cationic and the anionic complex.

❖ **Ex : -** $[Pt(NH_3)_4][Pd(Cl)_4]$ and $[Pd(NH_3)_4][Pt(Cl)_4]$

c) Ionisation Isomerism :-

❖ When a simple ion act as a ligand and exchange with one or more ligands present in the coordination sphere is called ionsation isomerism.

❖ They give different ions in solution.

❖ **Ex : -** $[Co(H_2O)Cl]Br$ $[Co(H_2O)_5Br]Cl$

d, Solvate (or) Hydrate isomers :-

❖ When solvent molecules like water are exchange by the ligands in the crystal lattice of the coordination compounds is called solvate isomerism.

❖ **Ex : -**

$[Cr(H_2O)_6]Cl_3$	Violet colour
$[Cr(H_2O)_5 Cl]Cl_2.H_2O$	Pale green colour
$[Cr(H_2O)_4 Cl_2]Cl.2H_2O$	Dark green colour

11. For the complex identify the following. a) central metal atom/ion   b) Co-ordination number
c) Oxidation number of central metal ion

a) central metal atom/ion	Pt^{2+}
b) Co-ordination number	3
c) Oxidation number of central metal ion	+2

12. Explain Optical isomerism with an example.
❖ Compounds with chiral atoms are Optically active.
❖ Enantiomers are optically active mirror images.

Dextro Isomer:-
It rotate the plane of polarized light towards the right (or) clockwise direction.
Laevo Isomer :-
It rotate the plane of polarized light towards the left ® anticlockwise direction.
Ex : - $[Co(en)_3]^{3+}$

13. Indicate the possible type of Isomerism for the following complexes
(A) $[Co(en)_3]^{3+}$ (B) $[Pt(NH_3)_2Cl_2]^{2+}$

(A) $[Co(en)_3]^{3+}$	Optical isomerism
(B) $[Pt(NH_3)_2Cl_2]^{2+}$	Geometrical isomerism (cis – Trans isomerism)

14. Write the following for the complex $[Ag(NH_3)_2]^+$
(a) Ligand   (b) Central metal ion   (c) IUPAC name

(a) Ligand	NH_3 Ammine
(b) Central metal ion	Ag^+
(c) IUPAC name	Diamminesilver(I)ion

15. Write the central metal ion, oxidation state , coordination number, nature of the ligand and magnetic property for $K_4[Mn(CN)_6]$

Central metal ion	Mn^{2+}
Oxidation state	+2
Coordination number	6
Nature of the ligand	CN^- strong ligand
Magnetic property	Paramaganetic

16. Write the IUPAC ligand name for the following   a) $C_2O_4^{2-}$ b) H_2O c) Cl^-

a) $C_2O_4^{2-}$	Oxalato
b) H_2O	Aqua
c) Cl^-	Chlorido

17. Define Ambidentate ligand
❖ When the ligand is capable of bonding by more than one donor atom to the central metal ion are called ambidentate ligands.
❖ **Ex : -**– NO_2, $- ONO$

18. Write the IUPAC name of the following :   A) $[Ag(NH_3)_2]^+$ B) $[Co(NH_3)_5Cl]^{2+}$

A) $[Ag(NH_3)_2]^+$	Diamminesilver(I)ion
B) $[Co(NH_3)_5Cl]^{2+}$	Pentaaminechloridocobalt(III)ion

19. Write any two hydrate isomers of the complex with the molecular formula $CrCl_3.6H_2O$

$[Cr(H_2O)_6]Cl_3$	Violet colour
$[Cr(H_2O)_5 Cl]Cl_2.H_2O$	Pale green colour
$[Cr(H_2O)_4 Cl_2]Cl.2H_2O$	Dark green colour

20. Explain Valence bond theory.
❖ The ligand metal bond is covalent bond and formed by sharing of electrons between the central metal atom and the ligands.
❖ The ligand should contain atleast one filled orbital with a lone pair of electrons.
❖ To accept the electron pair donated by the ligands the central metal atom should contain vacant orbitals.
❖ The vacant orbital of the metal atom undergoed hybridization. Hybridization is the intermixing of atomic orbitals of same energy to give equal number of new orbitals of same energy.
❖ The vacant metal orbitals linearly overlap with the filled ligand orbitals to form metal ligand coordinate sigma bonds.
❖ The hybridized orbitals are directionsl in space and give geometry to the complex.

Coordination No.	Hybridisation	Geometry
2	sp	Linear
3	sp^2	Trigonal planar
4	sp^3	Tetrahedral
4	dsp^2	Square planar
6	sp^3d^2 (or) d^2sp^3	octahedral

❖ Central metal atom with unpaired electrons paramagnetic , with paired electrons diamagnetic.
❖ Ligands like Co & CN- are strong field ligands.
❖ Greater the ligand metal orbitals overlapping greater is the bond strength.
❖ In octahedral comples
$\quad$ (n-1)d $\Rightarrow$ low spin
$\quad\quad$ nd $\Rightarrow$ high spin

21. What are the limitations of VB theory ?
❖ It does not explain the colour of the complex
❖ It considers only the spin only magnetic moments and does not consider the other components of magnetic moments.
❖ It does not provide a quantitative explanation as to why certain complexes are inner orbital complexes and the others are outer orbital complexes for the same metal.

22. List the features of crystal field theory.
❖ The bonding between the ligand and the central metalatom is purely an ionic bond.
❖ In the coordination compounds, the central metal atom/ion and the ligands are considered as point charges for charged metal atoms and electric dipoles for neutral metal atom.
❖ In the isolated state,all the five d-orbitals are degenerate.
❖ The ligands form a spherical field of negative charge around the metal atom. Due to repulsion between the electrons, the energy of the five d-orbitals will increase.
❖ The ligands approach the metal atom in the bonding direction. Due to repulsion, the energies of eg orbitals dx^2-y^2 and dz^2 lying along the axis will increase . the five d-orbitals will split into two sets. This is called crystal field splitting.
❖ When the ligand approaches further there will be an attraction between the negative charged ligand and the positive charged metal ion. The net energy decreases and leads to complex formation.

23. Define crystal field splitting energy?
$\quad\quad$ It is the energy associated with the absorbed wavelength of light is called crystal field splitting energy.
$$\Delta = hc\bar{v}$$
Δ - crystal field splitting energy ; h – Plank's constant ;
c – velocity of light $\&\bar{v}$ - wavelength

24. Define crystal field stabilizing energy (CFSE)
$\quad\quad$ It is the energy difference between the electronic configuration of the ligand field electronic configuration of the ligand field and the bary centre.
$$\textbf{CFSE } (\Delta E^0) = [E_{LF}] - [E_{Iso}]$$

25. Why are Sc^{3+}, Ti^{4+}, Cu^+ and Zn^{2+} are colourless.

Ion	Configuration	Reason
Sc^{3+}	$3d^0$	No unpaired electrons and they do not have d-d transition
Ti^{4+}	$3d^0$	No unpaired electrons and they do not have d-d transition
Cu^+	$3d^{10}$	Completely filled electrons and they do not have d-d transition
Zn^{2+}	$3d^{10}$	Completely filled electrons and they do not have d-d transition

26. $[Ti(H_2O)_6]^{3+}$ is coloured, while $[Sc(H_2O)_6]^{3+}$ is colourless -Explain.
$[Ti(H_2O)_6]^{3+}$
❖ The central metal ion of $[Ti(H_2O)_6]^{3+}$ is Ti^{3+}

- ❖ Ti^{3+} ion has one unpaired electron for d-d transition, hence it is coloured

$[Sc(H_2O)_6]^{3+}$
- ❖ The central metal ion of $[Sc(H_2O)_6]^{3+}$ is Sc^{3+}
- ❖ Have vacant d^0 orbitals
- ❖ No unpaired electrons
- ❖ No d-d displacement therefore colourless.

27. A solution of $[Ni(H_2O)_6]^{2+}$ is green whereas a solution of $[Ni(CN)_4]^{2-}$ is colourless –Explain.

$[Ni(H_2O)_6]^{2+}$	H_2O is a weaker ligand. Don't pair d electrons.Presence of unpaired electron, d-d displacement.Therefore green in colour.
$[Ni(CN)_4]^{2-}$	CN^- is a strong ligand, d electrons are paried.Absence of unpaired electron. No d-ddisplacement. Therefore colourless.

28. $[CuCl_4]^{2-}$ exists while $[CuI_4]^{2-}$ does not exist why?

- ❖ $[CuCl_4]^{2-}$ ⟹ The chloride ion does not reduce Cu^{2+} to Cu^+
  Therefore $[CuCl_4]^{2-}$ exists
- ❖ $[CuI_4]^{2-}$ ⟹ The iodide ion reduces Cu^{2+} to Cu^+
  Therefore $[CuI_4]^{2-}$ does not exist.

29. Arrange the following in order of increasing molar conductivity
i) Mg $[Cr(NH_3)(Cl)_5]$ ii) $[Cr(NH_3)_5Cl]_3[CoF_6]_2$ iii) $[Cr(NH_3)_3Cl_3]$

The larger the number of ions and larger the charge on each the larger is the molar conductivity.

On ionisaton:

i) Mg $[Cr(NH_3)(Cl)_5]$ ⇋ **1**Mg^{2+} + **1**$[Cr(NH_3)(Cl)_5]^{2-}$	No.of ions = 2
ii) $[Cr(NH_3)_5Cl]_3[CoF_6]_2$ ⇋ **3**$[Cr(NH_3)_5Cl]^{2+}$ + **2**$[CoF_6]^{3-}$	No.of ions = 5
iii) $[Cr(NH_3)_3Cl_3]$ ⇋ **does not ionize**	No.of ions = 0

Order of molar conductivity = $[Cr(NH_3)_3Cl_3]$ < Mg $[Cr(NH_3)(Cl)_5]$ < $[Cr(NH_3)_5Cl]_3[CoF_6]_2$

30. What is the coordination entity formed when excess of liquid ammonia is added to an aqueous solution of copper sulphate?

- ❖ When excess of liquid ammonia is added to an aqueous solution of copper sulphate it gives tetraamminecopper (II) sulphate.
  $CuSO_4 + 4NH_3$ ⟶ $[Cu(NH_3)_4]SO_4$(tetraamminecopper (II) sulphate)
- ❖ So, the coordination entity is : $[Cu(NH_3)_4]^{2+}$

31. How will you differentiate $[Co(NH_3)_5SO_4]Cl$ and $[Co(NH_3)_5Cl]SO_4$.

They are ionization isomers.
$[Co(NH_3)_5SO_4]Cl$ will give a white precipitate with Silver nitrate for Chloride
$[Co(NH_3)_5Cl]SO_4$ will give white precipitate with Barium chloride for Sulphate.

32. $[Ni(CN)_4]^{2-}$ is diamagnetic, while $[Ni(Cl)_4]^{2-}$ is paramagnetic using crystal field theory ?

- ❖ **$[Ni(CN)_4]^{2-}$** is diamagnetic due to CN^- strong ligand.
- ❖ It pairs the d electrons of Nickel.
- ❖ There are no single unpaired electron.
- ❖ It forms zero spin complex.
- ❖ **$[Ni(CN)_4]^{2-}$;** is diamagnetic due to CN^- strong ligand. Therefore d electrons get paired, therefore it forms high spin complexes. No unpaired electrons

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

3d				
1↓	1↓	1↓	1↓	
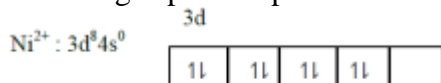
- ❖ **$[Ni(Cl)_4]^{2-}$** is paramagnetic due to Cl^- weak ligand.
- ❖ So d electrons not paired,
- ❖ Therefore it forms low spincomplexes. unpaired electrons present.

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

3d				
1↓	1↓	1↓	1	1
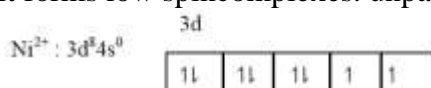
33. Why tetrahedral complexes do not exhibit geometrical isomerism.

- ❖ All the four ligands are *adjacent or equidistant* to one another in tetrahedral complex.
- ❖ As the relative positions of donor atoms of ligands attached to the central atom are same with respect to each other

34. Explain the crystal field spilitting in Tetrahedral complexes

- ❖ When the ligand approaches the metal diagonally, the t_{2g} orbitals are closer to the ligands then the e_g orbitals.
- ❖ It maintain the average energy, the energy of dx^2-y^2 and dz^2 orbitals will decrease by $3/5\Delta_t$.
- ❖ The energy of dxy, dyz and dxz will increase by $2/5\Delta_t$
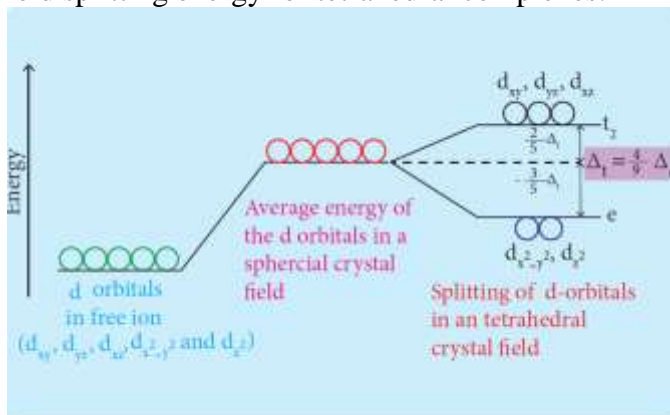- ❖ Δ_t is the crystal field splitting energy for tetrahedral complexes.

35. Explain the crystal field splitting in Octahedral complexes.

- ❖ When the ligand approaches the metal along the axis. E_g orbitals are closer to the ligands than the t_{2g} orbitals.
- ❖ To maintain the average energy, the energy of dx^2-y^2 and dz^2 orbitals will increased by $3/5\Delta_0$.
- ❖ The energy of dxy, dyz and dxz will decreased by $2/5\Delta_0$.
- ❖ Δ_0 is the crystal field splitting energy for octahedral complexes.
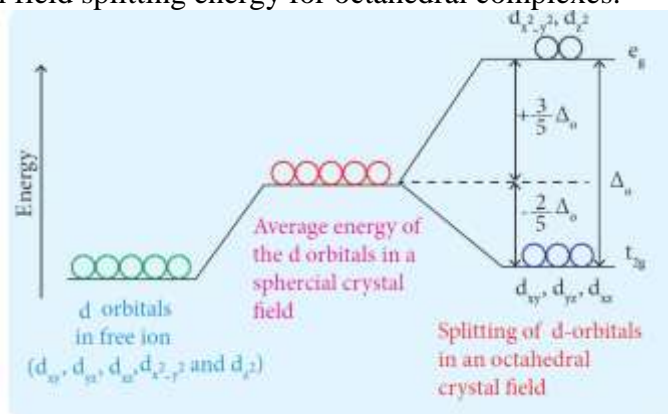
36. Explain metal carbonyls

Metal carbonyls are transition metal complexes of carbon monoxide with carbon bonds

Ex : – $[Ni(CO)_4]$

a, Mono nuclear Carbonyls:

These compounds contain only one metal atom Ex :- $[Ni(CO)_4]$

b, Poly nuclear carbonyls:

These compounds contain more than one metal atom. Ex :- $[Fe_2(CO)_9]$

C, Non – bridged Carbonyls :

- ❖ These metal carbonyls which contain only terminal carbonyls. Ex :- $[Ni(CO)_4]$
- ❖ These metal carbonyls which contain terminal carbonyls as well as Metal-Metal bonds. Ex :- $[Mn_2(CO)_{10}]$
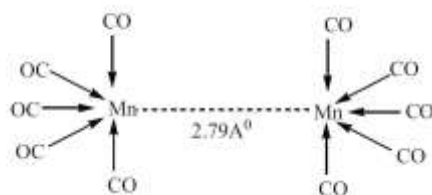
d, Bridged carbonyls:

- ❖ These will contain bridging carbonyl ligands along with terminalcarbonyl ligands
- ❖ One or more Metal-Metal bonds. For example,$[Fe_2(CO)_9]$
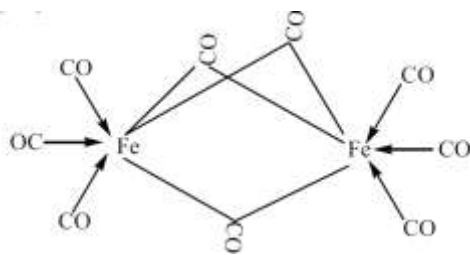
37. Describe the nature of bonding in metallic carbonyls.

- ❖ In metal carbonyls, the bond between metal atom and the carbonyl ligand consists of two components.
- ❖ An electron pair donation from the carbon atom of carbonyl ligand into a vacant d-orbital of central metal atom.
- ❖ This electron pair donation forms $M \xleftarrow{\sigma \text{ bond}} CO$ sigma bond.
- ❖ This sigma bond formation increases the electron density in metal d orbitals and makes the metal electron rich.
- ❖ In order to compensate for this increased electron density, a filled metal d-orbital interacts with the empty π* orbital on the carbonyl ligand and transfers the added electron density back to the ligand. This second component is called π-back bonding .
- ❖ Thus in metal carbonyls, electron density moves from ligand to metal through sigma bonding and from metal to ligand through pi bonding, this synergic effect accounts for strong M ← CObond in metal carbonyls.
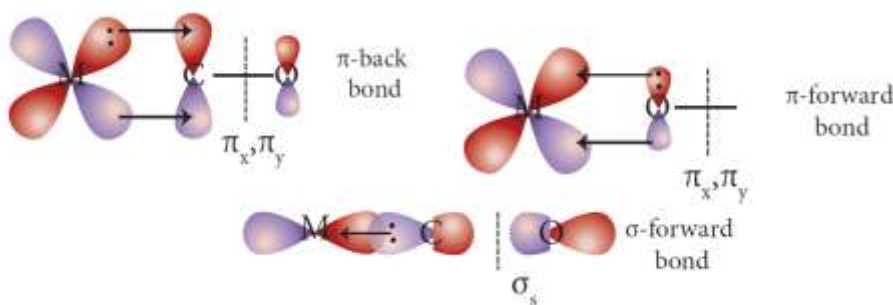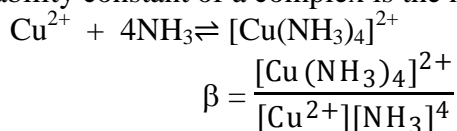

38. Define stability constant.

The stability constant of a complex is the measure of its resistance to replaces one ligand by another.

$$Cu^{2+} + 4NH_3 \rightleftharpoons [Cu(NH_3)_4]^{2+}$$

$$\beta = \frac{[Cu(NH_3)_4]^{2+}}{[Cu^{2+}][NH_3]^4}$$

39. Give the IUPAC names.

Sl.No.	Complex	IUPAC Name
1	Na$_2$[Ni (EDTA)]	Sodium 2,2',2'',2'''-(ethane-1,2-diyldinitrilo)tetraacetatonickelate(II)
2	[Ag (CN) $_2$]$^-$	dicyanidoargentate(I) ion
3	[Co (en)$_3$]$_2$(SO$_4$)$_3$	tris(ethane1,2-diamine)cobalt(III)sulphate
4	[Co (ONO) (NH$_3$)$_5$]$^{2+}$	pentaamminenitrito-K-O-cobalt(III)ion
5	Pt (NH$_3$)$_2$Cl(NO$_2$)]	diamminechloridonitrito- K-N-platinum(II)

40. Write the formula for the following coordination compounds.

Sl.No.	IUPAC Name	Formula
a)	Potassiumhexacyanidoferrate(II)	K$_4$[Fe(CN)$_6$]
b)	Pentacarbonyliron(0)	[Fe(CO)$_5$]
c)	Pentaamminenitrito- K-N-cobalt(III)ion	[Co(NH$_3$)$_5$(NO$_2$)]
d)	Hexaamminecobalt(III)sulphate	[Co(NH$_3$)$_6$]$_2$(SO$_4$)$_3$
e)	Sodiumtetrafluoridodihydroxidochromate(III)	Na$_3$[CrF$_4$(OH)$_2$]

41. Give an example of coordination compound used in medicine
Medicine:

Ca-EDTA chelate	in the treatment of lead and radioactivity poisoning.
Cis – platin	antitumor drug in cancer treatment

42. Give two examples of biologically important coordination compounds.
Biologically important coordination compounds:

Complexes	Central Metal ion	Uses
red blood corpuscles(RBC)	Fe^{2+}	carrying oxygen from lungs totissues and carbon dioxide from tissues to lungs
Chlorophyll	Mg^{2+}	Photosynthesis

43. Based on VB theory explain why $[Cr(NH_3)_6]^{3+}$ is paramagnetic, while $[Ni(CN)_4]^{2-}$ is diamagnetic.

Complex	$[Cr(NH_3)_6]^{3+}$
Central metal ion and its outer electronic configuration	$Cr^{3+} : 3d^3 4s^0$
Outer orbitals of metal atom / ion	3d 4s 4p
Nature of ligand	NH_3 is weak field ligand and hence no pairing of 3d electrons in the metal.
Outer orbital of metal atom / ion in presence of ligand.	3d 4s 4p
Hybridized orbitals of the metal atom in the complex	3d 4s 4p
Hybridization	Coordination No. 6 ; Hybridisation : d^2sp^3
Geometry	Octahedral
Magnetic property	Number of unparied electrons = **3**, It is **Paramagnetic** in nature
Magnetic moment	$\mu_s = \sqrt{n(n+2)} = \sqrt{3(3+2)} = 3.872$ BM

Complex	$[Ni(CN)_4]^{2-}$
Central metal ion and its outer electronic configuration	$Ni^{2+} : 3d^8 4s^0$
Outer orbitals of metal atom / ion	$3d^8$ 4s 4p
Nature of ligand	CN^- strong field ligand causes the paring of 3d electrons in the metal.
Outer orbital of metal atom / ion in presence of ligand	3d 4s 4p
Hybridized orbitals of the metal atom in the complex	3d 4s 4p
Hybridization	Coordination No. 4 ; Hybridisation : dsp^2
Geometry	Square planar
Magnetic property	Number of unparied electrons = 0 It is **Diamagnetic** in nature.
Magnetic moment	$\mu_s = \sqrt{n(n+2)} = \sqrt{0(0+2)} = \mathbf{0}$ BM

44. On the basis of VB theory explain the nature of bonding in $[Co(C_2O_4)_3]^{3-}$

Complex	$[Co(C_2O_4)_3]^{3-}$
Central metal ion and its outer electronic configuration	$Co^{3+} : 3d^6$
Outer orbitals of metal atom / ion	[↑↓][↑][↑][↑][↑] [ ] [ ][ ][ ] 3d⁶ 4s 4p
Nature of ligand	$C_2O_4^{2-}$ **strong field** ligand. It causes the pairing of 3d electrons in the metal ion.
Outer orbital of metal atom / ion in presence of ligands	[↑↓][↑↓][↑↓][ ][ ] [ ] [ ][ ][ ] 3d⁶ 4s 4p
Hybridisation	Co-ordination Number = 6 Hybridization : d^2sp^3
Hybridized orbitals of the metal atom in the complex	[↑↓][↑↓][↑↓][↑↓][↑↓] [↑↓] [↑↓][↑↓][↑↓] 3d 4s 4p
Geometry	**Octahedral**
Magnetic property	Number of unpaired electon = 0. Hence it is **diamagnetic** in nature.
Magnetic moment	$\mu_s = \sqrt{n(n+2)} = 0$ BM

45. Show that $[CoF_6]^{3-}$ is octahedral and paramagnetic using VB theory

Complex	$[Co(F)_6]^{3-}$
Central metal ion and its outer electronic configuration	$Co^{3+} : 3d^6$
Outer orbitals of metal atom / ion	[↑↓][↑][↑][↑][↑] [ ] [ ][ ][ ] 3d⁶ 4s 4p
Nature of ligand	F^- **Weak field** ligand. Hence no the pairing of 3d electrons in the metal ion.
Outer orbital of metal atom / ion in presence of ligands	[↑↓][↑][↑][↑][↑] [ ] [ ][ ][ ] 3d⁶ 4s 4p
Hybridisation	Co-ordination Number = 6 Hybridization : sp^3d^2
Hybridized orbitals of the metal atom in the complex	[↑↓][↑↑][↑↑][ ][ ] [↑↓] [↑↓][↑↓][↑↓] 3d 4s 4p [↑↓][↑↓][ ][ ][ ] **4d**
Geometry	**octahedral**
Magnetic property	Number of unpaired electon = 4. Hence it is **paramagnetic** in nature.
Magnetic moment	$\mu_s = \sqrt{n(n+2)} = \sqrt{4(4+2)} = 4.9$ BM

46. Show that $[Fe(CN)_6]^{3-}$ is octahedral and paramagnet using VB theory

Complex	$[Fe(CN)_6]^{3-}$
Central metal ion and its outer electronic configuration	$Fe^{3+} : 3d^5$
Outer orbitals of metal atom / ion	[↑][↑][↑][↑][↑] [ ] [ ][ ][ ] 3d⁵ 4s 4p
Nature of ligand	CN^- **strong field** ligand. It causes the pairing of 3d electrons in the metal ion.

Outer orbital of metal atom / ion in presence of ligands	<table><tr><td>1↓</td><td>1↓</td><td>1</td><td></td><td></td></tr></table> $3d^5$ 4s 4p
Hybridisation	Co-ordination Number = 6 Hybridization : d^2sp^3
Hybridized orbitals of the metal atom in the complex	<table><tr><td>1↓</td><td>1↓</td><td>1</td><td>1↓</td><td>1↓</td></tr></table> <table><tr><td>1↓</td></tr></table> <table><tr><td>1↓</td><td>1↓</td><td>1↓</td></tr></table> 3d 4s 4p
Geometry	**Octahedral**
Magnetic property	Number of unpaired electon = 1. Hence it is **paramagnetic** in nature.
Magnetic moment	$\mu_s = \sqrt{n(n+2)} = \sqrt{1(1+2)} = 1.730$ BM

47. Classify the following ligand based on the number of donor atoms.
   a) NH_3 b) en   c) ox^{2-} d) **Triaminotriethylamine**   e)**pyridine**

Sl.No.	Ligand	Number of donor atoms
a)	NH_3	1
b)	En	2
c)	OX^{2-}	2
d)	Triaminotriethylamine	4
e)	பிரிடின்	1

48. Give the structures of isomers of $[Co(en)_2Cl_2]^+$
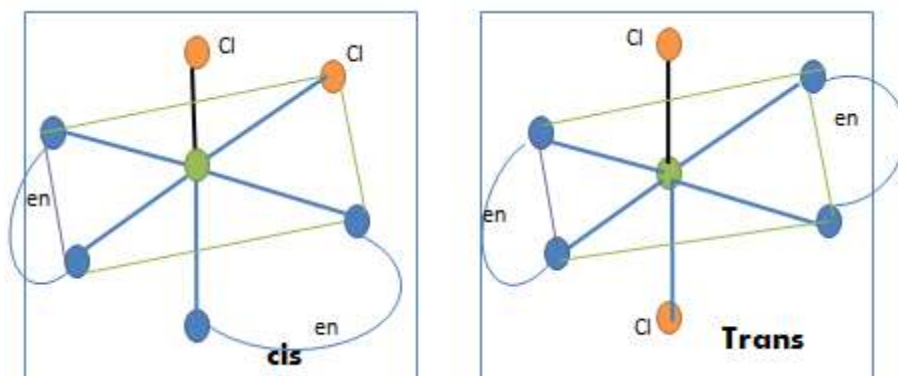
49. Write briefly about the applications of coordination compounds in volumetric analysis.
   ❖ EDTA is used in the volumetric determination of a wide variety of metal ions in solution.
   ❖ Eg. Zn^{2+}, Pb^{2+}, Ca^{2+}, Co^{2+}, Ni^{2+}, Cu^{2+}, etc.
   ❖ By carful adjustment of the pH and using suitable indicators, mixture of metals can be analysed
   ❖ Eg: Bi^{3+} In the presence of Pb^{2+}.
   ❖ EDTA may be used as a masking agent to remove a metal ion which would interfere with the analysis of a second metal ion present.
   ❖ Hardness of water due to the presence of Ca^{2+} and mg^{2+} ions are estimated by complex metric titrations using EDTA.

6. SOLID STATE

1. **Define unit cell**

   A Basic repeating the structural unit of crystalline solid is called unit cell.

2. **What are the characteristics of ionic crystal**
   - ❖ They are hard .
   - ❖ Have high Melting Point.
   - ❖ Do not conduct electricity in solid state (Ions are fixed in their lattice position)
   - ❖ They do conduct the electricity in molten state(or) when dissolved in water.

3. **What are difference between crystalline and amorphous solids**

Sl.No	Crystalline Solid	Amorphous Solid
1	Long range orderly arrangement of constituents.	Short range (or) random arrangement of Constituents.
2	Definite Shape.	Irregular Shape.
3	Anisotropic Nature.	Isotropic Nature.
4	True Solids.	Pseudo Solids (or) Super cooled liquids.
5	Definite Heat of fusion.	Heat of fusion not definite.
6	Have Sharp Melting Point.	No Sharp Melting Point.
7	Ex.NaCl, Diamond.	Ex. Rubber, Plastic.

4. **Classify the following solids a) P_4 b) Brass   c) Diamond d) NaCl   e) Iodine**

a) P_4	Molecular solids
b) Brass	Molecular solids
c)Diamond	Covalent solids
d)NaCl	Ionic solids
e)Iodine	Molecular solids

5. **Explain briefly Seven types of unit cell**

Unit cell	Edge length
1, Cubic	$a = b = c$
2, Tetragonal	$a = b = c$
3, Orthorhombic	$a = b \neq c$
4, Rhombohederal	$a = b \neq c$
5, Hexagonal	$a \neq b \neq c$
6, Monoclinic	$a \neq b \neq c$
7, Triclinic	$a \neq b \neq c$

6. **Distinguish between Hexagonal close packing and cubic packing**

Sl.No	Hexagonal close packing	cubic close packing
1.	The spheres can be arranged so as to fit into the depression in such a way that the thirdlayer is directly over a first layer (ABA arrangement)	In cubic close packing (ccp), the spheres of the fourth layer are present above the spheres of the first layer(ABC arrangement)
2.	This type is found in metals like Mg,Zn, etc.	This type is found in metals like Cu, Ag, etc.
3.	The unit cell of hexagonal close packing has 6 spheres.	The unit cell of cubic close packing has 4 spheres.
4.	The repeating unit of hexagonal close packing has two layers of spheres.	The repeating unit of hexagonal close packing has Threelayers of spheres.

7. Distinguish between Tetrahedral and Octahedral voids

Sl.No	Tetrahedral voids	Octahedral voids
1,	When the spheres of the second layer is above the voids of the first layer is called as Tetrahedral voids	When the spheres of the second layer partially covers the voids of the first layer is called as Octahedral voids
2,	The number of Tetrahedral voids is given by '2n'. where 'n' is the closed packed sphere.	The number of Octahedral voids is given by 'n'. where 'n' is the closed packed spheres.
3,	There are 3 spheres in the lower layer and one in the upper layer. Total 4 spheres.	There are 3 lspheres in the power layer and 3 in the upper layer. Total 6 spheres.
4,	When the 4 spheres are joined the center gives a Tetrahedron.	When the 6 spheres are joined the center gives a Octahedron.

8. If the no,of close packed sphere is 6, calculate the number of Octahedral voids and Tetrahedral voids generated.

- ❖ No,of close packed sphere n = 6
- ❖ Number of Octahedral voids (2n) = 12
- ❖ Number of Tetrahedral voids (n) = 6

9. What is meant by Isotropy and Anisotropy? (or) Distance between Isotropy and Anisotropy in solids.

Isotropy :-
- ❖ Isotropy means uniformity in all direction.
- ❖ Same physical properties in all direction (refractive index electrical conductance etc)
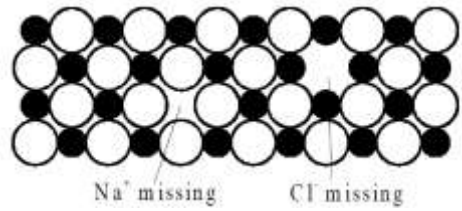
Anisotropy :-
- ❖ Not Uniformity in all the direction.
- ❖ Different physical properties in different direction.
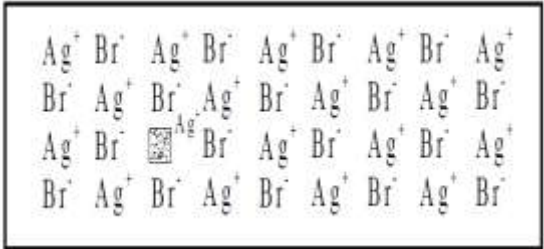
10. What are point defects?
- ❖ Deviation from ideal arrangement around a point or an atom in a crystalline substance is called as Point defect.
- ❖ Examples : Schottky defect , Frenkel defect, metal excess defect, metal deficiency defect etc
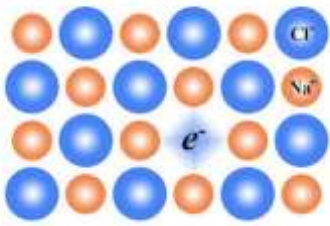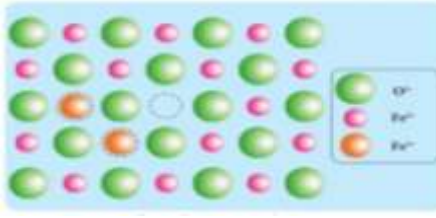
11. Explain Schottky defect.

- ❖ Arises due to the missing of equal number of cations and anions.
- ❖ Does not change the stoichiometry of the crystal.
- ❖ Ionic solids in which the cation and anion are of almost of similar size show schottky defect.
- ❖ Example: NaCl.
- ❖ Lowers its density
- ❖ Presence of Schottky defect in the crystal provides a simple way by which atoms or ions can move within the crystal lattice.

Na⁺ missing   Cl⁻ missing

12. Write a note on Frenkel defect with example

- ❖ Arises due to dislocation of ions from its crystal lattice
- ❖ The ion which is missing from the lattice point occupies an interstitial position
- ❖ This defect found in ionic solids in which size of anion and cation differ
- ❖ Does not affect the density of crystal
- ❖ Ex : AgBr (Br larger size)

13. Write a short note on a) Metal excess and b) Metal deficiency defect with an example.

a) Metal excess defect
  ❖ Arises due to presence of more number of metal ions as compared to anions
  ❖ For example : When NaCl crystal are heated in the presence of sodium vapourNa^+ions are formed and are deposited on the surface of the crystal
  ❖ Chloride ions (Cl^-) ions diffuse to the surface from the lattice point and combine with Na^+ion
  ❖ The electron lost by the sodium vapour diffuse into the crystal lattice and occupie the vacancy created by Cl^-ions
  ❖ Such anionic Vacancies which are occupied by unpaired electrons are called **F – Centers.**
  ❖ Hence the formula of NaCl which contains Na+ ions can be written as $Na_{1+x}Cl$.
	F- CENTERS

b) Metal deficiency defect
  ❖ Arises due to the presence of less number of cations than the anions
  ❖ Observed in a crystal in which, the cations have variable oxidation states.
  ❖ For example : in FeO Crystal some of Fe^{2+}ions are missing from the the crystal lattice.
  ❖ To maintain the electrical neutrality, twice the number of other Fe^{2+}ions in the crystal is oxidized to Fe^{3+}
  ❖ In such cases, over all number of $Fe^{2+}$and Fe^{3+}ions are less than the O^{-2}ions.	

14. Calculate the number of atoms in an FCC unit cell.

Identical atoms lie at each corner as well as in the centre of each face.
The total number of atoms in a Face centred cubic unit cell

$$= \frac{N_c}{8} + \frac{N_f}{2} = \frac{8}{8} + \frac{6}{2} = 1 + 3 = 4$$

N_c – Number of atoms at the corners.
N_f – Number of atoms at the face.
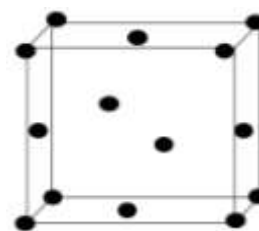
15. Explain the AAAA , ABABA and ABCABC type of three dimensional packing with the help of neat diagram

AAAA TYPE: (Simple Cubic Arrangement)
  ❖ Spheres in one layer sitting directly on top of those in the previous layer, so that all layers are identical.
  ❖ All spheres of different layers of crystal are perfectly aligned horizontally and also vertically, so that unit cell of such arrangement as simple cubic structure
  ❖ Each sphere is in contact with 6 neighbouring spheres and hence the coordination number is 6.	

ABAB TYPE: (Body Cubic Arrangement) ❖ The spheres in the first layer (A type) are slightly separated and the second layer is formed by arranging the spheres in the depressions between the spheres in layer A. ❖ The third layer is the repeat of the first. ❖ This pattern ABABAb is repeated throughtout the crystal ❖ In this arrangement, each sphere has a coordination number of 8	
ABCABC TYPE (Face centered Cubic Arrangement) ❖ The third layer may be placed over the second layer in such a way that all the spheres of the third layer fit in octahedral voids. ❖ This arrangement of the third layer is different from other two layers (a) and (b), and hence, the third layer is designated (c). ❖ The coordination number of each sphere is 12	
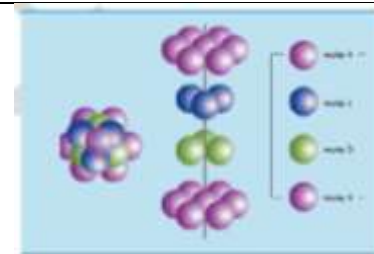
16. Why ionic crystals are hard and brittle?

❖ The structural units of an ionic crystal are cations and anions.

❖ They are bound together by strong electrostatic attractive forces.

❖ To maximize the attractive force, cations are surrounded by as many anions as possible.

❖ Hence ionic crystals are hard and battle.

17. Calculate the percentage efficiency of packing in case of a body centred cubic crystal.

In Δ ABC, $AC^2 = AB^2 + BC^2$

$$AC = \sqrt{AB^2 + BC^2}$$

$$AC = \sqrt{a^2 + a^2} = \sqrt{2a^2} = \sqrt{2}a$$

In Δ ACG, $AG^2 = AC^2 + CG^2$

$$AG = \sqrt{AC^2 + CG^2}$$

$$AG = \sqrt{(\sqrt{2}\,a)^2 + a^2} = \sqrt{3a^2} = \sqrt{3}a$$

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

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

volume of the sphere $= \frac{4}{3}\pi r^3$

$$= \frac{4}{3}\pi\left(\frac{\sqrt{3}a}{4}\right)^3 \qquad = \frac{\sqrt{3}}{16}\pi a^3$$
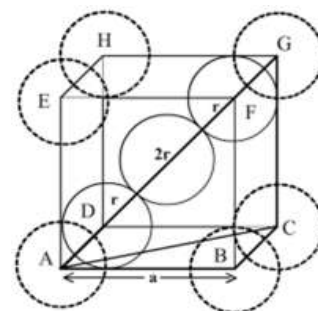
Number of spheres belong to a unit cell in bcc arrangement is equal to two and hence the total volume of all spheres

$$= 2 \text{ x} \frac{\sqrt{3}}{16}\pi a^3 == \frac{\sqrt{3}}{8}\pi a^3$$

Packing fraction $= \dfrac{\frac{\sqrt{3}}{16}a^3}{a^3}$ x 100

$$= \frac{\sqrt{3}}{\pi 8} \text{ x } 100$$

$$= 1.732 \text{ x } 12.5 \text{ x } 3.14$$

Packing fraction = 68%

18. What is the two dimensional coordination number of a molecule in square close packed layer?

❖ In this arrangement each sphere is in contact with four of its neighbors.

❖ Hence its coordination number is 4.

19. What is meant by the term 'coordination number'? what is the coordination number of atoms in a bcc structure?

❖ The number of nearest neighbours that surrounding a particle in a crystal is called the coordination number of that particle.

❖ Coordination number of atoms in a bcc structure is 8.

20. What are the general characteristics of solids?

❖ Have definite volume and shape
❖ Rigid and incompressible
❖ have strong cohesive forces
❖ Have shorter inter atomic, ionic (or) molecular distance
❖ Their constitutions (atoms, ions or molecules) have fixed positions and can only oscillate about their mean positions.

21. Explain the classification of Solids.

Solids

Crystalline solids   Amorphous solids
(Ex :- Glass, rubber)

→ Ionic crystals (NaCl, KCl)
→ Covalent crystals (Diamond, SiC)
→ Molecular crystals (Glucose, Ice)
→ Metallic crystals (Iron, Copper)
→ Atomic solids (Frozen elements)
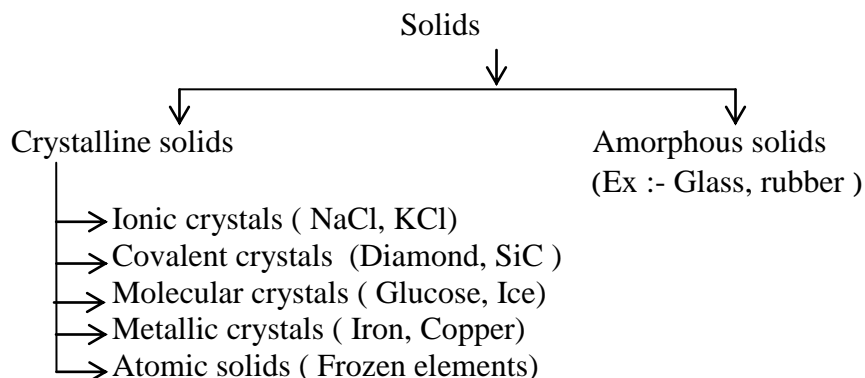
22. Write a short note on ionic crystals.

❖ The structural units are anions and cations
❖ Two ions bound together by Strong electrostatic force
❖ To maximize the attractive force, Cations are surround by many anions possible vice versa
❖ Possesses definite crystal structure
❖ Many solids are cubic close packed.
❖ Ex : NaCl crystal

23. Write a note on covalent crystals.

❖ The constituents are bound together by covalent bond
❖ They are very hard and have high melting points.
❖ They are usually poor thermal and electrical conductors
❖ Ex : Diamond, SiC

24. What are the characteristics of Covalent crystals?

❖ They are hard
❖ They have high melting points
❖ They do not conduct electricity and poor thermal conductors.

25. What are molecular crystals?

❖ The constituents are neutral molecules
❖ They are held together by Vanderwaals forces
❖ They are soft and do not conduct the electricity.

26. Explain type of molecular crystals with example.

Type	Explanation	Example
1, **Non‑Polar molecular solid**	❖ Constituent molecules are held together by London forces. ❖ Have low Melting Point. ❖ Usually liquid (or) gaseous state at room temperature	Naphthalene
ii) Polar molecular solid	❖ Constituent molecules are held together by polar covalent bonds. ❖ Have high Melting Point. ❖ Non–Polar molecular solid	Solid CO_2 & Solid NH_3.

iii) Hydrogen bonded molecular solids	❖ Constituent molecules areheld together by hydrogen bonds. ❖ Generally soft solids at room temperature.	Solid ice, Glucose & Urea.

27. Explain the types of Unit Cell.

Simple Cubic unit cell :-

Atoms are present at the corners only.

Each atom at the corner is shared equally by Eight other unit cells.

Hence the contribution of each atom to the unit cell is $\frac{1}{8}$

The total number of atoms in a simple cubic unit cell $= \frac{N_c}{8} = \frac{8}{8} = 1$

N_c – Number of atoms at the corners.

Body centred cubic unit cell :-

Each corner is occupied by an identical particle and in addition to that one atom occupies the body centre.

The total number of atoms in a Body centred cubic unit cell

$$= \frac{N_c}{8} + \frac{N_b}{1} = \frac{8}{8} + \frac{1}{1}$$
$$= 1 + 1 = 2$$

N_c – Number of atoms at the corners.

N_b – Number of atoms inside the body

Face centred cubic unit cell :-

Identical atoms lie at each corner as well as in the centre of each face.

The total number of atoms in a Face centred cubic unit cell

$$= \frac{N_c}{8} + \frac{N_f}{2} = \frac{8}{8} + \frac{6}{2}$$
$$= 1 + 3 = 4$$

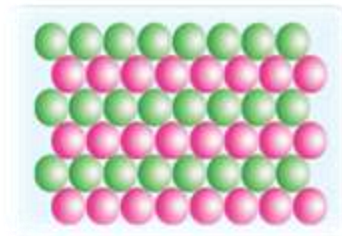N_c – Number of atoms at the corners.

N_f – Number of atoms at the face.

Simple cubic   Body - centred cubic   Face - centred cubic
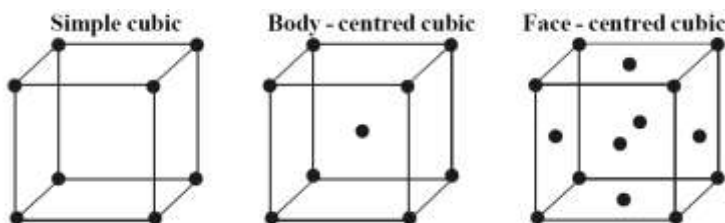
28. Write a note on Metallic solids.

The lattice points are occupied by positive metal ions and a cloud of electrons pervades the space.

Ex : Copper & Iron

29. What are the general characteristics of Metallic solids?

❖ They are hard

❖ They have high melting point.

❖ Possess excellent electrical and thermal conductivity.

❖ They possess bright luster.

30. Define crystal lattice.

The regular arrangement of the ions in a crystal is called as crystal lattice.

31. Define density of Unit Cell.

$$\text{Density of Unit Cell } (\rho) = \frac{\text{Mass of the Unit Cell}}{\text{Volume of the Unit Cell}}$$

32. What is Bragg's equation?

$$n\lambda = 2d\sin\theta$$

where $\Rightarrow$ n – order of reflection, λ - wave length of X-ray used for diffraction

d – inter planar distance between two successive planes and θ - angle of diffraction

33. What are primitive and non-primitive unit cell?

Primitive unit cell $\Rightarrow$ A unit cell contain only one lattice point
Made up from the lattice points at each of the corners.

Non -primitive cell $\Rightarrow$ There are additional lattice point
Either on the face of the unit cell (or) with in the unit cell .

34. Explain the calculation of density of unit cell.

$$\text{Density of unit cell} = \frac{\text{Mass of the unit cell}}{\text{Volume of the unit cell}}$$

Mass of the unit cell = (Total number of atoms belongs to that unit cell) x (Mass of one atom)

$$\text{Mass of one atom (m)} = \frac{\text{Molar mass (gmol}^{-1})}{\text{Avagadro number (mol}^{-1})} = \frac{M}{N_A}$$

$$\text{Mass of unit cell} = n \times \frac{M}{N_A}$$

For a cubic unit cell, all the edge lengths are equal i.e, a = b = c

Volume of the unit cell = a x a x a = a^3

$$\textbf{Density of the unit cell } (\rho) = \textbf{n} \times \frac{\textbf{M}}{\textbf{a}^3\textbf{N}_\textbf{A}}$$

35. Define Packing Efficiency.

$$\textbf{Packing Efficiency} = \frac{\text{Total Volume occupied by spheres in a unit cell}}{\text{Volume of the unit cell}} \times 100$$
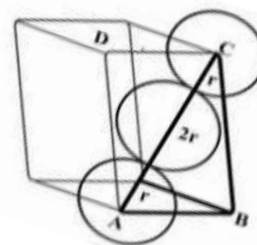
36. Calculate the percentage efficiency of packing in case of a simple cubic crystal

Volume of the unit cell $=$ a x a x a $= a^3$

Radius of the sphere $(r) = \dfrac{a}{2}$

Volume of the sphere $= \dfrac{4\pi r^3}{3}$

Substitute the value of 'r' $\Rightarrow = \dfrac{4}{3}\pi\left(\dfrac{a}{2}\right)^3$

$$= \dfrac{4}{3}\pi\left(\dfrac{a^3}{8}\right)$$

Volume of the sphere $= \dfrac{\pi a^3}{6}$

$$\textbf{Packing Efficiency} = \frac{\text{Total Volume occupied by spheres in a unit cell}}{\text{Volume of the unit cell}} \times 100$$

Substitute all the value

$$\textbf{Packing Efficiency} = \frac{\left(\dfrac{\pi a^3}{6}\right)}{a^3} \times 100 = \frac{100\,\pi}{6} = \frac{100 \times 3.14}{6} = 52.31$$

> **Packing Efficiency of simple cubic unit cell= 52.31%**
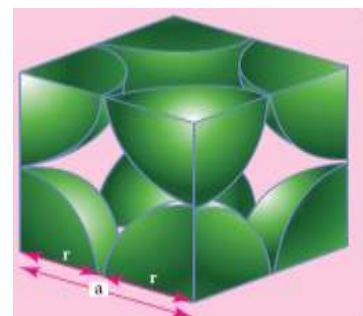
37. Calculate the percentage efficiency of packing in case of a face centred cubic crystal

In $\triangle ABC$
$AC^2 = AB^2 + BC^2$
$AC = \sqrt{AB^2 + BC^2}$

$AC = \sqrt{a^2 + a^2} = \sqrt{2a^2} = \sqrt{2}\,a$

$AC = 4r$

$4r = \sqrt{2}\,a$

Radius of the sphere $(r) = \dfrac{\sqrt{2}}{4}a$

Volume of the unit cell $=\ a\ \text{x}a\ \text{x}a = a^3$

Volume of thesphere$=\dfrac{4\pi r^3}{3}$

Substitute the value of 'r' $\Rightarrow =\dfrac{4}{3}\pi\left(\dfrac{\sqrt{2}}{4}a\right)^3$

$=\dfrac{4}{3}\pi\left(\dfrac{2\sqrt{2}}{64}a^3\right)$

Volume of thesphere $=\dfrac{\sqrt{2}}{24}\pi a^3$

Number of spheres belong to a unit cell in fcc arrangement is equal to Four and hence the total volume of all spheres

$= 4\ \text{x}\dfrac{\sqrt{2}}{24}\pi a^3 =\dfrac{\sqrt{2}}{6}\pi a^3$

Packing Efficiency $= \dfrac{\text{Total Volume occupied by spheres in a unit cell}}{\text{Volume of the unit cell}} \times 100$

Substitute all the value

Packing Efficiency $= \dfrac{\left(\frac{\sqrt{2}}{6}\pi a^3\right)}{a^3}\text{x}\ 100 = \dfrac{\sqrt{2}\times\pi\times100}{6} = \dfrac{1.414\times3.14\times100}{6}$

> **Packing Efficiencyof face centred cubic unit cell= 74%**

38. Explain classification of Point defects.

Point defects

Stiochiometricdefect   Non – stoichiometric defect   Impurity defect

Schottky defect   Frenkel defect   Metal excess defect   Metal deficiency defect
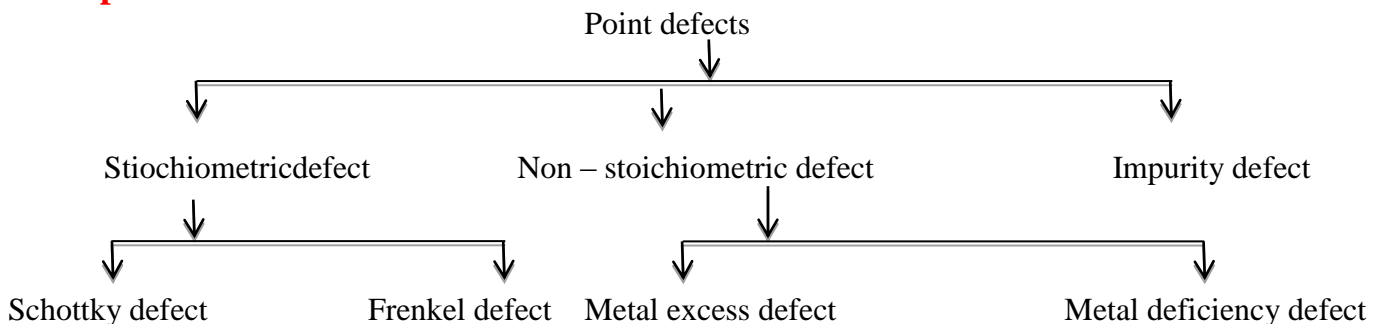
39. Define Imperfection in solids and give its advantages.

The defects in the arrangement of the particles in a crystal, affects the physical and chemical properties. They are called as Imperfection in solids.

They are Four types.

1, Point defect, 2, Line defect 3, Interfacial defect 4, Volume defect

Advantages of Imperfection in solids :-

❖ Increases the electrical conductivity of semi conductor like Silicon

❖ Ferromagnetic substance like Iron can be magnetized and demagnetized by imperfection.
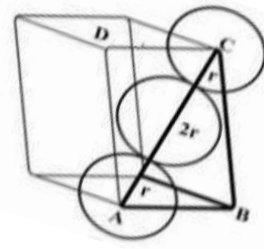
40. What is Stoichiometric defect ?

Stoichiometric defect will occur due to

- ❖ Missing of anions and cations.
- ❖ Presence of a positive ion in the interstitial position.
- ❖ Ex :- Schottky defect and Frenkel defect

41. Why ZnO turns yellow on heating ?

- ❖ On heating it loses oxygen atom and forms a free Zn^{2+} ion.
- ❖ This Zn^{2+} ion and electrons occupy the interstitial position.
- ❖ This is due to formation of Metal excess defect.

42. Write a short note on impurity defect?

- ❖ A general method of introducing defects in ionic solids by adding impurity ions.
- ❖ For example, addition of CdI_2 to silver chloride yields solid solutions where the divalent cation Cd^{+2} occupies the position of Ag^+.
- ❖ In order to maintain the electrical neutrality of the crystal, proportional number of Ag^+ ions leavesthe lattice.

7 . CHEMICAL KINETICS

1) Define Rate of a chemical reaction.

In a chemical reaction, the change in concentration of the species involved per unit time the rate of areaction.

$$Rate = \frac{Change \; in \; the \; concetration \; of \; the \; reactant}{Change \; in \; time}$$

2) Write the unit of rate of reaction.

$$Unit \; of \; Rate \; of \; reaction \; = \frac{Unit \; of \; the \; concetration \; of \; the \; reactant}{Unit \; of \; time} = \frac{mol \; L^{-1}}{s}$$

$$Unit: molL^{-1}s^{-1}$$

3) What is average rate of a chemical reaction?

Average rate:

The change in concentration of a reactant (or product) of a chemical reaction in a given interval of time is called as an average rate.

$$Average \; Rate = \frac{-\Delta[A]}{\Delta t}$$

4) What is Instantaneous rate of a chemical reaction?

The change in concentration of a reactant or product of a chemical reaction at a given instant is called an instantaneous rate.

$$Instantaneous \; Rate = \frac{-d[A]}{dt}$$

5) Differentiate between rate and rate constant of a reaction.

Sl.No	Rate of a reaction	Rate constant of a reaction
1	It represents the speed in which thereactants are converted into products at any instant.	It is a proportional constant.
2	It is measured as decrease in the conc. of the reactants or increase in the concentration of products.	It is equal to the rate of reaction, when the concentration of each of the reactants in unity.
3	It dependson the initial concentration of reactants.	It does not depend on the initial concentration of reactants.

6) Define Rate Law.

Rate law is the expression which relates the rate, the rate constant and the concentration of the reactants.

$$xA + yB \longrightarrow Product$$
$$\textbf{Rate = } \; \textbf{K[A]}^{\textbf{x}} \; \textbf{[B]}^{\textbf{y}}$$

7) Define Rate

Rate constant is equal to the rate of reaction, when the concentration of each of the reactants in unity.

$$xA + yB \longrightarrow Product$$
$$\textbf{Rate = } \; \textbf{K[A]}^{\textbf{x}} \; \textbf{[B]}^{\textbf{y}}$$

When $[A] = [B] = 1$

$$\textbf{Rate = K}$$

8) Define Elementary reaction

Each and every single step in a reaction mechanism is called as Elementary reaction

9) Define molecularity.

It is the total number of reactant species that are involved in an elementary step is called molecularity of that particular step.

10) Define order.

It is the sum of the powers of concentration terms involved in the experimentally determined rate law.

11) Define Rate determining

The slowest step in a chemical reaction is called as rate determining step.

12) Give the differences between order and molecularity of a reaction.

Sl.No	Order of a reaction	Molecularity of a reaction
1	It is the sum of the powers of concentration terms involved in the experimentally determined rate law.	It is the total number of reactant species that are involved in an elementary step.
2	It can be zero (or) fractional (or)integer.	It always a whole number, cannot be zero or fractional.
3	It is assigned for an overall reaction.	It is assigned for each elementary step of mechanism.

13) Give any three examples for the first order reaction.
- ❖ Decomposition of dinitrogen pentoxide (N_2O_5)
- ❖ Decomposition of Thionylchloride ($SO_2Cl_{2(l)}$)
- ❖ Decomposition of the Hydrogen peroxide in aqueous solution ($H_2O_{2(l)}$)

14) Give any three examples for the zero order reaction
- ❖ Photochemical reaction between H_2 and I_2
- ❖ Decomposition of N_2O on hot platinumsurface
- ❖ Iodination of acetone in acid medium iszero order with respect to iodine.

15) Derive integrated rate law for a first order reaction.

$$A \rightarrow Product$$
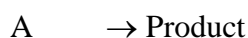
$$\text{Rate of the reaction} = \frac{-dA}{dt}$$

$$\frac{-d[A]}{dt} \alpha [A]^1$$

$$\frac{-d[A]}{dt} = K[A]^1 .$$

$$\frac{-d[A]}{A} = K . dt$$

When time changes from (t = 0) $\Rightarrow$ (t = t)
Concentration changes from [A$_0$] $\Rightarrow$ [A]
On Integrating the above equation within these limits

$$\int_{[A_0]}^{[A]} \frac{-d[A]}{A} = K \int_{t_0}^{t} dt$$

$$[-\ln[A]]_{[A_0]}^{[A]} = K [t]_{t_0}^{t}$$

$$[-\ln[A]] - [-\ln[A_0]] = K [t - 0]$$

$$Kt = \ln\frac{[A_0]}{[A]}$$

$$K = \frac{1}{t} \ln \frac{[A_0]}{[A]} \qquad\qquad \ln = 2.303\log$$

$$\boxed{K = \frac{2.303}{t} \log \frac{[A_0]}{[A]}}$$

16) What are pseudo first order reactions? Give an example.

"In a second order reaction, when one of the reactants concentration is in excess of the other then the reaction follows a first order kinetics, such reactions are calledPseudo first order reactions.
Example: Acid hydrolysis of an ester.

$$CH_3\text{-}COOCH_3 + H_2O \xrightarrow{H^+} CH_3\text{-}COOH + CH_3\text{-}OH$$
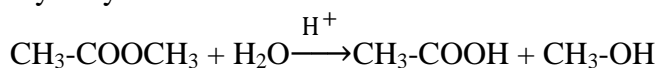
17) What are zero order reactions?

A reaction in which the rate is independent of the concentration of the reactant over a wide range of concentrations is called as zero order reactions.

Ex. Photochemical reaction between H_2 and I_2

18) Derive integrated rate law for a zero order reaction.

$$A \rightarrow Product$$

$$Rate = \frac{-dA}{dt}$$

$$\frac{-d[A]}{dt} \ \alpha \ [A]^0$$

$$\frac{-d[A]}{dt} = K[A]^0$$

$$-d[A] = K.dt$$

When time changes from (t = 0) $\Rightarrow$ (t = t)

Concentration changes from $[A_0] \Rightarrow [A]$

On Integrating the above equation within these limits

$$\int_{[A_0]}^{[A]} -d[A] = K \int_{t_0}^{t} dt \quad.$$

$$[-[A]]_{[A_0]}^{[A]} = K\,[\,t\,]_{t_0}^{t}$$

$$[-[A]] - [-[A_0]] = K\,[t - 0]$$

$$Kt = [A_0] - [A]$$

$$\boxed{K = \frac{[A_0]-[A]}{t}}$$

.

19) Define and Derive the half-life period for first order reaction

The half-life of a reaction is defined as the time required for the reactant concentration to reach one half its initial value. For any first order reaction

$$K = \frac{2.303}{t} \log \frac{[A_0]}{[A]}$$

When $[A] = \frac{[A_0]}{2}$; t = t$_{½}$.

$$K = \frac{2.303}{t_{½}} \log \frac{[A_0]}{\frac{[A_0]}{2}}$$

$$t_{½} = \frac{2.303}{K} \log \frac{[A_0] \times 2}{[A_0]}$$

$$t_{½} = \frac{2.303}{K} \times 0.3010$$

$$\boxed{t_{½} = \frac{0.6932}{K}}$$

20) Derive an equation for the half-life period of a zero order reaction.

The rate constant for a zero order reaction is given by
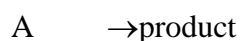
$$A \rightarrow product$$

$$K = \frac{[A_0] - [A]}{t} \ldots\ldots (1)$$

When $[A] = \frac{[A_0]}{2}$; t = t$_{½}$.

$$K = \frac{[A_0] - \frac{[A_0]}{2}}{t_{1/2}}$$

$$t_{1/2} = \frac{\frac{[A_0]}{2}}{K}$$

$$t_{1/2} = \frac{[A_0]}{2K}$$

21) Define Activation energy

       The minimum energy required by the molecules to react, and form the products is called Activation energy.

22) Write Arrhenius equation and explains the terms involved.

$$K = A e^{\frac{-E_a}{RT}}$$

A -Frequency factor ;R -Gas constant   ;E_a-Activation Energy   ;T -Temperature (in K)

23) Define Collision Rate.

       The number of Collisions taking place per second per liter of the reactant.

24) Define Fraction of effective collisions (f)

$$f = e^{\frac{-E_a}{RT}}$$

  f -Fraction of effective collision ; E_a - Activation Energy;

  R - Gas constant ;   T − Temperature (in K)

25) What is Steric factor

       The fraction of effective collisions (f) having proper orientation is given by the steric factor (p).

           $\Rightarrow$ Rate = p x f x collision rate

26) Write a note on Frequency factor.

       The frequency factor (A) is related to the frequency of collisions (number of collisions per second) between the reactant molecules.

27) List the factors affecting reaction rate.

The rate of a reaction is affected by the following factors.

- ❖ Nature and state of the reactant
- ❖ Concentration of the reactant
- ❖ Surface area of the reactant
- ❖ Temperature of the system
- ❖ Presence of a catalyst

28) Powdered $CaCO_3$ reacts much faster with dilute HCl than with the same mass of $CaCO_3$ as marble. Give reason.

- ❖ When the particle size decreases surface area increases.
- ❖ Increase in surface area of reactant leads to more collisions per litre per second,and hence the rate of reaction is increased.

29) How do nature of the reactant influence rate of reaction?

- ❖ The net energy involved in a reaction depends on the nature of the reactant and hence the rates are different for different reactants.
- ❖ For example, reaction of sodium metal with iodine vapours is faster than the reaction between solid sodium and solid iodine.

30) How do concentrations of the reactant influence the rate of reaction?

- ❖ The rate of a reaction increases with increase of concentration of the reactants.
- ❖ According to collision theory of reaction rates, the rate of a reaction depends upon the number of collisions between the reacting molecules.
- ❖ Higher the concentration, greater is the possibility for collision and hence the rate.

31) How do surface area of the reactant influence the rate of reaction?

❖ In heterogeneous reactions, the surface areas of the solid reactants play an important role in deciding the rate. For a given mass of a reactant, when the particle size decreases surface area increases.

❖ Increase in surface area of reactant leads to, more collisions per litre per second, and hence rate of reaction is increased.

❖ For example, powdered calcium carbonate reacts much faster with dilute HCl than with the same mass of $CaCO_3$ as marble

32) Explain the effect of catalyst on reaction rate.

❖ A catalyst is substance which alters the rate of a reaction without itself undergoing any permanent chemical change.

❖ In the presence of a catalyst, the energy of activation is lowered and hence, greater number of molecules can cross the energy barrier and change over to products, thereby increasing the rate of reaction.

33) Show that in case of first order reaction the time required for the completion of 99% is twice the time required for the completion of 90% of the reaction.

$$\frac{2.303}{t_{99}} \cdot \log \frac{100}{100-99} = \frac{2.303}{t_{90}} \cdot \log \frac{100}{100-90}$$

$$\cdot \frac{2}{t_{99}} = \frac{1}{t_{90}} \quad \Rightarrow \quad t_{99} = 2\ t_{90}$$

8 . IONIC EQUILIBRIUM

1. **What are Lewis acids and bases? Give two example for each.**
   - ❖ **Lewis Acids**
     Positive ion (or) an electron deficient molecule. Species that ***accepts an electron pair***
     Ex: BF_3, $AlCl_3$
   - ❖ **Lewis Bases**
     Anion (or) neutral molecule with at least one lone pair of electrons. ***Electron Rich***.
     Ex: NH_3, H_2O

2. **Discuss the Lowry – Bronsted concept of acids and bases.**
   - ❖ An acid is a proton donar.
     $$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$$
   - ❖ A base is a proton acceptor.
     $$NH_3 + H_2O \rightleftharpoons NH_4^+ + OH^-$$
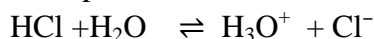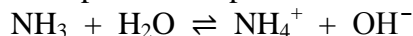
3. **Write note on Conjucate acid and base with one example**.
   - ❖ The species that remains after the donation of a proton is a base (Base1) and is called the conjugate base of the Bronsted acid (Acid 1) .
   - ❖ The species that remains after the acceptance of a proton is an acid(Acid2) and is called the conjugate acid of the Bronsted base (Base2) .
   - ❖ Lowry –Bronsted (acid –base) reaction is represented as
     Acid1+ Base 2 $\rightleftharpoons$ Acid 2+ Base1
     conjugate acid – base pair
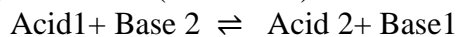
   $$
   \begin{array}{llll}
   HCl & + H_2O \leftrightharpoons & H_3O^+ + & Cl^- \\
   \text{Proton donar} & \text{Proton acceptor} & \text{Proton donar} & \text{Proton acceptor} \\
   \text{(acid1) (Base2)} & & \text{(acid2)} & \text{(Base1)}
   \end{array}
   $$
   conjugate acid – base pair
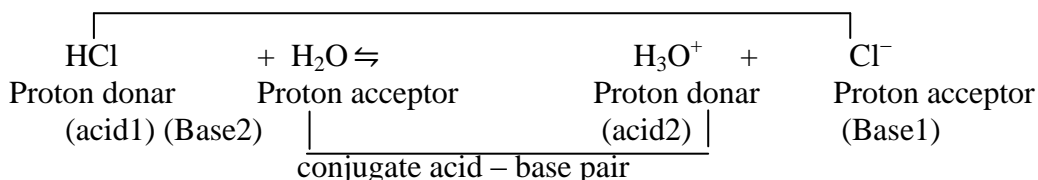
4. **What is conjcate Acid – Base pairs?**
   In other words, chemical species that differ only by a proton are called conjugate acid – base pairs.

5. **Indentify the conjugate acid base pair for the following reaction in aqueous solution**
   i) $HS^-_{(aq)} + HF \leftrightharpoons F^-_{(aq)} + H_2S_{(aq)}$
   conjugate acid – base pair

   $$
   \begin{array}{llll}
   HS^-_{(aq)} & + HF \leftrightharpoons & F^-_{(aq)} & + & H_2S_{(aq)} \\
   \text{(Base2)} & \text{(acid1)} & \text{(Base1)} & & \text{(acid2)}
   \end{array}
   $$
   conjugate acid – base pair

   ii) $HPO_4^{2-} + SO_3^{2-} \leftrightharpoons PO_4^{3-} + HSO_3^-$
   conjugate acid – base pair

   $$
   \begin{array}{lllll}
   HPO_4^{2-} & + SO_3^{2-} & \leftrightharpoons & PO_4^{3-} & + & HSO_3^- \\
   \text{(acid 1)} & \text{(Base 2)} & \text{(Base1)} & & \text{(acid2)}
   \end{array}
   $$
   conjugate acid – base pair

   iii) $NH_4^+ + CO_3^{2-} \leftrightharpoons NH_3 + HCO_3^-$
   . conjugate acid – base pair
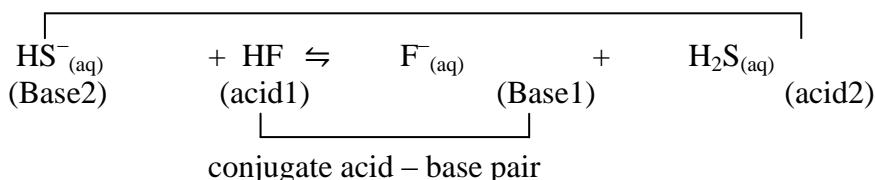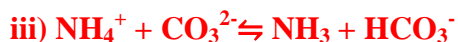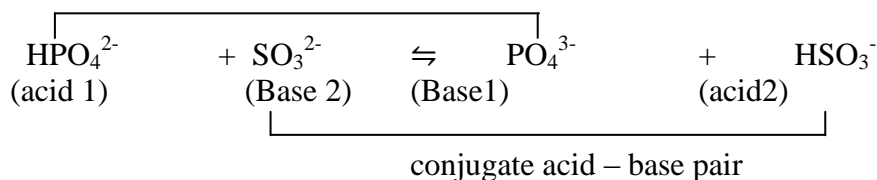
   $$
   \begin{array}{lllll}
   NH_4^+ & + CO_3^{2-} \leftrightharpoons & NH_3 & + & HCO_3^- \\
   \text{(acid 1)} & \text{(Base 2)} & \text{(Base1)} & & \text{(acid2)}
   \end{array}
   $$
   conjugate acid – base pair
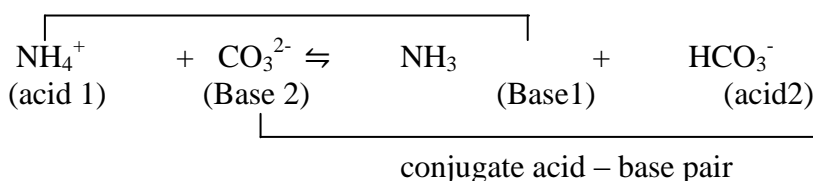
6. **Account for the acidic nature of $HClO_4$ in terms of Bronsted – Lowry theory, identify its conjugate base.**
   $$HClO_4 + H_2O \rightleftharpoons H_3O^+ + ClO_4^-$$
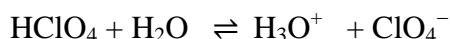
- The conjugate base of $HClO_4$ is ClO_4^-.
- When oxidation number of an element in an oxy acid increases then its acidic nature increases.
- The oxidation number of chlorine in $HClO_4$ is 7, which weakens the bond between O-H bond and increases the acidity.

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

- In complexes, central metal ion act as a lewis acid which has a tendency to accept lone pair of electron from lewis base (ie) ligands.
- In the presence of a strong lewis base, the lewis acid (ie) the central metal ion undergoes ligand exchange reaction with weak lewis base.
- In the above equation, NH_3 replaces H_2O molecule to form the deep blue complex, so NH_3 is the stronglewis base.

8. **Define Oswald's Dilution law**

Ostwald's dilution law relates the dissociation constant of the weak acid (K_a) with its degree of dissociation (α) and the concentration (C).

9. Define Solubility Product.

The solubility product of a compound 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.

$$X_mY_n \rightleftharpoons mX^{n+} + nY^{m-}$$

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

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

- The product of concentration of hydrogen ion and hydroxyl ion of pure water is known as ionic product of water(K_w).

$K_w = [H_3O^+][OH^-]$
$K_w = 1 \times 10^{-7} \times 1 \times 10^{-7}$
$K_w = 1 \times 10^{-14} mol^2 dm^{-6}$
$K_w = $ Ionic product of water

- At room temperature, the value of K_w is $1 \times 10^{-14} mol^2 dm^{-6}$.

11. Explain Common Ion effect with an example.

- When the salt of the weak acid is added to the acid, the dissociation of the weak acid decreases. This is known as common ion effect.
- Ex. When sodium acetate is added to acetic acid, the dissociation of acetic acid decreases. Here CH_3COO^- is the common ion present.

12. Derive an expression for Oswald's Dilution law

Ostwald's dilution law relates the dissociation constant of the weak acid (K_a) with its degree of dissociation (α) and the concentration (C).

$$\text{Degree of dissociation } (\alpha) = \frac{\text{Number of moles dissiciation}}{\text{Total no.of moles}}$$

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

Dissociation constant of Acetic acid is

$$K_a = \frac{[H^+][CH_3COO^-]}{[CH_3COOH]} \text{ ---- (1)}$$

Content	CH_3COOH	H^+	CH_3COO^-
initial number of moles	1		
Number of moles Ionized	α		
Number of moles remaining	$(1 - \alpha)$	α	α
Equilibrium concentration	$C(1 - \alpha)$	$C\alpha$	$C\alpha$

Substitute the value in equation (1)

$$K_a = \frac{C\alpha . C\alpha}{C(1 - \alpha)}$$

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

When $1 >> \alpha$ the denominator is neglected so $(1 - \alpha) \approx 1$

$$K_a = C\alpha^2$$
$$\alpha^2 = K_a / C$$

Degree of dissociation $\quad \alpha = \sqrt{K_a / C}$

Concentration of acid $[H^+] = C\alpha$

$$= C \sqrt{K_a / C}$$
$$[H^+] = \sqrt{K_a C}$$

13. Define pH

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

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

14. Give the difference between acids and bases.

Reagent	Acids	Bases
1, Taste	Sour taste	Bitter taste
2, With litmus paper	It turns blue litmus paper Red.	It turns red litmus paper blue.
3, With metal	Liberates hydrogen gas with zinc metal.	No hydrogen gas is liberated with metals.

15. Explain the Arrhenius concept of acid and bases

❖ An acid dissociates to give H+ ions in water.

Ex. $\qquad HCl \xrightarrow{H_2O} H^+ + Cl^-$

❖ A base dissociates to give OH^- ions in water.

Ex. $\qquad NaOH \xrightarrow{H_2O} Na^+ + OH^-$
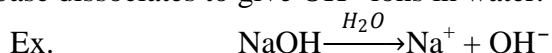
16. What are the Limitations of Arrhenius concept

❖ It fails to explain the behavior of acids and base in non-aqueous solutions like acetone.

❖ It fails to explain the Basicity of Ammonia which do not have OH^- ions.

17. What are the Limitations of Lowry – Bronsted concept

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

18. Explain the bond formation between Ammonia and BF₃

BF_3 is a Lewis acid

Ammonia is a Lewis base

$$NH_3 + BF_3 \longrightarrow H_3N \rightarrow BF_3$$
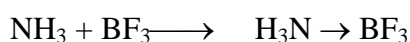
Base Acid Adduct

❖ Boron atom have vacant 2p orbital.

❖ The Boron atom accepts a pair of electron from ammonia and forms a coordinate bond.

19. Distinguish between Lewis Acid and Lewis Base

Sl.No	Lewis Acid	Lewis Base
1.	Electron Deficient. Ex. BF_3	Electron Rich. Ex. NH_3
2.	All metal ions. Ex. Fe^{+2}	All anions. Ex. OH^-
3.	They contain Polar double bonds. Ex: CO_2	They contain carbon-carbon double Bond. Ex: Ethylene.
4.	They are CarboCation.	They are Carbanion. Ex. CH_3^-
5.	They contain empty D-orbitals. And can expand its octet. Ex: SF_4.	All metal oxides. Ex. CaO

20. Derive the relationship between pH and pOH

$$p^H = -\log_{10}[H_3O^+]$$
$$p^{OH} = -\log_{10}[OH^-]$$
$$K_w = [H_3O^+][OH^-] = 10^{-14}$$

Taking log on both sides of the equation

$$\log K_w = \log[H_3O^+] + \log[OH^-] = \log 10^{-14}$$

Reverse the sign on both sides

$$-\log K_w = -\log[H_3O^+] + (-\log[OH^-]) = -\log 10^{-14}$$
$$P^{Kw} = p^H + p^{OH} = 14$$
$$p^H + p^{OH} = 14$$

21. 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.

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

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$
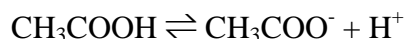
❖ However, the added salt, sodium acetate, completely dissociates to produce CH_3COO^- and Na^+ ions.

$$CH_3COONa \rightarrow CH_3COO^- + Na^+$$
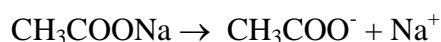
❖ Hence, the overall concentration of CH_3COO- is increased, and the acid dissociation equilibrium is disturbed.

❖ So, inorder 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 ioncommon to the weak electrolyte.

22. Write a notes on Buffer solution. And mention its types

❖ Buffer is a solution which consists of a mixture of a weak acid and its conjugate base (or) a weak base and its conjugate acid.

❖ This buffer solution resists drastic changes in its pH upon addition of a small quantities of acids (or) bases, and this ability is called buffer action.

There are two types of buffer solutions.

I. Acidic buffer solution : a solution containing a weak acid and its salt.
Eg: a solution containing CH_3-$COOH + CH_3COONa$

II. Basic buffer solution : a solution containing a weak base and its salt.
Eg: a solution containing $NH_4OH + NH_4Cl$

23. What is Buffer capacity

It is defined as the number of gram equivalents of acid or base added to 1 litre of the buffersolution to change its pH by unity.

$$\beta = \frac{d[B]}{d[pH]}$$

24. Write the pH value of the following substances:

A) Vinegar   **B) Black coffee**   **C) Baking soda**   **D) Soapy water.**

A) Vinegar	pH = 2
B) Black coffee	pH = 5
C) Baking soda	pH = 9
D) Soapy water	pH = 12

25. What is Salt hydrolysis?

Salts completely dissociate in aqueous solutions to give their constituent ions.
The ions so produced are hydrated in water. In certain cases, the cation, anion or both react with water and the reaction is called salt hydrolysis.

26. Classify the following into Lewis acids and Lewis bases. (A) BF_3 (B) CO_2 (C) MgO (D) CH_3^-

A) BF_3	Lewis acid
B) CO_2	Lewis acid
C) MgO	Lewis base
D) CH_3^-	Lewis base

27. Explain buffer action

I. **Acidic buffer solution** : a solution containing a weak acid and its salt.
Eg: a solution containing CH_3-$COOH + CH_3COONa$

- ❖ If an acid is added to this mixture, it will be consumed by the conjugate base **CH₃-COO⁻** to form the undissociated weak acid i.e, the increase in the concentration of H⁺ does not reduce the pH significantly.
- ❖ If a base is added, it will be neutralized by H⁺, and the acetic acid is dissociated to maintain the equlibrium. Hence the pH is not significantly altered.
- ❖ Let us explain the buffer action in a solution containing CH_3COOH and CH_3COONa. The dissociation of the buffer components occurs as below.

Addition of base OH^- → H_2O
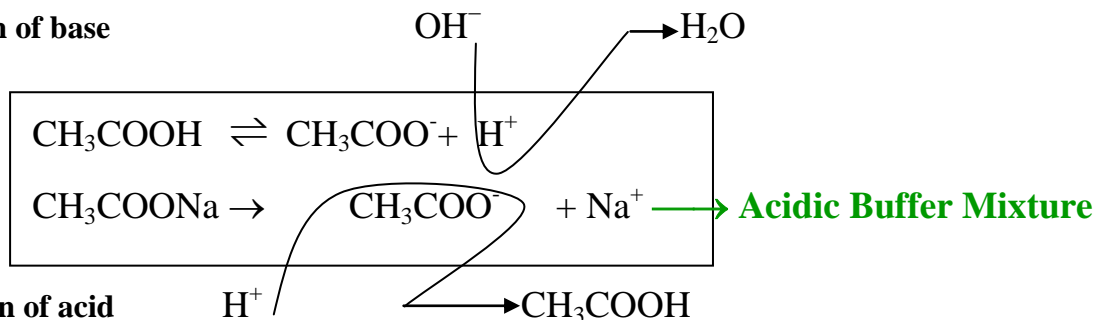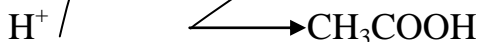
$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

$$CH_3COONa \rightarrow CH_3COO^- + Na^+ \longrightarrow \textbf{\textcolor{green}{Acidic Buffer Mixture}}$$

Addition of acid H^+ → CH_3COOH

II.   Basic buffer solution : a solution containing a weak base and its salt.
Eg: a solution containing $NH_4OH + NH_4Cl$

- ❖ If aacid is added, it will be neutralized by OH⁻, and the NH₄OHis dissociated to maintain the equlibrium. Hence the pH is not significantly altered.
- ❖ If anbase is added to this mixture, it will be consumed by the conjugate base **NH₄⁺** to form the undissociated weak basei.e, the increase in the concentration of OH⁻ does not reduce the pH significantly.

Let us explain the buffer action in a solution containing $NH_4OH + NH_4Cl$. The dissociation of the buffer components occurs as below.

Addition of acid H^+ → H_2O

$$NH_4OH \rightleftharpoons NH_4^+ + OH^-$$

$$NH_4Cl \rightarrow NH_4^+ + Cl^- \longrightarrow \textbf{\textcolor{green}{Basic Buffer Mixture}}$$
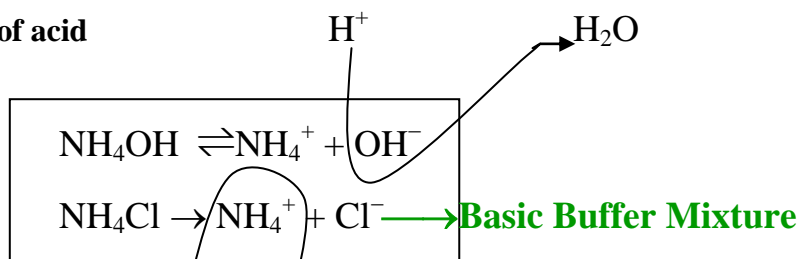
Addition of Base OH^- → NH_4OH
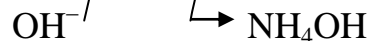
28. Derive Henderson – Hasselbalch equation to calculate pH of acidic buffer.

Let as consider dissociation of weak acid

$$\textbf{HA} + \textbf{H}_2\textbf{O} \rightleftharpoons \textbf{H}_3\textbf{O}^+ + \textbf{A}^-$$
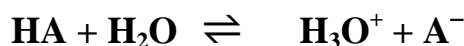
The concentration of hydronium ion in an acidic buffer solution depends on the ratio of theconcentration of the weak acid tothe concentration of its conjugate base present in the solution.

The dissociation constant of weak acid$(K_a) = \dfrac{[H_3O^+][A^-]}{[HA]}$ …..(1)   [HA]= [Acid];

$$K_a = \dfrac{[H_3O^+][\text{Salt}]}{[\text{Acid}]} \quad …..(2) \qquad\qquad [A^-] = [\text{Salt}]$$

$$[H_3O^+] = K_a \dfrac{[\text{Acid}]}{[\text{Salt}]} \quad …..(3)$$

Taking log on both sides of the equation $\Rightarrow$

$$\log[H_3O^+] = \log K_a + \log\dfrac{[\text{Acid}]}{[\text{Salt}]} …..(4)$$

Reverse the sign on both sides $\Rightarrow$

$$-\log [H_3O^+] = -\log K_a - \log\frac{[Acid]}{[Salt]}\ .....(5)$$

$$P^H = p^{Ka} - \log\frac{[Acid]}{[Salt]}$$

$$\mathbf{P^H = - p^{Ka} + \log\frac{[Salt]}{[Acid]}}\ .....(6)$$

For Basic buffer solution $\Rightarrow$

$$\mathbf{P^{OH} = - p^{Kb} + \log\frac{[Salt]}{[Base]}}\ .....(7)$$

Equations (6) and (7) are Henderson – Hasselbalch equations.

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

Hydrolysis:

$$\mathbf{NH_4^+ \ + H_2O \ \rightleftharpoons NH_4OH \ + H^+}$$
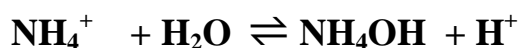
$$\text{C(1-h)} \qquad\qquad \text{Ch} \qquad\quad \text{Ch}$$

$$K_h = \frac{[NH_4OH]\,[H^+]}{[NH_4^+]}\ .....(1)$$

$$K_h = \frac{Ch.Ch}{C(1-h)} = \frac{Ch^2}{(1-h)} = Ch^2 \qquad\qquad (1-h)\approx 1$$

$$h^2 = K_h / C$$

$$h = \sqrt{K_h / C}$$

$$[H^+] = Ch = C\sqrt{K_h / C}$$

$$[H^+] = \sqrt{K_h\, C} \qquad .....(2)$$

Dissociation:

$$NH_4OH \rightleftharpoons NH_4^+ \ + OH^-$$

$$K_b = \frac{[NH_4^+]\,[OH^-]}{[NH_4OH]}\ .....(3)$$

$$K_h .K_b = [H^+]\,[OH^-]$$

$$K_h . K_b = K_w$$

$$K_h = \frac{K_w}{K_b}$$

$$[H^+] = \sqrt{\frac{K_w}{K_b}\ C}$$

Taking log on both side $\Rightarrow$

$$\log[H^+] = \log \sqrt{\frac{K_w}{K_b}\ C}$$

$$\log[H^+] = \tfrac{1}{2}\log K_w + \tfrac{1}{2}\log C - \tfrac{1}{2}\log K_b$$

Reverse the sign on both side $\Rightarrow$

$$-\log[H^+] = -\tfrac{1}{2}\log K_w - \tfrac{1}{2}\log C - (-\tfrac{1}{2}\log K_b)$$

$$\mathbf{P^H = 7 - \tfrac{1}{2}P^{Kb} - \tfrac{1}{2}\log C}$$

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

Hydrolysis:
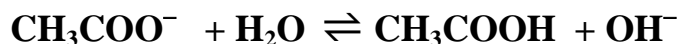
$$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$$

$$\quad C(1-h) \qquad\qquad\qquad Ch \qquad\quad Ch$$

$$K_h = \frac{[CH_3COOH][OH^-]}{[CH_3COO^-]} \quad .....(1)$$

$$K_h = \frac{Ch.Ch}{C(1-h)} = \frac{Ch^2}{(1-h)} = Ch^2 \qquad\qquad (1-h) \approx 1$$

$$h^2 = K_h / C$$

$$h - \sqrt{K_h / C}$$

$$[OH^-] = Ch = C\sqrt{K_h / C}$$

$$[OH^-] = \sqrt{K_h\, C} \quad .....(2)$$

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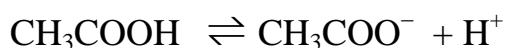
$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

$$K_a = \frac{[CH_3COO^-][H^+]}{[CH_3COOH]} \quad .....(3)$$

$$K_h . K_a = [H^+][OH^-]$$

$$K_h . K_a = K_w$$

$$K_h = \frac{K_w}{K_a}$$

$$[OH^-] = \sqrt{\frac{K_w}{K_a}\, C}$$

Taking log on both side $\Rightarrow$

$$\log[OH^-] = \log\sqrt{\frac{K_w}{K_a}\, C}$$

$$\log[OH^-] = \tfrac{1}{2}\log K_w + \tfrac{1}{2}\log C - \tfrac{1}{2}\log K_a$$

Reverse the sign on both sides $\Rightarrow$

$$-\log[OH^-] = -\tfrac{1}{2}\log K_w - \tfrac{1}{2}\log C - (-\tfrac{1}{2}\log K_a)$$

$$P^{OH} = 7 - \tfrac{1}{2}P^{Ka} - \tfrac{1}{2}\log C$$

$$P^H + P^{OH} - 14$$

$$P^H = 14 - P^{OH}$$

$$P^H = 14 - (7 - \tfrac{1}{2}P^{Ka} - \tfrac{1}{2}\log C)$$

$$\mathbf{P^H = 7 + \tfrac{1}{2}P^{Ka} + \tfrac{1}{2}\log C}$$

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

Hydrolysis:
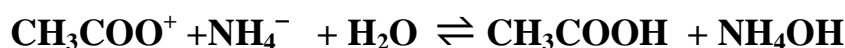
$$CH_3COO^+ + NH_4^- + H_2O \rightleftharpoons CH_3COOH + NH_4OH$$

$$\quad C(1-h) \qquad C(1-h) \qquad\qquad\qquad Ch \qquad\qquad Ch$$

$$K_h = \frac{[CH_3COOH\,][NH_4OH\,]}{[CH_3COO^-]\,[NH_4OH^+]}..(1)$$

$$K_h = \frac{Ch.Ch}{C(1-h)C(1-h)} = \frac{h^2}{(1-h)^2} = h^2 \qquad (1-h) \approx 1$$

$$h^2 = K_h$$

$$h = \sqrt{K_h} \qquad .....(2)$$

Dissociation:

$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$
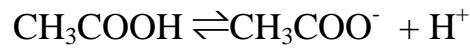
$$K_a = \frac{[CH_3COO^-]\,[H^+]}{[CH_3COOH\,]} .....(3)$$
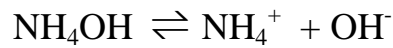
$$NH_4OH \rightleftharpoons NH_4^+ + OH^-$$

$$K_b = \frac{[NH_4^+]\,[OH^-]}{[NH_4OH]} .....(4)$$

Multiply Equations (1), (3) & (4) we get $\Rightarrow$

$$K_h .K_a K_b = [H^+]\,[OH^-]$$

$$K_h .K_a K_b = K_w$$

$$K_h = \frac{K_w}{K_a K_b}$$
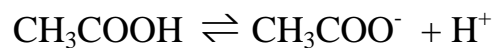
$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

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

$$[H^+] = K_a \frac{[CH_3COOH\,]}{[CH_3COO^-]} = K_a \cdot \frac{Ch}{C(1-h)} = K_a.h = K_a \cdot \sqrt{K_h}$$

Taking log on both side $\Rightarrow$

$$\log[H^+] = \log K_a . \log\sqrt{K_h}$$

Reverse the sign on both sides $\Rightarrow$

$$-\log[H^+] = -\log K_a . -\log\sqrt{K_h} \qquad\qquad K_h = \frac{K_w}{K_a K_b}$$

$$-\log[H^+] = -\log K_a . -\log\sqrt{\frac{K_w}{K_a K_b}}$$

$$-\log[H^+] = -\log K_a . -\tfrac{1}{2}[\,\log K_w - \log K_a - \log K_b\,]$$

$$P^H = P^{Ka} + \tfrac{1}{2}P^{Kw} - \tfrac{1}{2}P^{Ka} - \tfrac{1}{2}P^{Kb}$$

$$P^H = \tfrac{1}{2}P^{Kw} + \tfrac{1}{2}P^{Ka} - \tfrac{1}{2}P^{Kb} \qquad\qquad \tfrac{1}{2}P^{Kw} = 7$$

$$\mathbf{P^H = 7 + \tfrac{1}{2}P^{Ka} - \tfrac{1}{2}P^{Kb}}$$

9 . ELECTROCHEMISTRY

1. Define Kohlraush law

❖ At infinite dilution, the limiting molar conductivity of an electrolyte is equal to the sum of the limiting molar conductance of it constitute ions.

Eg; $NaCl \longrightarrow Na^+ + Cl^-$

$(\lambda_m^0)_{NaCl} = (\lambda_m^0)_{Na^+} + (\lambda_m^0)_{Cl^-}$
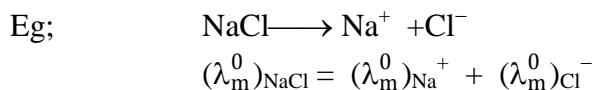
2. State Faraday's Laws of electrolysis.

First Law :

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

$$m \alpha Q$$
m = Z It

Where, m – mass of the substance, Z- electro chemical equivalent of the substance,
I- current in Amphere& t- time in sec.

Faraday's Second Law

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

$$m \alpha Z$$

Where, m – mass of the substance& Z- electro chemical equivalent of the substance

3. Write a note on sacrificial protection.

❖ In this technique, unlike galvanising the entire surface of the metal to be protected need not be
❖ covered with a protecting metal.
❖ Instead, metals such as Mg or zinc which is corroded more easily than
❖ iron can be used as a sacrificial anode and the iron material acts as a cathode.
❖ So iron is protected, but Mg or Zn is corroded.
❖ Hence, this process is otherwise known as sacrificial protection.

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

❖ If we apply 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.

5. Is it possible to store copper sulphate in an iron vessel for a long time? (Given : $E^o_{Cu2+/Cu}$ = 0.34V and $E^o_{Fe2+/Fe}$ = -0.44V

❖ It is not possible to store copper sulphate in an iron vessel for long time.
❖ **Reason** is that iron will **oxidise** and copper will get **reduced** from the given emf values.

6. Define Specific conductance .

❖ The conductance of 1 meter cube of a electrolytic solution is called as Specific conductance.

$$\kappa = C \times \frac{l}{A} \qquad \text{Unit} \Rightarrow Sm^{-1}$$

❖ The reciprocal of the specific resistance is called the specific conductance conductivity.

7. Define Molar Conductance

Conductivity cell in which the electrodes are separated by 1m and having V m³ of electrolytic solution which contains 1 mole of electrolyte. The conductance of such a system is called the molar conductance (Λ_m)

$$\Lambda_m = \frac{\kappa \times 10^{-3}}{M} \qquad \text{Unit} \Rightarrow Sm^2 mol^{-1}$$

8. Define Equivalent Conductance

The conductance of one gram equivalent of an electrolytic solution is called Equivalent conductance.

$$\lambda_c = \frac{\kappa \times 10^{-3}}{C}$$
Unit $\Rightarrow$ S.m^{2}gram.eq^{-1}

9. What are the factors affecting electrolytic conductance

- ❖ When temperature increases, the conductance will also increases.
- ❖ When dilution increases, the conductance will also increases.
- ❖ When the viscosity increases, the conductance will decreases.
- ❖ When the dielectric constant of the solvent increases, the conductance will also increases.

10. Write uni – univalent electrolyte Debye – Huckel and Onsagar equation.

$$\wedge_m = (\wedge_m^0) - (A + B\wedge_m^0) \sqrt{C}$$

A and B –are constants

The expression for A and B are

$$A = \frac{82.4}{\sqrt{DT}\,\eta} \;\; ; B = \frac{8.20 \times 10^5}{\sqrt[3]{DT}}$$

D – Dielectric constant of the medium

η – Viscosity of the medium

T – temperature in Kelvin

11. Write the Galvanic cell notation
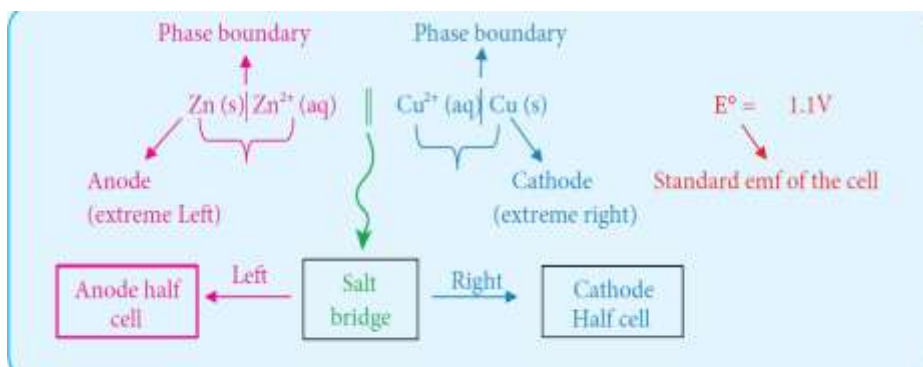
12. Define Std Hydrogen Electrode (SHE)

- ❖ The SHE is used as the reference electrode .its EMF is Zero Volts.
- ❖ It consists of a Platinum electrode placed in 1M HCl solution at 25^{0}C.
- ❖ 1atm Hydrogen gas.
- ❖ The SHE can act both as a cathode and anode .

13. Mention the application of Kohlrausch's law.

- ❖ Calculation of molar conductance at infinite dilution of a weak electrolyte
- ❖ Calculation of degree of dissociation of weak electrolytes
- ❖ Calculation of solubility of sparingly soluble salts

14. What is Intercalation.

In Lithium – ion Battery the Li$^+$ ions move from cathode to anode, where they become embedded on the porous graphite electrode.

15. How are metals protected from corrosion by cathodic production method?

Metals such as Mg or zinc which is corroded more easily than iron can be used as a sacrificial anode and the iron material acts as a cathode. So iron is protected, but Mg or Zn is corroded.

16. Derive an expression for Nernst equation.

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

$$xA + yB \rightleftharpoons lC + mD$$
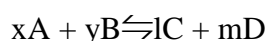
The reaction quotient Q for the above reaction is given below

$$Q = \frac{[\,C\,]^l [\,D\,]^m}{[\,A\,]^x [\,B\,]^y}$$

$$\Delta G = \Delta G^0 + RT\ln Q$$

Gibbs free energy can be related to the cell emf as follows

$$\Delta G = -nFE_{cell} \; ; \Delta G^0 = -nFE^0_{cell}$$

Substituting these values,

$$-nFE_{cell} = -nFE^0_{cell} + RT\ln\frac{[C]^l[D]^m}{[A]^x[B]^y}$$

Dividing by $-nF$ on both sides,

$$E_{cell} = E^0_{cell} - \frac{RT}{nF} \ln\frac{[C]^l[D]^m}{[A]^x[B]^y} \qquad\qquad \ln = 2.303\log$$

$$\boxed{E_{cell} = E^0_{cell} - \frac{2.303RT}{nF} \log\frac{[C]^l[D]^m}{[A]^x[B]^y}}$$

The above equation is called Nernst equation.

At 25^0C (298K) the above equation becomes $[R = 8.314 JK^{-1}mol^{-1} \quad T = 298K \; ; F = 96500 Cmol^{-1}]$

$$\boxed{E_{cell} = E^0_{cell} - \frac{0.0591}{n} \log\frac{[C]^l[D]^m}{[A]^x[B]^y}}$$

17. Explain the construction of Leclanche cell.

Anode :	Zinc container
Cathode :	Graphite rod in conduct with MnO_2
Electrolyte :	Ammonium chloride and Zinc chloride in water
EMF of the cell	1.5V
Cell reaction :	**Oxidation at Anode** $\qquad Zn \rightarrow Zn^{2+} + 2e^-$ …. (1) **Reduction at Cathode** $\qquad 2NH_4^+{}_{(aq)} + 2e^- \rightarrow 2NH_{3(aq)} + H_2$ …. (2) $\qquad 2MnO_2 + H_2 \rightarrow H_2O_{(l)} + Mn_2O_3$ …. (3) Add Equation (1) + (2) + (3) ⇒**overall redox reaction** $Zn + 2NH_4^+{}_{(aq)} + 2MnO_2 \rightarrow Zn^{2+} + 2NH_{3(aq)} + H_2O_{(l)} + Mn_2O_3$

18. Explain the construction of Mercury button cell.

Anode :	Zinc amalgamated with mercury
Cathode :	HgO mixed with Graphite
Electrolyte :	Paste of KOH and ZnO
EMF of the cell	1.35V
Cell reaction :	**Oxidation at Anode** $\qquad Zn + 2OH^-{}_{(aq)} \rightarrow ZnO + H_2O_{(l)} + 2e^-$ …. (1) **Reduction at Cathode** $\qquad HgO_{(s)} + H_2O_{(l)} + 2e^- \rightarrow Hg_{(l)} + 2OH^-$ …. (2) Add Equation (1) + (2) ⇒**overall redox reaction** $Zn + HgO_{(s)} \rightarrow ZnO + Hg_{(l)}$
Uses	Pacemakers, electronic watches, cameras etc …

19. Differentiate Primary batteries and Secondary batteries.

Primary batteries : Non – rechargeable Ex :- Mercury button cell

Secondary battery : rechargeable Ex :- Lithium – ion battery

20. Explain the construction of Lead – storage battery cell.

Anode :	Spongy Lead
Cathode :	Lead plate bearing PbO_2
Electrolyte :	38% by mass of H_2SO_4 with density 1.2 g/mL
EMF of the cell	2V
Cell reaction :	**Oxidation at Anode** $$Pb_{(s)} \rightarrow Pb^{2+}_{(aq)} + 2e^- \qquad \dots (1)$$ $$Pb^{2+}_{(aq)} + SO_4^{2-} \rightarrow PbSO_4\downarrow \qquad \dots (2)$$ **Reduction at Cathode** $$PbO_{2(s)} + 4H^+_{(aq)} + 2e^- \rightarrow Pb^{2+}_{(aq)} + 2H_2O_{(l)} \qquad \dots(3)$$ $$Pb^{2+}_{(aq)} + SO_4^{2-} \rightarrow PbSO_4\downarrow \qquad \dots (4)$$ Add Equation (1) + (2) + (3) + (4)⇒**overall redox reaction** $$\mathbf{Pb_{(s)} + PbO_{2(s)} + 4H^+_{(aq)} + 2SO_4^{2-}{}_{(aq)} \rightarrow\ 2PbSO_4 + 2H_2O_{(l)}}$$
Uses	Automobiles, trains, inverters.

21. Explain the construction of Lithium – ion battery cell.

Anode :	Porous Graphite
Cathode :	Transition metal oxide such as CoO_2
Electrolyte :	Lithium salt in an organic solvent
Cell reaction :	**Oxidation at Anode** $$Li_{(s)} \rightarrow Li^+_{(aq)} + e^- \qquad \dots (1)$$ **Reduction at Cathode** $$Li^+_{(aq)} + CoO_{2(s)} + e^- \rightarrow LiCoO_{2(s)} \qquad \dots (2)$$ Add Equation (1) + (2)⇒**overall redox reaction** $$\mathbf{Li_{(s)} + CoO_{2(s)} \rightarrow LiCoO_{2(s)}}$$
Uses	Cellular phones, laptops, computers, digital cameras.

22. Explain the construction of Fuel cell.

Anode :	Porous graphite electrode containing Ni and NiO.
Cathode :	Graphite
Electrolyte :	Aqueous KOH maintained at $\mathbf{200^0C}$ and $\mathbf{20 – 40\ atm.}$
Cell reaction :	**Oxidation at Anode** $$2H_{2(g)} + 4OH^-_{(aq)} \rightarrow 4H_2O_{(l)} + 4e^- \qquad \dots (1)$$ **Reduction at Cathode** $$O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)} \qquad \dots (2)$$ Add Equation (1) + (2)⇒**overall redox reaction** $$\mathbf{2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}}$$

10. SURFACE CHEMISTRY

1) What are the factors affecting adsoption.

Surface area of adsorbent : - Higher the surface area , higher is the amount adsorbed.

Nature of adsorbate :-

❖ Easily liquefiable gases like SO_2, NH_3, HCl and CO_2 are adsorbed readily.

❖ On the other hand permanent gases like H_2, N_2 and O_2 are adsorbed slowly.

Effect of temperature :-

❖ When temperature is raised chemisorptions first increases and then decreases.

❖ Whereas Physisorption decreases with increase in temperature.

Effect of pressure :-

❖ Chemical adsorption is fast with increase in pressure,

❖ It can not alter the amount of adsorption.

❖ In physisortion the extent of adsorption increases with increase in pressure.

2) Differentiate physisorption and chemisorption.

S.No`	Chemical adsorption (Activated adsorption)	Physical adsorption (van der waalsadsorption)
1.	It is very slow.	It occurs immediately.
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 can not alter the amount.	In Physical adsorption when pressure increases the extent of adsorption increases.
4.	When temperature is raised Chemisorption first increases and then decreases.	Physical adsorption decreases with increases in temperature.
5.	Heat of adsorption is high i.e., from 40 - 400KJ / mole.	Heat of adsorption is low in the order of 40kJ/mole.
6.	Monolayer of the adsorbate is formed.	Multilayer of the adsorbate is formed on the adsorbent.

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

❖ In chemical adsorption, gas molecules are held to the surface by **formation of strong chemical bonds** and hence heat of adsorption is high.

❖ In physical adsorption, **weak physical forces** such as Vander Waals force of attraction, dipole-dipole interaction etc exist between adsorbent and adsorbate and hence heat of adsorption is low.

4) In case of chemisorption, why adsorption first increases and then decreases with temperature?

❖ In chemisorption, adsorption first increases with rise in temperature due to the fact that **formation of activated complex** requires certain energy.

❖ The decrease at high temperature is due to **desorption**, as the kinetic energy of the adsorbate increases.

5) Which will be adsorbed more readily on the surface of charcoal and why? NH_3 or CO_2?

❖ NH_3 will be more readily adsorbed on the surface of charcoal than CO_2.

❖ Because the **critical temperature** of NH_3 is **greater than** that of CO_2.

6) What is the difference between a sol and a gel?

CONTANT	SOL	GEL
Dispersion medium	liquid	Solid
Dispersed phase	solid	Liquid
Example	Ink, Paint	Butter, Cheese

7) Why are lyophillic colloidal sols are more stable than lyophobic colloidal sols?

❖ In lyophillic colloidal sols , definite **attractive force** exists between dispersion medium and dispersed phase.

- E.g: sols of starch.
- In lyophobic colloidal sols, **no attractive force** exists between the dispersed phase and dispersion medium.
- E.g: sols of gold , silver.
- Hence, lyophillic colloidal sols are more stable than lyophobic colloidal sol.

8) What is peptisation? Give an example.

The dispersion of a precipitated material into colloidal solution by the action of an electrolyte in solution is termed as peptisation.

Ex: $\qquad$ AgCl $\xrightarrow{\text{HCl}}$ AgCl

Precipitate $\qquad\qquad$ colloid
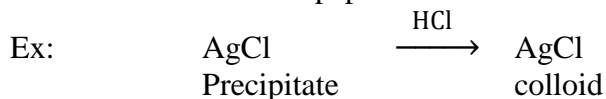
9) Addition of Alum purifies water. Why?

- Water containing suspended impurities are negatively charged.
- The Al^{3+} was present in alum coagulates the suspended impurities in water,
- These impurities settle down and are removed by filtration, thus purifying the water.

10) What happens when a colloidal sol of As_2S_3 and $Fe(OH)_3$ are mixed?

- $Fe(OH)_3$ is positive sol whereas As_2O_3 is a negative sol
- When they are mixed charges are neutralized mutual coagulation takes place.

11) What do you mean by activity and selectivity of catalyst?

Activity :
- Ability of a catalyst to alter the rate of a reaction is called activity of catalyst
- Ability of a catalyst depends on chemisorption.

Ex: $\qquad$ $2H_2 + O_2 \xrightarrow{\text{Pt}} 2H_2O$
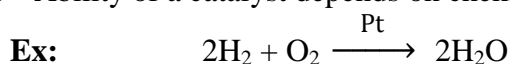
Selectivity:
- Ability of a catalyst to direct the reaction to give particular products.

Ex: $\qquad$ $CO_{(g)} + H_{2(g)} \xrightarrow{\text{Ni}} CH_{4(g)} + H_2O_{(l)}$

$\qquad\qquad$ $CO_{(g)} + H_{2(g)} \xrightarrow{\text{Cu}} HCHO$
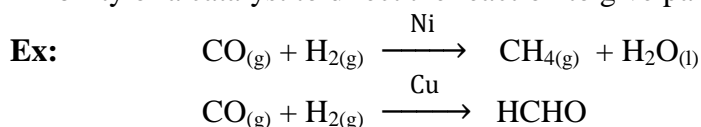
12) What are enzymes? Write a brief note on the mechanism of enzyme catalysis.

- Enzymes are complex protein molecules with three dimensional structures.
- They catalyse the chemical reaction in living organisms.
- 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** - enzyme, **S** - substrate (reactant), **ES** - activated complex
P - products.
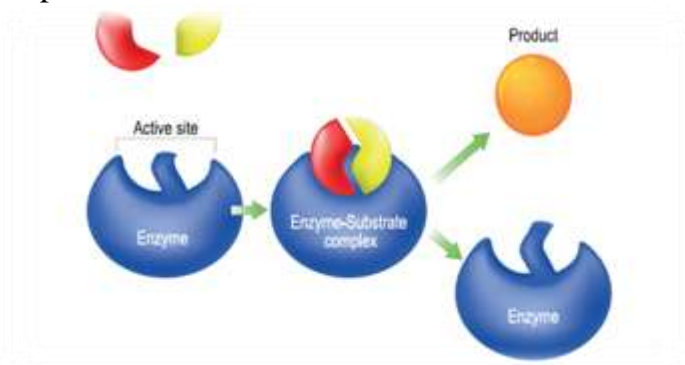
13) Give three uses of emulsions.

- **Food:** milk, cream, butter
- **In washing:** The cleansing action of soap is due to the formation of emulsion of soap molecules with dirt and grease.
- **Rubber industry:** Latex is the emulsion of natural rubber with negative particles.

14) Why does bleeding stop by rubbing moist alum?
- ❖ Blood is a colloidal sol.
- ❖ Ions present in moist alum (Coagulating agent) neutralizes the colloidal protein present in blood and coagulate it by forming a clot.
- ❖ Thus due to coagulation of blood, bleeding stops by rubbing with moist alum.

15) 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.
- ❖ Dependent on the size of the particle.
- ❖ Colloid is a homogeneous mixture of two substance in which one substance is dispersed in another substance

16) Write a note on Electrophoresis
Migration of sol particles under the influence of electrical field is called electrophoresis.

17) Write a note on Electro osmosis.
- ❖ A sol is electrically neutral.
- ❖ When **sol particles are prevented from moving**, under the influence of electric field.
- ❖ The dispersion medium moves in a direction opposite to that of the sol particles.
- ❖ This **movement of dispersion medium** under the influence of electric potential is called electro osmosis.

18) What is coagulation? Mention the various methods of coagulation.
The flocculation and settling down of the sol particles is called coagulation.
Various methods of coagulation are :
- 1, Addition of electrolytes
- 2, Electrophoresis
- 3, Mixing oppositively charged sols.
- 4, Boiling

19) Write a note on catalytic poison. Give one example
- ❖ Certain substances when added to a catalysed reaction either decreases or completely destroys the activity of a catalyst and they are often known as catalytic poisons.
- ❖ For Ex:

$$N_2 + 3H_2 \xrightarrow{\text{Fe/ H}_2\text{S}} 2NH_3$$
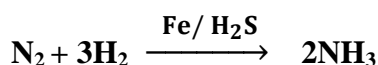
In this reaction,

Catalyst → **Fe**	Catalytic poison → **H₂S**

20) What are promoters? Give one example
- ❖ In a catalysed reaction the presence of a certain substance increases the activity of a catalyst.
- ❖ Such a substance is called a promoter.
- ❖ For Eg:

$$N_2 + 3H_2 \xrightarrow{\text{Fe/ Mo}} 2NH_3$$
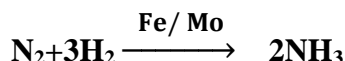
In this reaction,

Catalyst →**Fe**	Promoter→ **Mo**

21) Write the dispersed phase and dispersion medium of butter

dispersion medium	solid
dispersed phase	liquid

22) Mention the shapes of the following colloidal particles.
i) As_2S_3 ii) Blue gold sol   iii) Tungstic acid sol

i) As_2S_3	Spherical
ii) Blue gold sol	Disc or plate like
iii) Tungstic acid sol	Rod like

23) Name the factors affecting adsorption
Nature of adsorbent, nature of adsorbate, pressure and temperature

24) Explain intermediate compound formation theory of catalysis with an example.
- ❖ According to this theory, the catalyst first forms an intermediate compound with one of the reactants.
- ❖ The compound is formed with less energy consumption than needed for the actual reaction.
- ❖ The intermediate compound being unstable combines with other reactant to form the desired
- ❖ product and the catalyst is regenerated.

For Example:

$$2SO_{2(g)} + O_2 \xrightarrow{NO_{(g)}} 2SO_3$$

Step – 1:

$$2NO + O_2 \longrightarrow 2NO_2$$

Step – 2:

$$NO_2 + SO_2 \longrightarrow SO_3 + NO$$
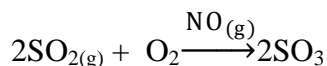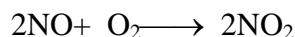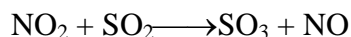
($NO_2 \rightarrow$ Intermediate; $NO_{(g)} \rightarrow$ Catalyst & $SO_3 \rightarrow$ Product)

25) What are the Limitations of intermediate compound theory?

❖ The intermediate compound theory fails to explain the action of catalytic poison and promoters.

❖ This theory is unable to explain the mechanism of heterogeneous catalysed reactions.

26) Differentiate Homogeneous and Heterogeneous catalysis

Homogenous catalysis	Heterogeneous catalysis
1, The reactants, products and catalyst are present in the same phase.	1,The reactants, products and catalyst are present in the different phase.
2, Example : $2SO_{2(g)} + O_{2(g)} \xrightarrow{NO_{(g)}} 2SO_{3(g)}$	2,Example : $2SO_{2(g)} + O_{2(g)} \xrightarrow{Pt_{(s)}} 2SO_{3(g)}$

27) Write note on Freundlich adorption isotherm.

According to Freundlich,

$$\frac{x}{m} = K\, P^{\frac{1}{n}}$$

For adsorption of gases in solutions, with 'C' as concentration.

$$\frac{x}{m} = k\, C^{\frac{1}{n}}$$

where 'x' is the amount of adsorbate adsorbed on 'm' gm of adsorbent at a pressure of 'p'. K and n are constants.

Limitations :-

❖ Freundlichequation is purely empirical and valid over a limited pressure range.

❖ The values of constants 'k' and 'n' also found vary with temperature.

❖ No theoretical explanations were given.

28) Describe adsorption theory of catalysis.

❖ Adsorption theory explains the action of catalyst in heterogeneous catalysis. It 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 the bulk to the catalyst surface.
2. The reactant molecules are adsorbed on the surface of the catalyst.
3. The adsorbed reactant molecules are activated to form activated complex, which is decomposed to form the products.
4. The product molecules are desorbed.
5. The products diffuse away from the surface of the catalyst.

29) Write the characteristics of catalysts.

❖ Alters the rate (speed) of chemical reaction

❖ Needed in very small quantity.

❖ Specific in nature.

❖ Does not change the nature of products.

❖ A solid catalyst will be more effective if it is taken in a finely divided form.

30) Define the following. a) Positive catalysis b) Negative catalysis c) Auto catalysis d) active centers

a) Positive catalysis:

The rate of a reaction is increased by the presence of catalyst.
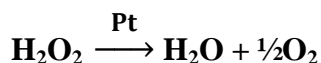
$$H_2O_2 \xrightarrow{\text{Pt}} H_2O + \tfrac{1}{2}O_2 \qquad\qquad \text{Pt} \longrightarrow \text{Positive catalysis}$$

b) Negative catalysis:

The rate of reaction is decreased by the presence of a catalyst.
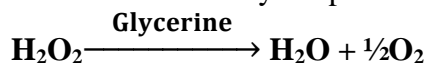
$$H_2O_2 \xrightarrow{\text{Glycerine}} H_2O + \tfrac{1}{2}O_2 \qquad\qquad \text{Glycerine} \longrightarrow \text{negative catalysis}$$

c) Auto catalysis :

In certain reactions one of the products formed acts as a catalyst to the reaction.

Eg: In this reaction **(CH$_3$COOH)acetic acid**acts as auto catalyst.

$$CH_3COOC_2H_5 + H_2O \longrightarrow CH_3COOH + C_2H_5\text{-}OH$$
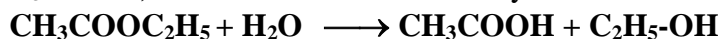
d) Active centers :

❖ The surface of a catalyst is not smooth.
❖ It bears steps, cracks and corners.
❖ Hence atoms on such locations of the surface are co-ordinatively unsaturated.
❖ They have much residual force of attraction.
❖ Such sites are called active centres.
❖ The presence of such active centres increases the rate of reaction by adsorbing and activating the reactants.

31) Identify the auto catalyst in the following reaction.

a, $CH_3COOC_2H_5 + H_2O \longrightarrow CH_3COOH + C_2H_5OH$

b, $2AsH_3 \longrightarrow 2As + 3H_2$

Reaction	Auto catalyst
a, $CH_3COOC_2H_5 + H_2O \longrightarrow CH_3COOH + C_2H_5OH$	CH_3COOH
b, $2AsH_3 \longrightarrow 2As + 3H_2$	As

32) Why gas in gas colloid is not following formed?

❖ Gases are completely miscible with each other and form a homogeneous mixture.
❖ A gas in gas is a true solution and not a colloidal solution.

33) Explain dispersion methods of preparation of colloids.

Mechanical dispersion :-

❖ The colloidal mill cosists of two metal places roating in opposite direction at very high speed and the solid is ground to colloidal dimension.
❖ By this method, colloidal solutions of **ink and graphite** are prepared.

Electro dispersion (or) Bredig's arc method:–

❖ This method is suitable for the preparation of colloidal solution of metals like **gold, silver, platinum** etc.
❖ An arc is struck between the metal electrodes under the surface of water containing some stabilising agent such as trace of alkali.
❖ The water is cooled by immersing the container in a cold bath.

Ultrasonic dispersion :-

❖ Sound waves of **frequency more than 20kHz** (audible limit) could cause transformation of coarse suspension to colloidal dimensions.
❖ Claus obtained mercury sol by subjecting **mercury** to sufficiently high frequency ultrasonic vibrations.

Peptisation :-

❖ The dispersion of a precipitated material into colloidal solution by the action of an electrolyte in solution is termed as peptisation.
❖ Ex: $\qquad$ AgCl $\xrightarrow{\text{HCl}}$ AgCl
$\qquad\qquad\qquad$ Precipitate $\qquad\qquad$ colloid

34) Explain chemical methods of the preparation of colloids.

Methods	Reactions
Oxidation:	$2H_2S + SO_2 \longrightarrow 2H_2O + 3S_{(sol)}$
Reduction:	$2AuCl_3 + \text{Tannic acid} \longrightarrow Au_{(sol)}$
Hydrolysis:	$FeCl_3 + 3H_2O \longrightarrow Fe(OH)_{3(sol)} + 3HCl$

Double decomposition	$As_2O_3 + 3H_2S \longrightarrow As_2S_{3(sol)} + 3H_2O$
Decomposition:	$Na_2S_2O_3 + 2HCl \longrightarrow S_{(sol)} + H_2O + SO_2 + 2NaCl$

35) Why Colloids should be purified ?
- ❖ The impurities will Destabilize the colloid
- ❖ So the impurities should be removed to increase the stabilization of the colloid.
- ❖ The impurities will precipitate the colloid. This is called as coagulation.
- ❖ Ex :- Dialysis and Electro Dialysis.

36) What is Ultrafiltration?
- ❖ The **separation of sol particles from electrolyte** by filtration through an ultrafilter is called ultrafiltration.
- ❖ In ultra filtrations, the membranes are made by using **collodion cellophane or visiking**.
- ❖ When a colloidal solution is filtered using such a filter,colloidal particles are separated on the filter and the impurities are removed as washings.

37) What is inversion of phase ? Give an example
- ❖ The change of W/O emulsion into O/W emulsion
- ❖ Ex: An oil in water emulsion containing potassium soap as emulsifying agent can be converted into water in oil emulsion by adding $CaCl_2$ or $AlCl_3$.

38) How colloids are used in tanning of leather and in Rubber industry?
Tanning of leather :
- ❖ Chromium salts are used forthe purpose.
- ❖ Chrome tanning can produce soft and polishable leather.

Rubber industry:
- ❖ Latex is the emulsion of natural rubber with negative particles.
- ❖ By heating rubber with sulphur, vulcanized rubbers are produced for tyres, tubes, etc.

39) What is Tyndall effect?
- ❖ When beam of light is passed through colloidal solution, the path of light is illuminated by the **scattering of light**by colloidal particles.
- ❖ The phenomenon of scattering of light by the solution particles is called Tyndall effect.

40) Write a short note on Brownian movement
When a colloidal solutionis viewed through **Ultra microscope**, continuous bombardment of colloidal solution particles with the molecules of the dispersion mediumcan be seenand they showa **random, zigzag, ceaseless motion**. This is called Brownian movement.

41) What is Helmholtz double layer?
- ❖ The surface of colloidal particle adsorbs one type of ion due to preferential adsorption
- ❖ This layer attracts oppositely charged ions in the medium and hence at the boundary seprating the two electrical double layers are setup.
- ❖ This is called as Helmholtz electrical double layer.

42) What is flocculation value?
- ❖ The precipitation power of electrolyte is determined by finding the minimum concentration (millimoles / lit) required to cause precipitation of a sol in 2 hours.This value is called flocculation value.
- ❖ The smaller the flocculation value greater will be precipitation.

43) Define Gold number.
- ❖ Gold number is defined as the number of milligrams of hydrophilic colloid that will just prevent the precipitation of 10ml of gold sol on the addition of 1ml of 10% NaClsolution.
- ❖ Smaller the gold number greater the protective power.

44) Write the uses of colloids in medicine .

Colloids	Uses
Penicillin	Antibodies (injections)
Colloidal gold and colloidal calcium	Tonics
Milk of magnesia	Stomach troubles

| Silver sol (Argyrol) | Eye lotion |

45) Explain the Identification of types of Emulsion by Dye test.

- ❖ A small amount of dye soluble in oil is added to the emulsion.
- ❖ The emulsion is shaken well.
- ❖ The aqueous emulsion will not take the colour whereas oily emulsion will take up the colour of the dye.

46) Give an account on Nano catalysis.

- ❖ Nano materials such a metallic nano particles, metal oxides, are used as catalyst in many chemical transformations.
- ❖ Nano catalysts carry the advantages of both homogeneous and heterogeneous catalysis.
- ❖ Like homogeneous catalysts, the nano catalysts give 100% selective transformations and excellent yield and show extremely high activity.
- ❖ Like the heterogeneous catalysts nano catalysts can be recovered and recycled
- ❖ Nano catalysis are soluble heterogeneous catalysts.

(i) Lindane $\xrightarrow[H_2O]{Fe^0/Pd^0}$ cyclohexane + 6 HCl

Fe^0/Pd^0 : Nanobimetallic catalyst (Zerovalent state)
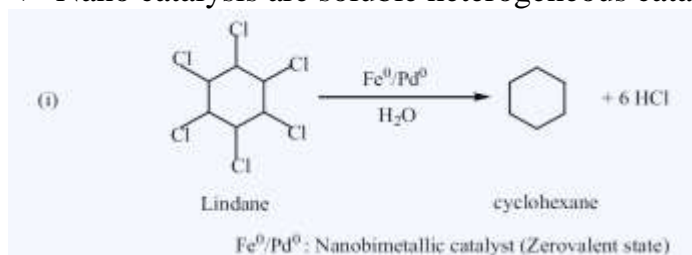
11.HYDROXY COMPOUNDS AND ETHERS

1) **Write the preparation of glycol from ethylene**

$$CH_2 = CH_2 + H_2O \xrightarrow{\text{Alkaline } KMnO_4} \begin{array}{c} CH_2 - CH_2 \\ | \quad\quad | \\ OH \quad OH \end{array}$$

Ethylene   (Glycol)
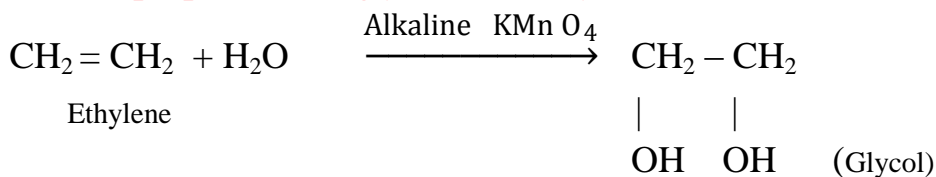
2) **Mention the uses of Glycerol.**
   - ❖ Sweetening agent
   - ❖ Manufacture of cosmetics and transparent soaps
   - ❖ Making printing inks and stamp pad ink.
   - ❖ Manufacture of explosive like dynamite

3) **Write Coupling reaction**

Benzene diazonium chloride   Phenol   p-hydroxy azobenzene
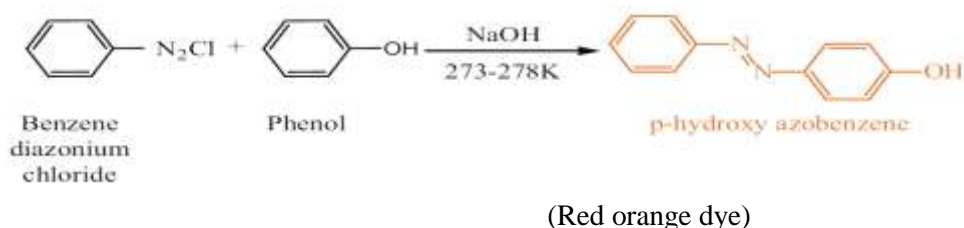
(Red orange dye)

4) **Give the IUPAC names :**

(a)
$$\begin{array}{c} CH_3 \\ | \\ CH_3 - C - OH \\ | \\ CH_3 \end{array}$$
2-methyl-2-propanol

(b)

$CH_2 - OH$

phenylmethanol
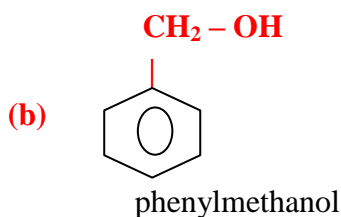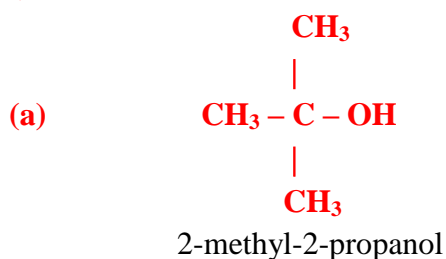
5) **Write the uses of diethyl ether**
   - ❖ Surgical anesthetic agent in surgery
   - ❖ Good solvent for organic reactions
   - ❖ Used as a refrigerant.

6) **What happens when anisole is nitrated?**

Anisole   o-nitro anisole   p-nitro anisole (major product)

(con H_2SO_4 / con HNO_3 Nitration mixture)
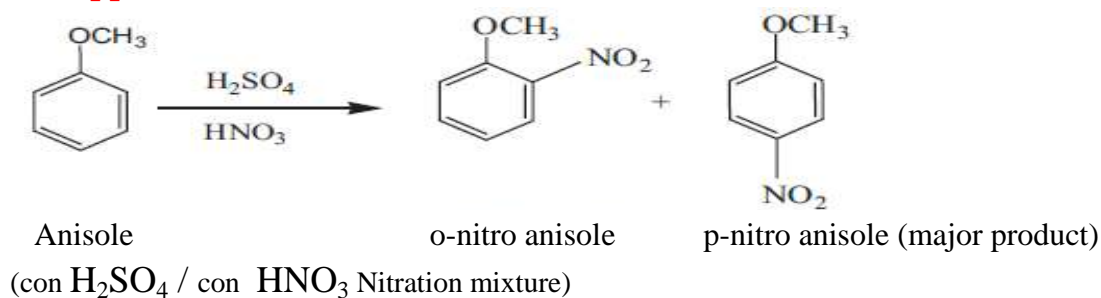
7) **Primary alcohols are more acidic than secondary and tertiary alcohols. Why?**

Increase in the number of alkyl groups decrease the acidity

$$1^0 \text{alcohols} > 2^0 \text{alcohols} > 3^0 \text{alcohols}$$

8) **Write the Bromination reaction of anisole.**

Anisole   o-bromo anisole   p-bromo anisole (major product)
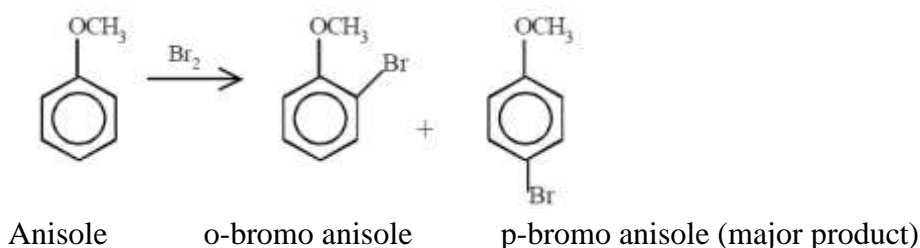
9) Write the preparation of diethyl ether.

$$2CH_3\text{-}CH_2\text{-}OH \xrightarrow[413K]{H_2SO_4} CH_3\text{-}CH_2\text{-}O\text{-}CH_2\text{-}CH_3$$

Ethanol   diethyl ether
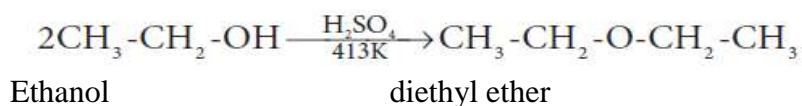
10) Why $C - O - C$ bond angle in ether is slightly greater than the tetrahedral bond angle?

Due to the repulsive interaction between the two bulkier alkyl groups.

11) How will you prepare primary, secondary and tertiary alcohols from Grignard reagent?

Primary alcohol: –

$$CH_3 - Mg\,Br + H - \underset{\underset{Formaldehyde}{\|}}{\overset{O}{C}} - H \xrightarrow{Ether} H - \underset{\underset{CH_3}{|}}{\overset{O-MgBr}{\underset{|}{C}}} - H \xrightarrow{H^+/H_2O} CH_3 - CH_2 - OH + Mg(OH)Br$$

$$Ethyl\ alcohol$$

Secondary alcohol : –

$$CH_3 - MgBr + CH_3 - \underset{\underset{Acetaldehyde}{\|}}{\overset{O}{C}} - H \xrightarrow{Ether} CH_3 - \underset{\underset{CH_3}{|}}{\overset{O-Mg\,Br}{\underset{|}{C}}} - H \xrightarrow{H^+/H_2O} CH_3 - \underset{}{\overset{OH}{\underset{|}{CH}}} - CH_3 + Mg(OH)Br$$

$$Isopropyl\ alcohol$$

Tertiary alcohol: –

$$CH_3 - MgBr + CH_3 - \underset{\underset{Acetone}{\|}}{\overset{O}{C}} - CH_3 \xrightarrow{Ether} CH_3 - \underset{\underset{CH_3}{|}}{\overset{O-MgBr}{\underset{|}{C}}} - CH_3 \xrightarrow{H^+/H_2O} CH_3 - \underset{\underset{CH_3}{|}}{\overset{OH}{\underset{|}{C}}} - CH_3 + Mg(OH)Br$$
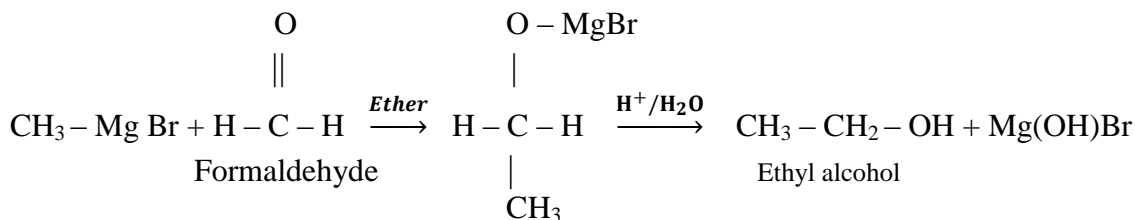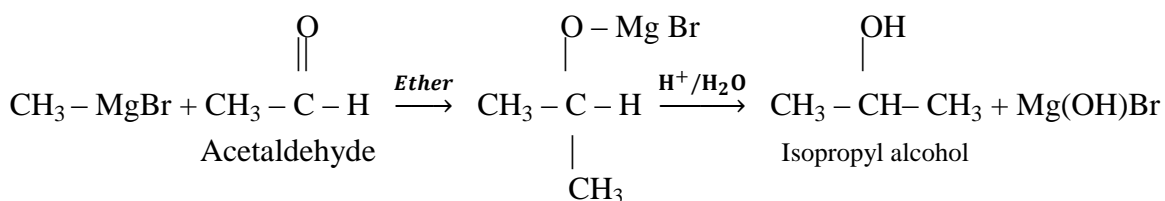
$$Tertiary\ butyl\ alcohol$$
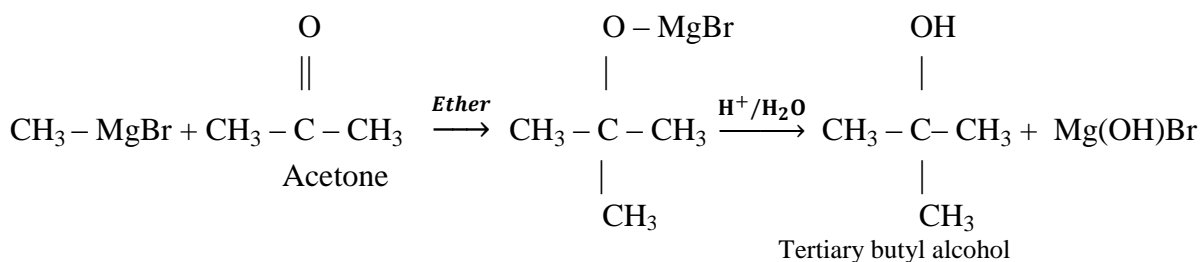
12) Write a note on Williamson's synthesis

$$CH_3\text{-}ONa + Br\text{-}C_2H_5 \xrightarrow{\Delta} CH_3\text{-}O\text{-}C_2H_5 + NaBr$$

Ethyl methyl ether
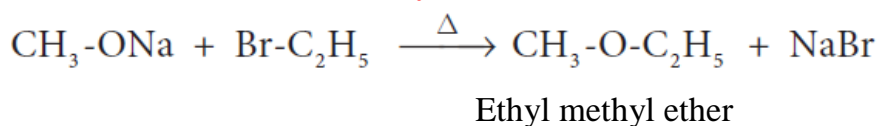
13) How will you prepare the following by using Grignard reagent? A) Propan-1-ol B) Propan-2-ol

A) Propan-1-ol : –

$$CH_3 - CH_2 - Mg\,Br + H - \underset{\underset{Formaldehyde}{\|}}{\overset{O}{C}} - H \xrightarrow{Ether} H - \underset{\underset{CH_3}{|}}{\overset{O-MgBr}{\underset{|}{C}}} - H \xrightarrow{H^+/H_2O} CH_3 - CH_2 - CH_2 - OH + Mg(OH)Br$$

$$Propan\text{-}1\text{-}ol$$

B) Propan-2-ol : –

$$CH_3 - MgBr + CH_3 - \underset{\underset{Acetaldehyde}{\|}}{\overset{O}{C}} - H \xrightarrow{Ether} CH_3 - \underset{\underset{CH_3}{|}}{\overset{O-Mg\,Br}{\underset{|}{C}}} - H \xrightarrow{H^+/H_2O} CH_3 - \underset{}{\overset{OH}{\underset{|}{CH}}} - CH_3 + Mg(OH)Br$$
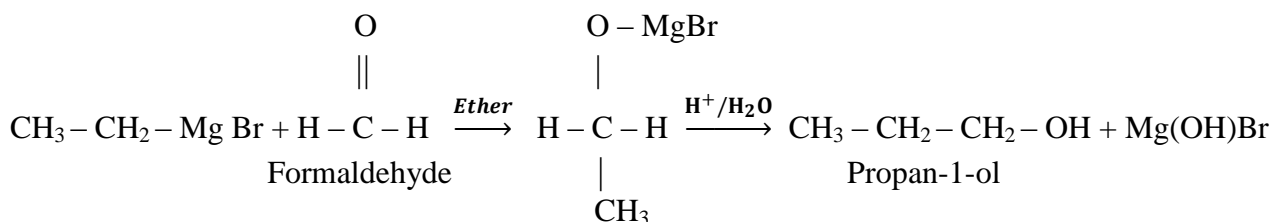
$$Propan\text{-}2\text{-}ol$$
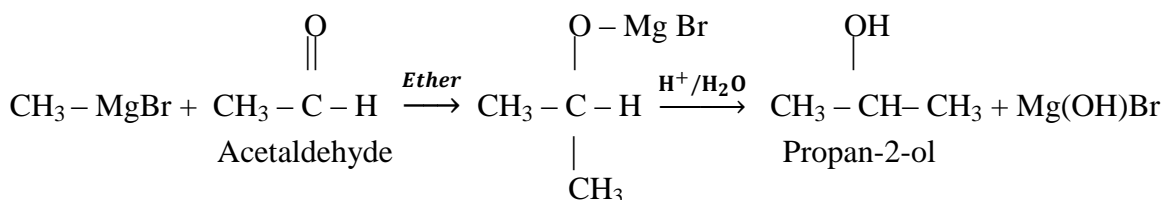
14) How will you prepate the following compounds from Glycerol ?

   a) trinitro glycerol   b) Acrolein

a) Trinitro glycerol :–

$$
\begin{array}{c}
CH_2-OH \\
| \\
CH-OH \\
| \\
CH_2-OH
\end{array}
\;+\; 3\,HONO_2
\xrightarrow[-3H_2O]{\text{Con } H_2SO_4}
\begin{array}{c}
CH_2-O-NO_2 \\
| \\
CH-O-NO_2 \\
| \\
CH_2-O-NO_2
\end{array}
$$

Trinitro glycerol

b) Acrolein :–

$$
\begin{array}{c}
CH_2-OH \\
| \\
CH-OH \\
| \\
CH_2-OH
\end{array}
\xrightarrow[\triangle]{KHSO_4}
\begin{array}{c}
CH_2 \\
\| \\
CH \\
| \\
CHO
\end{array}
$$
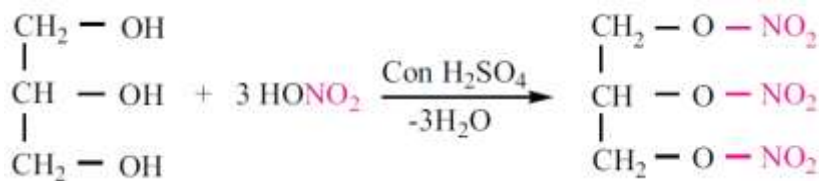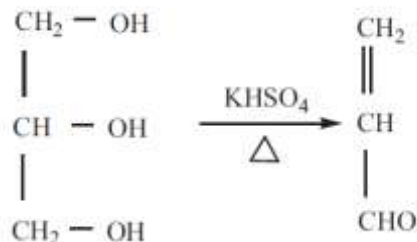
Acrolein

15) Mention the mechanism in the following reations:

    a. One mole of HI reacts with methoxy ethane

$$CH_3-O-C_2H_5 \;+\; HI \longrightarrow CH_3-I \;+\; C_2H_5-OH$$

                              Methyliodide   Ethylalcohol
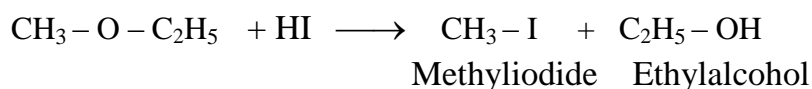
    b. one mole of HI reacts with 2-methoxy-2-methylpropane

$$CH_3-O-CH_2-\overset{\overset{\displaystyle CH_3}{|}}{CH}-CH_3 \;+\; HI \longrightarrow CH_3-I \;+\; CH_3-\overset{\overset{\displaystyle CH_3}{|}}{CH}-CH_2-OH$$

                              Methyliodide   2-Methyl-1-propanol
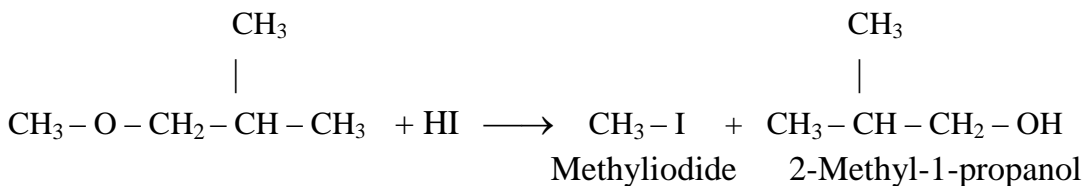
16) Mention the uses of Phenol

❖ It is used for making phenol formaldehyderesin. (**Bakelite**).

❖ It is used as an antiseptic-carbolic lotion and carbolic soaps.

❖ Preapartion of phenolphthalein indicator and explosive like picric acid

17) Write a note on Kolbe's (or) Schmitt's reaction.

phenol   sodium phenoxide   sodium salicylate   Salicyclic acid
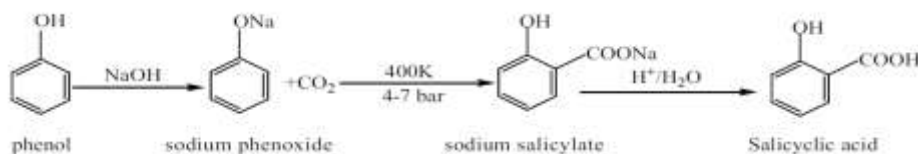
18) Write a note on Schotten – Baumann's reaction.

$$\underset{\text{phenol}}{C_6H_5OH} \;+\; \underset{\text{acetyl chloride}}{CH_3COCl} \xrightarrow[Py]{NaOH} \underset{\text{phenyl ethanoate}}{CH_3\text{-}COOC_6H_5} \;+\; HCl$$

$$\underset{\text{phenol}}{C_6H_5OH} \;+\; \underset{\text{benzoyl chloride}}{C_6H_5COCl} \xrightarrow[Py]{NaOH} \underset{\text{phenyl benzoate}}{C_6H_5\text{-}COOC_6H_5} \;+\; HCl$$
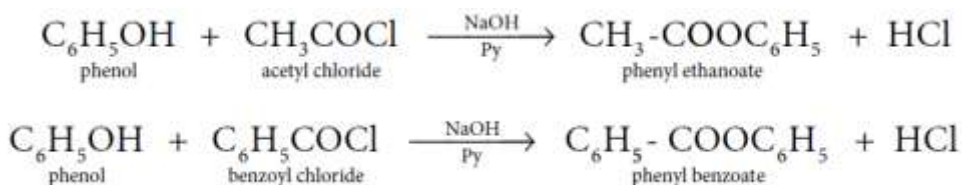
19) How is phenol prepared by Dows process?

Chlorobenzene   Sodium phenoxide   Phenol
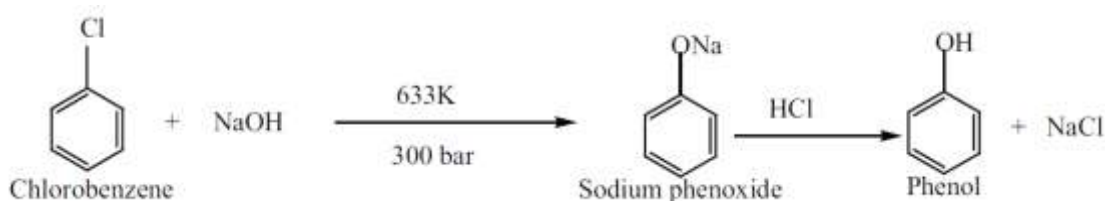
20) How will you differentiate primary, secondary and tertiary alcohols by Lucas test?

$$CH_3 - CH_2 - OH \xrightarrow{con\ HCl\ /anhydrous\ ZnCl_2}$$ No reaction at room temperature

Primary alcohol (Turbidity appears only on **heating**)

$$(CH_3)_2\ CH - OH \xrightarrow{con\ HCl\ /anhydrous\ ZnCl_2} (CH_3)_2\ CH - Cl$$

Secondary alcohol (**slow** appearance of turbidity)

$$(CH_3)_3\ C - OH \xrightarrow{con\ HCl\ /anhydrous\ ZnCl_2} (CH_3)_3\ C - Cl$$

Tertiary alcohol (**immediate** appearance of turbidity)
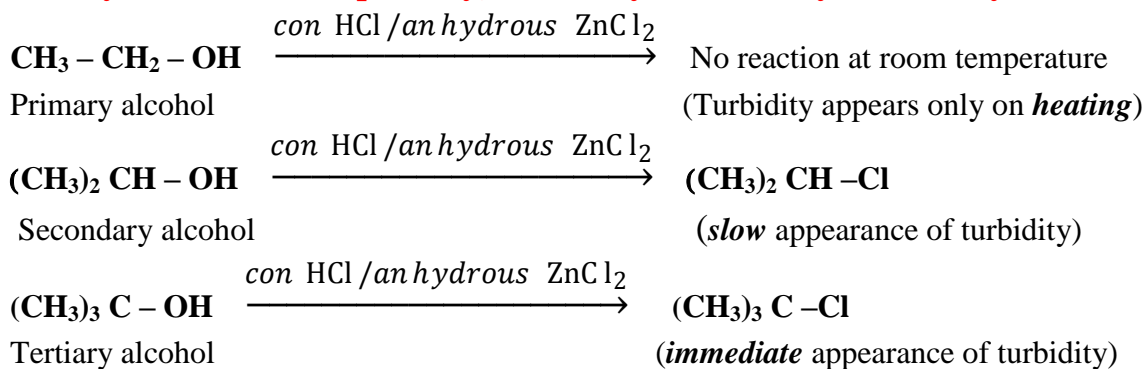
21) Write a note on Swern oxidation reaction.

In this method, **dimethyl sulfoxide (DMSO)** is used as the oxidising agent
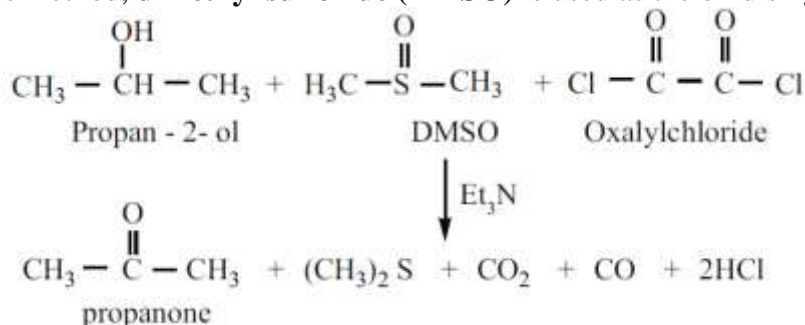
22) Explain Saytzeff's rule.

During intra molecular dehydration, if there is a possibility to form a carbon – carbon double bond at different locations, **the preferred location is the one that gives the more (highly) substituted alkene** i.e., the stable alkene.
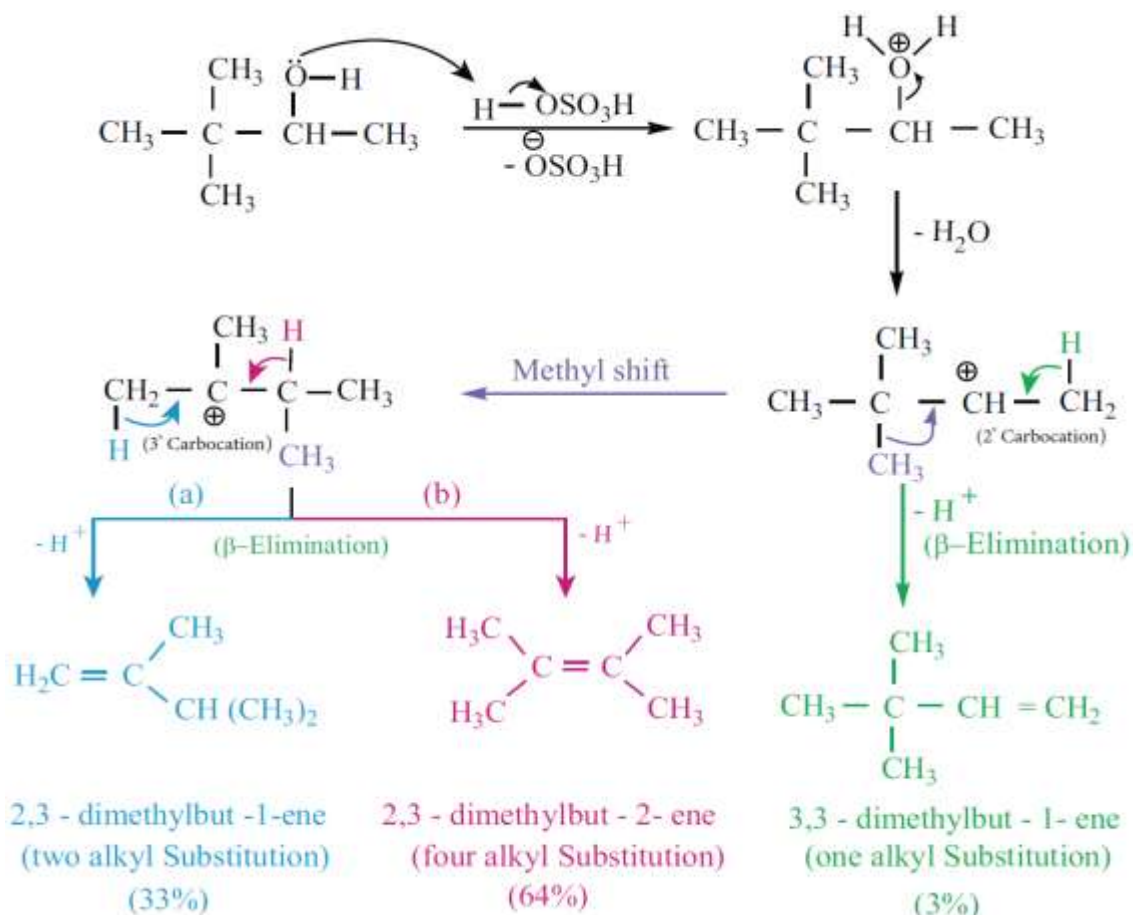
23) How will you differentiate primary, secondary and tertiary alcohols by Victor meyer's method ?

Primaryalcohol	Secondaryalcohol	Tertiaryalcohol
$CH_3 - CH_2 - OH$ Ethyl alcohol $\downarrow$ $+ P / I_2$ $CH_3 - CH_2 - I$ Ethyl iodide $\downarrow$ $+ AgNO_2$ $CH_3 - CH_2 - NO_2$ Nitro ethane $\downarrow$ $+ O = N - OH$ $CH_3 - C - NO_2$ $\parallel$ $N - OH$ Nitrolic acid $\downarrow$ $+ KOH$ $CH_3 - C - NO_2$ $\parallel$ $N - OK$ **Red colour**	$(CH_3)_2 CH - OH$ Propan-2-ol $\downarrow$ $+ P / I_2$ $(CH_3)_2 CH - I$ 2-Iodo prapane $\downarrow$ $+ AgNO_2$ $(CH_3)_2 CH - NO_2$ 2-Nitro propane $\downarrow$ $+ HO - N = O$ $(CH_3)_2 C - NO_2$ $\parallel$ $N = O$ 2-Nitro-2-nitrosopropane $\downarrow$ $+ KOH$ **Blue colour**	$(CH_3)_3 C - OH$ 3^0-butyl alcohol $\downarrow$ $+ P / I_2$ $(CH_3)_3 C - I$ 3^0-butyl iodide $\downarrow$ $+ AgNO_2$ $(CH_3)_3 C - NO_2$ 2-Methyl-2-nitropropane $\downarrow$ $+ HNO_2$ (No reaction) **Colurless**

24) Convert ethan – 1,2 – diol(Glycol) $\longrightarrow$ ethylene (Ethene)

Ethan -1,2 – diol   Ethene
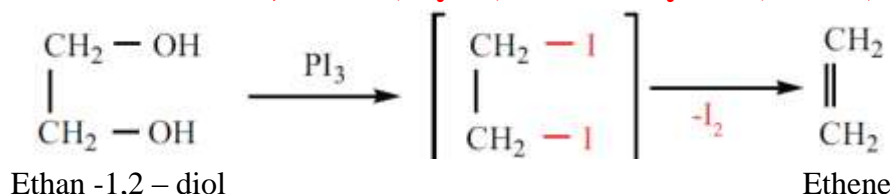
25) Convert ethan – 1,2 – diol(Glycol) to Ethanal (Acetaldehyde)

ethane -1,2 - diol   ethenol (Vinylalcohol)   Ethanal
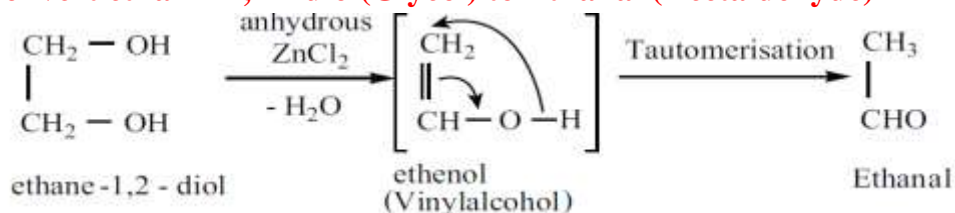
26) Convert ethan – 1,2 – diol(Glycol) to 1,4 – dioxane

ethane - 1,2 - diol   1,4 - dioxane
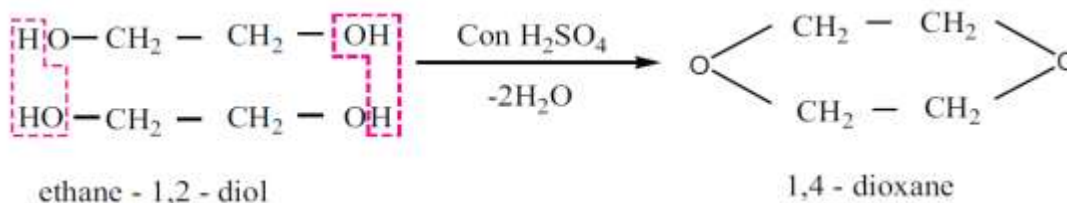
27) Convert ethan – 1,2 – diol(Glycol) to Methanal (Formaldehyde)

$$HO - CH_2 - CH_2 - OH \xrightarrow{HIO_4} 2\ HCHO$$

Glycol   Formaldehyde
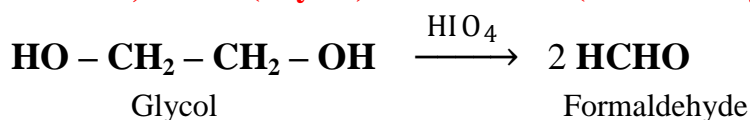
28)   Convert Aniline to Phenol

$$C_6H_5 - NH_2 \xrightarrow{NaNO_2/HCl\ 273K} C_6H_5 - N = N - Cl \xrightarrow{H_2O} C_6H_5 - OH + N_2 + HCl$$

Aniline   Benzene diazonium chloride   Phenol
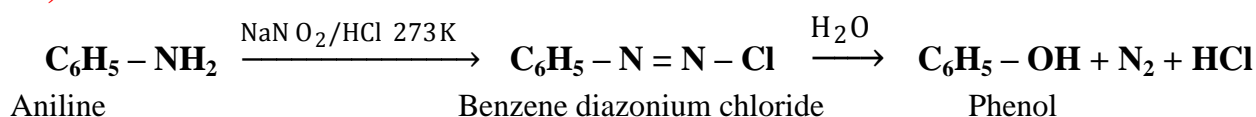
29) How will you prepare Phenol from Cumene .
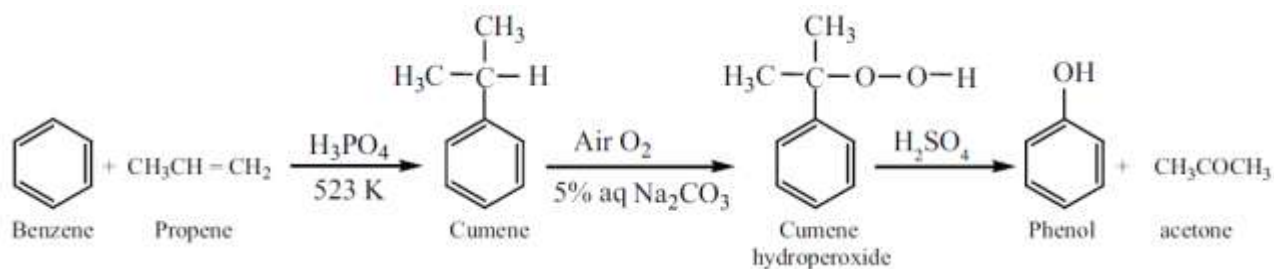
30) Convert Phenol to Benzene

$$C_6H_5 -OH + Zn \longrightarrow C_6H_6 + ZnO$$
Phenol   Benzene
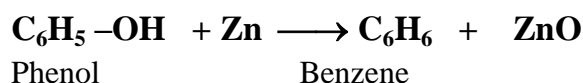
31) Convert Phenol to Aniline

$$C_6H_5 - OH + NH_3 \xrightarrow{anhydrous\ ZnCl_2\Delta} C_6H_5 - NH_2 + H_2O$$
Phenol   Aniline
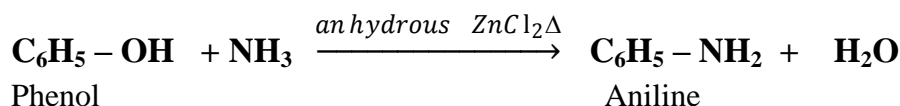
32) Convert Phenol to Picric acid (2,4,6-trinitrophenol)
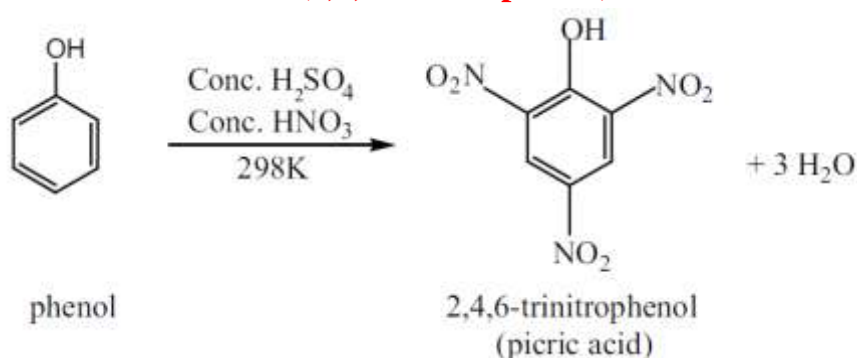
33) Write a note on Riemer Tiemann Reaction.
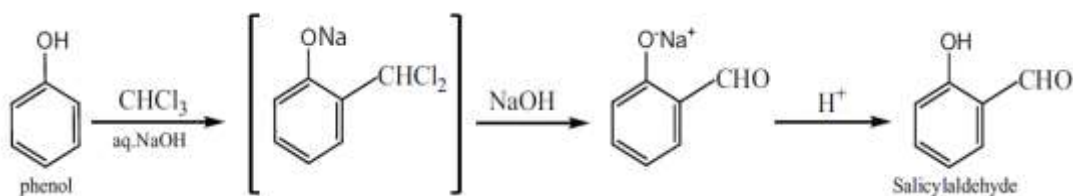
34) How will you prepare Phenolphthalein from Phenol (or) Write a note on Phthalein Reaction.

Phenolphthalein
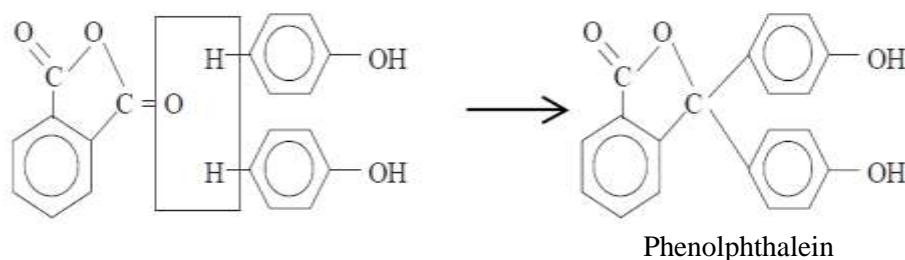
35) Difference between Phenol and Alcohol

Test	Phenol	Alcohol
1, With neutral $FeCl_3$	Purple colouration	No reaction
2, With Benzene diazonium chloride	To form a red orange dye	No reaction
3, With NaOH	To give sodium phenoxide	No reaction

36) Write a note on Metamerism.

In ether the different Alkyl group on two sides of Oxygen atom.

Ex:- $C_2H_5 - O - C_2H_5$ $CH_3 - O - C_3H_7$
   Diethyl ether   Methyl propyl ether
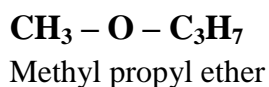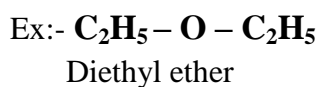
37) What happen when Anisole (Methoxy benzene) react with HI ?

$$C_6H_5 - O - CH_3 + HI \longrightarrow C_6H_5 - OH + CH_3 - I$$

         Anisole   Phenol
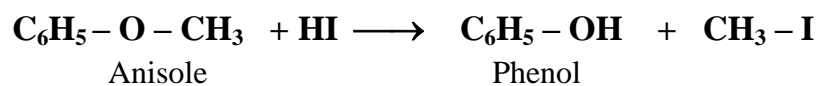
38) Explain auto oxidation of ethers

$$CH_3\text{-}CH_2\text{-}O\text{-}CH_2\text{-}CH_3 \xrightarrow[\text{slow}]{\text{excess}O_2} CH_3\text{-}CH_2\text{-}O\text{-}\overset{\overset{\displaystyle O-O-H}{|}}{C}H\text{-}CH_3 + CH_3\text{-}CH_2\text{-}O\text{-}O\text{-}CH_2\text{-}CH_3$$

ethoxyethane   1-ethoxyethyl   diethylperoxide

                                               hydroperoxide
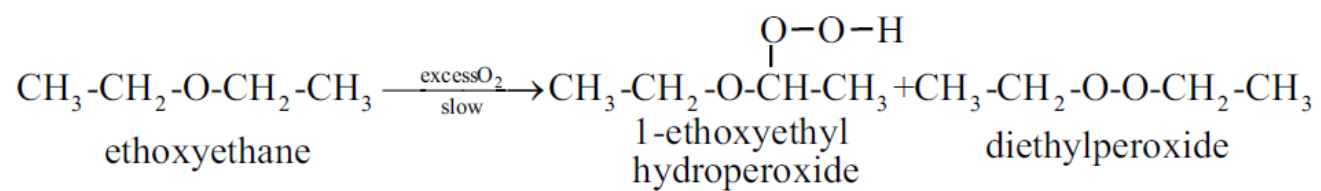
12 . CARBONYL COMPOUNDS

1) Write preparation of Urotropine and Mention its uses.

Urotropine – Hexamethylene tetraamine

Preparation :-

$$6HCHO + 4NH_3 \longrightarrow (CH_2)_6N_4 + 6H_2O$$
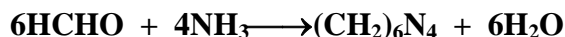
Formaldehyde　　　　　　　Urotropine

Uses : -
- ❖ It is used as a medicine to treat urinary infection.
- ❖ Nitration of Urotropine under controlled condition gives an explosive RDX

2) Give tests to identify Aldehydes.
- ❖ Aldehydes reduce Tollen's reagent to silver mirror
- ❖ Aldehydes reduce Fehling's solution to Cu_2O.

3) Give tests to Carboxylic acids.
- ❖ Change the Colour of Blue Litmus paper into Red Colour.
- ❖ Brisk effervescence with Sodium bicarbonate solution.
- ❖ When heated with Alcohol and con.H_2SO_4, Fruity odour ester is obtained.

4) Write a note on reducing property of Formic acid.

Formic acid has an aldehyde group. So it acts as a reducing agent.
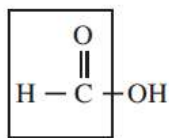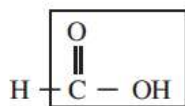
Aldehyde group　　　　　　　Carboxylic acid group

5) Write a note on Trans Esterification Reaction.

$$CH_3-COOCH_3 + HO-C_2H_5 \xrightarrow{H^+} CH_3-COOC_2H_5 + CH_3-OH$$

Methyl acetate　　　Ethyl alcohol　　　Ethyl acetate　　　Methyl alcohol
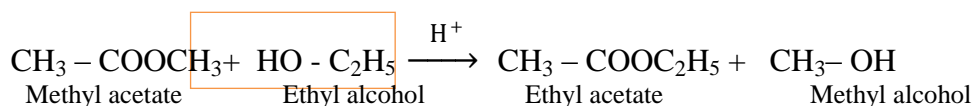
6) Write a note on Rosenmund Reduction Reaction

$$CH_3-COCl + H_2 \xrightarrow{Pd/BaSO_4} CH_3-CHO + HCl$$

Acetyl chloride　　　　　　　　Acetaldehyde

　　Pd – Catalyst ; BaSO$_4$ – Catalytic poison
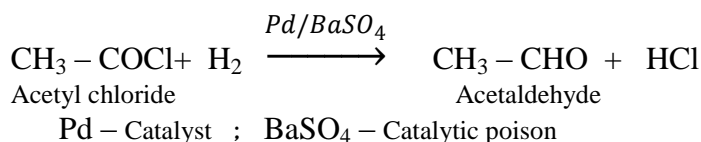
7) Name the catalyst and catalytic poison used in Rosenmund reduction and state its importance.

Palladium (Pd) – Catalyst ;　BaSO$_4$ – Catalytic poison

Importance :
- ❖ Palladium (Pd) is used as reduction catalyst
- ❖ BaSO$_4$ is used to stop the reduction at the stage of aldehyde

8) Write a note on Fridel – craft Acylation Reaction.

$$C_6H_5-\boxed{H+Cl}-CO-CH_3 \xrightarrow{anydrous\ AlCl_3} C_6H_5-CO-CH_3 + HCl$$

Benzene　　Acetyl chloride　　　　　　　Acetophenone

9) Write a note on Fridel – craft Benzylation Reaction.

$$C_6H_5-H+Cl-CO-C_6H_5 \xrightarrow{anhydrous\ AlCl_3} C_6H_5-CO-C_6H_5 + HCl$$

BenzeneBenzene daizonium chlorideBenzophenone
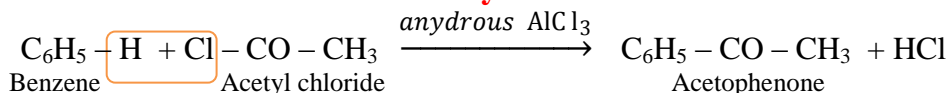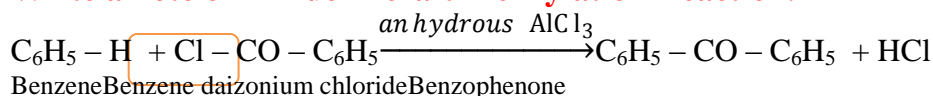
10) Write a note on Cannizaro's Reaction.

$$C_6H_5-CHO + C_6H_5-CHO \xrightarrow{NaOH} C_6H_5-CH_2-OH + C_6H_5-COONa$$

Benzaldehyde　　　　　　　　　Benzyl alcohol　　　　Sodium benzoate
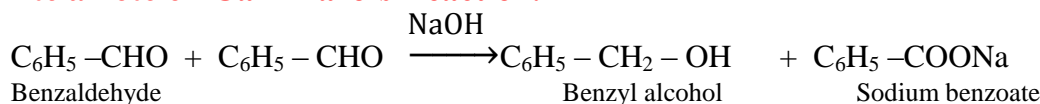
11) Write a note on Aldol Condensation Reaction.

$$CH_3 - CHO + CH_3 - CHO \xrightarrow{\text{NaOH}} CH_3 - CH(OH) - CH_2 - CHO$$

Acetaldehyde   Aldol
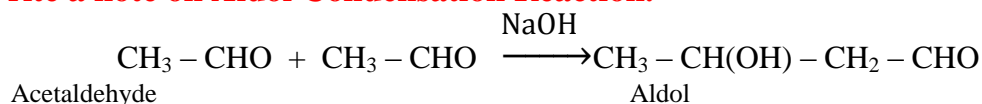
12) Write a note on Perkin's Reaction.

$$C_6H_5 - CH = O + H_2CH - CO - O - CO - CH_3 \xrightarrow{\text{CH}_3 - \text{COONa}} C_6H_5 - CH = CH - COOH +$$

Benzaldehyde   Acetic anhydride   Cinnamic acid CH_3 -COOH
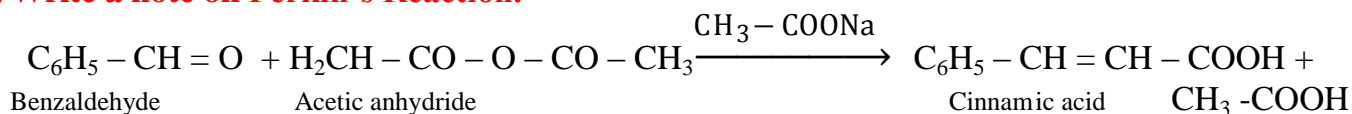
13) Write the formation of Malachite Green dye Reaction.

Benzaldehyde   N, N - Dimethyl aniline   Malachite green dye
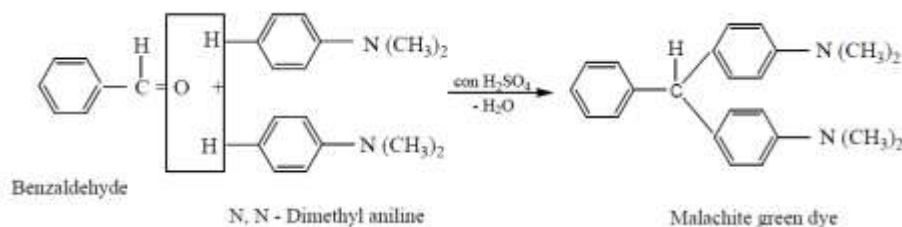
14) Explain Poppof's rule

When an asymmetric Ketone is oxidized, the Keto group stays with the small alkyl group.

$$CH_3 - CH_2 - CH_2 - \underset{\underset{O}{\|}}{C} - CH_3 \xrightarrow[\text{Con HNO}_3]{\text{(O)}} CH_3 CH_2 - COOH + CH_3 COOH$$

                                                  Propanoic acid   acetic acid
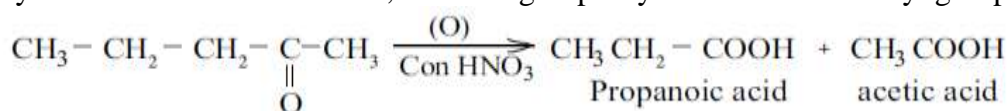
15) Write a note on Hell – Volhard – Zelinsky (HVZ) Reaction.

$$CH_3 - COOH \xrightarrow[\text{H}_2\text{O}]{\text{Cl}_2 / \text{red P}_4} \underset{\underset{Cl}{|}}{CH_2} - COOH$$

Acetic acid   Mono Chloro acetic acid
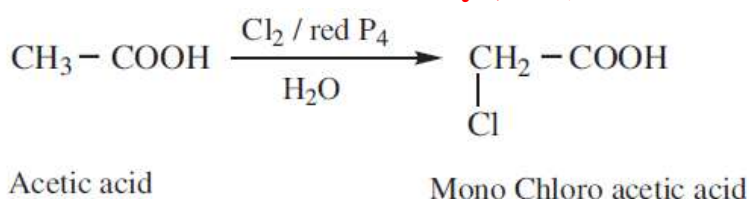
16) Write a note on Stephen's Reaction.

$$CH_3 - C \equiv N \xrightarrow[\text{(H)}]{\text{SnCl}_2/\text{HCl}} CH_3 - CH = NH \xrightarrow{\text{H}_3\text{O}^+} CH_3 - CHO + NH_3$$

     Methyl cyanide   Acetaldehyde
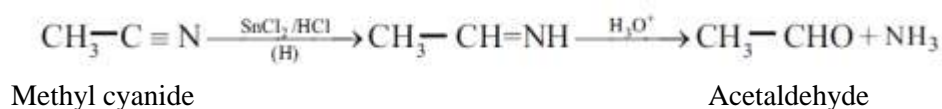
17) Convert but – 2 – ene to Ethanal (Acetaldehyde)

but - 2- ene
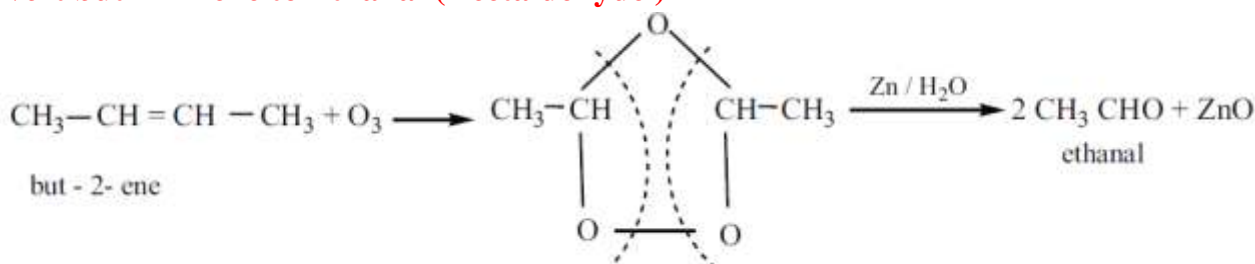
18) Write a note on Etard Reaction.

$$C_6H_5 - CH_3 + CrO_2Cl_2 \xrightarrow{\text{CS}_2/\text{H}_3\text{O}^+} C_6H_5 - CHO$$

     Toluene   Benzaldehyde
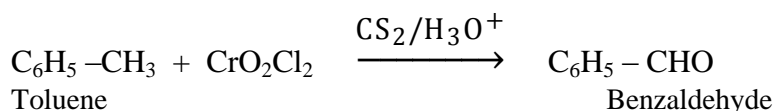
19) Write a note on Gattermann – Koch Reaction.

Benzene   Benzaldehyde
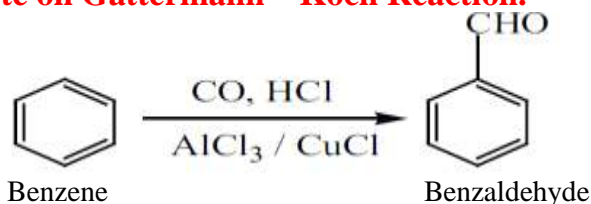
20) What is Formalin and mention its uses ?

40% aqueous solution of Formaldehyde is called Formalin

Uses : -
- ❖ Preserving biological specimens
- ❖ It is used for Tanning
- ❖ Production of Bakelite.

21) Write a note on Knovenagal Reaction.

$$C_6H_5-CH=O + H_2C \begin{array}{c} COOH \\ \diagdown \\ COOH \end{array} \xrightarrow[-H_2O]{\text{பிரிடின்}} C_6H_5\,CH=C \begin{array}{c} \boxed{COOH} \\ \diagdown \\ COOH \end{array} \xrightarrow[-CO_2]{\Delta} C_6H_5\,CH=CH-COOH$$

Benzaldehyde   Malonic acid   Cinnamic acid
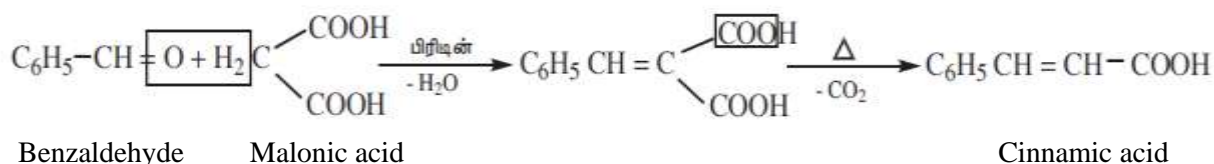
22) Write a note on Benzoin Condensation Reaction.

$$C_6H_5-\overset{H}{\underset{\underset{O}{\parallel}}{C}} + H-\overset{}{\underset{\underset{O}{\parallel}}{C}}-C_6H_5 \xrightarrow[\Delta]{alc\,KCN} C_6H_5-\overset{}{\underset{\underset{OH}{|}}{CH}}-\overset{}{\underset{\underset{O}{\parallel}}{C}}-C_6H_5$$

Benzaldehyde   Benzoin
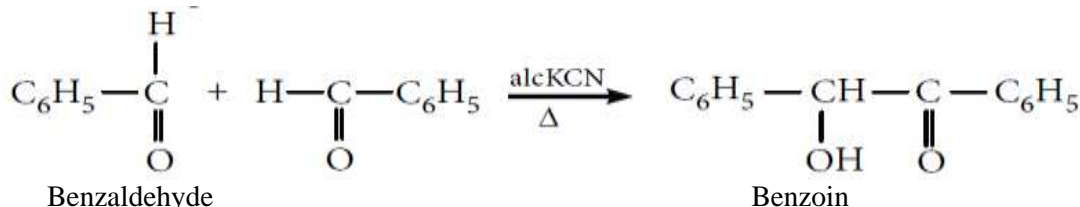
23) Write a note on Claisen – Schmidt Condensation Reaction.

$$C_6H_5\boxed{-CH=O} + H_2\,CH-CHO \xrightarrow{NaOH} C_6H_5-CH=CH-CHO + H_2O$$
Benzaldehyde   Acetaldehyde   Benzal acetaldehyde
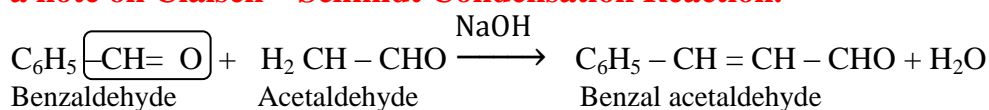
24) Write a note on Clemmensen Reduction Reaction. Convert Acetone ⟶ Propane

$$CH_3-CO-CH_3 + 4[H] \xrightarrow{Zn/Hg\ /\ Con\ HCl} CH_3-CH_2-CH_3$$
Acetone   Propane
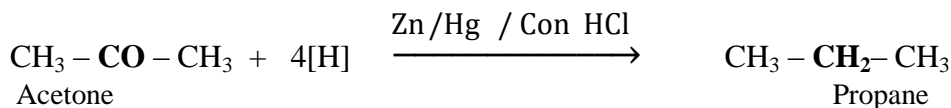
25) Write a note on Wolf Kishner Reduction Reaction.

$$CH_3-CO-CH_3 + 4[H] \xrightarrow{NH_2-NH_2\ /\ C_2H_5ONa} CH_3-CH_2-CH_3$$
Acetone   Propane
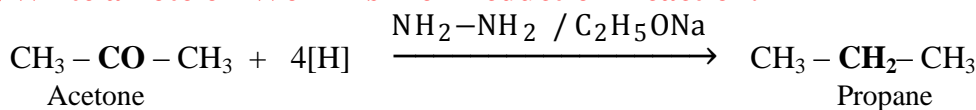
26) Convert Acetone to Pinacols

$$CH_3-\overset{}{\underset{\underset{CH_3}{|}}{C}}=O + O=\overset{}{\underset{\underset{CH_3}{|}}{C}}-CH_3 + 2(H) \xrightarrow[H_2O]{Mg-Hg} CH_3-\overset{CH_3}{\underset{\underset{OH}{|}}{\overset{|}{C}}}-\overset{CH_3}{\underset{\underset{OH}{|}}{\overset{|}{C}}}-CH_3$$

Acetone   Acetone   2,3 – dimethyl butane -2,3-diol
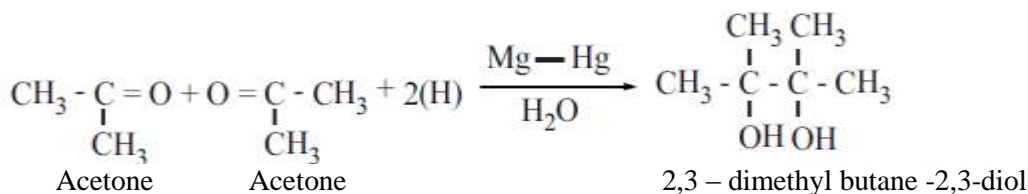
27) Write a note on Kolbe's Electrolytic Decarboxylation Reaction.

$$\begin{array}{c} CH_3COONa \\ + \\ CH_3COONa \end{array} \xrightarrow{Electrolysis} \begin{array}{c} CH_3 \\ | \\ CH_3 \end{array} + 2CO_2 + 2Na$$

Sodium acetate   Anode   Cathode
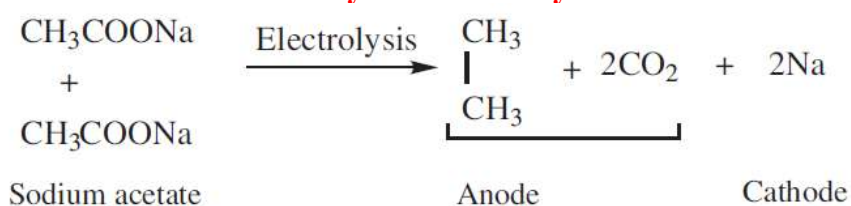
28) Convert Calcium formate to Formaldehyde(Methanl)

$$\begin{array}{c} H-COO \\ \diagdown \\ \\ H-COO \end{array} Ca \xrightarrow{\Delta} H-CHO + CaCO_3$$

Formaldehyde

Calcium formate
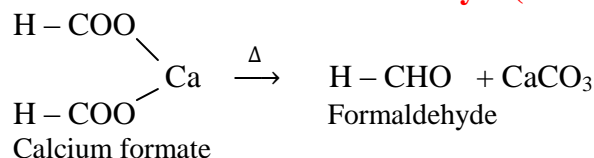
29) Convert Calcium acetate to Acetone(Prapanone)

$$\begin{array}{c} CH_3-COO \\ \diagdown \\ \\ CH_3-COO \end{array} Ca \xrightarrow{\Delta} CH_3-CO-CH_3 + CaCO_3$$

Aectone

Calcium acetate
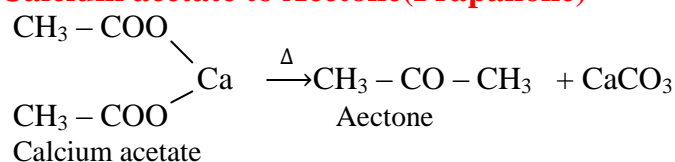
30) How will you preapare Acetaldehyde from Calcium salt ?

$$\begin{array}{c} CH_3-COO \\ \\ CH_3-COO \end{array}\!\!Ca \; + \; Ca\!\!\begin{array}{c} OOC-H \\ \\ OOC-H \end{array} \xrightarrow{\;\Delta\;} \; 2\,CH_3-CHO \; + 2\,CaCO_3$$

Calcium acetate   Calcium formate   Acetaldehyde
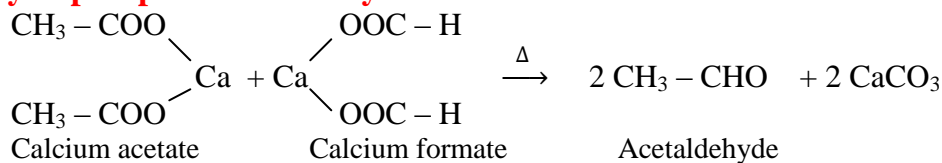
31) How will you preapare Benzaldehyde from Calcium salt ?

$$\begin{array}{c} C_6H_5-COO \\ \\ C_6H_5-COO \end{array}\!\!Ca \; + \; Ca\!\!\begin{array}{c} OOC-H \\ \\ OOC-H \end{array} \xrightarrow{\;\Delta\;} \; 2\,C_6H_5-CHO \; + 2\,CaCO_3$$

Calcium benzoate   Calcium formate   Benzaldehyde(Phenyl methal)
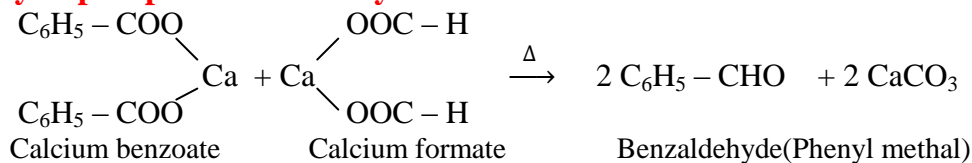
32) What happens when Ammonia react with following compounds?
a) Acealdehyde   **b) Bezaldehyde**   **c) Acetone**

a) Acealdehyde:–

Acetaldehyde   Ammonia   Avetaldehyde ammonia   Aldimine

b) Benzaldehyde :–

3 molecules Benzaldehyde   Ammonia   Hydro benzamide

c) Acetone :–
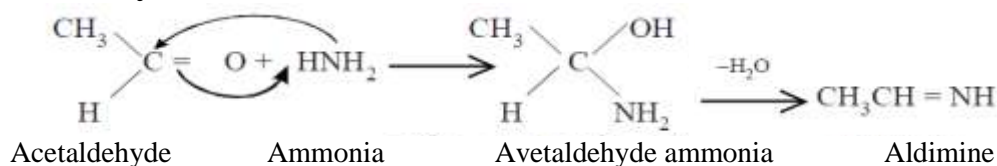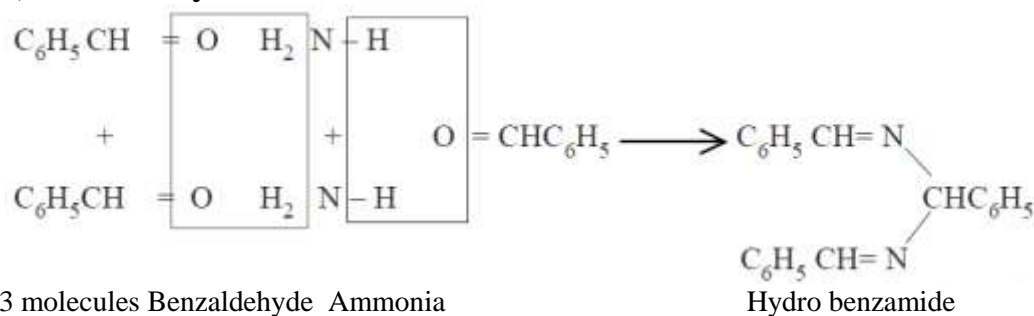
2 molecules Acetone   Ammonia   Di acetone amine
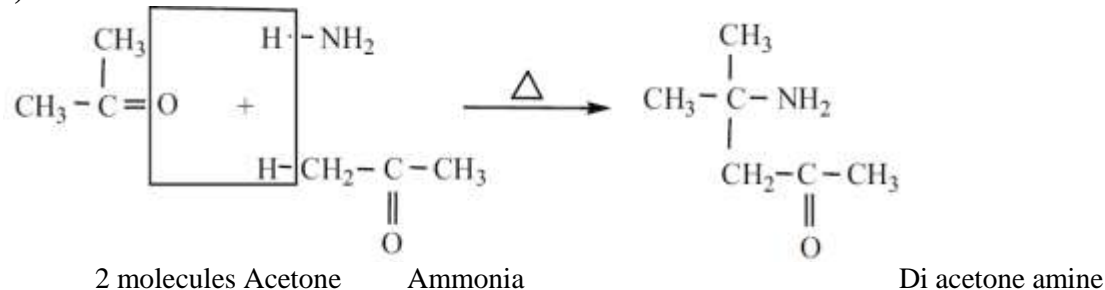
33) Explain Tollens reagent test
- ❖ Tollens reagent :- Ammonical silver nitrate solution.
- ❖ When an aldehyde is warmed with Tollens reagent a bright silver mirror is produced due to the formation of silver metal.

34) Explain Fehlings solution test
- ❖ **Fehlings solution 'A'** : - Aqueous copper sulphate
- ❖ **Fehlings solution 'B'** :- Alkaline solution of sodium potassium tartarate
- ❖ When aldehyde is warmed with Fehlings solution deep blue colour solution is changed to *red precipitate of cuprous oxide*

35) Explain Benedict's solution Test
- ❖ **Benedicts solution** : - Mixture of $CuSO_4$ + sodium citrate + NaOH.
- ❖ Cu^{2+} is reduced by aldehyde to give *red precipitate of cuprous oxide*.

36) How will you convert Ethylacetate into Ethylaceto acetate?

$$CH_3-\overset{\overset{\textstyle O}{\|}}{C}-OCH_2-CH_3 \; + H\,CH_2-\overset{\overset{\textstyle O}{\|}}{C}-OCH_2-CH_3 \xrightarrow{C_2H_5-ONa} CH_3-\overset{\overset{\textstyle O}{\|}}{C}-CH_2-\overset{\overset{\textstyle O}{\|}}{C}-OCH_2-CH_3$$

Ethylacetate   Ethylacetate   Ethylaceto acetate
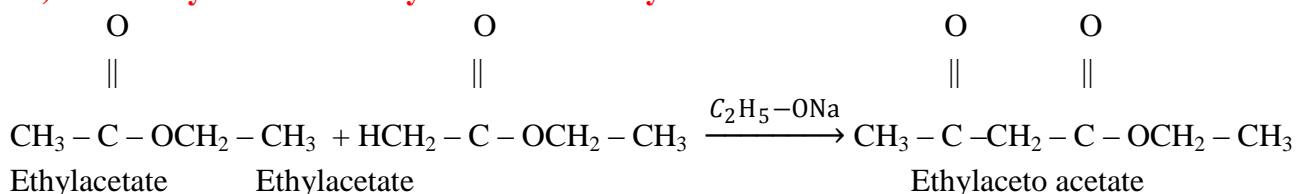
37) Explain Mechanism of Aldol condensation Reaction

$$CH_3 - CHO + CH_3 - CHO \xrightarrow{\text{NaOH}} CH_3 - CH(OH) - CH_2 - CHO$$

  Acetaldehyde   Aldol
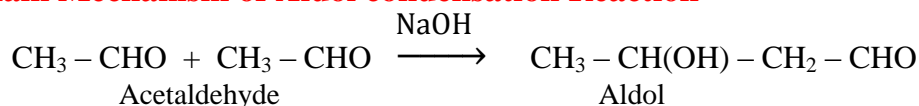
Mechanism :–
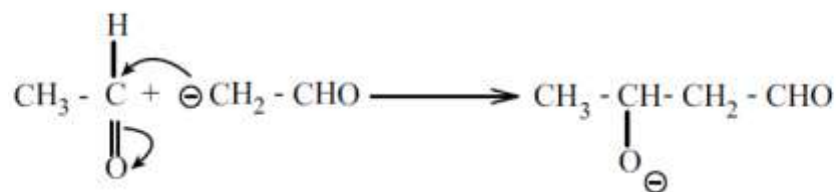
Step 1 :–

Step 2 :–

Step 3 :–
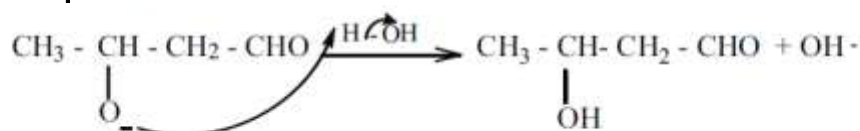
3-Hydroxy butanal

38) Write a note on Crossed Aldol Condensation Reaction. .

$$HCHO + CH_3CHO \xrightarrow{\text{சிறிய NaOH}} HO - CH_2 - CH_2 - CHO$$

Formaldehyde   Acetaldehyde   3-Hydroxypranal
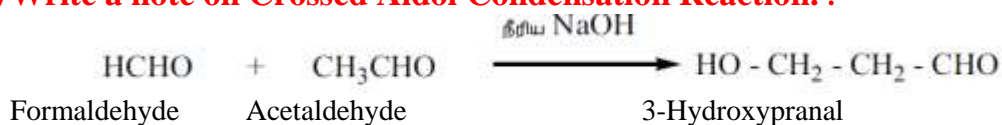
39) Explain Mechanism of Cannizaro Reaction.

$$C_6H_5 - CHO + C_6H_5 - CHO \xrightarrow{\text{NaOH}} C_6H_5 - CH_2 - OH + C_6H_5 - COONa$$

BenzaldehydeBenzyl alcohol   Sodium benzoate
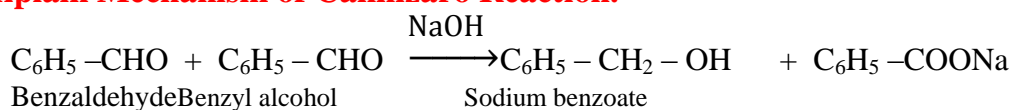
Step 1 :–Attack of OH⁻ on the carbonyl carbons
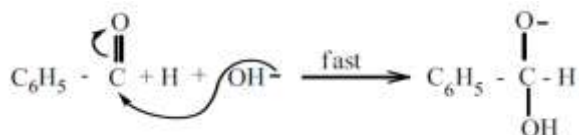
Step 2 :–Hydride ion transfer

Step 3 :–Acid – base reaction

Sodium benzoate   Benzyl alcohol
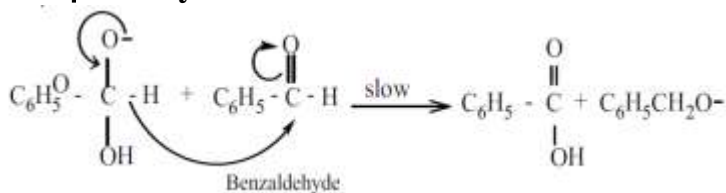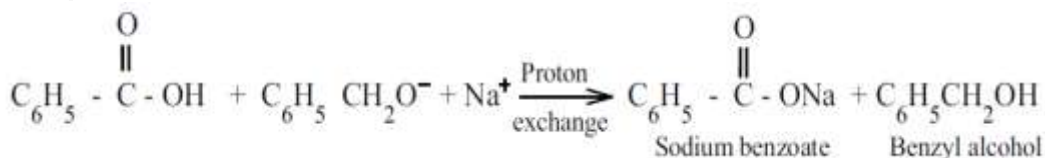
13. ORGANIC NITROGEN COMPOUNDS

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

Tautomerism : CH_3NO_2 exists as an equilibrium mixture of two tautomers, namely Nitro and Aci – form.
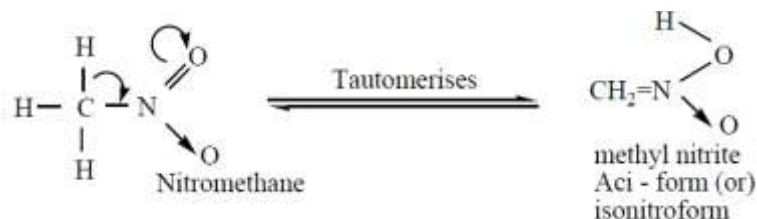
Nitro form	Aci form
1, Less Acidic	1, More acidic
2, Dissolves in NaOH slowly	2, Instantly.
3, decolourless $FeCl_3$ solution.	3, Gives Reddish Brown colour.
4, Electrical conductivity is low.	4, High.

2. Write a note on Gabriel Phthalimide Synthesis.

3. Write a note on Carbyl amine reaction.

Aliphatic (or) Aromatic primary amines react with $CHCl_3$ / alcoholic KOH to give isocyanides (Carbyl amines). Which has an unpleasant smell. This reaction is used to identify Primary amines.

$$C_2H_5 - NH_2 + CHCl_3 + 3KOH \longrightarrow C_2H_5 - NC + 3KCl + 3H_2O$$

Ethyl amine   Chloroform   Ethyl isocyanide

4. Write a note on Gomberg Reaction.

$$C_6H_5N_2Cl + C_6H_6 \xrightarrow{\text{NaOH}} C_6H_5 - C_6H_5 + N_2 + HCl$$

Benzene diazonium chloride   Biphenyl
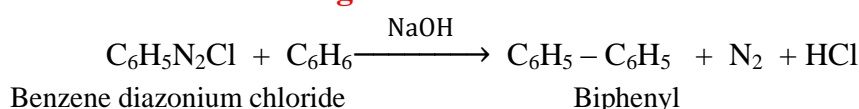
5. Aniline does not undergo Fridel – Craft's Reaction. Why?

Aniline is ***basic in nature*** and it donates its pair to the ***Leis acid*** $AlCl_3$ to form an adduct which inhibits further the electrophilic substitution reaction.

6. Ethyl amine is soluble in water whereas aniline is not Why ?

❖ When Ethyl amine is added to water, it forms intermolecular H – bond with water

❖ But Aniline does not form H – bond with water to a large extent due to the presence of a large hydrophobic (C_6H_5 -) group .

❖ Hence Aniline is insoluble in water.

7. Amines are more basic than amide. Why?

❖ In Amines, +I groups like –CH3 is attached to the nitrogen increase the electron density on Nitrogen which makes the electron pair readily available for protonation.

❖ In Amides, the lone pair of electrons on an oxide are delocalized between Nitrogen and Oxygen (– $CONH_2$) through resonance.

❖ This makes amides much less basic compared to alkyl amines.

8. How is Chloropicrin prepared and mention its use ?

$$CH_3NO_2 + 3Cl_2 \xrightarrow{NaOH} CCl_3NO_2 + 3HCl$$

Nitro methane   Chloropicrin
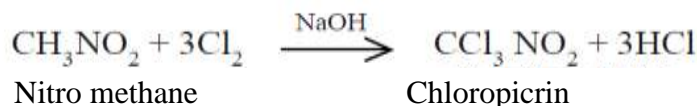
Uses : - **Sterilizing agent**

9. Write a note on Mustard Oil Reaction.

$$CH_3 - NH_2 + \quad S=C=S \longrightarrow CH_3 - N=C=S \ + \ H_2S$$

Methyl amine   Methyl iso thiocyanate

10. Write a note on Hofmann – Mustard Oil Reaction.

Aniline   S - diphenyl thiourea   Phenyl isothiocyanate
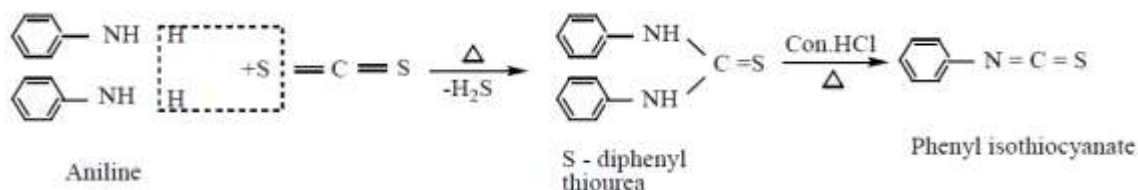
This test is used to identify the primary amines.

11. How will you prepare p-Nitro aniline ?

To get p-nitro aniline, the – NH_2 group in Aniline is producted by acetylation with acetic anhydride, then the nitrated product is hydrolysed to form – Nitro aniline.

Aniline   Acetanilide   p- Nitro acetanilide   p- Nitro aniline
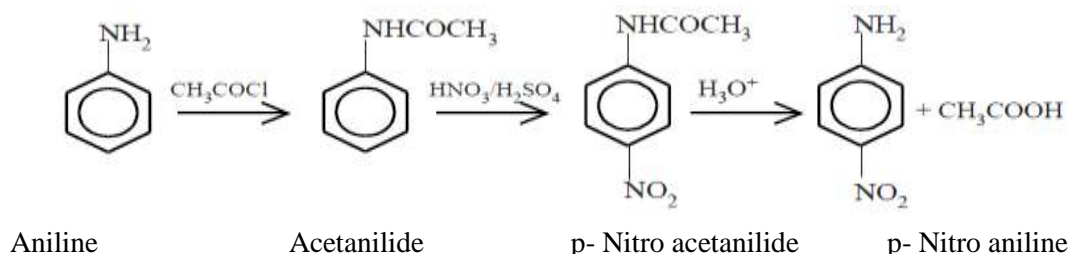
12. Write a note on Diazotization Reaction.

$$C_6H_5 - NH_2 + HNO_2 + HCl \xrightarrow{273-278\ K} C_6H_5N_2Cl + 2H_2O$$

Aniline   Benzene diazonium chloride
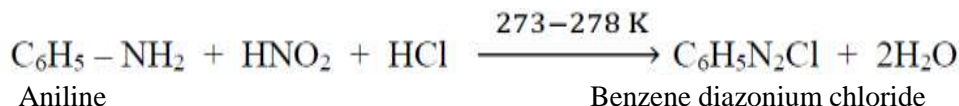
13. Write Acylation reaction in Ethyl amine.

$$CH_3 - CO - Cl \ + HNH - C_2H_5 \xrightarrow{Pyridine} CH_3 - CO - NH - C_2H_5 \ + \ HCl$$

Acetyl chloride   Ethyl amine   **N- Ethyl acetamide**
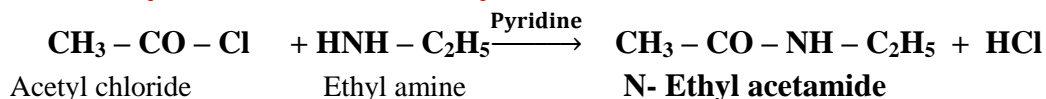
14. Write a note on Sandmeyer Reaction (or) How is aryl halide prepared by using Cu_2Cl_2 / HCl (or) Cu_2Br_2 / HBr ?.

When aqueous solution of $C_6H_5N_2Cl$ is warmed with Cu_2Cl_2 / HCl chlorobenzene is formed.

$$C_6H_5N_2Cl \xrightarrow{Cu_2Cl_2/HCl} C_6H_5 - Cl \ + N_2 \text{(Chlorobenzene)}$$

15. Write the uses of Nitroalkanes

❖ Nitromethane - as a Fuel for cars.

❖ Chloropicrin – as an Sterilizing agent

❖ Nitroethane – as a Fuel additive and precursor to explosive.

16. Identify A and B in the following sequence of reactions.

$$CH_3 - Br \xrightarrow{NaN_3} A \xrightarrow{LiAlH_4} B \ + \ N_2$$

$$CH_3 - Br \xrightarrow{NaN_3} CH_3N_3 \xrightarrow{LiAlH_4} CH_3 - NH_2 \ + \ N_2$$

A – Methyl azide & **B** - Methyl amine
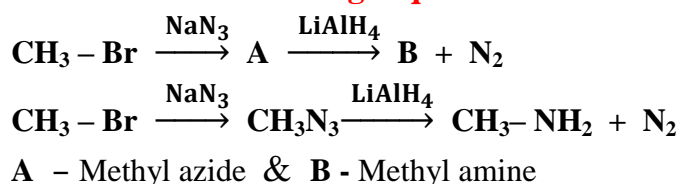
17. Write a note on Hoffmann's degradation Reaction.

$$CH_3 - CO - NH_2 \xrightarrow{Br_2/KOH} CH_3 - NH_2 \ + \ K_2CO_3 \ + KBr \ + \ H_2O$$

Acetamide   Methyl amine
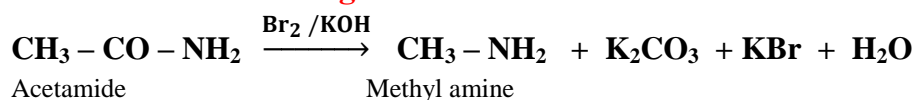
18. Differentiate Nitroethane and Ethylnitrite

Test	Nitroethane	Ethylnitrite
1, Reduction with Sn / HCl	Forms Ethylamine	Forms Alcohol
2, Acid hydrolysis	Forms Acetic acid	Forms Alcohol

19. How will you prepare the following compounds from Benzene diazonium chloride

a, p-Hydroxy azobenzene   b, Phenol   c, Nitrobenzene

a, p- Hydroxy azobenzene:–

Benzene diazonium chloride   Phenol   p- Hydroxy azobenzene

b. Phenol :–

$$C_6H_5 \, N_2Cl \; + \; H - OH \xrightarrow{\Delta} C_6H_5 - OH \; + N_2 \; + HCl$$

Benzene diazonium chloride   Phenol

c, Nitrobenzene :–

$$C_6H_5 \, N_2Cl \quad + \quad HBF_4 \xrightarrow{NaNO_2, \; Cu, \; \Delta} C_6H_5 - NO_2 \; + N_2 \; + NaBF_4$$
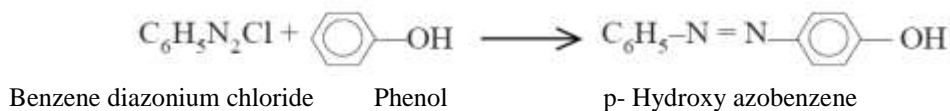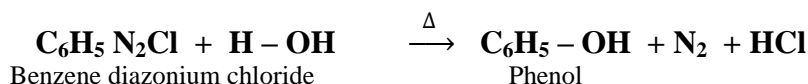
Benzene diazonium chloride   Fluoboric acid   Nitro benzene
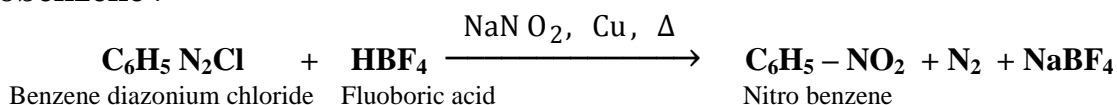
20. Write a note on the reduction of Nitro benzene under different conditions.

Acid Medium :–

$$C_6H_5 - NO_2 \; + \; 6[H] \xrightarrow{Sn/HCl} C_6H_5 - NH_2 \text{Aniline}$$

Neutral Medium :–

$$C_6H_5 - NO_2 \; + \; 4[H] \xrightarrow{Zn/NH_4Cl} C_6H_5 - NHOH$$

Phenyl hydroxylamine

$$C_6H_5 - NO_2 \; + \; 2[H] \xrightarrow{Fe/H_2O \text{(Steam)}} C_6H_5 - N = O$$

Nitro benzene

Alkaline Medium :–

$$C_6H_5 - NO_2 \longrightarrow$$

SnCl$_2$ + NaOH → $C_6H_5 - N = N - C_6H_5$

Azo benzene

Zn / NaOH → $C_6H_5 - NH - NH - C_6H_5$

Hydro azo benzene (or) N,N'-diphenyl hydrazine
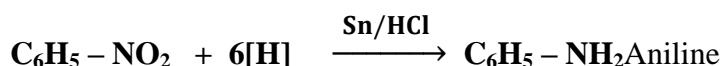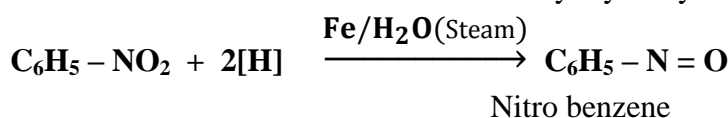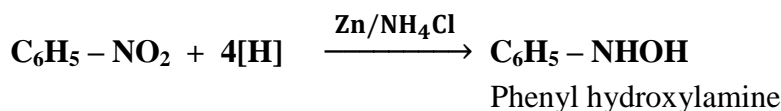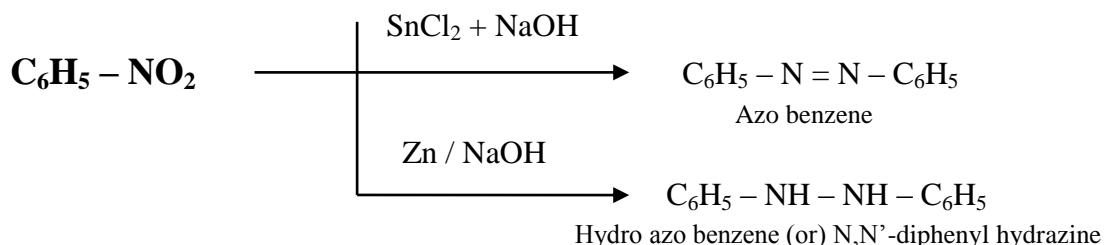
21. How will you distinguish between Primary, Secondary and Tertiary aliphatic amines?

Reagent	Primary amine	Secondary amine	Tertiary amine
1, With Nitrous acid	Forms Alcohol	Forms **N – Nitroso amine.**	Forms salt.
2, With CHCl$_3$ / alcoholicKOH	Forms Carbylamine.	No reaction.	No reaction.
3, With Acetyl chloride	Forms N-alkyl acetmide	Forms N,N-di alkyl acetamide	No reaction.
4, With **CS$_2$** and **HgCl$_2$**	Forms alkyl isothiocyanate	No reaction.	No reaction.
5, With diethyl oxalate at room temperature	Solid dialkyl oxamide is formed.	Liquid N,N-di alkyl oxamic ester is formed.	No reaction.
6, With Alkyl halides.	Three molecules of alkyl halide, quarternary ammonium salt is formed.	Two molecules of alkyl halide, quarternary ammonium salt is formed.	One molecule of alkyl halide, quarternary ammonium salt is formed.

22. Write the Bromination reaction of Aniline
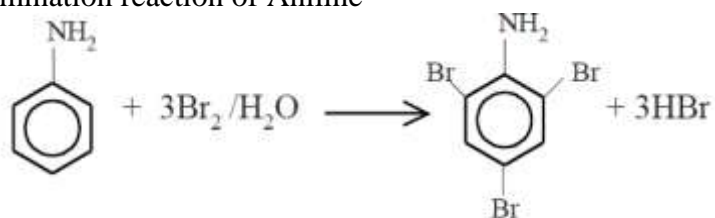
      Aniline   2,4,6-Ttibromoanilne

23. Write short note on Thope nitrile condensation reaction.

   Propanenitrile   Ethanenitrile   3 - imino - 2- methylpentanenitrile
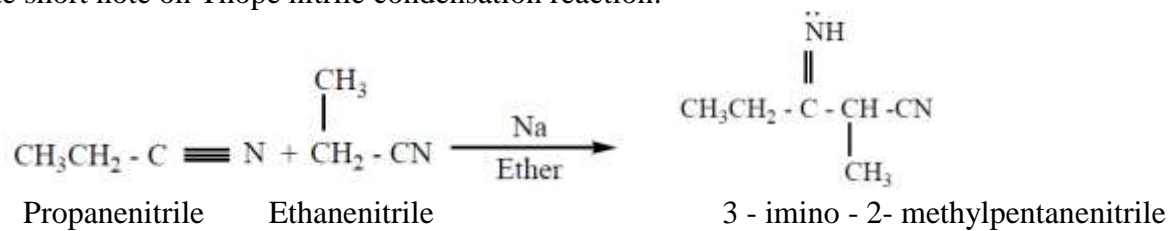
UNIT – 14, BIOMOLECULES

1. What type of linkages hold together monomers of DNA?

❖ Monomers of DNA are linked together by phosphor di ester bond between 5'OH group of one nucleotide and 3'OH group on another nucleotide.

2. Give the difference between primary and secondary structure of proteins.

Sl.No.	Primary	Secondary
1,	It is the relative arrangement of amino acids in the polypeptide chain	The amino acids in the polypeptide chain forms highly regular shapes through the hydrogen bond between carbonyl oxygen and amine hydrogen.
2,	It is essential as even small changes can alter the overall structure and function of a protein.	$\propto$- helix andβ–strands or sheets are two most common sub –structures formed by proteins.

3. Name the Vitamins whose deficiency cause i) rickets ii) scurvy

i) Rickets	Vitamin D
ii)Scurvy	Vitamin C

4. Write the Zwitter ion structure of alanine.

$$H_3{}^+N – CH – COO^-$$
$$|$$
$$CH_3$$
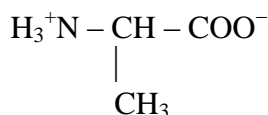
5. Give any three difference between DNA and RNA.

Sl.No.	DNA	RNA
1,	It is mainly present in nucleus, mitochondria and chloroplast.	It is mainly present in cytoplasm, nucleolus and ribosomes.
2,	It contains deoxyribose sugar.	It contains ribose sugar.
3,	Base pair A=T G≡C	Base pair A=U C ≡G
4,	Double stranded molecules.	Single stranded molecules.
5,	It's life time is high.	It is short lived.
6,	It is stableand not hydrolysed easily by alkalies.	It is unstable and hydrolysed easily by alkalies.
7,	It can replicate itself.	It cannot replicate itself.It is formed from DNA.

6. Write a short note on peptide bond.

The carboxyl group of the first amino acid react with the amino group of the second amino acid togive an amide linkage between these amino acids. This amide linkage is called peptide bond.

$$– C – N –$$
$$|| \quad |$$
$$O \quad H$$
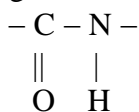
7. Give two difference between Hormones and Vitamins.

Sl.No.	Hormones	Vitamins
1,	Hormone is an organic substance that is secreted by one tissue. It limits the blood stream and induces a biological response in other tissues.	Vitaminsare organic compounds that cannot be synthesized by our body and must be obtained through diet.
2,	Endocrine glands, which are special groups of cells, make hormones.	They are essential for the normal growth and maintenance of our health.
3,	Eg: Insulin	Eg : Vitamin A,B,C,D,E and K.

8. Write a note on denaturation of Proteins.

❖ Each protein has a unique three dimensional structure formed by interactions.
❖ These interactions can be disturbed when the protein is exposed to a higher temperature.
❖ The process of losing its higher order structure without losing the primary structures is called denaturation.
❖ When a protein denatures, its biological function is lost.

❖ Eg. Coagulation of egg white by action of heat.

9. What are reducing and non- reducing sugars.

Reducing sugars:
❖ Theseare carbohydrates which contain free aldehyde or ketonic group.
❖ Reduces Fehling's solution and Tollen'sreagent.   Ex: Glucose.

Non - reducing sugars:
❖ They do not have free aldehyde group.
❖ They do not reduce Tollen's reagent and Fehling's solution.   Ex: Sucrose

10. Why carbohydrates are generally optically active.
Carbohydrates are optically active as they *have one or more chiral carbons*.

11. Classify the following into monosaccharides,oligosaccharides and polysaccharides.
i) Starch -   Polysaccharides
ii) Fructose - Monosaccharides
iii) Sucrose-   Oligosaccharides (disaccharides)
iv) Lactose -   Oligosaccharides(disaccharides)
v) Maltose -   Oligosaccharides(disaccharides)

12. How are vitamins classified.
Vitamins are classified into two groups based on their solubility.
i)   Fat soluble Vitamins –They do not dissolve in water.
           Eg: Vitamin A, D, E and K.
ii)   Water soluble Vitamins - They are readily soluble in water
           Eg： Vitamins B(B_1, B_2, B_3, B_5, B_6, B_7, $B_9$and B_{12}) and Vitamin C

13. Write the structure of all possible dipeptides which can be obtained from glycine and alanine.
They form two dipeptides namely glycylalanine and alanylglycine

$$H_2N - CH_2 - \overset{\overset{O}{\|}}{C} - OH + HNH - \overset{\overset{CH_3}{|}}{CH} - \overset{\overset{O}{\|}}{C} - OH \longrightarrow H_2N - CH_2 - \overset{\overset{O}{\|}}{C} - NH - \overset{\overset{CH_3}{|}}{CH} - \overset{\overset{O}{\|}}{C} - OH$$

Glycine   Alanine   Glycylalanine

$$H_2N - \overset{\overset{CH_3}{|}}{CH} - \overset{\overset{O}{\|}}{C} - OH + HNH - CH_2 - \overset{\overset{O}{\|}}{C} - OH \longrightarrow H_2N - \overset{\overset{CH_3}{|}}{CH} - \overset{\overset{O}{\|}}{C} - NH - CH_2 - \overset{\overset{O}{\|}}{C} - OH$$

Alanine   Glycine   Alanylglycine
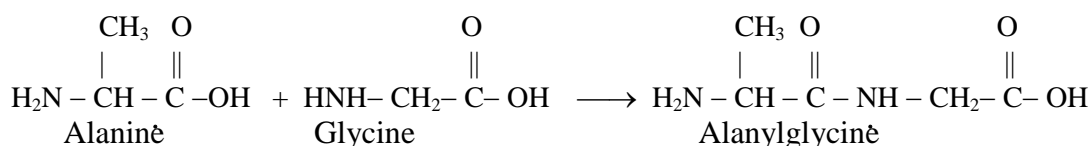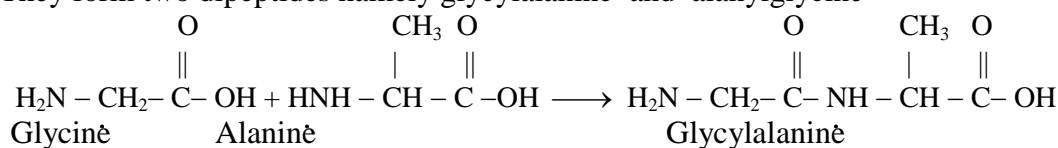
14. Define enzymes.
❖ All biochemical reactions occur in the living systems are catalysed by thecatalytic proteins called Enzymes.
❖ Enzymes are biocatalysts that acceleratethe reaction rate in the orders of 105and also make them highly specific.
❖ Eg: Sucrase

15. Write the structure of α–D(+) glucophyranose.
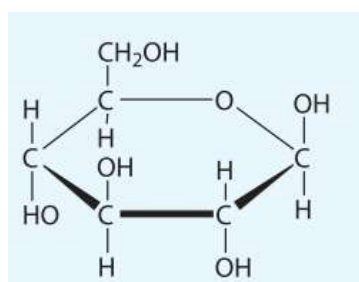
α–D(+) glucophyranose

16. What are the different types of RNA which are found in cell?
RNA molecules are classified into three major types.
❖ Ribosomal RNA (rRNA)
❖ Messenger RNA (mRNA)
❖ Transfer RNA (tRNA)

17. Write a note on formation of α-helix.

- ❖ In theα-helix sub-structure, the amino acids are arranged in a righthanded helical structure.
- ❖ They are stabilised by the hydrogen bond between the carbonyl oxygen of one amino acid with amino hydrogen of the fifth residue.
- ❖ The side chains of the residues protrude outside of the helix.
- ❖ Each turn contains 3.6 residues and is about 5.4 A°long.
- ❖ The amino acid proline produces a kink in the helical structureand often called as helix breaker due to its rigid cyclic structure.

18. What are the functions of lipids in living organisms.

- ❖ Lipids are the integral component of cell membrane.
- ❖ The main function of triglycerides(lipids)in animals is as an energy reserve.
- ❖ They act as protective coating in aquatic organisms.
- ❖ Lipids of connective tissues give protection to internal organs.
- ❖ Lipids help in the absorption and transport of fat soluble vitamins.
- ❖ Essential for activation of enzymes such as lipases.
- ❖ Act as emulsifier in fat metabolism.

19. Is the following sugar, D- sugar or L–sugar?

$$
\begin{array}{c}
\text{CHO} \\
\text{HO}\!-\!\!-\!\!-\!\!|\!\!-\!\!-\!\!-\!\text{H} \\
\text{HO}\!-\!\!-\!\!-\!\!|\!\!-\!\!-\!\!-\!\text{H} \\
\text{HO}\!-\!\!-\!\!-\!\!|\!\!-\!\!-\!\!-\!\text{H} \\
\text{CH}_2\text{OH}
\end{array}
$$
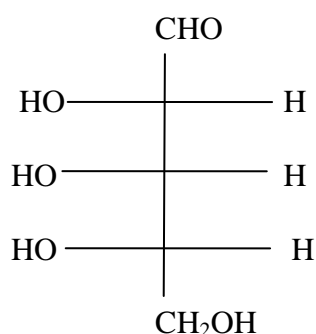
L - Sugar

Additional questions and Answers.

1) What are monosaccharides? Give example.

- ❖ Monosaccharides are carbohydrates that cannot be hydrolysed furtherand are also called simple sugars.
- ❖ General formula $Cn(H_2O)_n$
- ❖ Eg: glucose, fructose

2) What are disaccharides? Give example.

- ❖ Disaccharides are sugars that yield two molecules of monosaccharides on hydrolysiscatalysed by dilute acid or enzyme.
- ❖ General formula$Cn(H_2O)_{n-1}$.
- ❖ Eg: Sucrose, Lactose

3) What are polysaccharide? Give example.

- ❖ Polysaccharideconsists of large number of monosaccharide units bonded together byglycosidicbonds.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 formoccurs 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 bywhich one epimer is converted into other is called epimerisation and it requires the enzymesepimerase.

❖ 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 'glycosidiclinkage'.
   ❖ It is formed by the reaction of the anomeric carbon of one monosaccharidewith 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 bondbetween 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 are hormones? Give examples.
   ❖ Hormone is an organic substance that is secreted by one tissue.
   ❖ It limits the blood stream and induces a physiological response in other tissues.
   ❖ Endocrine glands, which are special groups of cells make hormones
   ❖ It is an intercellular signaling molecule.
   ❖ Eg. Insulin, estrogen.

13) Draw the structure of D(+) Fructose
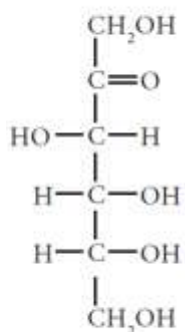
14)Write two differencebetween Amylose and Amylopectin

Sl.No.	Amylose	Amylopectin
1.	Amylose is composed of unbranched chains upto 4000 α-D-glucose molecules joined byα(1,4) glycosidic bonds.	Amylopetin contains chains upto 10000 α-D-glucose molecules linked byα(1,4)glycosidic bonds. At branch points, new chains of 24 to 30 glucose molecules are linked by α(1,6)glycosidic bonds.
2.	Gives blue colour with iodine solution.	Gives purple colour with iodine solution.

| 3. | Starch contains 20% amylose which is water soluble. | Starch contains 80% amylopectin which is water insoluble. |

15).Write the importance of carbohydrates?

- ❖ Carbohydrates, widely distributed in plants and animals, act mainly as energy sourcesand structural polymers
- ❖ Carbohydrate is stored in the body as glycogen and in plant as starch.
- ❖ Carbohydrates such as cellulose which is the primary components of plant cell wall, isused to make paper, furniture and cloths.
- ❖ Simple sugar glucose serves as an instant source of energy.
- ❖ Ribose sugars are oneof the components of nucleic acids.
- ❖ Modified carbohydrates such as hyaluronate (glycosaminoglycans) act as shockabsorber and lubricant.

16)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.

17)What areZwitter ions?

- ❖ In aqueous solution the proton from carboxyl group can be transferred to the amino group ofan amino acid leaving these groups with opposite charges.
- ❖ Despite having both positive and negativecharges this molecule is neutral and has amphoteric behaviour.
- ❖ These ions are called zwitter ions.

$$^+H_3N - CH_2 - COO^-\ \text{Zwitter ions}$$

18)How are proteins classified? Explain.

Proteins are classified into two major types.

1.Fibrous proteins

- ❖ Fibrous proteins are linear molecules similar to fibres.
- ❖ Generally insoluble in water and are held together by disulphide bridges and weak intermolecular hydrogen bonds.
- ❖ The proteins are often used as structural proteins. Example: Keratin, Collagen

2.Globular proteins

- ❖ They have an overall spherical shape.
- ❖ The polypeptide chain is folded into a spherical shape.
- ❖ These proteins are usually soluble in water and have many functions includingcatalysis Example: myoglobin

19)Give the importance of proteins.

- ❖ All biochemical reactions occur in the living systems are catalysed by the catalyticproteins called enzymes.
- ❖ Proteins such as keratin, collagen act as structural back bones.
- ❖ Antibodies help the body to fight various diseases.
- ❖ They are used as messengers to coordinate many functions. Insulin and glucagoncontrol the glucose level in the blood.
- ❖ They act as receptors that detect presence of certain signal molecules and activatethe proper response.
- ❖ They are also used to store metals such as iron (Ferritin).

20)Give the catalytic activity of the following enzymes
i) Carbonic anhydrase   ii) Sucrase   iii) Lactase.

| (i) Carbonic anhydrase | Catalyses the interconversion of carbonic acid to water and carbon dioxide. |
| (ii) Sucrase | Catalyses the hydrolysis of sucrose to fructose and glucose. |

(iii) Lactase enzyme	Hydrolyses the lactose into its constituent monosaccharides, glucose and galactose.

21) What are the components of nucleic acids?

The three components of nucleic acids

  (i) Nitrogenous base
  (ii) Pentose sugar
  (iii) Phosphate group

22) Human cannot use cellulose as food? Why?

Human cannot use cellulose as food because our digestive system do not contain the necessary enzymes (glycosidases or cellulases) that can hydrolyse the cellulose.

23) What are nucleoside and nucleotide.

Sugar + Base $\longrightarrow$ Nucleoside

Nucleoside+ Phosphate $\longrightarrow$ Nucleotide

24) Give the Biological functions of nucleic acids.

  (i) Energy carriers (ATP)
  (ii) Components of enzyme cofactors (Eg. FAD)
  (iii) Chemical messengers. (Eg. Cyclic AMP)

25) What are the types of RNA? Write its functions. Explain.

Types of RNA

i. Ribosomal RNA (rRNA)

❖ Rrnais mainly found in cytoplasm and in ribosomes.
❖ It contains 60% RNA and 40% protein.
❖ Protein synthesis takes place at this site.

ii. Messenger RNA (mRNA)

❖ It is present in small quantity and very short lived.
❖ The synthesis of mRNAfrom DNA strand is called transcription.
❖ It carries genetic informationfrom DNA to the ribosomes for protein synthesis.

iii. Transfer RNA (tRNA)

❖ Molecules have lowest molecular weight of all nucleic acids.
❖ They carry amino acids to the sites of protein synthesis on ribosomes.

26) What are anomers

❖ In the formation of cyclic structure of glucose, the achiral aldehyde carbon init is converted to achiral one leading to the possibility of two isomers.
❖ These two isomers differ only in the configuration of C_1 carbon.These isomers are called anomers.
❖ The two anomeric forms of glucose are called α and β-forms.

27) Write a note on DNA finger printing.

❖ DNA fingerprinting is also called DNA typing or DNA profiling.
❖ The DNA finger print is unique for every person.
❖ It can be extracted from traces of samples from blood, saliva, hair etc...
❖ By using this method we can detect the individual specific variation in human DNA.

28) Explain the method of DNA finger printing.

❖ The extracted DNA is cut at specific points along the strand with restriction of enzymes.
❖ It resulting in the formation of DNA fragments of varying lengths which were analysed by technique called gel electrophoresis.
❖ This method separates the fragments based on their size.
❖ The gel containing the DNA fragments is then transferred to a nylon sheet using a technique called blotting.
❖ Then, the fragments will undergo autoradiography in which they were exposed to DNA probes.
❖ A piece of X-ray film was then exposed to the fragments, and a dark mark was produced at any point where a radioactive probe had become attached.
❖ The resultant pattern of marks could then be compared with other samples.
❖ DNA fingerprinting is based on slight sequence differences between individuals

29) Elucidate the structure of glucose.

Experiment	Observation	Inference
Elemental analysis and molecular weight determination of fructose	$C_6H_{12}O_6$.	Determine Molecular formula
Withconcentrated 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 givesgluconic 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 givesglucaric acid (saccharic acid)	Presence of Primary alcohol (-CH_2-OH)group at the other end

Structure of D(+) glucose
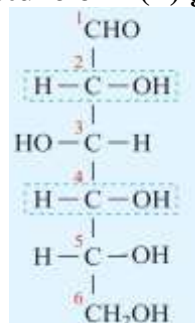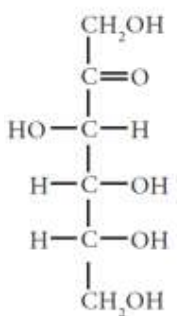

30) Elucidate the structure of fructose.

Experiment	Observation	Inference
Elemental analysis and molecular weight determination of fructose	$C_6H_{12}O_6$.	Determine Molecular formula
Withconcentrated HI and red phosphorus	It gives n-hexane	Six carbon atoms are bonded linearly
With water	It givesneutral 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 givesglycolic acid and tartaric acids	This shows that a ketogroup**(-CO-)** is present in C-2.

The structure of fructose is

15 . CHEMISTRY IN EVERDAY LIFE

1) Which chemical is responsible for the antiseptic properties of dettol?
    (i) Chloroxylenol,
    (ii) terpineol

2) What are antibiotics?
  ❖ The medicines that have the ability to kill the pathogenic bacteria are grouped as antibiotics.
  ❖ Example: (i) Penicillins (ii) amoxicillin (iii) cefpodoxime

3) Name one substance which can act as both analgesic and antipyretic.
    (i) Aspirin (ii) paracetamol

4) Write a note on synthetic detergents.
      Synthetic detergents are formulated products containing either sodium salts of alkyl hydrogen sulphates or sodium salts of long chain alkyl benzene sulphonic acids. There are three types of detergents.

Detergent type	Example
(i) Anionic detergent	Sodium Lauryl sulphate (SDS)
(ii) Cationic detergent	n- hexaadecyltrimethyl ammonium chloride
(iii) Non – ionic detergent	pentaerythrityl stearate

5) How do antiseptics differ from disinfectants?

Antiseptics	Disinfectants
Stop or slow down the growth of micro Organisms.	Stop or slow down the growth of micro Organisms.
Applied to living tissue	Generally used on inanimated objects
Example (i) Hydrogen peroxide (ii) Povidine – Iodine (iii) Benzalkonium chloride	**Example** (i) Chlorine compounds (ii) Alcohol (iii) Hydrogen peroxide

6) What are food preservatives?
      Preservatives are capable of inhibiting retarding or arresting the process of fermentation acidification or other decomposition of food by growth of microorganisms.
Examples:
        ACETIC ACID
  ❖ Acetic acid is used as a preservative for the preparation of pickles.
  ❖ Sodium metasulphite is used as a preservative for fresh vegetables and fruits.
  ❖ Benzoic acid, sorbic acid and their salts are potent inhibitors of a number of fungi, yeast and bacteria.

7) Why do soaps not work in hard water?
  ❖ Ca^{2+} and Mg^{2+} ions present in hard water reacts with soaps to produce insoluble calcium ormagnesium salts of fatty acids.
  ❖ These insoluble salts separate as scum, and get on the fabrics of the clothes.

8) What are drugs? How are they classified?
      A drug is substance that is used to modify or explore physiological systems or pathological states for benefit of the recipient. It is used for the purpose of diagnosis, prevention cure or relief of a disease.
.   **Classification of drugs:**
Classification based on
    i. The chemical structure
    ii. Pharmacological effect
    iii. Target system (drug action)
    iv. Site of action (molecular target)

9) How the tranquilizers work in body?
  ❖ They are neurologically active drugs.
 ❖ They acts on the central nervous system by blocking the neuro transmitter dopamine in thebrain.

❖ They are used in the treatment of stress, anxiety, depression, sleep disorders and severe mentaldiseases like schizophrenia.

10) Write the structural formula of aspirin.

$C_9H_8O_4$ (or)
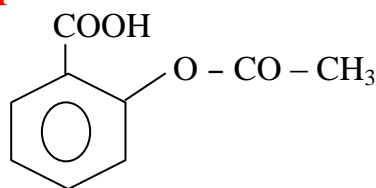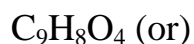
11) Explain the mechanism of cleansing action of soaps of detergents

❖ The cleansing action of soap is directly related to the structure of carboxylate ions (palmitate ion) present in soap. The structure of palmitate exhibit dual polarity. The hydrocarbon portion is non polar and the carboxyl portion is polar.

❖ The non polar portion is hydrophobic while the polar end is hydrophilic. The hydrophobic hydrocarbon portion is soluble in oils and greases, but not in water.

❖ The hydrophilic carboxylate group is soluble in water.
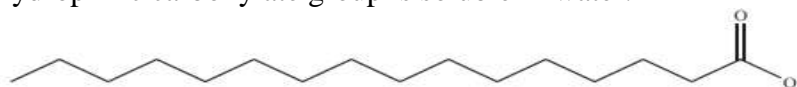
❖ When the soap is added to an oily or greasy part of the cloth. The hydrocarbon part of the soap dissolve in the grease, leaving the negatively charged carboxylate end exposed on the grease surface.

❖ At the same time the negatively charged carboxylate groups are strongly attracted by water, thus leading to the formation of small droplets called micelles and grease is floated away from the solid object

❖ When the water is rinsed away the grease goes with it. As a result, the cloth gets free from dirt and the droplets are washed away with water.

Eg. Sodium Palmitate

Detergents:-

❖ Detergents are superior to soaps as they can be used even in hard water and in acidic conditions. The cleansing action of detergents are similar to the cleansing action of soaps.

12) Which sweetening agents are used to prepare sweets for a diabetic patient?

i) Saccharin ii) Aspartarme iii) Sucralose iv) Alitame are artificial sweeteners.

13) What are narcotic and non-narcotic drugs. Give examples

Narcotic drugs relieve pain and produce sleep. These drugs are addictive. In poisonous dose, these produces coma and ultimately death.

i) **Narcotic drugs Uses**:

❖ Used for either short – term or long term relief of severe pain.

❖ Mainly used for post operative pain, pain of terminal cancer.

❖ Example: Morphine, Codeine.

❖ Non narcotic drugs are Analgesics reduce the pain without causing impairment of consciousness.

❖ They alleviate pain by reducing local inflammatory responses.

ii) **Non-narcotic drugs Uses**:

i. Used for short – term pain

ii. Relief and for modest pain like headache, muscle strain, bruising (arthritis)

Example: paracetamol, Asprin

14) What are antifertility drugs? Give examples

Antifertility drugs are synthetic hormones that suppresses ovulation (or) fertilisation.

Uses: used in birth control pills.

Example:

❖ **Synthetic oestrogen**

i. Ethynylestradiol

ii. Menstranol

❖ **Synthetic progesterone**

i. Norethindrone

ii. Norethynodrel

15) **Write a note on co- polymer**

A polymer containing two or more different kinds of monomer units is called a co-polymer.

Example:

i. Buna ‑S(SBR rubber) contains styrene and butadiene monomer units.

ii. Buna ‑N, Nylon ‑ 6, 6

16) **What are bio degradable polymers? Give examples**.

☐ The materials that are readily decomposed by microorganisms in the environment are called biodegradable.

Examples:
- ❖ Poly hydroxy butyrate (PHB)
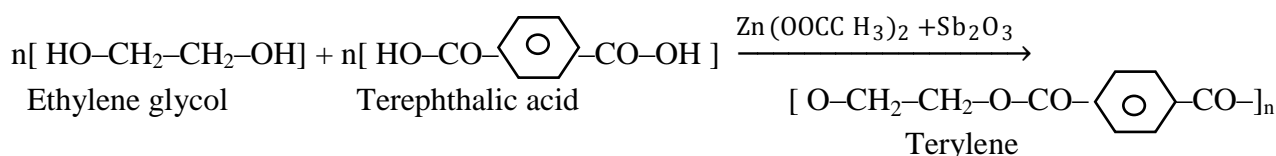- ❖ Polyglycolic acid (PGA)
- ❖ Polylactic acid (PLA)

Uses:

In medical field such as
- ❖ Surgical sutures
- ❖ Plasma substitute

17) **How is terylene prepared?**

The monomers are ethylene glycol and terephthalic acid these monomers are mixed and heated at 500K in the presence of zinc acetate and antimony trioxide catalyst, terylene is formed.

$$n[HO-CH_2-CH_2-OH] + n[HO-CO-\langle O \rangle-CO-OH] \xrightarrow{Zn(OOCCH_3)_2 + Sb_2O_3} [O-CH_2-CH_2-O-CO-\langle O \rangle-CO-]_n$$

Ethylene glycol   Terephthalic acid   Terylene

Uses:
- ❖ Blending with cotton or wool fibres.
- ❖ Glass reinforcing materials in safety helmets.

18) **Write a note on vulcanization of rubber?**
- ❖ Natural rubber is not so strong or elastic, the properties of natural rubber can be modified by the process called vulcanization.
- ❖ 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. The physical properties of rubber can be altered by controlling the amount of sulphur that is used for vulcanization.
- ❖ Ratio of sulphur controls the properties of rubber.

Sulphur Ratio	Properties of rubber
1-3%	Soft and stretchy
3 -10%	Harder but flexible

19) **Classify the following as linear, branched or cross linked polymers.**
a) Bakelite b) Nylon c) polythene

a) Bakelite	cross linked polymers
b) Nylon	linear polymers
c) Polyethene	linear polymers

20) **Differentiate thermoplastic and thermosetting**.

S.No	Thermoplastic	Thermosetting
1,	Linear polymers	Cross linked polymers
2,	They become soft on heating and hard on cooling.	Don't become soft on heating butset to an infusible mass uponheating.
3,	They can be remoulded	They cannot be remoulded
4,	Example: Polyethene, PVC, Polystrene	Example: Bakelite

Additional Questions

1. Explain the terms (i) drug (ii) medicine (iii) chemotherapy

(i) Drug:

    A drug is a substance that is used to modify or explore physiological systems or pathological statesfor the benefit of the recipient. It is used for the purpose of diagnosis, prevention, cure/relief of adisease.

(ii) Medicine:

    The drug which interacts with macromolecular targets such as proteins to produce a therapeutic anduseful biological response is called medicine.

(iii) Chemotherapy:

    The specific treatment of a disease using medicine is known as chemotherapy.

2. Define the term therapeutic index?

- ❖ Therapeutic index is defined as the ratio between the maximum tolerated dose of a drug (above
- ❖ which it becomes toxic) and the minimum curative dose (below which the drug is ineffective).
- ❖ Higher the value of therapeutic index, safer is the drug.

3. How do you classify the following into various class of drugs ?

(A) Milk of Magnesia (B) Aspirin (C) Penicillin (D) Procaine

(A) Milk of Magnesia	Antacids
(B) Aspirin	Antiinflammatory drugs
(C) Penicillin	Antimicrobials
(D) Procaine	Anaesthetics

4. Write short notes on (i) antagonists (ii) agonists

- ❖ Antagonist is drug which block the message by binding to the receptor side and inhibits tonatural function.
- ❖ Agonists are drugs which mimic the natural messenger by switching on the receptor.

5. Explain the action of antagonist and agonist with examples.

    When adenosine binds to the adenosine receptors, it induces sleepiness. On the other hand, the antagonist drug caffeine binds to the adenosine receptor and makes it inactive. This results in the reduced sleepiness (wakefulness).

    Antagonist is a drug, morphine, which is used as a pain killer, binds to the opioid receptors and activates them. This suppress the neuro transmitters that causes pain.

6. Explain Anaesthetics with example.

    Anaesthetics are two types. They are (i) Local Anaesthetics (ii) General Anaesthetics.

Types	Mode of action	Uses	Example
Local anaesthetics	It causes loss of sensation, in the area in which it is applied without losing consciousness. They block pain perception that is transmitted via peripheral nerve fibres to the brain.	They are often used during minor surgical procedures.	(i) Procaine **(Ester-linked local)** (ii)Lidocaine **(Amide-linked)**
General Anaesthetics	Cause a controlled and reversible loss of consciousness by affecting central nervous system	They are often used for major surgical procedures.	(i) Propofol (Intravenous) (ii) Isoflurane (Inhalational)

7. What are antacids? Give examples?

Antacids neutralize the acid in the stomach that causes acidity.

Uses:

To relieve symptoms such as burning sensation in the chest/ throat area (heart burns) caused by acid reflux.

Examples:

(i) Milk of Magnesia, (ii) calcium bicarbonate, (iii) Aluminium hydroxide

8. What are Antihistamines? Give examples.

Antihistamines block histamine release from histamine-1 receptors.

Uses:

To provide relief from the allergic effects.

Examples:

(i)Cetirizine, (ii) levocetirizine

9. Write short notes on Antioxidant with example.

❖ Antioxidants are substances which retard the oxidative deteriorations of food. Food containing fats and oils are easily oxidised and turn rancid.

❖ To prevent the oxidation of the fats and oils, chemical **BHT**(butylhydroxy toluene), **BHA**(Butylated hydroxy anisole) are added as food additives.

Example:-

Sulphur dioxide and sulphites are used as as antioxidants and enzyme inhibitors.

10. Define Saponificaiton.

Soaps are made from animal fats or vegetable oils. They contain glyceryl esters of long chain fatty acids. When the glycerides are heated with a solution of sodium hydroxide they become soap and glycerol..

11. Define TFM value.

The quality of a soap is described in terms of total fatty matter (TFM value). It is defined as the total amount of fatty matter that can be separated from a sample after splitting with mineral acids., Higher the TFM quantity in the soap better is its quality.

As per BIS standards

Grade-1 soaps 76% TFM,

Grade-2 soaps 70% TFM

Grade-3 soaps 60% TFM

12. Explain the types of polyethene (LDPE, HDPE)

LDPE:

It is formed by heating ethene at 200° to 300°C under oxygen as a catalyst. The reaction follows free radical mechanism. The peroxides formed from oxygen acts as a free radical initiator.

$$nCH_2 = CH_2 \xrightarrow{200°C-300°C/1000atm} (-CH_2- CH_2-) \ n$$

Ethene   Polythene
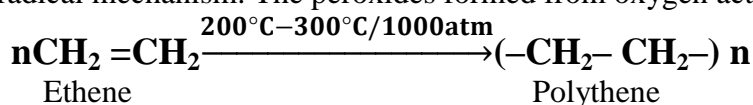
Uses:

(i) insulators for cables, making toys etc…

HDPE:

The polymerization of ethylene is carried out at 373K and 6 to 7 atm pressure using Zeiglar – Natta catalyst [$TiCl_4$ +$(C_2H_5)_3$ Al] HDPE has high density and melting point and it is used to make bottles, pipes etc..,

13. How Teflon is prepared?

The monomer is tetrafluroethylene when heated with oxygen (or) ammonium persulphate under high pressure, Teflon is obtained
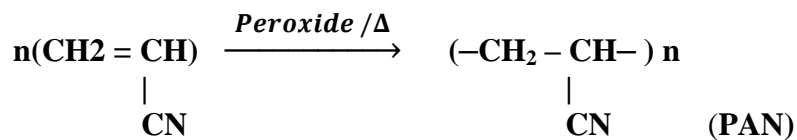
$$nCF_2 = CF_2 \xrightarrow{\Delta} (-CF_2 - CF_2-)_n$$
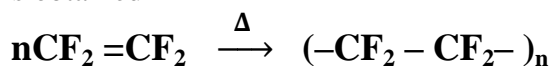
Uses:

coating articles and preparing non‐stick utensils.

14. How orlon (PAN) is prepared?

It is prepared by the addition polymerisation of vinylcyanide (acrylonitrile) using a peroxideinitiator.

$$\text{n(CH}_2 = \text{CH)} \xrightarrow{\textit{Peroxide} / \Delta} (-\text{CH}_2 - \text{CH}-)\,\text{n}$$
$$\quad\quad\quad | \quad\quad\quad\quad\quad\quad\quad\quad\quad\quad | $$
$$\quad\quad\quad \text{CN} \quad\quad\quad\quad\quad\quad\quad\quad\quad \text{CN} \quad\quad \textbf{(PAN)}$$
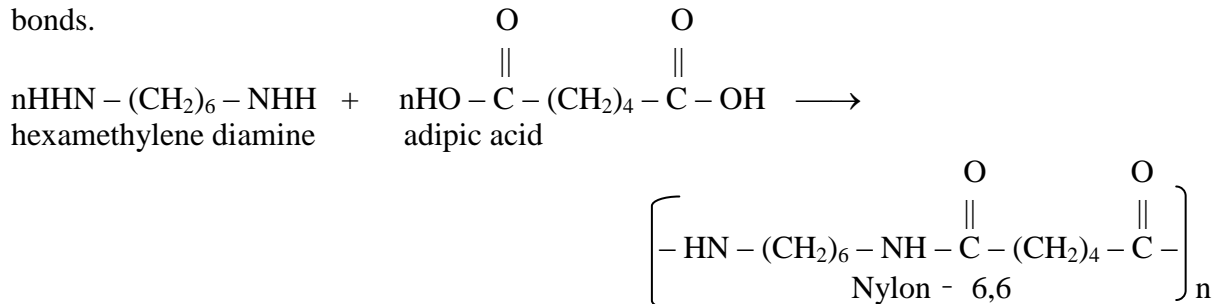
Uses:

It is used as a substitute of wool for making blankets, sweaters etc.,

15. How Nylon 6,6 is prepared? Give its use.

Nylon ‑ 6,6 can be prepared by mixing equi molar adipic acid and hexamethylene diamine in equimolar proportion to form a nylon salt which on heating eliminate a water molecule to form amide bonds.
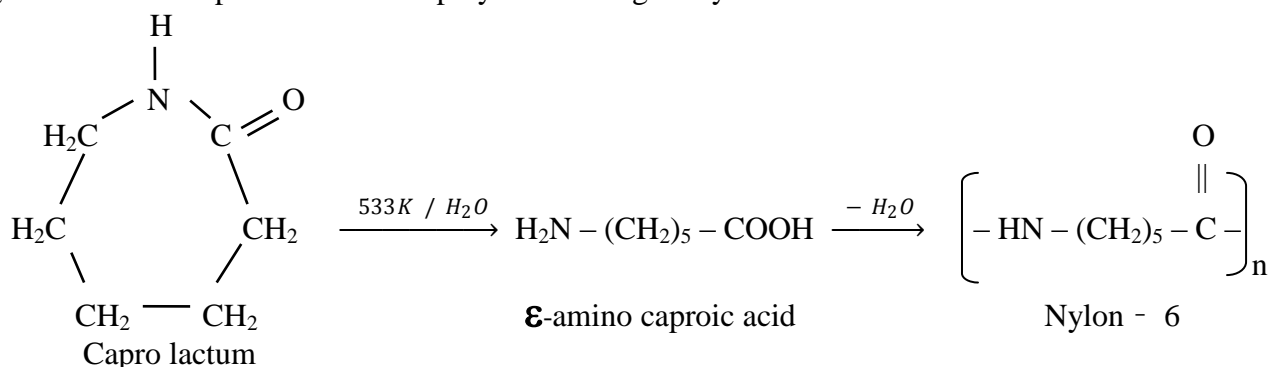
$$n\text{HHN} - (\text{CH}_2)_6 - \text{NHH} \;+\; n\text{HO} - \overset{O}{\overset{||}{C}} - (\text{CH}_2)_4 - \overset{O}{\overset{||}{C}} - \text{OH} \longrightarrow$$
hexamethylene diamine   adipic acid

$$\left[- \text{HN} - (\text{CH}_2)_6 - \text{NH} - \overset{O}{\overset{||}{C}} - (\text{CH}_2)_4 - \overset{O}{\overset{||}{C}} - \right]_n$$
Nylon ‑ 6,6

Uses:

It is used in textiles, manufacture of cards etc…

16. How Nylon-6 is prepared? Give its uses.

Capro lactum (monomer) on heating at 533K in an inert atmosphere with traces of water gives ε-amino caproic acid which polymerises to give nylon ‑6

Capro lactum $\xrightarrow{533K \,/\, H_2O}$ $H_2N - (CH_2)_5 - COOH$ $\xrightarrow{- H_2O}$ $\left[- HN - (CH_2)_5 - \overset{O}{\overset{||}{C}} - \right]_n$

ε-amino caproic acid   Nylon ‑ 6

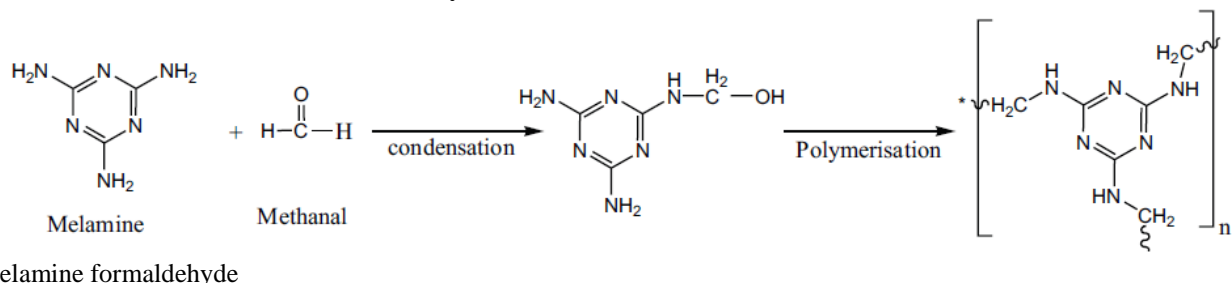**Uses:**

It is used in the manufacture of tyrecords fabrics etc….

17. How is melamine prepared? Give its uses

The monomers are melamine and formaldehyde. These monomers undergocondensation polymerisation to form melamine formaldehyde resin.
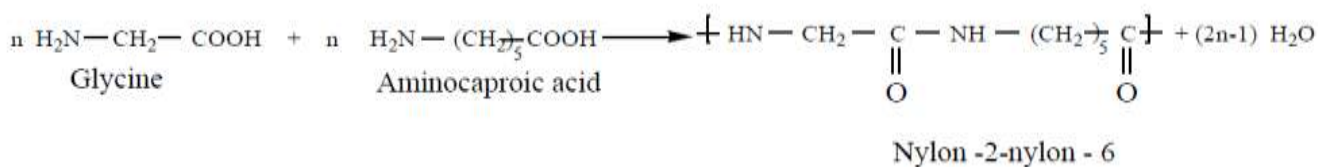

Melamine   Methanal   Melamine formaldehyde

Usage: It is used for making unbreakable crockery.

18. How Nylon -2 - Nylon-6 is prepared?

❖ It is a co ‑ polymer which contains polyamide linkages.

❖ It is obtained by the condensation polymersiation of the monomers, glycine and ∈- amino caproic acid.

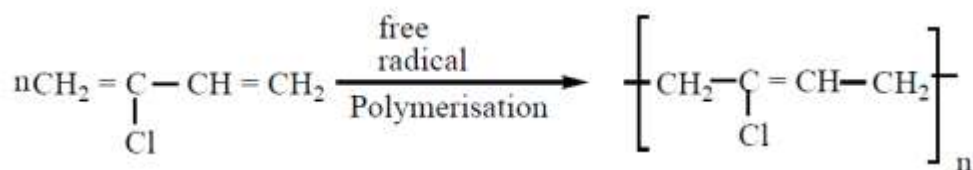❖ **Uses:** It is used in orthopaedic devices, and in controlled release of drugs

$$n \ H_2N-CH_2-COOH \ + \ n \ H_2N-(CH_2)_5COOH \longrightarrow \left[HN-CH_2-\underset{O}{\underset{\|}{C}}-NH-(CH_2)_5\underset{O}{\underset{\|}{C}}\right] + (2n\text{-}1) \ H_2O$$

Glycine   Aminocaproic acid

Nylon -2-nylon - 6

19. How is Urea formaldehyde polymer prepared?

It is formed by the condensation polymerisation of the monomers urea and formaldehyde

urea formaldehyde
polymer
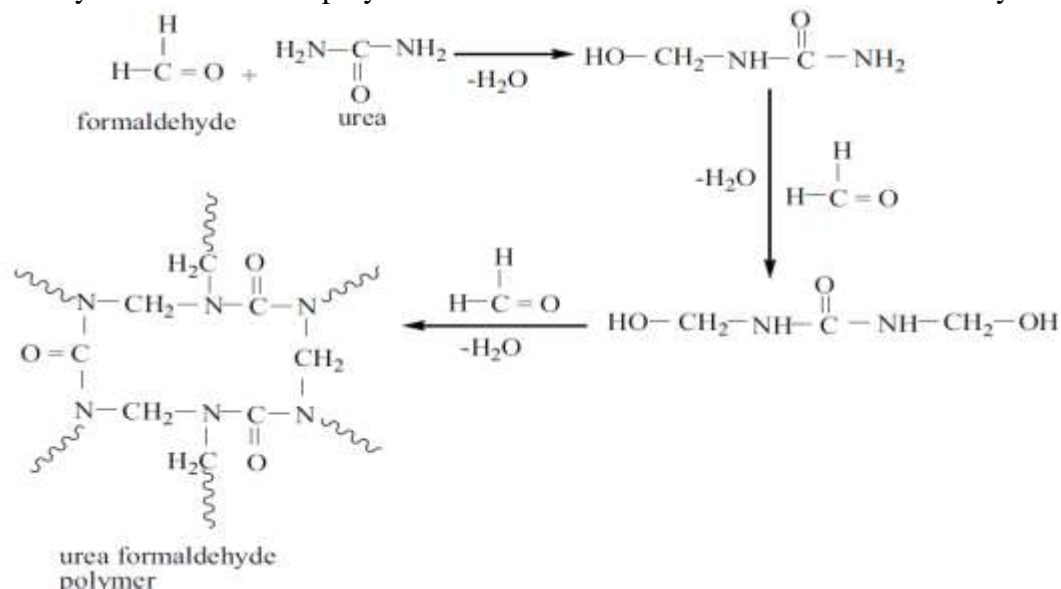
20. How Neoprene prepared? Mention its uses

The free radical polymerization of the monomer chloroprene gives Neoprene.

$$nCH_2=\underset{Cl}{\underset{|}{C}}-CH=CH_2 \xrightarrow[\text{Polymerisation}]{\text{free radical}} \left[CH_2-\underset{Cl}{\underset{|}{C}}=CH-CH_2\right]_n$$

Uses: It is used in the manufacture of **chemical containers, conveyer belts**.

21. How Buna-N rubber prepared? Mention its uses.

It is a co-polymer of acrylonitrile and buta-1,3-diene.

$$n \ CH_2=CH-CH=CH_2 \ + \ nCH_2=\underset{CN}{\underset{|}{CH}} \longrightarrow \left(CH_2-CH=CH-CH_2-\underset{CN}{\underset{|}{CH}}-CH_2\right)_n$$

                    Vinyl cyanide   Buna-N
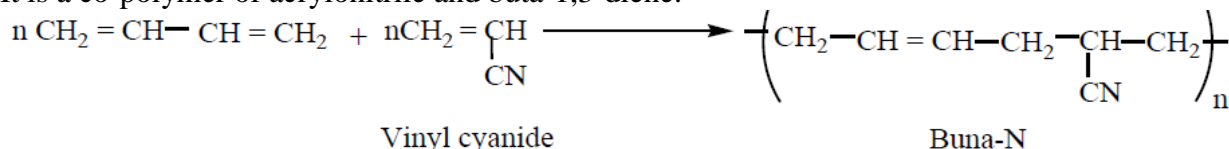
Uses: It is used in the manufacture of **hoses and tanklinings**.

22. How Buna-S rubber is prepared?

It is a co-polymer. It is obtained by the polymerisation of buta-1,3-diene and styrene in the ratio3:1 in the presence of sodium.

Vinyl benzene
(styrene)

SBR
Buna-S
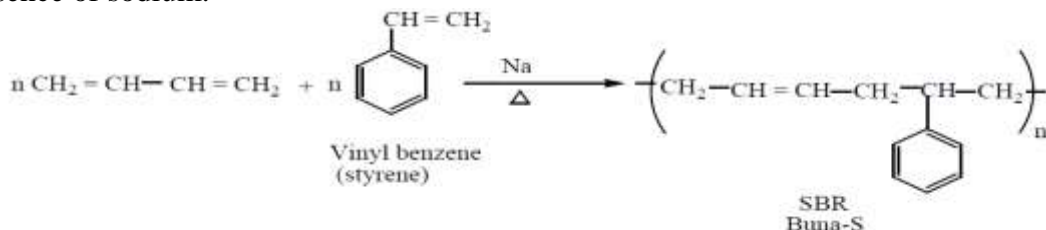
Uses: It is used in the manufacture of **Tyres and Tubes**.