1. **What are the differences between minerals and ores? Sep-2020 & May 2022**
   - ♥ A naturally occurring substance which contains the metal in free state (or) in the form of oxides, sulphides etc... is called a **mineral**.
   - ♥ A mineral that contains a high percentage of metal, from which it can be extracted conveniently and economically are called **ores**.

2. **What are gangue? Sep-2020**
   Non-metallic impurities, rocky materials and siliceous matter associated with the ores are called as gangue.The process of removal of gangue from the ore is called as concentration.

3. **Write a short note on froth floatation. June-2020 , Aug-2021**

Froth floatation process for the concentration of sulphide ores.
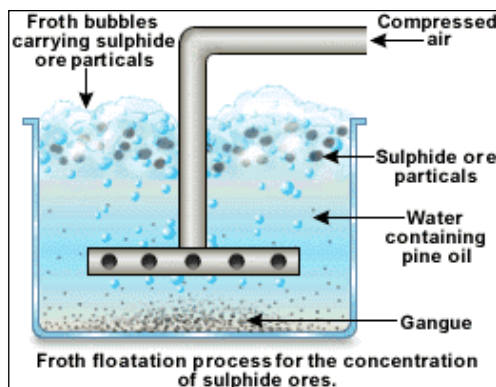
   - This method is suitable only for sulphide ores. Example: Galena, zinc blende.
   - The metallic ore which are preferentially wetted by oil can be separated from gangue.
   - The crushed ore is suspended in water and mixed with **frothing agent** such as pine oil, eucalyptus oil etc. A small amount of **sodium ethyl xanthate** is added, it acts as a collector. The collector molecules attach to the ore particle and make them water repellent.
   - A froth is generated by blowing air through this mixture.
   - Ore particles are wetted by the oil and rise to the surface along with the froth. The froth is skimmed off and dried to get the concentrated ore.
   - Gangue particles that are preferentially wetted by water settle at the bottom.
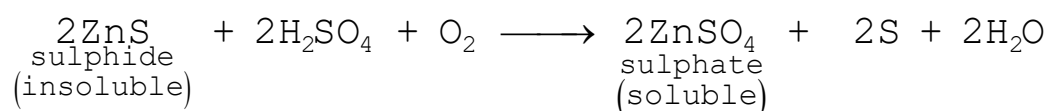
4. **Write a short note on gravity separation. May-2022**
   This method is used to concentrate oxide ores. For example: Haematite (Fe_2O_3), tin stone (SnO_2).The ore (high specific gravity) is separated from the gangue (low specific gravity).Finely powdered ore is treated with rapidly flowing current of water. The lighter gangue particles are washed away by the running water.

5. **What is the principle behind a method called leaching?**
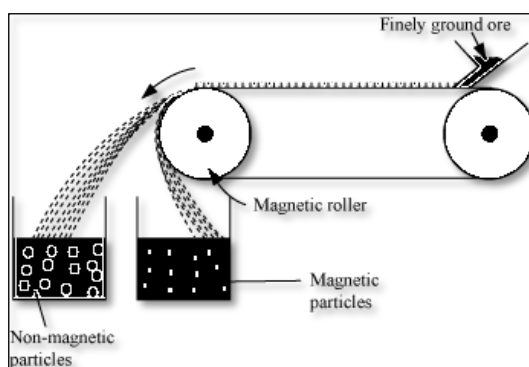   - ✓ This method is based on the solubility of the ore in a suitable solvent.
   - ✓ The crushed ore is allowed to dissolve in a suitable solvent.
   - ✓ Metal is converted to its soluble salt or complex, gangue remains insoluble.

6. **What is acid leaching? Sep-2022**
   Sulphide ores are leached with hot aqueous sulphuric acid. Insoluble sulphide is converted into soluble sulphate and elemental sulphur.

$$\underset{\substack{\text{sulphide}\\(\text{insoluble})}}{2ZnS} + 2H_2SO_4 + O_2 \longrightarrow \underset{\substack{\text{sulphate}\\(\text{soluble})}}{2ZnSO_4} + 2S + 2H_2O$$

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7. **Write a short note on magnetic separation.**

- This is based on the difference in the magnetic properties of ore and impurities.
- Crushed ore is poured on to an electromagnetic separator consisting of a belt moving over two rollers of which one is magnetic.
- The magnetic ore particles are attracted towards the magnet and collected as a heap close to the magnetic region.Non-magnetic impurities are collected as a separate heap away from magnetic region.
- For example: Tin stone (nonmagnetic) is separated from wolframite (magnetic) impurities.

8. **What is roasting?**

The process in which the concentrated ore is heated in the presence of excess oxygen is called roasting. Roasting is carried out below the melting point of the metal. During Roasting sulphide ores are converted into their oxides.

$$2PbS + 3O_2 \xrightarrow{\Delta} 2PbO + 2SO_2$$

$$2ZnS + 3O_2 \xrightarrow{\Delta} 2ZnO + 2SO_2$$
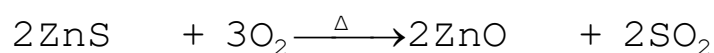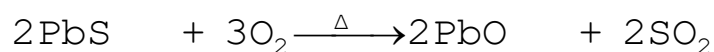
Impurities such as S, P and As are converted into volatile oxides and removed.

9. **What is Calcination?**

The process in which the concentrated ore is heated in the absence of oxygen is called Calcination.

(i) Organic matter expelled leaving behind a porous ore.

(ii) Water is expelled from hydrated ore.

(iii) Carbonate ore is converted into its oxide and carbon dioxide is expelled

$$PbCO_3 \xrightarrow{\Delta} PbO + CO_2$$

$$ZnCO_3 \xrightarrow{\Delta} ZnO + CO_2$$
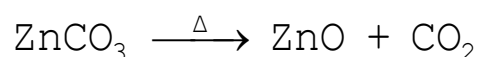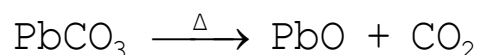
10. **What is smelting? Explain with an example.**

The process in which the ore is heated with reducing agents such as C, CO , Al etc beyond its melting point is called smelting. Usually smelting is carried out in the presence of a flux.

For example,

Fe_2O_3 can be reduced by carbon monoxide as follows.

$$Fe_2O_3 + 3CO \longrightarrow 2Fe + 3CO_2$$
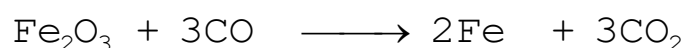
The ore is smelted with basic flux limestone (CaO).

The silica gangue present in the ore is acidic in nature, it combines with limestone (CaO) form calcium silicate (slag).

$$\underset{(flux)}{CaO} + \underset{(gangue)}{SiO_2} \longrightarrow \underset{(slag)}{CaSiO_3}$$
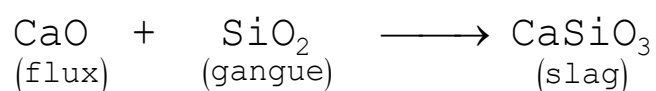
11. What is the role of Limestone in the extraction of Iron from its oxide Fe_2O_3? June-2020

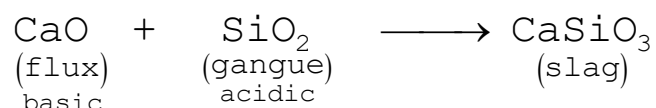In the extraction of Iron from its oxide ore Fe_2O_3 (haematite ore), lime stone is added as a basic flux to remove acidic SiO_2 present as gangue.

$$\underset{\substack{(flux)\\basic}}{CaO} + \underset{\substack{(gangue)\\acidic}}{SiO_2} \longrightarrow \underset{(slag)}{CaSiO_3}$$

12. What is flux?

A substance that combines with gangue to form an easily fusible slag is called a flux. Slag separates more easily from the ore than the gangue.

Examples: SiO_2, CaO... etc are used as fluxes in metallurgy.

13. What is slag? Explain with an example. Sep-2020

An easily fusible substance obtained when the ore is heated with flux is called a slag. The gangue present in the ore reacts with flux to form slag.
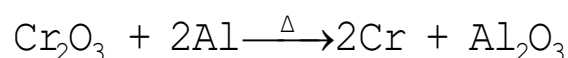
$$\underset{(flux)}{CaO} + \underset{(gangue)}{SiO_2} \longrightarrow \underset{(slag)}{CaSiO_3}$$
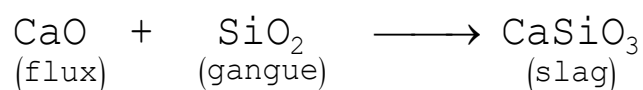
14. Write a note on Aluminothermite process.

Cr_2O_3 is mixed with Aluminium powder in a fire clay crucible. The reduction process is initiated by an ignition mixture ($Mg + BaO_2$).

$$BaO_2 + Mg \longrightarrow BaO + MgO$$
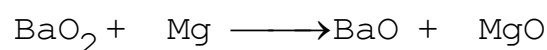
During the above reaction a large amount of heat is evolved which facilitates the reduction.(

$\Delta H = 852 kJmol^{-1}(\gg 2400^{0}C))$

$$Cr_2O_3 + 2Al \xrightarrow{\Delta} 2Cr + Al_2O_3$$

15. Give the limitations of Ellingham diagram.

1. It gives information about the thermodynamic feasibility of a reaction. It does not tell anything about the rate of the reaction.
2. It does not give any idea about the possibility of other reactions that may take place.
3. The interpretation of ΔG is based on the assumption that the reactants are in equilibrium with the products which is not always true.

16. Explain the principle involved in zone refining. Mar-2020 & Mar-2023

Principle: The principle involved in Zone refining is fractional crystallisation. When the molten impure metal is allowed to solidify, the impurities prefer to be in the molten region.

Process: Impure metal is taken in the form of a rod. One end of the rod is heated using a mobile induction heater which results in melting of the metal on that portion of the rod. When the heater is slowly moved to the other end, the pure metal crystallises while the impurities will move on to the adjacent molten zone. As the heater moves further away, the molten zone containing impurities also moves along with it.

The process is repeated several times in the same direction to get high purity. This process is carried out in an inert gas atmosphere to prevent the oxidation of metals. Ge, Si and Ga are refined by this process.

**17. Give the basic requirement for vapour phase refining.**

♣ Metal must be able to form a volatile compound with the particular reagent.
♣ The volatile compound must decompose to give the pure metal.

18. How is nickel refined by Mond's process? May-2022

Impure nickel is heated in a stream of carbon monoxide at 350 K. Nickel reacts with CO to form a highly volatile Nickel tetra carbonyl. The solid impurities are left behind.

$$\text{Ni} + 4\text{CO} \xrightarrow{350K} \text{Ni(CO)}_4$$
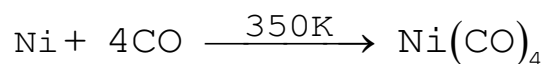
Nickel tetracarbonyl is decomposed at 460 K to get pure Nickel.

$$\text{Ni(CO)}_4 \xrightarrow{460K} \text{Ni} + 4\text{CO}$$
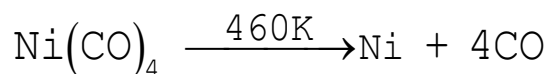
19. Explain the principle of electrolytic refining with an example. Sep-2022

The crude metal is refined by electrolysis in an electrolytic cell.

Anode   : Impure silver rod

Cathode   : Pure silver strip

Electrolyte : Acidified aqueous solution of silver nitrate

When a current is passed through the electrodes,

≈   Silver atoms from anode, lose electrons and enter the solution.

At anode   : $\text{Ag} \longrightarrow \text{Ag}^+ + \text{e}^-$

≈   Silver cations migrate towards the cathode and gets reduced and deposited.

At cathode   : $\text{Ag}^+ + \text{e}^- \longrightarrow \text{Ag}$

20. Explain how Titanium is refined by Van-Arkel method.

Impure Titanium is heated with iodine at 550 K in an evacuated vessel to form the volatile titanium tetra-iodide (TiI_4). Impurities do not react with Iodine and are left behind.

$$\text{Ti} + 2\text{I}_2 \xrightarrow{550K} \text{TiI}_4$$
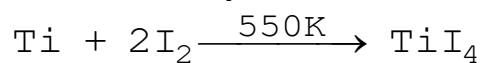
When TiI_4 vapour is passed over a tungsten filament at 1800 K, it decomposes to give pure titanium which deposits on the filament.

$$\text{TiI}_4 \longrightarrow \text{Ti} + 2\text{I}_2$$
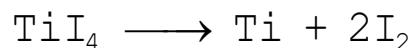
UNIT-2 P-BLOCK ELEMENTS-I

1. **What is inert pair effect? Explain with an example. May-2022**

   In p- block elements, while moving down a group, the outer s electrons (ns) have a tendency to remain inert and show reluctance to take part in the bonding. This is known as inert pair effect.

2. **What is catenation? Sep-2020**

   The tendency of an element to form a chain of bonds with itself or with other atoms is known as catenation.**Carbon has a greater tendency of catenation.**

3. **What are the necessary conditions for catenation? (or) Bring out the reasons for an extreme tendency of carbon for catenation. Mar-2020 & Sep-2022**

   ≈ Catenation is an ability of an element to form chain of atoms.

   ≈ The following conditions are necessary for catenation.

      a. The element should have its valency greater than or equal to 2.
      b. The element should have an ability to bond with itself.
      c. The self-bond must be as strong as its bond with other elements.
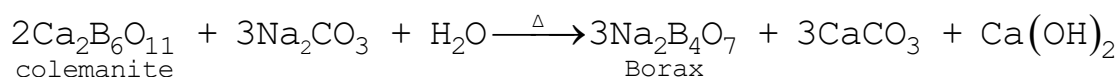   d. Kinetic inertness of catenated compound towards other molecules.

   ≈ Carbon possesses all the above properties and forms a wide range of catenated compounds.

4. **List the Uses of boron.**

   1. $_5B^{10}$ Absorbs neutrons, therefore it is used as moderator in nuclear reactors.
   2. Amorphous boron is used as a rocket fuel igniter.
   3. Boron is essential for the cell walls of plants.
   4. Boric acid and borax are used in eye drops, antiseptics, washing powders etc.
   5. Boric acid is used in the manufacture of Pyrex glass.

5. **How is borax prepared from colemanite ore?**

   Borax is a sodium salt of tetra boric acid. It is obtained by boiling colemanite ore solution with sodium carbonate.
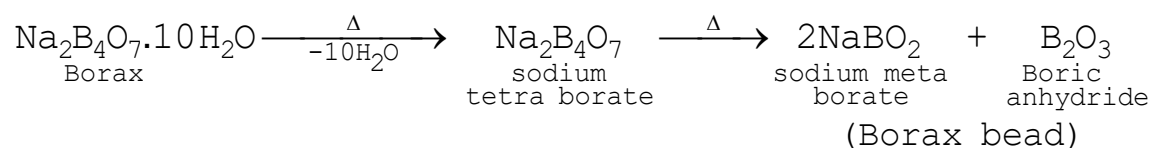
   $$\underset{\text{colemanite}}{2Ca_2B_6O_{11}} + 3Na_2CO_3 + H_2O \xrightarrow{\Delta} \underset{\text{Borax}}{3Na_2B_4O_7} + 3CaCO_3 + Ca(OH)_2$$

6. **List the Uses of borax. Aug-2021**

   1. Borax is used for the identification of coloured metal ions.
   2. It is used in the manufacture of optical and borosilicate glass, enamels and glazes for pottery
   3. It is used as a flux in metallurgy.
   4. It acts as a preservative.

7. **What are borax beads? (or) what is borax bead test? How is it useful in identifying transition metal ions?**

   On heating, borax first loses water molecules and swells up. On further heating it turns into a transparent liquid, which solidifies into glass like material known as borax bead.

   $$\underset{\text{Borax}}{Na_2B_4O_7.10H_2O} \xrightarrow[-10H_2O]{\Delta} \underset{\substack{\text{sodium} \\ \text{tetra borate}}}{Na_2B_4O_7} \xrightarrow{\Delta} \underset{\substack{\text{sodium meta} \\ \text{borate}}}{2NaBO_2} + \underset{\substack{\text{Boric} \\ \text{anhydride}}}{B_2O_3}$$
   $$\text{(Borax bead)}$$

   The metaborates of many transition metals have characteristic colours. For example: $Co(BO_2)_2$ is blue.

8. **How will you identify borate radical? (or) what is ethyl borate test? Mar-2023**

When boric acid or borate salt is heated with ethyl alcohol in presence of conc. sulphuric acid, an ester, trialkylborate is formed.

$$\underset{\substack{\text{boric}\\\text{acid}}}{B(OH)_3} + \underset{\text{Ethanol}}{3C_2H_5OH} \xrightarrow[\Delta]{\text{conc } H_2SO_4} \underset{\substack{\text{Triethyl}\\\text{borate}}}{B(OC_2H_5)_3} + 3H_2O$$
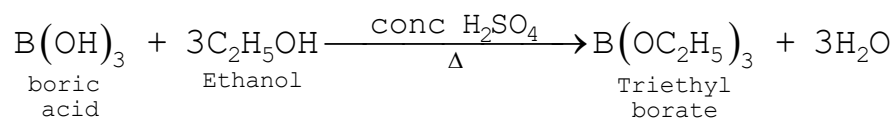
The vapour of this ester burns with a green edged flame and this reaction is used to identify the presence of borate radicals.

9. **List the Uses of boric acid. May-2022 & Sep-2022**

   1. Boric acid is used in the manufacture of pottery glasses, enamels and pigments.
   2. It is used as an antiseptic and as an eye lotion
   3. It is used as a food preservative.

10. **List the Uses of diborane.**

   - Diborane is used as a high energy fuel for propellant.
   - It is used as a reducing agent in organic chemistry.
   - It is used in welding torches.

11. **Explain the Reaction of diborane with ammonia(OR) What is inorganic benzene?**

Diborane reacts with ammonia at higher temperatures give borazine (or) borazole.

$$3B_2H_6 + 6NH_3 \xrightarrow[\text{closed vessel}]{180-190^0C} 2 \underset{\text{Borazole}}{B_3N_3H_6} + 12H_2 \uparrow$$
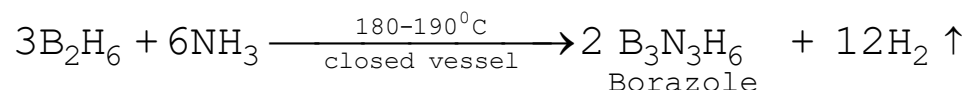
It is known as Inorganic benzene because of its structural resemblance with benzene.

12. **Describe the structure of diborane. Mar-2023**

   ♥ In diborane two BH₂ units are linked by two bridged Hydrogens.

   ♥ There are eight B-H bonds. However, it contains only 12 valance electrons.

   ♥ The 4 terminal B-H bonds are normal covalent bonds.
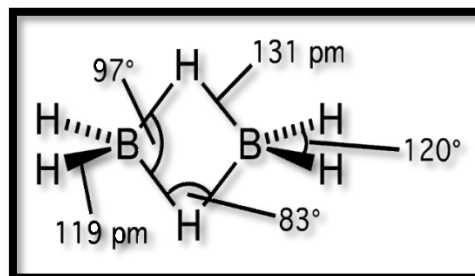
   ♥ The remaining four electrons have to be used for the bridged bonds. i.e. two three cantered B-H-B bonds utilize two electrons each. Hence, these bonds are three centre- two electron bonds (3c-2e).The bridging hydrogen atoms are in a same plane.

   ♥ In diborane, the boron is sp^3 hybridised, three of the four sp^3 hybridised orbitals contains single electron and the fourth orbital is empty.

   ♥ Two half-filled hybridised orbitals of each boron overlap with the two Hydrogens to form four terminal 2c-2e bonds, leaving one empty and one half filled hybridised orbitals on each boron.

   ♥ The 3c-2e B-H-B bond formation involves 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.

13. **Write a note on McAfee process.**

$AlCl_3$ is obtained by heating a mixture of alumina and coke in a current of chlorine.

$$Al_2O_3 + 3C + 3Cl_2 \longrightarrow 2AlCl_3 + 3CO$$
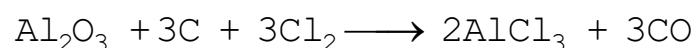
14. How is potash alum prepared? June-2020

The Alunite (or) alum stone is $K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 4Al(OH)_3$. When alum stone is treated with excess of sulphuric acid, the aluminium hydroxide is converted to aluminium sulphate.
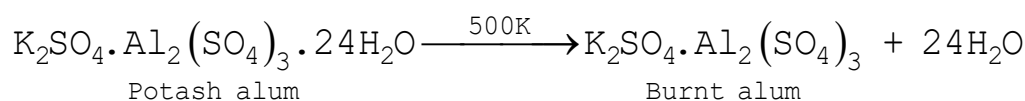
$$K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 4Al(OH)_3 + 6H_2SO_4 \xrightarrow{\Delta} K_2SO_4 + 3Al_2(SO_4)_3 + 12H_2O$$
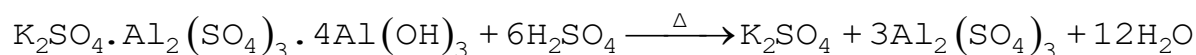
A calculated quality of potassium sulphate is added and the solution is crystallized to generate potash alum.

$$K_2SO_4 + Al_2(SO_4)_3 + 24H_2O \xrightarrow{\Delta} K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O$$
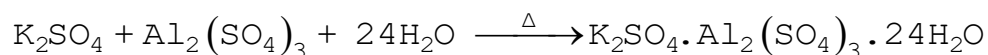
It is purified by recrystallization.

15. Discuss the action of heat on potash alum.

When potash alum is heated, At 500 K it loses water of hydration and swells up. The swollen mass is known as burnt alum.

$$\underset{\text{Potash alum}}{K_2SO_4 \cdot Al_2(SO_4)_3 \cdot 24H_2O} \xrightarrow{500K} \underset{\text{Burnt alum}}{K_2SO_4 \cdot Al_2(SO_4)_3} + 24H_2O$$

Heating to red hot it decomposes into potassium sulphate, alumina and sulphur trioxide.

$$\underset{\text{Burnt alum}}{K_2SO_4 \cdot Al_2(SO_4)_3} \xrightarrow{\text{Red hot}} K_2SO_4 + Al_2O_3 + 3SO_3$$
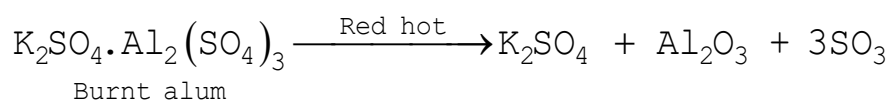
16. List the Uses of potash alum.
1. It is used for purification of water.
2. It is used for water proofing and textiles.
3. It is used in dyeing, paper and leather tanning industries.
4. It is employed as a styptic agent to arrest bleeding.

17. Write a note on the following:
(i) Fullerenes:
   ✓ They exist as discrete molecules such as C_{32}, C_{50}, C_{60}, C_{70}, C_{76} etc..
   ✓ They have cage like structures.
   ✓ C_{60} Molecule has soccer ball structure and is called Buckminster fullerene or Bucky balls. It has a fused ring structure consists of 20 six membered rings and 12 five membered rings.
   ✓ Each carbon atom is SP^2 hybridised and forms three σ bonds & a delocalized π bond giving aromatic character to these molecules. The C-C bond distance is 1.44 Å and C=C distance 1.38 Å.

(ii) Carbon nanotubes:
   ♣ Carbon nano tubes have graphite like tubes with fullerene ends.
   ♣ Along the axis, they are stronger than steel and conduct electricity.
   ♣ They are used in Nano scale electronics, catalysis, polymers and medicine.

(iii) Graphene:
   ♥ Graphene has a single planar sheet of sp^2 hybridised carbon atoms that are densely packed in a honeycomb crystal lattice.

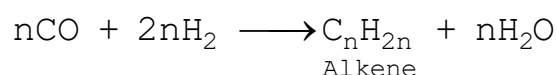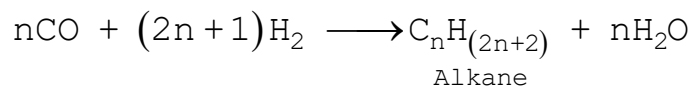## 18. What is phosgene gas? What for it is used?

Carbonyl chloride is known as phosgene. It is a highly poisonous gas. Phosgene is prepared by treating CO with chlorine in presence of light or charcoal.

$$CO + Cl_2 \xrightarrow{\text{light}} COCl_2$$
$$\text{phosgene}$$
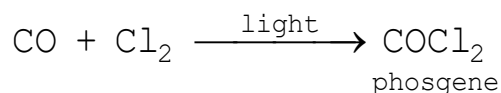
It is used in the synthesis of isocyanate.

19. Write a note on Fisher Tropsch synthesis. Mar-2023

Carbon monoxide reacts with hydrogen in the presence of metal catalyst, at a pressure of less than 50 atm, at a temperature of 500 - 700 K, to yields saturated and unsaturated hydrocarbons.

$$nCO + (2n+1)H_2 \longrightarrow C_nH_{(2n+2)} + nH_2O$$
$$\text{Alkane}$$

$$nCO + 2nH_2 \longrightarrow C_nH_{2n} + nH_2O$$
$$\text{Alkene}$$

20. Write a note on Water gas equilibrium.

The equilibrium involved in the reaction between carbon dioxide and hydrogen, has many industrial applications and is called water gas equilibrium.

$$CO_2 + H_2 \rightleftharpoons CO + H_2O$$
$$\text{water gas}$$
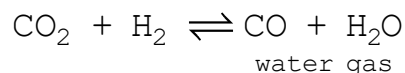
21. How are silicones prepared?

Dialkyldichlorosilanes (R_2SiCl_2) are prepared by passing vapours of RCl or ArCl over silicon at 570 K with copper as a catalyst.

$$2RCl + Si \xrightarrow{\text{Cu/570 K}} R_2SiCl_2$$
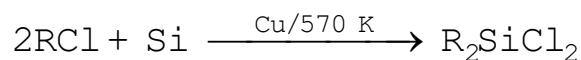
The hydrolysis of R_2SiCl_2 yields to a straight chain polymer which grown from both the sides.
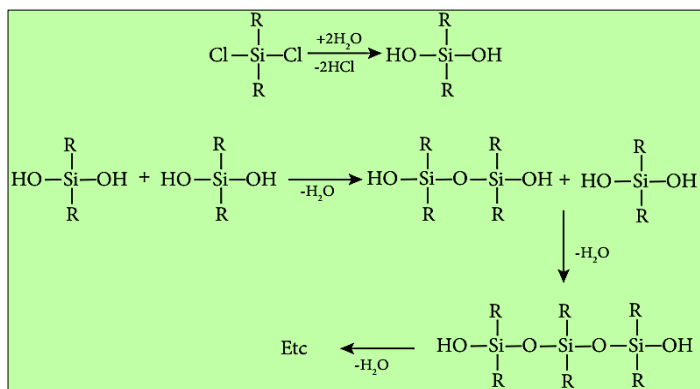
The hydrolysis of $RSiCl_3$ yields to a very complex cross linked polymer.

Linear silicones can be converted into cyclic or ring silicones when water molecules is removed from the terminal –OH groups.

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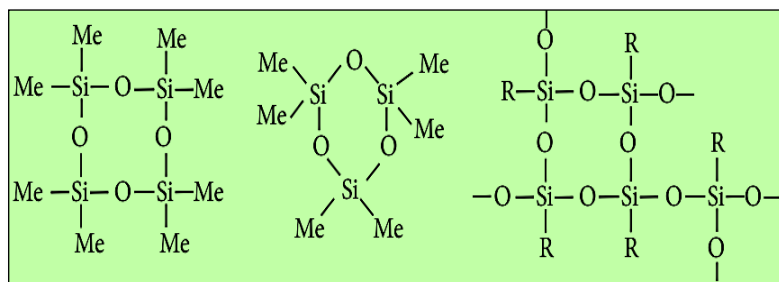
22. List the characteristics of silicones.

- All silicones are water repellent because of their organic side groups.
- They are thermal and electrical insulators.
- They are chemically inert.
- Lower silicones are oily liquids, whereas long chain silicones are waxy solids.
- Viscosity of silicon oil doesn't change with temperature, they don't thicken during winter.
- The extent of cross linking and nature of alkyl group determine the nature of polymer. They range from oily liquids to rubber like solids.

23. List the uses of silicones. Mar-2023

- Silicones are used for low temperature lubrication and in vacuum pumps, high temperature oil baths etc...
- They are used for making water proofing clothes.
- They are used as insulting material in electrical motor and other appliances
- They are mixed with paints and enamels to make them resistant towards high temperature, sunlight, dampness and chemicals.

# UNIT-3 -P-BLOCK ELEMENTS –II

1. Write a short note on allotropes of phosphorous.

S.NO	yellow phosphorous	Red phosphorous
1	It is poisonous	It is Non-poisonous
2	It has garlic smell	It has no smell
3	It glows in the dark due to oxidation which is called phosphorescence	It is and does not show Phosphorescence
4	Its ignition temperature is very low	It does not ignite at low temperatures

2. How is phosphine prepared?

Phosphine is prepared by action of sodium hydroxide with white phosphorous in an inert atmosphere.

$$P_4 + 3NaOH + 3H_2O \xrightarrow{CO_2} 3NaH_2PO_2 + PH_3$$
$$\text{sodium hypophosphite} \quad \text{Phosphine}$$
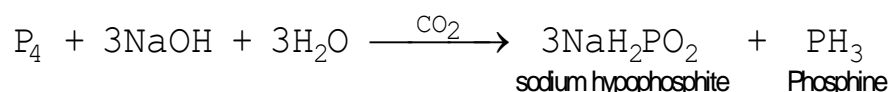
3. List the Uses of phosphine. (or) write a note on holme's signal. Sep-2020

1. It is used for producing smoke screen.
2. When a perforated container containing a mixture of calcium carbide and calcium phosphide is thrown into the sea, it liberates a mixture of phosphine and acetylene. Phosphine catches fire and ignites acetylene. These burning gases serves as a signal to the approaching ships. This is known as **Holmes signal**.

4. How is ozone prepared in the laboratory?

Ozone is prepared by passing electrical discharge through oxygen. At a potential of 20,000 V about 10% of oxygen is converted into ozone. This mixture is known as ozonised oxygen. Pure ozone is obtained as a pale blue gas by the fractional distillation of liquefied ozonised oxygen.

$$O_2 \rightleftharpoons 2(O) \qquad\qquad O_2 + (O) \rightleftharpoons O_3$$

5. Show that ozone is a powerful oxidising agent.

Ozone is a powerful oxidising agent. It oxidises potassium iodide to iodine. This reaction is quantitative and can be used for estimation of ozone.

$$O_3 + KI + H_2O \longrightarrow 2KOH + O_2 + I_2$$
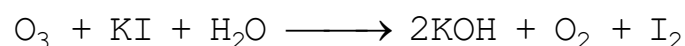
6. List the uses of oxygen. May-2022

1. Oxygen is one of the essential components for the survival of living organisms.
2. oxygen is used in welding process (oxyacetylene welding)
3. Liquid oxygen is used as fuel in rockets etc…

7. Discuss the reducing property of sulphur dioxide.

Sulphur dioxide reduces chlorine into hydrochloric acid.

$$Cl_2 + 2H_2O + SO_2 \longrightarrow 2HCl + H_2SO_4$$
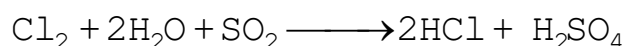
8. Discuss the bleaching action of sulphur dioxide. Aug-2021

In presence of water, SO_2 bleaches coloured wool, silk, sponges and straw into colourless due to its reducing property.

$$SO_2 + 2H_2O \longrightarrow 2H_2SO_4 + 2(H)$$

$$\underset{\text{Coloured}}{X} + 2(H) \longrightarrow \underset{\text{colourless}}{XH_2}$$
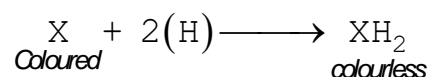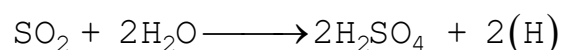
The bleached product is reoxidised by atmospheric oxygen to its original colour.

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9. **Give a reason to support that sulphuric acid is a dehydrating agent.**

    Sulphuric acid has strong affinity towards water and hence it can be used as a dehydrating agent.

    Example. $HCOOH + H_2SO_4 \longrightarrow CO + H_2SO_4.H_2O$
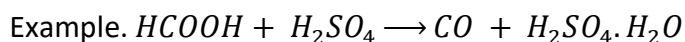
10. **Give the uses of sulphuric acid.**
    1. It is used in the manufacture of fertilisers like ammonium sulphate, super phosphates and other chemicals such as hydrochloric acid, nitric acid etc...
    2. It is used as a drying agent and in the preparation of pigments, explosives etc..

11. **Give a test for sulphuric acid.**

    Dilute sulphuric acid gives white precipitate with barium chloride solution.

    $$H_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + 2HCl$$

12. **How is chlorine manufactured by electrolysis of brine solution?**

    Chlorine is manufactured by the electrolysis of aqueous solution of brine (NaCl).

    $$NaCl \longrightarrow Na^+ + Cl^-$$
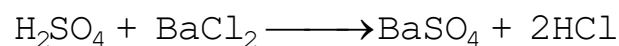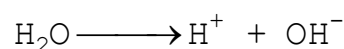 $$H_2O \longrightarrow H^+ + OH^-$$
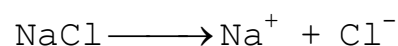
    Na^+ and OH^- ions combine to forms sodium hydroxide.

    $$Na^+ + OH^- \longrightarrow NaOH$$
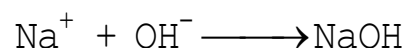
    Hydrogen and chlorine are liberated at respective electrodes.

    @cathode   *@anode*

    $H^+ + e^- \longrightarrow H$ $Cl^- \longrightarrow Cl + e^-$

    $H + H \longrightarrow H_2$ $Cl + Cl \longrightarrow Cl_2$
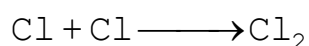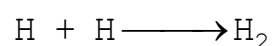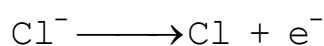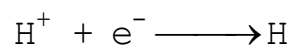
13. **How is chlorine manufactured by Deacon's process? June-2020**

    A mixture of air and HCl is passed up a chamber containing a number of shelves in which pumice stones soaked in cuprous chloride are placed. Hot gases at about 723 K are passed through a jacket that surrounds the chamber.

    $$4HCl + O_2 \xrightarrow{400^0C \ / \ Cu_2Cl_2} 2H_2O + 2Cl_2$$
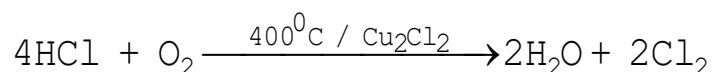
14. **Discuss the bleaching action of chlorine.**

    Chlorine is a strong bleaching agent because it forms nascent oxygen.

    $$Cl_2 + H_2O \longrightarrow HOCl + HCl$$
    $$HOCl \longrightarrow HCl + (O)$$
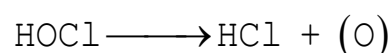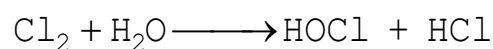
15. **How is bleaching powder prepared from chlorine? Mar-2020 & May-2022**

    Bleaching powder is produced by passing chlorine gas through dry slaked lime.

    $$Ca(OH)_2 + Cl_2 \longrightarrow CaOCl_2 + H_2O$$
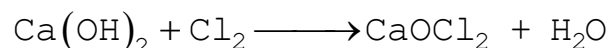
16. **List the uses of chlorine.**
    1. Chlorine is used to purify drinking water
    2. It is used in Bleaching of cotton textiles, paper and rayon.
    3. It is used in Extraction of gold and platinum.

17. HF cannot be stored in glass bottles. Why? Mar-2020

Moist hydrofluoric acid (not dry) rapidly react with silica and glass. Hence it cannot be stored in glass bottles.

$$SiO_2 + 4HF \longrightarrow SiF_4 + 2H_2O$$
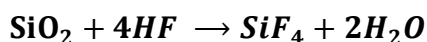
18. What are interhalogen compounds? Give examples. Aug-2021 & May-2022

The compounds formed by the combination of two different halogens are called interhalogen compounds. Examples: ClF, ClF_3, ICl, $BrCl$ etc

19. What are the properties of interhalogen compounds? July 2022

1. It can be formed only between two halogen and not more than two halogens.
2. The central atom will be the larger one.
3. Fluorine being the smallest one it cannot act as a central metal atom.
4. They can undergo the auto ionization.

20. Why are the elements of Group 18 known as noble gases?

Group 18 elements have their valence shell orbitals completely filled and, therefore, react with a few elements only under certain conditions. Therefore, they are now known as noble gases.

21. Discuss the structure of ammonia molecule.

Shape	:	Pyramidal
N-H bond distance	:	1.016 Å
H-H bond distance	:	1.645 Å
Bond angle	:	107 °

The structure of ammonia may be regarded as a tetrahedral with one lone pair of electrons in one tetrahedral position.
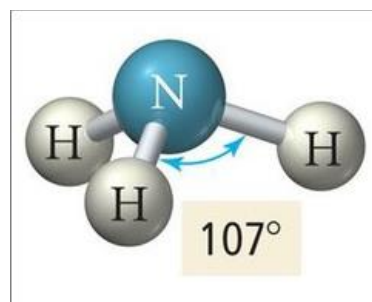
22. List the uses of Argon.

Argon prevents the oxidation of hot filaments in bulbs.

23. List the uses of Helium. Sep-2020

♣ He – O₂ mixture is used by sea divers. This mixture prevents the painful "bends".
♣ Helium is used for filling air balloons
♣ Helium is used in cryogenics.

UNIT-4 TRANSITION & INNER TRANSITION ELEMENTS

1. **What are transition metals? Give four examples.**

   An element whose atom has an incomplete d sub shell or which can give rise to cation with an incomplete d sub shell is called a transition metal. Examples: Cu, Fe, Zn, Au..

2. **Write the electronic configurations of Chromium and Copper.**

   $$_{24}Cr - [Ar]3d^5 4s^1$$
   $$_{29}Cu - [Ar]3d^{10} 4s^1.$$
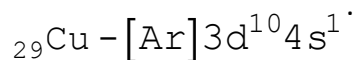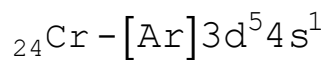
   Chromium gets extra stability due to half-filled electronic configuration.

   Copper gets extra stability due to fully-filled electronic configuration.

3. **Why transition elements show variable oxidation states?**

   Transition elements exhibit variable oxidation state. This is because,
   - They have more number of electrons in (n-1)d and ns orbitals.
   - The energy difference between them (n-1)d and ns orbitals is very small.

4. **Why is Cr^{2+} reducing and Mn^{3+} oxidizing when both have d^4 configuration?**

   ➢ $Cr^{2+}(d^4)$ Readily loses one electron and changed into $Cr^{3+}(d^3)$ ion having half-filled t_{2g} level. Thus Cr^{2+} ion is a strong reducing agent.

   ➢ $Mn^{3+}(d^4)$ Readily accepts one electron and changed into $Mn^{2+}(d^5)$ ion having half-filled d^5 configuration. Thus Mn^{3+} ion is a strong oxidising agent.

5. **Which is a stronger reducing agent $Cr^{2+} (or) Fe^{2+}$ and why?**

   - $Cr^{2+}(d^4)$ is stronger reducing agent than $Fe^{2+}(d^6)$
   - Reason:
     $d^4 \rightarrow d^3$ occurs in case of $Cr^{2+} \rightarrow Cr^{3+}$ but,
     $d^6 \rightarrow d^5$ occurs in case of $Fe^{2+} \rightarrow Fe^{3+}$
   - In a medium (like water) d^3 is more stable as compared to d^5 *(# CFSE)*

6. **Which metal of 3d series exhibits +1 oxidation state most frequently and why? Sep-2020**

   Copper most frequently exhibit +1 oxidation state, because Cu^+ ion is stabilized by fully filled $3d^{10}$ configuration.

7. **Calculate the number of unpaired electrons in Ti³⁺ and calculate the spin only magnetic moment.** (Aug 21)

   electronic configuration of Ti : $3d^2\ 4s^2$

   electronic configuration of Ti^{3+} : $3d^1\ 4s^0$

   Ti^{3+} ion consists of only one unpaired electron. Its spin only magnetic moment is

   $$\mu = \sqrt{1(1+2)} = \sqrt{3} = 1.73\mu_B$$

8. **What are the essential conditions for the formation of alloys?** (or) **Explain Hume-Rothery theory of alloys.**

According to Hume-Rothery rule to form substitute alloy
- The difference between the atomic radii of solvent and solute is less than 15%.
- Both solvent and solute must have the same crystal structure and valency.
- The electro negativity difference must be close to zero.

Transition metals satisfy these rules and hence they form a number of alloys.

9. **What are interstitial compounds? (Sep 20, Aug 21)**

A compound that is formed when small atoms like Hydrogen, Boron, Carbon or Nitrogen are trapped in the interstitial hole in a metal lattice is called an interstitial compound. They are usually non-stoichiometric compounds. Examples : $TiC, ZrH_{1.92}, Mn_4N$ etc .

10. **List the properties of interstitial compounds? May-2022**
- They are hard and show electrical and thermal conductivity.
- They have high melting points higher than those of pure metals.
- Transition metal hydrides are used as powerful reducing agents.
- Metallic carbides are chemically inert.

11. **Why do transition elements form more number of complexes?**

1. Small size of the metal ion.

2. High positive charge density of the metal ion.

3. Availability of low energy vacant orbitals to accept an electron pairs.

Examples: $[Fe(CN)_6]^{4-}$

12. **Transition metals and their compounds act as good catalysts. Why?**
- They have energetically available d orbitals to accept electrons from reactant molecule.
- Metal can form bond with reactant molecule using its d electrons.
- The variable oxidation states of transition metals.

13. **How is Potassium dichromate prepared from chromate ore? (or) Describe the preparation of potassium dichromate.**

$$4FeO.Cr_2O_3 + 8Na_2CO_3 + 7O_2 \xrightarrow{900-1000^0C} 8Na_2CrO_4 + 2Fe_2O_3 + 8CO_2 \uparrow$$
$$2Na_2CrO_4 + H_2SO_4 \longrightarrow Na_2Cr_2O_7 + Na_2SO_4 + H_2O$$
$$Na_2Cr_2O_7 + 2KCl \longrightarrow K_2Cr_2O_7 + 2NaCl$$
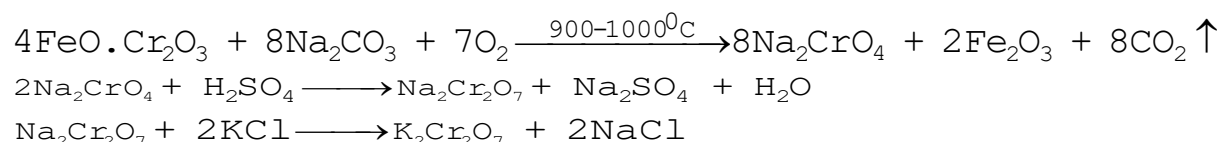
14. **What is Chromyl chloride test? Mar-2020**

When $K_2Cr_2O_7$ is heated with any chloride salt in the presence of Conc H_2SO_4, orange red vapours of chromyl chloride (CrO_2Cl_2) is evolved.

$$K_2Cr_2O_7 + 4NaCl + 6H_2SO_4 \longrightarrow \underset{Chromyl\ chloride}{2CrO_2Cl_2} + 2KHSO_4 + 4NaHSO_4 + 3H_2O$$ The

CrO_2Cl_2 vapours are dissolved in NaOH solution, then acidified with acetic acid and treated with lead acetate. A yellow precipitate of PbCrO₄ is obtained.

$$CrO_2Cl_2 + 4NaOH \longrightarrow Na_2CrO_4 + 2NaCl + 2H_2O$$
$$Na_2CrO_4 + (CH_3COO)_2Pb \longrightarrow \underset{\substack{Leadchromate \\ (Yellowprecipitate)}}{PbCrO_4} \downarrow + 2CH_3COONa$$

15. List the uses of potassium dichromate.

- $K_2Cr_2O_7$ It is used as a strong oxidizing agent.
- It is used in dyeing and printing.
- It used in leather tanneries for chrome tanning.
- It is used in quantitative analysis of iron compound and iodides.
- It is used photography for hardening gelatin films.

16. What are inner transition elements?

The elements in which last electron enters into the $(n-2)f$ orbital are called inner transition or f- block elements. F- Block consists of two series of elements.

(i) Lanthanoids.   (ii) Actinoids.

17. What is Zeiglet-Natta catalyst? Mention its uses.

A mixture of TiCl₄ and tri alkyl aluminium is called zeigler natta catalyst. It is used as a catalyst in polymerisation reactions.

18. What are Lanthanoids? Give three examples.

The 14 elements from Cerium ($_{58}$Ce) to Lutetium ($_{71}$Lu) following Lanthanum ($_{57}$La) are called Lanthanoids. They are characterised by the preferential filling of 4f orbital. Examples: Ce, Gd, Lu

19. What is lanthanide contraction? What are the effects of lanthanide contraction?

As we move across from La to Lu in 4f series, there is a gradual decrease in atomic and ionic radii of Lanthanoids with increase of atomic number. This decrease in ionic size is called Lanthanoid contraction.

Cause of Lanthanoid contraction:

1. As we move from one element to another in 4f series, the nuclear charge increases by one unit and an additional electron enters the same 4f sub shell.
2. 4f sub shell is diffused and the shielding effect of 4f electrons are relatively poor.\
3. When nuclear charge increases, the valence shell is pulled slightly towards nucleus. As a result, the elective nuclear charge increases and the size of Ln^{3+} ions decreases.

Consequences of Lanthanoid contraction:

1. **Basicity differences**

   As we from $Ce^{3+} - Ln^{3+}$, the size of Ln^{3+} ions decreases, the ionic character of $Ln - OH$ bond decreases (covalent character increases) which results in the decrease in the basicity of $Ln(OH)_3$.

2. **Similarities among Lanthanoids:**

   In the complete f - series only 10 pm decrease in atomic radii and 20 pm decrease in ionic radii is observed. Because of very small change in radii of Lanthanoids, their chemical properties are quite similar.

20. Out of Lu(OH)₃ and La(OH)₃ which is more basic and why?

Because of Lanthanoid contraction, while moving from La^{3+} to Lu^{3+}, the size of Ln^{3+} ions decreases, the ionic character of $Ln - OH$ bond decreases, covalent character increases. Thus $La(OH)_3$ is the most basic, $Lu(OH)_3$ is least basic.

21. What are actinides? Give three examples.

The 14 elements from Thorium ($_{90}$Th) to Lawrencium ($_{103}$Lr) following Actinium ($_{89}$Ac) are called Actinoids. They are characterised by the preferential filling of 5f orbital. Examples: Th, U, Pu

22. Compare lanthanides and actinides. Sep-2022 & MARCH 2023

s.no	Lanthanoids	Actinoids
1	Differentiating electron enters in 4f orbital	Differentiating electron enters in 5f orbital
2	Binding energy of 4f orbitals are higher	Binding energy of 5f orbitals are lower
3	Less tendency to form complexes	Greater tendency to form complexes
4	Most of the Lanthanoids are colourless	Most of the Actinoids are coloured.
5	They do not form Oxo cations	They do form Oxo cations.
6	oxidation states : +2,+3,+4	oxidation states : +3,+4,+5,+6,+7

UNIT-5 COORDINATION CHEMISTRY

1. Differentiate between Double salts and Coordination complexes. June-2020 & Aug-2021

s.no	Double salts	Coordination complexes
1	Formed by the evaporation of solution containing two simple salts	formed from a Lewis acid and Lewis base.
2	In solutions they lose their identity and dissociate into their constitute ions.	They do not lose its identity and never dissociate to give simple ions
3	Ex: mohr'ssalt $- FeSO_4.(NH_4)_2SO_4.6H_2O$	$Ex:$ $K_4[Fe(CN)_6]$

2. What is Coordination entity?

Coordination entity is an ion or a neutral molecule, composed of a central metal atom/ion and the array of ligands that are attached to it. In the formula, the coordination entity is enclosed in square brackets. For example: The coordination entity of $K_4[Fe(CN)_6]$ is $[Fe(CN)_6]^{4-}$

3. What is Coordination polyhedron?

The three dimensional spatial arrangement of ligands that are directly attached to the central atom is known as the coordination polyhedron.

In $K_4[Fe(CN)_6]$, the coordination polyhedra is octahedral.

4. What are homoleptic and heteroleptic complexes? Give two examples.

♣ The complex in which central metal ion/atom is coordinated to only one kind of ligands is called a homoleptic complex.Examples: $[Co(NH_3)_6]Cl_3$

♣ The complex in which the central metal ion/atom is coordinated to more than one kind of ligands is called a heteroleptic complex. Examples: $[Co(NH_3)_5 Cl]Cl_2$

5. Write the names of the following ligands. Sep-2022

(a) $C_2O_4^{2-}$ (b) H_2O (c) Cl^-

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

**6. Write the ligand, central metal ion, and IUPAC name of the complex $[Ag(NH_3)_2]^+$. Sep-2022**

Ligand – Ammine

Central metal ion - Ag^+

IUPAC Name – diamminesilver(I) ion

7. What are coordinate isomers? Explain with an example.

Bimetallic complexes containing complex cation and complex anion exhibit coordination isomerism. The exchange of one or more ligands between the coordination entities result in different isomers. For example:

$[Co(NH_3)_6][Cr(CN)_6]$ and $[Cr(NH_3)_6][Co(CN)_6]$
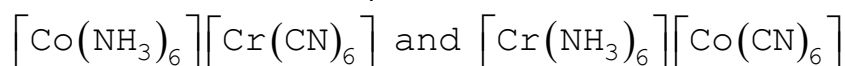
8. What is linkage isomerism? Explain with an example.

This type of isomerism arises when an ambidentate ligand binds the central metal ion through either of its two different donor atoms. For example: The nitrite ion can bind to the central metal ion either through N- atom or through O- atom.

$[Co(NH_3)_5(NO_2)]^{2+}$ and $[Co(NH_3)_5(ONO)]^{2+}$ are linkage isomers.
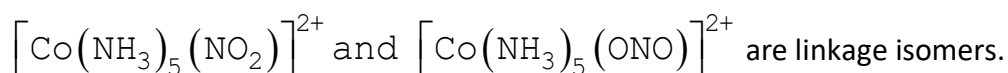
9. **What is Ionisation isomerism? Explain with an example.**

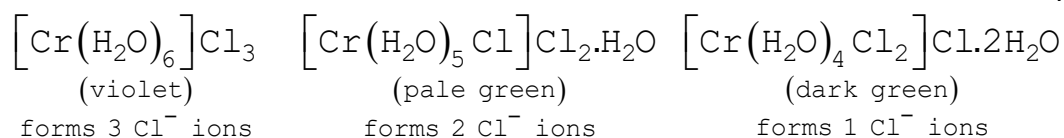This type of isomerism arises when one or more ligands are exchanged with ionisable counter ions. They will release different ions in solution. For example:

$\left[Pt(en)_2 Cl_2 \right] Br_2$: free Br^- ions are released in solution.

$\left[Pt(en)_2 Br_2 \right] Cl_2$: free Cl^- ions are released in solution.

10. **What are hydrate isomers or solvate isomers? Explain with an example.**

This type of isomerism arises when one or more ligands are exchanged with solvent molecules such as water, ammonia, alcohol etc., from the crystal lattice. For example, $CrCl_3.6H_2O$ has three hydrate isomers as shown below. If water is solvent, then these isomers are called hydrate isomers.

$\left[Cr(H_2O)_6 \right] Cl_3$ $\left[Cr(H_2O)_5 Cl \right] Cl_2.H_2O$ $\left[Cr(H_2O)_4 Cl_2 \right] Cl.2H_2O$
    (violet)   (pale green)   (dark green)
  forms 3 Cl^- ions   forms 2 Cl^- ions   forms 1 Cl^- ions

11. **What are fac and mer isomers? Explain with an example.**

- ♥ Octahedral complex of the type $\left[MA_3B_3 \right]^{n\pm}$ shows geometrical isomerism.
- ♥ The isomer in which the three similar ligands present in the corners of one triangular face is referred as a fac (facial) isomer.
- ♥ The isomer in which the three similar ligands are present around the meridian is referred as mer (Meridional) isomer.
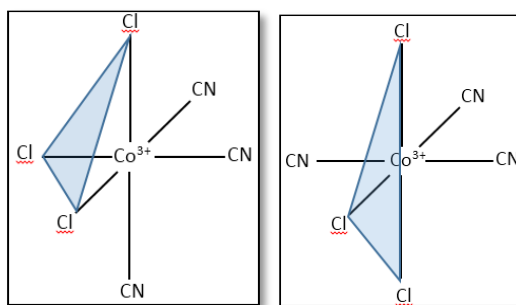
fac (facial)   mer (Meridional)

12. **Mention the metal complexes and their metal ions used in biologicaL Systems.(OR) Give two examples of biologically important coordination compounds.**

s.no	Complex	Found in	Biological importance
1	Fe^{2+}-Porphyrin complex	Red blood corpuscles (RBC)	Carries O2 from lungs to tissues and CO2 from tissues to lungs.
2	Mg^{2+}-corrin complex	Chlorophyll (green pigment in green plants)	Plays an important role in photosynthesis. $xCO_2 + yH_2O \xrightarrow{chlorophyll} C_x(H_2O)_y + xO_2$

13. Explain the postulates of Werner's theory. Sep-2020 & May-2022
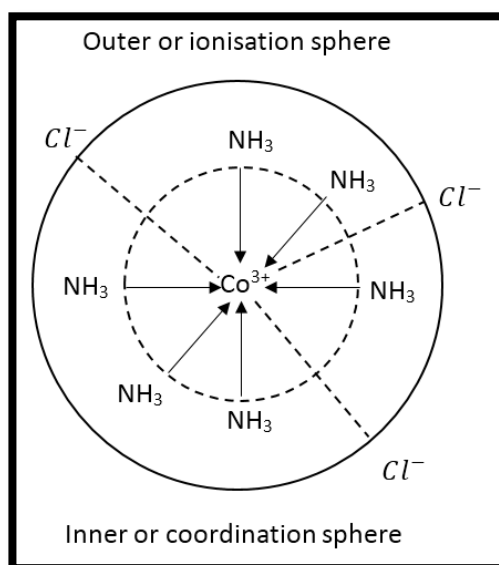
1. Most of the elements exhibit, two types of valencies.
   (i)   Primary valency - referred as the oxidation state of the metal ion.
   (ii)   Secondary valence- referred as the coordination number of the metal ion.
2. Primary valence of a metal ion is positive, they are always satisfied by negative ions. In some cases the primary valency may be zero.

   $CoCl_3. 6NH_3$: The primary valence is +3 and is satisfied by $3Cl^-$ ions.
3. Secondary valence is satisfied by negative ions, neutral molecules, positive ions or the combination of these.

   $CoCl_3. 6NH_3$: The secondary valence is 6 and is satisfied by $6NH_3$ molecules.
4. There are two spheres of attraction around a metal atom/ion in a complex.
   (i)   The inner sphere (or) coordination sphere: The groups in this sphere are firmly attached to the central metal ion and are non-ionisable.
   (ii)   The outer sphere (or) ionisation sphere. The groups in this sphere are loosely bound to the central metal ion, and are ionisable.
5. The primary valences are non-directional but secondary valences are directional.
6. The geometry of the complex is determined by the spatial arrangement of the groups which satisfy the secondary valence. For example,
   (i)   Secondary valence 6   : Octahedral.
   (ii)   Secondary valence 4   : Tetrahedral or square planar.
- ♥ **Limitations of Werner's theory:**
   Werner's theory does not explain their colour and the magnetic properties.

14. What Limitations of VB theory? SEP-2021 & JULY -02022
   i.   It does not explain the colour of the complex.
   ii.   It considers only the spin only magnetic moments. But, no other components of magnetic moments.
   iii. 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.

15. In an octahedral crystal field, draw the figure to show splitting of d orbitals. June-2022

During crystal field splitting in octahedral field, in order to maintain the average energy of the orbitals (bary centre) constant, the energy of the orbitals $d_{x^2-y^2}$ and d_{z^2} (e_g orbitals) will increase by $\left(\frac{3}{5}\right)\Delta_0$ while that of the other three orbitals d_{xy}, d_{yz} and d_{zx} (t_{2g} orbitals) decrease by $\left(\frac{2}{5}\right)\Delta_0$. Here, Δ_0 represents the crystal field splitting energy in the octahedral field.
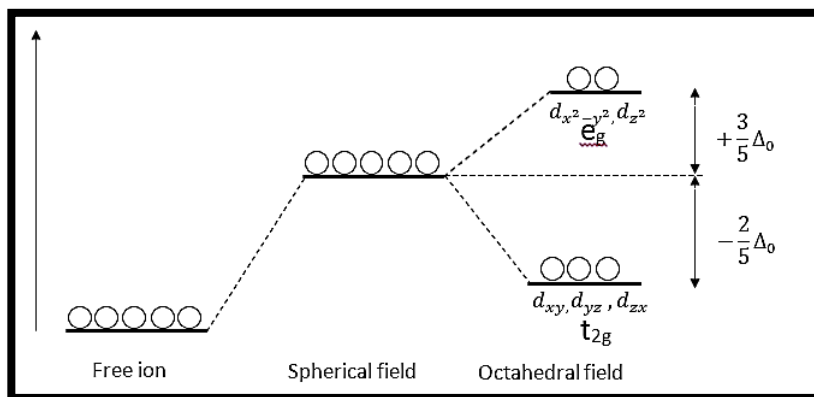
16. Explain the crystal field splitting in tetrahedral complexes.

❖ the four ligands approach the central metal atom along the direction of the leading diagonals drawn from alternate corners of the cube.

❖ In tetrahedral complexes none of the d orbitals point directly towards the ligands.

❖ However the t_2 orbitals (d_{xy}, d_{yz} and d_{zx}) are pointing close to the direction in which ligands are approaching than the e orbitals ($d_{x^2-y^2}$ and d_{z^2}).

❖ As a result, the energies of t_2 orbitals increases by $\left(\frac{2}{5}\right)\Delta_t$ and that of e orbitals decreases by $\left(\frac{3}{5}\right)\Delta_t$ as shown below. When compared to the octahedral field, this splitting is inverted and the splitting energy is less. The relation between the crystal field splitting energy in octahedral and tetrahedral ligand field is given by the expression; $\Delta_t = \left(\frac{4}{9}\right)\Delta_0$
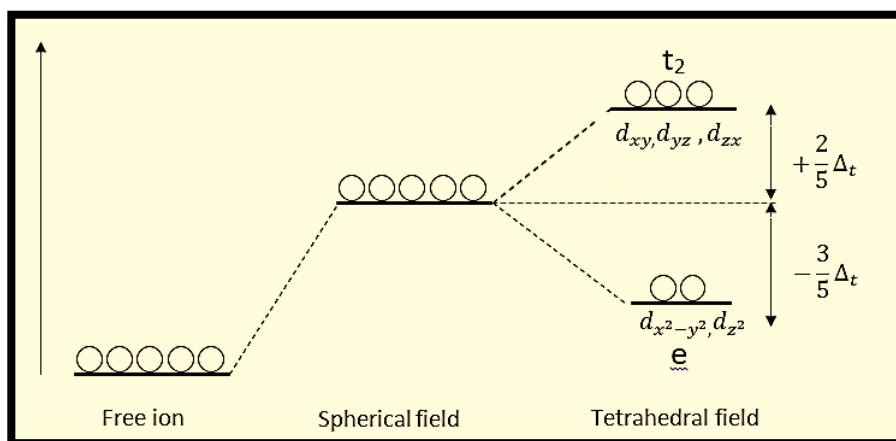
17. What is crystal field stabilization energy (CFSE) ?

The crystal field stabilization energy is defined as the energy difference of electronic configurations in the ligand fled (E_{LF}) and the isotropic field/ barycentre (E_{iso}).

$$\text{CFSE}(\Delta E) = (E_{LF}) - (E_{iso})$$
$$= \{[n_{t_{2g}}(-0.4) + n_{e_g}(0.6)]\,\Delta o + n_p P\} - \{n'_p P\}$$

Here,

$n_{t_{2g}}$ -   the number of electrons in t_{2g} orbitals;

n_{e_g} -   the number of electrons in e_g orbitals;

n_p -   the number of electron pairs in the ligand field;

n'_p -   the number of electron pairs in the isotropic field

18. What is crystal field splitting energy (CFSE)?

In an octahedral complexes, the d orbitals of central metal ion splits into two sets namely t_{2g} and e_g in the ligand field. The separation in energies of these two sets is called crystal filed splitting energy.

19. $\left[Ti(H_2O)_6\right]^{3+}$ **is coloured , while** $\left[Sc(H_2O)_6\right]^{3+}$ **is colourless- explain. MARCH-2020**

The central metal ion in the complex $\left[Ti(H_2O)_6\right]^{3+}$ is Ti^{3+}. Its electronic configuration is d^1.this complex exhibits d-d transition, hence it is coloured.

The central metal ion in the complex $\left[Sc(H_2O)_6\right]^{3+}$ is Sc^{3+}. Its electronic configuration is d^0.this complex exhibits no d-d transition, hence it is colourless.

20. What is d-d transition? Explain.

The electron transition from low energy t_{2g} orbitals to high energy e_g orbital by absorbing sunlight in the visible region is called as d-d transition.

21. What are metal carbonyls? Give an example.

The coordination compounds formed by the combination of CO with transition metal atoms in their low oxidation states are called metallic carbonyls.Example: $\left[Ni(CO)_4\right]$

22. What are terminal and bridging carbonyl groups? give an example.

❖ The carbonyl ligands that are attached to only one metal atom are referred to as *terminal* carbonyl groups.

❖ The carbonyl ligands that are attached to two metal atoms simultaneously are called *bridging* carbonyls.

UNIT-6 - Solid state

1. Differentiate crystalline solids and amorphous solids.

S.No	Crystalline solids	Amorphous solids
1	Orderly arrangement of constituents over a long range.	Random arrangement of constituents.
2	They have definite shape.	They have Irregular shape.
3	They are anisotropic	They are isotropic.
4	They are true solids	They are super cooled liquids
5	They have definite heat of fusion	They do not have definite heat of fusion
7	Examples: NaCl , diamond etc.,	Examples: Rubber , plastics, glass etc

2. Give the characteristics of ionic crystals.

- The structural units of an ionic crystal are cations and anions
- Ionic solids have high melting points.
- They do not conduct electricity in solid state, because the ions are not free to move.
- They do conduct electricity in molten state or in solution because, the ions are free to move.
- They are hard as only strong external force can change the relative positions of ions.

3. Define unit cell.

The fundamental repeating structural unit of a crystalline solid is called a unit cell. A unit cell is characterized by the three edge lengths (a, b & c) and the angle between the edges α, β and γ (interfacial angles)

4. What is 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. In bcc each atom is surrounded by 8 neighboring atoms. Hence its coordination number is 8.

5. Write the Bragg's equation? Explain the terms in it.

The fundamental equation that relates inter planar distance (d) in a crystal, the wave length of X rays and the angle of diffraction is called a Bragg's equation.

$$n\lambda = 2d \sin\theta$$
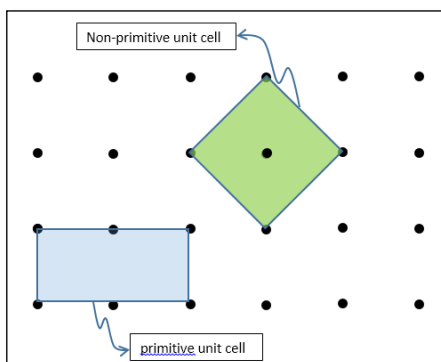
$\lambda - wavelength\ of\ X-ray$; $\theta -$ diffraction angle , d- inter planar distance

6. What are Primitive and non-primitive unit cell?

primitive unit cell : A unit cell in which only the corners are occupied.

non-primitive unit cell : A unit cell in which constituent particles present either at body centre or at face centres in addition to those at corners is called.
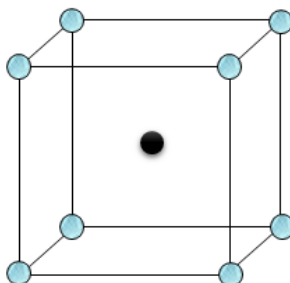
7. **Calculate the number of atoms in a body centred cubic (BCC) unit cell.**
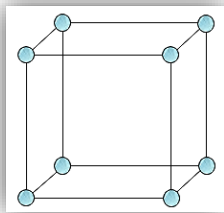
$$\therefore no \ of \ atoms \ in \ a \ \text{SC} \ unit \ cell \ = \left(\frac{Nc}{8} \right)$$

$$= \left(\frac{8}{8} \right) = 1$$

8. **Calculate the number of atoms in a body centred cubic (BCC) unit cell.**

$$\therefore \text{Number of atoms in a bcc unitcell} \ = \left(\frac{Nc}{8} \right) + \left(\frac{N_b}{1} \right)$$

$$= \left(\frac{8}{8} \right) + \left(\frac{1}{1} \right)$$

$$= 2$$

9. **Calculate the number of atoms in a face centred cubic (FCC) unit cell.**
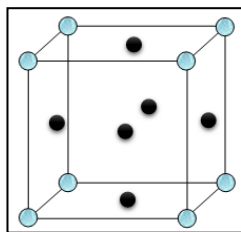
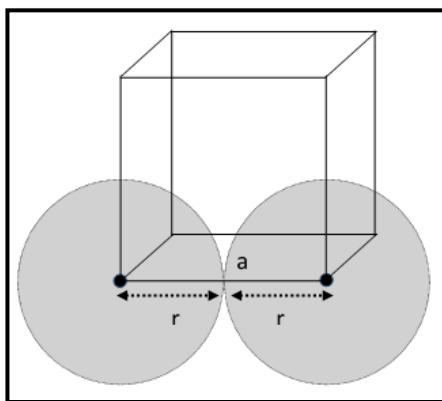$$\therefore \text{Number of atoms in a fcc unitcell} = \left(\frac{Nc}{8} \right) + \left(\frac{N_f}{2} \right)$$

$$= \left(\frac{8}{8} \right) + \left(\frac{6}{2} \right)$$

$$= 4$$

10. Calculate the packing fraction in simple cubic crystal.

In SC unit cell, each corner is occupied by identical constitutes. They touch along the edges of the cube and do not touch diagonally.

If the edge length of the unit cell is a. then the $Volume\ of\ the\ unit\ cell = a^3$

If the radius of the sphere is r then $\quad\quad a = 2r \implies r = \left(\frac{a}{2}\right)$

∴ Volume of the sphere with radius 'r' is $\quad\quad V = \left(\frac{4}{3}\right)\pi r^3$

$$V = \left(\frac{4}{3}\right)\pi\left(\frac{a}{2}\right)^3$$

$$V = \left(\frac{\pi}{6}\right)a^3$$

In a simple cubic arrangement, number of spheres belongs to a unit cell is 1

∴ Total volume occupied by the spheres in SC unit cell $= 1 \times \left(\frac{\pi}{6}\right)a^3$

$$\text{Packing fraction} = \left(\frac{\text{Total volume occupied by spheres in a unit cell}}{\text{Volume of the unit cell}}\right) \times 100$$

$$\text{Packing fraction} = \frac{\left(\frac{\pi a^3}{6}\right)}{\left(a^3\right)} \times 100$$

$$= \frac{100\,\pi}{6}$$

$$= 52.33\%$$

In simple cubic packing, the packing fraction is only **52.33%.**

---

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

In bcc arrangement, the spheres are touching along the leading diagonal of the cube.

Volume of the unit cell $= a^3$

Length of the cube diagonal $DF = \sqrt{3}\, a$

If the radius of the sphere is r then

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

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

∴ Volume of the sphere with radius 'r' is $V = \left(\dfrac{4}{3}\right) \pi\, r^3$

$$V = \frac{4}{3}\pi \left(\frac{\sqrt{3}}{4}a\right)^3$$

$$V = \frac{\sqrt{3}}{16}\pi\, a^3$$

In a bcc arrangement, number of spheres belongs to a unit cell is 2

Total volume occupied by the spheres in unit cell $= 2 \times \left(\dfrac{\sqrt{3}\,\pi\, a^3}{16}\right)$

$$= \frac{\sqrt{3}\,\pi\, a^3}{8}$$

$$\text{Packing fraction} = \left(\frac{\substack{\text{Total volume occupied by}\\ \text{spheres in a unit cell}}}{\text{Volume of the unit cell}}\right) \times 100$$

$$\text{Packing fraction} = \frac{\left(\dfrac{\sqrt{3}\,\pi\, a^3}{8}\right)}{\left(a^3\right)} \times 100$$

$$= \frac{\sqrt{3}\,\pi}{8} \times 100 = \frac{1.732 \times 3.14 \times 100}{8}$$

$$= 68\ \%$$

In body centered cubic packing, the packing fraction is 68%. The available space is used more efficiently than in simple cubic packing.

12. Calculate the percentage efficiency of packing in fcc crystal.

In fcc arrangement, the spheres are touching along the face diagonal.
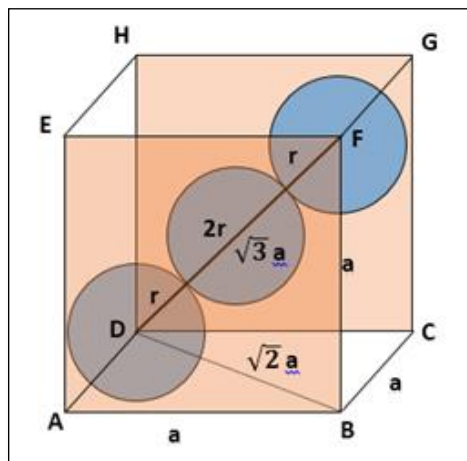
Volume of the unit cell $= a^3$

Length of the face diagonal $= \sqrt{2}\ a$

If the radius of the sphere is r then

$4r = \sqrt{2}\ a \quad ; \qquad r = \dfrac{\sqrt{2}\ a}{4}$

∴ Volume of the sphere with radius 'r' is

$V = \left(\dfrac{4}{3}\right) \pi\ r^3$

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

$V = \dfrac{\sqrt{2}}{24} \pi\ a^3$

In a fcc arrangement, number of spheres belongs to a unit cell is 4

Total volume occupied by the spheres in a bcc unit cell $= 4 \times \left(\dfrac{\sqrt{2}\ \pi\ a^3}{24}\right)$

$= \dfrac{\sqrt{2}\ \pi\ a^3}{6}$

$\text{Packing fraction} = \left(\dfrac{\text{Total volume occupied by spheres in a unit cell}}{\text{Volume of the unit cell}}\right) \times 100$

$\text{Packing fraction} = \dfrac{\left(\dfrac{\sqrt{2}\ \pi\ a^3}{6}\right)}{\left(a^3\right)} \times 100$

$= \dfrac{\sqrt{2}\ \pi}{6} \times 100 = \dfrac{1.414 \times 3.14 \times 100}{6}$

$= 74\%$
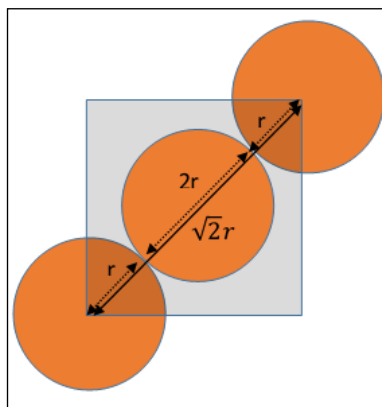
In face centered cubic packing, the packing fraction is 74%. The available space is used most efficiently than both in simple cubic and body centered packing.

13. Explain Schottky defect.
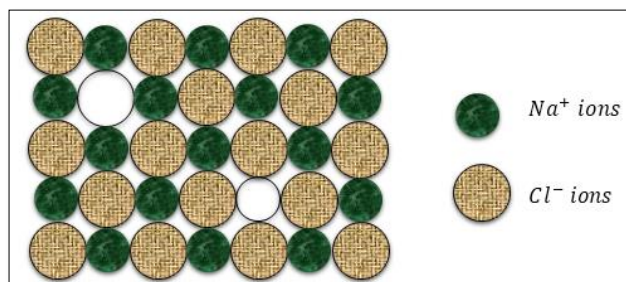
♥ Schottky defect arises due to the missing of equal number of cations and anions from the crystal lattice.

♥ This defect is shown by the crystals in which the cation and anion are of almost of similar size. Example: NaCl.

♥ This defect does not affect the stoichiometry of the crystal.

♥ Schottky defect lowers the density of a crystal.

14. Write a note on Frenkel defect.
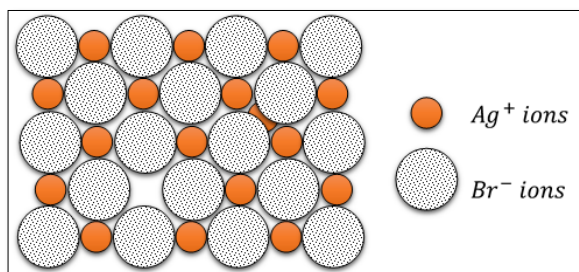
♣ Frenkel defect arises due to the dislocation of ions from their lattice points to interstitial position.

♣ This defect is shown by the crystals in which cation and anion differ in their sizes. Example AgBr.

♣ In AgBr, small Ag^+ ion leaves its normal site and occupies an interstitial position.

♣ This defect does not affect the density of the crystal.

15. Explain metal deficiency defect with an example.
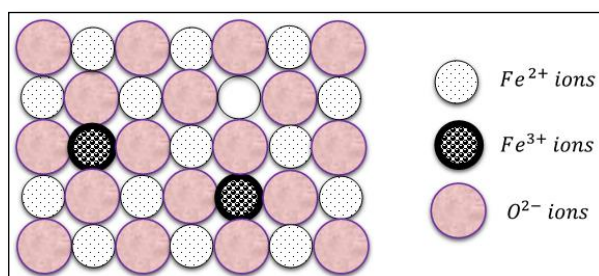
♣ This defect arises due to the presence of less number of cations than the anions.

♣ This defect is observed in a crystal in which, the cations have variable oxidation states. Example : FeO and FeS.

♣ In FeO crystal, some of the Fe^{2+} ions are missing from the crystal lattice. To maintain the electrical neutrality, twice the number of other Fe^{2+} ions in the crystal is oxidized to Fe^{3+} ions. In such cases, overall number of Fe^{2+} and Fe^{3+} ions is less than the O^{2-} ions.

16. **Explain metal excess defect with an example. (or) What are F centers? (or) What happens when sodium chloride crystal is heated in the presence of sodium vapour?**
   ♥ It arises due to the presence of excess of metal ions as compared to anions.
   ♥ The electrical neutrality of the crystal can be maintained by the presence of anionic vacancies equal to the excess metal ions (or) by the presence of extra cation and electron present in interstitial position. Examples: NaCl, KCl

F center
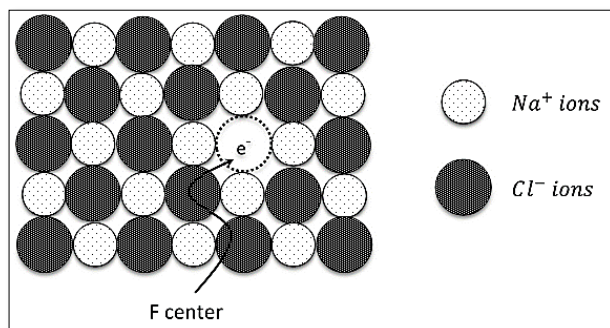
   ✓ When NaCl crystals are heated in the presence of sodium vapour, Na^+ ions are formed and are deposited on the surface of the crystal.
   ✓ Cl^- diffuse to the surface from the lattice point and combines with Na^+ ion.
   ✓ The electron lost by the sodium atoms diffuse into the crystal lattice and occupies the vacancy created by the Cl^- ions.
   ✓ Such anionic vacancies occupied by unpaired electrons are called F centers. They impart yellow colour to NaCl crystal.
   ✓ Hence, the formula of NaCl can be written as $Na_{1+x}Cl$.

17. **ZnO crystal is yellow when hot and white when cold. Account**
   • ZnO is colourless at room temperature. When it is heated, it becomes yellow in colour.
   • On heating, it loses oxygen and thereby forming free Zn^{2+} ions.
   • The excess Zn^{2+} ions move to interstitial sites and the electrons also occupy the interstitial positions.

18. **What is Radius ratio? In what way radius ratio value is help ful in finding crystal structure?**
   ♣ Generally anions are bigger than cations. The ratio of radius of cation and the radius of anion is called a radius ratio.

$$\text{Radius ratio} = \left(\frac{r_{C^+}}{r_{A^-}} \right)$$

19. **Distinguish tetrahedral and octahedral voids.**

Td void   Oh voids
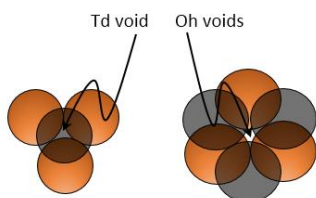
The vacant space among four spheres having tetrahedral arrangement is called tetrahedral void. The Void firmed by two equilateral triangles with apices in opposite direction is called an octahedral void.

1. **Differentiate between rate and rate constant of a reaction.**

s.no	Rate of a reaction	Rate constant of a reaction
1	It represents the speed in which the reactants 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 depends on the initial concentration of reactants.	It does not depend on the initial concentration of reactants.

2. **Define rate constant.**

Rate constant of a reaction is defined as "Rate of the reaction, when the concentration of each of the reactants in unity".

$$x\text{A} + y\text{B} \longrightarrow \text{products}$$
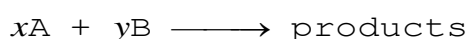
$$\text{Rate} = k\,[A]^m[B]^n$$

$$k = \dfrac{\text{Rate}}{[A]^m[B]^n}$$

If [A]=1 ; [B]=1

$$k = \text{Rate}$$

3. **Define order.**

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

$$x\text{A} + y\text{B} \longrightarrow \text{products}$$
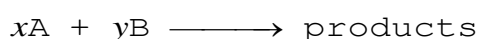
$$\text{Rate} = k\,[A]^m[B]^n$$

$$\text{order} = (m+n)$$

4. **Give the differences between order and molecularity of a reaction.**

S.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.

5. Give any three examples for the first order reaction.

 1   Decomposition of dinitrogen pentoxide

 $N_2O_5 \longrightarrow 2NO_2 + 1/2O_2$
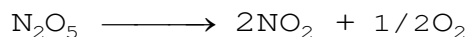
 2   Decomposition of **sulphuryl chloride**

 $SO_2Cl_2 \longrightarrow SO_2 + Cl_2$
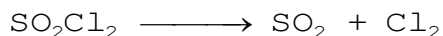
 3   Decomposition of the **Hydrogen peroxide** in aqueous solution

 $H_2O_2 \longrightarrow H_2O + 1/2O_2$
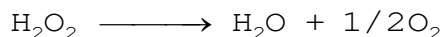
6. **What are pseudo first order reactions? Give an example.**

"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 called Pseudo first order reactions."
Example: Acid hydrolysis of an ester.

7. What are zero order reactions? Give an example.

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.

 1   Photochemical reaction between H_2 and Cl_2

$$H_2 + Cl_2 \xrightarrow{\text{light}} 2HCl$$
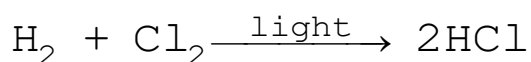
8. Write Arrhenius equation and explains the terms involved.

The rate constant is directly proportional to $e^{-\left(\frac{Ea}{RT}\right)}$. Arrhenius proposed a relation between the rate constant and temperature.

$$k = A\, e^{-\left(\frac{E_a}{RT}\right)}$$

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

9. Derive integrated rate law for a first order reaction.

Let us consider the following first order reaction $A \longrightarrow$ product

Rate law can be expressed as

$\text{Rate} = k\,[A]^1 \sim\sim\sim\sim\sim\sim \{1\}$

$\dfrac{-d[A]}{dt} = k[A]$

$\dfrac{-d[A]}{[A]} = k\,dt$

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

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

on Integrating the above equation within these limits

$$\int_{[A_0]}^{[A]} \frac{-d[A]}{[A]} = k \int_0^t dt$$

$$\left[-\ln[A]\right]_{[A_0]}^{[A]} = k\left[t\right]_0^t$$

$$-\ln[A] - \left(-\ln[A_0]\right) = k\,(t - 0)$$

$$-\ln[A] + \ln[A_0] = kt$$

$$\ln\left(\frac{[A_0]}{[A]}\right) = kt \quad \sim\sim\sim\sim\sim\sim\sim \{2\}$$

$$2.303\log\left(\frac{[A_0]}{[A]}\right) = kt$$

$$k = \frac{2.303}{t}\log\left(\frac{[A_0]}{[A]}\right) \quad \sim\sim\sim\sim\sim\sim\sim \{3\}$$

Equation (2) can be written in the form $y = mx + c$ as below

$$\ln[A_0] - \ln[A] = kt$$

$$\ln[A] = -kt + \ln[A_0]$$

$$y = mx + c$$

A plot of $(\ln[A])$ against (t) mat be drawn. A straight line with negative slope of is obtained.

From this, the rate constant is calculated.

10. **Define half-life of a reaction. Show that for a first order reaction half-life is independent of initial concentration.**

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

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

$$\text{when} \quad t = t_{1/2} \quad ; \quad [A] = \left(\frac{[A_0]}{2}\right)$$

$$k = \left(\frac{2.303}{t_{1/2}}\right)\log\frac{[A_0]}{\left(\frac{[A_0]}{2}\right)}$$

$$k = \frac{2.303}{t_{1/2}}\log 2$$

$$k = \frac{2.303 \times 0.3010}{t_{1/2}} = \frac{0.6932}{t_{1/2}}$$

$$\boxed{t_{1/2} = \frac{0.6932}{k}}$$

Half-life period is independent on the initial concentration and it is a constant.

11. Derive integrated rate law for a zero order reaction.

Such reactions are rare. Let us consider the following hypothetical zero order reaction.

$$A \longrightarrow product$$

$$Rate = k[A]^0 \sim\sim\sim\sim\sim\sim\sim \{1\}$$

$$\frac{-d[A]}{dt} = k \qquad \left(\because [A]^0 = 1\right)$$
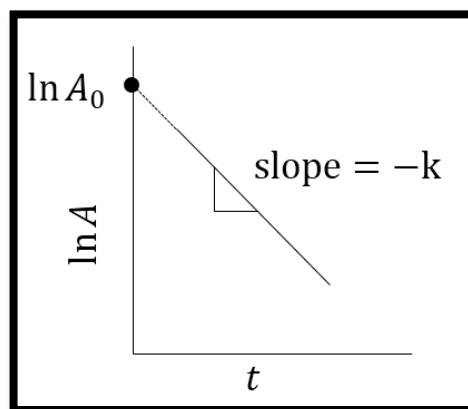
$$-d[A] = k\,dt$$

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

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

On integrating the above equation within these limits

$$-\int_{[A_0]}^{[A]} d[A] = k\int_0^t dt$$

$$-\left([A]\right)_{[A_0]}^{[A]} = k\left(t\right)_0^t$$

$$-[A] - \left(-[A_0]\right) = k(t - 0)$$

$$[A_0] - [A] = kt \sim\sim\sim\sim\sim\sim\sim \{2\}$$

$$k = \frac{[A_0] - [A]}{t} \sim\sim\sim\sim\sim\sim\sim \{3\}$$
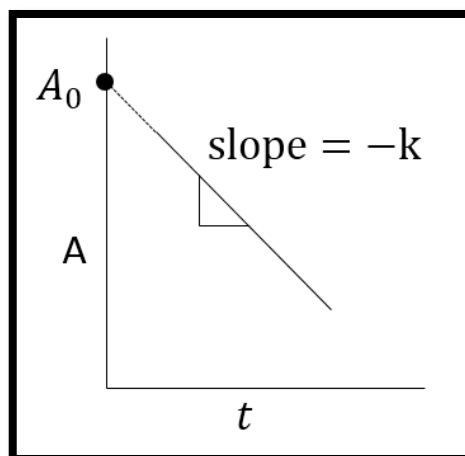
Equation (2) can be written in the form $y = mx + c$ as below

$$[A] = -k\,t \ + [A_0]$$

$$y = m\,x + c$$

A plot of $([A]\ Vs\ t)$ gives a straight line with a slope of $-k$ and y - intercept of $[A_0]$.

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

The rate constant for a zero order reaction is given by

$$k = \frac{[A_0] - [A]}{t} \qquad \text{when } t = t_{1/2} \ ; \quad [A] = \left(\frac{[A_0]}{2}\right)$$

$$k = \frac{[A_0] - \left(\frac{[A_0]}{2}\right)}{t_{1/2}}$$

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

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

The half-life of a zero order reaction is directly proportional to the initial concentration of the reactant.

13. Explain briefly the collision theory of bimolecular reactions.

- Chemical reactions occur as a result of collisions between the reacting molecules. The reaction between A_2 & B_2 proceeds through collisions between them.

$$A_2(g) + B_2(g) \longrightarrow 2AB(g)$$
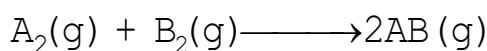
- The rate of the reaction is directly proportional to the number of collisions per second. The number of collisions is directly proportional to the concentration of both A_2 & B_2.

$$\text{Rate} \propto \text{number of collisions } L^{-1}s^{-1} \text{ (collision rate)}$$

$$\text{Collision rate} \propto [A_2][B_2]$$

$$\text{Collision rate} = Z[A_2][B_2] \qquad \text{Where, Z is a constant.}$$

- In order to react, the colliding molecules must possess a minimum energy called activation energy (E_a). Molecules with less than activation energy will not react. Fraction of effective collisions (f) is given by the following expression.

$$f = e^{-\left(\frac{E_a}{RT}\right)}$$

- This fraction of collisions is further reduced due to orientation factor i.e., even if the reactant collide with sufficient energy, they will not react unless the orientation of the reactants is suitable for the formation of the transition state.

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

$$\text{Rate} = p \times f \times \text{collision rate}$$

$$\text{Rate} = p \times e^{-\left(\frac{E_a}{RT}\right)} \times Z [A_2][B_2] \sim\sim\sim\sim\sim\sim \{1\}$$

$$\text{Rate} = k[A_2][B_2] \sim\sim\sim\sim\sim\sim \{2\}$$

On comparing equation {1} and {2}

$$k = pZe^{-\left(\frac{E_a}{RT}\right)}$$

14. What is activation energy?

The minimum amount of energy that is required by the molecule to take part in a chemical reaction is defined as the activation energy.
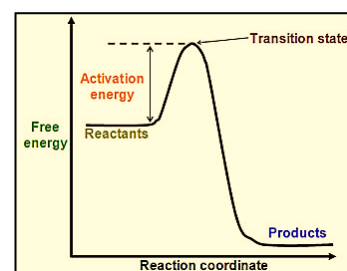
15. List the factors affecting reaction rate.

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

1) Nature and state of the reactant and product
2) Concentration of the reactant
3) Surface area of the reactant
4) Temperature of the system
5) Presence of a catalyst

1. **Write a note on Arrhenius Concept of acids and bases.**

   An acid is a substance that dissociates to give H^+ ions in water.

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

   A base is a substance that dissociates to give hydroxyl ions in water.

   $$NaOH \ + \ H_2O \ \rightleftharpoons \ Na^+ + \ OH^-$$

2. **What are Limitations of Arrhenius concept? MAY 2022**

   - It does not explain the behaviour of acids and bases in non-aqueous solvents like THF.
   - It does not explain for the basic nature of ammonia which do not possess -OH group.

3. **Discuss the Lowery – Bronsted concept of acids and bases.**

   Acid is a proton donor. $HCl \ + \ H_2O \ \rightleftharpoons \ H_3O^+ + \ Cl^-$

   Base is a proton acceptor. $NH_3 \ + \ H_2O \ \rightleftharpoons \ NH_4^+ + \ OH^-$

4. **What are conjugate acid-base pairs? Explain with an example. MAR 2023**

   According to Lowery- Bronsted concept of acids and bases an acid is a proton donor and a base is a proton acceptor. The species that remains after the donation of a proton is a base (Base1) and, is called the conjugate base of (Acid₁).

   Chemical species that differ only by a proton are called conjugate acid – base pairs.

   conjugate acid base pair

   $$CH_3COOH \ + \ H_2O \ \rightleftharpoons \ H_3O^+ \ + \ CH_3COO^-$$
   $$Acid_1 \qquad\quad Base_2 \qquad\qquad Acid_2 \qquad\quad Base_1$$

   conjugate acid base pair

5. **What are Lewis acids and bases? Give two example for each. MARCH-2020 & SEP-2022**

   A species that accepts an electron pair is called a Lewis acid. **Examples**: , $BF_3, AlCl_3$

   A species that donates a pair of electron is called a Lewis base. **Examples**: NH_3, H_2O

6. **Define ionic product of water. Give its value at room temperature. SEP-2020**

   $$H_2O \ + \ H_2O \ \rightleftharpoons \ H_3O^+ \ + \ OH^-$$
   $$acid_1 \qquad base_2 \qquad\quad acid_2 \qquad base_1$$

   The dissociation constant

   $$K = \frac{\left[H_3O^+\right]\left[OH^-\right]}{\left[H_2O\right]^2}$$

   $$K\left[H_2O\right]^2 = \left[H_3O^+\right]\left[OH^-\right]$$

   $$K_w = \left[H_3O^+\right]\left[OH^-\right]$$

   Here, K_w represents the ionic product of water, the ionic product of water at 25^0 C   is

   $$K_w = 1 \times 10^{-14} \ mol^2 L^{-2}$$

---

7. **Define pH. MAY 2022**

   p^H of a solution is defined as the negative logarithm of, molar concentration of the hydronium $\left(H_3O^+\right)$ ions present in the solution. $P^H = -\log\left[H_3O^+\right]$

8. **Derive the relation between p^H and P^{OH} .**

$$K_w = \left[H_3O^+\right]\left[OH^-\right]$$

$$\log K_w = \log\left[H_3O^+\right] + \log\left[OH^-\right]$$

At 25⁰C

$$-\log K_w = -\log\left[H_3O^+\right] - \log\left[OH^-\right]$$

$$P^{K_w} = P^H + P^{OH}$$

$$K_w = 1\times 10^{-14} \qquad \therefore P^{K_w} = 14$$

$$\boxed{P^H + P^{OH} = 14}$$

9. **Derive an expression for Ostwald's dilution law. JUNE 2020 , AUG-2021 & MAR 2023**

   ➢ Ostwald's dilution law relates the dissociation constant of the weak acid $\left(K_a\right)$ with its degree of dissociation $\left(\alpha\right)$ and the concentration (c).

$$\text{degree of dssociation } (\alpha) = \frac{\left(\text{no of moles dissociated}\right)}{\left(\text{Total number of moles}\right)}$$

	CH_3COOH	⇌	CH_3COO^-	H^+
Initial number of moles	1		-	-
Degree of dissociation of CH_3COOH	α		-	-
Number of moles at equilibrium	$(1-\alpha)$		α	α
Equilibrium concentration	$(1-\alpha)C$		αC	αC
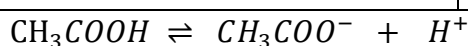
$$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$$

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

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

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

α is so small for a weak acid and hence in the denominator (1 - α) = 1.

$$K_a = \alpha^2 C$$

$$\alpha = \sqrt{\frac{K_a}{C}}$$

When dilution increases, the degree of dissociation of weak electrolyte also increases. This statement is known as Ostwald's dilution Law.

10. **What is common ion effect ?.JUNE 2020 & MAY 2022**

   "The phenomenon of suppression of degree of dissociation of a weak acid (or base) by the addition of a strong electrolyte containing a common ion is called as common ion effect."

11. 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.

$$X_mY_n \xrightleftharpoons{H_2O} mX^{n+} + nY^{m-} \qquad Ksp = \left[X^{n+} \right]^m \left[y^{m-} \right]^n$$
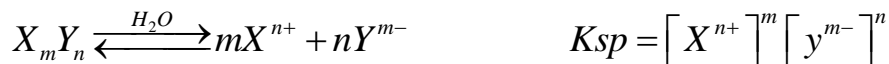
12. What are buffer solutions? Give an example. JUNE 2020 & SEP 2022
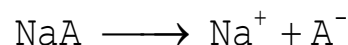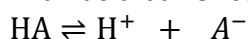
A solution whose P^H is resistant to addition of small amounts of strong acid or strong base is called a buffer solution.

Acidic buffer: $\left(CH_3COOH + CH_3COONa \right)$

Basic buffer: $\left(NH_4OH + NH_4Cl \right)$

13. Derive Henderson-Hassel Balch equation. MARCH 2020

In an acid buffer containing a weak acid and its salt,

$$HA \rightleftharpoons H^+ + A^-$$

$$NaA \longrightarrow Na^+ + A^-$$

$$K_a = \frac{\left[H_3O^+ \right]\left[A^- \right]}{\left[HA \right]}$$

$$\left[H_3O^+ \right] = K_a \frac{\left[HA \right]}{\left[A^- \right]}$$

$$\left[H_3O^+ \right] = K_a \frac{\left[acid \right]}{\left[conjugate\ base \right]}$$

$$\left[H_3O^+ \right] = K_a \frac{\left[acid \right]}{\left[salt \right]}$$

$$\log\left[H_3O^+ \right] = \log K_a + \log \frac{\left[acid \right]}{\left[salt \right]}$$

$$-\log\left[H_3O^+ \right] = -\log K_a - \log \frac{\left[acid \right]}{\left[salt \right]}$$

$$P^H = P^{K_a} - \log \frac{\left[acid \right]}{\left[salt \right]}$$

$$P^H = P^{K_a} + \log \frac{\left[salt \right]}{\left[acid \right]}$$

Similarly for base buffer

$$P^{OH} = P^{K_b} + \log \frac{\left[salt \right]}{\left[base \right]}$$

14. Define buffer index.

Buffer index is defined as the number of gram equivalents of acid or base added to 1 litre of the buffer solution to change its pH by unity.

$$\text{buffer index } (\beta) = \frac{dB}{d\left(P^H \right)}$$

---

1. **Define Resistivity (ρ) (or) Define specific resistance.**

   Resistivity is defined as the resistance of an electrolyte confined between two electrodes having unit cross sectional area and are separated by a unit distance.

   $$R \propto \frac{l}{a} \quad\Rightarrow\quad R = \rho\left(\frac{l}{a}\right) \quad\Rightarrow\quad \rho = \frac{Ra}{l}$$

2. **Define Conductivity** $\left(\kappa\right)$ **(or) Define specific conductance.**

   The reciprocal of specific resistance is called the specific conductance (or) conductivity.

   $$\left(\kappa\right) = \left(\frac{1}{\rho}\right) = \frac{1}{R}\left(\frac{l}{a}\right) = C\left(\frac{l}{a}\right) \qquad \text{If } A = 1m^2 \text{ and } l = 1m \text{ then } \kappa = C.$$

   The specific conductance is defined as the conductance of a cube of an electrolytic solution of unit dimensions. The SI unit of conductivity is Sm^{-1}.

3. **Define Molar conductivity** (Λ_m)

   Molar conductance is defined as the conductance of 'V' m³ of electrolytic solution containing one mole of electrolyte in a conductivity cell in which the electrodes are one metre apart.

   $$\Lambda_m = \frac{\kappa \times 10^{-3}}{M} \; Smol^{-1}m^2$$

4. **Define equivalent conductance (Λ)**

   Equivalent conductance is defined as the conductance of 'V' m³ of electrolytic solution containing one gram equivalent of electrolyte in a conductivity cell in which the electrodes are one metre apart.

   $$\Lambda = \frac{\kappa \times 10^{-3}}{N} \; S\left(gram.equ\right)^{-1}m^2$$

5. **State Kohlraush's law**

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

   $$\left(\Lambda_m^0\right)_{NaCl} = \left(\lambda_m^0\right)_{Na^+} + \left(\lambda_m^0\right)_{Cl^-}$$

6. **Define emf of a Cell.**

   In a galvanic cell, the force that pushes the electrons away from the anode and pulls them toward cathode is called the electromotive force (emf) or cell potential. The SI unit of cell potential is the volt (V).

7. **Derive an expression for Nernst equation**

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

   $$xA + yB \rightleftharpoons lC + mD$$
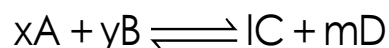
   The reaction quotient $Q = \dfrac{[C]^l[D]^m}{[A]^x[B]^y} \; -----(1)$

   We know that $\Delta G = \Delta G° + RT\, lnQ \; ----(2)$

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

$$\Delta G° = -nFE°_{Cell} \quad \Box \qquad \Delta G = -nFE_{Cell} \quad -----(3)$$

From $(2) \Rightarrow$

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

$$E_{Cell} = E°_{Cell} - \frac{RT}{nF}\ln\frac{[C]^l[D]^m}{[A]^x[B]^y}$$

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

The above equation is called the Nernst equation. At 298K,

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

8. **State Faraday's Laws of electrolysis**

   First Law:

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

   $$m \propto It \qquad m = ZIt$$

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

   Second Law:

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

   $$\frac{m_{Ag}}{Z_{Ag}} = \frac{m_{Zn}}{Z_{Zn}} = \frac{m_{Cu}}{Z_{Cu}}$$

9. **Define electrochemical equivalent of the substance.**

   The electrochemical equivalent is defined as the amount of substance liberated at the electrode by a charge of 1 coulomb.

   $$m = ZIt$$

   $$\text{if } I = 1 \text{amp ; } t = 1 \text{ sec ; } Q = 1C$$

   $$m = Z$$

10. **Write a note on mercury button cell.**

Anode	:	Zinc amalgam
Cathode	:	HgO mixed with graphite
Electrolyte	:	Paste of KOH & ZnO
Cell emf	:	$\simeq 1.35V$
At anode	:	$Zn + 2OH^- \longrightarrow ZnO + H_2O + 2e^-$ (oxidation)
At cathode	:	$HgO + H_2O + 2e^- \longrightarrow Hg + 2OH^-$ (Reduction)

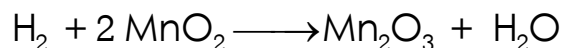   The Overall redox reaction is $Zn + HgO \longrightarrow ZnO + Hg$

Uses: It is used in pacemakers, electronic watches, cameras etc…

11. Write a note on Leclanche cell
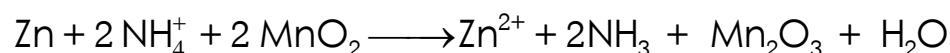
Anode	:	Zinc container
Cathode	:	Graphite rod in contact with MnO_2
Electrolyte	:	Ammonium chloride and zinc chloride in water
Cell emf	:	$\simeq 1.5V$
At anode	:	$Zn \longrightarrow Zn^{2+} + 2e^-$ (Oxidation)
At cathode	:	$2\,NH_4^+ + 2e^- \longrightarrow 2NH_3 + H_2$ (Reduction)

The hydrogen gas is oxidised to water by MnO_2

$$H_2 + 2\,MnO_2 \longrightarrow Mn_2O_3 + H_2O$$

The overall redox reaction

$$Zn + 2\,NH_4^+ + 2\,MnO_2 \longrightarrow Zn^{2+} + 2NH_3 + Mn_2O_3 + H_2O$$

12. Write a note on lithium – ion Battery

Anode	:	Porous graphite
Cathode	:	Transition metal oxide such as CoO_2 .
Electrolyte	:	Lithium salt in an organic solvent
At anode	:	$Li \longrightarrow Li^+ + e^-$ (oxidation)
At cathode	:	$Li^+ + CoO_2 + e^- \xrightarrow{\circledR} Li\,CoO_2$ (reduction)

The Overall reaction is $Li + CoO_2 \longrightarrow Li\,CoO_2$
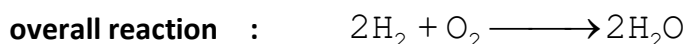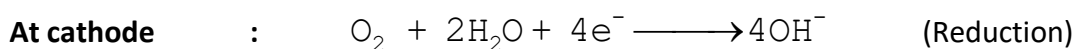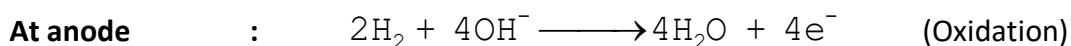
Uses : Used in cellular phones, laptop computer digital camera etc…

13. Explain the function of H_2-O_2 fuel cell.

The galvanic cell in which the energy of combustion of fuels is directly converted into electrical energy is called the fuel cell. It requires a continuous supply of reactant to keep functioning. The general representation of a fuel cell is follows

```
Fuel │ Electrode │ Electrolyte │ Electrode │ Oxidant
```
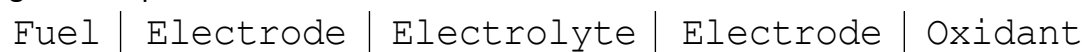
In H_2 –O_2 fuel cell, hydrogen act as a fuel and oxygen as an oxidant and the electrolyte is aqueous KOH maintained at $200\,^{\circ}C$ and at 20–40 atm. Porous graphite electrode containing Ni and NiO serves as the inert electrodes. Hydrogen and oxygen gases are bubbled through the anode and cathode respectively.

At anode	:	$2H_2 + 4OH^- \longrightarrow 4H_2O + 4e^-$	(Oxidation)
At cathode	:	$O_2 + 2H_2O + 4e^- \longrightarrow 4OH^-$	(Reduction)
overall reaction	:	$2H_2 + O_2 \longrightarrow 2H_2O$	

14. Suggest any three methods of Protection of metals form corrosion

This can be achieved by the following methods.

♥ Coating metal surface by paint.

♥ **Galvanization:**
Iron is coated with zinc. Zinc is stronger reducing agent than iron and hence it can be more easily corroded than iron.

♥ **Alloy formation:**
The oxidising tendency of iron can be reduced by forming its alloy with other more anodic metals. Example: stainless steel

♥ **Passivation:**
When the metal is treated with concentrated HNO_3, a protective oxide layer is formed on the surface of metal.

1. **Differentiate between physisorption and chemisorption. Mar-2020**

s.n0	Chemical adsorption	Physical adsorption
1	It is very slow process.	It is an instantaneous process.
2	Involves transfer of electrons	No transfer of electrons
3	Heat of adsorption is high	Heat of adsorption is low
4	Monolayer of Adsorbate is formed.	Multilayers of Adsorbate is formed.
5	Occurs only at active centres.	It occurs on all sides.
6	It is very specific.	It is non-specific
7	As temperature is raised it increases first and then decreases.	Decreases with increase in temperature.

2. **What are adsorption isotherms and isobars?**

   A plot of amount of adsorption is against pressure at constant temperature is called adsorption isotherm.

   A plot of amount of adsorption is against temperature at constant pressure is called as adsorption isobar.

3. **Write a note on Freundlich adsorption isotherm.**

   A plot of amount of adsorption is against pressure at constant temperature is called adsorption isotherm. According to Freundlich, for adsorption of gases on solid surfaces.

$$\left(\frac{x}{m}\right) = KP^{\left(\frac{1}{n}\right)}$$

$\left(x/m\right)$: Amount of adsorbate adsorbed on 'm' gm of adsorbent;

P - pressure

K & n : Freundlich constants.

4. **List the Characteristics of catalysts. June-2020 & May-2022**
   1. The catalyst remains unchanged in mass and chemical composition.
   2. A catalyst cannot initiate a reaction, but, it can increase the rate of slow reaction.
   3. Catalyst is needed in very small quantity.
   4. A solid catalyst will be more effective in a finely divided form.
   5. A catalyst is specific in nature.
   6. A catalyst does not affect the position of equilibrium and the value of equilibrium constant. It speeds up attainment of equilibrium.
   7. A catalyst is highly effective at a particular temperature called as optimum temperature.

5. **What is the difference between homogenous and heterogeneous catalysis? May-22 & Sep-2022**
   Homogeneous catalysis:

   The reaction in which all the reactants, products and catalyst are in same phase is called as a homogeneous catalysed reaction. Example: $2SO_2(g) + O_2(g) \xrightarrow{NO(g)} 2SO_3(g)$

   Heterogeneous catalysis:

   The reaction in which the reactants, products and catalyst are in different phases is called as a heterogeneous catalysed reaction. Example: $2SO_2(g) + O_2(g) \xrightarrow{Pt(s)} 2SO_3(g)$

6. **What are Negative Catalysis? Give an example.**

The substances which decreases the rate of the reaction is called as a negative catalyst. This phenomena is called as negative catalysis.

For example, in the decomposition of H_2O_2, glycerol acts as a negative catalyst.

$$2H_2O_2 \xrightarrow{\text{Glycerol}} 2H_2O + O_2$$
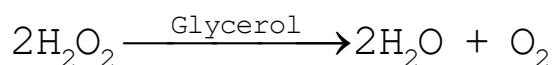
7. **What are Auto catalysis? Give an example. (or) Predict auto catalysts in the following reactions. Sep-2020**
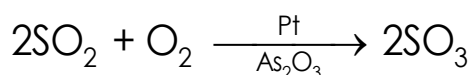
If one of the products formed in a reaction acts as a catalyst for the same the reaction, then it is called an auto catalyst.

$$2AsH_3 \longrightarrow \underset{\text{Auto catalyst}}{As} + 3H_2$$

8. **Write a note on catalytic poison.**

The substance which decreases the activity of catalyst is called as catalytic poison.

$$2SO_2 + O_2 \xrightarrow[\text{As}_2\text{O}_3]{\text{Pt}} 2SO_3$$

In this reaction As_2O_3 destroys the activity of Pt catalyst.

9. **Write a note on promoters.**

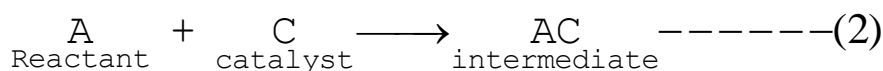The substance which increases the activity of catalyst is called as a promoter.

$$N_2 + 3H_2 \xrightarrow[\text{Mo}]{\text{Fe}} 2NH_3$$
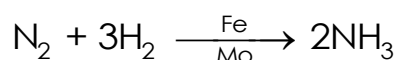
In the Haber's process, the activity of the iron catalyst is increased by Mo.

10. **Describe intermediate compound formation theory of catalysis.**

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

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

Step-1:

$$\underset{\text{Reactant}}{A} + \underset{\text{catalyst}}{C} \longrightarrow \underset{\text{intermediate}}{AC} ------(2)$$

Step-2 :

$$\underset{\text{intermediate}}{AC} + \underset{\text{Reactant}}{B} \longrightarrow \underset{\text{Product}}{AB} + \underset{\text{catalyst}}{C} ------(3)$$

11. **Describe adsorption theory of catalysis. Aug-2021 & Sep-2022**

The various steps involved in a heterogeneous catalysed reactions are

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

12. What are Active centres?

The surface of a catalyst is not smooth. It contains steps, cracks and corners. The atoms on such locations of the surface are coordinately unsaturated. They have much residual force of attraction. Such sites are called active centres.

13. Explain the factors affecting adsorption of gases on solid. Sep-2020

1. **Surface area of adsorbent:**

   Adsorption is a surface phenomenon it depends on the surface area of adsorbent.

   i.e., higher the surface area, higher is the amount adsorbed.

2. **Nature of adsorbate**
   - ♥ The nature of adsorbate can influence the adsorption.
   - ♥ Easily liquefiable Gases like SO_2, NH_3, HCl and CO_2 have greater van der waal's attraction and are readily adsorbed.
   - ♥ Permanent gases like H_2, N_2 and O_2 cannot be liquefied easily. These permanent gases are having low critical temperature and adsorbed slowly.
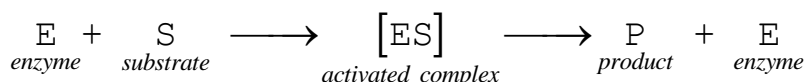
3. **Effect of temperature**
   - When temperature is raised chemisorption first increases and then decreases.
   - Physisorption decreases with increase in temperature.

4. **Effect of pressure:**
   - Chemical adsorption is fast with increase pressure, it cannot alter the amount.
   - In Physisorption, pressure increases the amount of adsorption.

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

- ✓ Enzymes are complex protein molecules with three dimensional structures. They catalyze the chemical reaction in living organism.
- ✓ The following mechanism is proposed for the enzyme catalysis

$$\underset{enzyme}{E} + \underset{substrate}{S} \longrightarrow \underset{activated\ complex}{[ES]} \longrightarrow \underset{product}{P} + \underset{enzyme}{E}$$

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

- ➢ Sol is a colloidal solution of type solid in liquid. Examples: Inks, Paints
- ➢ Gel is a colloidal solution of type liquid in solid. Examples: Butter, cheese

16. What are lyophilic and lyophobic colloids?

Lyophilic colloids:

There exist a definite attractive force between dispersed phase and dispersion medium. Examples: sols of starch and protein. They are stable and cannot be precipitated easily.

Lyophobic colloids:

There is no attractive force between dispersed phase and dispersion medium. Examples: sols of silver, gold, platinum, copper. They are less stable and can be precipitated easily.

## 17. What is Tyndall effect? June-2020

When light passes through colloidal solution, it is scattered in all directions. This scattering of light by colloidal solutions is called as Tyndall effect.

18. Define electrophoresis. May-2022

Migration of sol particles under the influence of electric field is called electrophoresis or Cataphoresis.

19. What is Brownian movement?

The zigzag, random, continuous, ceaseless motion movement exhibited by colloidal particles in dispersion medium is called Brownian movement. The reason for this is continuous bombardment of colloidal particles with the molecules of the dispersion medium.
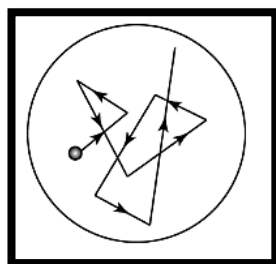
20. Write a note on Helmholtz double layer.

The surface of colloidal particle adsorbs one type of ion due to preferential adsorption. This layer attracts the oppositely charged ions in the medium.

The combination of the two layers of opposite charges around the colloidal particle is called Helmholtz electrical double layer.
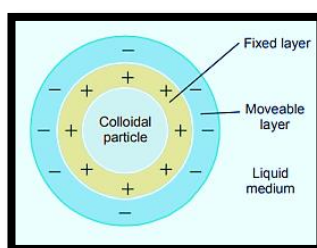
21. Discuss the shapes of colloidal particles.(March 2020)

s.n	Colloidal Particles	Shapes
1	AS_2S_3	Spherical
2	$Fe(OH)_3$ sol, blue gold sol	Disc or plate like
3	W_3O_5 sol	Rod like

22. Explain the dispersion Methods of preparation of colloids.

i. **Mechanical Dispersion:**

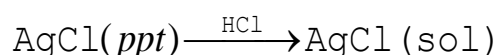   **Examples**: Ink and colloidal graphite.

ii. **Electro Dispersion:**

   Examples: copper, silver, gold, platinum sols

iii. **Ultrasonic dispersion:**

   Examples: mercury sols

iv. **Peptisation:**
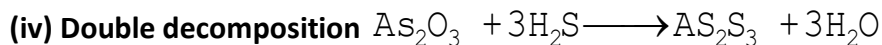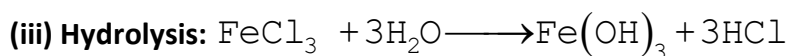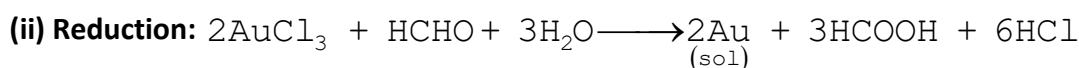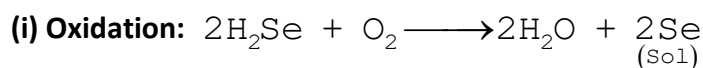
   The process in which precipitated particles are converted into colloidal solutions by the addition of electrolytes is called as Peptisation. The electrolyte added is called peptising agent.

$$AgCl(ppt) \xrightarrow{\text{HCl}} AgCl(sol)$$

23. Explain the Condensation Methods of preparation of colloids.

(i) Oxidation: $2H_2Se + O_2 \longrightarrow 2H_2O + 2\underset{(Sol)}{Se}$

(ii) Reduction: $2AuCl_3 + HCHO + 3H_2O \longrightarrow 2\underset{(sol)}{Au} + 3HCOOH + 6HCl$

(iii) Hydrolysis: $FeCl_3 + 3H_2O \longrightarrow Fe(OH)_3 + 3HCl$

(iv) Double decomposition $As_2O_3 + 3H_2S \longrightarrow AS_2S_3 + 3H_2O$

(v) Decomposition $S_2O_3^{2-} + 2H^+ \longrightarrow S + SO_2 + H_2O$
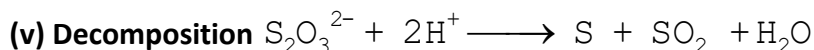
24. What is flocculation value?

The minimum concentration (millimoles/lit) of an electrolyte required to cause precipitation of a sol in 2hours is called its flocculation value. The smaller the flocculation value greater will be precipitation.

25. Explain how the charge on the sol particle be determined by electrophoresis experiment.
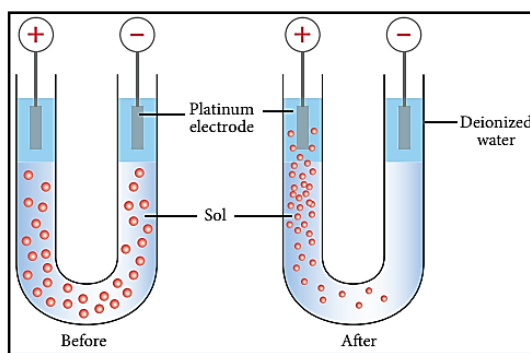
* ♣ When electric potential is applied across two platinum electrodes immersed in a hydrophilic sol, the dispersed particles move toward one or other electrode.
* ♣ Migration of sol particles under the influence of electric field is called electrophoresis or Cataphoresis.
* ♣ Positively charged sol particles migrate toward the cathode, and negatively charged sol particles migrate toward anode.
* ♣ Thus the charge of the sol particles can be determined from the direction of migration of sol particles.
* ♣ Examples:
  Positively charge colloids   : Fe(OH)$_3$, Al(OH)$_3$, haemoglobin
  Negatively charge colloids   : As$_2$S$_3$, starch, Ag, Au & Pt

26. What is gold number of the colloid?

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% NaCl solution.

27. What are emulsions? Explain the types of emulsions.

Emulsions are colloidal solution two immiscible liquids. i.e., one liquid is dispersed in another liquid. Generally there are two types of emulsions.

(i) Oil in water (O/W)   (ii) Water in oil (W/O)

28. Write a note on electro osmosis. Aug-2021
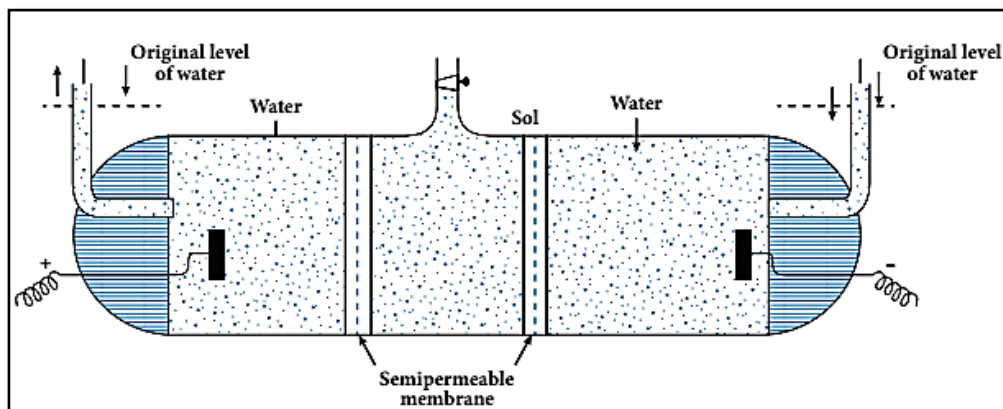
A sol is electrically neutral. The medium carries an equal but opposite charge to that of dispersed particles. When sol particles are prevented from moving, under the influence of electric field the medium moves in a direction opposite to that of the sol particles.

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

29. List the medicinal applications of colloids.

- Antibodies penicillin is produced in colloidal form for suitable injections.
- Colloidal gold and colloidal calcium are used as tonics.
- Silver sol protected by gelatin known as Argyrol is used as eye lotion.
- Milk of magnesia is used for stomach troubles.

UNIT-11 HYDROXY DERIVATIVES AND ETHERS

1. **What is Hydroboration reaction?**

$$6CH_3-CH=CH_2 \ + \ B_2H_6 \ \longrightarrow \ 2\left(CH_3-CH_2-CH_2-\right)_3 B$$
$$\textit{Tripropylborane}$$

$$\left(CH_3-CH_2-CH_2-\right)_3 B \ + \ 3H_2O_2 \ \xrightarrow{OH^-} \ 3 \ CH_3-CH_2-CH_2-OH \ + \ B\left(OH\right)_3$$

2. **What is an esterification reaction?**

$$H_3C—COOH \ + \ HO−C_2H_5 \ \xrightarrow[\Delta]{Conc \ H_2SO_4} \ H_3C—COOC_2H_5 \ + \ H_2O$$
Acetic acid   Ethanol   Ethylacetate

3. **List the Uses of ethanol.**
    1. Ethanol is used as an important beverage.
    2. It is also used in the preparation of Paints and varnishes,Dyes, transparent soaps
    3. As a substitute for petrol under the name power alcohol used as fuel for airplane
    4. It is used as a preservative for biological specimens.

4. **How do 1°,2°,3° alcohols differentiated by Lucas test?**

    Lucas agent is a mixture of conc HCl and anhyd $ZnCl_2$.

    Alcohols react with Lucas reagent at room temperature to give alkyl chloride which is insoluble in the medium.

Tert.butyl alcohol   Tert.butyl chloride

Turbidity appears immediately

isopropyl alcohol   isopropyl chloride

Turbidity appears within 10 min

ethyl alcohol   ethyl chloride

Turbidity appears only on heating

5. **How do 1°,2°,3° alcohols differ by Victor Mayer's test?**
    - Alcohols are converted into alkyl iodide by treating it with I_2 / P .
    - Alkyl iodide so formed is then treated with $AgNO_2$ to form nitro alkanes.
    - Nitro alkanes are finally treated with HNO_2 and the resultant solution is made alkaline with KOH.
    - **Result:**

        Primary alcohol gives red colour

        Secondary alcohol gives blue colour.

        No colouration will be observed in case of tertiary alcohol.

6. **Write a note on biological oxidation of alcohols?**
   In animals consumed food is fermented to produces alcohols.
   liver produces an enzyme called alcohol dehydrogenase (ADH).
   Nicotinamide adenine dinucleotide (NAD) acts as an oxidising agent.
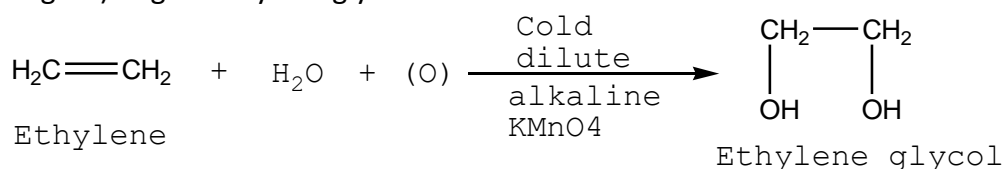   ADH catalyzes the oxidation of toxic alcohols into non-toxic aldehyde.

$$CH_3CH_2OH + NAD^+ \xrightarrow{ADH} CH_3CHO + NADH + H^+$$
   Ethanol $\qquad\qquad\qquad\qquad$ Acetaldehyde
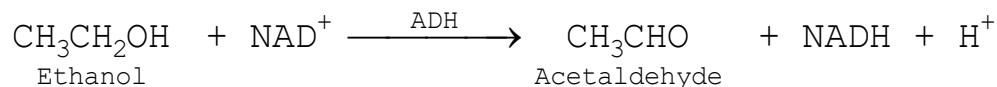
7. **What is Swern oxidation?**
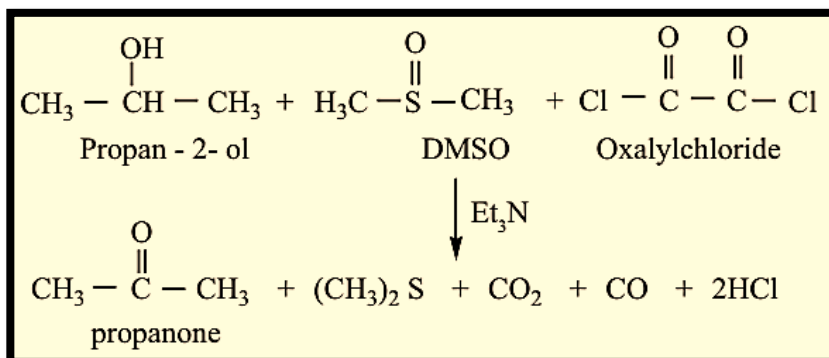
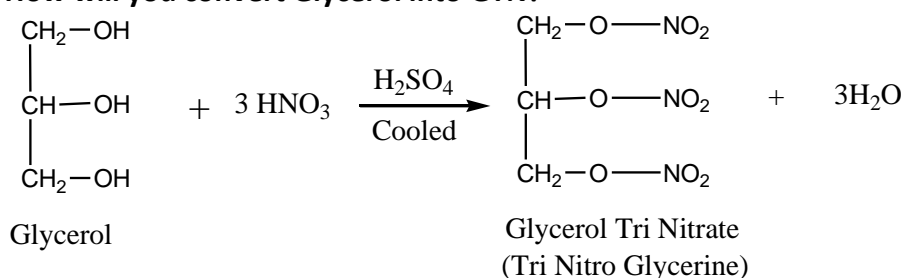8. **How is ethylene glycol prepared from ethylene?**
   Ethylene undergoes hydroxylation with cold dilute alkaline potassium permanganate (Bayer's reagent) to give ethylene glycol.
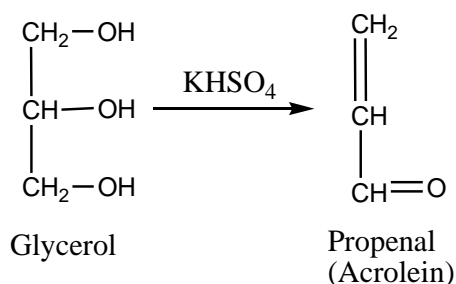

9. **Discuss the oxidation of Glycol with periodic acid?**
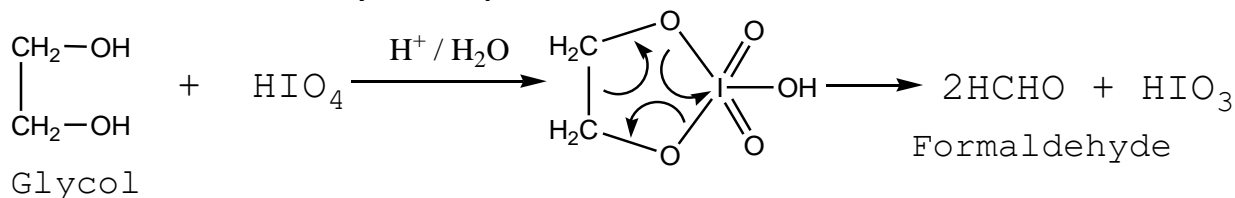
10. **How will you convert Glycerol into GTN?**

11. **How Glycerol reacts with KHSO₄? (or) How is glycerol converted into acrolein?**

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12. List the Uses of ethylene glycol:

1. Ethylene glycol is used as an antifreeze in automobile radiator
2. Glycol dinitrate is used as an explosive with TNG.

13. List the Uses of glycerol

1. Glycerol is used as a sweetening agent in confectionery and beverages.
2. It is used in the manufacture of cosmetics and transparent soaps.
3. It is used in making printing inks,stamp pad ink.
4. It is used as lubricant for watches and clocks.
5. It is used in the manufacture of explosives like dynamite and cordite by mixing it with china clay.
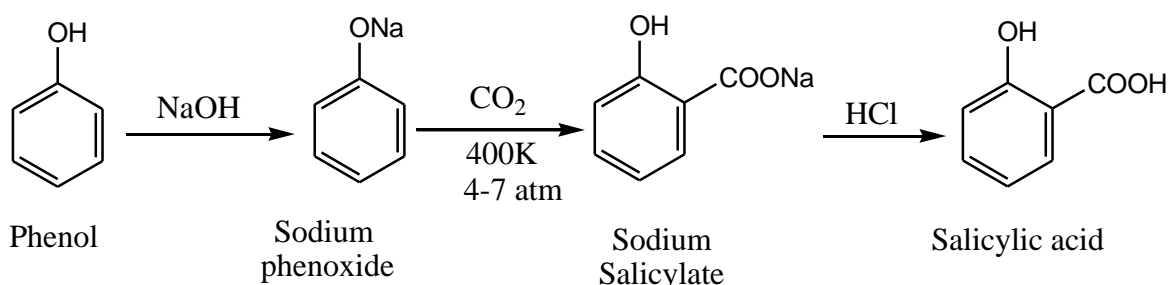
14. List the uses of phenol.

1. Phenol is used for making phenol-formaldehyde resin (Bakelite).
2. It is used as an antiseptic-carbolic lotion and carbolic soaps.
3. Phenol is used to prepare phenacetin, Salol, aspirin, etc
4. It is used to prepare Phenolphthalein indicator.
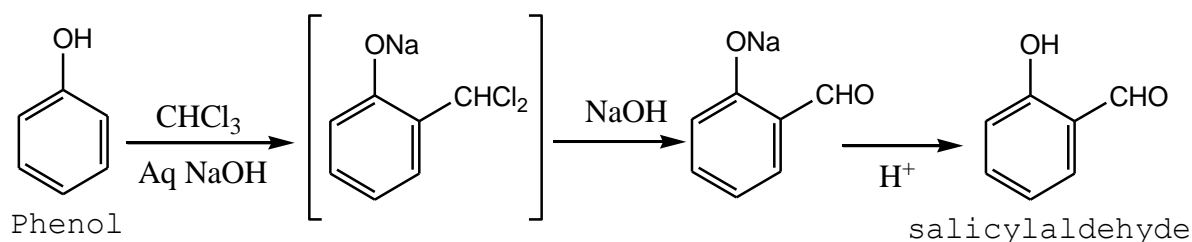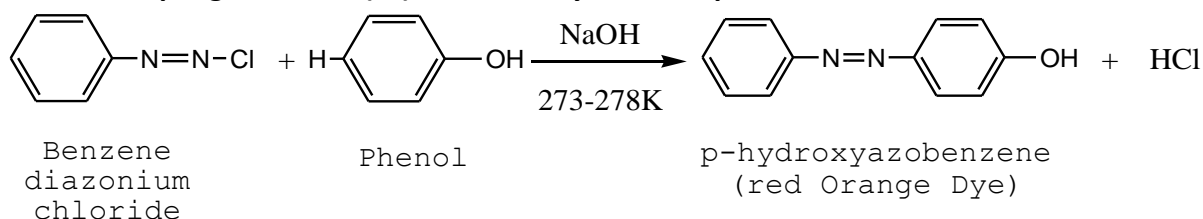5. It is used to prepare picric acid an explosive.

15. What is Dow's process?
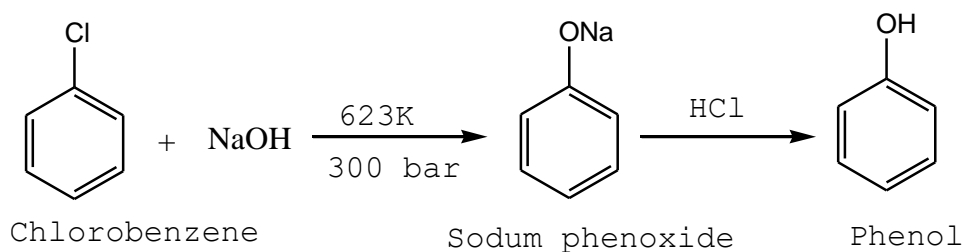
16. What is Kolbe reaction?
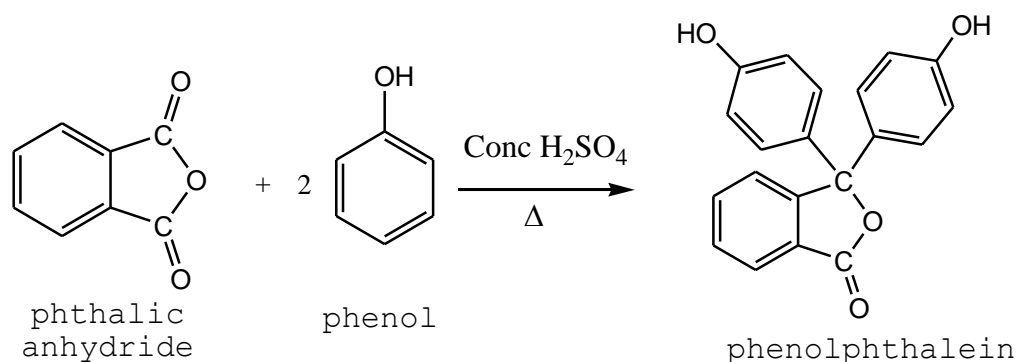

17. What is Reimer Tiemann reaction?

18. What is coupling reaction? (or) Write the dye test for phenols.

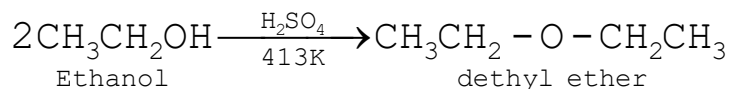## 19. How will you convert Phenol into Phenolphthalein?

20. Write any three Tests to differentiate alcohols (ethanol) from phenols.
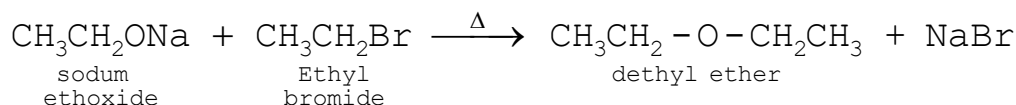
1. Phenol react with benzene diazonium chloride to form a red orange dye, but ethanol does not.
2. Phenol gives purple colouration with neutral ferric chloride solution, alcohols do not give such coloration with $FeCl_3$.
3. Phenol reacts with NaOH to give sodium phenoxide. Ethyl alcohol does not react with NaOH.

21. Write the methods of preparation of ethers.

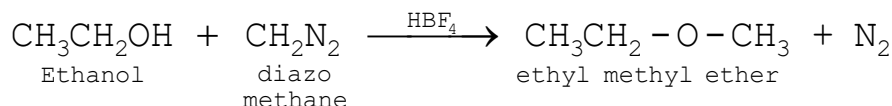1. **Inter molecular dehydration of alcohol.**

$$2CH_3CH_2OH \xrightarrow[413K]{H_2SO_4} CH_3CH_2-O-CH_2CH_3$$

Ethanol → dethyl ether

2. **Williamsons synthesis:**

$$CH_3CH_2ONa + CH_3CH_2Br \xrightarrow{\Delta} CH_3CH_2-O-CH_2CH_3 + NaBr$$

sodium ethoxide + Ethyl bromide → dethyl ether

3. **Methylation of alcohol**

$$CH_3CH_2OH + CH_2N_2 \xrightarrow{HBF_4} CH_3CH_2-O-CH_3 + N_2$$

Ethanol + diazo methane → ethyl methyl ether

22. Explain how diethyl ether reacts with the following.

(1) Cl₂/light   (2) PCl₅   (3) dil H₂SO₄   (4)CH₃COCl/anhyd AlCl₃

1. $$CH_3-CH_2-O-CH_2-CH_3 + 10Cl_2 \xrightarrow{Light} CCl_3-CCl_2-O-CCl_2-CCl_3$$
   diethyl ether → perchlorodiethyl ether

2. $$CH_3-CH_2-O-CH_2-CH_3 + PCl_5 \longrightarrow 2\ CH_3-CH_2-Cl + POCl_3$$
   diethyl ether → Ethyl chloride

3. $$CH_3-CH_2-O-CH_2-CH_3 + H_2O \xrightarrow{H_2SO_4} 2\ CH_3-CH_2-OH$$
   diethyl ether → Ethanol

4. $$CH_3-CH_2-O-CH_2-CH_3 + CH_3COCl \xrightarrow[AlCl_3]{anhyd} 2\ CH_3-CH_2-Cl + CH_3COOCH_2CH_3$$
   diethyl ether → Ethyl chloride + Ethyl acetate
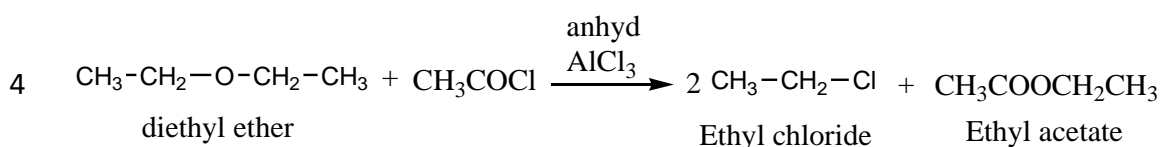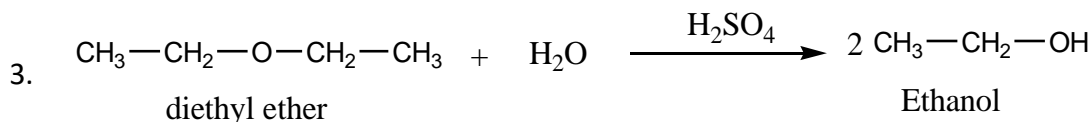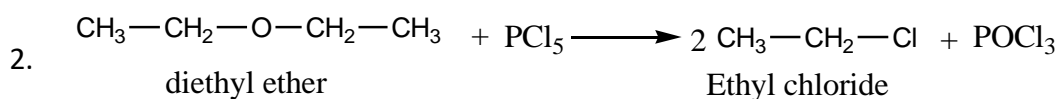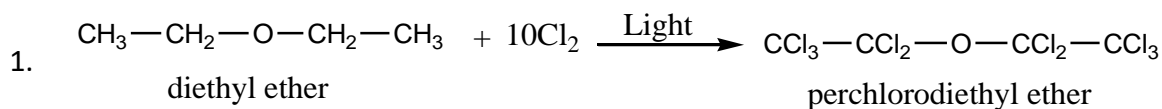
23. Write a note on auto oxidation of ethers.

Stored ethers undergo slow oxidation the presence of atmospheric oxygen to form hydroperoxides and dialkylperoxides. These are explosive in nature.

diethyl ether → (Excess O₂ / Slow) → 1-ethoxyethyl hydroperoxide + diethyl peroxide
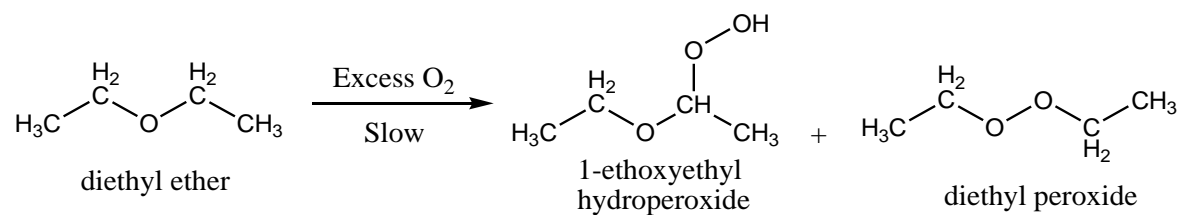
24. List the Uses of Diethyl ether

1. Diethyl ether is used as a surgical aesthetic agent.

2. It is a good solvent for organic reactions and extraction.

3. It is used as a volatile starting fluid for diesel and gasoline engine.

4. It is used as a refrigerant.

25. List the Uses of anisole

1. Anisole is a precursor in the synthesis of perfumes, insecticide pheromones,

2. It is used as a pharmaceutical agent.

UNIT-12 CARBONYL COMPOUNDS

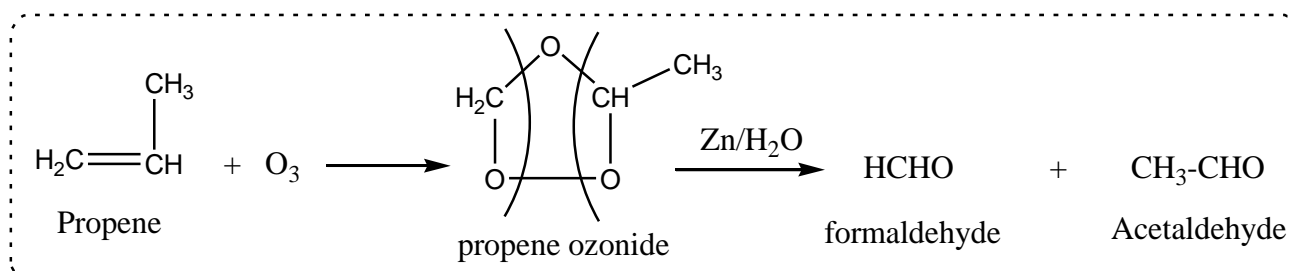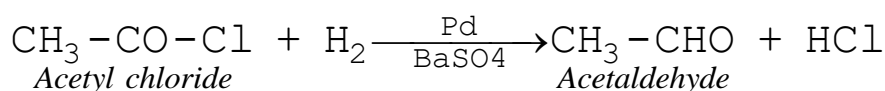1. **What is Ozonolysis? Give an example.**

   Alkenes react with ozone to form Ozonide and it is cleaved by Zn/H2O to form smaller molecules.

2. **What is Rosenmund reduction?**

$$\underset{\text{Acetyl chloride}}{CH_3-CO-Cl} + H_2 \xrightarrow[\text{BaSO4}]{\text{Pd}} \underset{\text{Acetaldehyde}}{CH_3-CHO} + HCl$$

   In this reaction *BaSO4* is used as a *Catalytic Poison*

3. **What is Stephen's reaction?**

   Aldehydes can be prepared by the reduction of alkyl cyanides by $SnCl_2$/HCl.

$$\underset{\text{Methyl cyanide}}{CH_3-C\equiv N} \xrightarrow[\text{HCl}]{SnCl_2} \underset{\text{acetaldimine}}{CH_3-CH=NH} \xrightarrow{H_3O^+} \underset{\text{acetaldehyde}}{CH_3-CHO}$$
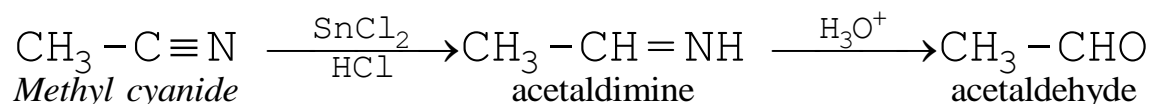
4. **What is Gattermann –Koch reaction?**
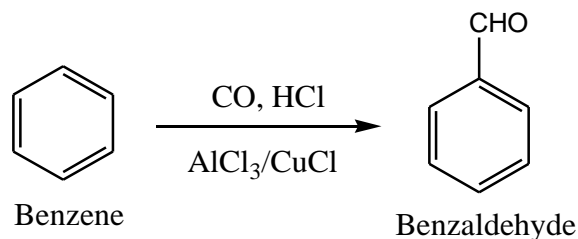
5. **What is Urotropine? How is it prepared? Give its structure and use.**

   Formaldehyde reacts with ammonia to give Urotropine (*hexa methylene tetramine)*

$$6HCHO + 4NH_3 \longrightarrow \underset{\substack{\text{hexamethylenetetraamine}\\(\textit{urotropine})}}{\left(CH_2\right)_6 N_4} + 6H_2O$$
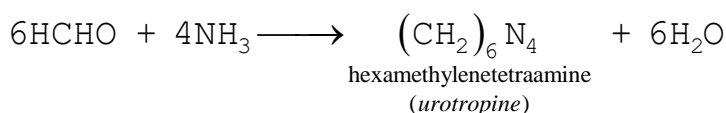
   Uses:

   Urotropine is used to treat urinary infection.

6. **What is Clemmenson reduction?**

7. What is Wolf kishner reduction?

$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 \xrightarrow[C_2H_5ONa]{N_2H_4} CH_3-CH_2-CH_3 \ + \ H_2O \ + \ N_2$$

Acetone   Propane

8. What is pinacol ? How is it prepared?

2,3-dimethylbutane-2,3-diol is known as Pinacol. It is prepared by the reduction of acetone with magnesium amalgam and water.

$$CH_3-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle O}{\|}}{C}} \ + \ \overset{\overset{\displaystyle CH_3}{|}}{\underset{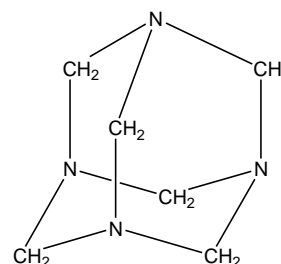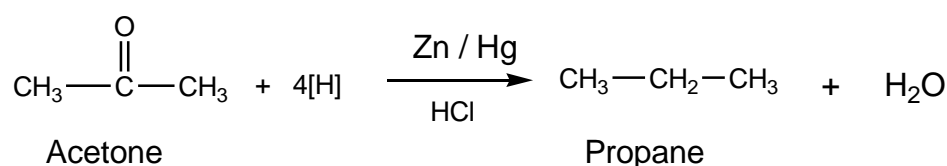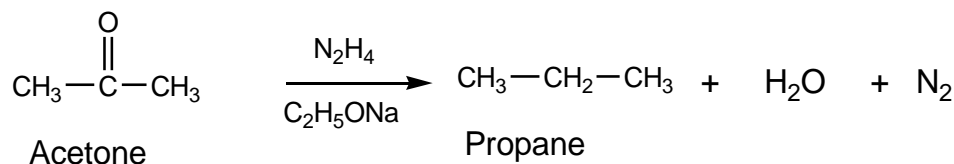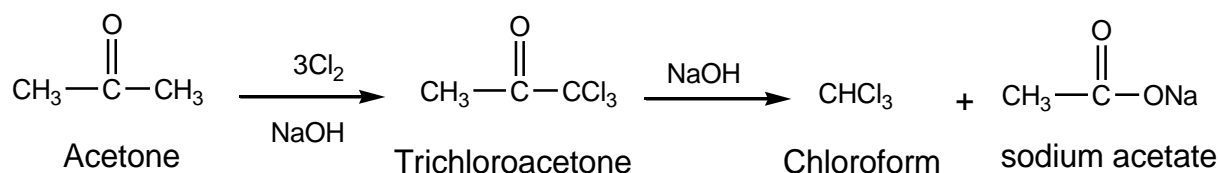\underset{\displaystyle O}{\|}}{C}}-CH_3 \ + \ 2(H) \xrightarrow[H_2O]{Mg/Hg} CH_3-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle OH}{|}}{C}}-\overset{\overset{\displaystyle CH_3}{|}}{\underset{\underset{\displaystyle OH}{|}}{C}}-CH_3$$

Acetone   Acetone   2,3-dimethylbutane-2,3-diol
(pinacol)
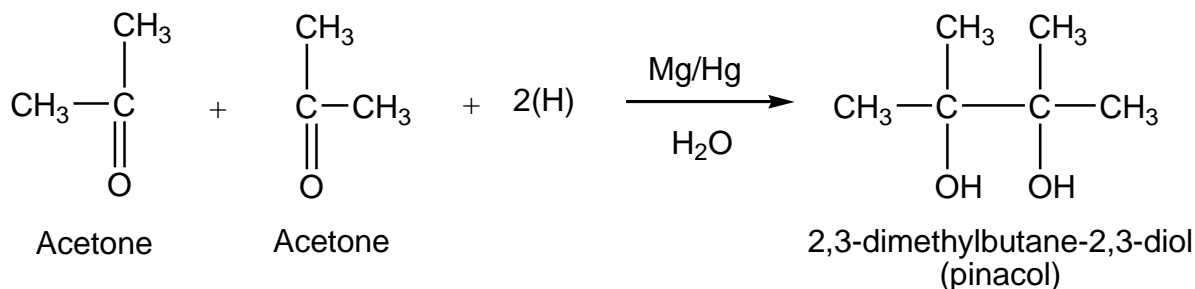
9. What is Iodoform (Haloform) reaction ?

The carbonyl compounds having Methyl Keto group, undergoes Haloform reaction with halogen and alkali to form an haloform.

$$CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 \xrightarrow[NaOH]{3Cl_2} CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-CCl_3 \xrightarrow{NaOH} CHCl_3 \ + \ CH_3-\overset{\overset{\displaystyle O}{\|}}{C}-ONa$$

Acetone   Trichloroacetone   Chloroform   sodium acetate

10. What is Claisen-Schmidt condensation?

$$C_6H_5-CHO \ + \ CH_3-CHO \xrightarrow{dil \ NaOH} C_6H_5-CH=CH-CHO$$

Benzaldehyde   Acetaldehyde   cinnamaldehyde
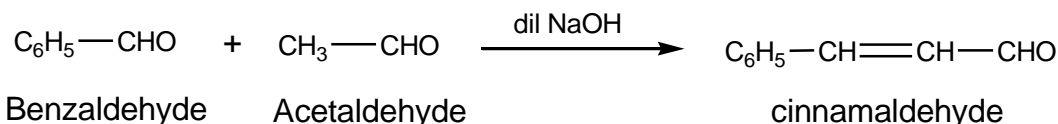
11. What is Benzoin condensation?

$$C_6H_5-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle H}{|}}{C}} \ \ \overset{\overset{\displaystyle H}{|}}{\underset{\underset{\displaystyle O}{\|}}{C}}-C_6H_5 \xrightarrow[KCN]{alc} C_6H_5-\overset{\overset{\displaystyle OH}{|}}{CH}-\overset{}{\underset{\underset{\displaystyle O}{\|}}{C}}-C_6H_5$$

Benzaldehyde   Benzaldehyde   Benzoin
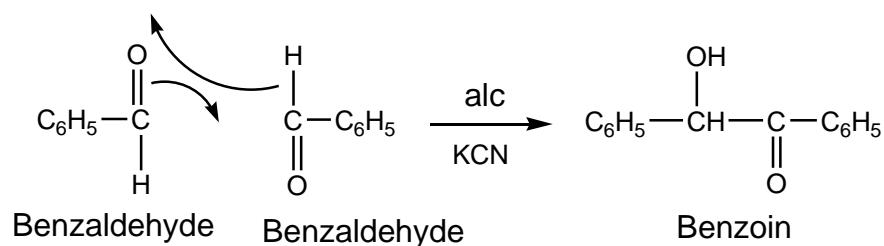
12. What is Perkin reaction?

$$C_6H_5-CH=O \ + \ H_3C-\overset{\overset{\displaystyle O}{\|}}{C}-O-\overset{\overset{\displaystyle O}{\|}}{C}-CH_3 \xrightarrow[\Delta]{CH_3COONa} C_6H_5-CH=CH-CHO \ + \ CH_3COOH$$

Benzaldehyde   acetic anhydride   Cinnamic acid   Acetic acid
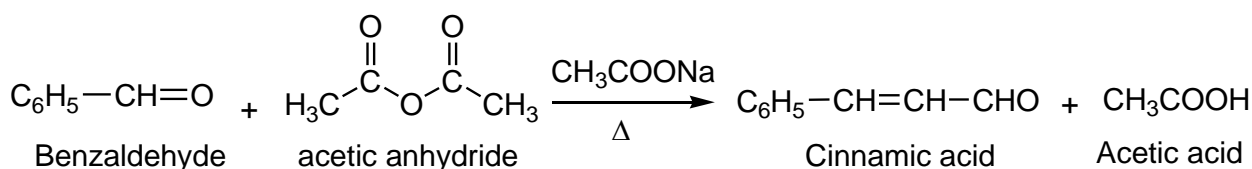
13. Explain the mechanism of aldol condensation.

When acetaldehyde is warmed with dil NaOH it gives acetaldol.

$$CH_3-\overset{\overset{\displaystyle O}{\|}}{CH} + CH_3-CHO \xrightarrow{NaOH} CH_3-\overset{\overset{\displaystyle OH}{|}}{CH}-CH_2-CHO$$

Acetaldehyde   Acetaldehyde   3 hydroxy butanal (Aldol)

Mechanism:

Step-I : The carbanion is formed by the removal of α hydrogen atom by a base.

$$H-CH_2-CHO \; + \; \overset{\ominus}{O}H \longrightarrow \overset{\ominus}{C}H_2-CHO \; + \; H_2O$$

Step-II: Nucleophilic attack of carbonyl carbon by a carbanion to form an alkoxide ion.
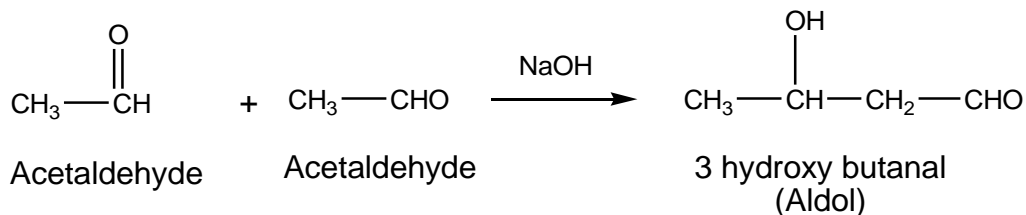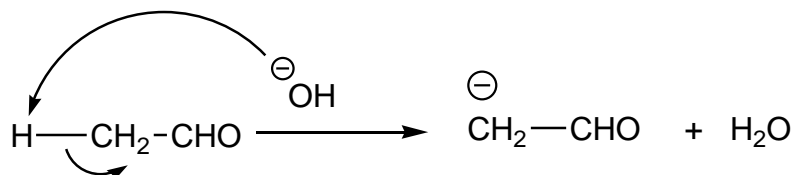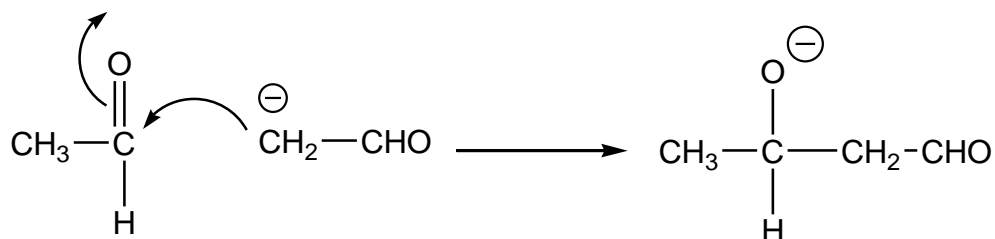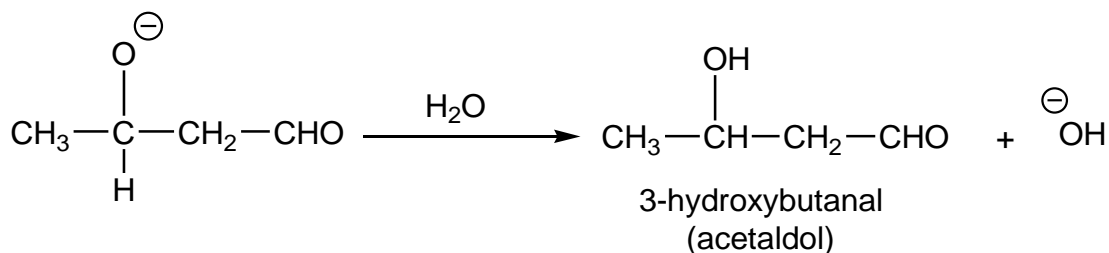
$$CH_3-\overset{\overset{\displaystyle O}{\|}}{\underset{\underset{\displaystyle H}{|}}{C}} \; + \; \overset{\ominus}{C}H_2-CHO \longrightarrow CH_3-\overset{\overset{\displaystyle O^{\ominus}}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-CH_2-CHO$$

Step-III: protonation of alkoxide ion leads to an aldol.

$$CH_3-\overset{\overset{\displaystyle O^{\ominus}}{|}}{\underset{\underset{\displaystyle H}{|}}{C}}-CH_2-CHO \xrightarrow{H_2O} CH_3-\overset{\overset{\displaystyle OH}{|}}{CH}-CH_2-CHO \; + \; \overset{\ominus}{O}H$$

                                                3-hydroxybutanal (acetaldol)

This aldol rapidly undergoes dehydration on heating to form an $\alpha-\beta$ `unsaturated aldehyde.`

$$CH_3-\overset{\overset{\displaystyle OH}{|}}{CH}-CH_2-CHO \xrightarrow{\Delta} CH_3-CH=CH-CHO \; + \; H_2O$$

        Aldol   Crotonaldehyde
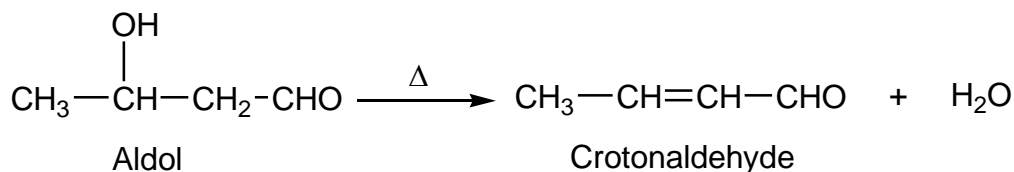
14. What is crossed aldol condensation?

$$H-CHO \; + \; CH_3-CHO \xrightarrow{dil\ NaOH} \overset{\overset{\displaystyle OH}{|}}{C}H_2-CH_2-CHO$$

Formaldehyde   Acetaldehyde   3 hydroxy propanal
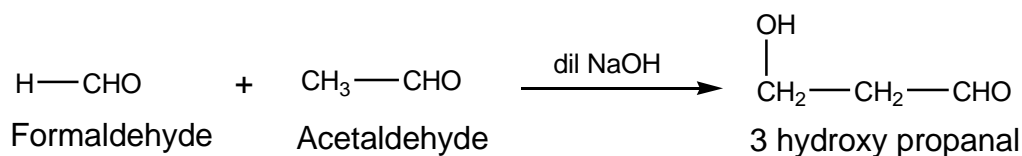
15. Explain the mechanism of Cannizaro reaction.

$$C_6H_5-CHO \quad + \quad C_6H_5-CHO \quad \xrightarrow[\text{NaOH}]{50\%} \quad C_6H_5-COONa \quad + \quad C_6H_5-CH_2-OH$$

Benzaldehyde   Benzaldehyde   Sodium benzoate   Benzyl alcohol
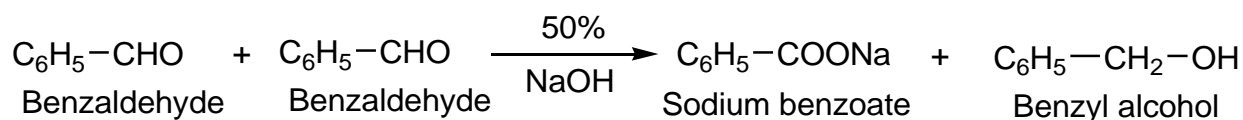
Mechanism:

Step-1: Nucleophilic attack by OH^- ion on carbonyl carbon
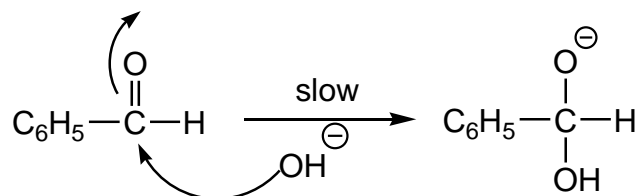
Step-2: Transfer of hydride ion.

Step-3: Transfer of proton:

Sodium benzoate   Benzyl alcohol
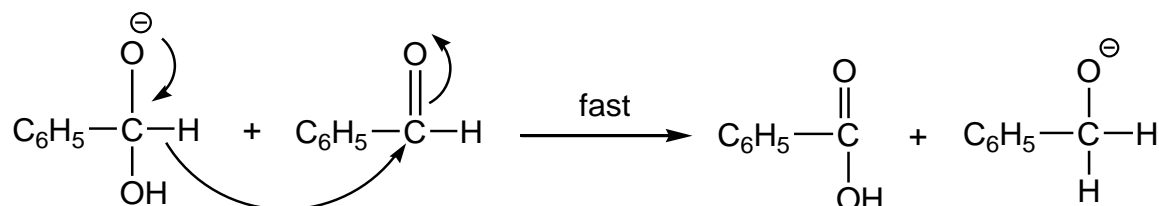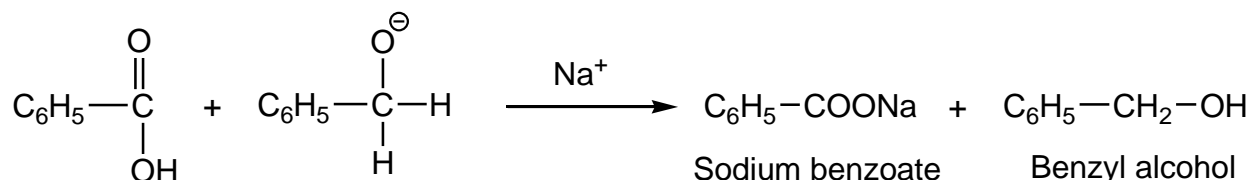
16. What is crossed Cannizaro reaction?

$$C_6H_5-CHO \quad + \quad H-CHO \quad \xrightarrow[\text{NaOH}]{50\%} \quad H-COONa \quad + \quad C_6H_5-CH_2-OH$$

Benzaldehyde   Formaldehyde   Sodium formate   Benzyl alcohol

17. What is Knoevenagal reaction?

Benzaldehyde   Malonic acid   Cinnamic acid
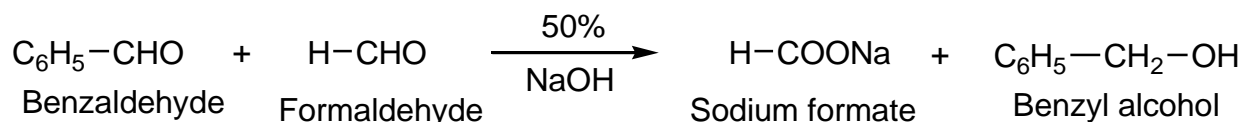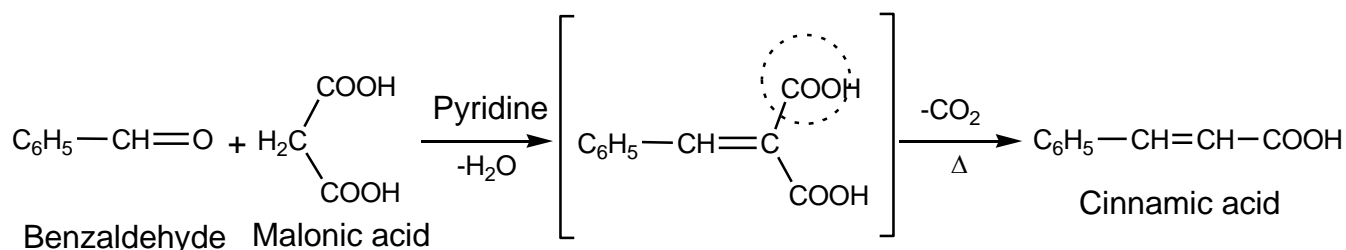
18. What is formalin? Mention its uses.

40% aqueous solution of formaldehyde is called formalin. It is used for preserving biological specimens.Formalin has hardening effect, hence it is used for tanning.

19. What is glacial acetic acid?

Pure acetic acid is called glacial acetic acid.When aqueous acetic acid is cooled at 289.5 K (16.35^0C), acetic acid solidifies and forms ice like crystals, whereas water remains in liquid state and removed by filtration. This process is repeated to obtain glacial acetic acid.

20. Give any three tests for carboxylic acids.

- Aqueous solution of carboxylic acids turns Blue litmus into Red.
- When carboxylic acid is warmed with alcohol and Con H_2SO_4 it forms an ester, which is detected by its fruity odour.
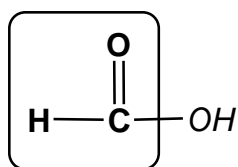- Carboxylic acids give brisk effervescence with sodium bi carbonate solution due to evolution of carbon di oxide.

21. Discuss the reducing nature of Formic acid.

Formic acid is unique, because it contains both an Aldehyde and carboxylic acid groups. Hence it can act as a reducing agent. It reduces Tollen's reagent.
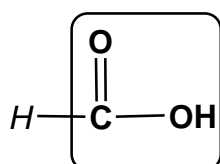
Aldehyde   Carboxylic acid

Formic acid reduces Tollen's reagent into metallic silver

$$HCOO^- + \; 2Ag^+ + 3OH^- \longrightarrow \; 2Ag\downarrow \; + CO_3^{2-} + 2H_2O$$
$$\quad\quad\text{(Tollens reagent)} \quad\quad\quad \text{(Silver mirror)}$$

UNIT-13 ORGANIC NITROGEN COMPOUNDS

1. What is tautomerism, explain with an example.

Primary and secondary nitro alkanes, having α-H show an equilibrium mixture of two tautomer namely 'nitro' and 'aci' forms

Nitro form   Aci form

2. Differentiate between nitro and aci-nitro form.

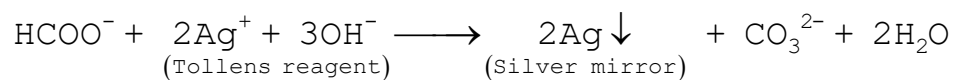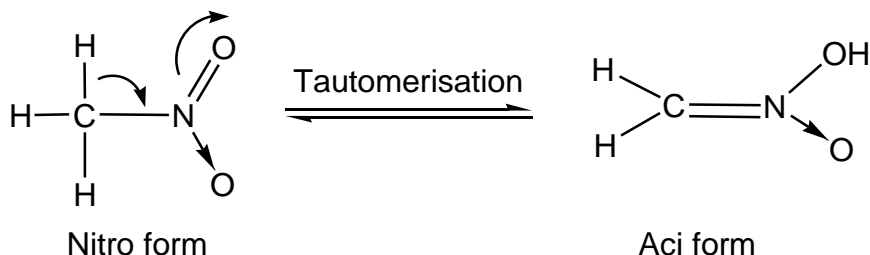| S.N	Nitro form	Aci – form
1.	Less acidic	More acidic and also called pseudo acids
2.	Dissolves in NaOH slowly	Dissolves in NaOH instantly
3.	Decolourises $FeCl_3$ solution	With $FeCl_3$ gives reddish brown colour
4.	Electrical conductivity is low	Electrical conductivity is high

3. How will you convert α -Chloro acetic acid into nitro methane?

α- Chloro acetic acid when boiled with aqueous solution of sodium nitrite gives nitro methane.

$$Cl-CH_2-COOH + NaNO_2 \xrightarrow[\Delta]{H_2O} CH_3-NO_2 + CO_2 + NaCl$$

α-chloro acetic acid   Nitromethane
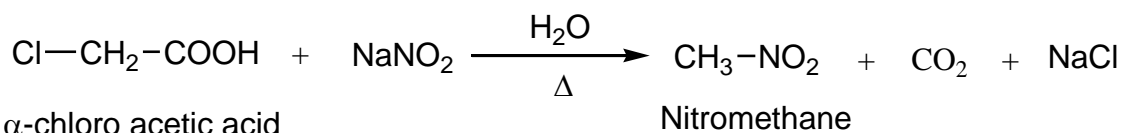
4. What is chloropicrin? How is it prepared? Mention its uses. MAR-2020

Chloropicrin is Trichloro nitro methane.

$$\underset{\text{Nitromethane}}{CH_3-NO_2} + 3Cl_2 \xrightarrow{NaOH} \underset{\text{Chloropicrin}}{CCl_3-NO_2} + 3HCl$$
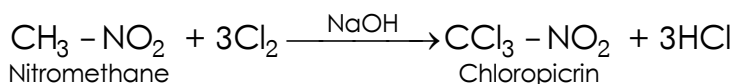
Uses: Chloropicrin is used as an insecticide

5. What is nef carbonyl synthesis?

$$\underset{\text{Nitroethane}}{CH_3-CH_2-NO_2} \xrightarrow{KOH} CH_3-CH=N \xrightarrow{H_2O} \underset{\text{Acetaldehyde}}{CH_3-CHO}$$
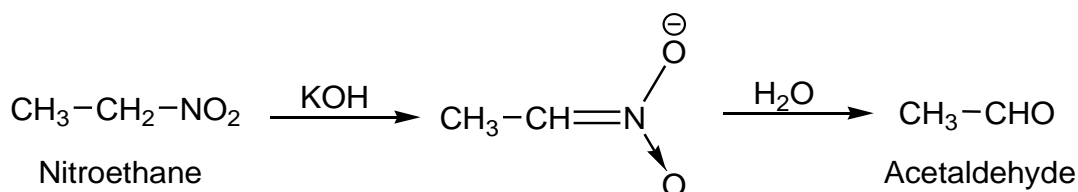
6. Uses of nitro alkanes

- Nitro methane is used as a fuel for race cars.
- Chloropicrin (CCl_3-NO_2)is used as an insecticide.
- 4% alcoholic solution of ethyl nitrite is known as "sweet spirit of nitre" and in used as diuretic.

7. Write a short note on Hofmann's bromide reaction.

$$\underset{\text{acetamide}}{CH_3CONH_2} + Br_2 + 2KOH \longrightarrow \underset{\text{methylamine}}{CH_3NH_2} + 2KBr + CO_2 + H_2O$$
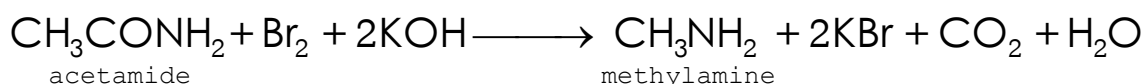
8. **Discuss the reduction of nitro benzene under different conditions. SEP-2020 & SEP-2022**

   Ψ **Catalytic reduction:**

   $$C_6H_5 - NO_2 \xrightarrow[\text{(or) LiAlH}_4]{\text{Ni (or) Pt/H}_2} C_6H_5 - NH_2 + 2H_2O$$

   Nitro benzene $\qquad\qquad\qquad$ Aniline

   Ψ **Acid medium reduction:**

   $$C_6H_5 - NO_2 \xrightarrow[6[H]]{\text{Sn/HCl}} C_6H_5 - NH_2 + 2H_2O$$

   Nitro benzene $\qquad\qquad$ Aniline

   Ψ **Alkaline medium reduction:**

   $$2\,C_6H_5NO_2 \xrightarrow[6[H]]{\text{SnCl}_2/\text{KOH}} \begin{bmatrix} C_6H_5 - NH_2 \\ + \\ C_6H_5 - N = O \end{bmatrix} \xrightarrow[\text{condensation}]{\text{self}} C_6H_5 - N = N - C_6H_5$$

   Nitro benzene $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ azobenzene

   $$2\,C_6H_5NO_2 \xrightarrow[8[H]]{\text{Zn/NaOH}} [C_6H_5 - N = N - C_6H_5] \xrightarrow{2H} C_6H_5 - NH - NH - C_6H_5$$
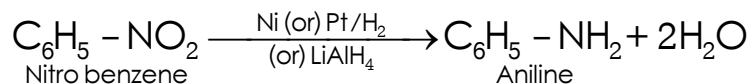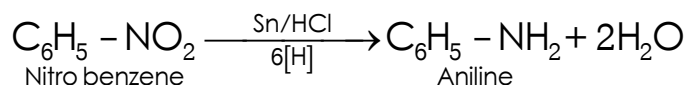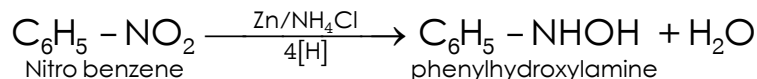
   Nitro benzene $\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad$ hydrazo benzene (diphenyl hydrazine)
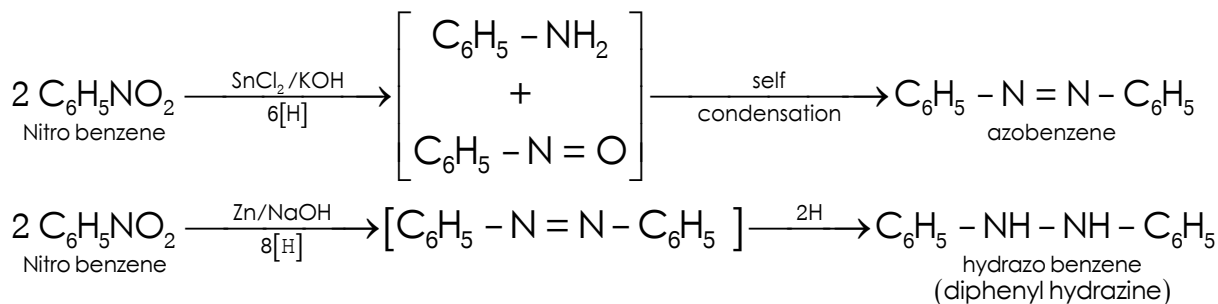
   Ψ **Neutral medium reduction:**

   $$C_6H_5 - NO_2 \xrightarrow[4[H]]{\text{Zn/NH}_4\text{Cl}} C_6H_5 - NHOH + H_2O$$

   Nitro benzene $\qquad\qquad\qquad$ phenylhydroxylamine

   Ψ **Electrolytic reduction:**
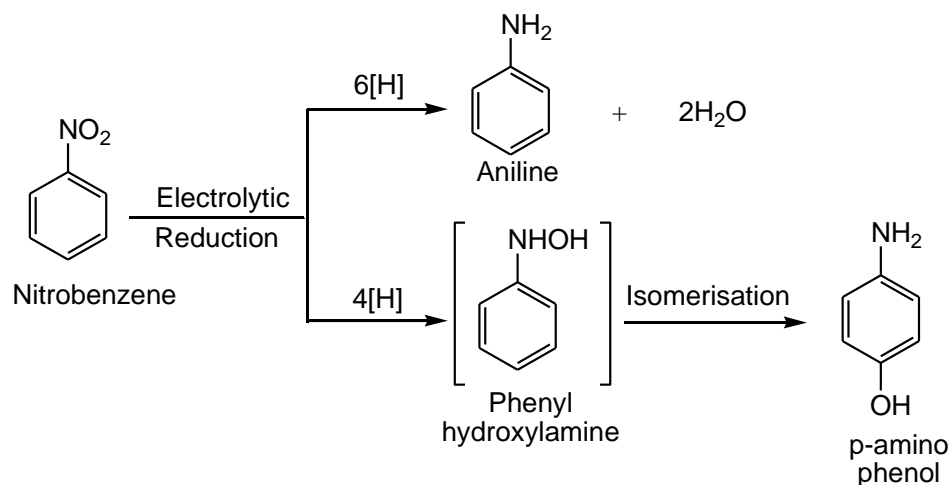
9. **Write a note on Sabatier-mailhe method?**

$$C_2H_5OH \xrightarrow[\text{Al}_2\text{O}_3]{\text{NH}_3} C_2H_5NH_2 \xrightarrow{C_2H_5OH} (C_2H_5)_2 NH \xrightarrow{C_2H_5OH} (C_2H_5)_3 N$$

$\qquad\qquad\qquad\qquad\qquad$ 1^0 amine $\qquad\qquad$ 2^0 amine $\qquad\qquad$ 3^0 amine
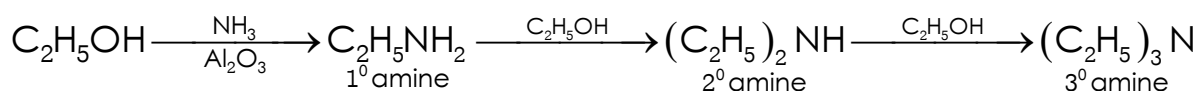
10. **Ethylamine is soluble in water whereas aniline is not: account**

   ♣ Ethylamine can form hydrogen bonds with water molecules hence, it is soluble.

   ♣ Aniline cannot form hydrogen bond with water molecule hence, it is insoluble.

11. **Aniline is less basic than ammonia why?**

   In aniline, the NH_2 group is directly attached to the benzene ring. The lone pair of electron on N atom gets delocalized over the benzene ring and is less available for protonation. This makes aniline (aromatic amines) less basic than NH_3.

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12. Write a short note on Gabriel phthalimide synthesis. JUNE 2020

phthalimide → N-Pot.phthalimide → N-alkylphthalimide

pot.Phthalate + R—NH$_2$ (1° amine)
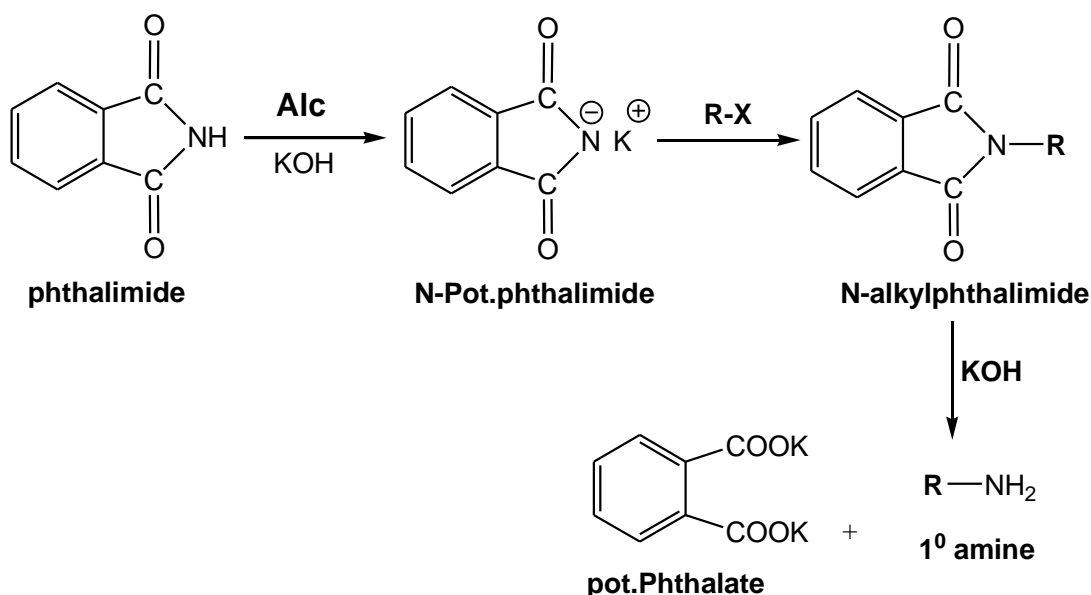
13. How is aniline prepared from (i) phenol   (ii) chlorobenzene

Phenol reacts with ammonia at 300°C in the presence of anhydrous ZnCl$_2$ to give aniline.

Phenol + NH$_3$ $\xrightarrow[\text{anhyd ZnCl}_2]{300^0C}$ Aniline

Chlorobenzene reacts with ammonia at 200°C in the presence of Cu$_2$O to give aniline.

Chlorobenzene + NH$_3$ $\xrightarrow[\text{Cu}_2\text{O}]{200^0C}$ Aniline
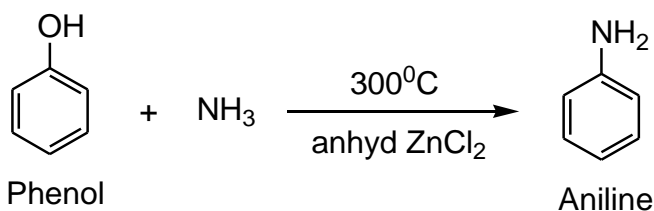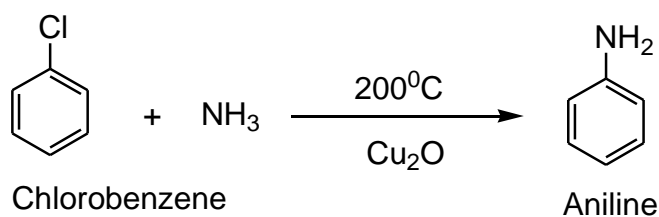
14. Write a short note on Schotten – Baumann reaction.

Benzoyl chloride + Aniline $\xrightarrow[\text{(or) pyridine}]{\text{NaOH}}$ N-phenyl benzamide
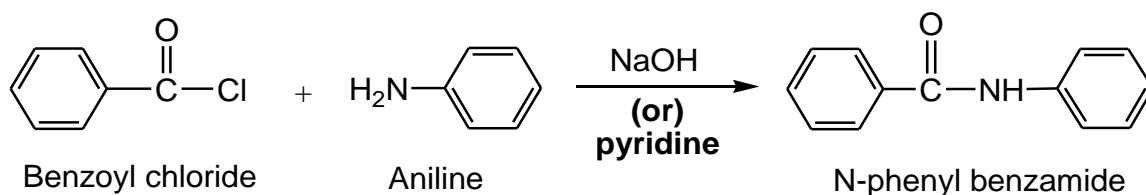
15. What is Carbylamine reaction. MAY-2022

$$CH_3NH_2 + CHCl_3 + 3KOH \longrightarrow CH_3NC + 3KCl + 3H_2O$$

methylamine → methyl isocyanide
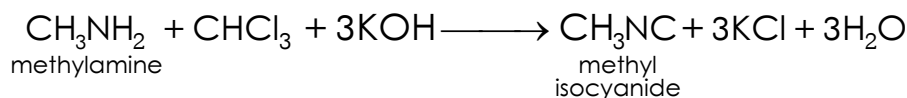
16. What is mustard oil reaction. SEP-2020 & SEP-2022

CH_3-NH_2 (Methylamine) + $C=S$ (with S) → $CH_3-NH-C-SH$ (with S) (N-Methyl carbamic acid) $\xrightarrow{HgCl_2}$ $CH_3-N=C=S$ (Methylisothiocyanate) + 2HCl
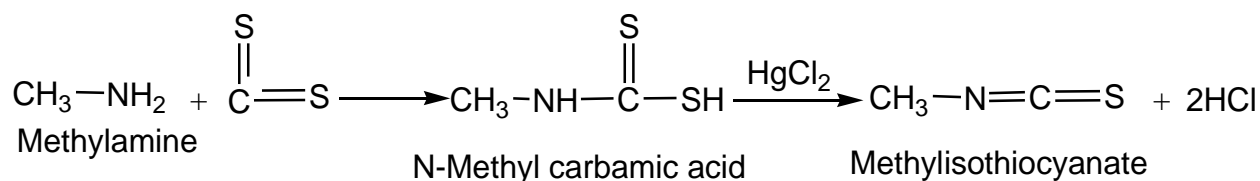
17. Aniline does not undergo Friedel Craft's reaction: account. JUNE -2020

Aniline does not undergo Friedel Craft's reaction because, it is basic in nature and it donates its lone pair to $AlCl_3$ to form an adduct which inhibits further the electrophilic substitution reaction.

18. What is diazotization reaction?

Aniline + $NaNO_2$ + $2HCl$ $\xrightarrow{\text{273-278K}}$ Benzene diazonium chloride + $NaCl$ + $2H_2O$
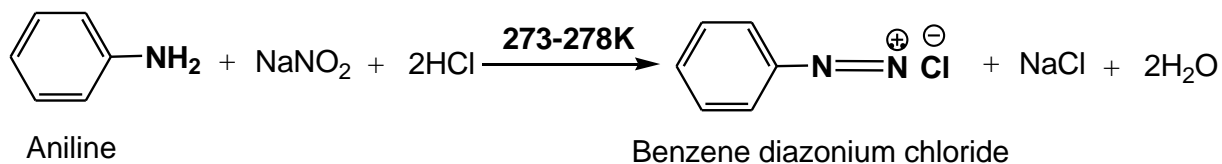
19. What is Sandmeyer's reaction?

$C_6H_5N_2Cl \xrightarrow[HCl]{Cu_2Cl_2} C_6H_5Cl + N_2$
chloro benzene

$C_6H_5N_2Cl \xrightarrow[HBr]{Cu_2Br_2} C_6H_5Br + N_2$
chloro benzene
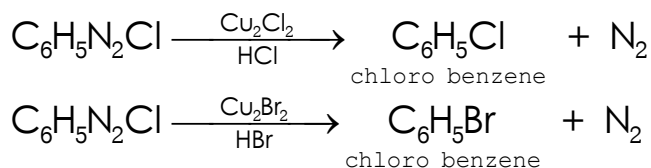
20. What is gattermann's reaction?

$C_6H_5N_2Cl \xrightarrow[HCl]{Cu\ powder} C_6H_5Cl + N_2$
chloro benzene

$C_6H_5N_2Cl \xrightarrow[HBr]{Cu\ powder} C_6H_5Br + N_2$
chloro benzene
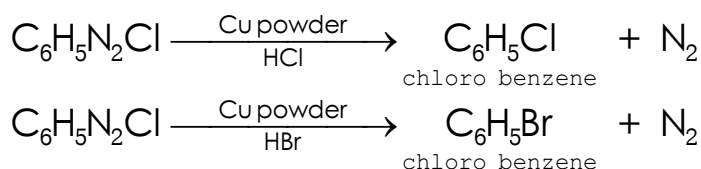
21. What is baltz –schiemann reaction?

$C_6H_5N_2Cl + HBF_4 \xrightarrow{-HCl} [C_6H_5N_2]^+ [BF_4]^- \xrightarrow{\Delta} C_6H_5 - F + N_2 + BF3$
benzene diazonium chloride — benzene diazonium fluoro borate — Fluoro benzene
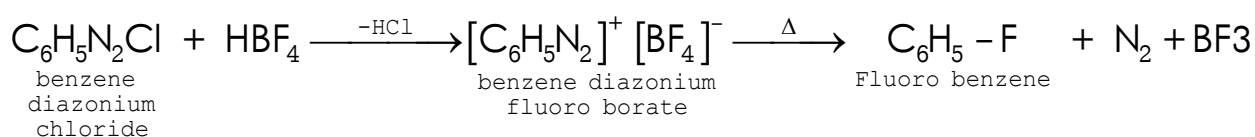
22. What is Gomberg reaction? MAR-2020

Benzene diazonium chloride + Benzene $\xrightarrow{NaOH}$ biphenyl
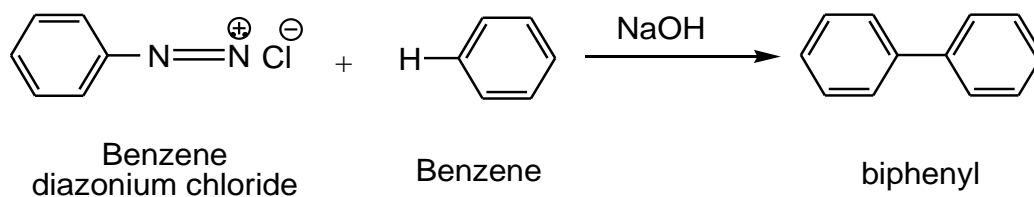
23. Write a note on coupling reaction.

Benzene diazonium chloride reacts with phenol, aniline to form azo dyes.

Benzene diazonium chloride + Phenol $\xrightarrow[P^H=9-10]{NaOH \\ 273-278K}$ p-hydroxy azobenzene
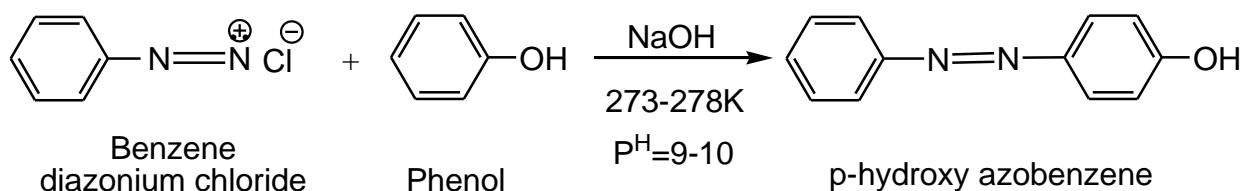
24. Write a note on Thorpe nitrile condensation reaction.

A reaction in which two alkyl nitrile (containing $\alpha-H$ atom) molecules undergo Self condensation in the presence of sodium to form iminonitrile is called Thorpe condensation.

$$\underset{\text{Ethane nitrile}}{CH_3-\overset{\overset{N}{\lvert\lvert\lvert}}{C}} \quad + \quad CH_3-CN \quad \xrightarrow[\text{Ether}]{\text{Na}} \quad \underset{\text{3-imino butane nitrile}}{CH_3-\overset{\overset{NH}{\lvert\lvert}}{C}-CH_2-CN}$$
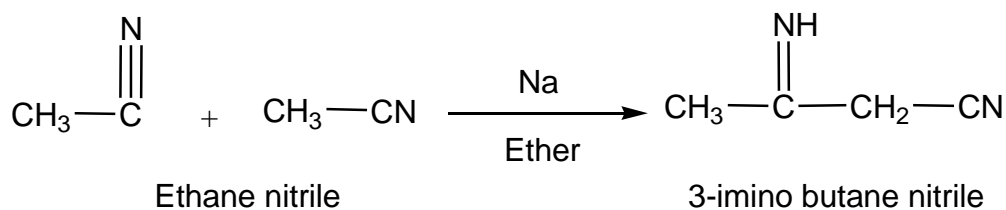
25. What is cyanomethylation reaction? (Or) what is Levine and Hauser acetylation?

This reaction involves replacement of Ethoxy group by methylnitrile group and is called as cyanomethylation reaction.

$$\underset{\text{Ethyl acetate}}{H_3C-\overset{\overset{O}{\lvert\lvert}}{C}-OC_2H_5} \quad + \quad \underset{\text{Ethane nitrile}}{H-CH_2-CN} \quad \xrightarrow[\text{(ii) } H^+]{\text{(i) NaNH}_2 \text{ -NH}_3} \quad \underset{\text{3-ketobutanenitrile}}{H_3C-\overset{\overset{O}{\lvert\lvert}}{C}-CH_2-CN}$$
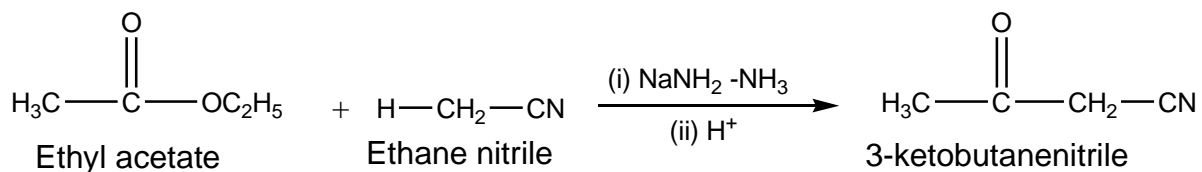
1. **What are anomers? Give an example.**

   The two isomers differ only in the configuration at C_1 carbon are called anomers. **Example:** α-D glucose and β -D glucose

2. **What is Mutarotation?**

   When pure form of any one of glucose is dissolved in water, slow interconversions of α-D glucose and β -D glucose via open chain form occurs to form an equilibrium mixture with constant specific rotation of $+53°$. This phenomenon of change in the optical rotation is called Mutarotation.

3. **What are Epimers? Give an example. MAY-2022**

   Sugars differing in configuration at an asymmetric centre are known as Epimers. Examples: (D-Glucose and D-galactose) , (D-glucose and D-mannose)

4. **What are reducing and non – reducing sugars?**

   - Sugars with aldehyde groups can reduce both Tollen's and Fehling's solutions, they are called reducing sugars. Examples: glucose, lactose, maltose etc.,

   - Sugars with no free aldehyde groups cannot act as reducing agents, they are called non-reducing sugars. Examples: fructose, sucrose etc.,

5. **What are homo poly and hetero poly saccharides?**

   ✓ Homo polysaccharides are composed of only one type of Monosaccharides. Example: starch, cellulose and glycogen.

   ✓ Hetero polysaccharides are composed of more than one type of Monosaccharides.Examples: hyaluronic acid, heparin.

6. **What is glycosidic linkage? MARCH-2020**

   Two monosaccharide units are linked by *Glycosidic linkage* which is formed between anomeric carbon of one unit and a hydroxyl group of another unit. Example: Sucrose, Lactose

7. **Differentiate between amylose and amylopectin.**

s.no	amylose	amylopectin
1	water soluble	Water insoluble
2	Composed of linear chains up to 4000 α-D-glucose units.	Composed of linear chains up to 10000 α-D-glucose units.
3	No branching chains present.	There is a branching from linear chain.
4	Gives blue colour with iodine solution	Gives purple colour with iodine solution

8. **What are essential and non-essential amino acids?**

   - The amino acids that can be synthesised by our body are called non-essential amino acids. **Examples**: Gly, Ala

   - The amino acids that cannot be synthesised by our body and must be obtained through diet are called essential amino acids.**Examples:** Phe, Val

9. **What is isoelectric point of an amino acid?**

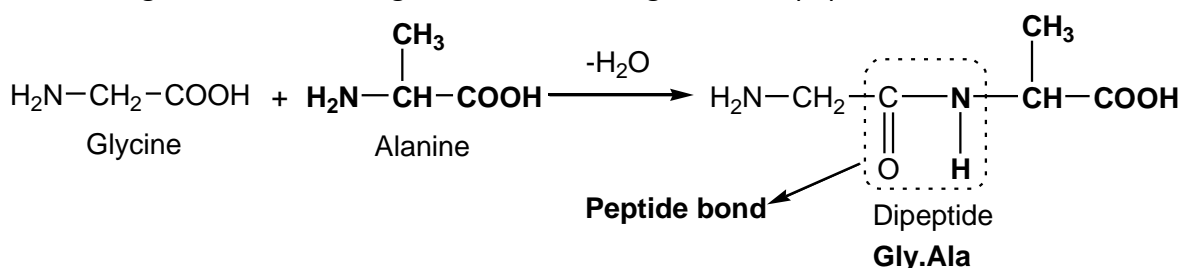   A specific pH at which the net charge of an amino acid is neutral is called isoelectric point

10. What are Zwitter ions? Draw the Zwitter ion structure of alanine. SEP-2022, MARCH-2023

In aqueous solutions, the proton from $-COOH$ group can be transferred to the $-NH_2$ group of an amino acid leaving these groups with opposite charges. These ions are called Zwitter ions.

$$H_3\overset{\oplus}{N}-\underset{\displaystyle |}{\overset{\displaystyle CH_3}{\underset{\displaystyle }{CH}}}-CO\overset{\ominus}{O}$$

Zwitter ion of alanine
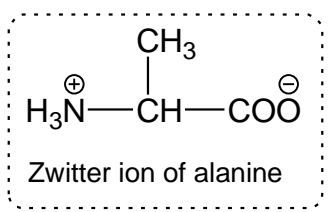
11. Write a short note on peptide bond. AUG 2021

In proteins the carboxyl group of the first amino acid react with the amino group of the second amino acid to give an amide linkage. This amide linkage is called peptide bond.

$$H_2N-CH_2-COOH \;+\; H_2N-\underset{\displaystyle}{\overset{\displaystyle CH_3}{CH}}-COOH \xrightarrow{-H_2O} H_2N-CH_2-\underset{\displaystyle O}{\overset{\displaystyle}{C}}-\underset{\displaystyle H}{\overset{\displaystyle}{N}}-\underset{\displaystyle}{\overset{\displaystyle CH_3}{CH}}-COOH$$

Glycine   Alanine

Peptide bond   Dipeptide **Gly.Ala**

12. How are proteins classified based on their structures? MARCH-2020

Based on their structure Proteins are classified into two major types.

♣ **Fibrous protein:**

They are linear molecules similar to fibres. They are generally insoluble in water. They are held together by disulphide bridges & weak intermolecular hydrogen bonds. These proteins often used as structural proteins. Example: Keratin, Collagen.

♣ **Globular proteins:**

They have an overall spherical shape.They are generally soluble in water. They perform many functions including catalysis.Example: haemoglobin, myoglobin.

13. Explain the mechanism of enzyme action.

- Enzymes are biocatalysts that catalyse a specific biochemical reaction.
- They reduce the activation energy of the reaction by stabilising the transition state.
- In a typical reaction enzyme E binds the substrate molecule reversibly to produce an Enzyme-Substrate complex.
- During this stage the substrate is converted into product and the enzyme becomes free and is ready to bind to another substrate molecule.

$$\underset{enzyme}{E} + \underset{substrate}{S} \longrightarrow \underset{Complex}{[ES]} \longrightarrow \underset{enzyme}{E} + \underset{product}{P}$$

14. Write a note on denaturation of proteins. SEP-2020

The process in which a protein loses its higher order structure without losing its primary structure is called denaturation. **Example**: coagulation of egg white by action of heat.

15. How are lipids classified based on their structures.

Based on their structures Lipids can be classified as follows:

- **Simple lipids:**

  Fats : Esters of long chain fatty acids with glycerol (triglycerides)

  Waxes : Esters of fatty acids with long chain alcohols (Bees wax).

- **Compound lipids:**

  They are the esters of simple fatty acid with glycerol which contain additional groups. Based on the groups attached, they are further classified into

  Phospholipids : contain a phospho-ester linkage

  Glycolipids : contain a sugar molecule attached.

  Lipoproteins : complexes of lipid with proteins.

16. What are the functions of lipids in living organism? SEP-2020

1. Lipids are the integral component of cell membrane.
2. The main function of lipids in animals is as an energy reserve.
3. They act as protective coating in aquatic organisms.
4. Lipids of connective tissue give protection to internal organs.
5. Lipids help in the absorption and transport of fat soluble vitamins.
6. Lipids act as emulsifier in fat metabolism.

17. How are vitamins classified?

- **Fat soluble vitamins:** Vitamin A, D, E & K do not dissolve in water. They are called fat soluble vitamins.They absorbed best when taken with fatty food and stored in fatty tissues and livers.

- **Water soluble vitamins:** Vitamins B and C are readily soluble in water. The excess vitamins present will be excreted through urine and are not stored in our body.

18. Name the Vitamins whose deficiency cause JUNE-2020

(i)	Rickets	:	vitamin D
(ii)	Scurvy	:	vitamin C
(iii)	Pellagra	:	vitamin B_3
(iv)	Beriberi	:	vitamin B_1
(v)	Xerophthalmia	:	vitamin A
(vi)	Hair loss	:	vitamin B_7

19. What are different types of RNA which are found in cell. JUNE 2020

1. Ribosomal RNA : (rRNA)
2. Messenger RNA : (mRNA)
3. Transfer RNA (tRNA)

20. What are hormones? Give examples. MARCH 2023

Hormones are intercellular signalling molecules secreted by one tissue into the blood stream and induces a physiological response in other tissues. Examples: insulin

21. How are Hormones classified according to the distance over which they act?

- **Endocrine hormones:**

  They act on cells distant from the site of their release. **Example**: insulin and epinephrine.

- **Paracrine hormones:**

  They act only on cells close to the cell that released them. **Example**, Interleukin-1

- **Autocrine hormones:**

 They act on the same cell that released them.**Example**: Interleukin-2

22. Give two difference between Hormones and vitamins

S.NO	VITAMINS	HORMONES
1	It is carried in the food.	is produced by an endocrine gland.
2	It act as coenzyme.	act as a stimulating substance.
3	It may be organic acid, amide, amine, ester, alcohol or steroid.	is a glycoprotein, steroid or polypeptide.

23. Give any three difference between DNA and RNA. AUG-2021

S.N	DNA	RNA
1	present in nucleus, mitochondria and chloroplast	It is 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 can replicate itself	It cannot replicate itself but from DNA

24. Draw the structures of D- glucose and D- fructose.

Glucose

Fructose
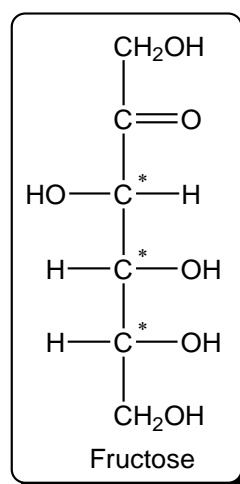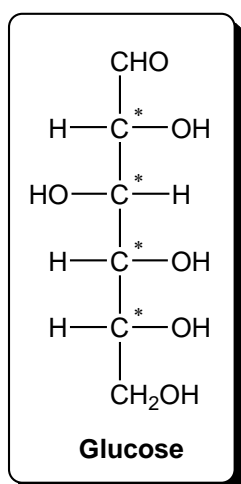
UNIT-15 CHEMSITRY IN EVERYDAY LIFE

1. **What are drugs?**

    A drug is a substance that is used to modify (or) explore physiological systems (or) pathological states for the benefit of the recipient. Drugs are used for the purpose of diagnosis, prevention, cure/relief of a disease.

2. **What is therapeutic index?**

    Therapeutic index is defined as the ratio between the maximum tolerated dose and the minimum curative dose of the drug.

    $$Therapeutic\ index\ (T_i) = \frac{Maximum\ tolerated\ dose}{Minimum\ curative\ dose}$$

3. **What are allosteric inhibitors?**

    In certain enzymes, the inhibitor molecule binds to a different binding site, which is referred to as allosteric site, and causes a change in its active site geometry. As a result, the substrate cannot bind to the enzyme. This is type of inhibitors are called allosteric inhibitors.

4. **What are agonists and antagonists?**
    - An agonist is a chemical that binds to a receptor and activates it to produce a biological response.
    - An antagonist is a chemical that binds to a receptor and inactivate it.

5. **How the tranquilizers work in body. Mention their uses.**

    Tranquilizers are neurologically active drugs. They act on the central nervous system by blocking the neurotransmitter in the brain. Examples: Haloperidol, Diazepam

    Uses : They are used to treat stress, anxiety, depression, sleep disorders and schizophrenia.

6. **What are Antacids? Give some Examples.**

    The substances that are used to neutralize the acid in the stomach are called antacids. They are used to relieve burning sensation caused by acid reflux.

    Examples: Milk of Magnesia, $Al(OH)_3$

7. **What are antihistamines? Give examples.**

    A drug which blocks histamine release from histamine-1 receptors is called as antihistamine. It is used relive allergic effect. **Examples:** Cetirizine, levocetirizine.

8. **Whar are antipyretics? Give examples.**

    These drugs are used to reduce fever and to prevent platelet coagulation. Ex: Paracetamol, Aspirin.

9. **Explain the types of anaesthetics with suitable examples.**

    Local anaesthetics:

    The substance which causes loss of sensation, in the area in which it is applied without losing consciousness is called local anaesthetic. They are used during minor surgical procedures. Examples: Lidocaine.

    General anaesthetics:

    The substance which causes a controlled and reversible loss of consciousness by affecting central nervous system is called a general aesthetic. They are used for major surgical procedures. Examples: Propofol

MINI CHEM – VELLORE DIST – 2023   **[65]**

10. **What are Antiseptics? Give examples.**

The substance which can Stop or slow down the growth of microorganisms, and are applied to living tissue is called antiseptic. They are used to reduce the risk of infection during surgery.

Example: povidone-iodine.

11. **What are Disinfectants? Give examples.**

The substance which can stop or slow down the growth of microorganisms and are used on inanimate objects is called a disinfectant. Examples: H_2O_2, alcohol.

12. **How do antiseptics differ from disinfectants? Sept-2020**

Antiseptic can be applied to living tissue, but disinfectant can be used on inanimate objects only.

13. **What are antifertility drugs? Give examples.**

The synthetic hormones that suppress ovulation / fertilisation are called antifertility drugs. They are used in birth control pills.**Example:**

Synthetic oestrogen – Menstranol   Synthetic Progesterone - Norethindrone

14. **What are food preservatives? Give some examples.** *March -2023*

The substances which are capable of inhibiting, arresting the process of fermentation, decomposition of food by growth of microorganisms is called Preservatives.

- Benzoic acid, sorbic acid and their salts are potent inhibitors of a fungi, yeast and bacteria.
- Acetic acid is used as a preservative for pickles and vegetables.
- Sodium met sulphite is used as preservatives for fresh vegetables and fruits.

15. **List the advantages of food additives. March -2020**

- Preservatives reduce the spoilage and extend the shelf-life of food.
- Addition of vitamins and minerals reduces the mall nutrients.
- Flavouring agents enhance the aroma of the food.
- Antioxidants prevent the formation of potentially toxic oxidation products of lipids.

16. **What are Antioxidants? June-2020**

A substance which retard the oxidative deteriorations of food is called an Antioxidant. Ex: BHT, BHA

17. **What is Sugar Substituent? Give two examples.**

The substance that is used like sugar for sweetening, but are metabolised without the influence of insulin are called sugar substituents. Examples: Sorbitol, Mannitol.

18. **What are artificial sweetening agents? Give two examples.**

Synthetic compounds which imprint a sweet sensation and possess no nutritional value are called artificial sweeteners. Example. Saccharin, sucralose.

19. **What is Total fatty matter (TFM)?**

It is defined as the total amount of fatty matter that can be separated from a sample after splitting with mineral acids.

Grade-1 soaps should have minimum 76% TFM,

Grade-2 soaps should have minimum 70% TFM

Grade-3 soaps should have minimum 60% TFM

20. **What are detergents?**

Synthetic detergents are either sodium salts of alkyl hydrogen sulphates (or) sodium salts of long chain alkyl benzene sulphonic acids.

21. What is polymerisation? Explain their types.

The process of forming a very large molecule with high molecular mass from small structural units is called polymerisation. Polymerisation occurs in the following two ways

1. Addition polymerization.

2. Condensation polymerisation.

22. What are Condensation polymers? Give an example.

The polymers which are formed by the condensation of two or more monomers with the elimination of simple molecules like H_2O, NH_3 etc., are called condensation polymers. Examples: Terylene, Nylon

23. What are copolymers? Give an example.

A polymer containing two or more different kinds of monomer units is called a copolymer. For example: Buna-Rubbers, Nylon6,6 etc **.**

24. What are synthetic rubbers?

Polymerisation buta-1,3-diene (or) its derivatives gives rubber like polymer with desirable properties. Such polymers are called synthetic rubbers. They have greater stretching ability.

25. What are bio degradable polymers? Give examples.

A polymer which can be decomposed by soil microorganism are called biodegradable polymer. They are used in surgical sutures, plasma substitute etc.Examples PHB, PHBV
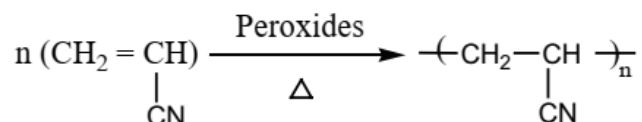
26. How is Teflon prepared?

Teflon is prepared by heating tetrafluroethylene in the presence of oxygen under high pressure.

$$n\, CF_2 = CF_2 \xrightarrow{\ \Delta\ } \left(CF_2 - CF_2\right)_n$$
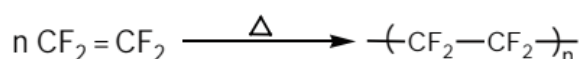
Uses: It is used for coating articles and preparing non – stick utensils.

27. How is Orlon (Polyacrylonitrile – PAN) prepared?

Orlon is prepared by the addition polymerisation of vinyl cyanide using a peroxide initiator.

$$n\, (CH_2 = \underset{CN}{CH}) \xrightarrow[\Delta]{\text{Peroxides}} \left(CH_2 - \underset{CN}{CH}\right)_n$$

Uses: It is used as a substitute of wool for making blankets, sweaters etc…

28. How is Terylene (Dacron) prepared?

Terylene is prepared by mixing ethylene glycol and terephthalic acid at 500K in the presence of zinc acetate and antimony trioxide catalyst.
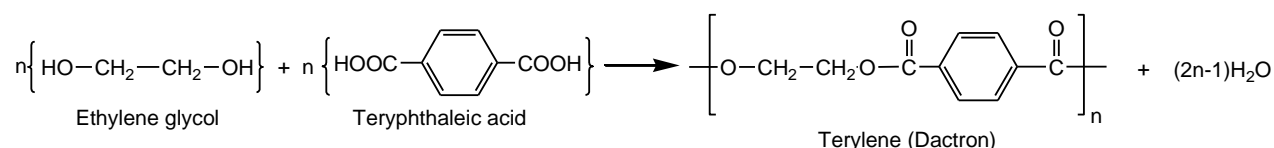
Uses:

Terylene is used in blending with cotton or wool

Terylene is used as glass reinforcing materials in safety helmets.

29. Write a note on vulcanization of rubber. March-2020

- Natural rubber is a polymer of cis isoprene (2-methylbuta-1,3-diene).It is not so strong (or) elastic.

- The process in which natural rubber is mixed with 3-5% sulphur and heated at $100 - 150°C$ is called vulcanisation. It 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.

- Vulcanised rubber containing 1 to 3% sulphur is soft and stretchy.
- Vulcanised rubber containing 3 to 10% sulphur hard but flexible.

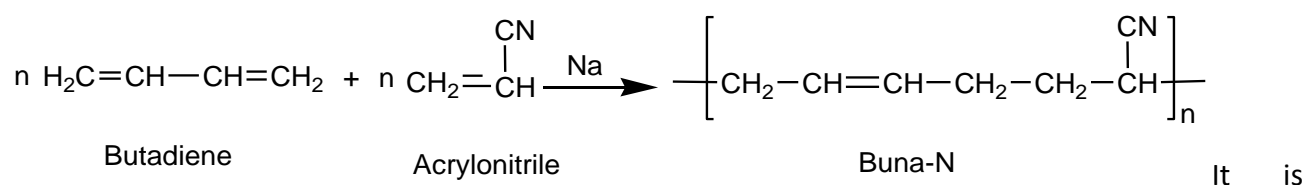**30. Differentiate thermoplastic and thermosetting polymers.**

Thermoplastics: They become soft on heating and hard on cooling. They can be remoulded. Examples: polythene, PVC.

Thermosetting polymers: They do not become soft on heating but changed to an infusible mass. Examples: Bakelite

31. Write a note on Buna rubbers.
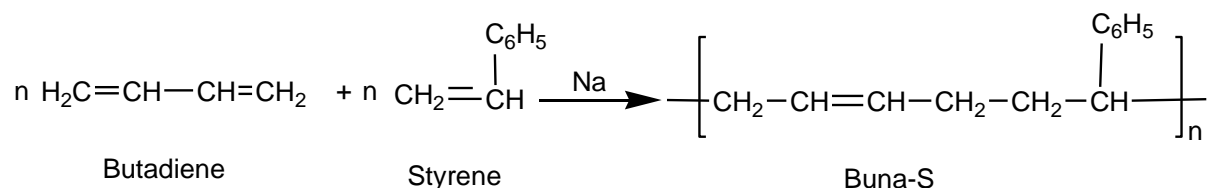
Buna-N: It is a co-polymer of buta-1,3-diene and acrylonitrile.

$$n\ H_2C=CH-CH=CH_2\ +\ n\ CH_2=\overset{CN}{\underset{|}{CH}}\ \xrightarrow{Na}\ \left[CH_2-CH=CH-CH_2-CH_2-\overset{CN}{\underset{|}{CH}} \right]_n$$

| Butadiene | Acrylonitrile | Buna-N |

It is used in the manufacture of hoses and tank linings.
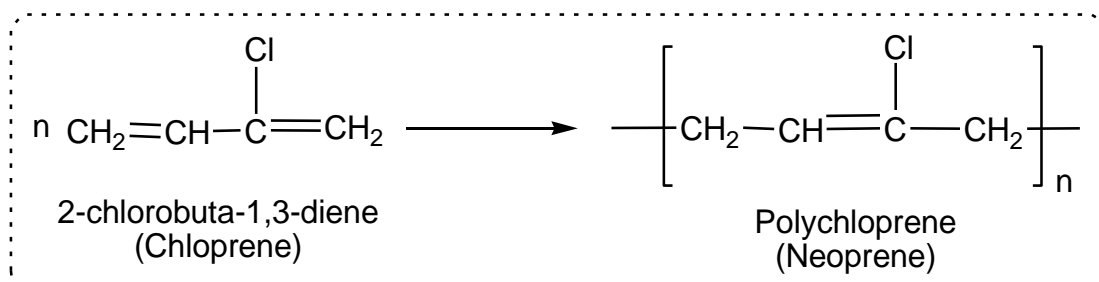
Buna-S:

It is a co-polymer of buta-1,3-diene and styrene. These monomers nixed in the ratio 3:1 in the presence of sodium.

$$n\ H_2C=CH-CH=CH_2\ +\ n\ CH_2=\overset{C_6H_5}{\underset{|}{CH}}\ \xrightarrow{Na}\ \left[CH_2-CH=CH-CH_2-CH_2-\overset{C_6H_5}{\underset{|}{CH}} \right]_n$$

| Butadiene | Styrene | Buna-S |

32. How is Neoprene rubber prepared? Sept-2020

The free radical polymerisation of 2-chlorobuta-1,3-diene (chloroprene) gives neoprene. It is superior to rubber and resistant to chemical action.

$$n\ CH_2=CH-\overset{Cl}{\underset{|}{C}}=CH_2\ \longrightarrow\ \left[CH_2-CH=\overset{Cl}{\underset{|}{C}}-CH_2 \right]_n$$

2-chlorobuta-1,3-diene (Chloprene)   Polychloprene (Neoprene)

Uses: It is used in the manufacture of chemical containers, conveyer belts.