



Edited BY

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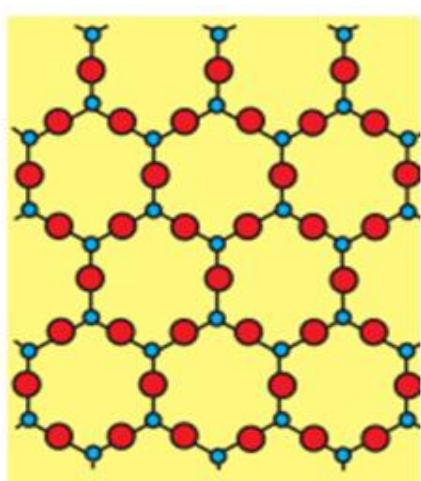
CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 1
The Solid State

Solid: Solid is a state of matter in which the constituting particles are arranged very closely. The constituent particles can be atoms, molecules or ions.

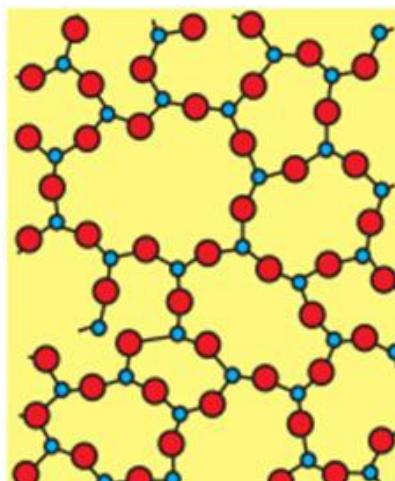
Properties of solids:

1. They have definite mass, volume and shape.
2. They are compressible and rigid.
3. Intermolecular distances are very short and hence the intermolecular forces are strong.
4. Their constituent particles have fixed position. sand can only oscillate about their mean positions.

Classification of on the basis of the arrangement of constituent particles:



Crystalline Solids

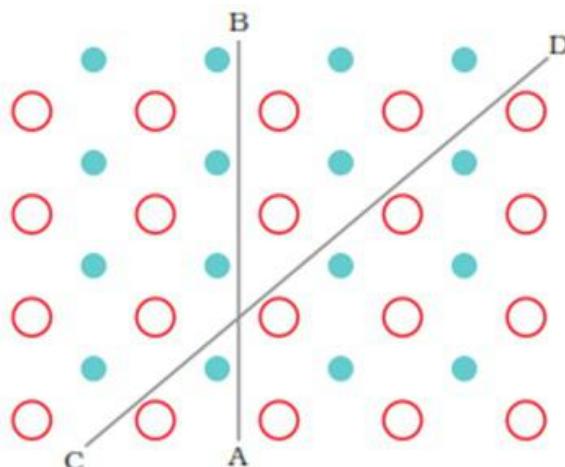


Amorphous Solids

• **Properties of crystalline solids:**

- They have a definite geometrical shape.
- They have a long range order.
- They have a sharp melting point.
- They are anisotropic in nature i.e. their physical properties show different values when measured along different directions in the same crystal.

- They have a definite and characteristic heat of fusion.
- They are called true solids.
- When cut with a sharp edged tool , they split into two pieces and the newly generated surfaces are plain and smooth.



Anisotropic nature of crystalline solids

- **Polymorphic forms or polymorphs:**

The different crystalline forms of a substance are known as polymorphic forms or polymorphs .For example: graphite and diamond.

- **Characteristics of amorphous solids:**

1. They have an irregular shape.
2. They have a short range order.
3. They gradually soften over a range of temperature.
4. They are isotropic in nature i.e. their physical properties are the same in all directions.
5. When cut with a sharp edged tool, they cut into two pieces with irregular surfaces.
6. They do not have definite heat of fusion.
7. They are called pseudo solids or super cooled liquids. This is because they have a tendency to flow, though very slowly.

- **Types of crystalline solids:**

A. Molecular Solids

Constituent Particles: Molecules

Type of solid	Constituent Particles	Bonding/ Attractive Forces	Electrical conductivity	physical nature	Melting point	Examples
Non-polar solids	Molecules	Dispersion or London forces	Insulator	Soft	Very low	$Ar, CCl_4, H_2, I_2, CO_2$
Polar solids	Molecules	Dipole-dipole interactions	Insulator	Soft	low	HCl , solid SO_2 , solid NH_3
Hydrogen bonded	Molecules	Hydrogen bonding	Insulator	Hard	low	H_2O (ice)

B. Ionic Solids

Constituent Particles: Ions

Bonding/Attractive Forces: Coulombic or Electrostatic

Electrical Conductivity: Insulators in solid state but conducts in molten state and in aqueous solutions

Physical Nature: Hard but brittle

Melting Point: High

Examples: CaF_2 , ZnS , MgO , $NaCl$

C. Metallic Solids

Constituent Particles: Positive ions in a sea of delocalized electrons

Bonding/Attractive Forces: Metallic bonding

Electrical Conductivity: Conductors in solid state as well as in molten state

Physical Nature: Hard but malleable and ductile

Melting Point: Fairly high

Examples: Fe, Cu, Ag, Mg

D. Covalent or Network Solids

Constituent Particles: Atoms

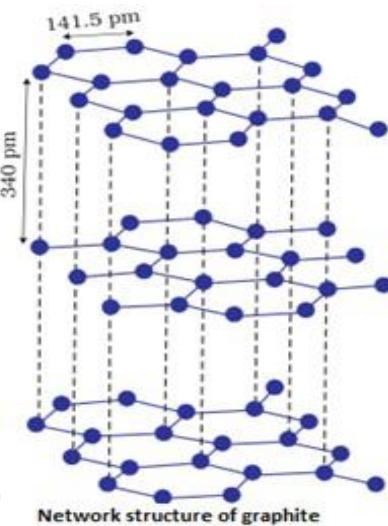
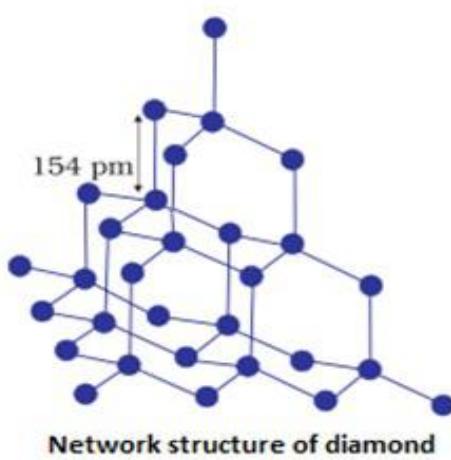
Bonding/Attractive Forces: Covalent bonding

Electrical Conductivity: Conductors in solid state as well as in molten state

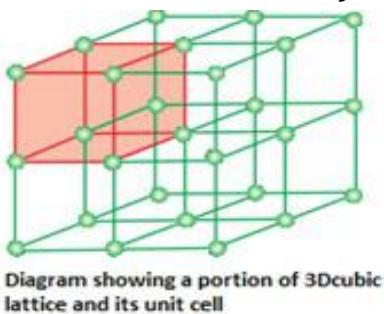
Physical Nature: Hard but malleable and ductile

Melting Point: Fairly high

Examples: SiO_2 , (quartz), SiC, C (diamond), C(graphite)



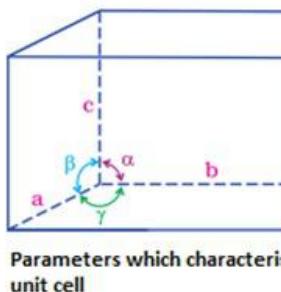
- **Crystal lattice:** A regular ordered arrangement of constituent particles in three dimensions is called crystal lattice.



- **Lattice points or lattice sites:** the fixed positions on which the constituent particles are present are called lattice points or lattice sites. A group of lattice points which when repeated over and over again in 3 dimensions give the complete crystal lattice.
- **Unit cell:** It is defined as the smallest repeating unit in space lattice which when repeated over and over again generates the complete crystal lattice. The crystal can consist of an infinite number of unit cells.

- **Parameters which characterize a unit cell:**

1. Dimensions of the unit cell along the three edges ,a, b and c:these edges may or may not be mutually perpendicular.
2. Inclination of the edges to each other:this is denoted by the angle between the edges α,β , and respectively. α is the angle between the edges b and c, β is the angle between the edges a and c ,and γ is the angle between a and b.



Parameters which characterise a unit cell

- **Seven crystal systems:**

1. Cubic: $\alpha=\beta=\gamma=90^\circ$, $a=b=c$
2. Tetragonal: $\alpha=\beta=\gamma=90^\circ$; $a=b\neq c$
3. Orthorhombic: $\alpha=\beta=\gamma=90^\circ$; $a\neq b\neq c$
4. Monoclinic: $\alpha=\gamma=90^\circ$, $\beta\neq 90^\circ$; $a\neq b\neq c$
5. Hexagonal: $\alpha=\beta=90^\circ$, $\gamma=120^\circ$; $a=b\neq c$
6. Rhombohedral or trigonal: $\alpha=\beta=\gamma\neq 90^\circ$; $a=b=c$
7. Triclinic: $\alpha\neq\beta\neq\gamma\neq 90^\circ$; $a\neq b\neq c$

- **Types of unit cells:**

1. Primitive or simple unit cells have constituent particles only at its corners.
2. Centered unit cells are those unit cells in which one or more constituent particles are present at positions in addition to those present at the corners.

- **Types of centered unit cells:**

1. Face centered unit cell: It consists of one constituent particle present at the centre of each face in addition to those present at the corners.
2. Body centered unit cell: It consists of a one constituent particle is present at its body centre in addition to those present at the corners.
3. End centered unit cell: It consists of one constituent particle present at the centre of any

two opposite faces in addition to those present at the corners.

- **Number of particles at different lattice positions:**

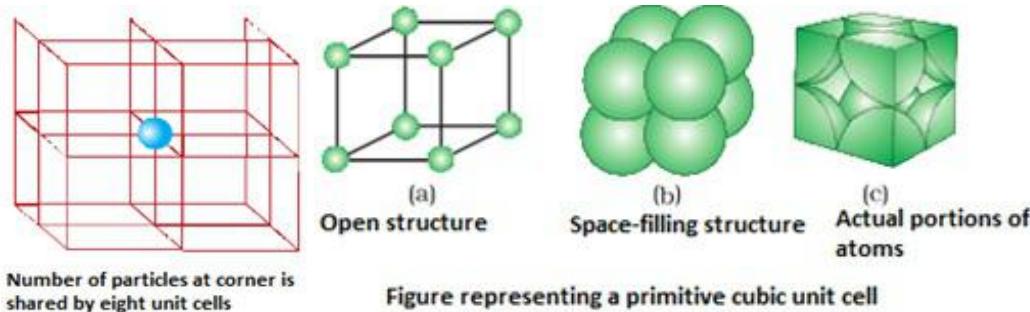
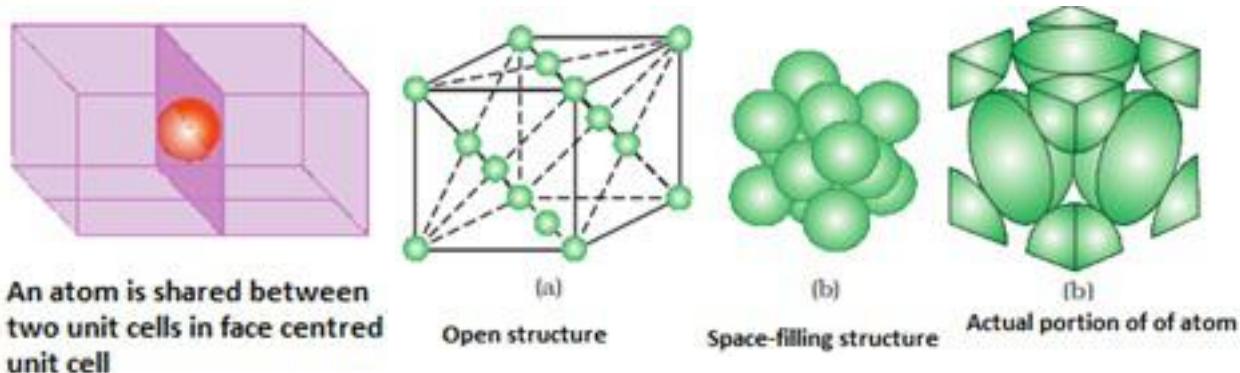


Figure representing a primitive cubic unit cell

- Face centre: if an atom is present at the centre of the face, it is shared by two unit cells. So, only half of the atom actually belongs to the unit cell.



- Body centre: if an atom is present at the body centre, it is not shared by any other unit cell. So, that one atom completely belongs to the same unit cell.

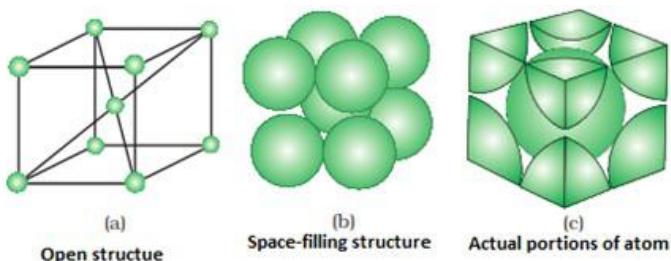


Figure representing a body centric cubic unit cell

- End centre: if an atom is present at the edge centre, it is shared by four unit cells. So, only one fourth of an atom belongs to the unit cell.

- **Number of atoms in different unit cells:**

1. Primitive unit cell have 1 atom

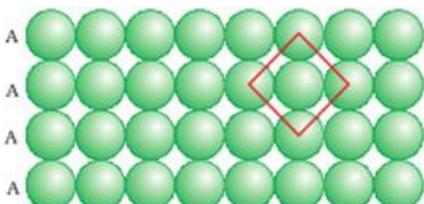
2. Face centered unit cell have 3 atoms
3. Body centered unit cell have 2atoms

- **Coordination number:** Coordination number is the number of nearest neighbours of a particle.
- **Close packed structures:**



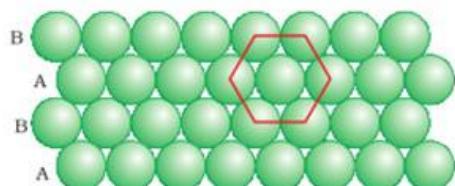
One dimensional close packing of spheres

- Close packing in two dimensions: It is generated by stacking the rows of close packed spheres in two ways:
 - i) Square close packing and ii) Hexagonal close packing.
- Close packing in three dimensions: They can be obtained by stacking the two dimensional layers one above the other. It can be obtained in two ways:
 - i) Square close packed layers and ii) Hexagonal close packed layers.
- **Square close packing:** Here, the spheres of the second row were placed exactly above those of the first row. This way the spheres are aligned horizontally as well as vertically. The arrangement is AAA type. The coordination number is 4.



Square close packing of spheres in two dimensions

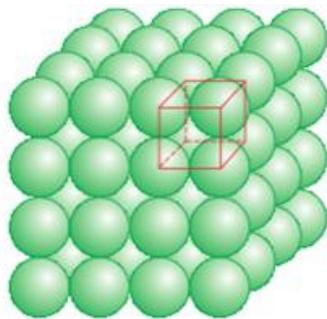
- **Hexagonal close packing:** Here, these spheres of these bond row are placed above the first one in a staggered manner in such a way that its spheres fit in the depression of the first row. The arrangement is ABAB type. The coordination number is 6.



Hexagonal close packing of spheres in two dimensions

- **Three dimensional close packing from two dimensional square close packed**

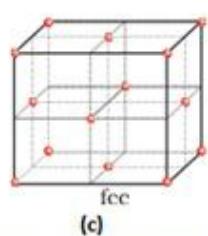
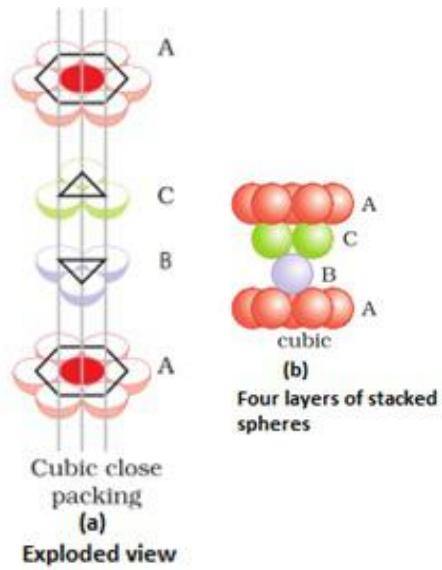
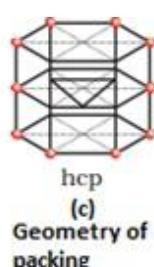
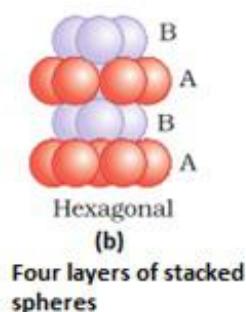
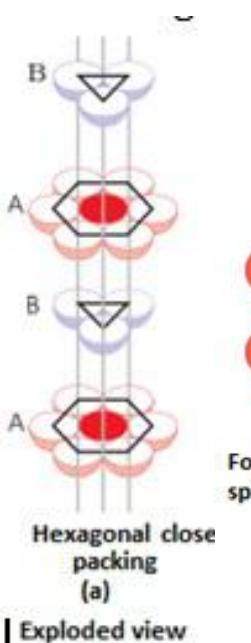
layers: Here , the spheres of the upper layer are placed exactly over the first layer such the spheres of the layers are perfectly aligned horizontally and vertically. It has a AAAA type pattern. The lattice is simple cubic lattice.



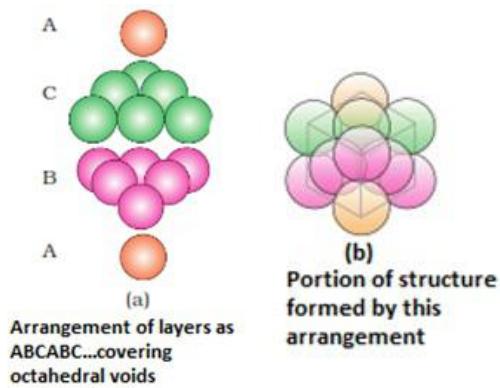
Three dimensional close packing from two dimensional square close packed layers

- Three dimensional close packing from two dimensional hexagonal close packed layers: There are two steps involved as:
 1. Placing these bond layer over the first layer
 2. Placing the third layer over the third layer

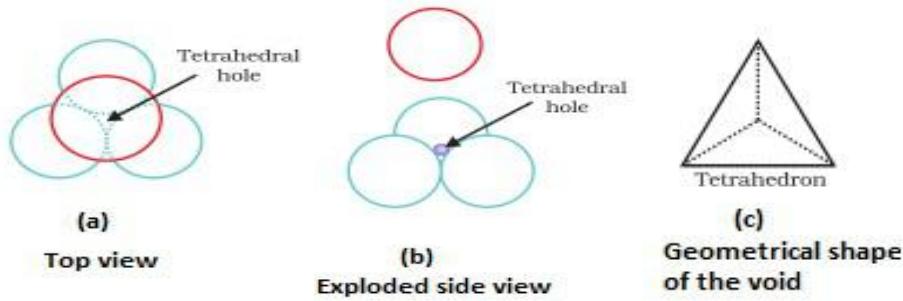
There are two possibilities:



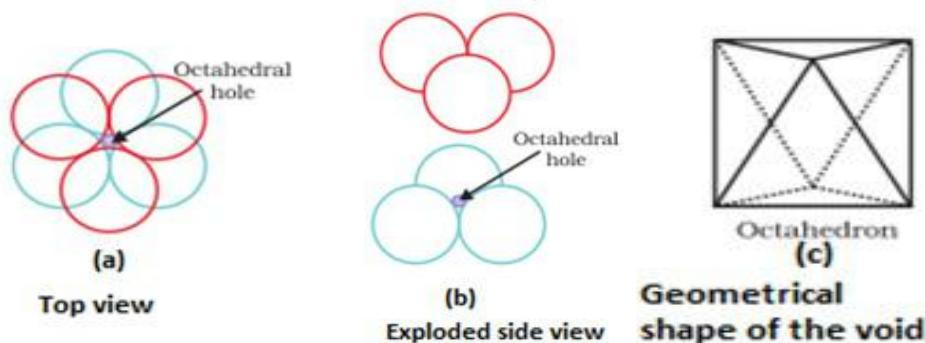
- **Covering the octahedral voids:** Here, octahedral voids of these bond layer may be covered by the spheres of the third layer. It gives rise to ABCABCABC type pattern. The three dimensional structure is called cubic close packed structure or face centered cubic structure. The coordination number is 12.Example: Cu, Ag.



- **Types of voids:**



- Octahedral void- It is formed at the centre when six spheres are joined in the form of an octahedron.



- In hexagonal close packing or cubic close packing arrangement, the octahedral and tetrahedral voids are present. The number of octahedral voids present in a lattice is equal to the number of close packed particles. The number of tetrahedral voids is twice the number of octahedral voids.

For example:

If the number of close packed particles = n

Number of particles present in octahedral voids = n

Then, the number of particles present in tetrahedral voids = 2n

- Packing efficiency: It is the percentage of total space occupied by constituent particles (atoms, molecules or ions).

$$\text{Packing Efficiency} = \frac{\text{Volume occupied by spheres}}{\text{Total volume of unit cell}} \times 100\%$$

- Packing efficiency for face centered unit cell = 74%
- Packing efficiency for body centered cubic unit cell = 68%
- Packing efficiency for simple cubic unit cell = 52.4%
- Radius ratio in an octahedral void: For an atom to occupy an octahedral void, its radius must be 0.414 times the radius of the sphere.

$$\frac{r}{R} = 0.414$$

- Radius ratio for tetrahedral void: For an atom to occupy a tetrahedral void, its radius must be 0.225 times the radius of the sphere.

$$\frac{r}{R} = 0.225$$

- Density of a unit cell is same as the density of the substance.
- Relationship between radius of constituent particle(r) and edge length(a):

1. Simple cubic unit cell: $a=2r$

2. Face centered unit cell: $a=2\sqrt{2}r$

3. Body centered unit cell: $a= \frac{4r}{\sqrt{3}}$

- Volume of a unit cell=(edge length)³= a^3

1. Simple cubic unit cell: Volume= $(2r)^3$

2. Face centered unit cell: Volume= $(2\sqrt{2}r)^3$

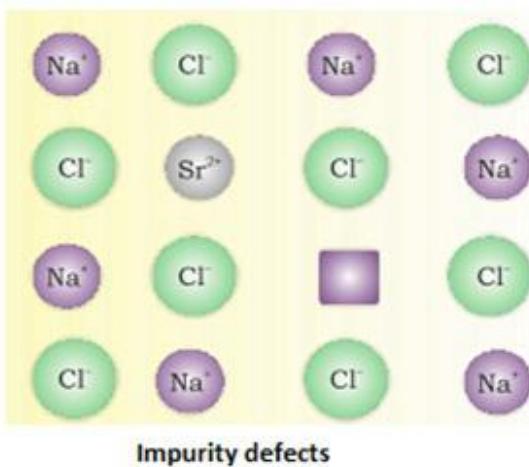
3. Body centered unit cell: Volume= $\left(\frac{4r}{\sqrt{3}}\right)^3$

- Number of atoms in a unit cell(z):

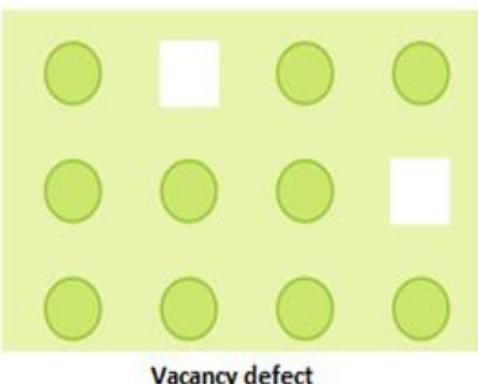
1. Simple cubic unit cell: $z=1$
2. Face centered unit cell: $z=4$
3. Body centered unit cell: $z=2$

- Density of unit cell=
 - Crystal defects are basically irregularities in the arrangement of constituent particles.
 - Types of defects:
1. Point defects- Point defects are the irregularities or deviations from ideal arrangement around a point or an atom in a crystalline substance.
 2. Line defects- Line defects are the irregularities or deviations from ideal arrangement in entire rows of lattice points.

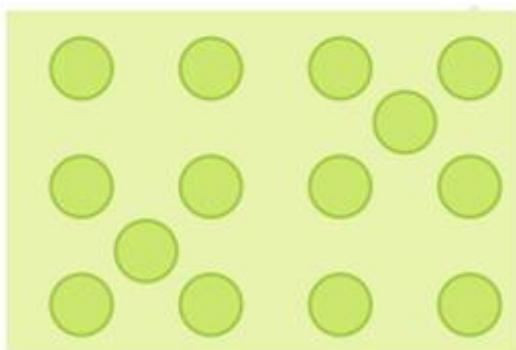
- Different types of point defects:



- Different types of stoichiometric defects for non- ionic solids:

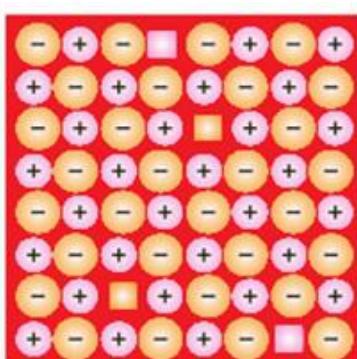


- **Interstitial defect:** A crystal is said to have interstitial defect when some constituent particles (atoms or molecules) occupy an interstitial site. This defect results in increase in density of the substance.



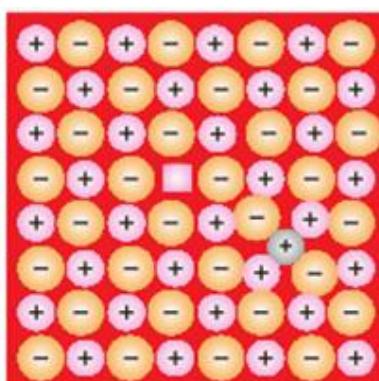
Interstitial defect

- Different types of stoichiometric defects for ionic solids:



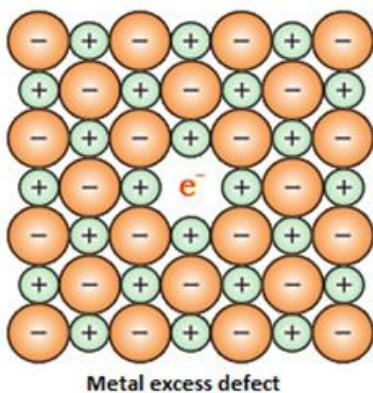
Schottky defects

- **Frenkel or dislocation defect:** In this defect, the smaller ion (usually cation) is dislocated from its normal site to an interstitial site. It creates a vacancy defect at its original site and an interstitial defect at its new location. It does not change the density of the solid. Frenkel defect is shown by ionic substance in which there is a large difference in the size of ions. It includes ZnS, AgCl, AgBr and AgI.



Frenkel defects

- Different types of non-stoichiometric defects:



- **Metal deficiency:** This defect arises because of absence of metal ions from its lattice sites. The electrical neutrality is maintained by an adjacention having a higher positive charge.
- **Reasons for the cause of metal excess defect:**

a) Anionic vacancies: A compound may have an extra metal ion if the negative ion is absent from its lattice site. This empty lattice site is called a hole. To maintain electrical neutrality this site is occupied by an electron. The hole occupied by an electron is called f-centre or Farbenz enter centre. The F- centre is responsible for the colour of the compound.

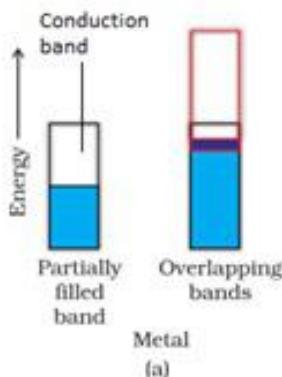
b) Presence of extracations: A compound is said to have extracations if a cation is present in the interstitial site. An electron is present in the interstitial site to maintain the electrical neutrality.

- **Classification of solids based on their electrical conductivities:**

a) Conductors: The solids with conductivities ranging between 10^4 to $10^7 \text{ ohm}^{-1} \text{ m}^{-1}$ are called conductors.

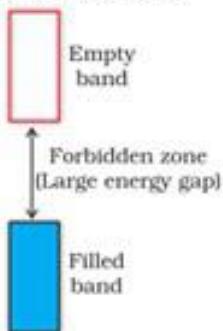
b) Insulators: These are the solids with very low conductivities ranging between 10^{-20} to $10^{-10} \text{ ohm}^{-1} \text{ m}^{-1}$.

c) Semi-conductors: These are the solids with conductivities in the intermediate range from 10^{-6} to $10^4 \text{ ohm}^{-1} \text{ m}^{-1}$.



b) In case of insulators, the forbidden gap is very large and the electrons are unable to excite to the conduction band.

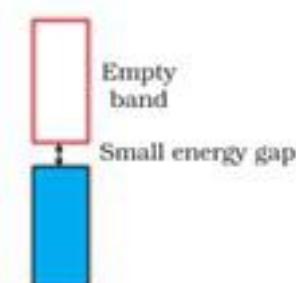
Conduction band



c) In case of semiconductors, forbidden gap is small. Therefore, some electrons may jump to conduction band and show some conductivity. Electrical conductivity of semiconductors increases with rise in temperature, since more electrons can jump to the conduction band.

Empty band

Small energy gap



- **Types of semiconductors:**

a) Intrinsic semiconductors: These are those semiconductors in which the forbidden gap is small. Only some electrons may jump to conduction band and show some conductivity. They have very low electrical conductivity. Example: Silicon, germanium.

b) Extrinsic semiconductors: When an appropriate impurity is added to an intrinsic semiconductor, it is called extrinsic semi conductors. Their electrical conductivity is high.

- **Doping:** The process of adding an appropriate amount of suitable impurity to increase the conductivity of semiconductors is known as doping.

a) The n-type semiconductors: They are formed when silicon is doped with electron rich impurity like group 15 elements. The increase in conductivity is due to the negatively charged electrons.

b) The p-type semiconductors: They are formed when silicon is doped with electron deficient impurity like group 13 elements. The increase in conductivity is due to the positively charged holes.

- **Types of extrinsic semiconductors:**
- **Diode:** It is a combination of n-type and p-type semiconductors and is used as a rectifier.
- **Transistors:** They are made by sandwiching a layer of one type of semiconductor between two layers of the other type of semi conductor. The npn and pnp type of transistors are used to detector amplify radio or audio signals.
- **The 12- 16 compounds:** These compounds are formed by the combination of group 12 and group 16 compounds. They possess an average valency of 4. Examples - ZnS, CdS, CdSe and HgTe.
- **The 13- 15 compounds:** These compounds are formed by the combination of group 13 and group 15 compounds. They possess an average valency of 4. Examples - InSb, AlP and GaAs.
- Every substance has some magnetic properties associated with it. The origin of these properties lies in the electrons.
- Each electron in an atom behaves like a magnet. Its magnetic moment originates from two types of motions:
 - (i) its orbital motion around the nucleus and

(ii) its spin around its own axis.

- **Classification of substances based on their magnetic properties:**

1. **Paramagnetic substances:** These are those substances which are weakly attracted by the magnetic field. It is due to presence of one or more unpaired electrons.
2. **Diamagnetic substances:** Diamagnetic substances are weakly repelled by a magnetic field. Diamagnetism is shown by those substances in which all the electrons are paired and there are no unpaired electrons.
3. **Ferromagnetic substances:** These are those substances which are attracted very strongly by a magnetic field.
4. **Anti ferromagnetic substances:** They have equal number of parallel and anti parallel magnetic dipoles resulting in a zero net dipole moment.
5. **Ferrimagnetic substances:** They have unequal number of parallel and anti parallel magnetic dipoles resulting in an at dipole moment.

CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 2
Solutions

$$\text{Molality} = \frac{\text{Number of moles of solute}}{\text{Mass of solvent in kilograms}}$$

$$\text{Molarity} = \frac{\text{Number of moles of solute}}{\text{Volume of solution in litres}}$$

$$P = KHx$$

The difference in boiling points of solution T_b and pure solvent T_b^0 is called elevation in boiling point $\Delta T = T_b - T_b^0$

$$\Delta T_b = \frac{k_b \times 1000 \times w_2}{M_2 \times w_1}$$

$$\Delta T_f = \frac{k_f \times 1000 \times w_2}{M_2 \times w_1}$$

$$\frac{p_1^0 - p}{p_1^0} = i \cdot \frac{n_2}{n_1}$$

$$\Delta T_b = i \cdot \frac{k_b \times 1000 \times w_2}{M_2 \times w_1}$$

$$\Delta T_f = i \cdot \frac{k_f \times 1000 \times w_2}{M_2 \times w_1}$$

- **Solutions:** Solutions are the homogeneous mixtures of two or more than two components.
- **Binary solution:** A solution having two components is called a binary solution.
- Components of a binary solution.

It includes solute and solvent.

1. When the solvent is in solid state, solution is called solid solution.
2. When the solvent is in liquid state, solution is called liquid solution.
3. When the solvent is in gaseous state, solution is called gaseous solution.

- **Concentration:** It is the amount of solute in given amount of solution.
- **Mass by volume percentage (w/v):** Mass of the solute dissolved in 100 mL of solution.
- **Molality (m)** is the number of moles of solute present in 1kg of solvent.
- **Molarity (M)** is the number of moles of solute present in 1L of solution.
- **Normality** is the number of gram equivalent of solute dissolved per litre of solution.
- **Solubility:** It is the maximum amount that can be dissolved in a specified amount of solvent at a specified temperature.
- **Saturated solution:** It is a solution in which no more solute can be dissolved at the same temperature and pressure.
- In a nearly saturated solution if dissolution process is an endothermic process, solubility increases with increase in temperature.
- In a nearly saturated solution if dissolution process is an exothermic process, solubility decreases with increase in temperature.
- **Henry's Law:** It states “at a constant temperature the solubility of gas in a liquid is directly proportional to the pressure of gas”. In other words, “the partial pressure of gas in vapour phase is proportional to the mole fraction of the gas in the solution”.
- When a non-volatile solute is dissolved in a volatile solvent, the vapour pressure of solution is less than that of pure solvent.
- **Raoult's law:** It states that “for a solution of volatile liquids the partial vapour pressure of each component in the solution is directly proportional to its mole fraction”.

$$p_1 = p^0_1 X_1; p_2 = p^0_2 X_2$$

- Using Dalton's law of partial pressure the total pressure of solution is calculated.

$$p_{total} = p^0_1 + (p_2 - p^0_1) X_2$$
- Comparison of Raoult's law and Henry's law: It is observed that the partial pressure of volatile component or gas is directly proportional to its mole fraction in solution. In case of Henry's Law the proportionality constant is K_H and it is different from p_{10} which is partial pressure of pure component. Raoult's Law becomes a special case of Henry's Law when K_H becomes equal to p_{10} in Henry's law.
- Classification of liquid–liquid solutions: It can be classified into ideal and non-ideal solutions on basis of Raoult's Law.

- Ideal solutions:
 1. The solutions that obey Raoult's Law over the entire range of concentrations are known as ideal solutions.
 2. $\Delta_{mix}H = 0$ and $\Delta_{mix}V = 0$
 3. The intermolecular attractive forces between solute molecules and solvent molecules are nearly equal to those present between solute and solvent molecules i.e. A-A and B-B interactions are nearly equal to those between A-B.
- Non-ideal solutions:
 1. When a solution does not obey Raoult's Law over the entire range of concentration, then it is called non-ideal solution.
 2. $\Delta_{mix}H \neq 0$ and $\Delta_{mix}V \neq 0$
 3. The intermolecular attractive forces between solute molecules and solvent molecules are not equal to those present between solute and solvent molecules i.e. A-A and B-B interactions are not equal to those between A-B
- Types of non-ideal solutions:
 1. Non ideal solution showing positive deviation
 2. Non ideal solution showing negative deviation
- Non ideal solution showing positive deviation
 1. The vapour pressure of a solution is higher than that predicted by Raoult's Law.
 2. The intermolecular attractive forces between solute-solvent molecules are weaker than those between solute-solute and solvent-solvent molecules i.e., $A-B < A-A$ and $B-B$ interactions.
- Non ideal solution showing negative deviation
 1. The vapour pressure of a solution is lower than that predicted by Raoult's Law.
 2. The intermolecular attractive forces between solute-solvent molecules are stronger than those between solute-solute and solvent-solvent molecules i.e. $A-B > A-A$ and $B-B$ interactions.
- Azeotopes: These are binary mixtures having same composition in liquid and vapour phase and boil at constant temperature. Liquids forming azeotrope cannot be separated by fractional distillation.
- Types of azeotropes: There are two types of azeotropes namely,
 1. Minimum boiling azeotrope
 2. Maximum boiling azeotrope

- The solutions which show a large positive deviation from Raoult's law form minimum boiling azeotrope at a specific composition.
- The solutions that show large negative deviation from Raoult's law form maximum boiling azeotrope at a specific composition.
- Colligative properties:** The properties of solution which depends on only the number of solute particles but not on the nature of solute are called colligative properties.
- Types of colligative properties:** There are four colligative properties namely,
 - Relative lowering of vapour pressure
 - Elevation of boiling point
 - Depression of freezing point
 - Osmotic pressure
- Relative lowering of vapour pressure:** The difference in the vapour pressure of pure solvent p_1^0 and solution p_1 represents lowering in vapour pressure ($p_1^0 - p_1$).
- Relative lowering of vapour pressure: Dividing lowering in vapour pressure by vapour pressure of pure solvent is called relative lowering of vapour pressure

$$\left(\frac{p_1^0 - p_1}{p_1^0} \right)$$
- Relative lowering of vapour pressure is directly proportional to mole fraction of solute. Hence it is a colligative property.
- Elevation of boiling point: $\left(\frac{p_1^0 - p_1}{p_1^0} \right) = X_2$
- For a dilute solution elevation of boiling point is directly proportional to molal concentration of the solute in solution. Hence it is a colligative property.
- Depression of freezing point: The lowering of vapour pressure of solution causes a lowering of freezing point compared to that of pure solvent. The difference in freezing point of the pure solvent T_f^0 and solution T_f is called the depression in freezing point.

$$\Delta T = T_f^0 - T_f$$

- For a dilute solution depression in freezing point is a colligative property because it is directly proportional to molal concentration of solute.
- Osmosis:** The phenomenon of flow of solvent molecules through a semi permeable membrane from pure solvent to solution is called osmosis.
- Osmotic pressure:** The excess pressure that must be applied to solution to prevent the

passage of solvent into solution through a semipermeable membrane is called osmotic pressure.

- Osmotic pressure is a colligative property as it depends on the number of solute particles and not on their identity.
- For a dilute solution, osmotic pressure (π) is directly proportional to the molarity (C) of the solution i.e. $\pi = CRT$
- Osmotic pressure can also be used to determine the molar mass of solute using the equation $M_2 = \frac{w_2 RT}{\pi V}$
- Isotonic solution: Two solutions having same osmotic pressure at a given temperature are called isotonic solution.
- Hypertonic solution: If a solution has more osmotic pressure than other solution it is called hypertonic solution.
- Hypotonic solution: If a solution has less osmotic pressure than other solution it is called hypotonic solution.
- Reverse osmosis: The process of movement of solvent through a semipermeable membrane from the solution to the pure solvent by applying excess pressure on the solution side is called reverse osmosis.
- Colligative properties help in calculation of molar mass of solutes.
- Abnormal molar mass: Molar mass that is either lower or higher than expected or normal molar mass is called as abnormal molar mass.
- Van't Hoff factor: Van't Hoff factor (i) accounts for the extent of dissociation or association.

$$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$$

$$= \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

$$= \frac{\text{Total number of moles of particles after association / dissociation}}{\text{Total number of moles of particles before association / dissociation}}$$

- Value of i is less than unity in case solute undergo association and the value of i is greater than unity in case solute undergo dissociation.
- Inclusion of van't Hoff factor modifies the equations for colligative properties as:

CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 3
Electrochemistry

- **Oxidation:** It is defined as a loss of electrons while reduction is defined as a gain of electrons.

In a redox reaction, both oxidation and reduction reaction takes place simultaneously.

- **Direct redox reaction:** In a direct redox reaction, both oxidation and reduction reactions take place in the same vessel. Chemical energy is converted to heat energy in a direct redox reaction.
- **Indirect redox reaction:** In indirect redox reactions, oxidation and reduction take place in different vessels.

In an indirect redox reaction, chemical energy is converted into electrical energy. The device which converts chemical energy into electrical energy is known as an electrochemical cell.

- **In an electrochemical cell:**
 1. The half-cell in which oxidation takes place is known as oxidation half-cell
 2. The half-cell in which reduction takes place is known as reduction half-cell.
 3. Oxidation takes place at anode which is negatively charged and reduction takes place at cathode which is positively charged.
 4. Transfer of electrons takes place from anode to cathode while electric current flows in the opposite direction.
 5. An electrode is made by dipping the metal plate into the electrolytic solution of its soluble salt.
 6. A salt bridge is a U shaped tube containing an inert electrolyte in agar-agar and gelatine.
- **Salt bridge:** A salt bridge maintains electrical neutrality and allows the flow of electric current by completing the electrical circuit.
- **Representation of an electrochemical cell:**
 1. Anode is written on the left while the cathode is written on the right.

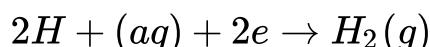
2. Anode represents the oxidation half-cell and is written as: Metal/Metal ion (Concentration)
 3. Cathode represents the reduction half-cell and is written as: Metal ion (Concentration)/Metal
 4. Salt bridge is indicated by placing double vertical lines between the anode and the cathode
 5. Electrode potential is the potential difference that develops between the electrode and its electrolyte. The separation of charges at the equilibrium state results in the potential difference between the metal and the solution of its ions. It is the measure of tendency of an electrode in the half cell to lose or gain electrons.
 6. Standard electrode potential: When the concentration of all the species involved in a half cell is unity, then the electrode potential is known as standard electrode potential. It is denoted as $E\theta$.
- According to the present convention, standard reduction potentials are now called standard electrode potential.
 - **Types of electrode potential:** There are 2 types of electrode potentials namely,
 1. Oxidation potential
 2. Reduction potential
 - **Oxidation potential:** It is the tendency of an electrode to lose electrons or get oxidized.
 - **Reduction potential:** It is the tendency of an electrode to gain electrons or get reduced.
- Oxidation potential is the reverse of reduction potential.
- The electrode having a higher reduction potential have higher tendency to gain electrons and so it acts as a cathode whereas the electrode having a lower reduction potential acts as an anode.
 - The standard electrode potential of an electrode cannot be measured in isolation.
 - According to convention, the Standard Hydrogen Electrode is taken as a reference electrode and it is assigned a zero potential at all temperatures.
 - Reference electrode: Standard calomel electrode can also be used as a reference electrode
 - **SHE:** Standard hydrogen electrode consists of a platinum wire sealed in a glass tube and carrying a platinum foil at one end. The electrode is placed in a beaker containing

an aqueous solution of an acid having 1 Molar concentration of hydrogen ions. Hydrogen gas at 1 bar pressure is continuously bubbled through the solution at 298 K. The oxidation or reduction takes place at the Platinum foil. The standard hydrogen electrode can act as both anode and cathode.

- If the standard hydrogen electrode acts as an anode:



If the standard hydrogen electrode acts as a cathode:



- In the electrochemical series, various elements are arranged as per their standard reduction potential values.
- A substance with higher reduction potential value means that it has a higher tendency to get reduced. So, it acts as a good oxidising agent.
- A substance with lower reduction potential value means that it has a higher tendency to get oxidised. So, it acts as a good reducing agent.
- The electrode with higher reduction potential acts as a cathode while the electrode with a lower reduction potential acts as an anode.
- The potential difference between the 2 electrodes of a galvanic cell is called cell potential and is measured in Volts.
- The cell potential is the difference between the reduction potential of cathode and anode.

$$E_{\text{cell}} = E_{\text{cathode}} - E_{\text{anode}}$$

- Cell potential is called the electromotive force of the cell (EMF) when no current is drawn through the cell.
- Nernst studied the variation of electrode potential of an electrode with temperature and concentration of electrolyte.
- Nernst formulated a relationship between standard electrode potential E^\ominus and electrode potential E .

$$E = E^\ominus - \frac{2.303RT}{nF} \log \frac{1}{[M^{n+}]}$$

$$E = E^\ominus - \frac{0.059}{n} \log \frac{1}{[M^{n+}]} \quad (\text{At } 298\text{K})$$

- Electrode potential increases with increase in the concentration of the electrolyte and decrease in temperature.
- Nernst equation when applied to a cell, it helps in calculating the cell potential.

$$E_{cell} = E_{cell}^0 - \frac{2.303RT}{nF} \log \frac{[Anode\ ion]}{[Cathode\ ion]}$$

- At equilibrium, cell potential becomes zero.
- Relationship between equilibrium constant K_c and standard cell potential E°_{cell} :

$$E_{cell}^0 = \frac{0.059}{n} \log K_c (At 298K)$$
- Work done by an electrochemical cell is equal to the decrease in Gibbs energy

$$\Delta G^0 = -nFE_{cell}^0$$
- The substances which allow the passage of electricity through them are known as conductors.
- Every conducting material offers some obstruction to the flow of electricity which is called resistance. It is denoted by R and is measured in ohm.
- The resistance of any object is directly proportional to its length l and inversely proportional to its area of cross section A .

$$R = \rho \frac{l}{A}$$

Where ρ is called specific resistance or resistivity.

- The SI unit of specific resistivity is ohm metre.
- The inverse of resistance is known as conductance, G
- Unit of conductance is ohm⁻¹ or mho. It is also expressed in Siemens denoted by S .
- The inverse of resistivity is known as conductivity. It is represented by the symbol κ .
- The SI unit of conductivity is Sm⁻¹. But it is also expressed in Scm⁻¹.
- Conductivity = Conductance × Cell constant
- For measuring the resistance of an ionic solution, there are 2 problems:
 1. Firstly, passing direct current changes the composition of the solution
 2. Secondly, a solution cannot be connected to the bridge like a metallic wire or a solid conductor.
- Conductivity cell: The problem of measuring the resistance of an ionic solution can be resolved by using a source of alternating current and the second problem is resolved by using a specially designed vessel called conductivity cell.
- A conductivity cell consists of 2 Pt electrodes coated with Pt black. They have area of cross section A and are separated by a distance ' l '. Resistance of such a column of solution is given by the equation:
- $$R = \rho \frac{l}{A} = \frac{1}{k} \frac{l}{A}$$

 Where $\frac{l}{A}$ is called cell constant and is denoted by the symbol G^*
- **Molar conductivity of a solution:** It is defined as the conducting power of all the ions

produced by dissolving 1 mole of an electrolyte in solution.

$$\text{Molar conductivity } \Lambda_m = \frac{k \times 1000}{M}$$

Where κ = Conductivity and M is the molarity Unit of Molar conductivity is Scm² mol⁻¹

- **Equivalent conductivity:** It is the conductivity of all the ions produced by dissolving one gram equivalent of an electrolyte in solution. Unit of equivalent conductivity is S cm² (g equiv)⁻¹

$$\text{Equivalent conductivity: } \Lambda_e = \frac{k \times 1000}{N}$$

- **Kohlrausch's Law of independent migration of ions:** According to this law, molar conductivity of an electrolyte, at infinite dilution, can be expressed as the sum of individual contributions from its individual ions.

- If the limiting molar conductivity of the cations is denoted by λ_+^0 and that of the anions by λ_-^0 , then the limiting molar conductivity of electrolyte is:

$$\text{Molar conductivity, } \Lambda_m^0 = v_+ \lambda_+^0 + v_- \lambda_-^0$$

Where v_+ and v_- are the number of cations and anions per formula of electrolyte

- **Degree of dissociation:** It is ratio of molar conductivity at a specific concentration 'c' to the molar conductivity at infinite dilution. It is denoted by.

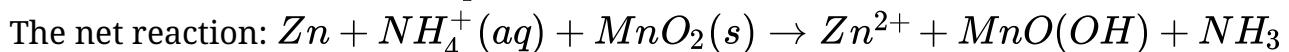
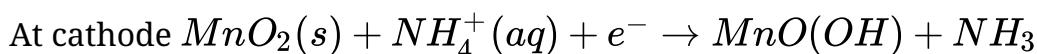
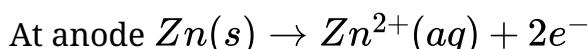
$$a = \frac{\Lambda_m^c}{\Lambda_m^0}$$

- **Dissociation constant:** $k_a = \frac{ca^2}{1-a}$ Where K_a is acid dissociation constant, 'c' is concentration of electrolyte, a is degree of ionization.
- **Faraday constant:** It is equal to charge on 1 mol of electrons. It is equal to 96487 C mol⁻¹ or approximately equal to 96500 C mol⁻¹.
- **Faraday's first law of electrolysis:** The amount of substance deposited during electrolysis is directly proportional to quantity of electricity passed.
- **Faraday's second law of electrolysis:** If same charge is passed through different electrolytes, the mass of substance deposited will be proportional to their equivalent weights.
- **Products of electrolysis:** The products of electrolysis depend upon
- The nature of electrolyte being electrolyzed and the nature of electrodes. If electrode is inert like platinum or gold, they do not take part in chemical reaction i.e. they neither lose nor gain electrons. If the electrodes are reactive then they will take part in chemical reaction and products will be different as compared to inert electrodes.
- The electrode potentials of oxidizing and reducing species. Some of the

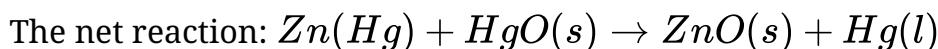
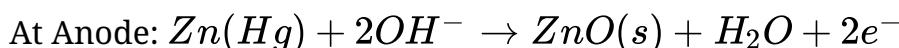
electrochemical processes although feasible but slow in their rates at lower voltage, these require extra voltage, i.e. over voltage at which these processes will take place. The products of electrolysis also differ in molten state and aqueous solution of electrolyte.

- **Primary cells:** A primary cell is a cell in which electrical energy is produced by the reaction occurring in the cell, e.g. Daniel cell, dry cell, mercury cell. It cannot be recharged.

- **Dry Cell:**

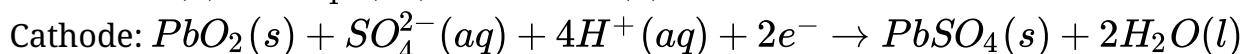
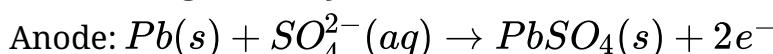


- **Mercury Cell:** The electrolyte is a paste of KOH and ZnO.

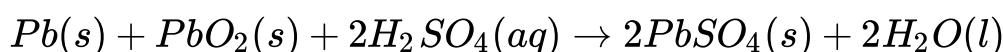


- **Secondary cells:** Those cells which are used for storing electricity, e.g., lead storage battery, nickel – cadmium cell. They can be recharged.

- **Lead storage battery:**



The overall cell reaction consisting of cathode and anode reactions is:



On recharging the battery, the reaction is reversed.

- **Nickel cadmium cell:** It is another type of secondary cell which has longer life than lead storage cell but more expensive to manufacture.

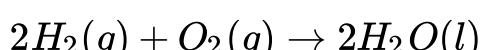
The overall reaction during discharge is



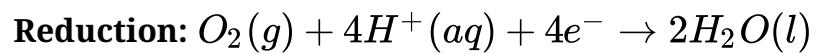
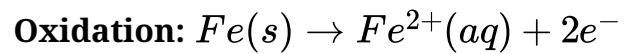
- **Fuel cells:**



- **Overall reaction:**



- **Corrosion:**



- **Galvanization:** It is a process of coating zinc over iron so as to protect it from rusting.
- **Cathodic protection:** Instead of coating more reactive metal on iron, the use of such metal is made as sacrificial anode.

CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 4
Chemical Kinetics

- **Chemical kinetics:** It is the branch of chemistry that deals with the study of reaction rates and their mechanisms.
- **Rate of reaction:** It is the change in concentration of reactant (or product) in unit time.
- The unit of rate of reaction is mol L⁻¹s⁻¹.
- A + B → C + D

$$\text{Rate of disappearance of } A = \frac{-d[A]}{dt}$$

where d[A] is small change in conc. of 'A' and dt is small interval of time

$$\text{Rate of disappearance of } B = \frac{-d[B]}{dt}$$

Where d[B] is small change in conc. of 'B' and dt is small interval of time

$$\text{Rate of appearance of } C = \frac{+d[C]}{dt}$$

Where d[C] is small change in conc. of 'C' and dt is small interval of time

$$\text{Rate of appearance of } D = \frac{+d[D]}{dt}$$

Where d[D] is small change in conc. of 'D' and dt is small interval of time

$$\text{Rate} = \frac{-d[A]}{dt} = \frac{-d[B]}{dt} = \frac{+d[C]}{dt} = \frac{+d[D]}{dt}$$

- **Rate law or rate equation:** It is the expression which relates the rate of reaction with concentration of the reactants. The constant of proportionality 'k' is known as rate constant.
- **Average rate:** It is the rate of reaction measured over a long time interval.
- Average rate = $\frac{\Delta x}{\Delta t}$
where Δx is change in concentration and Δt is large interval of time.
- **Instantaneous rate:** It is the rate of reaction when the average rate is taken over a particular moment of time. Instantaneous rate = $\frac{dx}{dt}$.
where dx is small change in conc. and dt is the smallest interval of time.
It is the expression which relates the rate of reaction with concentration of the reactants.
- **Rate constant:** When the concentration of reactants is unity, then the rate of reaction

is known as rate constant. It is also called specific reaction rate.

The constant of proportionality 'k' is known as rate constant.

- **Molecularity of a reaction:** The total number of atoms, ions or molecules of the reactants involved in the reaction is termed as its molecularity. It is always in whole number and is never more than three. It cannot be zero.
- **Order of a reaction:** The sum of the exponents (power) of the concentration of reactants in the rate law is termed as order of the reaction. It can be in fraction. It can be zero also.

If rate law expression for a reaction is Rate = $k [A]^x [B]^y$

Then its order of reaction = $x + y$

- Order cannot be determined with a given balanced chemical equation. It can be experimentally determined.

- **Integrated rate law for zero order reaction:** $R \rightarrow P$

$$\frac{dx}{dt} = k[R]^0$$
$$k = \frac{[R_0] - [R]}{t}$$

If we plot a graph between concentration of R vs time t, the graph is a straight line with slope equal to $-k$ and intercept is equal to $[R_0]$.

- **Half-life of a reaction:** The time taken for a reaction, when half of the starting material has reacted is called half-life of a reaction.

- For zero order reaction, the half-life time is $t_{1/2} = \frac{[R_0]}{2k}$
- For first order reaction, the half-life time is $t_{1/2} = \frac{0.693}{k}$, where 'k' is rate constant. It is independent of initial concentration for first order reaction.

- Rate law for first order reaction: $R \rightarrow P$

$$k = \frac{2.303}{t} \log \frac{[R_0]}{[R]}$$

where 'k' is rate constant or specific reaction rate, $[R_0]$ is initial molar conc., $[R]$ is final molar conc. after time 't'.

$$k = \frac{2.303}{t} \log \frac{a}{a-x}$$

where 'a' is initial conc. reacted in time 't' final conc., after time 't' is $(a - x)$.

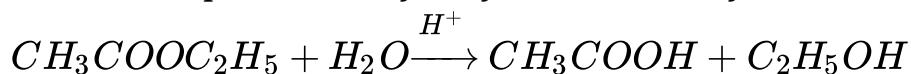
- If we plot a graph between $\ln[R]$ with time, we get a straight line whose slope = $-k$ and intercept $\ln[R_0]$.
- To calculate rate constant for first order gas phase reaction of the type $A(g) \rightarrow B(g) + C(g)$

$$k = \frac{2.303}{t} \log \frac{p_i}{(2p_i - p_t)}$$

Where p_i is initial pressure of A, p_t is total pressure of gaseous mixture containing A, B, C

$$p_t = pA + pB + pC$$

- **Pseudo first order reaction:** The reaction which is bimolecular but order is one is called pseudo first order reaction. This happens when one of the reactants is in large excess. Example - Acidic hydrolysis of ester (ethyl acetate).



- **Activation energy (E_a):** It is extra energy which must be possessed by reactant molecules so that collision between reactant molecules is effective and leads to the formation of product molecules.
- **Arrhenius equation of reaction rate:** It gives the relation between rate of reaction and temperature.

$$k = Ae^{-E_a/RT}$$

$$\ln k = \ln A - E_a/RT$$

$$\log k = \log A - \frac{E_a}{2.303RT}$$

where k = rate constant, A = frequency factor, E_a = energy of activation R = gas constant, T = temperature in Kelvin,

$$\log \frac{k_2}{k_1} = \frac{E_a}{2.303R} \left(\frac{T_2 - T_1}{T_1 T_2} \right)$$

- Probability factor or Steric factor

$$Rate = P Z_{AB} \cdot e^{\frac{-E_a}{RT}}$$

Where Z_{AB} represents the collision frequency of reactants, A and B, $e^{\frac{-E_a}{RT}}$ represents the fraction of molecules with energies equal to or greater than E_a and P is called the probability or steric factor.

- Mechanism of reaction: It is the sequence of elementary processes leading to the overall stoichiometry of a chemical reaction.
- Activated complex: It is an unstable intermediate formed between reacting molecules. Since, it is highly unstable and it readily changes into product.
- Rate determining step: It is the slowest step in the reaction mechanism.
- The number of collisions per second per unit volume of the reaction mixture is known as collision frequency (Z).

CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 5
Surface Chemistry

- **Adsorption:**
 - (i) The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid is termed as adsorption.
 - (ii) It is a surface phenomenon.
 - (iii) The concentration of adsorbate increases only at the surface of the adsorbent.
- **Adsorbate:** It is the substance which is being adsorbed on the surface of another substance.
- **Adsorbent:** It is the substance present in bulk, on the surface of which adsorption is taking place.
- **Desorption:** It is the process of removing an adsorbed substance from a surface on which it is adsorbed.
- **Absorption:**
 - (i) It is the phenomenon in which a substance is uniformly distributed throughout the bulk of the solid.
 - (ii) It is a bulk phenomenon.
 - (iii) The concentration is uniform throughout the bulk of solid.
- **Sorption:** When adsorption and absorption take place simultaneously, it is called sorption.
- **Enthalpy or heat of adsorption:** Since, adsorption occurs with release in energy, i.e., it is exothermic in nature. The enthalpy change for the adsorption of one mole of an adsorbate on the surface of adsorbent is called enthalpy or heat of adsorption.
- **Types of adsorption:** There are different types of adsorption namely,
 1. Physical adsorption
 2. Chemical adsorption
- **Physical adsorption**
 - (i) If the adsorbate is held on a surface of adsorbent by weak van der Waals' forces,

the adsorption is called physical adsorption or physisorption.

(ii) It is non-specific.

(iii) It is reversible.

(iv) The amount of gas depends upon nature of gas, i.e., easily liquefiable gases like NH_3 , CO_2 , gas adsorbed to greater extent than H_2 and He . Higher the critical temperature of gas, more will be the extent of adsorption.

(v) The extent of adsorption increases with increase in surface area, e.g. porous and finely divided metals are good adsorbents.

(vi) There are weak van der Waals' forces of attraction between adsorbate and adsorbent.

(vii) It has low enthalpy of adsorption ($20 - 40 \text{ kJ mol}^{-1}$).

(viii) Low temperature is favourable.

(ix) No appreciable activation energy is needed.

(x) It forms multimolecular layers.

- **Chemical adsorption or chemisorption:**

(i) If the forces holding the adsorbate are as strong as in chemical bonds, the adsorption process is known as chemical adsorption or chemisorption.

(ii) It is highly specific.

(iii) It is irreversible.

(iv) The amount of gas adsorbed is not related to critical temperature of the gas.

(v) It also increases with increase in surface area.

(vi) There is strong force of attraction similar to chemical bond.

(vii) It has enthalpy heat of adsorption ($180 - 240 \text{ kJ mol}^{-1}$).

(viii) High temperature is favourable.

(ix) High activation energy is sometimes needed.

(x) It forms unimolecular layers.

- **Factors affecting adsorption of gases on solids:**

a. **Nature of adsorbate:** Physical adsorption is non-specific in nature and therefore every gas gets adsorbed on the surface of any solid to a lesser or greater extent. However, easily liquefiable gases like NH_3 , HCl , CO_2 , etc. which have higher critical temperatures are

absorbed to greater extent whereas H₂, O₂, N₂ etc. are adsorbed to lesser extent. The chemical adsorption being highly specific, therefore, a gas gets adsorbed on specific solid only if it enters into chemical combination with it.

b. Nature of adsorbent: Activated carbon, metal oxides like aluminum oxide, silica gel and clay are commonly used adsorbents. They have their specific adsorption properties depending upon pores.

c. Specific area of the adsorbent: The greater the specific area, more will be the extent of adsorption. That is why porous or finely divided forms of adsorbents adsorb larger quantities of adsorbate. The pores should be large enough to allow the gas molecules to enter.

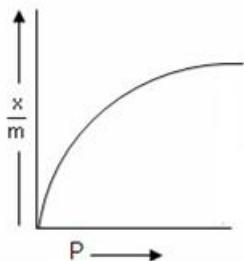
d. Pressure of the gas: Physical adsorption increases with increase in pressure.

- Adsorption isotherm:
- The variation in the amount of gas adsorbed by the adsorbent with pressure at constant temperature can be expressed by means of a curve is termed as adsorption isotherm.
- Freundlich Adsorption isotherm: The relationship between $\frac{x}{m}$ and pressure of the gas at constant temperature is called adsorption isotherm and is given by

$$\frac{x}{m} = kp^{1/n} (n > 1)$$

Where x- mass of the gas adsorbed on mass m of the adsorbent and the gas at a particular temperature k and n depends upon the nature of gas

- The solid $\frac{x}{m}$ first increases with increase in pressure at low pressure but becomes independent of pressure at high pressure.



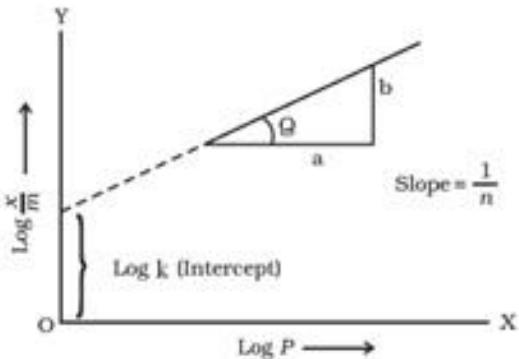
Taking logarithm on both sides, we get,

$$\log \frac{x}{m} = \log k + \frac{1}{n} \log p$$

Taking logarithm on both sides, we get,

$$\log \frac{x}{m} = \log k + \frac{1}{n} \log p$$

- If we plot a graph between $\log \frac{x}{m}$ and $\log P$, we get a straight line.



The slope of the line is $\frac{1}{n}$ and intercept will be equal to $\log k$.

- Catalyst: These are substances which alter the rate of a chemical reaction and themselves remain chemically and quantitatively unchanged after the reaction and the phenomenon is known as catalysis.
- Promoters: These are the substances which increase the activity of catalyst. Example - Mo is promoter whereas Fe is catalyst in Haber's Process.

$$N_{2(g)} + 3H_{2(g)} \xrightarrow{Fe(s)/Mo(s)} 2NH_{3(g)}$$
- Catalytic poisons (Inhibitors): These are the substances which decrease the activity of catalyst. Example - Arsenic acts as catalytic poison in the manufacture of sulphuric acid by 'contact process.'
- Types of catalysis:

There are two types of catalysis namely,

1. Homogeneous catalysis: When the catalyst and the reactants are in the same phase, this kind of catalytic process is known as homogeneous catalysis.
2. Heterogeneous catalysis: When the catalyst and the reactants are in different phases, the catalytic process is said to be heterogeneous catalysis.
3. Activity of catalyst: It is the ability of a catalyst to increase the rate of a chemical reaction.
4. Selectivity of catalyst: It is the ability of catalyst to direct a reaction to yield a particular

product (excluding others).

For example: CO and H₂ react to form different products in presence of different catalysts as follows:

1. $CO(g) + 3H_2(g) \xrightarrow{Ni} CH_4(g) + H_2O(g)$
2. $CO(g) + 2H_2(g) \xrightarrow{Cu/ZnO-Cr_2O_3} CH_3OH(g)$
3. $CO(g) + H_2(g) \xrightarrow{Cu} HCHO(g)$

- Shape – selective catalysis: It is the catalysis which depends upon the pore structure of the catalyst and molecular size of reactant and product molecules. Example - Zeolites are shape – selective catalysts due to their honey- comb structure.
- Enzymes: These are complex nitrogenous organic compounds which are produced by living plants and animals. They are actually protein molecules of high molecular mass. They are biochemical catalysts
- **Steps of enzyme catalysis:**

- (i) Binding of enzyme to substrate to form an activated complex.
- (ii) Decomposition of the activated complex to form product.

- **Characteristics of enzyme catalysis:**

- (i) They are highly efficient. One molecule of an enzyme can transform 10⁶ molecules of reactants per minute.
- (ii) They are highly specific in nature. Example - Urease catalysis hydrolysis of urea only.
- (iii) They are active at optimum temperature (298 – 310 K). The rate of enzyme catalysed reaction becomes maximum at a definite temperature called the optimum temperature.
- (iv) They are highly active at a specific pH called optimum pH.
- (v) Enzymatic activity can be increased in presence of coenzymes which can be called as promoters.
- (vi) Activators are generally metal ions Na⁺, Co²⁺ and Cu²⁺ etc. They weakly bind to enzyme and increase its activity.
- (vii) Influence of inhibitors (poison): Enzymes can also be inhibited or poisoned by the

presence of certain substances.

- **True solution:**

- (i) It is homogeneous.
- (ii) The diameter of the particles is less than 1 nm.
- (iii) It passes through filter paper.
- (iv) Its particles cannot be seen under a microscope.

- **Colloids:**

- (i) It appears to be homogeneous but is actually heterogeneous.
- (ii) The diameter of the particles is 1 nm to 1000 nm.
- (iii) It passes through ordinary filter paper but not through ultra-filters.
- (iv) Its particles can be seen by a powerful microscope due to scattering of light.

- **Suspension:**

- (i) It is heterogeneous.
- (ii) The diameter of the particles are larger than 1000 nm.
- (iii) It does not pass through filter paper.
- (iv) Its particles can be seen even with naked eye.

- Dispersed phase: It is the substance which is dispersed as very fine particles.
- Dispersion medium: It is the substance present in larger quantity.
- Classification of colloids on the basis of the physical state of dispersed phase and dispersion medium:

Name	Dispersed phase	Dispersed medium	Examples
Solid sol	solid	Solid	Coloured gem stones
Sol	Solid	Liquid	Paints

Aerosol	Solid	Gas	Smoke, dust
Gel	Liquid	Solid	Cheese, jellies
Emulsion	Liquid	Liquid	Hair cream, milk
Aerosol	Liquid	Gas	Mist, fog, cloud
Solid sol	Gas	Solid	Foam rubber, pumice stone
Foam	Gas	Liquid	Whipped cream

- Classification of colloids on the basis of nature of interaction between dispersed phase and dispersion medium, the colloids are classified into two types namely,

1. Lyophobic sols
2. Lyophilic sols

- **Lyophobic sols:**

- (i) These colloids are liquid hating.
- (ii) In these colloids the particles of dispersed phase have no affinity for the dispersion medium.
- (iii) They are not stable.
- (iv) They can be prepared by mixing substances directly.
- (v) They need stabilizing agents for their preservation.
- (vi) They are irreversible sols.

- **Lyophilic sols:**

- (i) These colloids are liquid loving.
- (ii) In these colloids, the particles of dispersed phase have great affinity for the dispersion medium.

- (iii) They are stable.
- (iv) They cannot be prepared by mixing substances directly. They are prepared only by special methods.
- (v) They do not need stabilizing agents for their preservation.
- (vi) They are reversible sols.

- Classification of colloids on the basis of types of particles of the dispersed phase:

There are three types of colloids based on the type of dispersed phase, namely,

1. Multimolecular colloids: The colloids in which the colloidal particles consist of aggregates of atoms or small molecules. The diameter of the colloidal particle formed is less than 1 nm.
2. Macromolecular colloids: These are the colloids in which the dispersed particles are themselves large molecules (usually polymers). Since these molecules have dimensions comparable to those of colloids particles, their dispersions are called macromolecular colloids, e.g., proteins, starch and cellulose form macromolecular colloids.
3. Associated colloids (Micelles): Those colloids which behave as normal, strong electrolytes at low concentrations, but show colloidal properties at higher concentrations due to the formation of aggregated particles of colloidal dimensions. Such substances are also referred to as associated colloids.

- Kraft Temperature (Tk): Micelles are formed only above a certain temperature called Kraft temperature.
- Critical Micelle Concentration (CMC): Micelles are formed only above a particular concentration called critical micelle concentration.
- Soaps: These are sodium or potassium salts of higher fatty acids e.g., sodium stearate $\text{CH}_3(\text{CH}_2)_{16}\text{COO-Na}^+$

- **Methods of preparation of colloids:**

1. Chemical methods: Colloids can be prepared by chemical reactions leading to the formation of molecules. These molecules aggregate leading to formation of sols.
2. Electrical disintegration or Bredig's Arc method: In this method, electric arc is struck

between electrodes of the metal immersed in the dispersion medium. The intense heat produced vaporizes the metal which then condenses to form particles of colloidal size.

3. Peptization: It is the process of converting a precipitate into colloidal sol by shaking it with dispersion medium in the presence of a small amount of electrolyte. The electrolyte used for this purpose is called peptizing agent.

- **Purification of colloids:**

1. Dialysis: It is a process of removing a dissolved substance from a colloidal solution by means of diffusion through a suitable membrane.
2. Electro dialysis. The process of dialysis is quite slow. It can be made faster by applying an electric field if the dissolved substance in the impure colloidal solution is only an electrolyte.
3. Ultrafiltration: It is the process of separating the colloidal particles from the solvent and soluble solutes present in the colloidal solution by specially prepared filters, which are permeable to all substances except the colloidal particles.
4. Ultracentrifugation: In this process, the colloidal solution is taken in a tube which is placed in ultracentrifuge. On rotating the tube at very high speed, the colloidal particles settle down at the bottom of the tube and the impurities remain in solution. The settled particles are mixed with dispersion medium to regenerate the sol.

- **Properties of colloids:**

Positively charged colloidal particles:

- (i) These include hydrated metallic oxides such as $\text{Fe}_2\text{O}_3 \cdot x\text{H}_2\text{O}$, $\text{Cr}_2\text{O}_3 \cdot x\text{H}_2\text{O}$, $\text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$
- (ii) Basic dye stuff like malachite green, methylene blue sols.
- (iii) Example - Haemoglobin (blood).

Negatively charged colloidal particles:

- (i) Metallic sulphides like As_2S_3 , Sb_2S_3 sols.
- (ii) Acid dye stuff like eosin, methyl orange, Congo red sols.
- (iii) Examples - Starch sol, gum, gelatin, clay, charcoal, egg albumin, etc.

1. Colour: The colour of colloidal solution depends upon the wavelength of light scattered by the colloidal particles which in turn depends upon the nature and size of particles. The colour also depends upon the manner in which light is received by the observer.
 2. Brownian movement: Colloidal particles move in zig – zag path. This type of motion is due to colliding molecules of dispersion medium constantly with colloidal particles.
 3. Colligative properties: The values of colligative properties (osmotic pressure, lowering in vapour pressure, depression in freezing point and elevation in boiling point) are of small order as compared to values shown by true solutions at the same concentrations.
 4. Tyndall effect: The scattering of a beam of light by colloidal particles is called Tyndall effect. The bright cone of light is called the Tyndall cone.
 5. Charge on colloidal particles: Colloidal particles always carry an electric charge. The nature of this charge is the same on all the particles in a given colloidal solution and may be either positive or negative.
 6. Helmholtz electrical double layer: When the colloidal particles acquire negative or positive charge by selective adsorption of one of the ions, it attracts counter ions from the medium forming a second layer. The combination of these two layers of opposite charges around colloidal particles is called Helmholtz electrical double layer.
 7. Electrokinetic potential or zeta potential: The potential difference between the fixed layer and the diffused layer of opposite charges is called electrokinetic potential or zeta potential.
 8. Electrophoresis: The movement of colloidal particles under an applied electric potential is called electrophoresis.
 9. Coagulation or precipitation: The process of settling of colloidal particles as precipitate is called coagulation.
- Hardy – Schulze rules:

- i) Oppositely charged ions are effective for coagulation.
- ii) The coagulating power of electrolyte increases with increase in charge on the ions used for coagulation. Examples - $\text{Al}^{3+} > \text{Ba}^{2+} > \text{Na}^+$ for negatively charged colloids. $\text{Fe}(\text{CN})_6^{4-} >$

$PO_4^{3-} > SO_4^{2-} > Cl^-$ for positively charged colloids.

- Types of emulsions:
 1. Water dispersed in oil: When water is the dispersed phase and oil is the dispersion medium. E.g. butter
 2. Oil dispersed in water: When oil is the dispersed phase and water is the dispersion medium. E.g. milk
- Emulsification: It is the process of stabilizing an emulsion by means of an emulsifier.
- Emulsifying agent or emulsifier: These are the substances which are added to stabilize the emulsions. Examples - soaps, gum
- Demulsification: It is the process of breaking an emulsion into its constituent liquids by freezing, boiling, centrifugation or some chemical methods.

CBSE Class-12 Chemistry Quick Revision Notes

Chapter-06: General Principles and Processes of Isolation of Elements

- Minerals:

The naturally occurring chemical substances in the earth's crust which are obtained by mining are known as minerals.

- Metals may or may not be extracted profitably from them.

- Ores:

The rocky materials which contain sufficient quantity of mineral so that the metal can be extracted profitably or economically are known as ores.

- Gangue:

The earthy or undesirable materials present in ore are known as gangue.

- Metallurgy:

- The entire scientific and technological process used for isolation of the metal from its ores is known as metallurgy.

- Chief Ores and Methods of Extraction of Some Common Metals:

Sodium metal

- a) Occurrence: Rock salt (NaCl), Feldspar ($\text{Na}_3\text{AlSi}_3\text{O}_8$)

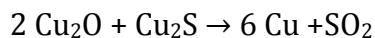
- b) Extraction method: Electrolysis of fused NaCl or $\text{NaCl}/\text{CaCl}_2$

- c) Inference: Sodium is highly reactive and hence, it reacts with water.

Copper metal

- a) Occurrence: Copper pyrites (CuFeS_2), Malachite ($\text{CuCO}_3\cdot\text{Cu}(\text{OH})_2$), Cuprite (Cu_2O)
Copper glance (Cu_2S)

- b) Extraction method: Roasting of sulphide partially and reduction.



- c) Inference: It is self-reduction in a specially designed converter. Sulphuric acid leaching is also employed.

Aluminium metal

- a) Occurrence: Bauxite: ($\text{AlO}_x(\text{OH})_{3-2x}$ where $0 < x < 1$), Cryolite (Na_3AlF_6), Kaolinite ($\text{Al}_2(\text{OH})_4\text{Si}_2\text{O}_5$)

- b) Extraction method: Electrolysis of Al_2O_3 dissolved in molten cryolite or in Na_3AlCl_6

- c) Inference: A good source of electricity is needed in the extraction of Al

Zinc metal

- a) Occurrence: Zinc blende or Sphalerite (ZnS), Zincite (ZnO), Calamine (ZnCO_3)

- b) Extraction method: Roasting and then reduction with carbon.

- c) Inference: The metal may be purified by fractional distillation.

Lead metal

- a) Occurrence: Galena (PbS)

- b) Extraction: Roasting of the sulphide ore and then reduction of the oxide.

- c) Inference: Sulphide ore is concentrated by froth floatation process.

Silver metal

- a) Occurrence: Argentite (Ag_2S)
- b) Extraction method: Sodium cyanide leaching of the sulphide ore and finally replacement of Ag by Zn.
- c) Inference: It involves complex formation and displacement.

Gold metal

- a) Occurrence: Native, small amounts in many ores such as those of copper and silver
- b) Extraction method: Cyanide leaching, same as in case of silver
- c) Inference: Gold reacts with cyanide to form complex

Iron metal

- a) Occurrence: Haematite (Fe_2O_3), Magnetite (Fe_3O_4), Siderite (FeCO_3), Iron pyrites (FeS_2)
- b) Extraction method: Reduction with the help of CO and coke in blast furnace.
- c) Inference: Limestone is added as flux which removes SiO_2 as calcium silicate (slag) floats over molten iron and prevents its oxidation. Temperatures approaching 2170 K is required.

- **Steps of metallurgy:**

- a) Concentration of ore
- b) Conversion of concentrated ore to oxide
- c) Reduction of oxide to metal
- d) Refining of metal

- **Concentration of ore:**

The process of removal unwanted materials like sand, clay, rocks etc from the ore is known as concentration, ore – dressing or benefaction. It involves several steps which depend upon physical properties of metal compound and impurity (gangue). The type of metal, available facilities and environmental factors are also taken into consideration.

- **Hydraulic washing (or gravity separation):**

It is based on difference in densities of ore and gangue particles. Ore is washed with a stream of water under pressure so that lighter impurities are washed away whereas heavy ores are left behind.

- **Magnetic separation:**

This method is based on the difference in magnetic and non – magnetic properties of two components of ore (pure and impure). This method is used to remove tungsten ore particles from cassiterite (SnO_2). It is also used to concentrate magnetite (Fe_3O_4), chromite (FeCr_2O_4) and pyrolusite (MnO_2) from unwanted gangue.

- **Froth floatation process:**

It is based on the principle that sulphide ores are preferentially wetted by the pine oil or fatty acids or xanthates etc., whereas the gangue particles are wetted by the water. Collectors are added to enhance the non-wettability of the mineral particles. Froth stabilizers such as cresols, aniline etc., are added to stabilize the froth.

If two sulphide ores are present, it is possible to separate the two sulphide ores by adjusting proportion of oil to water or by adding depressants.

For example, in the case of an ore containing ZnS and PbS, the depressant used is NaCN. It selectively prevents ZnS from coming to froth but allows PbS to come with the froth.

- **Leaching (Chemical separation):**

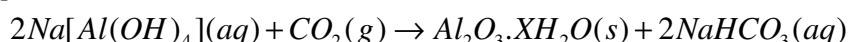
It is a process in which ore is treated with suitable solvent which dissolves the ore but not the impurities.

- **Purification of Bauxite by leaching (Baeyer's process):**

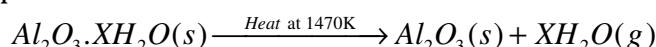
a) Step 1:



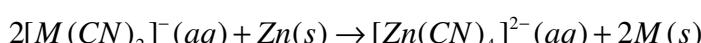
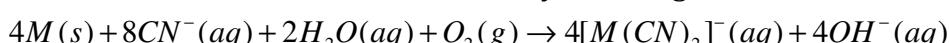
b) Step 2:



c) Step 3:



d) Concentration of Gold and Silver Ores by Leaching:



Where [M =Ag or Au]

- **Conversion of ore into oxide:**

It is easier to reduce oxide than sulphide or carbonate ore. Therefore, the given ore should be converted into oxide by any one of the following method:

- roasting
- calcination

- **Roasting:**

- It is a process in which ore is heated in a regular supply of air at a temperature below melting point of the metal so as to convert the given ore into oxide ore.
- Sulphide ores are converted into oxide by roasting
- It is also used to remove impurities as volatile oxides
- example - $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$

- **Calcination**

- It is a process of heating ore in limited supply of air so as to convert carbonate ores into oxides.
- Carbonate ores are converted into oxide by roasting
- It is also used to remove moisture and volatile impurities.
- Example - $CaCO_3 \xrightarrow{\text{Heat}} CaO + CO_2$

- **Reduction of oxide to metal:**

The process of converting metal oxide into metal is called reduction. It needs a suitable reducing agent depending upon the reactivity or reducing power of metal. The common reducing agents used are carbon or carbon monoxide or any other metals like Al, Mg etc.

- **Thermodynamic principles of metallurgy:**

Some basic concepts of thermodynamics help in understanding the conditions of temperature and selecting suitable reducing agent in metallurgical processes:

- Gibbs free energy change at any temperature is given by $\Delta G = \Delta H - T\Delta S$ where ΔG is free energy change, ΔH is enthalpy change and ΔS is entropy change.
- The relationship between ΔG^θ and K is $\Delta G^\theta = -2.303 RT \log K$ where K is equilibrium constant. $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$, T is temperature in Kelvin.
- A negative ΔG means +ve value of K i.e., products are formed more than the reactants. The reaction will proceed in forward direction.
- If ΔS is +ve, on increasing temperature the value of $T\Delta S$ increases so that $T\Delta S > \Delta H$ and ΔG will become negative.

- **Coupled reactions:**

If reactants and products of two reactions are put together in a system and the net ΔG of two possible reactions is -ve the overall reaction will take place. These reactions are called coupled reactions.

- **Ellingham diagrams:**

The plots between ΔfG^θ of formation of oxides of elements vs. temperature are called Ellingham diagrams. It provides a sound idea about selecting a reducing agent in reduction of oxides. Such diagrams help in predicting the feasibility of a thermal reduction of an ore. ΔG must be negative at a given temperature for a reaction to be feasible.

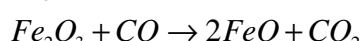
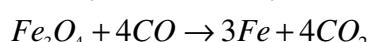
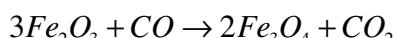
- **Limitations of Ellingham Diagrams:**

It does not take kinetics of reduction into consideration, i.e., how fast reduction will take place cannot be determined.

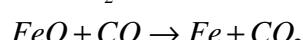
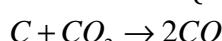
- **Reduction of iron oxide in blast furnace:**

Reduction of oxides takes place in different zones.

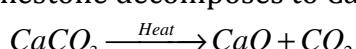
- At 500 – 800 K (lower temperature range in blast furnace)



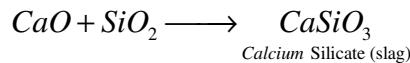
- At 900 – 1500 K (higher temperature range in blast furnace)



- Limestone decomposes to CaO and CO₂

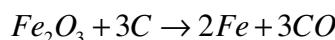


- Silica (impurity) reacts with CaO to form calcium silicate which forms slag. It floats over molten iron and prevents oxidation of iron.

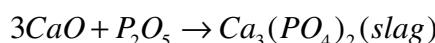
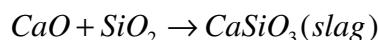
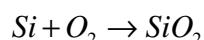
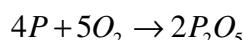
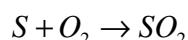


- **Types of iron:**

- Pig iron: The iron obtained from blast furnace is called pig iron. It is impure from of iron contains 4% carbon and small amount of S,P, Si and Mn. It can be casted into variety of shapes.
- Cast iron: It is made by melting pig iron with scrap iron and coke using hot air blast. It contains about 3% of carbon content. It is extremely hard and brittle.
- Wrought iron: It is the purest form of commercial iron. It is also called malleable iron. It is prepared by oxidative refining of pig iron in reverberatory furnace lined with haematite which oxidises carbon to carbon monoxide.



The substance which reacts with impurity to form slag is called flux e.g. limestone is flux.

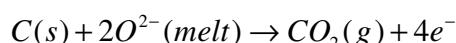
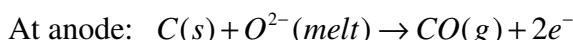
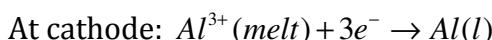
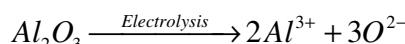
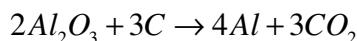


The metal is removed and freed from slag by passing through rollers.

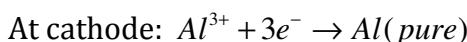
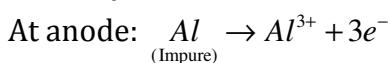
- **Electrolytic Reduction (Hall – Heroult Process):**

Purified bauxite ore is mixed with cryolite (Na_3AlF_6) or CaF_2 which lowers its melting point and increases electrical conductivity. Molten mixture is electrolysed using a number of graphite rods as anode and carbon lining as cathode.

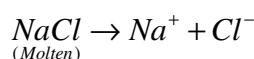
The graphite anode is useful for reduction of metal oxide to metal.



Graphite rods get burnt forming CO and CO_2 . The aluminium thus obtained is refined electrolytically using impure Al as anode, pure Al as cathode and molten cryolite as electrolyte.



- **Electrolysis of molten NaCl:**





Thus sodium metal is obtained at cathode and $Cl_2(g)$ is liberated at anode.

- **Refining:**

It is the process of converting an impure metal into pure metal depending upon the nature of metal.

- **Distillation:**

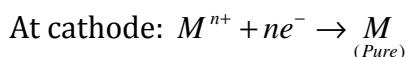
It is the process used to purify those metals which have low boiling points, e.g., zinc, mercury, sodium, potassium. Impure metal is heated so as to convert it into vapours which changes into pure metal on condensation and is obtained as distillate.

- **Liquation:**

Those metals which have impurities whose melting points are higher than metal can be purified by this method. In this method, Sn metal can be purified. Tin containing iron as impurities heated on the top of sloping furnace. Tin melts and flows down the sloping surface where iron is left behind and pure tin is obtained.

- **Electrolytic refining:**

In this method, impure metal is taken as anode, pure metal is taken as cathode, and a soluble salt of metal is used as electrolyte. When electric current is passed, impure metal forms metal ions which are discharged at cathode forming pure metal.



- **Zone refining:**

It is based on the principle that impurities are more soluble in the melt than in the solid state of the metal. The impure metal is heated with the help of circular heaters at one end of the rod of impure metal. The molten zone moves forward along with the heater with impurities and reaches the other end and is discarded. Pure metal crystallizes out of the melt. The process is repeated several times and heater is moved in the same direction. It is used for purifying semiconductors like B, Ge, Si, Ga and In.

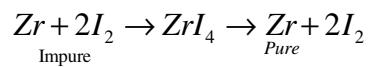
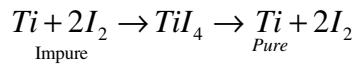
- **Vapour phase refining:**

Nickel is purified by Mond's process. Nickel, when heated in stream of carbon monoxide forms volatile $Ni(CO)_4$ which on further subjecting to higher temperature decomposes to give pure metal.



- **Van- Arkel method:**

It is used to get ultra pure metals. Zr and Ti are purified by this process. Zr or Ti are heated in iodine vapours at about 870 K to form volatile ZrI_4 or TiI_4 which are heated over tungsten filament at 1800K to give pure Zr or Ti.



- **Chromatographic method:**

It is based on the principle of separation or purification by chromatography which is based on differential adsorption on an adsorbent. In column chromatography, Al_2O_3 is used as adsorbent. The mixture to be separated is taken in suitable solvent and applied on the column. They are then eluted out with suitable solvent (eluent). The weakly adsorbed component is eluted first. This method is suitable for such elements which are available only in minute quantities and the impurities are not very much different in their chemical behaviour from the element to be purified.

CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 7
The P-Block Elements

- **The p-Block elements:** Elements belonging to groups 13 to 18 of the periodic table are called p-block elements.
- **General electronic configuration of p-block elements:** The p-block elements are characterized by the $ns^2np^1\text{-}6$ valence shell electronic configuration.
- **Representative elements:** Elements belonging to the s and p-blocks in the periodic table are called the representative elements or main group elements.
- **Inert pair effect:** The tendency of ns^2 electron pair to participate in bond formation decreases with the increase in atomic size. Within a group the higher oxidation state becomes less stable with respect to the lower oxidation state as the atomic number increases. This trend is called ‘inert pair effect’. In other words, the energy required to unpair the electrons is more than energy released in the formation of two additional bonds.

GROUP 15 ELEMENTS

- **Nitrogen family:** The elements of group 15 – nitrogen (N), phosphorus (P), arsenic (As), antimony (Sb) and bismuth (Bi) belong to configuration is ns^2np^3 .
- **Atomic and ionic radii:**
 1. Covalent and ionic radii increase down the group.
 2. There is appreciable increase in covalent radii from N to P.
 3. There is small increase from As to Bi due to presence of completely filled d or f orbitals in heavy elements.
- **Ionisation energy:**
 1. It goes on decreasing down the group due to increase in atomic size.

2. Group 15 elements have higher ionisation energy than group 14 elements due to smaller size of group 15 elements.
3. Group 15 elements have higher ionization energy than group 16 elements because they have stable electronic configuration i.e., half-filled p-orbitals.

- **Allotropy:** All elements of Group 15 except nitrogen show allotropy.

- **Catenation:**

1. Nitrogen shows catenation to some extent due to triple bond but phosphorus shows catenation to maximum extent.
2. The tendency to show catenation decreases down the group.

- **Oxidation states:**

1. The common oxidation states are +3, +5 and -3.
2. The tendency to show -3 oxidation state decreases down the group because of decrease in electronegativity by the increase in atomic size.
3. The stability of +5 oxidation state decreases whereas stability of +3 oxidation state increases due to inert pair effect.
4. Nitrogen shows oxidation states from -3 to +5.
5. Nitrogen and phosphorus with oxidation states from +1 to +4 undergo oxidation as well as reduction in acidic medium. This process is called disproportionation.



- **Reactivity towards hydrogen:**

1. All group 15 elements form trihydrides, MH_3 .
2. It belongs to sp^3 hybridisation.
3. The stability of hydrides decreases down the group due to decrease in bond dissociation energy down the group.



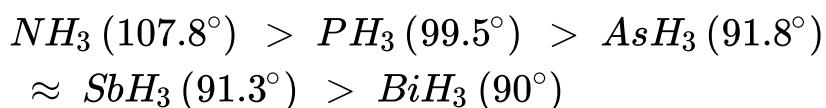
- **Boiling point:**



1. Boiling point increases with increase in size due to increase in van der Waals forces.

-
2. Boiling point of NH₃ is more because of hydrogen bonding.

- **Bond angle:**



1. Electronegativity of N is highest. Therefore, the lone pairs will be towards nitrogen and hence more repulsion between bond pairs. Therefore bond angle is the highest. After nitrogen, the electronegativity decreases down the group.
2. Basicity decreases as NH₃> PH₃> AsH₃> SbH₃< BiH₃. This is because the lone pair of electrons are concentrated more on nitrogen and hence the basicity will be maximum in the case of NH₃. It will decrease down the group as the electronegativity decreases down the group. The reducing power of hydrides increases down the group due to decrease in bond dissociation energy down the group.

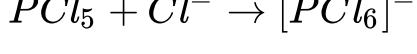
- **Reactivity towards oxygen:**

1. All group 15 elements from trioxides (M_2O_3) and pentoxides (M_2O_5).
2. Acidic character of oxides decreases and basicity increases down the group. This is because the size of nitrogen is very small.
3. It has a strong positive field in a very small area. Therefore, it attracts the electrons of water O-H bond to itself and release H⁺ ions easily.
4. As we move down the group, the atomic size increases and so, the acidic character of oxide decreases and basicity increases down the group.

- **Reactivity towards halogen:**

Group 15 elements form trihalides and pentahalides.

1. Trihalides: These are covalent compounds and become ionic down the group with sp^3 hybridisation, pyramidal shape.
2. Pentahalides
 - a). They are lewis acids because of the presence of vacant d – orbitals.
 - b). They possess sp^3d hybridisation and hence possess trigonalbipyramidal shape.



3. PCl_5 is ionic in solid state and exist as $[\text{PCl}_4]^+[\text{PCl}_6]^-$
4. In PCl_5 , there are three equatorial bonds and two axial bonds. The axial bonds are longer than equatorial bonds because of greater repulsion from equatorial bonds.
5. Nitrogen does not form pentahalides due to absence of d - orbitals.

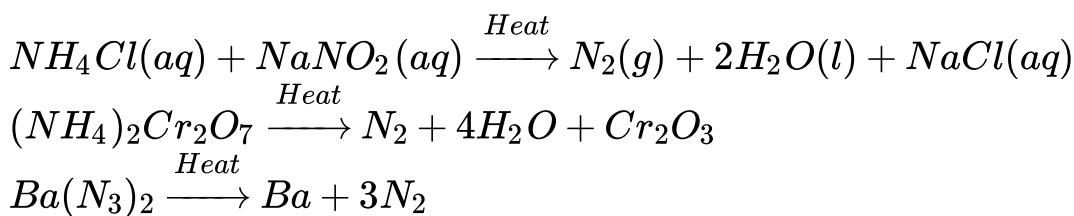
- **Reactivity towards metals:** All elements react with metals to form binary compounds in -3 oxidation state.
- **Anomalous behaviour of nitrogen:** The behaviour of nitrogen differs from rest of the elements.

Reasons:

- i. It has a small size.
- ii. It does not have d – orbitals
- iii. It has high electronegativity
- iv. It has high ionization enthalpy

- **Dinitrogen:**

a) Preparation:



b) Physical Properties:

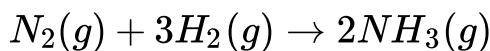
- i) It is a colourless, odourless, tasteless and non – toxic gas.
- ii) It is chemically un-reactive at ordinary temperature due to triple bond in $\text{N} \equiv \text{N}$ which has high bond dissociation energy.

- **Ammonia:**

1. Ammonia molecule is trigonal pyramidal with nitrogen atom at the apex.
2. It has 3 bond pairs and 1 lone pair.
3. N is sp^3 hybridised.

4. Preparation:

Haber's process:

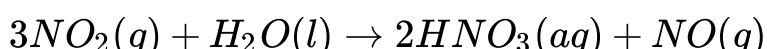


$$\Delta_f H^0 = -46.1 \text{ kJ mol}^{-1}$$

Pressure 200×10 Pa Temperature 773 K Catalyst is FeO with small amounts of K_2O and Al_2O_3

- **Nitric Acid:**

Ostwald Process: The NO thus formed is recycled and the aqueous HNO_3 can be concentrated by distillation upto $\sim 68\%$ by mass. Further concentration to 98% can be achieved by dehydration with concentrated H_2SO_4 . Nitric acid is strong oxidizing agent in the concentrated as well as in the dilute state.



Phosphorus:

a) It shows the property of catenation to maximum extent due to most stable P – P bond.

b) It has many allotropes, the important ones are:

i) White phosphorus

ii) Red phosphorus

iii) Black phosphorus

- **White phosphorus:**

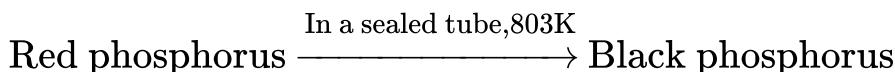
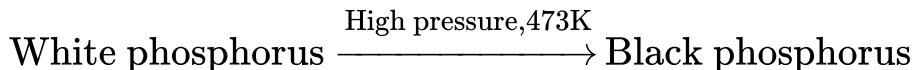
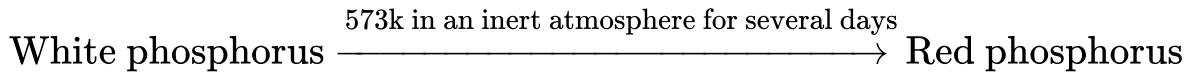
1. Discrete tetrahedral P₄ molecules
2. Very reactive
3. Glows in dark
4. Translucent waxy solid
5. Soluble in C_6H_6 but insoluble in water
6. It has low ignition temperature, therefore, kept under water

• Red phosphorus

1. Polymeric structure consisting of chains of P₄ units linked together
2. Less reactive than white phosphorus
3. Does not glow in dark
4. Has an iron grey lustre
5. Insoluble in water as well as CS₂

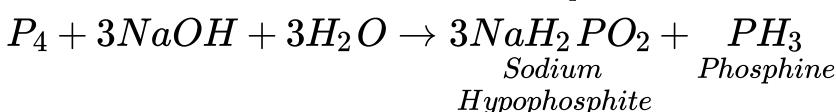
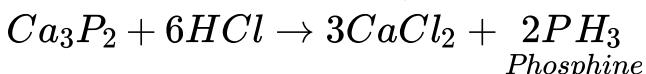
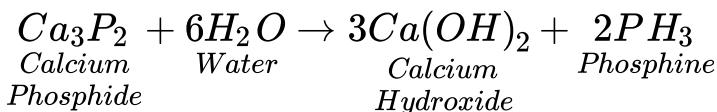
• Black phosphorus

1. Exists in two forms - α black phosphorus and β black phosphorus
2. Very less reactive
3. Has an opaque monoclinic or rhombohedral crystals



• Phosphine

1. It is highly poisonous, colourless gas and has a smell of rotten fish.
2. Preparation



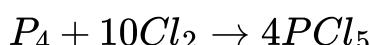
Sodium Hypophosphate

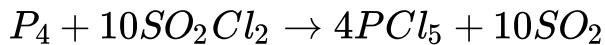
• Chlorides of Phosphorous:

a) Phosphorus Trichloride

- i) It is a colourless oily liquid.

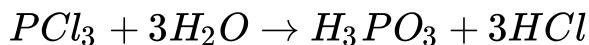
ii) Preparation





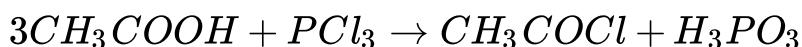
iii) With water,

It gets hydrolysed in the presence of moisture.

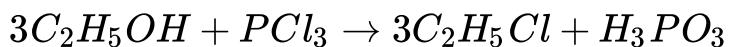


iv) Pyramidal shape, sp³ hybridisation

v) With acetic acid



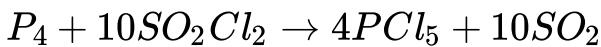
vi). With alcohol



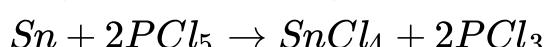
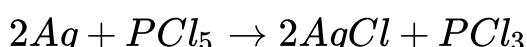
b) Phosphorus pentachloride



1. Yellowish white powder.
2. Trigonalbipyramidal shape, sp³dhybridisation .
3. Preparation
4. $P_4 + 10Cl_2 \rightarrow 4PCl_5$



5. With water
6. $PCl_5 + H_2O \rightarrow POCl_3 + 2HCl$
 $POCl_3 + 3H_2O \rightarrow H_3PO_4 + 3HCl$
7. With acetic acid
8. $3CH_3COOH + PCl_5 \rightarrow CH_3COCl + POCl_3 + HCl$
9. With alcohol
10. With metals



GROUP 16 ELEMENTS

- **Oxidation states:**

1. They show -2, +2, +4, +6 oxidation states.
2. Oxygen does not show +6 oxidation state due to absence of d – orbitals.
3. Po does not show +6 oxidation state due to inert pair effect.
4. The stability of -2 oxidation state decreases down the group due to increase in atomic size and decrease in electronegativity.
5. Oxygen shows -2 oxidation state in general except in OF_2 and O_2F_2
6. Thus, the stability of +6 oxidation state decreases and +4 oxidation state increases due to inert pair effect.

- **Ionisation enthalpy:**

1. Ionisation enthalpy of elements of group 16 is lower than group 15 due to half-filled p-orbitals in group 15 which is more stable.
2. However, ionization enthalpy decreases down the group.

- **Electron gain enthalpy:**

1. Oxygen has less negative electron gain enthalpy than S because of small size of O.
2. From S to Po electron gain enthalpy becomes less negative to Po because of increase in atomic size.

- **Melting and boiling point:**

1. It increases with increase in atomic number.
2. Oxygen has much lower melting and boiling points than sulphur because oxygen is diatomic (O_2) and sulphur is octatomic (S_8).

- **Reactivity with hydrogen:**

1. All group 16 elements form hydrides.
2. They possess bent shape.
3. Bond angle: H_2O [373K] > H_2S [213K] < H_2Se [232K] < H_2Te [269K]

- Acidic nature: H_2O < H_2S < H_2Se < H_2Te

This is because the H-E bond length increases down the group. Therefore, the bond dissociation enthalpy decreases down the group.

- Thermal stability: H_2O < H_2S < H_2Se < H_2Te < H_2Po

This is because the H-E bond length increases down the group. Therefore, the bond dissociation enthalpy decreases down the group.

- Reducing character: $H_2O < H_2S < H_2Se < H_2Te < H_2Po$

This is because the H-E bond length increases down the group. Therefore, the bond dissociation enthalpy decreases down the group.

- **Reactivity with oxygen:** EO_2 and EO_3

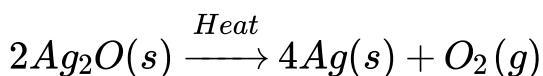
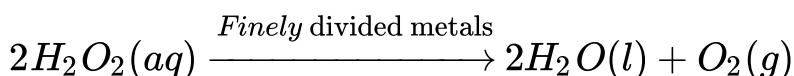
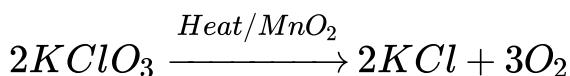
1. Reducing character of dioxides decreases down the group because oxygen has a strong positive field which attracts the hydroxyl group and removal of H^+ becomes easy.
2. Acidity also decreases down the group.
3. SO_2 is a gas whereas SeO_2 is solid. This is because SeO_2 has a chain polymeric structure whereas SO_2 forms discrete units.

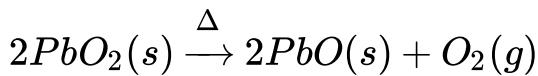
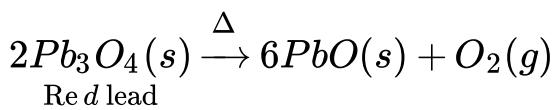
- **Reactivity with halogens:** EX_2 , EX_4 and EX_6

1. The stability of halides decreases in the order $F^- > Cl^- > Br^- > I^-$.
2. This is because E-X bond length increases with increase in size.
3. Among hexa halides, fluorides are the most stable because of steric reasons.
4. Dihalides are sp^3 hybridised and so, are tetrahedral in shape.
5. Hexafluorides are only stable halides which are gaseous and have sp^3d^2 hybridisation and octahedral structure.
6. H_2O is a liquid while H_2S is a gas. This is because strong hydrogen bonding is present in water. This is due to small size and high electronegativity of O.

Oxygen:

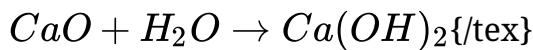
The compounds of oxygen and other elements are called oxides.



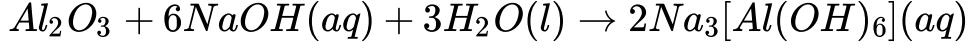
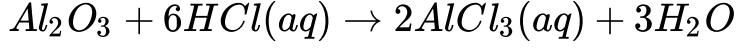


- **Oxides:** The compounds of oxygen and other elements are called oxides.

- **Types of oxides:**



1. Acidic oxides: Non-metallic oxides are usually acidic in nature.
2. Basic oxides: Metallic oxides are mostly basic in nature. Basic oxides dissolve in water forming bases e.g.,
3. Amphoteric oxides: They show characteristics of both acidic as well as basic oxides.



4. Neutral oxides: These oxides are neither acidic nor basic. Example: CO, NO and N₂O

- **Ozone:**

1. Preparation: It is prepared by passing silent electric discharge through pure and dry oxygen 10 – 15 % oxygen is converted to ozone.



2. Structure of Ozone: Ozone has angular structure. Both O = O bonds are of equal bond length due to resonance.

- **Sulphur:**

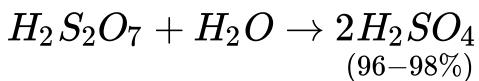
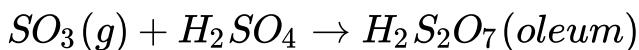
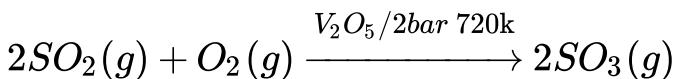
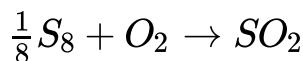
1. Sulphur exhibits allotropy:

1. Yellow Rhombic (α - sulphur)
2. Monoclinic (β - sulphur)

2. $\alpha - \text{sulphur} \xrightarrow{369K} \beta - \text{sulphur}$
3. At 369 K both forms are stable. It is called transition temperature.
 4. Both of them have S₈ molecules.
 5. The ring is puckered and has a crown shape.
 6. Another allotrope of sulphur – cyclo S₆ ring adopts a chair form.
 7. S₂ is formed at high temperature (~ 1000 K).
 8. It is paramagnetic because of 2 unpaired electrons present in anti bonding π^* orbitals like O₂.

- **Sulphuric acid:**

By contact process



1. Preparation:
2. Exothermic reaction and therefore low temperature and high pressure are favourable.
3. It is dibasic acid or diprotic acid.
4. It is a strong dehydrating agent.
5. It is a moderately strong oxidizing agent.

GROUP 17 ELEMENTS

- **Atomic and ionic radii:** Halogens have the smallest atomic radii in their respective periods because of maximum effective nuclear charge.
- **Ionisation enthalpy:** They have very high ionization enthalpy because of small size as compared to other groups.

- **Electron gain enthalpy:**

1. Halogens have maximum negative electron gain enthalpy because these elements have only one electron less than stable noble gas configuration.
2. Electron gain enthalpy becomes less negative down the group because atomic size increases down the group.

- **Electronegativity:**

1. These elements are highly electronegative and electronegativity decreases down the group.
2. They have high effective nuclear charge.

- **Bond dissociation enthalpy:**

1. Bond dissociation enthalpy follows the order: $Cl_2 > Br_2 > F_2 > I_2$
2. This is because as the size increases bond length increases.
3. Bond dissociation enthalpy of Cl_2 is more than F_2 because there are large electronic repulsions of lone pairs present in F_2 .

- **Colour:** All halogens are coloured because of absorption of radiations in visible region which results in the excitation of outer electrons to higher energy levels.

- **Oxidising power:**

1. All halogens are strong oxidising agents because they have a strong tendency to accept electrons.
2. Order of oxidizing power is: $F_2 > Cl_2 > Br_2 > I_2$

- **Reactivity with Hydrogen:**

1. Acidic strength: HF < HCl < HBr < HI
2. Stability: HF > HCl > HBr > HI. This is because of decrease in bond dissociation enthalpy.
3. Boiling point: HCl < HBr < HI < HF. HF has strong intermolecular H bonding. As the size increases van der Waals forces increases and hence boiling point increases.
4. % Ionic character: HF > HCl > HBr > HI Dipole moment: HF > HCl > HBr > HI. Electronegativity decreases down the group.
5. Reducing power: HF < HCl < HBr < HI

- **Reactivity with metals:**

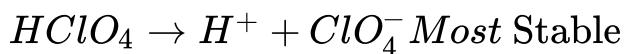
1. Halogens react with metals to form halides.
2. Ionic character: MF > MCl > MBr > MI. The halides in higher oxidation state will be more covalent than the one in the lower oxidation state.

- **Interhalogen compounds:**

Reactivity of halogens towards other halogens:

1. Binary compounds of two different halogen atoms of general formula $X X'_n$ are called interhalogen compounds where $n = 1, 3, 5$, or 7 . All these are covalent compounds.
2. Interhalogen compounds are more reactive than halogens because X-X is a more polar bond than X-X bond.
3. All are diamagnetic.
4. Their melting point is little higher than halogens.
5. XX' (ClF , BrF , BrCl , ICl , IBr , IF) (Linear shape) XX'_3 (ClF_3 , BrF_3 , IF_3 , ICl_3) (Bent T-shape) $XX'_5 - \text{ClF}_5$, BrF_5 , IF_5 , (square pyramidal shape) $XX'_7 - \text{IF}_7$ (Pentagonal bipyramidal shape)

- **Oxoacids of halogens:**



1. Fluorine forms only one oxoacid HOF (Fluoric (I) acid or hypofluorous acid) due to high electronegativity.
2. Acid strength: $\text{HOCl} < \text{HClO}_2 < \text{HClO}_3 < \text{HClO}_4$
3. Reason:
4. Acid strength: HOF > HOCl > HOBr > HOI. This is because Fluorine is most electronegative.

GROUP 18 ELEMENTS:

- **Ionisation enthalpy:**

1. They have very high ionization enthalpy because of completely filled orbitals.
2. Ionisation enthalpy decreases down the group because of increase in size.

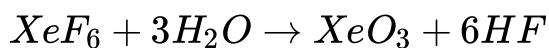
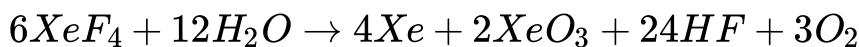
- **Atomic radii:** Increases down the group because the number of shells increases down the group.
- **Electron gain enthalpy:** They have large electron gain enthalpy because of stable electronic configuration.
- **Melting and boiling point:** It has low melting and boiling point due to the presence of only weak dispersion forces.
- **Shapes:**

XeF_2 is linear, XeF_4 is square planar and XeF_6 is distorted octahedral. KrF_2 is known but no true compound of He Ne and Ar are known.

- **Compounds of Xe and F:**
- $Xe + F_2 \xrightarrow{673k, 1bar} XeF_2$
- $Xe + 2F_2 \xrightarrow{873k/7bar} XeF_4$
- $Xe + 3F_2 \xrightarrow{573k/60-70bar} XeF_6$
- $XeF_4 + O_2F_2 \rightarrow XeF_6 + O_2$

XeF_2 , XeF_4 and XeF_6 are powerful fluorinating agents.

- **Compounds of Xe and O:**



CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 8
The D and F-Block Elements

• **The d -Block elements:**

1. The elements lying in the middle of periodic table belonging to groups 3 to 12 are known as d – block elements.
2. Their general electronic configuration is $(n - 1)d^{1-10}ns^{1-2}$ where (n – 1) stands for penultimate (last but one) shell.

• **Transition element:**

1. A transition element is defined as the one which has incompletely filled *d* orbitals in its ground state or in any one of its oxidation states.
2. Zinc, cadmium, mercury are not regarded as transition metals due to completely filled d – orbital.

• **The f-Block elements:** The elements constituting the *f*-block are those in which the 4 *f* and 5 *f* orbitals are progressively filled in the latter two long periods.

• **Lanthanoids:** The 14 elements immediately following lanthanum, i.e., Cerium (58) to Lutetium (71) are called lanthanoids. They belong to first inner transition series. Lanthanum (57) has similar properties. Therefore, it is studied along with lanthanoids.

• **Actinoids:** The 14 elements immediately following actinium (89), with atomic numbers 90 (Thorium) to 103 (Lawrencium) are called actinoids. They belong to second inner transition series. Actinium (89) has similar properties. Therefore, it is studied along with actinoids.

• **Four transition series:**

1. 3d – transition series. The transition elements with atomic number 21(Sc) to 30(Zn) and having incomplete 3d orbitals is called the first transition series.

2. 4d – transition series. It consists of elements with atomic number 39(Y) to 48 (Cd) and having incomplete 4d orbitals. It is called second transition series.
3. 5d – transition series. It consists of elements with atomic number 57(La), 72(Hf) to 80(Hg) having incomplete 5d orbitals. It is called third transition series.
4. 6d – transition series. It consists of elements with atomic number 89(Ac), 104(Rf) to 112(Uub) having incomplete 6d orbitals. It is called fourth transition series.

- **General Characteristics of transition elements:**

- a) Metallic character:** All transition elements are metallic in nature, i.e. they have strong metallic bonds. This is because of presence of unpaired electrons. This gives rise to properties like high density, high enthalpies of atomization, and high melting and boiling points.
- b) Atomic radii:** The atomic radii decrease from Sc to Cr because the effective nuclear charge increases. The atomic size of Fe, Co, Ni is almost same because the attraction due to increase in nuclear charge is cancelled by the repulsion because of increase in shielding effect. Cu and Zn have bigger size because the shielding effect increases and electron-electron repulsions repulsion increases.
- c) Lanthanoid Contraction:** The steady decrease in the atomic and ionic radii of the transition metals as the atomic number increases. This is because of filling of 4f orbitals before the 5d orbitals. This contraction in size is quite regular. This is called lanthanoid contraction. It is because of lanthanoid contraction that the atomic radii of the second row of transition elements are almost similar to those of the third row of transition elements.
- d) Ionisation enthalpy:** There is slight and irregular variation in ionization energies of transition metals due to irregular variation of atomic size. The I.E. of 5d transition series is higher than 3d and 4d transition series because of Lanthanoid Contraction.
- e) Oxidation state:** Transition metals show variable oxidation states due to tendency of $(n-1)d$ as well as ns electrons to take part in bond formation.
- f) Magnetic properties:** Most of transition metals are paramagnetic in nature as a result of which they give coloured compounds and it is all due to presence of unpaired electrons. It increases from Sc to Cr and then decreases because number of unpaired and then decrease because number of unpaired electrons increases from Sc to Cr and then decreases. They are rarely diamagnetic.
- g) Catalytic properties:** Most of transition metals are used as catalyst because of (i) presence

of incomplete or empty d – orbitals, (ii) large surface area, (iii) valuable oxidation state, (iv) ability to form complexes, e.g., Fe, Ni, V₂O₃, Pt, Mo, Co and used as catalyst.

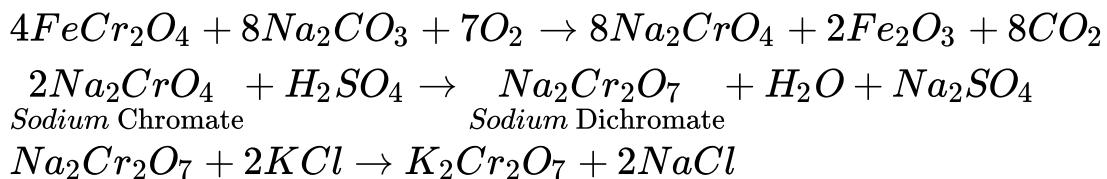
h) Formation of coloured compounds: They form coloured ions due to presence of incompletely filled d – orbitals and unpaired electrons, they can undergo d – d transition by absorbing colour from visible region and radiating complementary colour.

i) Formation of complexes: Transition metals form complexes due to (i) presence of vacant d – orbitals of suitable energy (ii) smaller size (iii) higher charge on cations.

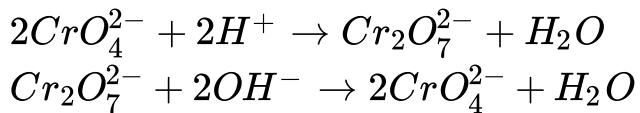
j) Interstitial compounds: Transition metals have voids or interstitials in which C, H, N, B etc. can fit into resulting in formation of interstitial compounds. They are non – stoichiometric, i.e., their composition is not fixed, e.g., steel. They are harder and less malleable and ductile.

k) Alloys formation: They form alloys due to similar ionic size. Metals can replace each other in crystal lattice, e.g., brass, bronze, steel etc.

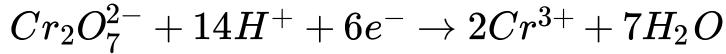
- **Preparation of Potassium dichromate (K₂Cr₂O₇):** It is prepared by fusion of chromate ore (FeCr₂O₄) with sodium carbonate in excess of air.



- **Effect of pH on chromate and dichromate ions:** The chromates and dichromates are inter-convertible in aqueous solution depending upon pH of the solution. The oxidation state of chromium in chromate and dichromate is the same.

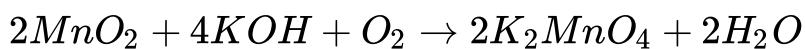


- **Potassium dichromate acts as a strong oxidizing agent in acidic medium:**

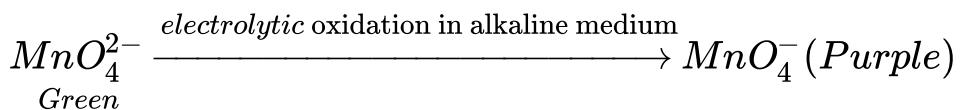
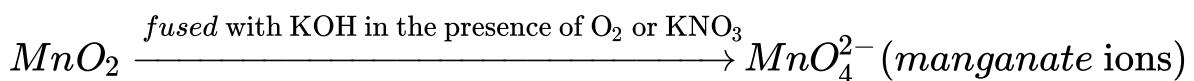


- **Preparation of Potassium permanganate (KMnO₄):**

a) Potassium permanganate is prepared by fusion of MnO₄ with alkali metal hydroxide (KOH) in presence of O₂ or oxidising agent like KNO₃. It produces dark green K₂MnO₄ which undergoes oxidation as well as reduction in neutral or acidic solution to give permanganate.



b) Commercially, it is prepared by the alkaline oxidative fusion of MnO₂ followed by the electrolytic oxidation of manganate (VI).



c) In laboratory, Mn²⁺ salt can be oxidized by peroxodisulphate ion to permanganate ion.



- **Properties of Lanthanoids:**

1. +3 oxidation state is most common along with +2 and +4.
2. Except Promethium, they are non – radioactive.
3. The magnetic properties of lanthanoids are less complex than actinoids.

- **Properties of Actinoids:**

1. Actinoids also show higher oxidation states such as +4, +5, +6 and +7.
2. They are radioactive.
3. The magnetic properties of the actinoids are more complex than those of the lanthanoids.
4. They are more reactive.

- **Mischmetall**

1. It is a well-known alloy which consists of a lanthanoid metal (~ 95%) and iron (~ 5%) and traces of S, C, Ca and Al.
2. A good deal of mischmetall is used in Mg-based alloy to produce bullets, shell and lighter flint.

CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 9
Co-ordination Compounds

• **Co-ordination compounds:**

1. A coordination compound contains a central metal atom or ion surrounded by number of oppositely charged ions or neutral molecules. These ions or molecules are bonded to the metal atom or ion by a coordinate bond.
2. Example: $K_4[Fe(CN)_6]$
3. They do not dissociate into simple ions when dissolved in water.

• **Double salt**

1. When two salts in stoichiometric ratio are crystallised together from their saturated solution they are called double salts
2. Example: $FeSO_4 \cdot (NH_4)_2SO_4 \cdot 6H_2O$ (Mohr's salt)
3. They dissociate into simple ions when dissolved in water.

• **Coordination entity:**

1. A coordination entity constitutes a central metal atom or ion bonded to a fixed number of ions or molecules.
2. Example: In $K_4[Fe(CN)_6]$, $[Fe(CN)_6]^{4-}$ represents coordination entity.

• **Central atom or ion:**

1. In a coordination entity, the atom/ion to which a fixed number of ions/groups are bound in a definite geometrical arrangement around it, is called the central atom or ion.
2. Example: In $K_4[Fe(CN)_6]$, Fe^{+} is the central metal ion.

• **Ligands:**

1. A molecule, ion or group that is bonded to the metal atom or ion in a complex or coordination compound by a coordinate bond is called ligand.

-
2. It may be neutral, positively or negatively charged.
 3. Examples: H_2O , CN^- , NO^+ etc.

- **Donor atom:**

1. An atom of the ligand attached directly to the metal is called the donor atom.
2. Example: In the complex $K_4[Fe(CN)_6]$, CN is a donor atom.

- **Coordination number:**

1. The coordination number (CN) of a metal ion in a complex can be defined as the number of ligand donor atoms to which the metal is directly bonded.
2. Example: In the complex $K_4[Fe(CN)_6]$, the coordination number of Fe is 6.

- **Coordination sphere:**

1. The central atom/ion and the ligands attached to it are enclosed in square bracket and are collectively termed as the coordination sphere.
2. Example: In the complex $K_4[Fe(CN)_6]$, $[Fe(CN)_6]^{4-}$ is the coordination sphere.

- **Counter ions:**

1. The ions present outside the coordination sphere are called counter ions.
2. Example: In the complex $K_4[Fe(CN)_6]$, K^+ is the counter ion.

- **Coordination polyhedron:**

1. The spatial arrangement of the ligand atoms which are directly attached to the central atom/ ion defines a coordination polyhedron about the central atom.
2. The most common coordination polyhedra are octahedral, square planar and tetrahedral.
3. Examples: $[PtCl_4]^{2-}$ is square planar, $Ni(CO)_4$ is tetrahedral while $[Cu(NH_3)_6]^{3+}$ is octahedral.

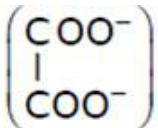
- **Charge on the complex ion:** The charge on the complex ion is equal to the algebraic sum of the charges on all the ligands coordinated to the central metal ion.

- **Denticity:** The number of ligating (linking) atoms present in ligand is called denticity.

- **Unidentate ligands:**

1. The ligands whose only one donor atom is bonded to metal atom are called unidentate ligands.
2. Examples: H_2O , NH_3 , CO , CN^-

- **Didentate ligands:**

1. The ligands which contain two donor atoms or ions through which they are bonded to the metal ion.
2. Examples: Ethylene diamine ($H_2NCH_2CH_2NH_2$) has two nitrogen atoms, oxalate ion  has two oxygen atoms which can bind with the metal atom.

- **Polydentate ligand:**

1. When several donor atoms are present in a single ligand, the ligand is called polydentate ligand.
2. Examples: In $N(CH_2CH_2NH_2)_3$, the ligand is said to be polydentate and Ethylenediaminetetraacetate ion ($EDTA^{4-}$) is an important hexadentate ligand. It can bind through two nitrogen and four oxygen atoms to a central metal ion.

- **Chelate:**

1. An inorganic metal complex in which there is a close ring of atoms caused by attachment of a ligand to a metal atom at two points.
2. An example is the complex ion formed between ethylene diamine and cupric ion, $[Cu(NH_2CH_2NH_2)_2]^{2+}$.

- **Ambidentate ligand:**

1. Ligands which can ligate (link) through two different atoms present in it are called ambidentate ligand.
2. Example: NO^{2-} and SCN^- . Here, NO^{2-} can link through N as well as O while SCN^- can link through S as well as N atom.

- **Werner's coordination theory:**

1. Werner was able to explain the nature of bonding in complexes.
2. The postulates of Werner's theory are:
 - a). Metal shows two different kinds of valencies: primary valence and secondary valence.
 - b). The ions/ groups bound by secondary linkages to the metal have characteristic spatial arrangements corresponding to different coordination numbers.
 - c). The most common geometrical shapes in coordination compounds are octahedral, square planar and tetrahedral.

- **Primary valence**

1. This valence is normally ionisable.
2. It is equal to positive charge on central metal atom.
3. These valencies are satisfied by negatively charged ions.
4. Example: In $CrCl_3$, the primary valency is three. It is equal to oxidation state of central metal ion.

- **Secondary valence**

1. This valence is non – ionisable.
2. The secondary valency equals the number of ligand atoms coordinated to the metal. It is also called coordination number of the metal.
3. It is commonly satisfied by neutral and negatively charged, sometimes by positively charged ligands.

- **Oxidation number of central atom:** The oxidation number of the central atom in a complex is defined as the charge it would carry if all the ligands are removed along with the electron pairs that are shared with the central atom.
- **Homoleptic complexes:** Those complexes in which metal or ion is coordinate bonded to only one kind of donor atoms. For example: $[Co(NH_3)_6]^{3+}$
- **Heteroleptic complexes:** Those complexes in which metal or ion is coordinate bonded to more than one kind of donor atoms. For example:
 $[CoCl_2(NH_3)_4]^+$, $[Co(NH_3)_5Br]^{2+}$

- **Isomers:** Two or more compounds which have same chemical formula but different arrangement of atoms are called isomers.

- **Types of isomerism:**

- a). Linkage isomerism
- b). Solvate isomerism or hydrate isomerism
- c). Ionisation isomerism
- d). Coordination isomerism
 1. Structural isomerism
 2. Stereoisomerism
 - a). Geometrical isomerism
 - b). Optical isomerism

- **Structural isomerism:**

1. It arises due to the difference in structures of coordination compounds.
2. Structural isomerism, or constitutional isomerism, is a form of isomerism in which molecules with the same molecular formula have atoms bonded together in different orders.

- **Ionisation isomerism:**

1. It arises when the counter ion in a complex salt is itself a potential ligand and can displace a ligand which can then become the counter ion.
2. Example: $[Co(NH_3)_5Br] SO_4$ and $[Co(NH_3)_5SO_4] Br$

- **Solvate isomerism:**

1. It is isomerism in which solvent is involved as ligand.
2. If solvent is water it is called hydrate isomerism, e.g., $[Cr(H_2O)_6] Cl_3$ and $[CrCl_2(H_2O)_4] Cl_2 \cdot 2H_2O$.

- **Linkage isomerism:**

- It arises in a coordination compound containing ambidentate ligand.
- In the isomerism, a ligand can form linkage with metal through different atoms.
- Example: $[Co(NH_3)_5ONO]Cl_2$ and $[Co(NH_3)_5NO_2]Cl_2$.

- Coordination isomerism:**

- This type of isomerism arises from the interchange of ligands between cationic and anionic entities of different metal ions present in a complex.
 - Example: $[Co(NH_3)_6][Cr(C_2O_4)_3]$ and $[Cr(NH_3)_6][Co(C_2O_4)_3]$.
- Stereoisomerism:** This type of isomerism arises because of different spatial arrangement.
 - Geometrical isomerism:** It arises in heteroleptic complexes due to different possible geometrical arrangements of ligands.
 - Optical isomerism:** Optical isomers are those isomers which are non-superimposable mirror images.

- Valence bond theory:**

- According to this theory, the metal atom or ion under the influence of ligands can use its (n-1)d, ns, np or ns, np, nd orbitals for hybridisation to yield a set of equivalent orbitals of definite geometry such as octahedral, tetrahedral, and square planar.
- These hybridised orbitals are allowed to overlap with ligand orbitals that can donate electron pairs for bonding.

Coordination Number	Type of hybridisation	Shape of hybrid
4	sp^3	Tetrahedral
4	dsp^2	Square planar

5	sp^3d	Trigonalbipyramidal
6	sp^3d^2 (nd orbitals are involved – outer orbital complex or high spin or spin free complex)	Octahedral
6	d^2sp^3 ($n - 1$) d orbitals are involved –inner orbital or low spin or spin paired complex)	Octahedral

- **Magnetic properties of coordination compounds:**

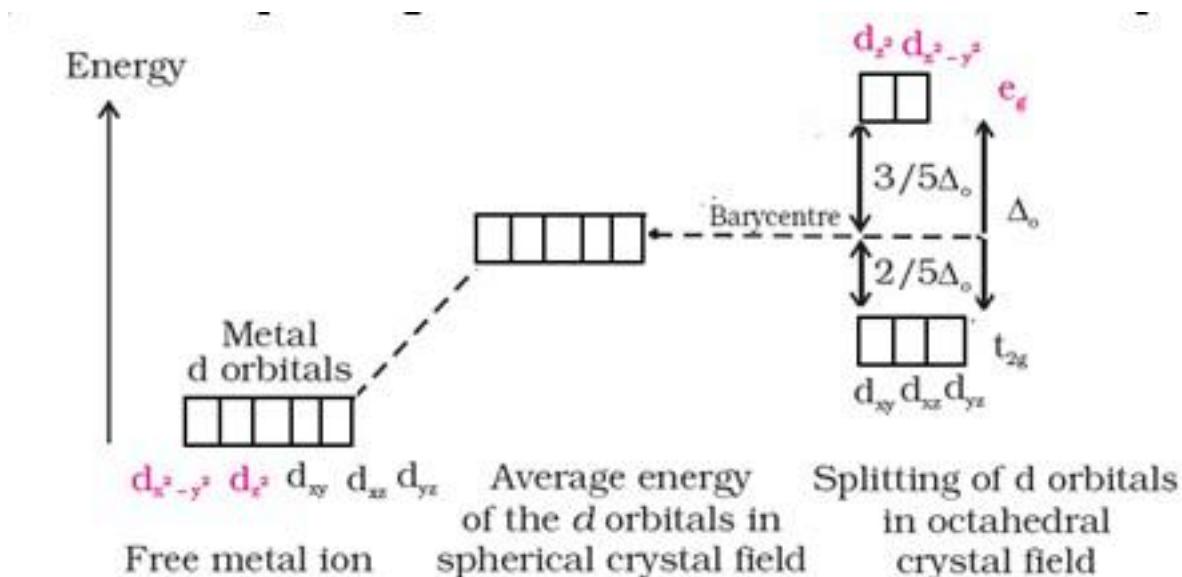
A coordination compound is paramagnetic in nature if it has unpaired electrons and diamagnetic if all the electrons in the coordination compound are paired.

Magnetic moment $\mu = \sqrt{n(n+2)}$ where n is number of unpaired electrons.

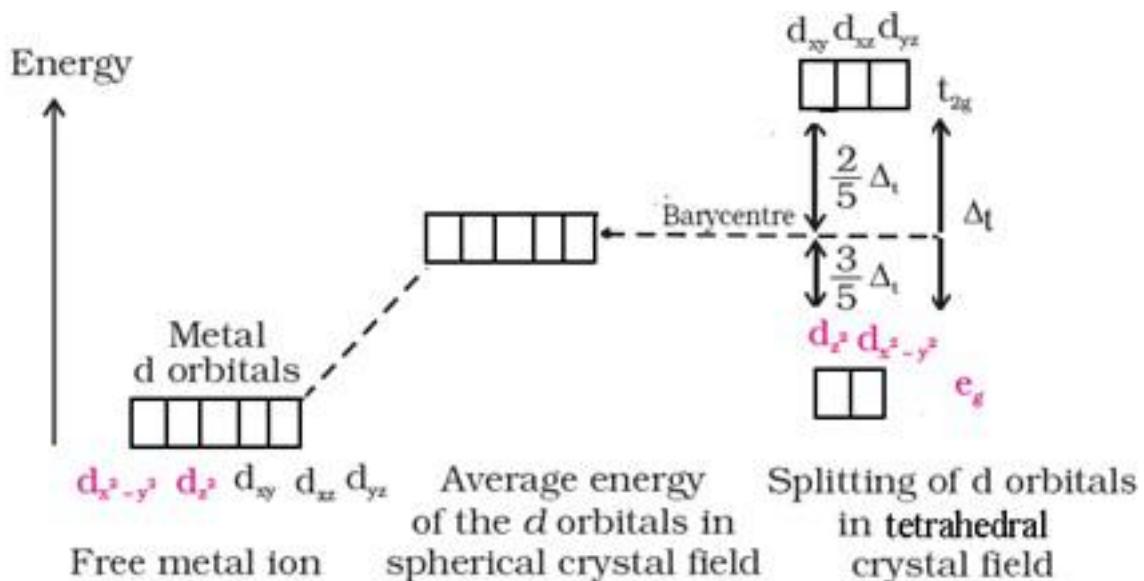
- **Crystal Field Theory:**

1. It assumes the ligands to be point charges and there is electrostatic force of attraction between ligands and metal atom or ion.
2. It is theoretical assumption.

- **Crystal field splitting in octahedral coordination complexes:**



- Crystal field splitting in tetrahedral coordination complexes:



- For the same metal, the same ligands and metal-ligand distances, the difference in

$$\text{energy between } e_g \text{ and } t_{2g} \text{ level is } \Delta_t = -\frac{4}{9} \Delta_0$$

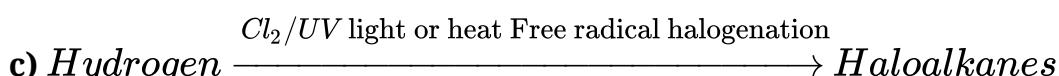
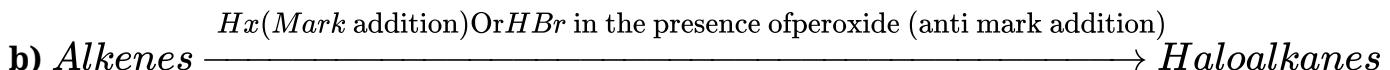
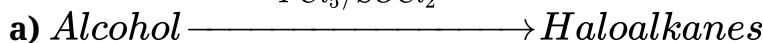
- Metal carbonyls:

1. Metal carbonyls are homoleptic complexes in which carbon monoxide (CO) acts as the ligand.
2. Example: $Ni(CO)_4$
3. The metal-carbon bond in metal carbonyls possess both s and p character.
4. The M–C σ bond is formed by the donation of lone pair of electrons from the carbonyl carbon into a vacant orbital of the metal.
5. The M–C π bond is formed by the donation of a pair of electrons from a filled d orbital of metal into the vacant antibonding π^* orbital of carbon monoxide.
6. The metal to ligand bonding creates a synergic effect which strengthens the bond between CO and the metal.

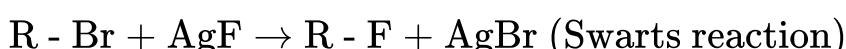
CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 10
Haloalkanes and Haloarenes

- **Nature of C-X bond in alkyl halides:** X is more electronegative than carbon. So, the C-X bond is polarized with C having a partial positive charge and X having a partial negative charge.
- **Preparation of haloalkanes:**

$Px_2/Hx, \text{anhyd. } ZnCl_2$
Re d p/ X_2 where $X_2 = Br_2, I_2$
 $PCl_5/SOCl_2$

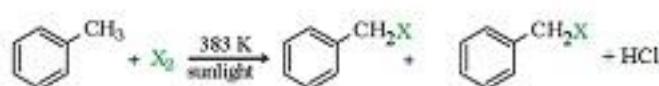
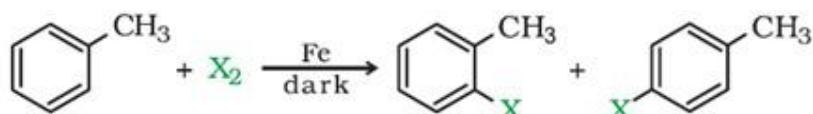


d) Halogen Exchange Method:

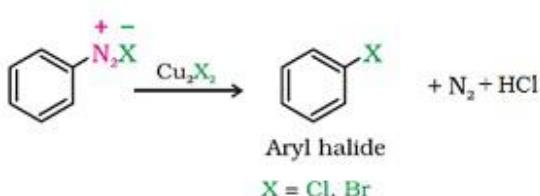
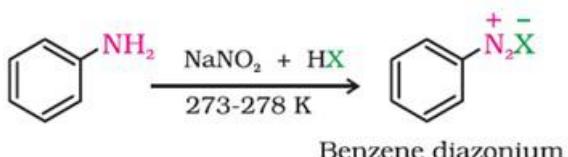


- **Preparation of haloarenes:**

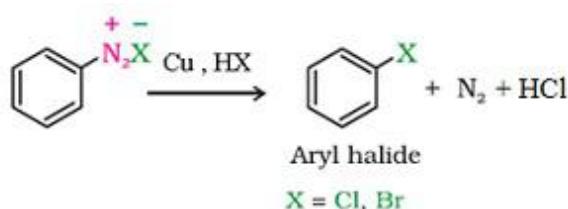
a) By electrophilic substitution reaction:



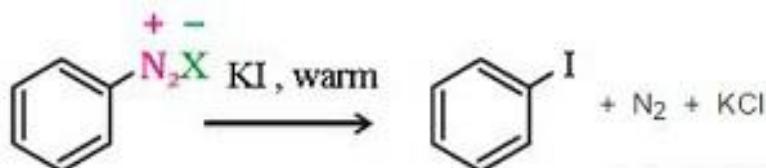
b) Sandmeyer's reaction:



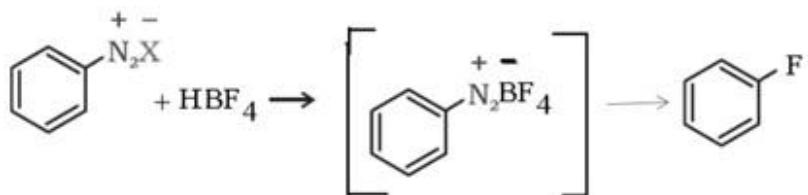
c) Gattermann reaction:



d) From Diazonium Chloride:



e). Balz – Schiemann reaction:



- **Physical properties of haloalkanes:**

a) Solubility

1. Although haloalkanes are polar in nature, yet they are practically very slightly soluble in water.
2. In order for a haloalkane to dissolve in water, energy is required to overcome the attractions between the haloalkane molecules and break the hydrogen bonds between water molecules.
3. However Haloalkanes are not able to form hydrogen bonds with water and therefore,

less energy is released when new attractions are set up between the haloalkane and the water molecules because these are not as strong as the original hydrogen bonds in water molecules.

4. As a result, solubility of haloalkanes in water is low.

b) Density

1. Simple fluoro and chloroalkanes are lighter than water while bromides and polychlorodevrivatives are heavier than water.
2. With the increase in number of carbon atoms, the densities go on increasing. With the increase in number of halogen atoms, the densities go on increasing. The densities increase in the order: Fluoride < chloride < bromide < iodide
3. The density also increases with increasing number and atomic mass of the halogen.

c) Boiling Points

1. Molecules of organic halogen compounds are generally polar.
2. Due to the polarity as well as higher molecular mass as compared to the parent hydrocarbon, the intermolecular forces of attraction (dipole – dipole and van der Waals) between the molecules are stronger in halogen derivatives of alkanes.
3. As a result melting and boiling points of chlorides, bromides and iodides are considerably higher than those of the parent hydrocarbon of comparable molecular mass.
4. For the same alkyl group the boiling points of alkyl chlorides, bromides and iodides follow the order $RI > RBr > RCl > RF$ where R is an alkyl group. This is because with the increase in the size of the halogen, the magnitude of van der Waals force increase.
5. In general, the boiling points of chloro, bromo and iodo compounds increase with increase in the number of halogen atoms.
6. For the same halogen atom, the boiling points of haloalkanes increase with increase in the size of alkyl groups.
7. For isomeric alkyl halides, the boiling points decrease with branching. This is because branching of the chain makes the molecule more compact and, therefore, decrease the surface area. Due to decrease in surface area, the magnitude of van der Waals forces of attraction decreases and consequently, the boiling points of the branched chain compound is less than those of the straight chain compounds.

- **Physical Properties of Haloarenes:**

- a. These are generally colourless liquids or crystalline solids.
- b. These are heavier than water.
- c. Melting and boiling points of haloarenes
 - i. Melting and boiling points of haloarenes are nearly the same as those of alkyl halides containing the same number of carbon atoms.
 - ii. The boiling points of monohalogen derivatives of benzene are in the order:
iodo>bromo>chloro>fluoro
 - iii. For the same halogen atom, the melting and boiling points increase as the size of the aryl group increases.
 - iv. The melting point of para isomer is quite higher than that of ortho or meta isomers. This is due to the fact that it has symmetrical structure and therefore, its molecules can easily pack loosely in the crystal lattice. As a result intermolecular forces of attraction are stronger and therefore, greater energy is required to break its lattice and it melts at higher temperature.

- **Chemical properties of haloalkanes:**

Nucleophilic substitution reaction:



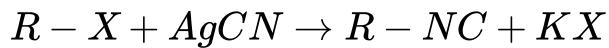
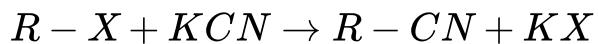
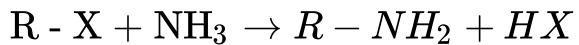
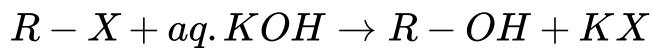
Mechanism of Nucleophilic Substitution Reaction:

SN1 Mechanism

1. First order reaction.
2. Rate = $k [\text{RX}] [\text{Nu}]$
3. Racemic mixture
4. One step reaction
5. Order: $\text{CH}_3\text{X} < 10 < 20 < 30$

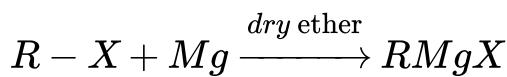
SN2 Mechanism

1. Second order reaction
2. Rate = k [RX]
3. Inversion of configuration
4. Two step reaction
5. Order: CH₃X > 10 > 20 > 30

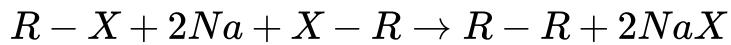


- Elimination reaction: Dehydrohalogenation (β -elimination): When a haloalkane with β -hydrogen atom is heated with alcoholic solution of potassium hydroxide, there is elimination of hydrogen atom from β -carbon and a halogen atom from the α -carbon atom. As a result, an alkene is formed as a product. Zaitsev rule (also pronounced as Saytzeff) is followed. It states that “In dehydrohalogenation reactions, the preferred product is that alkene which has the greater number of alkyl groups attached to the doubly bonded carbon atoms.”
- Reaction with metals:

a) Reaction with Magnesium

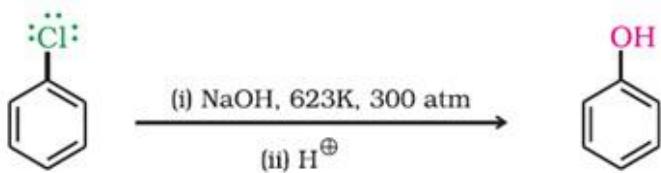


b) Wurtz reaction

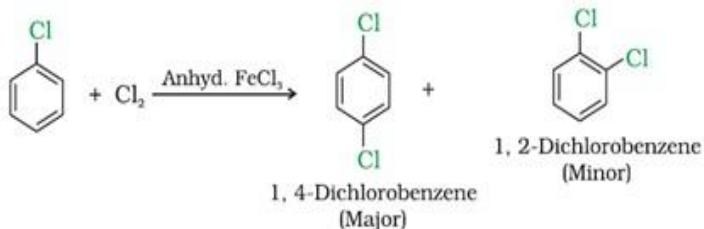


- **Chemical properties of haloarenes:**

a) Dow's Process



b) With halogens



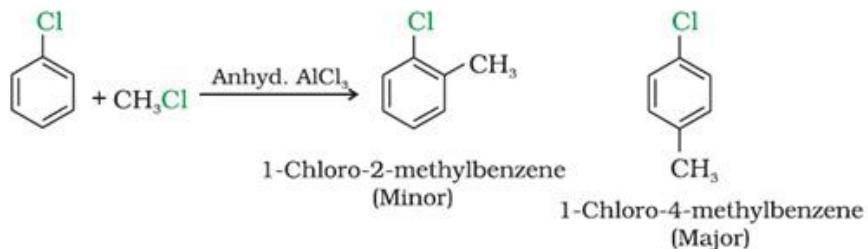
c) With conc. nitric and sulphuric acid



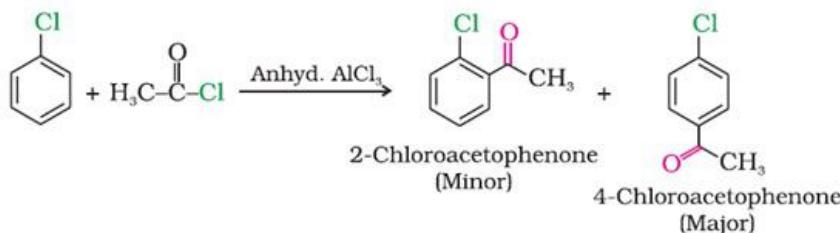
d) On heating with conc. sulphuric acid



e) With methyl chloride



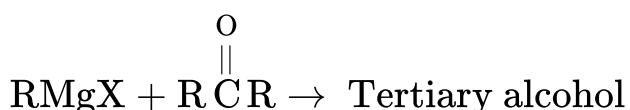
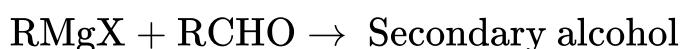
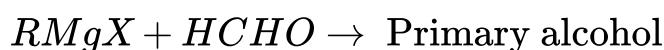
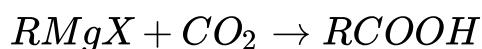
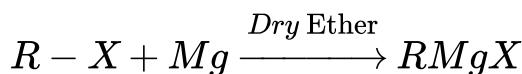
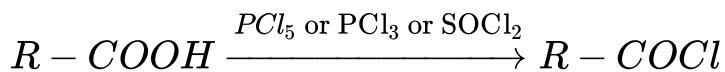
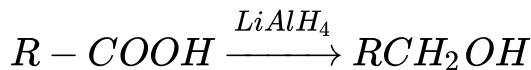
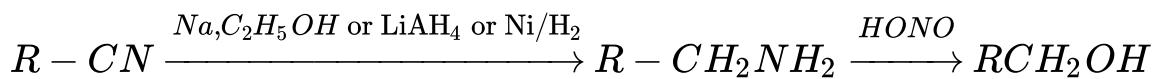
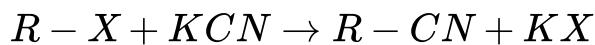
f) With acetyl chloride



g) Fittig reaction: $\text{Ar} - X + 2\text{Na} + X - \text{Ar} \rightarrow \text{Ar} - \text{Ar} + 2\text{NaX}$

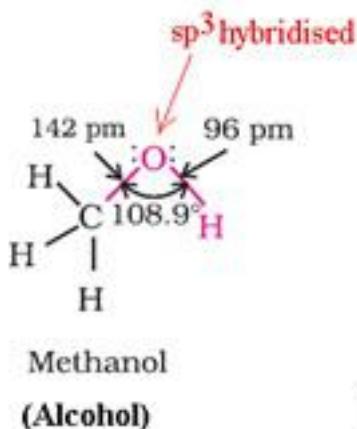
h) Wurtz – fittig reaction: $\text{R} - X + 2\text{Na} + X - \text{Ar} \rightarrow \text{R} - \text{Ar} + 2\text{NaX}$

i) Other conversions:



CBSE Class 12 Chemistry
Quick Revision Notes
Chapter 11
Alcohols, Phenols and Ethers

- **Structure of alcohols:**



- **Preparation of alcohols:**

a) From alkene

Acid catalysed hydration

$(\text{H}_2\text{O}, \text{H}^+)$

Mark, Addition

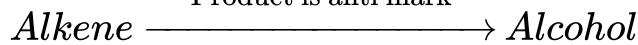
Or

Hydroboration - oxidation

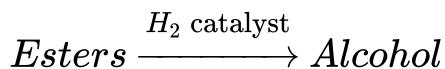
$\text{B}_2\text{H}_6, \text{H}_2\text{O}_2/\text{OH}^-$

Mark, addition

Product is anti mark



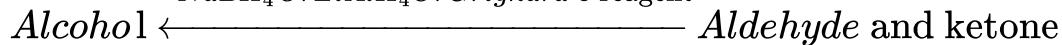
b) From esters



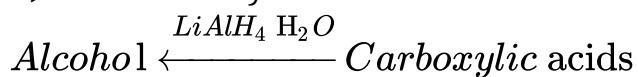
c) From aldehydes and ketones

$\text{H}_2/\text{Pd or}$

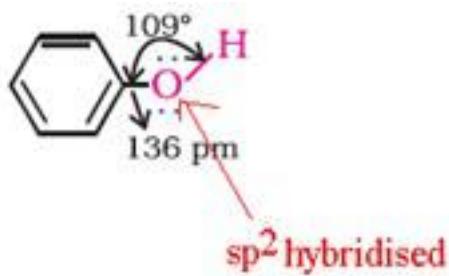
NaBH_4 Or LiAlH_4 Or Grignard's reagent



d) From carboxylic acids



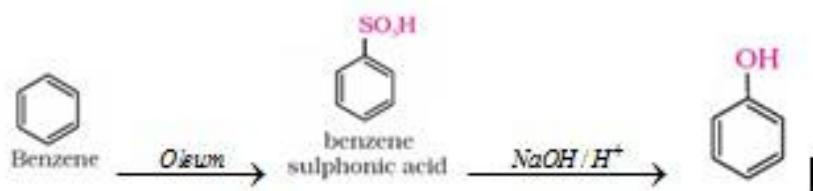
- **Structure of phenols:**



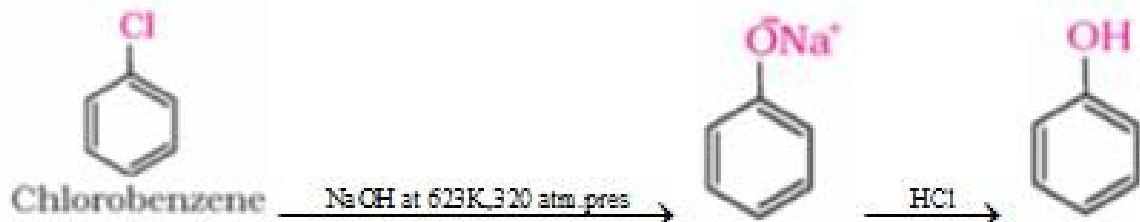
Phenol
(Phenol)

- Preparation of phenols:

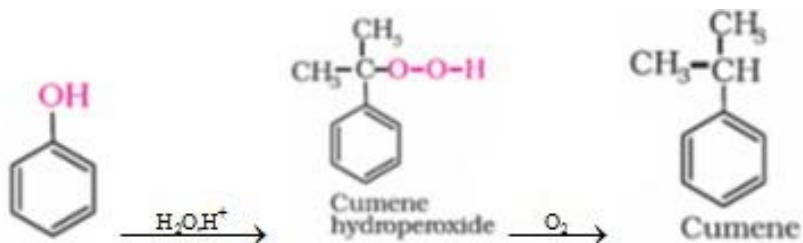
a) From benzene



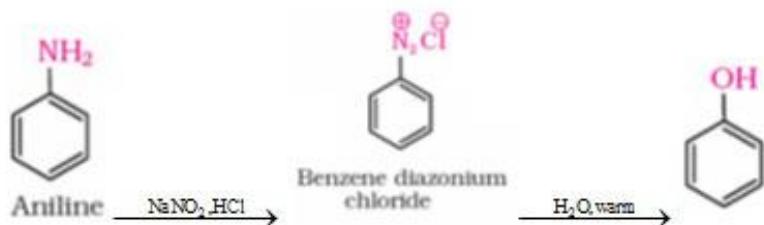
b) From chlorobenzene



c) From cumene

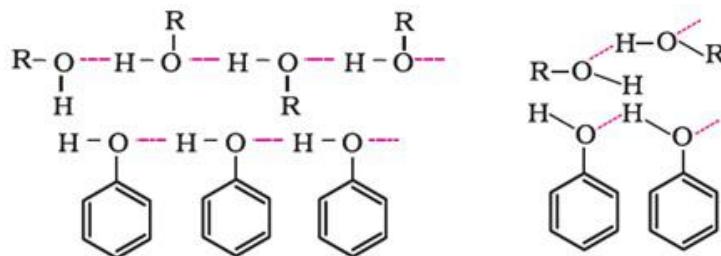


d) From aniline



- **Physical properties of alcohols and phenols:**

a) Boiling points: Boiling points of alcohols and phenols are higher in comparison to other classes of compounds. This is because the –OH group in alcohols and phenols is involved in intermolecular hydrogen bonding.



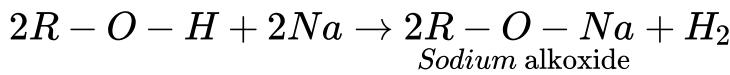
The boiling points of alcohols and phenols increase with increase in the number of carbon atoms. This is because of increase in van der Waals forces with increase in surface area. In alcohols, the boiling points decrease with increase of branching in carbon chain. This is because of decrease in van der Waals forces with decrease in surface area.

b) Solubility: Solubility of alcohols and phenols are soluble in water due to their ability to form hydrogen bonds with water molecules. The solubility of alcohols decreases with increase in size of alkyl/aryl (hydrophobic) groups.

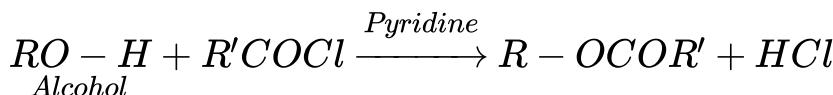
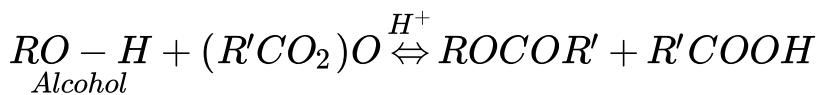
- **Chemical properties of alcohols:**

I. Reactions involving cleavage of O–H bond: Alcohols react as nucleophiles:

a) Reaction with metals

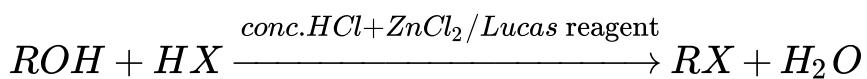


b) Esterification reaction

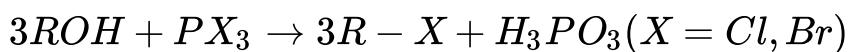


II. Reactions of alcohols involving cleavage of carbon – oxygen (C–O) bond:

a) Reaction with hydrogen halides



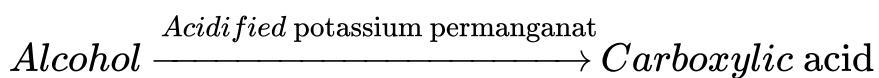
b) Reaction with phosphorus trihalides



c) Dehydration reaction



d). Oxidation reaction



CU,573k

Or

CrO_3

Or

PCC

i) Primary Alcohol \longrightarrow Aldehyde

CU,573k

Or

CrO_3

ii) Secondary Alcohol \longrightarrow Ketone

CU,573k

Or

$KMnO_4$

iii) Tertiary Alcohol \longrightarrow Alkene

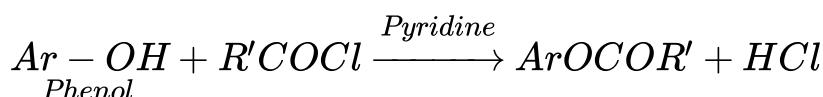
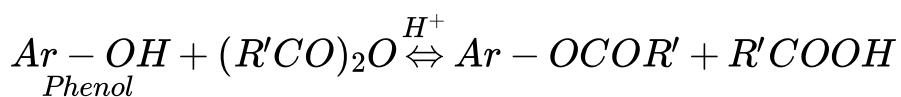
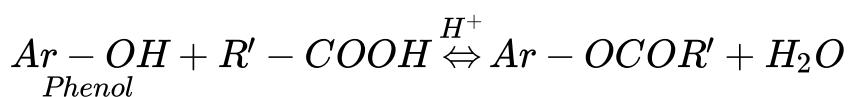
- Chemical properties of phenols:

I. Reactions involving cleavage of O–H bond: Alcohols react as nucleophiles:

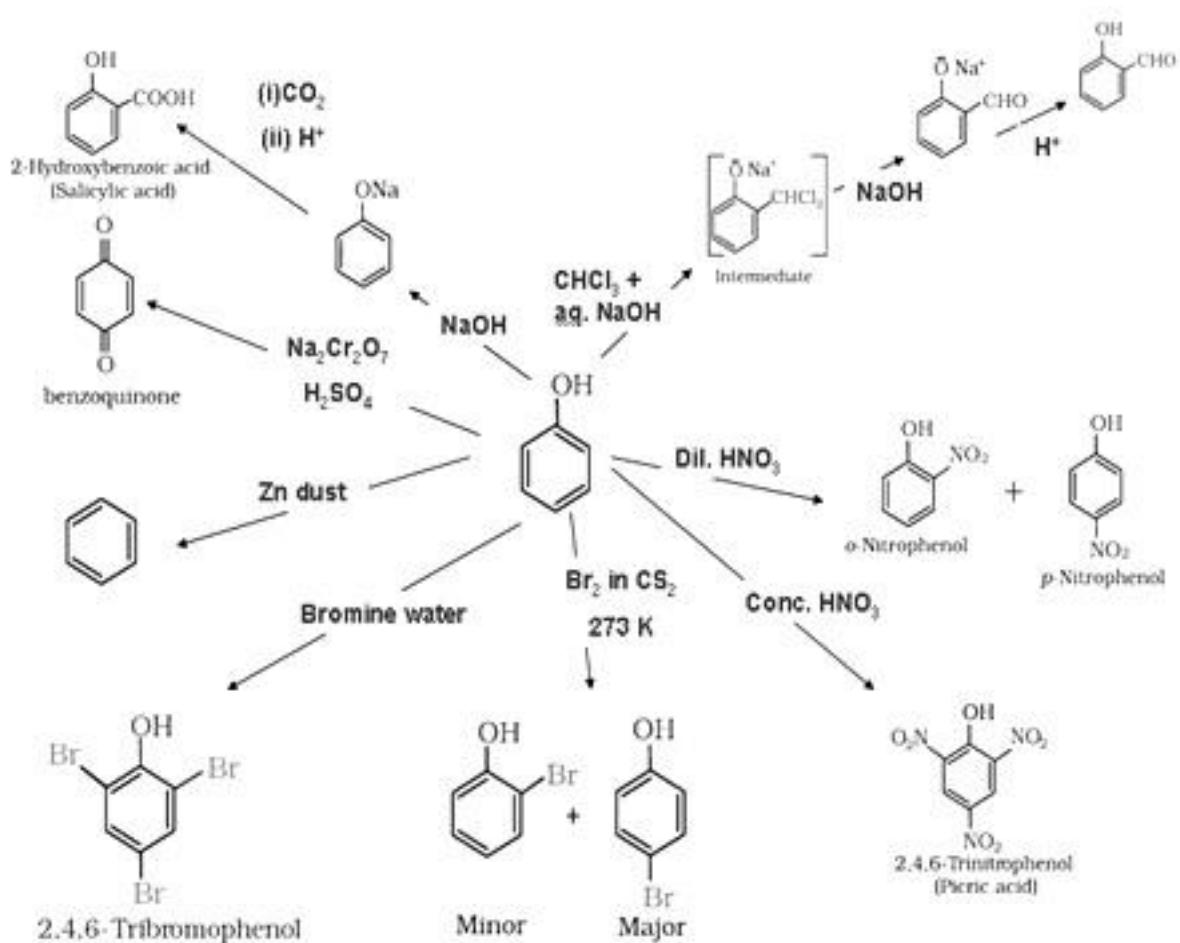
a) Reaction with metals



b) Esterification reaction



II. Other chemical reactions of phenols:

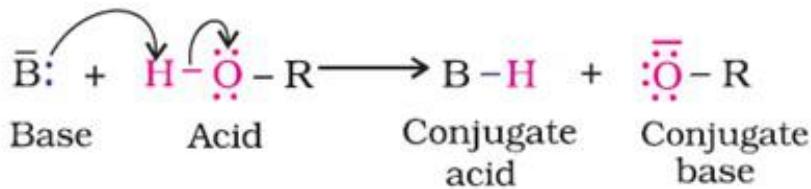


III. Acidic nature of phenol and alcohol:

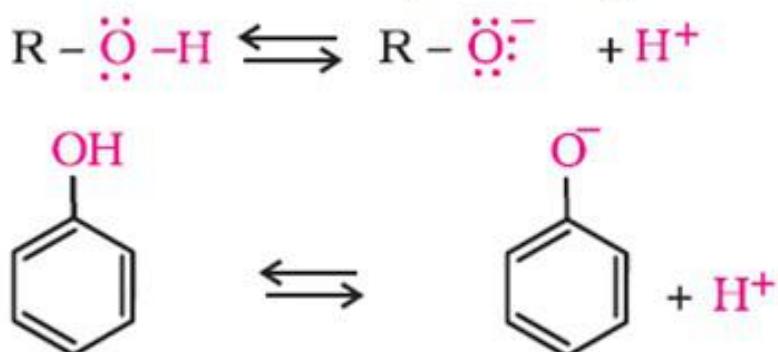
a). Phenol > H_2O > Primary alcohol > Secondary alcohol > Tertiary alcohol.

The acidic character of alcohols is due to the polar nature of O–H bond. Alkyl group is an electron-releasing group ($-\text{CH}_3$, $-\text{C}_2\text{H}_5$) or it has electron releasing inductive effect (+I effect). Due to +I effect of alkyl groups, the electron density on oxygen increases. This decreases the

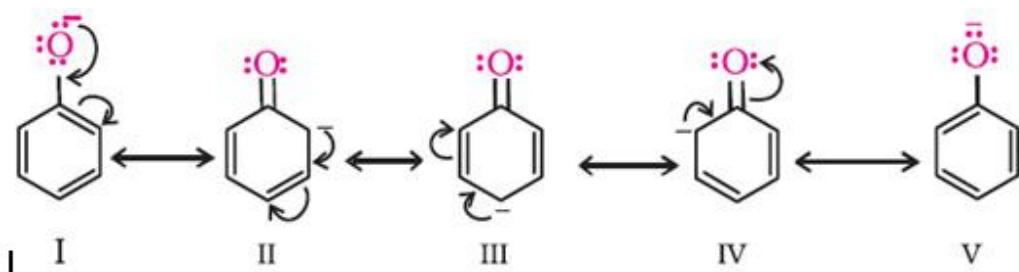
polarity of O-H bond. And hence the acid strength decreases.



b) Phenol is more acidic than alcohol: In phenol, the hydroxyl group is directly attached to the sp^2 hybridised carbon of benzene ring which acts as an electron withdrawing group whereas in alcohols, the hydroxyl group is attached to the alkyl group which have electron releasing inductive effect. In phenol, the hydroxyl group is directly attached to the sp^2 hybridised carbon of benzene ring whereas in alcohols, the hydroxyl group is attached to the sp^3 hybridised carbon of the alkyl group. The sp^2 hybridised carbon has higher electronegativity than sp^3 hybridised carbon. Thus, the polarity of O-H bond of phenols is higher than those of alcohols. Hence, the ionisation of phenols is higher than that of alcohols. The ionisation of an alcohol and a phenol takes place as follows:

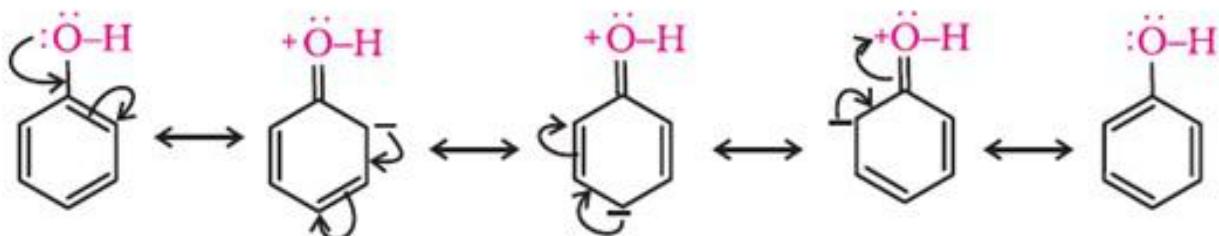


In alkoxide ion, the negative charge is localised on oxygen while in phenoxide ion, the charge is delocalised.



The delocalisation of negative charge makes phenoxide ion more stable and favours the ionisation of phenol. Although there is also charge delocalisation in phenol, its resonance structures have charge separation due to which the phenol molecule is less stable than

phenoxide ion.

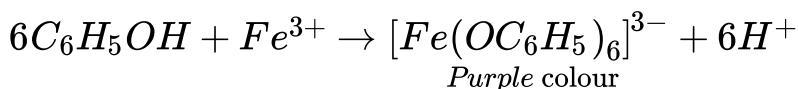


c) In substituted phenols, the presence of electron withdrawing groups such as nitro group enhances the acidic strength of phenol. On the other hand, electron releasing groups, such as alkyl groups, in general, decreases the acid strength. It is because electron withdrawing groups lead to effective delocalisation of negative charge in phenoxide ion.

- **Differentiate between organic compounds:**

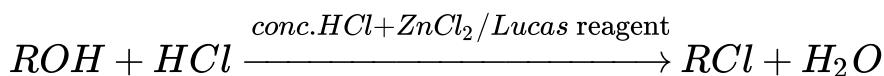
a) Alcohols and phenols

Phenol on reaction with neutral FeCl_3 gives purple colour whereas alcohols do not give purple colour.



b) Primary, secondary and tertiary alcohols

Lucas reagent test:



If it is a primary alcohol, no turbidity appears at room temperature. Turbidity appears only on heating. If it is a secondary alcohol, turbidity appears in 5 minutes. If it is a tertiary alcohol, turbidity appears immediately.

c) Methanol and ethanol

Iodoform test: Ethanol when reacted with (I_2 and NaOH) or NaOI gives yellow ppt of iodoform since it has the presence of $\text{CH}_3\text{-CH(OH)}$ - group.



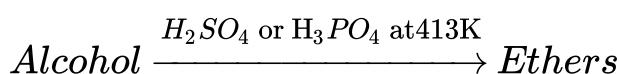
- **Structure of ethers:**



Methoxymethane
(Ether)

- **Preparation of ethers:**

a) From alcohols



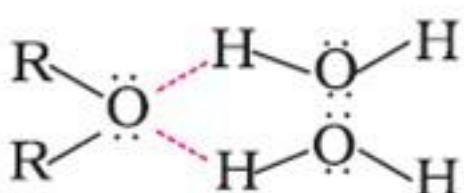
b) From alkyl halide and sodium alkoxide



Here, the alkyl halide should be primary and alkoxide should be tertiary. In case of aromatic ether, the aromatic part should be with phenoxide ion.

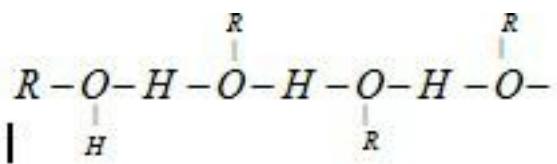
- **Physical properties of ethers:**

a) Miscibility: Miscibility of ethers with water resembles those of alcohols of the same molecular mass. This is due to the fact that just like alcohols, oxygen of ether can also form hydrogen bonds with water molecule.



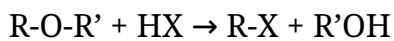
b) Boiling points:

Ethers have much lower boiling points than alcohols. This is due to the presence of hydrogen bonding in alcohols. Hydrogen bonding is absent in ethers.



- **Chemical properties of ethers:**

a) Cleavage of C–O bond in ethers:

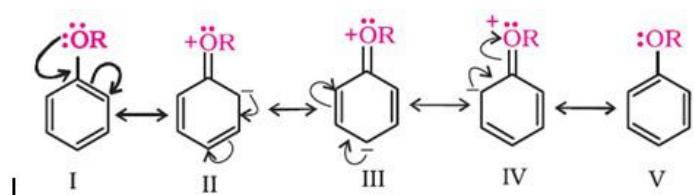


Excess

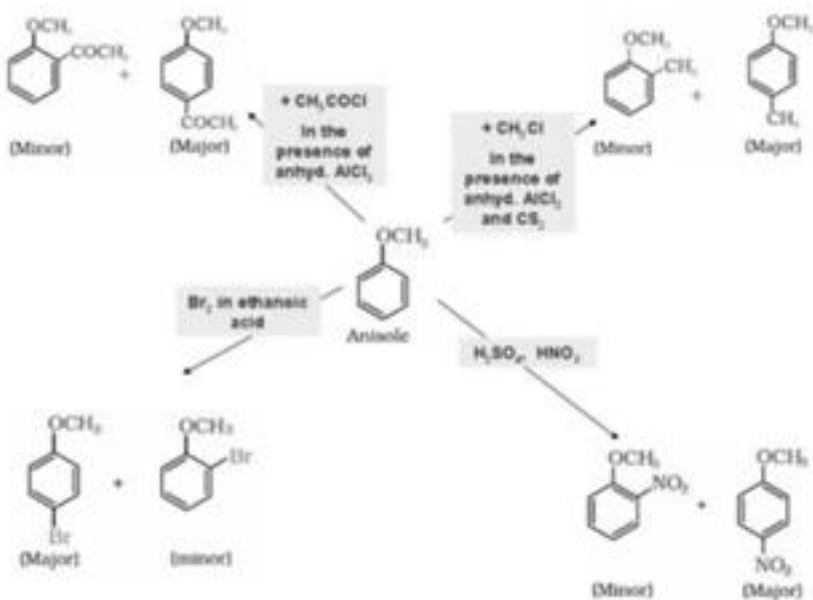
The order of reactivity of hydrogen halides is as follows: HI > HBr > HCl

Alkyl halide formed is always the lower alkyl group. But if a tertiary alkyl group is present, the alkyl halide is always tertiary. In case of phenolic ethers, the cleavage occurs with the formation of phenol and alkyl halide.

b) Electrophilic substitution reaction in aromatic ethers:

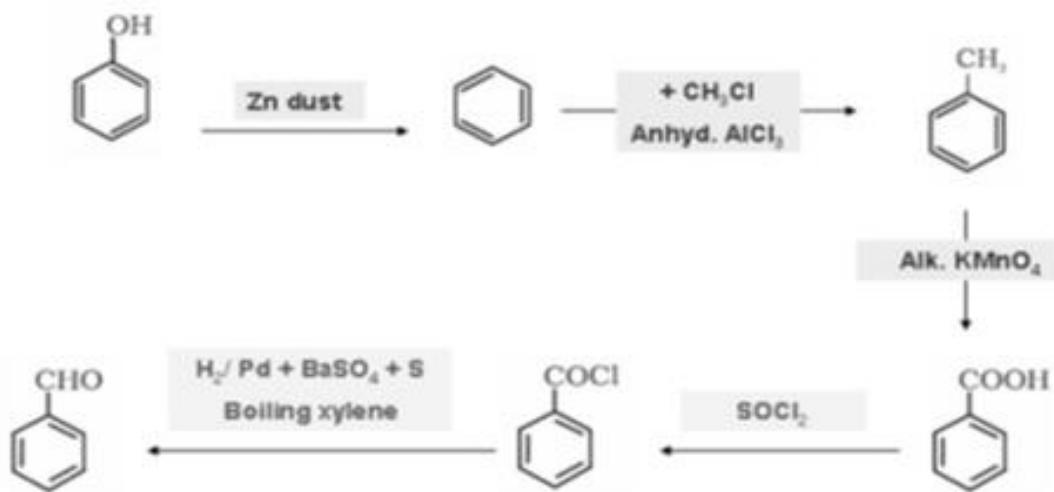


The electrophilic substitution reaction of aromatic ether involves the following reaction:

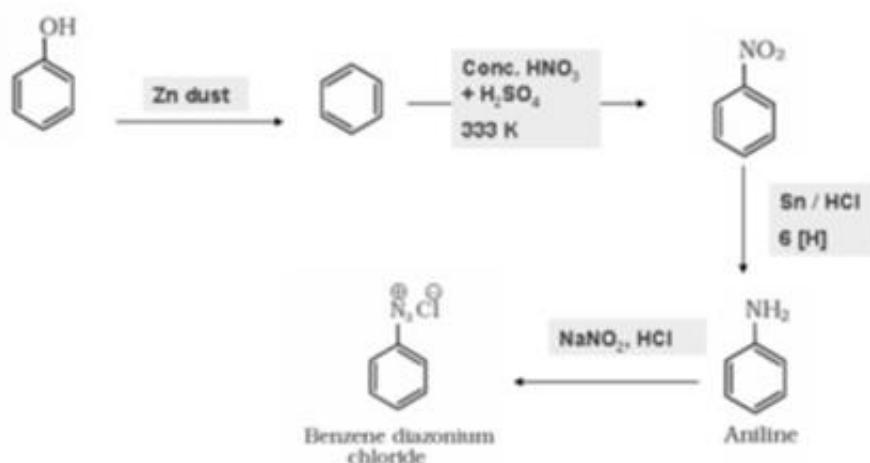


- Other conversion reactions:

a) Phenol to salicyldehyde

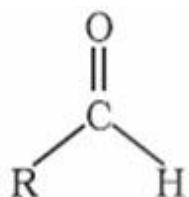


b) Phenol to benzene diazonium chloride



CSBE Class 12 Chemistry
Revision Notes
Chapter 12
Aldehydes, Ketones and Carboxylic acid

Aldehydes: Aldehydes are the organic compounds in which carbonyl group is attached to one hydrogen atom and one alkyl or aryl group.



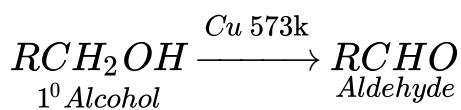
Where R can be an alkyl or aryl group

Preparation of aldehydes:

a) By oxidation of alcohols: Oxidation of primary alcohols in presence of oxidizing agent like $K_2Cr_2O_7/H_2SO_4$, $KMnO_4$, CrO_3 gives aldehydes.



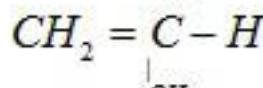
b) By dehydrogenation of alcohols: When the vapours of primary alcohol passed through heated copper at 573 K, it forms aldehyde.



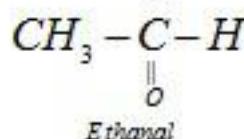
c) By hydration of alkynes: Ethyne on hydration with $HgSO_4/dil. H_2SO_4$ at 333 K forms acetaldehyde.



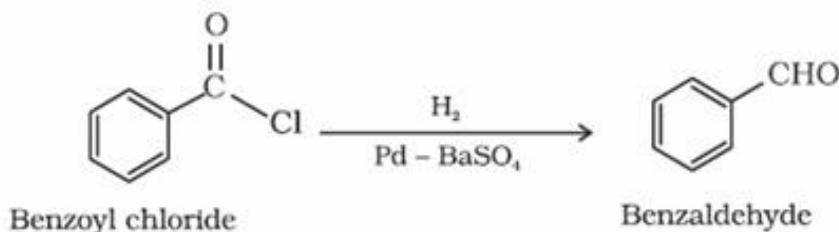
$Hg^{2+}/H^+/333k$



Isomerization

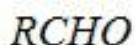
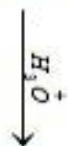
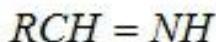
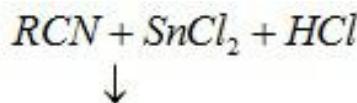


d) By Rosenmund reduction: Hydrogenation of acyl chloride over palladium on barium sulphate gives aldehyde.

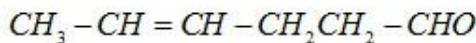
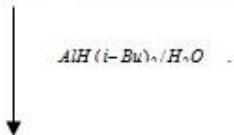
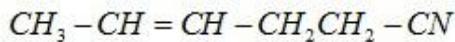
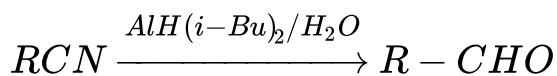


e) By reduction of nitriles:

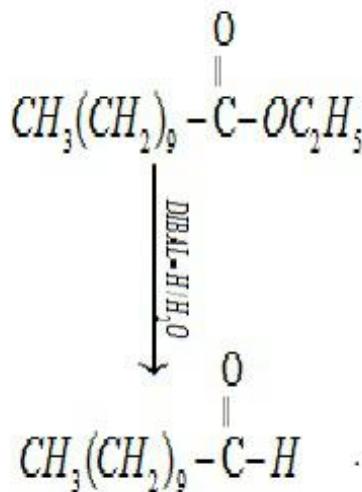
i) Stephen Reaction: Reduction of nitriles in presence of stannous chloride in presence of HCl gives imine which on hydrolysis gives corresponding aldehyde.



ii) Nitriles are selectively reduced by DIBAL-H (Diisobutylaluminium hydride) to aldehydes.

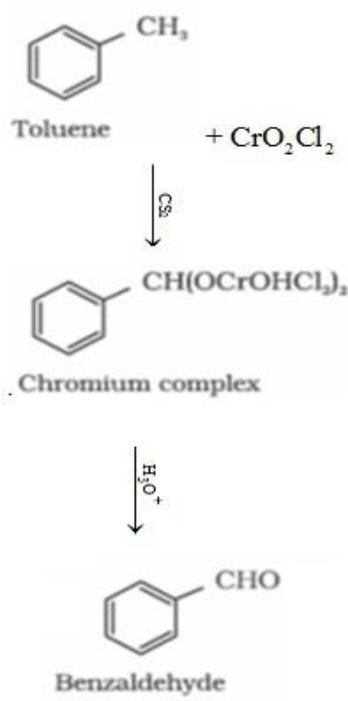


f) By reduction of ester: Esters are reduced to aldehydes in presence of DIBAL-H (Diisobutylaluminium hydride)

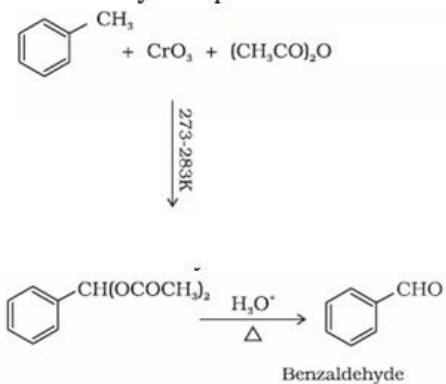


g) From Hydrocarbons:

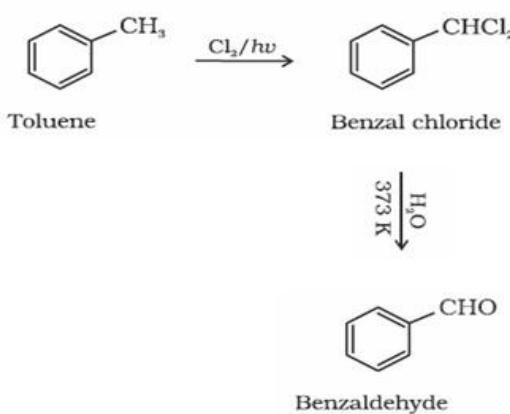
(i) By oxidation of methyl benzene: Etard Reaction: Chromyl chloride (CrO_2Cl_2) oxidizes methyl group to a chromium complex, which on hydrolysis gives corresponding benzaldehyde.



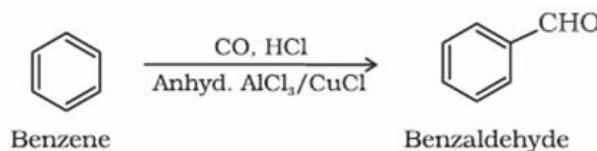
Using chromium oxide (CrO_3): Toluene or substituted toluene is converted to benzaldehyde in presence of chromic oxide in acetic anhydride.



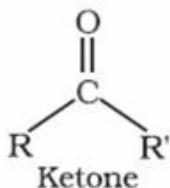
(ii) By side chain chlorination followed by hydrolysis: Halogenation of toluene: Side chain halogenation of toluene gives benzal chloride which on hydrolysis gives Benzaldehyde.



(iii) Gatterman –Koch reaction: Benzene or its derivatives on treatment with carbon monoxide and HCl in presence of anhydrous aluminium chloride or cuprous chloride (CuCl) gives benzaldehyde or substituted benzaldehydes.



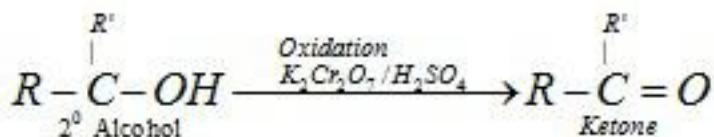
- **Ketones:** Ketones are the organic compounds in which carbonyl group is attached to two alkyl group or aryl group or both alkyl and aryl group.



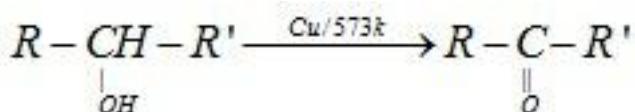
Where R, R' may be alkyl or aryl.

- **Preparation of ketones:**

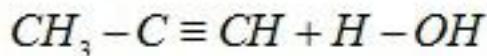
a) By oxidation of alcohols: Oxidation of secondary alcohols in presence of oxidizing agent like $K_2Cr_2O_7/H_2SO_4$, $KMnO_4$, CrO_3 gives ketones.



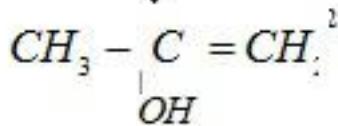
b) By dehydrogenation of alcohols: When the vapours of a secondary alcohol are passed over heated copper at 573 K, dehydrogenation takes place and a ketone is formed.



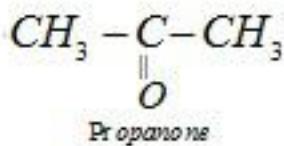
c) By hydration of alkynes: Alkynes on hydration with $HgSO_4/dil. H_2SO_4$ at 333 K form ketones.



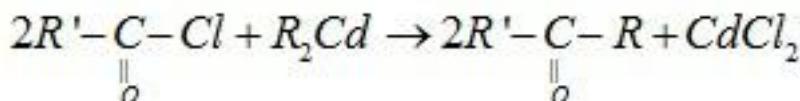
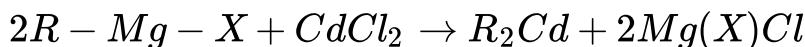
$Hg^{2+} / H^+ 3:1 t$



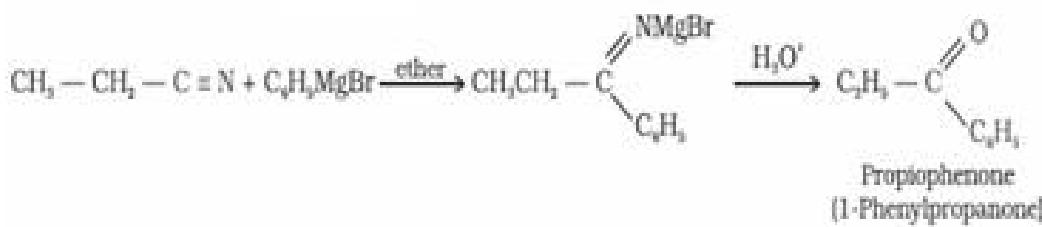
Lovenerization



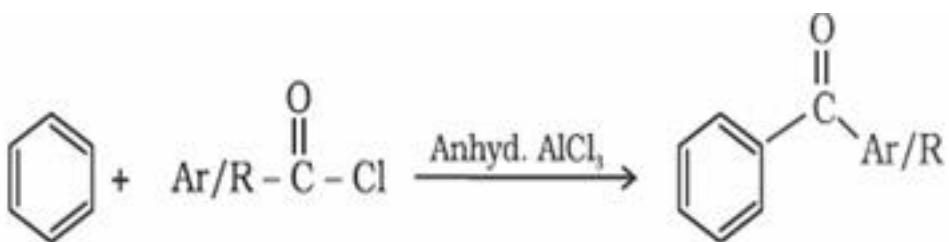
- d) From acyl chloride: Acyl chloride on treatment with dialkyl cadmium (prepared by reaction of cadmium chloride with Grignard reagent) gives ketone.



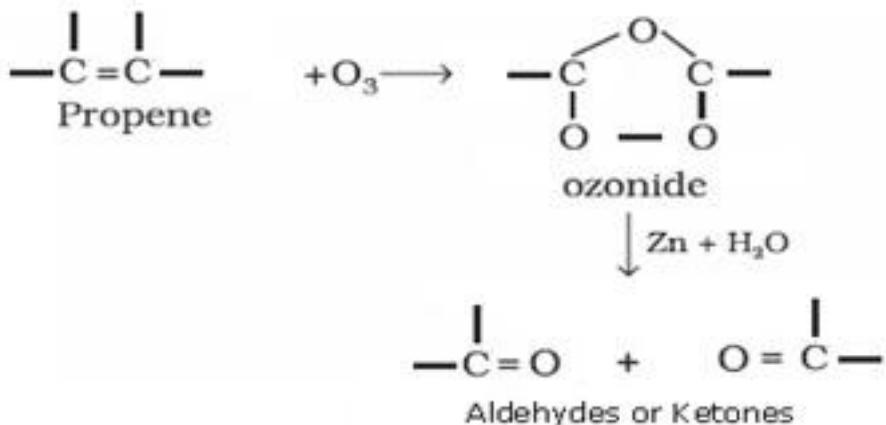
- e) From nitriles: Nitriles on treatment with Grignard reagent followed by hydrolysis give ketones.



- f) By Friedel Crafts acylation reaction: Benzene or substituted benzene on treatment with acid chloride in presence of anhydrous aluminium chloride forms ketone.



g) Preparation of aldehydes and ketones by ozonolysis of alkenes:

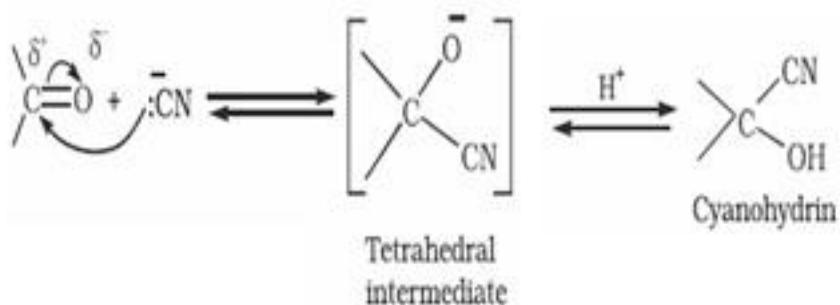


- **Reactions of aldehydes and ketones:**

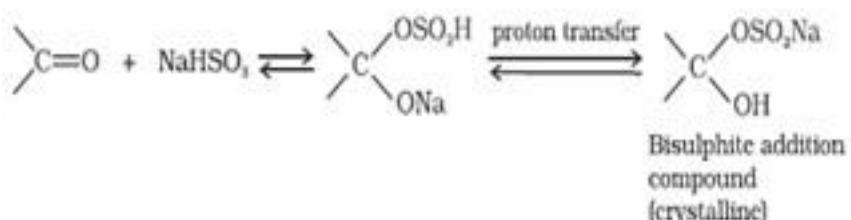
1. Aldehydes are generally more reactive than ketones in nucleophilic addition reactions due to steric and electronic reasons (or inductive effect).
2. Electronic Effect: Relative reactivities of aldehydes and ketones in nucleophilic addition reactions is due the positive charge on carbonyl carbon. Greater positive charge means greater reactivity. Electron releasing power of two alkyl groups in ketones is more than one in aldehyde. Therefore positive charge is reduced in ketones as compared to aldehydes. Thus ketones are less reactive than aldehydes.
3. Stearic Effect: As the number and size of alkyl group increase, the hindrance to the attack of nucleophile also increases and reactivity decreases. In aldehydes there is one alkyl group and one hydrogen atom, whereas in ketones there are two alkyl groups (same or different).

- **Nucleophilic addition reactions of aldehydes and ketones:**

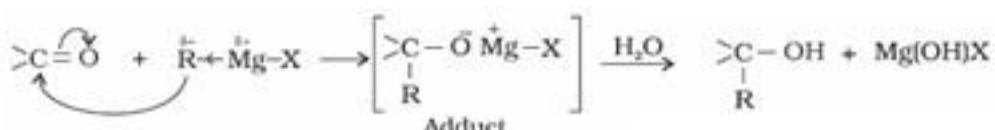
(a) Addition of hydrogen cyanide (HCN) to form cyanohydrins



(b) Addition of sodium hydrogensulphite ($NaHSO_3$) to form bisulphate addition compound

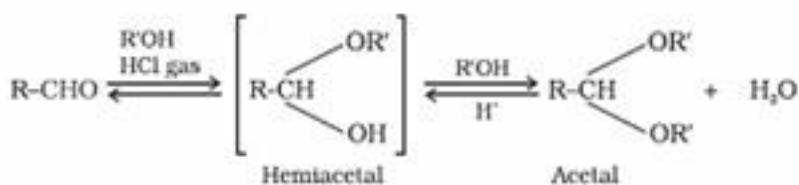


(c) Addition of Grignard reagent ($RMgX$) to form alcohol

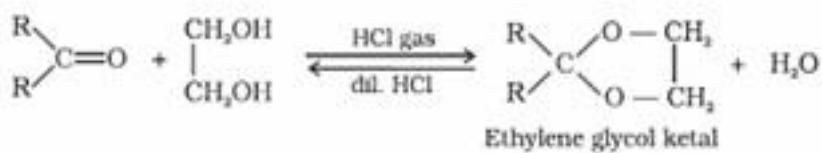


(d) Addition of alcohol:

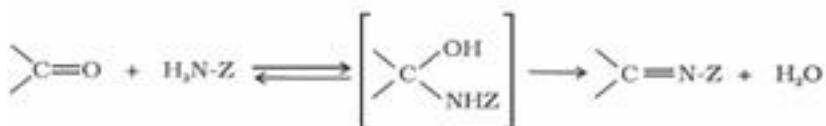
(i) Aldehydes on addition of monohydric alcohol in presence of dry HCl forms hemiacetal and acetal.



(ii) Ketones do not react with monohydric alcohols. Ketones react with ethylene glycol under similar conditions to form cyclic products known as ethylene glycol ketals.



(e) Addition of ammonia and its derivatives:

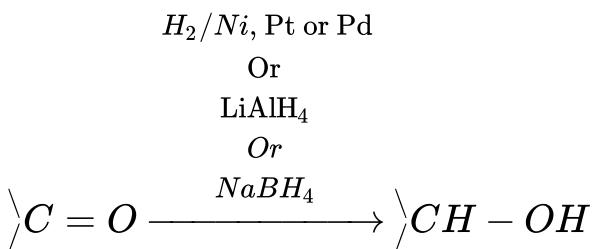


Z = Alkyl, aryl, OH, NH₂, C₆H₅NH, NHCONH₂, etc.

- **Reduction of aldehydes and ketones:**

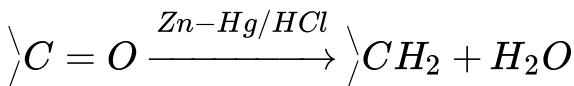
(a) Reduction to alcohols:

Aldehydes and ketones on catalytic hydrogenation in presence of Ni, Pt or Pd by using lithium aluminium hydride (*LiAlH*₄) or sodium borohydride (*NaBH*₄) forms primary and secondary alcohols respectively.



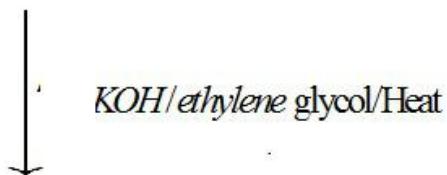
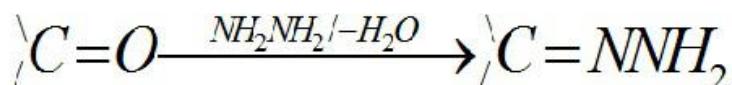
(b) Reduction to hydrocarbons:

(i) Clemmensen reduction: Carbonyl group of aldehydes and ketones is reduced to *CH*₂ group on treatment with zinc amalgam and concentrated hydrochloric acid.



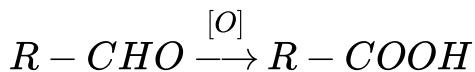
(ii) Wolff-Kishner reduction: Carbonyl group of aldehydes and ketones is reduced to *CH*₂ group on treatment with hydrazine followed by heating with sodium or potassium hydroxide in high boiling solvent such as ethylene glycol.

(iii)

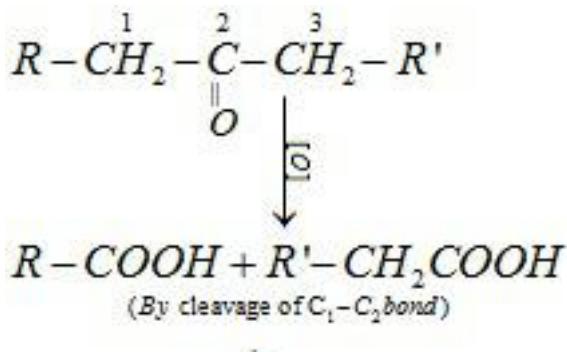


- **Oxidation of aldehydes and ketones:**

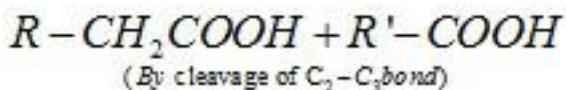
(i) Aldehydes are oxidized to acids in presence of mild oxidising agents HNO_3 , $\text{K}_2\text{Cr}_2\text{O}_7$, KMnO_4 .



(ii) Ketones are oxidized under drastic conditions i.e. with powerful oxidising agents like HNO_3 , $\text{K}_2\text{Cr}_2\text{O}_7 / \text{H}_2\text{SO}_4$, $\text{KMnO}_4 / \text{H}_2\text{SO}_4$ at higher temperature.

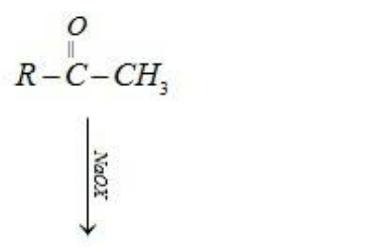


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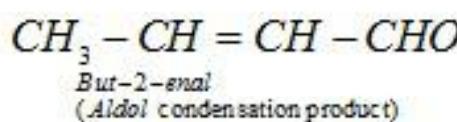
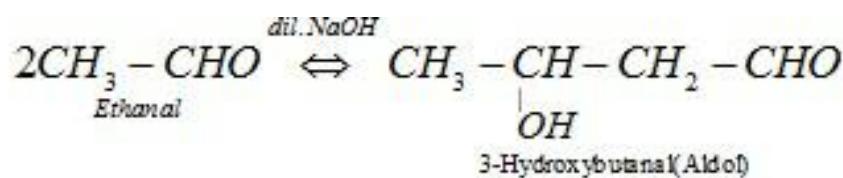
In case of unsymmetrical ketones cleavage occurs in such a way that keto group stays with smaller alkyl group. This is known as Popoff's rule.

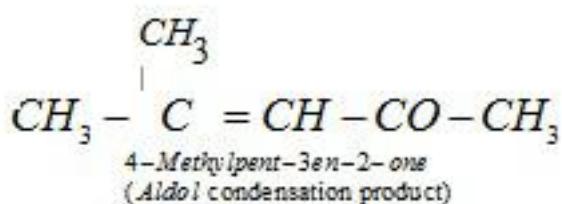
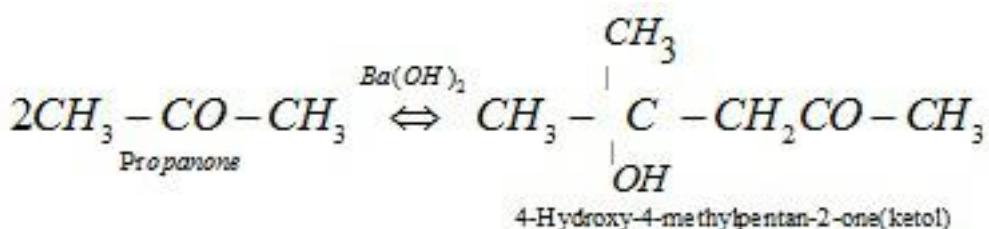
(iii) Haloform reaction: Aldehydes and ketones having at least one methyl group linked to the carbonyl carbon atom i.e. methyl ketones are oxidised by sodium hypohalite to sodium salts of corresponding carboxylic acids having one carbon atom less than that of carbonyl compound. The methyl group is converted to haloform.



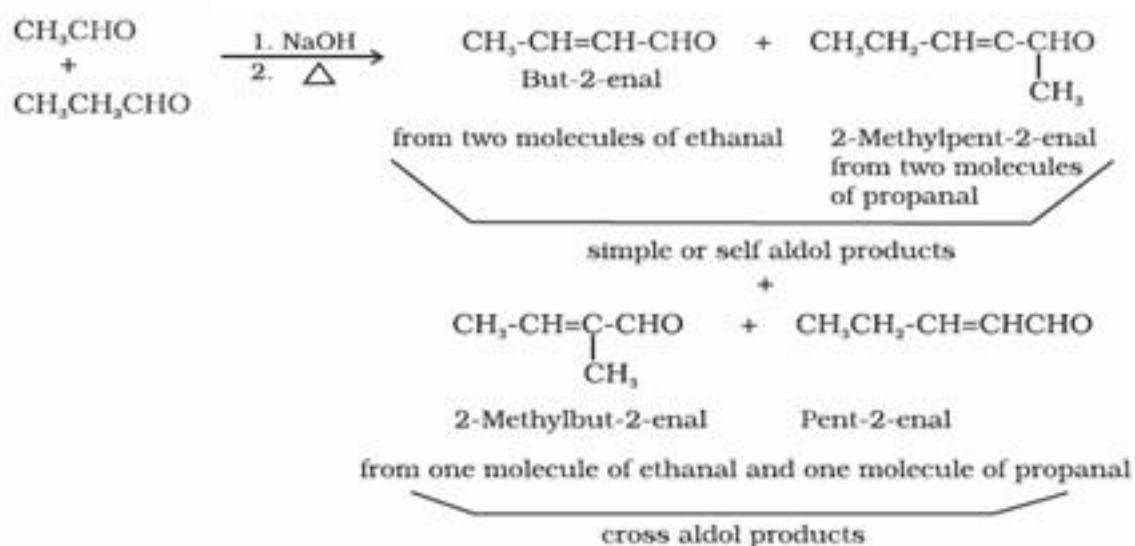
- **Reactions of aldehydes and ketones due to α -hydrogen:**

(i) Aldol condensation: Aldehydes and ketones having at least one α -hydrogen undergo a self condensation in the presence of dilute alkali as catalyst to form α -hydroxy aldehydes (aldol) or α -hydroxy ketones (ketol), respectively.

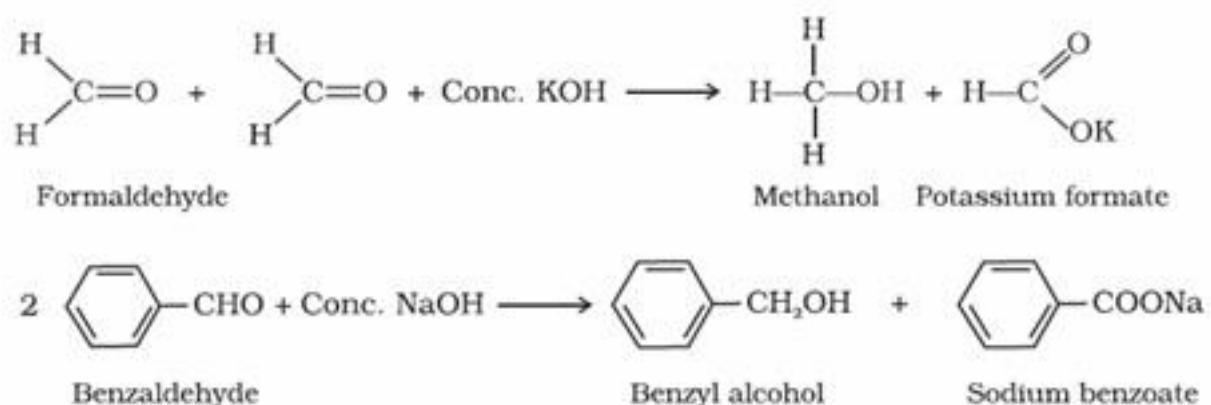




(ii) Cross aldol condensation: Aldol condensation between two different aldehydes and ketones is called aldol condensation. If both of them contain α -hydrogen atoms, it gives a mixture of four products.



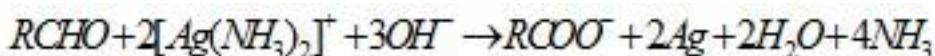
- **Canizzaro reaction:** Aldehydes which do not have an α -hydrogen atom undergo self-oxidation and reduction (disproportionation) reaction on treatment with concentrated alkali to form alcohol and salt of acid.



- **Test to distinguish aldehydes and ketones:**

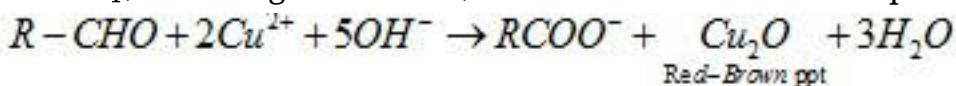
1. Tollen's test: When an aldehyde is heated with Tollen's reagent it forms silver mirror.

Tollen's reagent is ammoniacal solution of AgNO_3



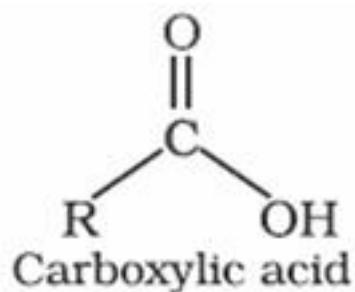
Ketones do not form silver mirror and hence do not give this test.

2. Fehling's test: When an aldehyde is heated with Fehling's reagent it forms reddish brown precipitates of cuprous oxide. Fehling's reagent: Fehling solution A (aqueous solution of CuSO_4) + Fehling solution B (alkaline solution of sodium potassium tartarate)



Ketones do not give this test.

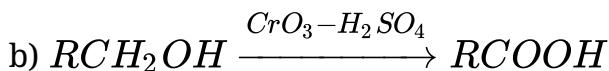
- **Carboxylic Acids:** Carboxylic acids are the compounds containing the carboxyl functional group (-COOH).



- **Preparation of carboxylic acid:**

(i) From alcohols: Primary alcohols are readily oxidised to carboxylic acids with common oxidising agents such as potassium permanganate (KMnO_4) in neutral, acidic or alkaline media or by potassium dichromate ($\text{K}_2\text{Cr}_2\text{O}_7$) and chromium trioxide (CrO_3) in acidic

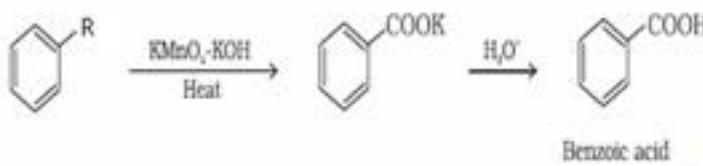
media.



(ii) From aldehydes: Oxidation of aldehydes in presence of mild oxidizing agents like Tollen's reagent (ammoniacal solution of $AgNO_3$) or Fehling reagent (Fehling solution A (aqueous solution of $CuSO_4$) + Fehling solution B (aqueous solution of sodium potassium tartarate)) forms carboxylic acids.

1. $RCHOH + 2[Ag(NH_3)_2]^+ + 3OH^- \rightarrow RCOO^- + 2Ag + 2H_2O + 4N$
2. $R-CHO + 2Cu^{2+} + 5OH^- \rightarrow RCOO^- + Cu_2O + 3H_2O$

(iii) From alkylbenzenes: Aromatic carboxylic acids can be prepared by vigorous oxidation of alkyl benzenes with chromic acid or acidic or alkaline potassium permanganate.

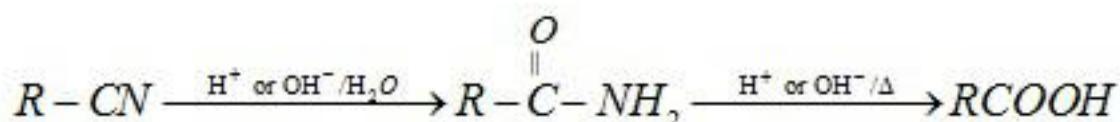


R is an alkyl group (primary or secondary)

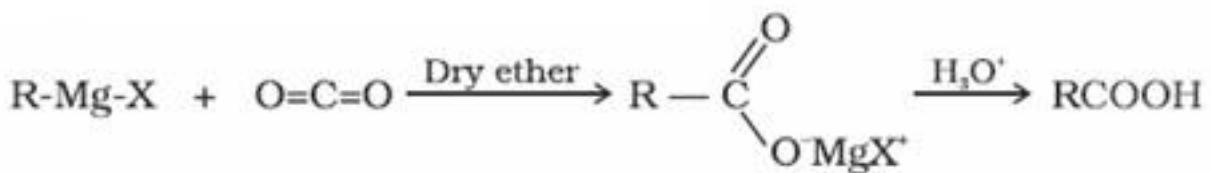
(iv) From alkenes: Suitably substituted alkenes are oxidised to carboxylic acids on oxidation with acidic potassium permanganate or acidic potassium dichromate.

1. $R-CH=CH-R \xrightarrow{kMnO_4/H^+} 2R-COOH$
2. $R-CH=CH-R_1 \xrightarrow{kMnO_4/H^+} R-COOH + R_1-COOH$

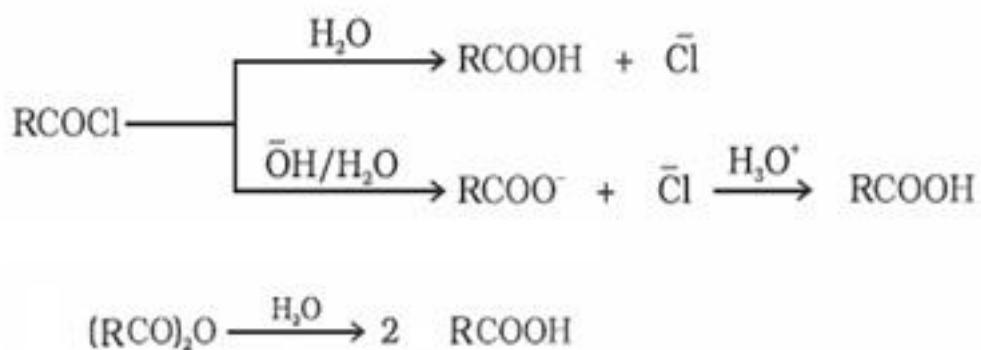
(v) From Nitriles: Nitriles on hydrolysis in presence of dilute acids or bases forms amide which on further hydrolysis gives carboxylic acid.



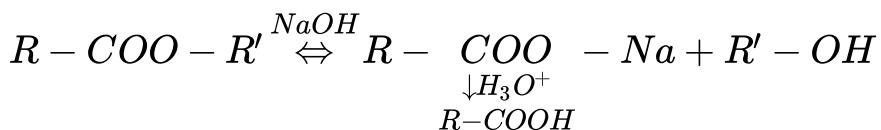
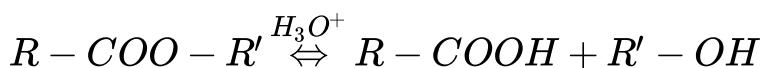
(vi) From Grignard reagent: Grignard reagents react with carbon dioxide (dry ice) to form salts of carboxylic acids which on hydrolysis forms carboxylic acids.



(vii) From acyl halides and anhydrides: Acid chlorides when hydrolysed with water give carboxylic acids .On basic hydrolysis carboxylate ions are formed which on further acidification forms corresponding carboxylic acids. Anhydrides on hydrolysis forms corresponding acid(s)



(viii) From esters: Acidic hydrolysis of esters gives directly carboxylic acids while basic hydrolysis gives carboxylates, which on acidification give corresponding carboxylic acids.

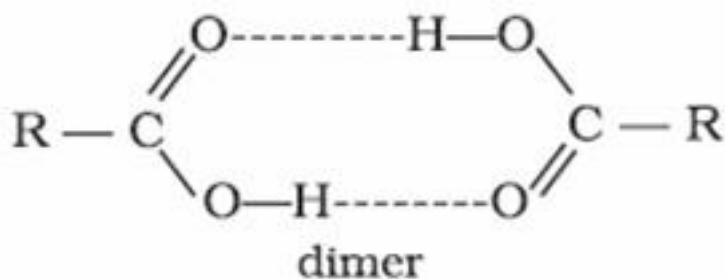


- Physical properties of carboxylic acids:**

(i) Solubility: As the size of alky group increases solubility of carboxylic acid decreases because non-polar part of the acid increases

(ii) Boiling points: Carboxylic acids are higher boiling liquids than aldehydes, ketones and even alcohols of comparable molecular masses. This is due to extensive association of

carboxylic acid molecules through intermolecular hydrogen bonding.



- **Acidity of carboxylic acids:**

Carboxylic acids are more acidic than phenols. The strength of acid depends on extent of ionization which in turn depends on stability of anion formed.

- (i) Effect of electron donating substituents on the acidity of carboxylic acids: Electron donating substituent decreases stability of carboxylate ion by intensifying the negative charge and hence decreases acidity of carboxylic acids.
- (ii) Effect of electron withdrawing substituent on the acidity of carboxylic acids: Electron withdrawing group increases the stability of carboxylate ion by delocalizing negative charge and hence, increases acidity of carboxylic acid. The effect of the following groups in increasing acidity order is $\text{Ph} < \text{I} < \text{Br} < \text{Cl} < \text{CF}_3$

(a) Effect of number of electron withdrawing groups: As the number of electron withdrawing groups increases $-I$ effect increases, increasing the acid strength

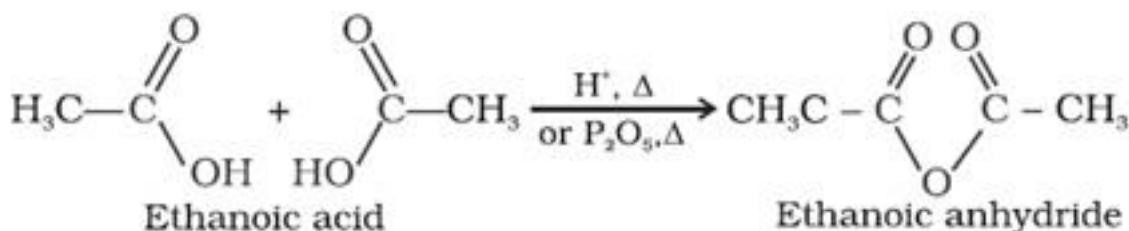
(b) Effect of position of electron withdrawing group: As the distance between electron withdrawing group and carboxylic group increases, electron withdrawing influence decreases.

- **Reaction of carboxylic acids:**

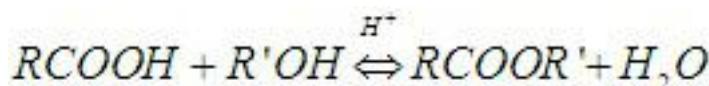
Reactions involving cleavage of C-OH bond:

Carboxylic acids on heating with mineral acids such as H_2SO_4 or with P_2O_5 give corresponding anhydride.

- (i) Anhydride formation:



(ii) Esterification: Carboxylic acids are esterified with alcohols in the presence of a mineral acid such as concentrated H_2SO_4 or HCl gas as a catalyst.

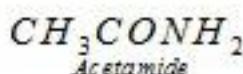
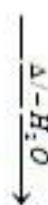
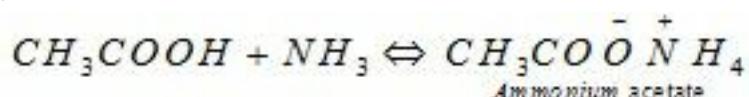


(iii) Carboxylic acids react with PCl_5 , PCl_3 and SOCl_2 to form acyl chlorides.

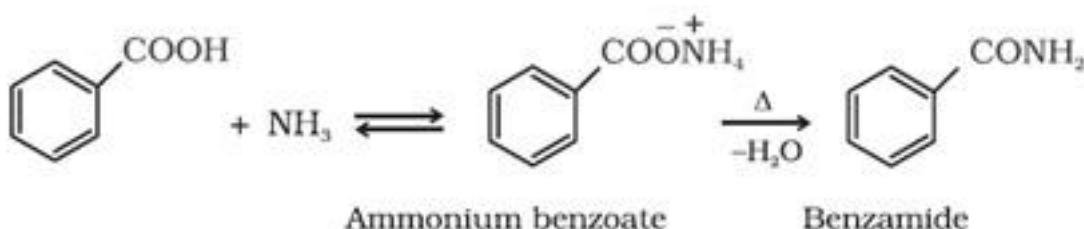
1. $\text{RCOOH} + \text{PCl}_5 \rightarrow \text{RCOCl} + \text{PCl}_3 + \text{HCl}$
2. $3\text{RCOOH} + \text{PCl}_3 \rightarrow 3\text{RCOCl} + \text{H}_3\text{PO}_3$
3. $\text{RCOOH} + \text{SOCl}_2 \rightarrow \text{RCOCl} + \text{SO}_2 + \text{HCl}$

(iv) Reaction with ammonia (NH_3): Carboxylic acids react with ammonia to give ammonium salt which on further heating at high temperature gives amides.

i)

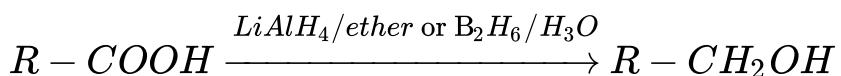


ii)

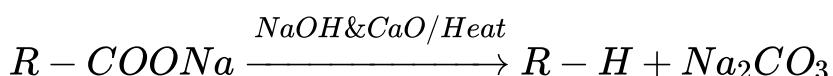


Reactions involving COOH group:

(i) Reduction: Carboxylic acids are reduced to alcohols in presence of LiAlH₄ or B₂H₆.

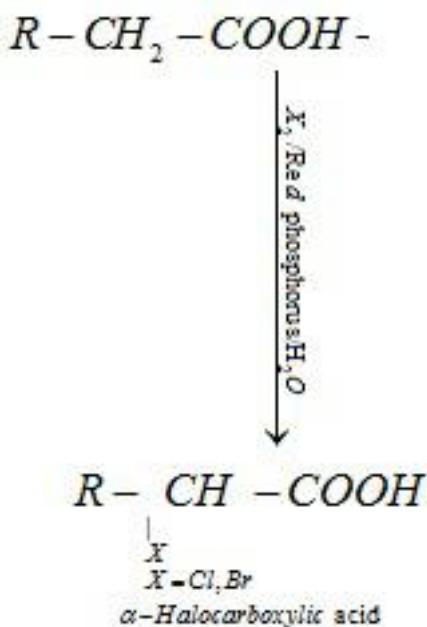


(ii) Decarboxylation : Sodium or potassium salts of carboxylic acids on heating with soda lime (NaOH + CaO in ratio of 3:1) gives hydrocarbons which contain one carbon less than the parent acid.



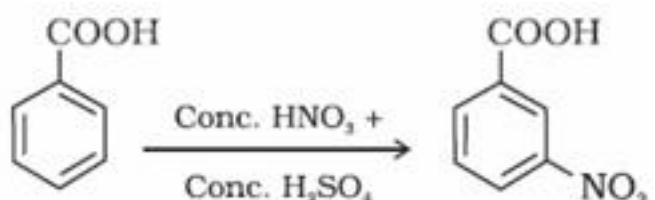
(c) Reactions involving substitution reaction in hydrocarbon part:

(i) Hell-Volhard-Zelinsky reaction: Carboxylic acids having an α -hydrogen are halogenated at the α -position on treatment with chlorine or bromine in the presence of small amount of red phosphorus to give α -halocarboxylic acids)

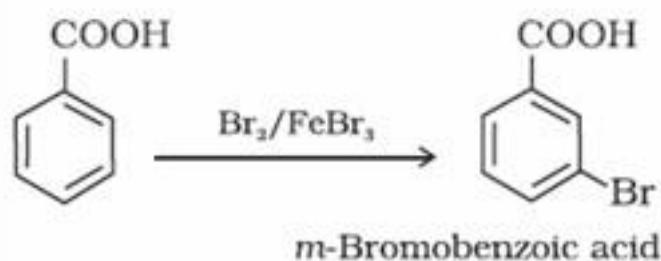


(ii) Ring substitution in aromatic acids: Aromatic carboxylic acids undergo electrophilic substitution reactions. Carboxyl group in benzoic acid is electron withdrawing group and is meta directing.

i)

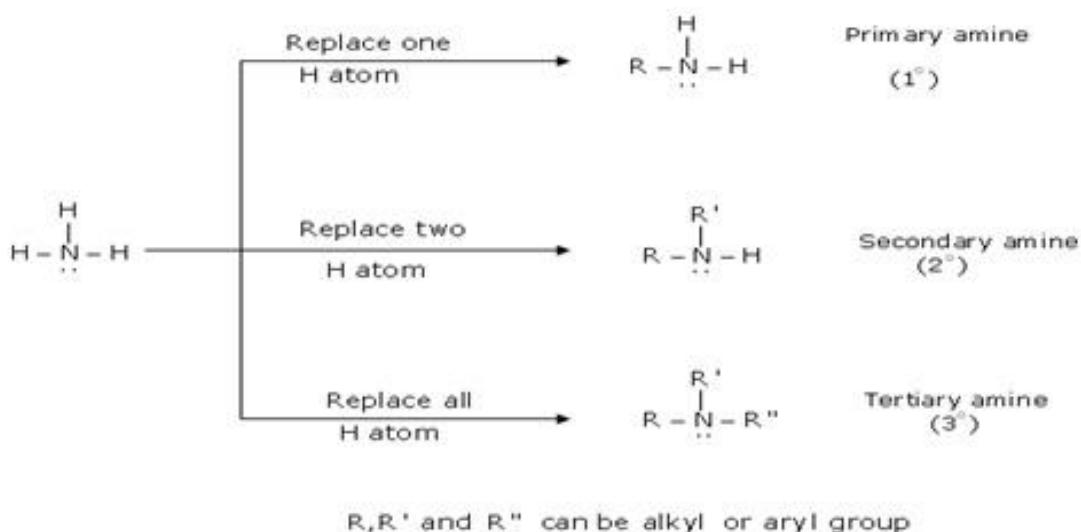


ii)



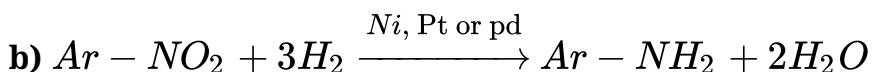
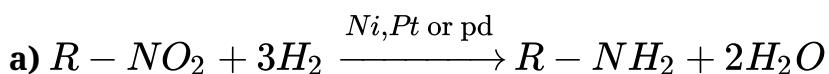
CBSE Class-12 Chemistry
Quick Revision Notes
Chapter 13
Amines

- **Amines:** Amines are regarded as derivatives of ammonia in which one, two or all three hydrogen atoms are replaced by alkyl or aryl group.
- **Classification of amines:**

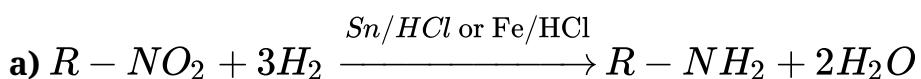


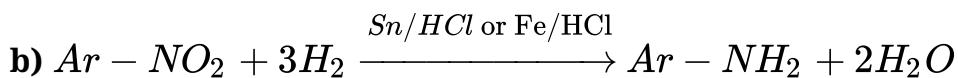
- **Preparation of amines:**

(i) By reduction of nitro compounds: Nitro compounds can be catalytically reduced by passing hydrogen gas in presence of Raney Ni, finely divided Pt or Pd as catalyst at room temperature.

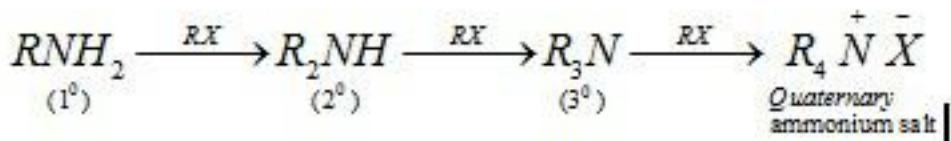


Nitro compounds can also be reduced with active metals such as Fe, Sn, Zn etc. with conc. HCl.

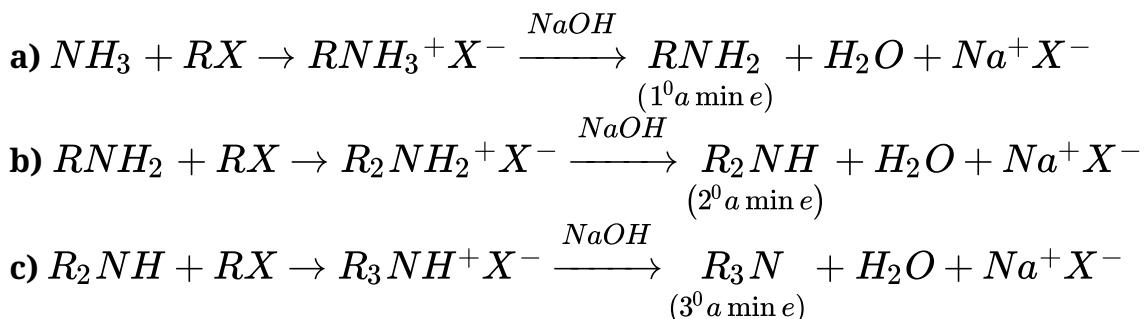




(ii) **By Hoffmann's method (Ammonolysis of alkyl halides):** Reaction of alkyl halides with an ethanolic solution of ammonia in a sealed tube at 373 K forms a mixture of primary, secondary and tertiary amine and finally quarternary ammonium salt. Process of cleavage of C-X bond by ammonia is called ammonolysis.



- The free amine can be obtained from the ammonium salt by treatment with a strong base:



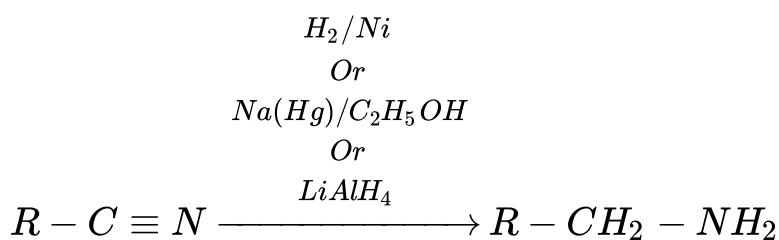
- Order of reactivity of halides is: RI>RBr>RCl
- Larger the size of halogen atom easier is the cleavage of R-X bond
- Limitations of Hoffmann's method:** Method gives mixture of amines which are difficult to separate in a laboratory.
- Methods to get only one product by Hoffmann's method:**

(i) When ammonia is taken in excess primary amine is formed as main product

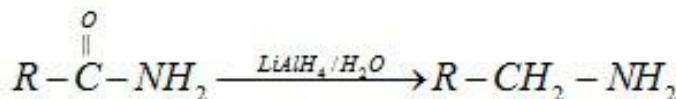
(ii) When alkyl halide is used in excess quarternary ammonium salt is formed as main product.

Method is not suitable for preparation of aryl amines because aryl amines are relatively less reactive than alkyl halides towards nucleophilic substitution reactions.

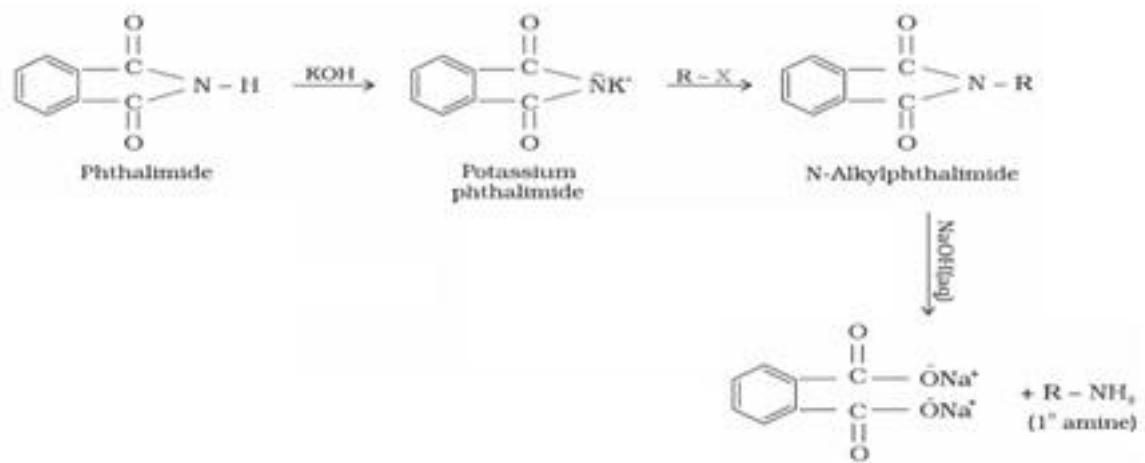
(iii) By reduction of nitriles: Nitriles can be reduced to amines using H_2 / Ni , $LiAlH_4$ or $Na(Hg) / C_2H_5 OH$



(iv) By reduction of amides: Amides are reduced to corresponding amines by LiAlH₄

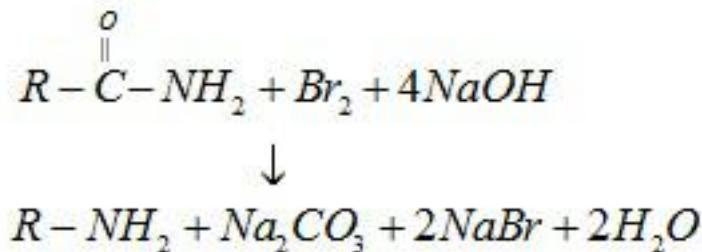


(v) By Gabriel phthalimide synthesis: Gabriel synthesis is used for the preparation of primary amines. When phthalimide is treated with ethanolic potassium hydroxide, it forms potassium salt of phthalimide which on heating further with alkyl halide followed by alkaline hydrolysis produces the corresponding primary amine.



Aromatic primary amines cannot be prepared by this method because aryl halides do not undergo nucleophilic substitution with potassium phthalimide.

(vi) By Hoffmann bromamide degradation reaction: Primary amines can be prepared from amides by treatment with Br₂ and KOH. Amine contains one carbon atom less than the parent amide.



- **Physical properties of amines:**

(i) Solubility: Lower aliphatic amine is soluble in water because they can form hydrogen bonding with water. Solubility decreases with increases in molar mass of amines due to increase in size of hydrophobic group

(ii) Boiling points: Among the isomeric amines primary and secondary amines have high boiling point because they can form hydrogen bonding. Tertiary amine cannot form hydrogen bonding due to the absence of hydrogen atom available for hydrogen bond formation. Hence order of boiling of isomeric amines is Primary>Secondary> Tertiary

- **Chemical properties of amines:**

(a) Basic character of amines: Amines have an unshared pair of electrons on nitrogen atom due to which they behave as Lewis base. Basic character of amines can be better understood in terms of their K_b and pK_b values



$$K = \frac{[R - \overset{+}{N}H_3][\bar{O}H]}{[R - NH_2][H_2O]}$$

$$\text{Or } K[H_2O] = \frac{[R - \overset{+}{N}H_3][\bar{O}H]}{[R - NH_2]}$$

$$K_b = \frac{[R - \overset{+}{N}H_3][\bar{O}H]}{[R - NH_2]}$$

$$pK_b = -\log K_b$$

Greater K_b value or smaller pK_b indicates base is strong.

(b) Comparison of basic strength of aliphatic amines and ammonia: Aliphatic amines are stronger bases than ammonia due to +I effect of alkyl groups leading to high electron density on the nitrogen atom.

(c) Comparison of basic strength of primary, secondary and tertiary amines

(i) The order of basicity of amines in the gaseous phase follows the expected order on the

basis of +I effect: tertiary amine > secondary amine > primary amine > NH₃

(ii) In aqueous solution it is observed that tertiary amines are less basic than either primary or secondary amines. This can be explained on basis of following factors:

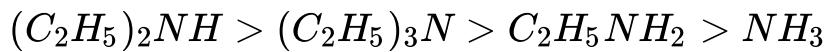
a) Solvation effect: Greater is the stability of the substituted ammonium cation formed, stronger is the corresponding amine as a base. Tertiary ammonium ion is less hydrated than secondary ammonium ion which is less hydrated than primary amine. Thus tertiary amines have fewer tendencies to form ammonium ion and consequently are least basic.

On the basis of solvation effect order of basicity of aliphatic amines should be primary amine > secondary amine > tertiary amine.

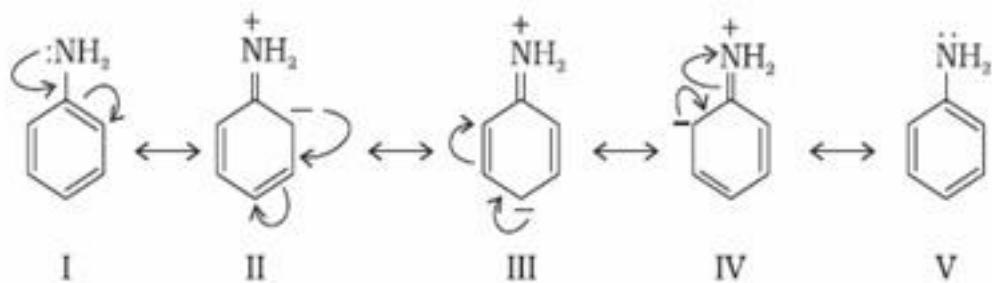
b) Steric factor: As the crowding of alkyl group increases from primary to tertiary amine hindrance to hydrogen bonding increases which eventually decreases the basic strength. Thus there is a subtle interplay of the inductive effect, solvation effect and steric hinderance of the alkyl group which decides the basic strength of alkyl amines in the aqueous state. When the alkyl group is small like CH₃ there is no steric hindrance to hydrogen bonding. In this case order of basicity in aqueous medium is



When alkyl group is ethyl group order of basicity in aqueous medium is



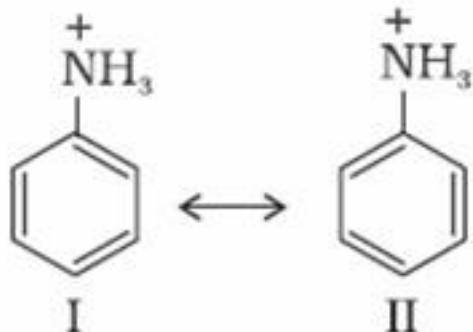
c) Comparison of basic strength of aryl amines and alkylamines: Generally aryl amines are considerably less basic than alkyl amines. Taking an example of aniline and ethylamine it is observed that ethyl amine is more basic than aniline. In aniline -NH₂ group is directly attached to benzene ring. Hence unshared pair of electron on nitrogen is less available for protonation because of resonance. Below mentioned are resonating structures of aniline.



In the above resonating structures there is a positive charge on nitrogen atom making the lone pair less available for protonation. Hence aniline is less basic than ethyl amine which

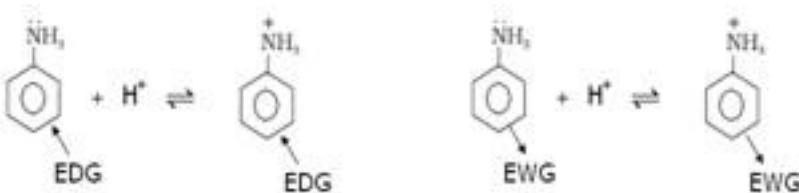
has no resonating structures. Less basicity of aniline can also be explained by comparing the relative stability of aniline and anilinium ion obtained by accepting a proton. Greater the number of resonating structures, greater is the stability of that species.

Aniline is resonance hybrid of five resonating structures whereas anilinium ion has only two resonating structures.



Thus aniline has less tendency to accept a proton to form anilinium ion.

d) Effect of substituent on basic character of amines: Electron donating or electron releasing group/groups (EDG) increases basic strength while electron withdrawing (EWG) decreases basic strength.

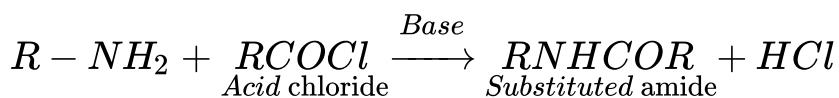


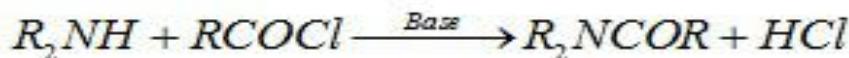
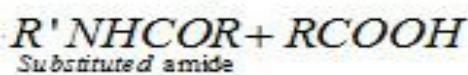
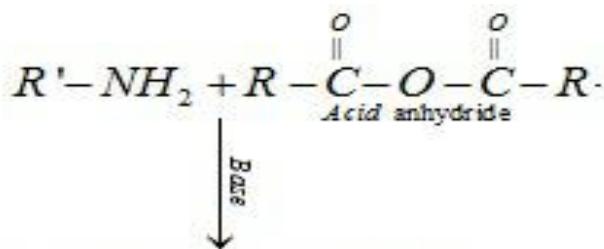
$$\text{EDG} = -\text{CH}_3, -\text{OCH}_3, -\text{NH}_2$$

$$\text{EWG} = -\text{NO}_2, -\text{CN}, -\text{X}(\text{Halogén})$$

- **Reactions of amines:**

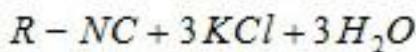
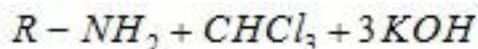
a) Acylation Reaction: Aliphatic and aromatic primary and secondary amines (which contain replaceable hydrogen atoms) react with acid chlorides, anhydrides and esters to form substituted amide. Process of introducing an acyl group (R-CO-) into the molecule is called acylation. The reaction is carried out in the presence of a stronger base than the amine, like pyridine, which removes HCl formed and shifts the equilibrium to the product side.





Since tertiary amine do not contain replaceable hydrogen atom they do not undergo acylation reaction.

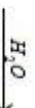
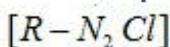
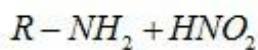
b) Carbylamine reaction: Only aliphatic and aromatic primary amines on heating with chloroform and ethanolic potassium hydroxide form isocyanides or carbylamines.



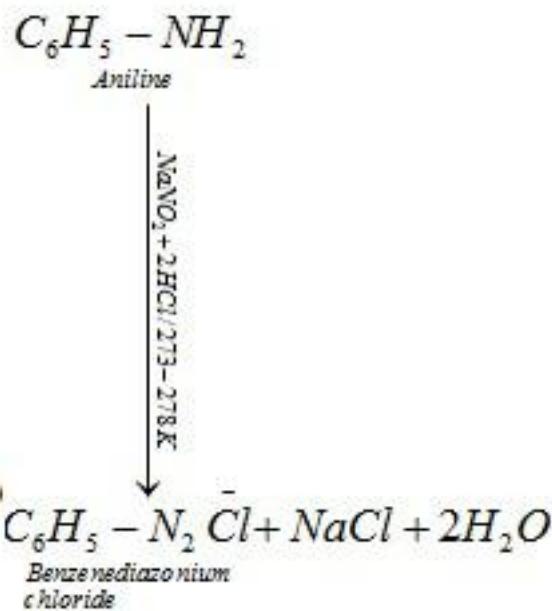
Secondary and tertiary amines do not give the above test.

c) Reaction of primary amine with nitrous acid:

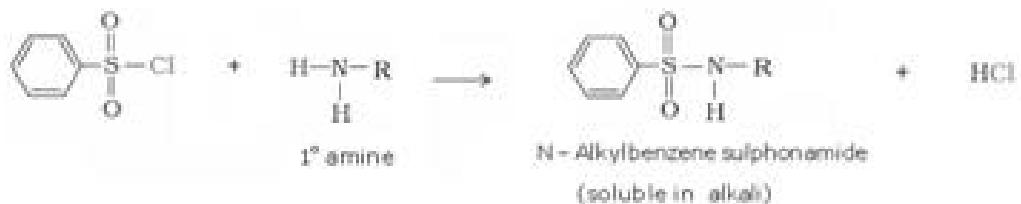
(i) Primary aliphatic amine on reaction with nitrous acid (HNO_2) forms aliphatic diazonium salt which decomposes to form alcohol and evolve nitrogen.



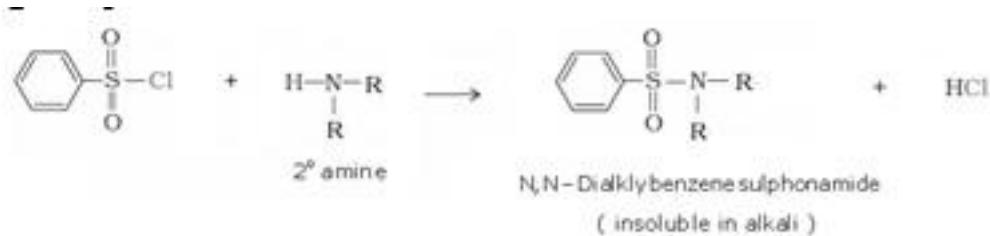
(ii) Primary aromatic amines react with nitrous acid (HNO_2) in cold (273-278 K) to form diazonium salt.



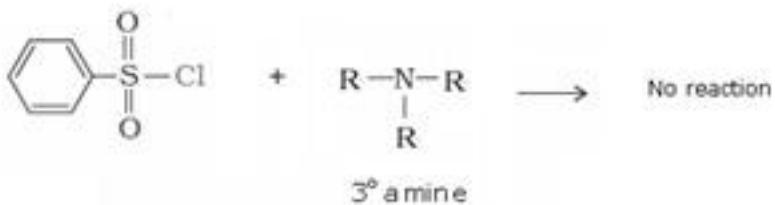
d) Reaction with benzene sulphonyl chloride: Hinsberg's reagent-Benzenesulphonyl chloride ($C_6H_5SO_2Cl$) reacts with primary and secondary amines to form sulphonamides.



The hydrogen attached to nitrogen in sulphonamide formed by primary amine is strongly acidic due to the presence of strong electron withdrawing sulphonyl group. Hence, it is soluble in alkali.



Since sulphonamide formed by secondary amine does not contain any hydrogen atom attached to nitrogen atom, so it is not acidic. Hence it is insoluble in alkali.

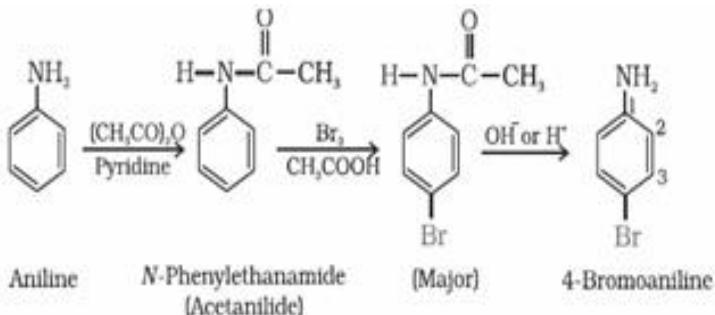


- **Ring substitution in aromatic amine:** Aniline is more reactive than benzene and undergoes electrophilic substitution reaction preferably at ortho and para position.

(i) Bromination: Aniline reacts with bromine water at room temperature to give a white precipitate of 2, 4, 6-tribromoaniline

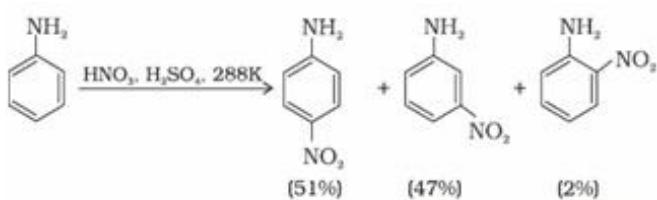


In order to stop reaction at monosubstitution activating effect of $-NH_2$ group is reduced by acetylation. This prevents di and tri substituted products. Acetyl group is removed by hydrolysis.



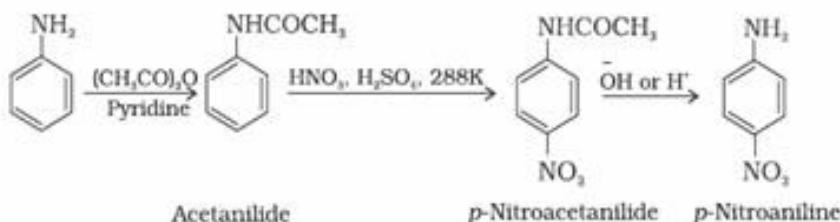
(ii) Nitration:

(a) Under strongly acidic medium aniline gets protonated to form anilinium ion, which is deactivating group and is meta directing. Hence minitroaniline is also formed in 47% along with ortho and para products.

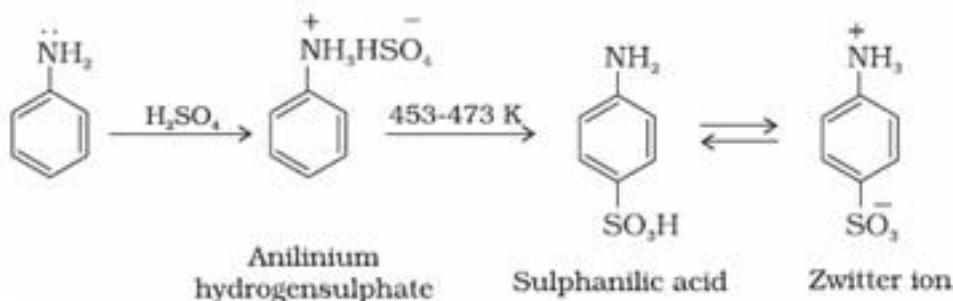


Aromatic amines cannot be nitrated directly because HNO_3 being a strong oxidising agent oxidises it forming black mass.

(b) Nitration by protecting the $-NH_2$ group by acetylation reaction with acetic anhydride:

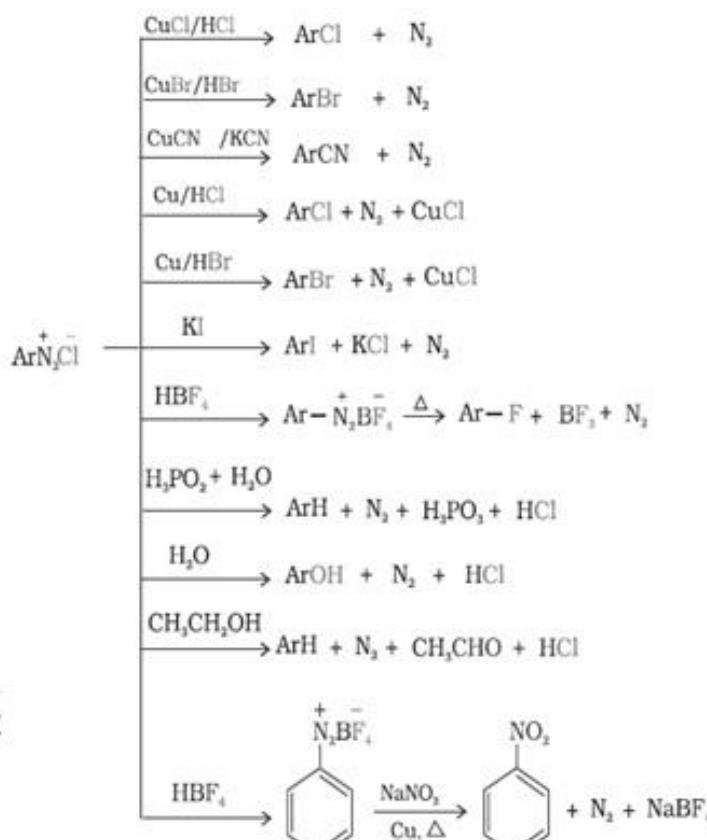


iii) Sulphonation: Aniline reacts with conc. H_2SO_4 to form aniliniumhydrogensulphate which on heating with sulphuric acid at 453-473K produces p-aminobenzenesulphonic acid, commonly known as sulphanilic acid, as the major product.

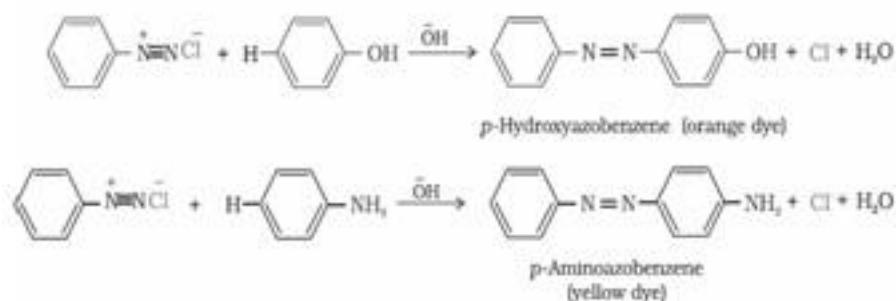


- **Reactions of benzene diazonium chloride:**

a) Reactions involving displacement of nitrogen:



b) Reactions involving retention of diazo group, coupling reactions: Diazonium ion acts as an electrophile because there is a positive charge on terminal nitrogen. Therefore benzene diazonium chloride couples with electron rich compounds like phenol and aniline to give azo compounds. Azo compounds contain $-N=N-$ bond and reaction is coupling reaction.



CBSE Class-12 Chemistry
Quick Revision Notes
Chapter 14
Biomolecules

- **Carbohydrates:** Polyhydroxy aldehydes or polyhydroxyketones or compounds on hydrolysis give carbohydrates.

- **Classification of carbohydrates:**

Monosaccharides

- (a) Simplest carbohydrates
- (b) It cannot be hydrolysed into simpler compounds
- (c) Examples - Glucose, mannose

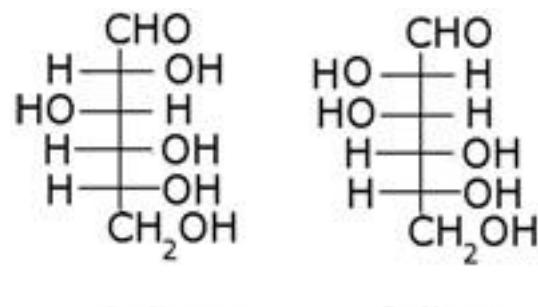
Oligosaccharides

- (a) Carbohydrates which gives 2 to 10 monosaccharide units on hydrolysis
- (b) Examples - Sucrose, Lactose, Maltose

Polysaccharides

- (a) Carbohydrates which on hydrolysis give large number of monosaccharide units.
- (b) Examples - Cellulose, starch

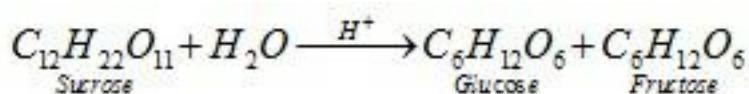
- **Anomers:** Pair of optical isomers which differ in configuration only around C1 atom are called anomers. Examples - α -D-glucopyranose and β -D-glucopyranose.
- **Epimers:** Pair of optical isomers which differ in configuration around any other C atom other than C1 atom are called epimers. E.g. D-glucose and D-mannose are C2epimers.



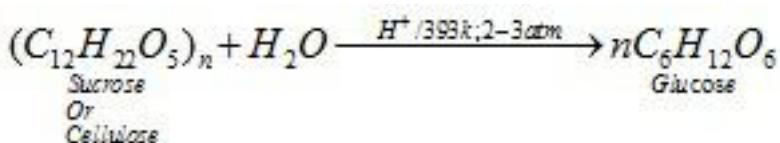
D - Glucose

D - Mannose

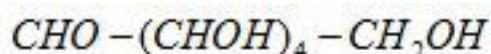
- **Preparation of glucose (also called dextrose, grape sugar):**



- From starch

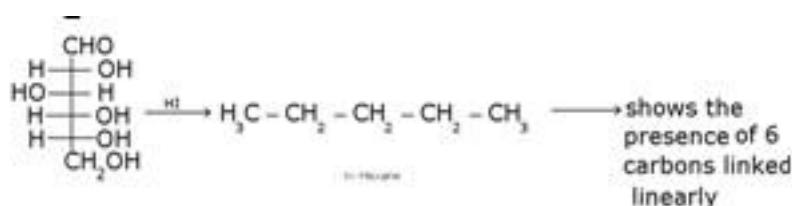


- Structure of glucose

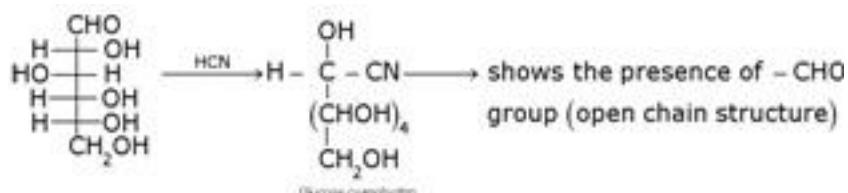


- Structure elucidation of glucose:

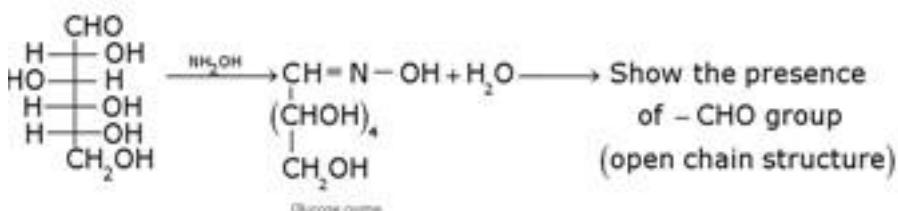
a) D – glucose with HI



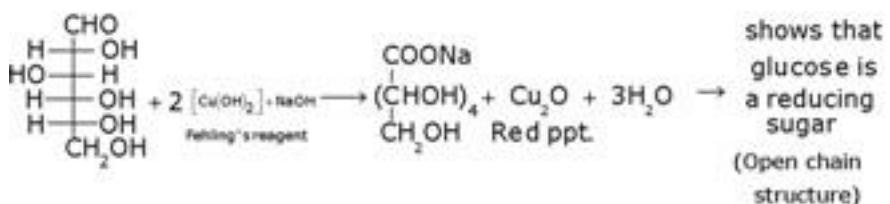
b) D – glucose with HCN



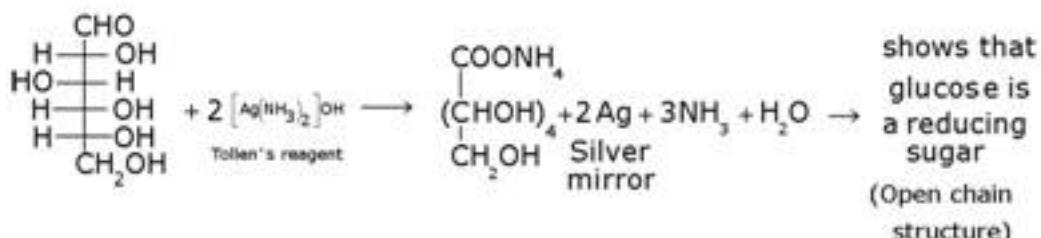
c) D – glucose with NH2OH



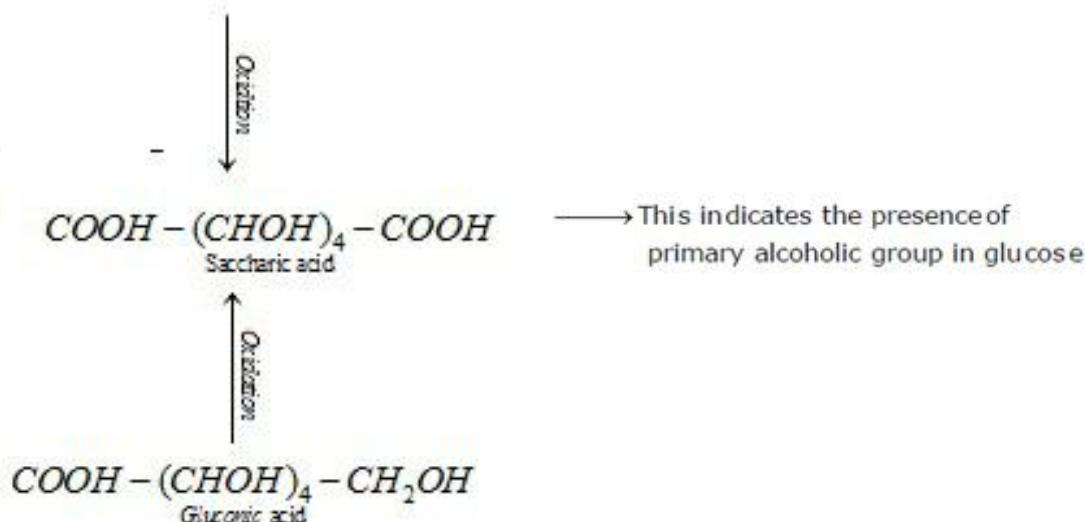
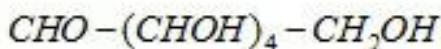
d) D- glucose with Fehling's reagent



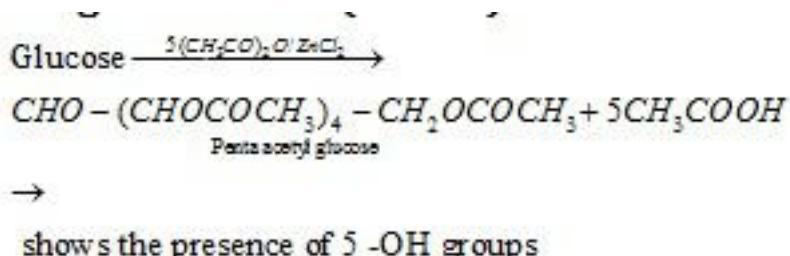
e) D – glucose with Tollen’s reagent



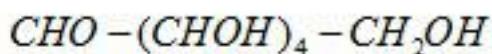
f) D – glucose with nitric acid



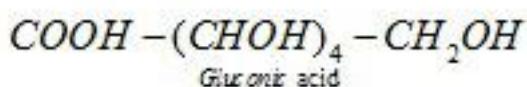
g) D – glucose with $(\text{CH}_3\text{CO})_2\text{O}$ and ZnCl_2



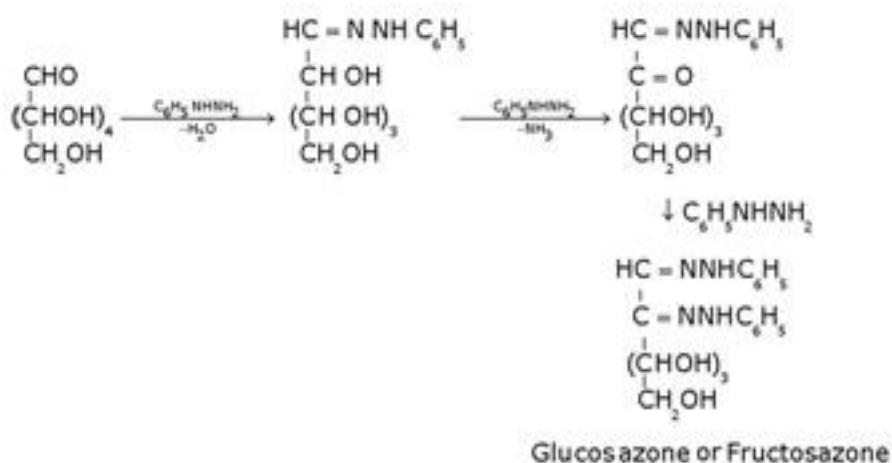
h) D – glucose with bromine water



$\xrightarrow{Br_2 \text{ water}}$

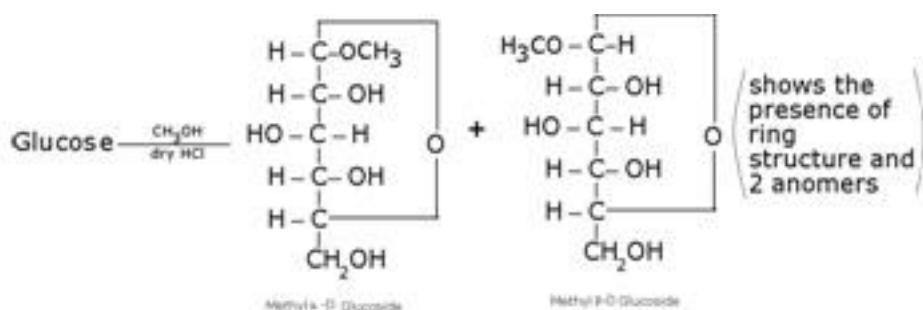


i) Glucose with phenyl hydrazine to form osazone



Glucose and fructose gives the same osazone because the reaction takes place at C1 and C2 only.

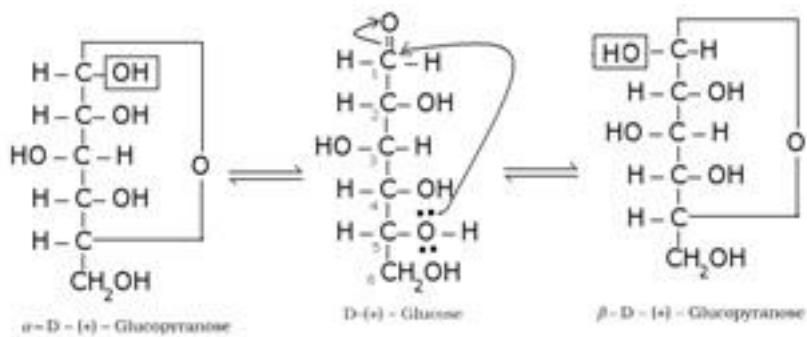
- Other Reactions of Glucose (Presence of ring structure)



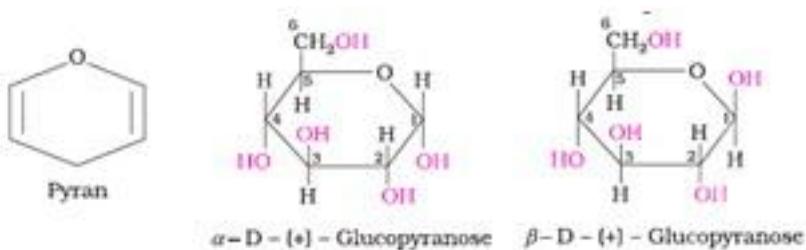
Glucose does not give Schiff's test and does not react with sodium bisulphite and NH₃.

Pentaacetyl glucose does not react with hydroxyl amine. This shows the absence of –CHO group and hence the presence of ring structure.

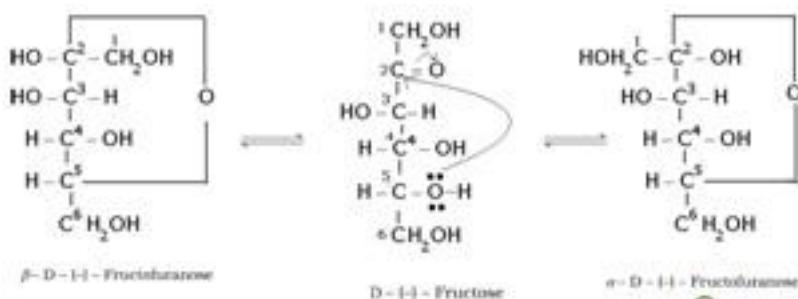
- Cyclic structure of glucose:



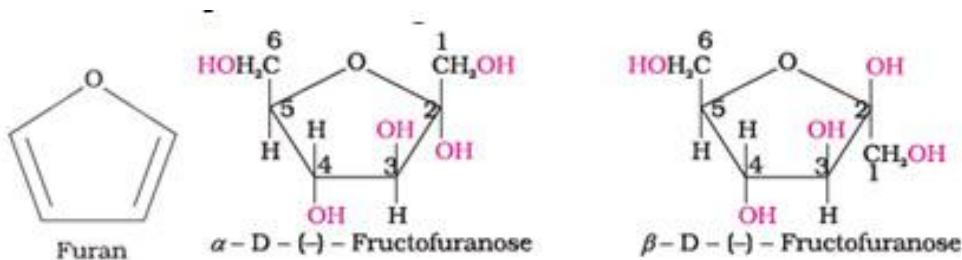
- Haworth representation of glucose:



- Cyclic structure of fructose:



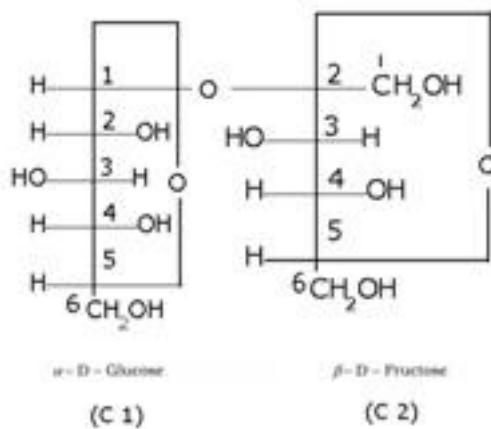
- Haworth representation of fructose



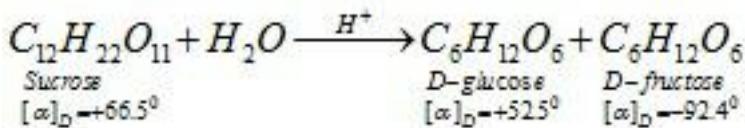
- **Glycosidic linkage:** The oxide linkage formed by the loss of a water molecule when two monosaccharides are joined together through oxygen atom is called glycosidic linkage.

- **Sucrose (invert sugar):**

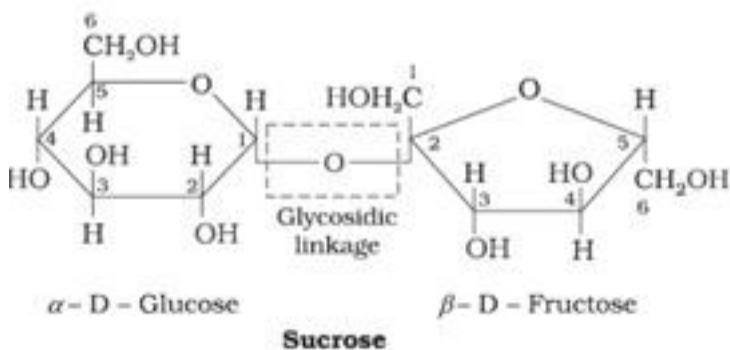
a) Sucrose is a non-reducing sugar because the two monosaccharide units are held together by a glycosidic linkage between C1 of α -glucose and C2 of β -fructose. Since the reducing groups of glucose and fructose are involved in glycosidic bond formation, sucrose is a non-reducing sugar.



b) Sucrose is dextrorotatory but on hydrolysis it gives dextrorotatory & laevorotatory and the mixture is laevorotatory.

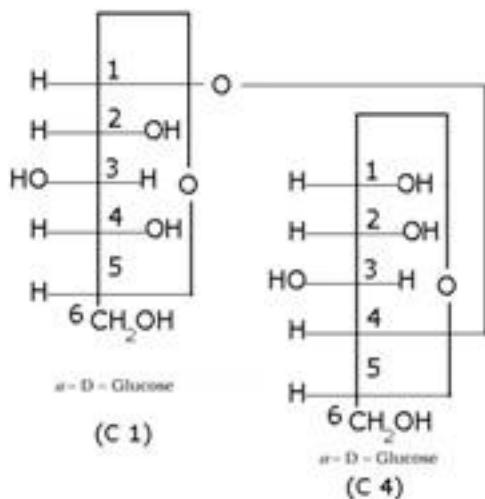
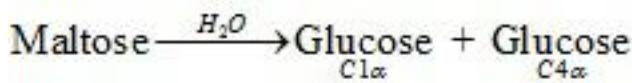


- **Haworth Projection of Sucrose:**

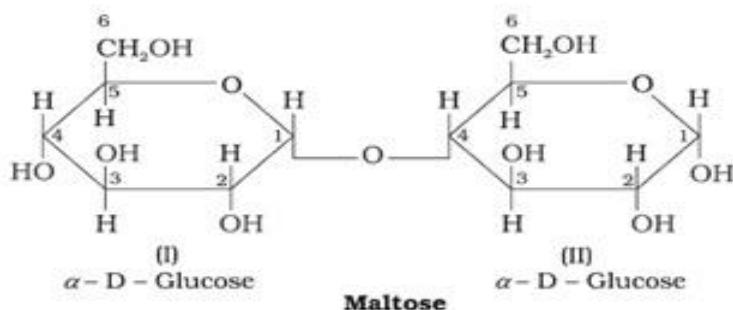


- **Maltose:**

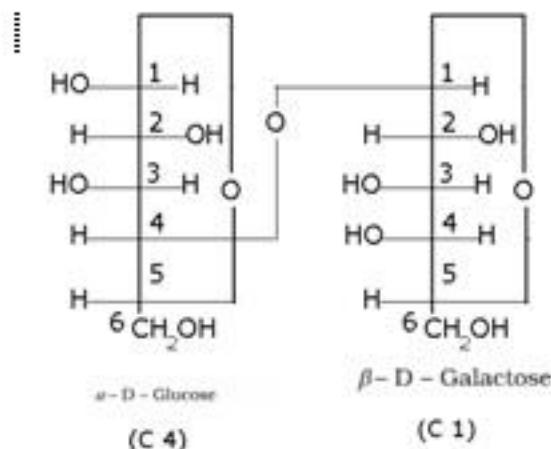
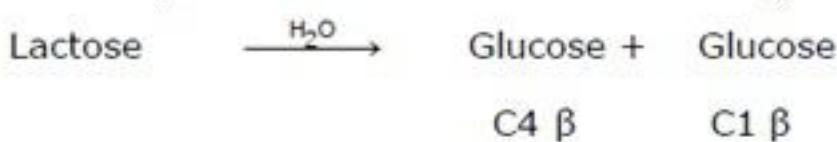
1. Maltose is composed of two α -D-glucose units in which C1 of one glucose (I) is linked to C4 of another glucose unit (II).
2. The free aldehyde group can be produced at C1 of second glucose in solution and it shows reducing properties so it is a reducing sugar.



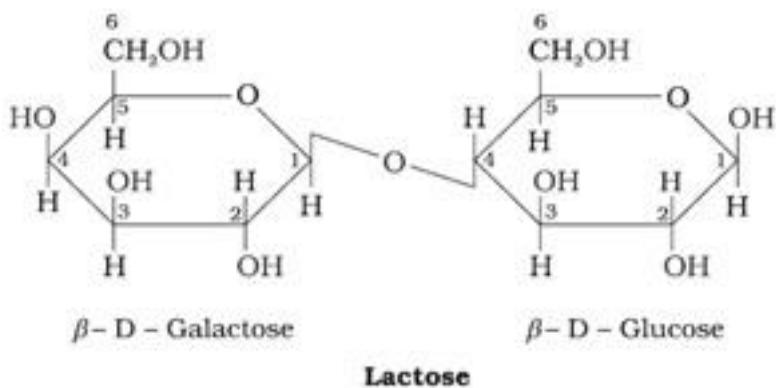
- **Haworth projection of maltose:**



- **Lactose (Milk sugar):** It is composed of β -D-galactose and β -D-glucose. The linkage is between C1 of galactose and C4 of glucose. Hence it is also a reducing sugar.



- **Haworth projection of lactose:**



- **Starch:** It is a polymer of -glucose and consists of two components — Amylose and Amylopectin.

- **Amylose:**

1. It is a water soluble component
2. It is a long unbranched chain polymer
3. It contains 200 – 1000 α -D-(+)- glucose units held by α - glycosidic linkages involving C1 – C4glycosidic linkage
4. It constitutes about 15-20% of starch

- **Amylopectin**

1. It is a water insoluble component
2. It is branched chain polymer
3. It forms chain by C1 – C4glycosidic linkage whereas branching occurs by C1 – C6glycosidic linkage
4. It constitutes about 80-85% of starch

- **Cellulose:**

1. It occurs exclusively in plants.
2. It is a straight chain polysaccharide composed only of β -D-glucose units which are joined by glycosidic linkage between C1 of one glucose unit and C4 of the next glucose unit.

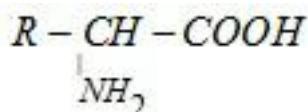
- **Glycogen:**

1. The carbohydrates are stored in animal body as glycogen.

2. It is also known as animal starch because its structure is similar to Amylopectin.
3. It is present in liver, muscles and brain.
4. When the body needs glucose, enzymes break the glycogen down to glucose.

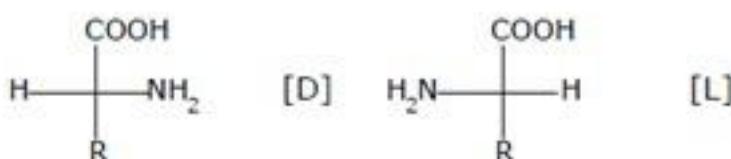
- **Amino acids:**

Amino acids contain amino ($-NH_2$) and carboxyl ($-COOH$) functional groups.



Where R – Any side chain

Most naturally occurring amino acids have L – Config.

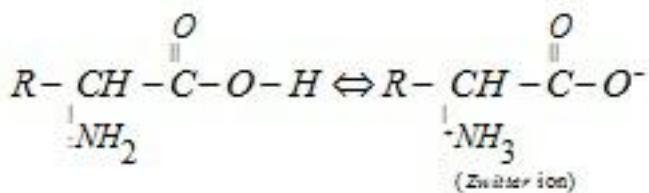


- **Types of amino acids:**

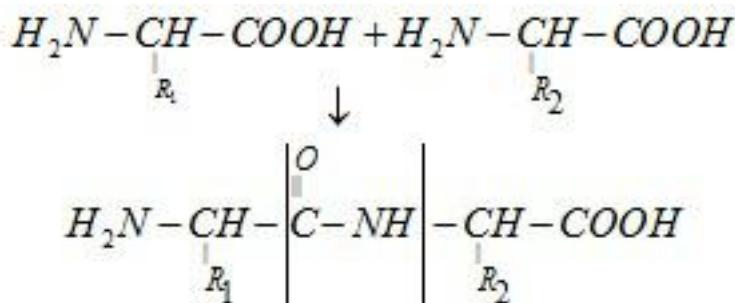
- a). **Essential amino acids:** The amino acids which cannot be synthesised in the body and must be obtained through diet, are known as essential amino acids. Examples: Valine, Leucine
- b). **Non-essential amino acids:** The amino acids, which can be synthesised in the body, are known as non-essential amino acids. Examples: Glycine, Alanine

- **Zwitter ion form of amino acids:**

1. Amino acids behave like salts rather than simple amines or carboxylic acids. This behaviour is due to the presence of both acidic (carboxyl group) and basic (amino group) groups in the same molecule. In aqueous solution, the carboxyl group can lose a proton and amino group can accept a proton, giving rise to a dipolar ion known as zwitter ion. This is neutral but contains both positive and negative charges.
2. In zwitter ionic form, amino acids show amphoteric behaviour as they react both with acids and bases.



- **Isoelectronic point:** The pH at which the dipolar ion exists as neutral ion and does not migrate to either electrode cathode or anode is called isoelectronic point.
- **Proteins:** Proteins are the polymers of α -amino acids and they are connected to each other by peptide bond or peptide linkage. A polypeptide with more than hundred amino acid residues, having molecular mass higher than 10,000u is called a protein.
- **Peptide linkage:** Peptide linkage is an amide linkage formed by condensation reaction between $-\text{COOH}$ group of one amino acid and $-\text{NH}_2$ group of another amino acid.



Peptide linkage

- **Primary structure of proteins:** The sequence of amino acids is said to be the primary structure of a protein.
- **Secondary structure of proteins:** It refers to the shape in which long polypeptide chain can exist. Two different types of structures:

α -Helix:

1. It was given by Linus Pauling in 1951
2. It exists when R- group is large.
3. Right handed screw with the NH group of each amino acid residue H – bonded to $-\text{C}=\text{O}$ of adjacent turn of the helix.
4. Also known as 3.613 helix since each turn of the helix has approximately 3.6 amino acids

and a 13 – membered ring is formed by H – bonding.

5. C = O and N – H group of the peptide bonds are trans to each other.
6. Ramchandran angles (Φ and Ψ) - Φ angle which C_α makes with N – H and Ψ angle which C_α makes with C = O.

β - pleated sheet:

1. It exists when R group is small.
2. In this conformation, all peptide chains are stretched out to nearly maximum extension and then laid side by side which are held together by hydrogen bonds.

- **Tertiary structure of proteins:** It represents the overall folding of the polypeptide chain i.e., further folding of the 2° structure.

- **Types of bonding which stabilize the 3° structure:**

1. Disulphide bridge (-S – S-)
2. H – bonding – (C = O ... H – N)
3. Salt bridge (COO⁻ ... + NH₃⁺)
4. Hydrophobic interactions
5. van der Waals forces

- **Two shapes of proteins:**

Fibrous proteins

- a) When the polypeptide chains run parallel and are held together by hydrogen and disulphide bonds, then fibre- like structure is formed.
- b) These proteins are generally insoluble in water
- c) Examples: keratin (present in hair, wool, silk) and myosin (present in muscles), etc

Globular proteins

- a) This structure results when the chains of polypeptides coil around to give a spherical shape.
- b) These are usually soluble in water.
- c) Examples: Insulin and albumins

- **Quaternary structure of proteins:**

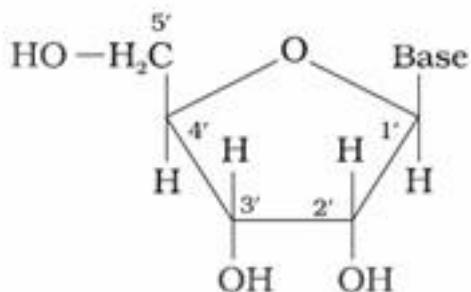
- Some of the proteins are composed of two or more polypeptide chains referred to as subunits.
- The spatial arrangement of these subunits with respect to each other is known as quaternary structure of proteins.

- Denaturation of proteins:**

- The loss of biological activity of proteins when a protein in its native form, is subjected to physical change like change in temperature or chemical change like change in pH. This is called denaturation of protein.
- Example: coagulation of egg white on boiling, curdling of milk.

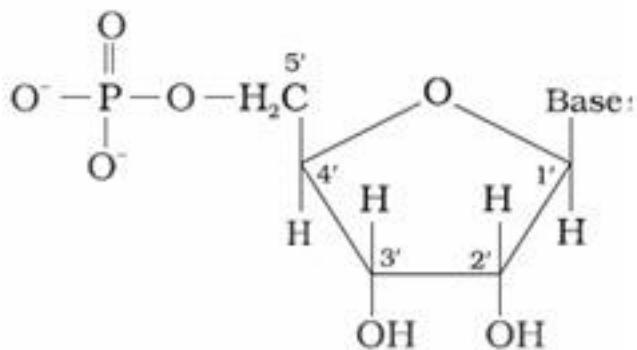
- Nucleoside:**

- Base + sugar



- Nucleotide:**

- Base + sugar + phosphate group



- Nucleic acids (or polynucleotides):**

1. Long chain polymers of nucleotides.
2. Nucleotides are joined by phosphodiester linkage between 5' and 3' C atoms of a pentose sugar.

- **Two types of nucleic acids:**

DNA

1. It has a double stranded α -helix structure in which two strands are coiled spirally in opposite directions.
2. Sugar present is β -D-2-deoxyribose
3. Bases:
 - i) Purine bases: Adenine (A) and Guanine (G)
 - ii) Pyrimidine bases: Thymine (T) and cytosine (C)
4. It occurs mainly in the nucleus of the cell.
5. It is responsible for transmission for heredity character.

RNA

1. It has a single stranded α -helix structure.
2. Sugar present is β -D-ribose
3. Bases:
 - i) Purine bases: Adenine (A) and Guanine (G)
 - ii) Pyrimidine bases: Uracil (U) and cytosine (C)
4. It occurs mainly in the cytoplasm of the cell.
5. It helps in protein synthesis.

- **Double helix structure of DNA:**

1. It is composed of two right handed helical polynucleotide chains coiled spirally in opposite directions around the same central axis.
2. Two strands are anti-parallel i.e., their phosphodiester linkage runs in opposite directions.
3. Bases are stacked inside the helix in planes \perp to the helical axis.
4. Two strands are held together by H – bonds (A = T, G \equiv C).
5. The two strands are complementary to each other because the hydrogen bonds are

formed between specific pairs of bases.

6. Adenine forms hydrogen bonds with thymine whereas cytosine forms hydrogen bonds with guanine.
7. Diameter of double helix is 2 nm.
8. Double helix repeats at intervals of 3.4 nm. (One complete turn)
9. Total amount of purine (A + G) = Total amount of pyrimidine (C + T)

- **Vitamins:** Vitamins are organic compounds required in the diet in small amounts to perform specific biological functions for normal maintenance of optimum growth and health of the organism.
- **Classification of vitamins:** Vitamins are classified into two groups depending upon their solubility in water or fat.

1. Water soluble vitamins

i) These vitamins are soluble in water.

ii) Water soluble vitamins must be supplied regularly in diet because they are readily excreted in urine and cannot be stored (except vitamin B12) in our body.

iii) Example: Vitamin C, B group vitamins.

2. Fat soluble vitamins

i) These vitamins are soluble in fat and oils but insoluble in water.

ii) They are stored in liver and adipose (fat storing) tissues.

iii) Example: Vitamin A, D, E and K

- **Important vitamins, their sources and their deficiency diseases:**

Name of vitamins	Sources	Deficiency diseases
Vitamin A	Fish liver oil, carrots, butter and milk	xerophthalmia (hardening of cornea of eye) Night blindness

Vitamin B1 (Thiamine)	Yeast, milk, green vegetables and cereals	Beriberi (loss of appetite, retarded growth)
Vitamin B2 (Riboflavin)	Milk, egg white, liver, kidney	Cheilosis (fissuring at corners of mouth and lips), digestive disorders and burning sensation of the skin.
Vitamin B6 (Pyridoxine)	Yeast, milk, egg yolk, cereals and grams	Convulsions
Vitamin B12	Meat, fish, egg and curd	Pernicious anaemia (RBC deficient in haemoglobin)
Vitamin C (Ascorbic acid)	Citrus fruits, amla and green leafy vegetables	Scurvy (bleeding gums)
Vitamin D	Exposure to sunlight, fish and egg yolk	Rickets (bone deformities in children) and osteomalacia (soft bones and joint pain in adults)
Vitamin E	Vegetable oils like wheat germ oil, sunflower oil, etc.	Increased fragility of RBCs and muscular weakness
Vitamin K	Green leafy vegetables	Increased blood clotting time

CBSE Class-12 Chemistry
Quick Revision Notes
Chapter 15
Polymers

- **Polymers:** Polymers are high molecular mass substance consisting of large number of repeating structural units. As polymers are single, giant molecules i.e. big size molecules, they are also called macromolecules
- **Monomers:** The simple molecules which combine to form polymers by forming single or multiple bonds are called monomers.
- **Polymerization:** The process of formation of polymers from respective monomers is called polymerization
- **Classification of Polymers:**
 1. Based on source of availability, it is classified into
 1. Natural polymers: Polymers obtained from nature, mostly plants and animals.
Examples - Cellulose, starch, etc.
 2. Synthetic polymers: Polymers prepared in laboratory. Examples - Teflon, Nylon 6,6 , Synthetic rubber (Buna - S) etc.
 3. Semi synthetic polymers: Polymers derived from naturally occurring polymers by carrying out chemical modifications. Examples - Rayon (cellulose acetate), cellulose nitrate, etc.
 2. Based on the structure of polymer, it is classified into
 1. Linear polymers: Polymer consists of long and straight chains. Examples - High density polythene, polyvinyl chloride, etc.
 2. Branched chain polymers: Polymers contains linear chains having some branches.
Examples - Low density polythene
 3. Cross linked or network polymers: Polymers in which monomer units are cross linked together to form a 3 dimensional network polymers. Examples - Bakelite, melamine, etc.
 3. Based on the mode of polymerisation, it is classified into

I. Addition polymers: Polymers are formed by the repeated addition of monomers with double and triple bonds. It is further classified into,

Homopolymers: Polymers formed by the polymerisation of a single monomeric species.

Examples - Polythene, Polystyrene.

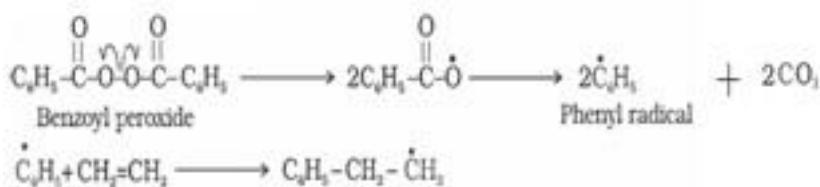
Copolymers: Polymers formed by addition polymerisation of two different monomers.

Examples - Buna-S, Buna -N.

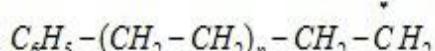
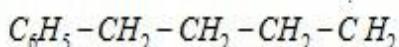
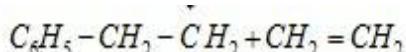
II. Condensation polymers: Polymers formed by repeated condensation reaction between two different bi-functional or tri-functional monomeric units with elimination of simple molecules. Examples - Nylon 6, 6, Nylon 6.

Based on Molecular forces, it is classified into

Step 1: Chain initiating step: Organic peroxides undergo homolytic fission to form free radicals which acts as initiator. Initiator adds to C-C double bond of an alkene molecule to form a new free radical

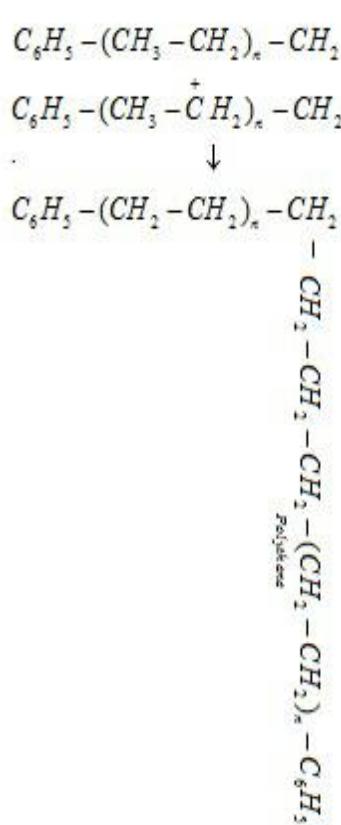


Step 2: Chain propagating step: Free radicals formed by homolytic cleavage adds to a double bond of monomer to form a larger free radical. Radical formed adds to another alkene molecule to form a larger free radical. This process continues until the radical is destroyed. These steps are called propagation steps.

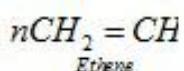


Step 3: Chain terminating step: For termination of the long chain, free radicals combine in

different ways to form polythene. One mode of termination of chain is shown as under:

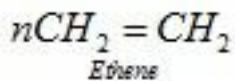


a). Low density polythene (LDP) is a polymer of ethene.

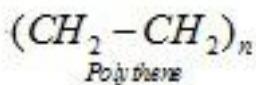


It is used in the insulation of electricity carrying wires and manufacture of squeeze bottles, toys and flexible pipes

b). High density polythene(HDP) is a polymer of ethene.

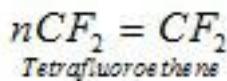


333-343K / 5-7 atm ziegler-Natta catalyst

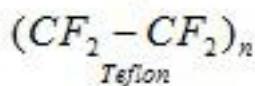


It is used for manufacturing buckets, dustbins, bottles, pipes, etc.

c). Polytetrafluoroethene (is a polymer of Teflon)

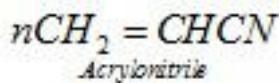


Catalyst / High F₂ pressure

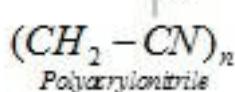


It is used in making oil seals and gaskets and also used for non – stick surface coated utensils

d). Polyacrylonitrile is a polymer of acrylonitrile.



↓
Polymerization / Peroxide catalyst



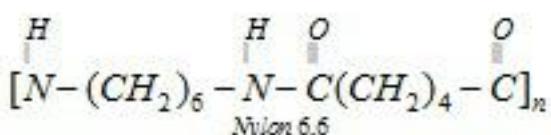
It is used as a substitute for wool in making commercial fibres such as orlon or acrilan.

1. Polyamides: Polymers possess amide linkage (-CONH-) in chain. These polymers are popularly known as nylons. Examples:

(a) Nylon 6, 6: It is prepared by the condensation polymerisation of hexamethylenediamine with adipic acid under high pressure and at high temperature.

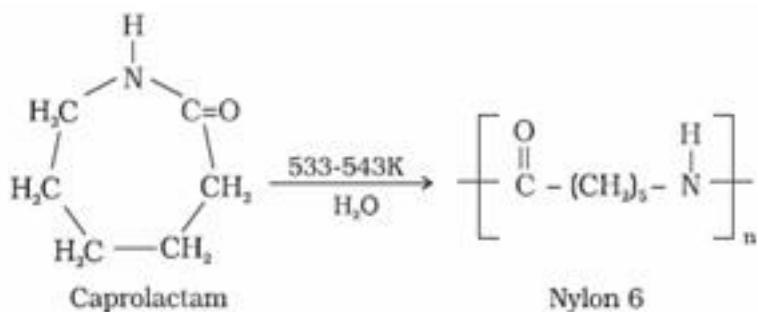


↓
553K / High pressure



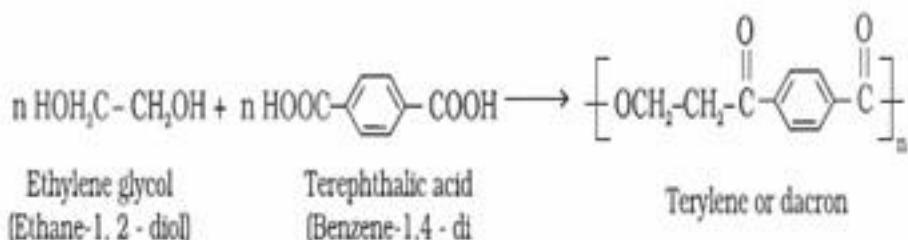
It is used in making sheets, bristles for brushes and in textile industry.

(b) Nylon 6: It is obtained by heating caprolactum with water at a high temperature



It is used for the manufacture of tyre cords, fabrics and ropes.

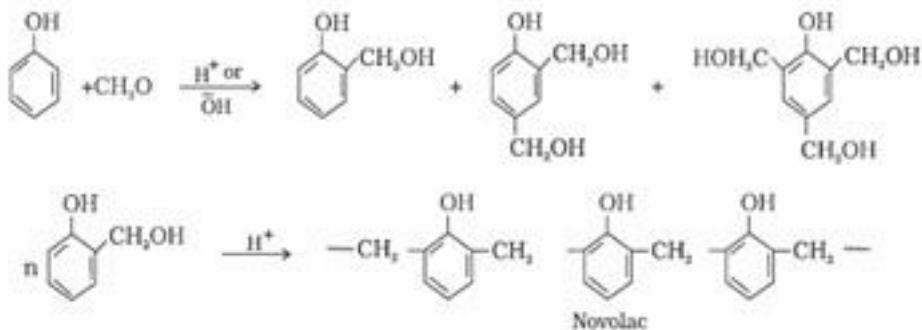
2. Polyesters: These are the polycondensation products of dicarboxylic acids and diols
Example: Terylene or Dacron



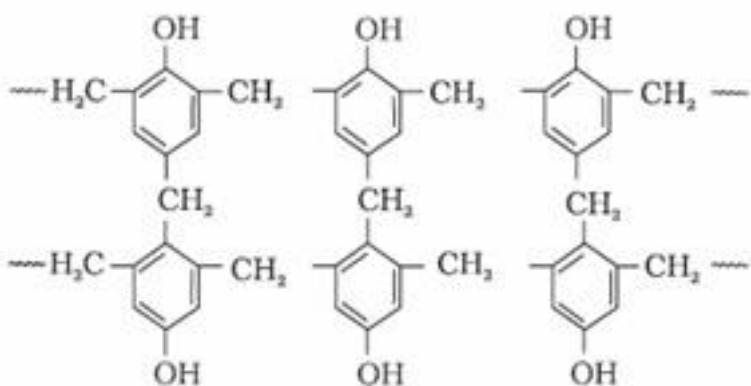
It is used to create resistance in polymerised product and is used in blending with cotton and wool fibres and also as glass reinforcing materials in safety helmets, etc.

3. Phenol - formaldehyde polymer (Bakelite and related polymers)

a). Bakelite: These are obtained by the condensation reaction of phenol with formaldehyde in the presence of either an acid or a base catalyst. The initial product could be a linear product – Novolac used in paints.

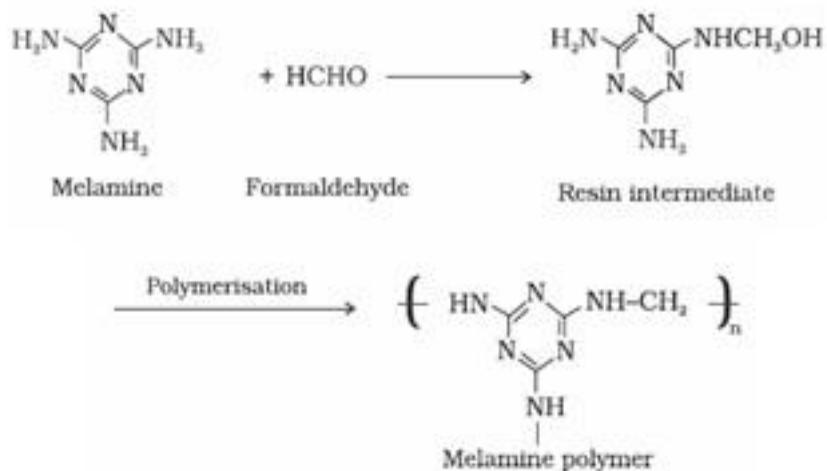


b). Novolac on heating with formaldehyde forms Bakelite

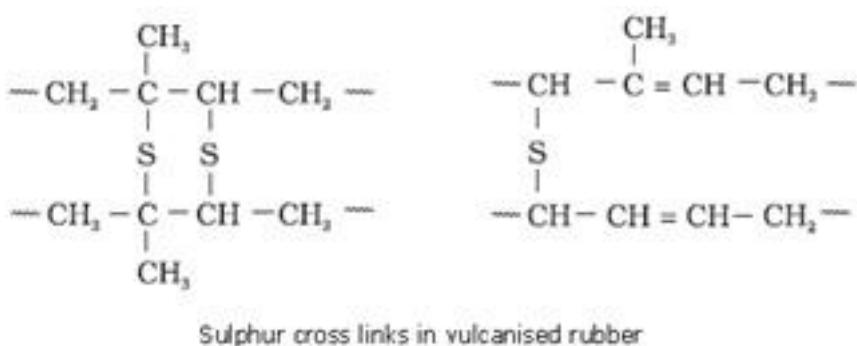


It is used for making combs, phonograph records, electrical switches and handles of various utensils

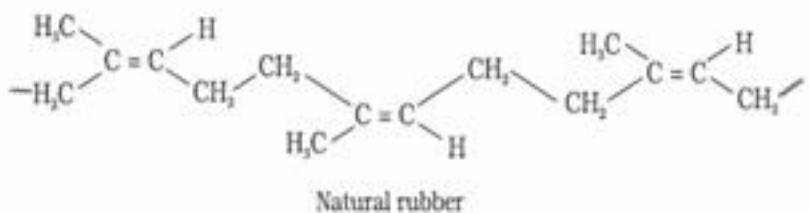
4. Melamine – formaldehyde polymer: Melamine formaldehyde polymer is formed by the condensation polymerisation of melamine and formaldehyde



It is used in the manufacture of unbreakable crockery.

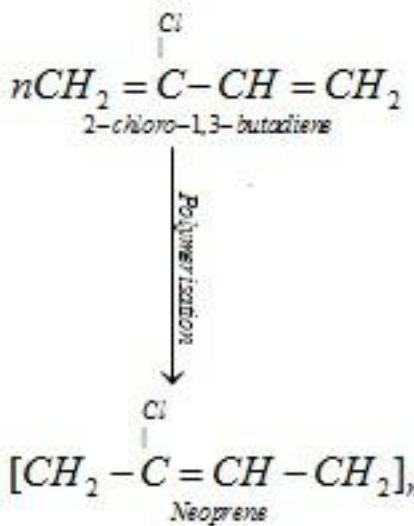


a). Natural rubber: Natural rubber is a linear polymer of isoprene (2-methyl-1, 3-butadiene) and is also called as *cis* - 1, 4 - polyisoprene.



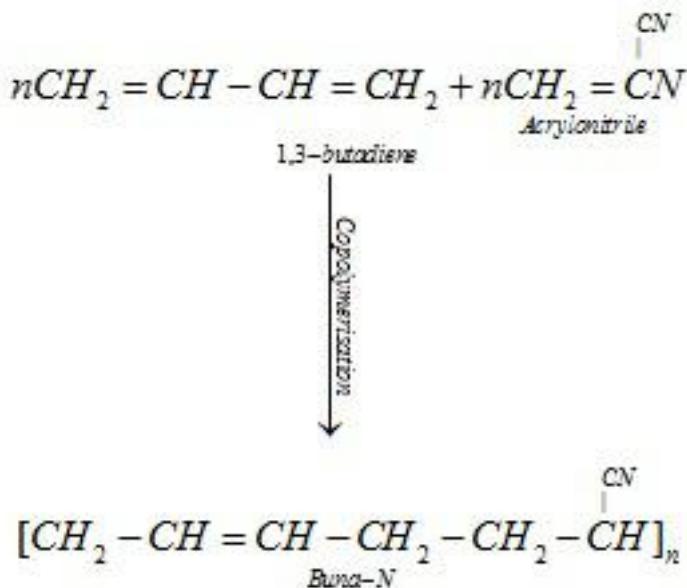
b). Synthetic rubber: Synthetic rubbers are either homopolymers of 1, 3 - butadiene derivatives or copolymers of 1, 3 - butadiene or its derivatives with another unsaturated monomer.

A) Neoprene or polychloroprene



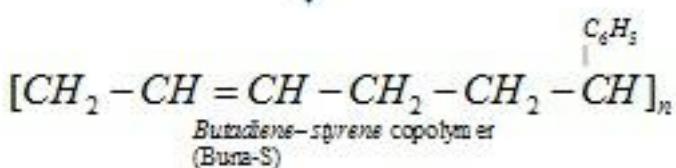
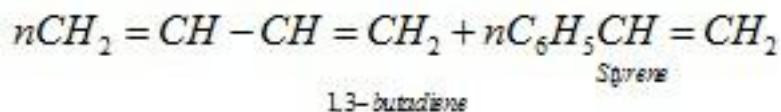
It is used for manufacturing conveyor belts, gaskets and hoses

B) Buna – N



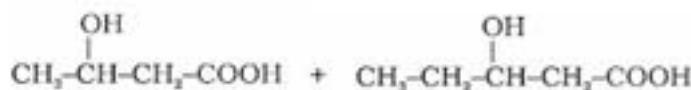
It is used in making oil seals, tank lining, etc. because it is resistant to the action of petrol, lubricating oil and organic solvents

C) Buna – S

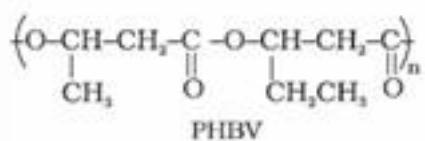


a). Poly - β -hydroxybutyrate – co- β -hydroxyvalerate (PHBV):

It is obtained by the copolymerisation of 3-hydroxybutanoic acid and 3 – hydroxypentanoic acid

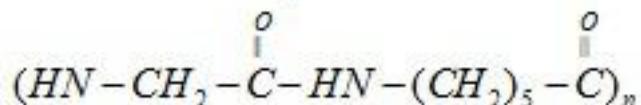
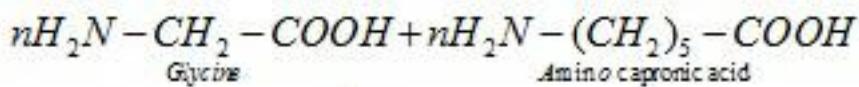


3-Hydroxybutanoic acid 3-Hydroxypentanoic acid



It is used in speciality packaging, orthopaedic devices and in controlled release of drugs.

b). Nylon 2–nylon 6: It is an alternating polyamide copolymer of glycine($\text{H}_2\text{N}-\text{CH}_2-\text{COOH}$) and amino caproic acid ($\text{H}_2\text{N}(\text{CH}_2)_5\text{COOH}$)



Name of Polymer	Monomer	Structure	Uses
Polypropene	Propene	$\begin{array}{c} CH_3 \\ \\ (CH_2 - CH)_n \end{array}$	Manufacture of ropes, toys, pipes, fibres, etc.
Glyptal	(a) Ethylene glycol Manufacture of (b) Phthalic acid	$\begin{array}{c} \text{OCH}_2\text{-CH}_2\text{OOC} \quad \text{CO} \\ \qquad \quad \\ \text{C}_6\text{H}_5 \end{array} \Big)_n$	Manufacture of paints and lacquers
Polystyrene	Styrene	$\begin{array}{c} C_6H_5 \\ \\ (CH_2 - CH)_n \end{array}$	As insulator, wrapping material, manufacture of toys, radio and television cabinets
Polyvinyl chloride (PVC)	Vinyl chloride	$\begin{array}{c} Cl \\ \\ (CH_2 - CH)_n \end{array}$	Manufacture of rain coats, hand bags, vinyl flooring, water pipes

1. Elastomers: Polymer chains are held together by weakest intermolecular forces. Polymers are rubber – like solids with elastic properties. Examples - Buna – S, Buna – N, Neoprene.
2. Fibre: Polymers have strong intermolecular force like hydrogen bonding. Fibres are the thread forming solids which possess high tensile strength and high modulus. Examples - Nylon 6, 6, Polyesters.
3. Thermoplastic polymers: Polymers are held by intermolecular forces which are in between those of elastomers and fibres. These polymers are capable of repeated softening on heating and hardening on cooling. Examples - Polythene, Polystyrene.
4. Thermosetting polymers: Polymers are cross linked or heavily branched molecules,

which on heating undergo extensive cross linking in moulds and eventually undergo a permanent change. Examples - Bakelite, Urea-formaldehyde resins

5. Addition Polymerisation or Chain Growth Polymerisation: Addition polymerisation is called chain growth polymerisation because it takes place through stages leading to increase in chain length and each stage produces reactive intermediates for use in next stage of the growth of chain. Most common mechanism for addition polymerisation reactions is free radical mechanism

Important Addition Polymers:

Condensation Polymerisation or Step Growth polymerization: Polymerisation generally involves a repetitive condensation reaction between two bi-functional monomers. In condensation reactions, the product of each step is again a bi-functional species and the sequence of condensation goes on. Since, each step produces a distinct functionalized species and is independent of each other, this process is also called as step growth polymerisation.

Condensation Polymers:

Terylene or Dacron: It is manufactured by heating a mixture of ethylene glycol and terephthalic acid at 420 to 460 K in the presence of zinc acetate-antimony trioxide catalyst.

Vulcanisation of rubber: The process of heating a mixture of raw rubber with sulphur and an appropriate additive in a temperature range between 373 K to 415 K to improve upon physical properties like elasticity, strength etc.

Examples of synthetic rubber:

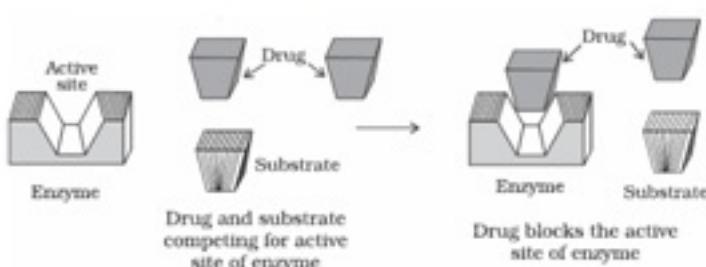
Biodegradable Polymers: Polymers which are degraded by microorganisms within a suitable period so that biodegradable polymers and their degraded products do not cause any serious effects on environment.

Examples of biodegradable polymer:

Commercially important polymers along with their structures and uses:

CBSE Class-12 Chemistry
Quick Revision Notes
Chapter 16
Chemistry in Everyday Life

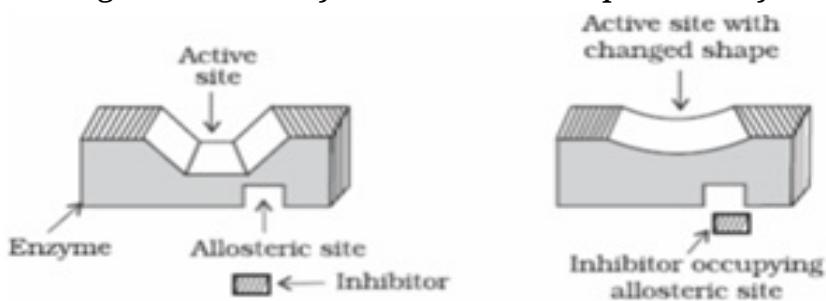
- **Drugs:** Drugs are low molecular mass substances which interact with targets in the body and produce a biological response.
- **Medicines:** Medicines are chemicals that are useful in diagnosis, prevention and treatment of diseases
- **Therapeutic effect:** Desirable or beneficial effect of a drug like treatment of symptoms and cure of a disease on a living body is known as therapeutic effect
- **Enzymes:** Proteins which perform the role of biological catalysts in the body are called enzymes
- **Functions of enzymes:**
 - (i) The first function of an enzyme is to hold the substrate for a chemical reaction. Active sites of enzymes hold the substrate molecule in a suitable position, so that it can be attacked by the reagent effectively.
 - (ii) The second function of an enzyme is to provide functional groups that will attack the substrate and carry out chemical reaction.
- **Role of drugs:** Main role of drugs is to either increase or decrease role of enzyme catalysed reactions. Inhibition of enzymes is a common role of drug action.
- **Enzyme inhibitor:** Enzyme inhibitor is drug which inhibits catalytic activity of enzymes or blocks the binding site of the enzyme and eventually prevents the binding of substrate with enzyme.
- Drug can inhibit attachment of substrate on active site of enzymes in following ways:
 - *



1. Competitive Inhibition: Competitive Inhibitors are the drugs that compete with the

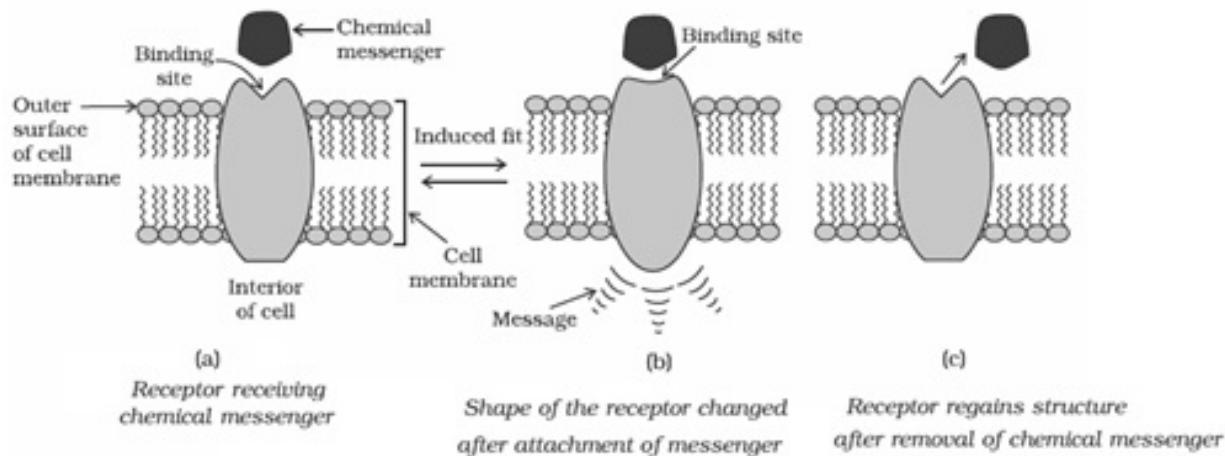
natural substrate for their attachment on the active sites of enzymes.

2. Non-Competitive Inhibition: Some drugs do not bind to the enzyme's active site, instead bind to a different site of enzyme called allosteric site. This binding of inhibitor at allosteric site changes the shape of the active site in such a way that substrate cannot recognise it. If the bond formed between an enzyme and an inhibitor is a strong covalent bond and cannot be broken easily, then the enzyme is blocked permanently. The body then degrades the enzyme-inhibitor complex and synthesizes the new enzyme.



Non-competitive inhibitor changes the active site of enzyme after binding at allosteric site

- **Receptors:** Proteins which are vital for communication system in the body are called receptors. Receptors show selectivity for one chemical messenger over the other because their binding sites have different shape, structure and amino acid composition.
- **Receptors as Drug Targets:** In the body, message between two neurons and that between neurons to muscles is communicated through chemical messengers. They are received at the binding sites of receptor proteins. To accommodate a messenger, shape of the receptor site changes which brings about the transfer of message into the cell. Chemical messenger gives message to the cell without entering the cell.



- **Antagonists and Agonists:** Drugs that bind to the receptor site and inhibit its natural function are called antagonists. These are useful when blocking of message is required. Drugs that mimic the natural messenger by switching on the receptor are called agonists. These are useful when there is lack of natural chemical messenger.
- **Therapeutic action of different classes of drugs:**
 - (i) Antacid: Chemical substances which neutralize excess acid in the gastric juices and give relief from acid indigestion, acidity, heart burns and gastric ulcers. Examples: Eno, gelusil, digene etc.
 - (ii) Antihistamines: Chemical substances which diminish or abolish the effects of histamine released in body and hence prevent allergic reactions. Examples: Brompheniramine (Dimetapp) and terfenadine (Seldane).
 - (iii) Neurologically Active Drugs: Drugs which have a neurological effect i.e. affects the message transfer mechanism from nerve to receptor.
- Tranquilizers: Chemical substances used for the treatment of stress and mild or severe mental diseases. Examples: Derivatives of barbituric acids like veronal, amytal, nembutal, luminal, seconal.
- Analgesics: Chemical substances used to relieve pain without causing any disturbances in the nervous system like impairment of consciousness, mental confusion, in coordination or paralysis etc.
- Classification of Analgesics:
 - (a) Non-narcotic analgesics: They are non-addictive drugs. Examples: Aspirin, Ibuprofen, Naproxen, Dichlofenac Sodium.
 - (b) Narcotic analgesics: When administered in medicinal doses, these drugs relieve pain and produce sleep. Examples: Morphine and its derivatives
- iv) Anti-microbials: Drugs that tends to destroy/prevent development or inhibit the pathogenic action of microbes such as bacteria (antibacterial drugs), fungi (anti-fungal agents), virus (antiviral agents), or other parasites (anti-parasitic drugs) selectively.
- v) Anti-fertility Drugs: Chemical substances used to prevent conception or fertilization are called anti-fertility drugs. Examples - Norethindrone, ethynodiol (novestrol).
- **Types of antimicrobial drugs :**

(a) Antibiotics: Chemical substances produced by microorganisms that kill or prevent the growth of other microbes.

Classification of antimicrobial drugs based on the mode of control of microbial diseases:

1. Bactericidal drugs - Drugs that kills organisms in body. Examples - Penicillin, Aminoglycosides, Ofloxacin.
2. Bacteriostatic drugs - Drugs that inhibits growth of organisms. Examples - Erythromycin, Tetracycline, Chloramphenicol.

Classification of antimicrobial drugs based on its spectrum of action:

1. Broad spectrum antibiotics - Antibiotics which kill or inhibit a wide range of Gram-positive and Gram-negative bacteria are called broad spectrum antibiotics. Examples - Ampicillin and Amoxycillin.
2. Narrow spectrum antibiotics - Antibiotics which are effective mainly against Gram-positive or Gram-negative bacteria are called narrow spectrum antibiotics. Examples- Penicillin G.
3. Limited spectrum antibiotics -Antibiotics effective against a single organism or disease

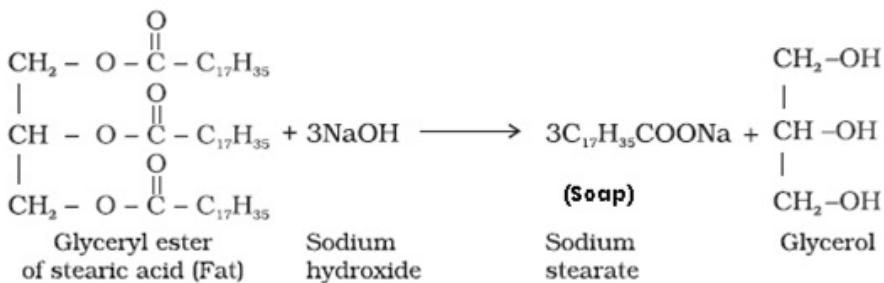
(b) Antiseptics: Chemical substances that kill or prevent growth of microorganisms and can be applied on living tissues such as cuts, wounds etc., are called anti-spetics. Examples - Soframicine, dettoletc.

(c) Disinfectants: Chemical substances that kill microorganisms but cannot be applied on living tissues such as cuts, wounds etc., are called disinfectants. Examples - Chlorine (Cl₂), bithional, iodoform etc.

- **Food additives:** Food additives are the substances added to food to preserve its flavor or improve its taste and appearance.
- **Different types of food additives:**

1. Artificial Sweetening Agents: Chemical compounds which gives sweetening effect to the food and enhance its flavour. Examples - Aspartame, Sucrolose and Alitame.
2. Food preservatives: Chemical substances which are added to food material to prevent their spoilage due to microbial growth. Examples - Sugar, Salts, Sodium benzoate

3. Food colours: Substances added to food to increase the acceptability and attractiveness of the food product. Examples - Allura Red AC, Tartrazine
 4. Nutritional supplements: Substances added to food to improve the nutritional value. Examples -Vitamins, minerals etc.
 5. Fat emulsifiers and stabilizing agents: Substances added to food products to give texture and desired consistency. Examples - Egg yolk (where the main emulsifying chemical is Lecithin)
 6. Antioxidants :Substances added to food to prevent oxidation of food materials. Examples - ButylatedHydroxy Toluene (BHT), ButylatedHydroxy Anisole (BHA).
- **Soaps:** It is a sodium or potassium salts of long chain fatty acids like stearic, oleic and palmitic acid.



This reaction is known as saponification.

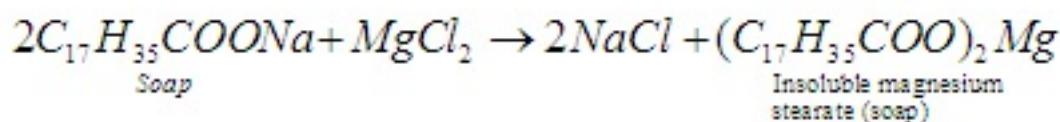
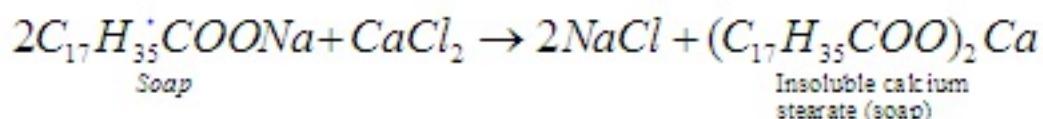
- **Types of soaps:**

1. Toilet soaps are prepared by using better grades of fats and oil sand care is taken to remove excess alkali. Colour and perfumes are added to make these more attractive.
2. Transparent soaps are made by dissolving the soap in ethanol and then evaporating the excess solvent.
3. In medicated soaps, substances of medicinal value are added. In some soaps, deodorants are added.
4. Shaving soaps contain glycerol to prevent rapid drying. A gum called, rosin is added while making them. It forms sodium rosinate which lathers well.
5. Laundry soaps contain fillers like sodium rosinate, sodium silicate, borax and sodium carbonate.
6. Soaps that float in water are made by beating tiny air bubbles before their hardening.
7. Soap chips are made by running a thin sheet of melted soap onto a cool cylinder and

scraping off the soaps in small broken pieces.

8. Soap granules are dried miniature soap bubbles.
9. Soap powders and scouring soaps contain some soap, a scouring agent (abrasive) such as powdered pumice or finely divided sand, and builders like sodium carbonate and trisodium phosphate.

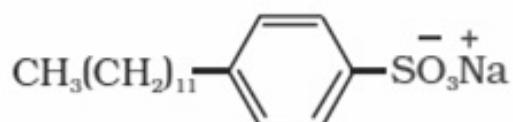
- **Advantages of using soaps:** Soap is a good cleansing agent and is 100% biodegradable i.e., micro-organisms present in sewage water can completely oxidize soap. Therefore, soaps do not cause any pollution problems.
- **Disadvantages of using soaps:** Soaps cannot be used in hard water because hard water contains metal ions like Ca^{2+} and Mg^{2+} which react with soap to form white precipitate of calcium and magnesium salts



These precipitates stick to the fibres of the cloth as gummy mass and block the ability of soaps to remove oil and grease from fabrics. Therefore, it interferes with the cleansing ability of the soap and makes the cleansing process difficult.

In acidic medium, the acid present in solution precipitate the insoluble free fatty acids which adhere to the fabrics and hence block the ability of soaps to remove oil and grease from the fabrics. Hence soaps cannot be used in acidic medium

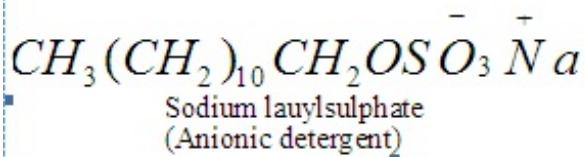
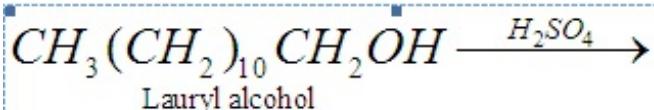
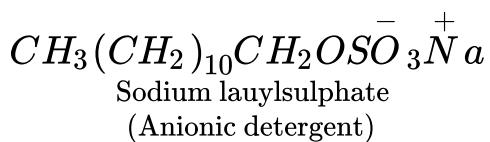
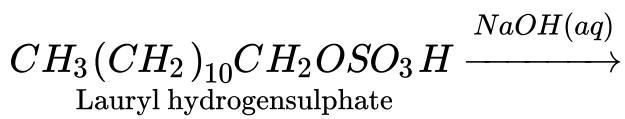
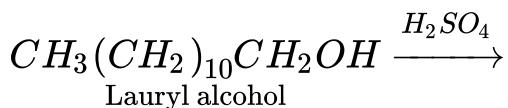
- **Detergents:** Detergents are sodium salts of long chain of alkyl benzene sulphonic acids or sodium salts of long chain of alkyl hydrogen sulphates.



Sodium dodecylbenzenesulphonate

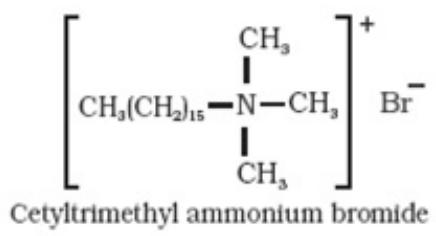
- **Classification of detergents:**

(a) Anionic detergents: Anionic detergents are sodium salts of sulphonated long chain alcohols or hydrocarbons. Alkyl hydrogen sulphates formed by treating long chain alcohols with concentrated sulphuric acid are neutralised with alkali to form anionic detergents. Similarly alkyl benzene sulphonates are obtained by neutralising alkyl benzene sulphonic acids with alkali. Anionic detergents are termed so because a large part of molecule is an anion.



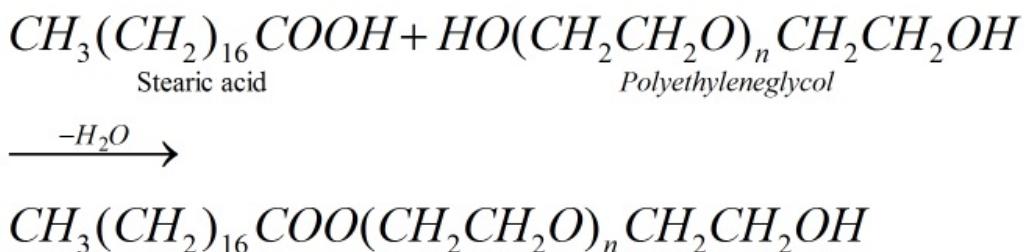
They are used in household cleaning like dishwasher liquids, laundry liquid detergents, laundry powdered detergents etc. They are effective in slightly acidic solutions where soaps do not work efficiently.

(b) Cationic detergents: Cationic detergents are quarternary ammonium salts of amines with acetates, chlorides or bromides as anions. Cationic parts possess a long hydrocarbon chain and a positive charge on nitrogen atom. Cationic detergents are termed so because a large part of molecule is a cation. Since they possess germicidal properties, they are used as germicides. They have strong germicidal action, but are expensive.



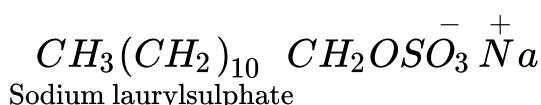
(c) Non- ionic detergents: They do not contain any ion in their constitution. They are like esters of high molecular mass.

Example: Detergent formed by condensation reaction between stearic acid reacts and poly ethyl eneglycol.



It is used in Making liquid washing detergents. They have effective H- bonding groups at one end of the alkyl chain which make them freely water soluble.

- **Biodegradable detergents:** Detergents having straight hydrocarbon chains that are easily decomposed by microorganisms. Example: Sodium lauryl sulphate



- **Non-Biodegradable detergents:** Detergents having branched hydrocarbon chains that are not easily decomposed by microorganisms.