Unit -I : Chemical Reactions and Equations

Chapter - 1 : Chemical Reactions and Equations

Quick Review

- A chemical reaction is a process in which the original substance(s) lose their nature and identity and form new substance(s) with different properties.
- Breaking of the chemical bonds and formation of the new chemical bonds is responsible for the occurrence of a chemical reaction.
- The substances which take part in chemical reaction are called **Reactants.**
- The substances which are formed in a chemical reaction are called **Products.**
- **Examples :** Where chemical reactions takes place :
  - **(i)** Digestion of food
  - **(ii)** Respiration
  - **(iii)** Rusting of iron
  - **(iv)** Burning of Magnesium ribbon
  - **(v)** Formation of curd
- A chemical reaction can be identified by either of the following observations :
  - **(i)** Change in state
  - **(ii)** Change in colour
  - **(iii)** Evolution of gas
  - **(iv)** Change in temperature
  - **(v)** Formation of a precipitate
- Writing a chemical equation :
  - **(i)** The symbols of elements and the formulae of reacting substances are written on the left hand side with a plus (+) sign between them.
  - **(ii)** The symbols and formulae of the substances formed are written on the right hand side with a plus sign (+) between them.
  - **(iii)** An arrow (→) sign is put between the reactants and the products.
  - **(iv)** The physical states of the reactants and products are also mentioned in a chemical equation.
- **Balanced Equations :** The equations in which atoms of various elements on both sides of a chemical equation are equal in accordance with the law of conservation of mass.
- The process of making atoms of various elements equal on either side of an equation is called balancing of chemical equation. This method of balancing the equation is known as hit and trial method.

  STEPWISE BALANCING (Hit and Trial)

  Step 1. Write a chemical equation and draw boxes around each formula.

$$Fe + H_2O \rightarrow Fe_3O_4 + H_2$$

- Do not change anything inside the box.

  Step 2. Count the number of atoms of each element on both the sides of chemical equation.

Element	No. of atoms at reactant side	No. of atoms at product side
1. Fe	1	3
2. H	2	2
3. O	1	4

  Step 3. Equalise the number of atoms of element which has maximum number by putting in front of it.

$$Fe + 4H_2O \rightarrow Fe_3O_4 + H_2$$

  Step 4. Try to equalize all the atoms of elements on reactant and product side by adding coefficient in front of it.

$$3Fe + 4H_2O \rightarrow Fe_3O_4 + 4H_2$$

- Now all the atoms of elements are equal on both sides.

Step 5. Write the physical states of reactants and products.

$$3Fe\ (s) + 4H_2O\ (g) \rightarrow Fe_3O_4\ (s) + 4H_2\ (g)$$

Solid state = (s)
Liquid state = (l)
Gaseous state = (g)
Aqueous state = (aq)

Step 6. Write necessary conditions of temperature, pressure or catalyst on arrow above or below.

TYPES OF CHEMICAL REACTIONS

I. COMBINATION REACTION : The reaction in which two or more reactant combine to form a single product.

e.g., (i) Burning of coal

$$C\ (s) + O_2\ (g) \rightarrow CO_2\ (g)$$

(ii) Formation of water

$$2H_2\ (g) + O_2\ (g) \rightarrow 2H_2O\ (l)$$

(iii) $CaO\ (s) + H_2O\ (l) \rightarrow Ca(OH)_2\ (aq)$

Quick lime Slaked lime

Exothermic Reactions : Reaction in which heat is released along with formation of products.

e.g., (i) Burning of natural gas.

$$CH_4\ (g) + O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (g) + Heat$$

(ii) Respiration is also an exothermic reaction.

$$C_6H_{12}O_6\ (aq) + 6O_2\ (g) \rightarrow 6CO_2\ (aq) + 6H_2O\ (l) + energy$$

II. DECOMPOSITION REACTION : The reaction in which a compound splits into two or more simple substances is called decomposition reaction.

$$A \rightarrow B + C$$

- **Thermal decomposition :** When decomposition is carried out by heating.

e.g., (i) $2FeSO_4\ (s) \xrightarrow{Heat} Fe_2O_3\ (s) + SO_2\ (g) + SO_3\ (g)$

(Ferrous sulphate) (Ferric oxide)
Green colour Red-brown colour

(ii) $CaCO_3\ (s) \xrightarrow{Heat} CaO\ (s) + CO_2\ (g)$

(Lime stone) (Quick lime)

- **Electrolytic Decomposition :** When decomposition is carried out by passing electricity.

e.g., $2H_2O \xrightarrow[current]{Electric} 2H_2 + O_2$

- **Photolytic Decomposition :** When decomposition is carried out in presence of sunlight.

e.g., (i) $2AgCl\ (s) \xrightarrow{Sunlight} 2Ag\ (s) + Cl_2\ (g)$

$2AgBr\ (s) \xrightarrow{Sunlight} 2Ag\ (s) + Br_2\ (g)$

- Above reaction is used in black and white photography.
- **Endothermic Reaction :** The reactions which require energy in the form of heat, light or electricity to break reactants are called endothermic reactions.

III. DISPLACEMENT REACTION : The chemical reactions in which more reactive element displaces less reactive element from its salt solution.

$$Fe\ (s) + CuSO_4\ (aq) \rightarrow FeSO_4\ (aq) + Cu\ (s)$$

The iron nail becomes brownish in colour by deposition of Cu and blue colour of $CuSO_4$ changes dirty green colour due to formation of $FeSO_4$.

$$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$$

Zn is more reactive than copper.

IV. DOUBLE DISPLACEMENT REACTION : A reaction in which new compounds are formed by mutual exchange of ions between two compounds.

$Na_2SO_4\ (aq)$ + $BaCl_2\ (aq)$ → $BaSO_4\ (s)$ + $2NaCl\ (aq)$

(Sodium sulphate) (Barium chloride) (Barium sulphate) (Sodium chloride)

White precipitate of $BaSO_4$ is formed, so it is also called precipitation reaction.

V. OXIDATION AND REDUCTION :

Oxidation : It is a process of gaining oxygen during a reaction.

$2Cu + O_2 \xrightarrow{Heat} 2CuO$

$CuO + H_2 \xrightarrow{Heat} Cu + H_2O$

Reduction : Reduction is just reverse of oxidation. It is a process of losing oxygen during a reaction.

$$CuO + H_2 \longrightarrow Cu + H_2O$$

In this reaction CuO is reduced to Cu and H_2 is oxidized H_2O. In other words, one reactant gets oxidised while the other gets reduced. Such reactions are called oxidation-reduction reactions or redox reactions.

- **Corrosion :** The surface of the reactive metals are attacked by air, water and other substances around it, and corrodes, the process is called corrosion. It is a redox reaction where metal gets oxidised to metal oxide and oxygen gets reduced to oxide ion.
- Rust is mainly hydrated iron (III) oxide $Fe_2O_3.xH_2O$. Rusting weakens the structure of the body of vehicles, bridges, iron railing etc.
- **Prevention of Rusting :**
  - **(i)** The iron articles should be painted.
  - **(ii)** The machine parts should be oiled and greased.
  - **(iii)** Galvanised iron pipes are used for water supply.
  - **(iv)** Iron can be coated with chromium to prevent rusting.
- **Rancidity :** Rancidity is the process of slow oxidation of oil and fat present in the food materials resulting in the production of foul odour and taste in them.
- When cooked food items are placed for a long time, they become rancid and unsuitable for the consumption.
- **Methods to prevent Rancidity :**
  - **(i)** Packing of food materials in air tight containers.
  - **(ii)** Refrigeration of cooked food at low temperature.

Know the Terms

- **Valency :** The number of electrons shared by an atom is called its valency. It is also called the combining capacity of an atom, *e.g.*, chlorine atom can share one valence electron as its valency is 1, oxygen can share two valence electrons as its valency is 2.
- **Chemical equation :** It is a complete symbolic representation of a chemical reaction involving reactants and products.
- **Balanced equation :** It is the equation in which atoms of various elements on the reactants and the products side are equal. The number of atoms of elements on both the sides of a chemical equation should be equal in accordance with the law of conservation of mass.
- In a **combination reaction**, two or more reactants combine to give a single product.

  For example : $\underset{\text{(Quick lime)}}{CaO(s)} + H_2O(l) \longrightarrow \underset{\text{(Slaked lime)}}{Ca(OH)_2(aq)}$

  Here, two reactants (quick lime and water) combine to produce a single product (slaked lime).
- In a **decomposition reaction**, a single reactant breaks down into two or more simpler products.

  For example : $\underset{\text{(Lead nitrate)}}{2Pb(NO_3)_2} \xrightarrow{\textbf{Heat}} \underset{\text{(Lead oxide)}}{2PbO(s)} + \underset{\text{(Nitrogen dioxide)}}{4NO_2(g)} + \underset{\text{(Oxygen)}}{O_2(g)}$

- When a decomposition reaction is carried out by heating, it is called **thermal decomposition reaction**.

  For example : $\underset{\text{(Calcium carbonate)}}{CaCO_3(s)} \xrightarrow{\textbf{Heat}} \underset{\text{(Quick lime)}}{CaO(s)} + \underset{\text{(Carbon dioxide)}}{CO_2(g)}$

- When a decomposition reaction is carried out in the presence of sunlight, the process is called as **photochemical decomposition**.

  For example : $\underset{\text{(Silver bromide)}}{2AgBr(s)} \xrightarrow{Sunlight} \underset{\text{(Silver)}}{2Ag(s)} + \underset{\text{(Bromine)}}{Br_2(g)}$

  This decomposition is used in black and white photography.

- **Electrolysis :** When a decomposition reaction is carried out with the help of electric current, the process is called electrolysis.

  For example : When a electric current is passed through the acidified water, it decomposes into hydrogen and oxygen gas.

  $$\underset{\text{(Water)}}{2H_2O(l)} \xrightarrow{\text{Electric current}} \underset{\text{(Hydrogen gas)}}{2H_2(g)} + \underset{\text{(Oxygen gas)}}{O_2(g)}$$

- In a **displacement reaction**, a more reactive element displaces a less reactive element from a compound.

  For example : $\underset{\text{(Iron)}}{Fe(s)} + \underset{\text{(Copper sulphate)}}{CuSO_4(aq)} \longrightarrow \underset{\text{(Iron sulphate)}}{FeSO_4(aq)} + \underset{\text{(Copper)}}{Cu(s)}$

  Here, more reactive element (Iron) displaces the less reactive element (Copper) from the salt of copper.

- The reactions in which the different atoms or group of atoms are displaced by other atoms or group of atoms, *i.e.* two compounds exchange their ions and one of the products formed is insoluble, are said to be **double displacement reactions**.

  For example : $\underset{\text{(Sodium sulphate)}}{Na_2SO_4(aq)} + \underset{\text{(Barium chloride)}}{BaCl_2(aq)} \longrightarrow \underset{\text{(Barium sulphate)}}{BaSO_4(s)} + \underset{\text{(Sodium chloride)}}{2NaCl(aq)}$

- The reactions in which acid or acidic oxide reacts with base or basic oxide to form salt and water are called **neutralization reactions.**

  For example : $\underset{\text{(Sodium hydroxide)}}{2NaOH} + \underset{\text{(Sulphuric acid)}}{H_2SO_4} \longrightarrow \underset{\text{(Sodium sulphate)}}{Na_2SO_4} + \underset{\text{(Water)}}{H_2O}$

- **Oxidation** is a process in which oxygen or an electronegative element is added. It can also be defined as a process in which hydrogen or an electropositive element is removed. In terms of electronic concept, oxidation is a process in which loss of electrons takes place.
- **Reduction** is a process in which addition of hydrogen or an electropositive element takes place. It is also defined as a process in which oxygen or an electronegative element is removed. In electronic concept, reduction process involves the gain of electrons.
- Those reactions in which oxidation and reduction take place simultaneously are called **redox reactions**.

  For example :

  $$\underset{\text{Reduction}}{MnO_2(s) + 4HCl\,(conc.)} \longrightarrow \underset{\text{Oxidation}}{MnCl_2(aq) + Cl_2(g) + 2H_2O}$$

- **Oxidising agent** is a substance which can add oxygen or an electronegative element to other materials. It can also remove hydrogen or an electropositive element from other materials.
- **Reducing agent** is a substance which can add hydrogen or an electropositive element to other materials. It can also remove oxygen or an electronegative element from other materials.

Chapter - 2 : Acids, Bases and Salts

Quick Review

- Acids are sour in taste. They turn blue litmus red. Acids are the substances that furnish H^+ ions in aqueous solution.
- If in an aqueous solution, concentration of acid is low, it is called dilute **solution** and if concentration of acid is high, it is called **concentrated solution**.
- Hydrochloric acid is released in stomach to make medium acidic in nature. It leads to coagulation of protein and helps in their digestion. HCl kills bacteria coming to the stomach along with the food.
- When a burning matchstick is brought near the hydrogen gas, it burns with a pop sound.
- When CO_2 gas is passed through lime water, it turns milky. If CO_2 is passed in excess, milkiness disappears.
- There are many natural substances like red onion peels, red cabbage leaves, beetroot extract, coloured petals of some flowers. They are called indicators because they indicate the presence of acid or base by showing the change in colour.

- Acids reacts with certain metal oxides to form salt and water. Acids react with metal carbonates and hydrogen carbonates to produce carbon dioxide gas.
- Strong bases react with active metals to produce hydrogen gas. Bases react with non-metallic oxides to produce salt and water.
- Both acids and bases conduct free electric current in their aqueous solution due to the presence of free ions.
- Strength of an acid or base depends on the number of H^+ ions or OH^- ions produced by them respectively. More the H^+ ions produced by an acid, stronger is the acid. More the OH^- ions produced by a base, stronger is the base.

Indicators :

These are the substances which change their colour / smell in different types of substances.

Types of Indicators

Natural indicators	**Synthetic indicators**	**Olfactory indicators**
Found in nature in plants.	These are chemical substances.	These substances have different odour in acid and bases.
Litmus, red cabbage leaves extract, flowers of hydrangea plant, turmeric	Methyl orange, phenolphthalein	

	S.No.	**Indicator**	**Smell/Colour in acidic solution**	**Smell/Colour in basic solution**
Natural Indicator	1.	Litmus	Red	Blue
	2.	Red cabbage leaf extract	Red	Green
	3.	Flower of hydrangea plant	Blue	Pink
	4.	Turmeric	No change	Red
Synthetic Indicator	1.	Phenolphthalein	Colourless	Pink
	2.	Methyl orange	Red	Yellow
Olfactory Indicator	1.	Onion	Characteristic smell	No smell
	2.	Vanilla essence	Retains smell	No smell
	3.	Clove oil	Retains smell	Loses smell

Chemical Properties of Acids and Bases

Reaction of Metals with

Acids	**Bases**
Acid + Metal → Salt + Hydrogen gas	Base + Metal → Salt + Hydrogen gas
e.g., $2HCl + Zn \rightarrow ZnCl_2 + H_2$	*e.g.*, $2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2\uparrow$ (Sodium zincate)

- Hydrogen gas released can be tested by ringing burning candle near gas bubbles, it burst with pop sound.

Reaction of Metal Carbonates / Metal Hydrogen Carbonates with

Acids	**Bases**

Acid + Metal Carbonate / Metal hydrogen Carbonate → Base + Metal Carbonate / Metal Hydrogen Carbonate

Salt + CO_2 + H_2O

e.g., $2HCl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O \rightarrow$ No Reaction

$HCl + NaHCO_3 \rightarrow NaCl + CO_2 + H_2O$

- CO_2 can be tested by passing it through lime water.

$Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$

(Lime water turns milky.)

- When excess CO_2 is passed,

$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO)_3$

(Milkiness disappears.)

Reaction of Acids and Bases With Each Other

Acid + Base → Salt + H_2O

Neutralisation Reaction : Reaction of acid with base is called as neutralization reaction.

e.g., $HCl + NaOH \rightarrow NaCl + H_2O$

IF :

Strong Acid + Weak Base → Acidic salt + H_2O

Weak Acid + Strong Base → Basic salt + H_2O

Strong Acid + Strong Base → Neutral salt + H_2O

Weak Acid + Weak Base → Neutral salt + H_2O

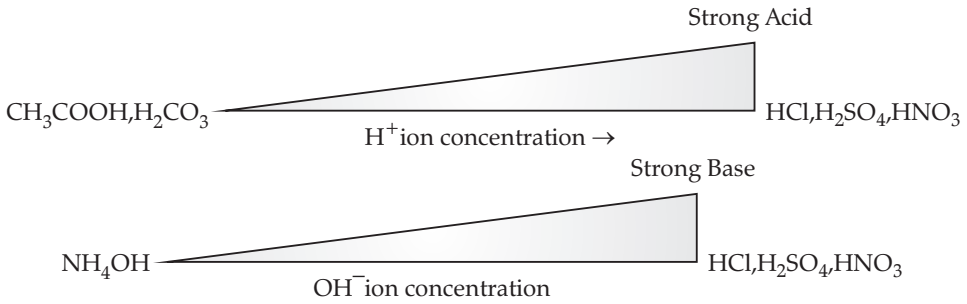
- pH of stomach is 1.5-3.0 due to secretion of HCl. In case of indigestion, acidity increases which can be neutralized by antacids like milk of magnesia.
- Cold drinks, chocolates and sweets are most harmful for health as well as tooth. They produce acids in mouth which are responsible for tooth decay.
- Salts of a strong acid and a strong base are neutral with pH value of 7.
- Salts have various uses in everyday life and in industries.
- A salt is soluble if it dissolves in water to give a solution with a concentration of at least 0.1 moles per litre at room temperature.

pH Scale : A scale for measuring H^+ ion concentration in a solution. *p* in pH stands for 'potenz' a German word which means power.

pH = 7 → neutral solution

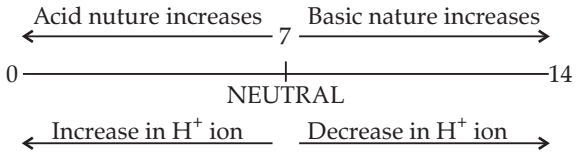
pH less than 7 → acidic solution

pH more than 7 → basic solution



On diluting an acid : pH increases ↑

On diluting a base : pH decreases ↓



Importance of pH in everyday life

1. Plants and animals are pH sensitive
   - Our body works within the pH range of 7 – 7.8.
   - When pH of rain water is less than 5.6, it is called acid rain.
2. pH of the soil
   - plants require a specific pH range for their healthy growth.

- **Salts :** Salts are formed when an acid and base reacts with each other Types of Salts :

1. Common Sal (NaCl) :

Preparation : $NaOH + HCl \rightarrow NaCl + H_2O$

2. Bleaching Powder ($CaOCl_2$) : It is produced by the action of chlorine on dry slaked lime.

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

Uses :

(a) Bleaching cotton and linen in textile industry.

(b) Bleaching wood pulp in paper factories.

(c) Oxidizing agent in chemical industries.

(d) Disinfecting drinking water.

3. Baking Soda (Sodium Hydrogen Carbonate) ($NaHCO_3$) :

$NaCl + H_2O + CO_2 + NH_3 \rightarrow NH_4Cl + NaHCO_3$

Baking soda

- It is mild non-corrosive base.
- When it is heated during cooking :

$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + H_2O + CO_2$

Uses :

(a) For making baking powder (mixture of baking soda and tartaric acid). When baking powder is heated or mixed with water, CO_2 is produced which causes bread and cake to rise making them soft and spongy.

(b) An ingredient in antacid.

(c) Used in soda acids, fire extinguishers.

4. **Washing Soda ($Na_2Co_3.10H_2O$) :** Recrystallization of sodium carbonate gives washing soda. It is a basic salt.

$$Na_2CO_3 + 10H_2O \rightarrow Na_2CO_3.10H_2O$$

Uses :

(a) In glass, soap and paper industry.

(b) Manufacture of borax.

5. **Plaster of Paris (Calcium sulphate hemihydrates) ($CaSO_4.½H_2O$) :** On heating gypsum ($CaSO_4.2H_2O$) at 373K, it loses water molecules and becomes Plaster of Paris (POP).

It is white powder and on mixing with water it changes to gypsum.

$$CaSO_4.½H_2O + 1½H_2O \rightarrow CaSO_4.2H_2O$$

Uses :

(a) Doctors use POP for supporting fractured bones.

(b) For making toys, material for decoration.

Know the Terms

- Those substances which turn blue litmus solution red are called acidic. The term 'acid' has been derived from the Latin word '*acidus*' which means sour. Acids are sour in taste. They give H^+ ions in aqueous solution.

  Example : HCl, H_2SO_4, HNO_3, CH_3COOH.
- Those substances which change their colour (or odour) in acidic or basic solutions are called **indicators**.
- The acids which are obtained from minerals are called **mineral acids**. Those acids which are obtained from plants and animals are called **organic acids**. Those acids which contain minimum amount of water are called **concentrated acids**.
- The acids which ionise almost completely are called **strong acids**, *e.g.*, mineral acids.
- The acids which ionise only partially or to a lesser extent are called **weak acids**, *e.g.*, organic acids.
- Substances that furnish hydroxide ions (OH^-) in aqueous solution are called **bases**. Bases have bitter taste and produce blue colour in litmus solution.
- The substances / bases which ionise completely to furnish OH^- ions are called **strong bases**, *e.g.*, KOH, NaOH etc.

  The bases which ionise only partially are called **weak bases**, *e.g.*, $Mg(OH)_2$, $Cu(OH)_2$ etc.
- Water soluble bases are called **alkalies**, *e.g.*, NaOH, KOH. Thus, all alkalies are bases but all bases are not alkali.
- When a concentrated acid or base is diluted, a vigorous reaction takes place. The process is called **dilution**. It is an exothermic process as a lot of heat is produced.
- The process of forming ions in aqueous solution is called **ionisation**. All ionic compounds like NaCl, $NaNO_3$, Na_2SO_4 form ions in aqueous solution.
- A **universal indicator** is a mixture of many different indicators which shows a gradual but well marked series of colour changes over a very wide range of change in concentration of H^+ ions.
- **pH** is the scale for measuring hydrogen ion concentration. The concentrations of H^+ are generally small, therefore concentrations of H^+ are expressed in terms of pH. pH is defined as negative logarithm of H^+ concentration or H_3O^+ concentration.

$$pH = -\log [H^+] \quad \text{or} \quad pH = -\log [H_3O^+]$$

- The reaction in which base or basic oxide reacts with acid or acidic oxide is called **neutralisation reaction**.

  Example : $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O.$
- A salt is an ionic compound that results from the neutralization reaction of an acid and a base. Salts are composed of related numbers of cations and anions, so that, the product is electrically neutral.

Chapter - 3 : Metals and Non-Metals

Quick Review

- Metals are mostly solids, possess high density. They have high melting and boiling points. They have lustre and they are sonorous. They are good conductors of heat and electricity.
- Most of the metals are hard. However some of the metals like sodium, potassium are soft metals and can be cut with knife.
- All metals are solids except Mercury, Cesium, Francium, Germanium and Gallium which are low melting solids Gallium becomes liquid if kept on palm. But Gallium has very high boiling point which makes it useful for high temperature thermometers.

I. Physical Properties

Property	Metals	Non-Metals
1. Lustre	Metals have shining surface.	They do not have shining surface. • Except Iodine.
2. Hardness	They are generally hard. • Except Sodium, Lithium and Potassium which are soft and can be cut with Knife.	Generally soft. • Except Diamond, a form of carbon which is the hardest natural substance.
3. State	Exist as solids. • Except Mercury.	Exist as solids or gaseous • Except Bromine.
4. Malleability	Metals can be beaten into thin sheets • Gold and Silver are the most malleable metals.	Non-metals are non-malleable.
5. Ductility	Metals can be drawn into thin wires.	They are non-ductile.
6. Conductor of heat & electricity	Metals are good conductor of heat and electricity.	Non-metals are poor conductor of heat and electricity. • Except Graphite.
7. Density	Generally have high density and high melting point. • Except Sodium and Potassium	Have low density and low melting point.
8. Sonorous	Metals produce a sound on striking a hard surface.	They are not sonorous.
9. Oxides	Metallic oxides are basic in nature.	Non-metallic oxides are acidic in nature.

I. Physical Properties

A. Reaction with Air :

Metals combine with oxygen to form metal oxide.

Metals + $O_2 \rightarrow$ Metal oxide

Examples :

(i) $2Cu + O_2 \rightarrow 3CuO$

Copper oxide (black)

(ii) $4Al + 3O_2 \rightarrow 2Al_2O_3$

Aluminium oxide

(iii) $2Mg + O_2 \rightarrow 2MgO$

Different metals show different reactivities towards O_2.

- Na and K react so vigorously that they catch fire if kept in open so they are kept immersed in kerosene.
- Surfaces of Mg, Al, Zn, Pb are covered with a thin layer of oxide which prevent them from further oxidation.
- Fe does not born on heating but iron fillings burn vigorously.
- Cud does not burn but is coated with black copper oxide.
- Au and Ag does not react with oxygen.

Amphoteric Oxides : Metal oxides which react with both acids as well as bases to produce salts and water called amphoteric oxides.

Examples : $Al_2O_3 + 6HCl \rightarrow 2AlCl_3 + H_2O$

$Al_2O_3 + 2NaOH \rightarrow 2NaAlO_2 + H_2O$

Sodium Aluminate

(B) Reaction of Metals with Water :

Metal + Water $\rightarrow$ Metal oxide + Hydrogen

Metal oxide + Water $\rightarrow$ Metal hydroxide

(D) Reaction of Metals with Solutions of other Metal Salts :

Metal A + Salt solution B $\uparrow$ Salt solution A + Metal B

- Reactive metals can displace less reactive metals from their compounds in solution form.

$$Fe + CuSO_4 \longrightarrow FeSO_4 + Cu$$

- All the metals do not react with the same rate. Some react very fast, some react moderately whereas others react very slowly. The series of metals in decreasing order of reactivity is called **reactivity** or **activity series of metals.** The metals at the top are most reactive whereas metals at the bottom are less reactive.

  K, Na, Ca, Mg, Al, Zn, Fe, Sn, Pb, H, Cu, Hg, Ag, Au, Pt.

- Metals react with dilute acids to form salt and hydrogen gas. The metal replaces hydrogen of the acid to form salt.
- **Aqua Regia** is a mixture of conc. HCl and conc. HNO_3 in the ratio of 3 : 1. It can dissolve gold and platinum. Aqua Regia is a strong oxidising agent due to the formation of NOCl (Nitrosyl chloride) and chlorine produced by reaction of two acids.
- **Alloys** are homogenous mixture of two or more metals. One of them can be non-metal also, *e.g.,* Brass is an alloy of copper and zinc. When a metal is alloyed with mercury, it is called amalgam.
- Metal, in reactivity series, if placed above hydrogen, can displace hydrogen from dilute acids (HCl and H_2SO_4).

Ionic Compounds

The compounds formed by the transfer of electrons from a metal to a non-metal are called ionic compounds or electrovalent compounds.

Properties of Ionic Compounds

1. **Physical nature :** The are solid and hard, generally brittle.
2. **Melting and Boiling Point :** They have high melting and boiling point.
3. **Solubility :** Generally soluble in water and insoluble in solvents such as kerosene, petrol etc.
4. **Conduction of electricity :** Ionic compounds conduct electricity in molten and solution form but not in solid state.

Occurrence of Metals

Minerals : The elements or compounds which occur naturally in the earth's crust are called minerals.

Ores : Minerals that contain very high percentage of particular metal and the metal can be profitably extracted from it , such minerals are called ores.

Know the Terms

- The ability of a metal due to which it can be beaten into sheets is called **malleability**. Iron, copper, zinc and aluminium are available in the form of a sheets. Aluminium, steel, copper, brass and bronze are used in making utensils.
- **Ductility** is the ability of metal due to which it can be drawn into wires. Copper, aluminium and iron can be drawn into wires. Silver, gold and platinum are highly ductile metals.
- **Electrical conductance** is the property due to which electric current can pass through the metal. It is due to presence of free electrons or mobile electrons. Copper, silver, gold and aluminium are good conductors of electricity.
- **Thermal conductivity** is the property due to which metals can conduct heat. *e.g.,* Copper, silver, aluminium, gold and iron are good conductors of heat.
- The process of forming oxide layer on the surface of metal is called **anodising**, *e.g.,* Aluminium forms an oxide layer on its surface when it is exposed to air. It is non-penetrating layer which protects it from corrosion.
- Metals in their pure state have bright shining surfaces. This property is called **metallic lustre**.
- When metals are struck with a hard substance, they produce sound. This property is called **sonority** and the metals are said to be **sonorous**.
- Those bases, which are soluble in water are called **alkalies**. Example, NaOH, KOH, $Ca(OH)_2$. The oxides which react with acids or acidic oxides to form salt and water are called Basic oxides. Example, Na_2O, CaO, K_2O, MgO. The oxides which react with bases or basic oxides to form salt and water are called **Acidic oxides** Example, CO_2, SO_2, SO_3, P_2O_5 etc.
- The oxides which are both acidic or basic in nature and react both with acids and bases to form salt and water are called as **Amphoteric oxide**. Example, ZnO, Al_2O_3 etc.
- The oxides which are neither acidic nor basic in nature, they are known as **Neutral oxides**. They neither react with acids nor with bases. Some non-metals form neutral oxides. Example, CO, NO, N_2O etc.
- The compounds in which metal loses electrons and non-metal gains electrons are called **electrovalent compounds or ionic compounds**. Example, NaCl, KCl etc.

$$2Na + Cl_2 \longrightarrow 2NaCl$$

Sodium Chlorine Sodium chloride

- A stable group of eight electrons in the outermost orbit of the atom is known as **Octet**.

The bond which is formed by loss and gain of electrons is called **ionic** or **electrovalent bond**.

- **Ionic compounds** or **electrovalent compounds** are solid, hard and brittle due to strong force of attraction between them. They have high melting and boiling points. These compounds are soluble in water but insoluble in organic solvents.
- **Corrosion** is a process in which metal reacts with substance present in the atmosphere to form surface compounds *e.g.*, silver metal turns black due to formation of Ag_2S, iron forms reddish brown coating of hydrated ferric oxide, $Fe_2O_3.xH_2O$.
- The process of coating iron articles with zinc which is more reactive than iron is called **Galvanisation**.
- **Metallurgy :** All the processes involved in the extraction of metals from their ores and refining them for use, is called metallurgy.
- **Ore-dressing** is a process of removing unwanted substances from the ore. This is also known as concentration of the ore or enrichment of ore. It is usually done by hydraulic washing, magnetic separation or froth floatation process.
- **Froth floatation** process is based on the principle that the mineral particles are more wetted by the oil, whereas the gangue particles are more wetted by water. Compressed air is bubbled through the mixture. As a result of agitation, oil froth is formed which contains minerals which float on the top of water and can be separated easily.
- The unwanted material present in the ores mined from earth is called **Gangue**. It needs to be removed prior to the extraction process.
- **Leaching** makes use of difference in the chemical properties of minerals and gangue. The ore is treated with suitable reagent which reacts with the ore, but not with the gangue. The purified ore is regenerated by sequence of reactions. An example of leaching is Baeyer's method of obtaining pure aluminium oxide from Bauxite.
- **Roasting** is the process in which ore is heated in the presence of air so as to obtain metal oxides, which can be reduced easily to get free metal. Sulphide ores are converted into oxides by roasting.

$$2ZnS(s) + 3O_2(g) \xrightarrow{\text{Heat}} 2ZnO(s) + 2SO_2(g)$$

- **Calcination** is the process of heating ore in absence of air so as to remove moisture and volatile impurities and to convert carbonate ores into oxides.

$$ZnCO_3(s) \xrightarrow{\text{Heat}} ZnO(s) + CO_2(g)$$

- **Thermite** process is a process in which molten metal oxides are treated with aluminium powder. It is highly exothermic reaction. The molten metal obtained is used for welding of railway tracks or cracked machine parts.

$$\underset{\text{Aluminium}}{2Al} + \underset{\text{Haematite}}{Fe_2O_3} \longrightarrow \underset{\text{Molten iron}}{2Fe} + \underset{\text{Aluminium oxide}}{Al_2O_3} + \text{Heat}$$

- **Refining** is a process of converting impure metal into pure metal by different processes depending on the nature of metals. It is a process of purification of metal.
- The substance which reacts with gangue to form a fusible mass which can easily be removed is known as **flux**, *e.g.*, CaO, (Calcium oxide) is used as flux so as to remove SiO_2 (Silica) as gangue.
- The fusible mass formed by the reaction of flux and gangue is known as **slag**. Slag is lighter than molten metal, hence floats over molten metal and can be easily removed. It prevents metal from oxidation.

Chapter - 4 : Carbon and Its Compounds

Quick Review

- The element carbon is non-metal. Its symbol is C.
- Carbon is a versatile element the percentage of carbon present in earth crust in form of mineral is 0.02% and in atmosphere as CO_2 is 0.03%.
- All the living things, plants and animals are made up of carbon based compounds.

  Carbon always from covalent bonds :

  The atomic number of carbon is 6.

  Electronic configuration :

	K	L
C (6)	2	4

  How carbon attain noble gas configuration ?

  (i) Carbon is tetravalent, it does not form ionic bond by either losing four electrons (C^{4+}) or by gaining four electrons (C^{4-}). It is because, it is difficult to hold four extra electron and would require large amount of

energy to remove four electrons. So, carbon can form bond by sharing of its electron with the electrons. of other carbon atom or with other element and attain noble gas configuration.

(ii) The atoms of other elements like hydrogen, oxygen and nitrogen, chlorine also form bonds by sharing of electrons.

(iii) The bond formed by sharing of electrons between same or different atoms is covalent bond.

- **Covalent Bond :** A covalent bond is formed by sharing of electrons between atoms. In a covalent bond, the shared pair of electrons belongs to the valence shell of both the atoms.
- Carbon forms covalent bonds.
- **Conditions for Formation of a Covalent Bond :**

(i) The combining atoms should have 4 to 7 electrons in their valence shell.

(ii) The combining atoms should not lose electrons easily.

(iii) The combining atoms should gain electrons readily.

(iv) The difference in electronegativities of two bonded atoms should be low.

- **Properties of Covalent Compounds :**

(i) Physical states : They are generally liquid or gases. Some covalent compounds may exist as solid.

(ii) Solubility : They are generally insoluble in water and other polar solvents but soluble in organic solvents such as benzene, toluene etc.

(iii) Melting and boiling points : They generally have low melting and boiling points.

(iv) Electrical conductivity : They do not conduct electrical current.

- **Steps for Writing the Lewis Dot Structures of a Covalent Compound :**

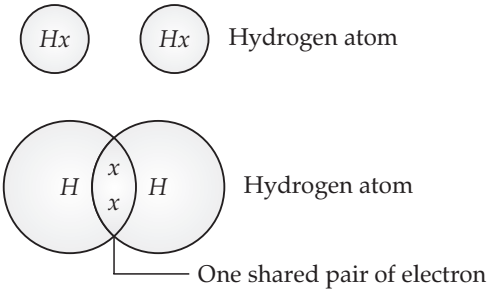
(i) Write the electronic configuration of all the atoms present in the molecule.

(ii) Identify how many electrons are needed by each atom to attain noble gas configuration.

(iii) Share the electrons between atoms in such a way that all the atoms in a molecule have noble gas configuration.

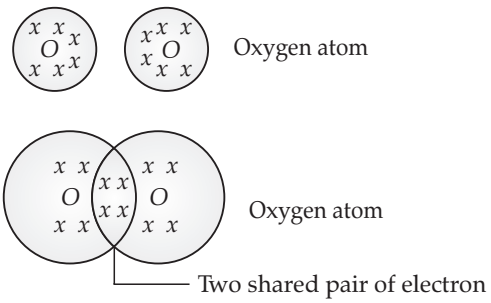
(iv) Keep in mind that the shared electrons are counted in the valence shell of both the atoms sharing it.

(i) H_2



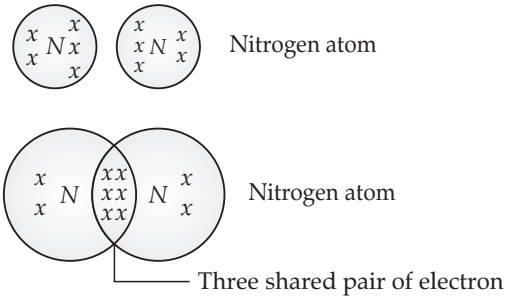
H – H Single bond between hydrogen atoms

(ii) O_2



O = O double bond between oxygen atoms

(iii) N_2

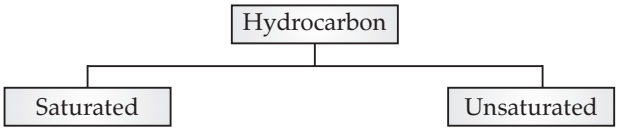


N ≡ N triple bond between nitrogen atoms

Saturated and Unsaturated Carbon Compounds

Compounds made up of hydrogen and carbon are called hydrocarbon.

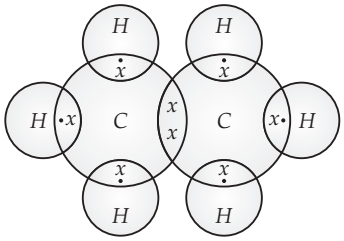
There are acyclic carbon compounds which form open carbon chains.

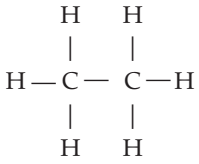


Saturated	Unsaturated	
➢ Single bond between carbon atoms.	➢ Double or triple bond between carbon atoms.	
➢ – C – C –	➢ – C = C –	– C ≡ C –
➢ Alkanes	➢ Alkenes	Alkynes
General formulae		
C_nH_{2n+2}	C_nH_{2n}	C_nH_{2n-2}

Electron Dot Structure of Saturated Hydrocarbons

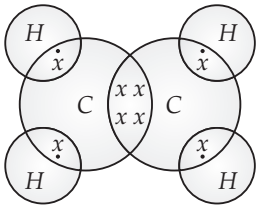
Ethane C_2H_6

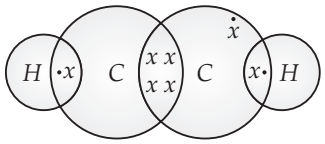


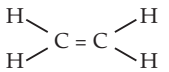


Electron Dot Structure of Unsaturated Hydrocarbons

Ethene C_2H_4 Ethyne C_2H_2







H – C = C – H

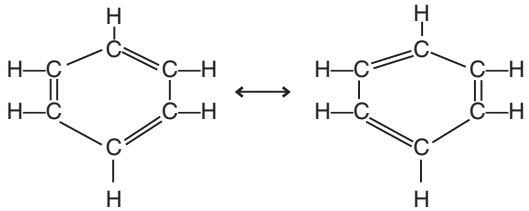
(2) Cyclic or Closed Chain Hydrocarbons : These are the hydrocarbons which do not have carbon carbon closed chain.

They are classified as :

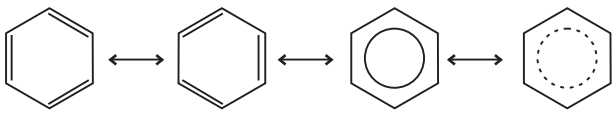
(i) Alicyclic hydrocarbons : These are the hydrocarbons which do not have benzene ring in their structures.

(ii) Aromatic hydrocarbons : These are the hydrocarbons which have benzene ring in their structures. When hydrogen bonded to carbon of benzene is substituted with halogens, radicals or other functional groups, the derivatives are called aromatic compounds.

➢ **Benzene :** It is an aromatic hydrocarbon which has the molecular formula C_6H_6. It has alternating carbon- carbon single and double bonds.



Benzene can also be represented as :



IUPAC name of hydrocarbon consists of two parts. It involves :

(i) Word root : Number of carbons in the longest carbon chain.

Number of carbon atoms	Word root (Greek name)
1	Meth
2	Eth
3	Prop
4	But
5	Pent
6	Hex
7	Hept
8	Oct
9	Non
10	Dec

(ii) Suffix : It depends on the type of carbon - carbon bond for single bond, suffix is – ane; for double bond, suffix is – *ene*; and for triple bond suffix is – *yne*.

- **Types of Formula for Writing Hydrocarbons :**

  (i) Molecular formula : It involves the actual number of each type of atom present in the compound.

  (ii) Structural formula : The actual arrangement of atoms is written in structural formula.

  (iii) Condensed formula : It is the shortened form of the structural formula.

Functional Groups

- In hydrocarbon chain, one or more hydrogen atom is replaced by other atoms in accordance with their valencies. These are heteroatom.
- These heteroatom or group of atoms which make carbon compound reactive and decides its properties are called functional groups.

Hetero atom	Functional group	Formula of functional group
Dl/Br	Halo (Chloro/Bromo)	— Cl, — B*r*, — I
Oxygen	1. Alcohol	— OH
	2. Aldehyde	— CHO
	3. Ketone	— **C** — || **O**
	4. Carboxylic acid	O || — C — OH
Double bond	1. Alkene group	> C = C <
Triple bond	2. Alkyne group	— C ≡ C —

- **Homologous Series :** A series of organic compounds in which every succeeding member differs from the previous one by – CH_2 or 14 a.m.u. is called homologous series. The molecular formula of all the members of a homologous series can be derived from a general formula.
- **Properties of a homologous series :** As the molecular mass increases in a series, physical properties of the compounds show a variation, but chemical properties which are determined by a functional group remain the same within a series.
- **Homologous series of alkanes :** General formula : C_nH_{2n+2}, where n = number of carbon atoms. CH_4, C_2H_6, C_3H_8..
- **Homologous series of alkenes :** General formula : C_nH_{2n}, where n = number of carbon atoms. C_2H_4, C_3H_6, C_4H_8..
- **Homologous series of alkynes :** General formula : C_nH_{2n-2}, where n = number of carbon atoms. C_2H_2, C_3H_4, C_4H_6..

Chemical Properties of Carbon Compounds

(a) Combustion

$$CH_4 + 2O_2 \xrightarrow{\text{Combustion}} CO_2 + 2H_2O + \text{Heat} + \text{Light}$$

- Carbon and its compounds are used as fuels because they burn in air releasing lot of heat energy.
- Saturated hydrocarbon generally burn in air with blue and non-sooty flame.
- Unsaturated hydrocarbon burns in air with yellow sooty flame because percentage of carbon is higher than saturated hydrocarbon which does not get completely oxidized in air.

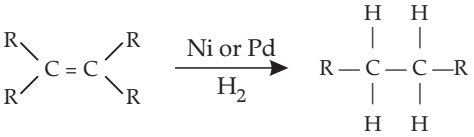
(b) Oxidation

Alcohols can be converted to carboxylic acid in presence of oxidizing agent alkaline $KMnO_4$ (potassium permanganate) or acidic potassium dichromate.

$$CH_3CH_2OH \xrightarrow[\text{Acidic } K_2Cr_2O_7]{\text{Alkaline } KmnO_4 \text{ Or}} CH_3COOH$$

Ethanol Ethanoic acid

(c) Addition Reaction :



Unsaturated hydrocarbon add hydrogen in the presence of catalyst palladium or nickel. Vegetable oils are converted into vegetable ghee using this process. It is also called hydrogenation of vegetable oils.

(d) Substitution Reaction :

$$CH_4 + Cl_2 \xrightarrow{\text{Sunlight}} CH_3Cl + HCl$$

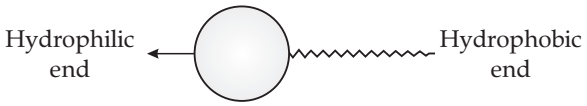
Soaps and Detergents

- Soap is sodium or potassium salt of long chain carboxylic acid. *e.g.*, $C_{17}H_{35}COONa^+$
- Soaps are effective only in soft water.
- Detergents are ammonium or sulphonate salt of long chain of carboxylic acid.
- Detergents are effective in both hard and soft water.

Soap molecule has :

(i) Ionic (hydrophilic) part

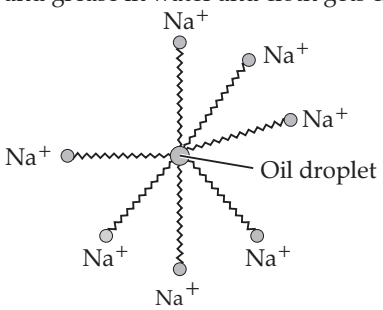
(ii) Long hydrocarbon chain (hydrophobic) part



Structure of soap molecule

Cleansing Action of Soap

- Most dirt is oily in nature and hydrophobic end attaches itself with dirt and the ionic end is surrounded with molecule of water. This result in formation of a radial structure called micelles.
- Soap micelles helps to dissolve dirt and grease in water and cloth gets cleaned.



- The magnesium and calcium salt present in hard water react with soap molecule to form insoluble product called scum. This scum create difficulty in cleansing action.
- By use of detergent, insoluble scum is not formed with hard water and cloths get cleaned effectively.

Know the Terms

- **Catenation :** The self linking property of carbon atoms through covalent bonds to form long chains and rings is called catenation.
- **Tetravalency :** Tetravalency is the state of an atom in which there are four electrons available with the atom for covalent chemical bonding. Carbon has a valency of four. So, it is capable of making bonds with four other atoms of carbon or any other element.
- **Electronegativity :** It is the ability of an atom to attract a shared pairs of electrons towards itself.
  If the atoms forming a covalent bond have different electronegativities, the atom with higher electronegativity pulls the shared pair of electrons towards itself. Thus, the atom with the higher electronegativity develops a partial negative charge and the atom with the lower electronegative develops a partial positive charge. This bond with some polarity is called polar covalent bond.

- **Isomerism :** The compounds which possess the same molecular formula but different structural formulae, are called isomers, and the phenomenon is known as isomerism. For example, butane with a molecular formula C_4H_{10} has two isomers.

$CH_3 — CH_2 — CH_2 — CH_3$ (*n*-butane)

$$CH_3 — \underset{\displaystyle CH_3}{\underset{|}{CH}} — CH_3$$

Iso-butane

- **Homologous Series :** It is a family of organic compounds having the same functional group in which the formulae of successive members differ by – CH_2 group. For example, CH_4, C_2H_6, C_3H_8, C_4H_{10} etc. All the members of a homologous series have similar structures and same chemical properties.
- **Oxidation :** Oxidation means controlled combustion. For example, when ethanol is heated with alkaline potassium permanganate solution or acidified potassium dichromate solution, it gets oxidised to ethanoic acid.

$$CH_3CH_2OH \xrightarrow[\text{Acidified}K_2Cr_2O_7+\text{Heat}]{\text{Al. }KMnO_4+\text{Heat}} CH_3COOH$$

- **Esterification Reaction :** When an organic acid reacts with an alcohol in the presence of acid catalyst, it produces a sweet smelling (fruity smell) substance called ester. The reaction is known as esterification reaction.

$$\underset{\text{Ethanoic acid}}{CH_3COOH} + \underset{\text{Ethanol}}{C_2H_5OH} \xrightarrow{H_2SO_4} \underset{\text{Ethyl acetate (ester)}}{CH_3COOC_2H_5} + H_2O$$

- **Saponification Reaction :** Esters react in the presence of an acid or a base to give back the alcohol and the carboxylic acid. This reaction is known as saponification because it is used in the preparation of soap.

$$CH_3COOC_2H_5 \xrightarrow{NaOH} CH_3COOH + C_2H_5OH.$$

- **Soaps and Detergents :** Soaps are sodium and potassium salts of long chain (higher) fatty acids such as stearic acid, palmitic acid etc. Detergents are ammonium or sulphonate salts of long chain hydrocarbons.

Chapter - 5 : Periodic Classification of Elements

Quick Review

Need for Periodic Classification

- To make the study of these elements easy, these element have been divided into few groups in such a way that elements in the same group have similar properties. Now study of a large number of elements is reduced to a few groups of elements.
- **Dobereiner's Triads :** When elements were arranged in the order of increasing atomic masses, groups of three elements (known as triads), having similar chemical properties are obtained.

  The atomic mass of the middle element of the triad was roughly the average of the atomic masses of the order two elements.

Elements	Atomic Mass
Ca	40.1
Sr	87.6
Ba	137.3

  Limitations : Only three triads were recognized from the elements known at that time.

Li	Ca	Cl
Na	Sr	Br
K	Ba	I

- Dobereiner could identify only three triads. He was not able to prepare triads of all the known elements.
- **Newlands Law of Octaves :** John Newlands arranged elements in order of increasing atomic mass.

  It states when elements are arranged in increasing order of atomic mass, the properties of the eighth element are a kind of repetition of the first, just like notes of music.

- **Table showing Newlands Octaves :**

Sa (do)	re (re)	ga (mi)	ma (fa)	pa (so)	dha (la)	ni (ti)
H	Li	Be	B	C	N	O
F	Na	Mg	Al	Si	P	S
Cl	K	Ca	Cr	Ti	Mn	Fe
Co & Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce, La	Zn		

- **Limitations of Newlands law of octaves :**
  - **(i)** The law was applicable to elements up to calcium (Ca) only.
  - **(ii)** It contained only 56 elements. Further it was assumed by Newlands that only 56 elements existed in nature and no more elements would be discovered in the future.
  - **(iii)** In order to fit elements into the table, Newlands adjusted two elements in the same column as fluorine, chlorine and bromine which have very different properties than these elements. Iron, which resemble cobalt and nickel in properties, has been placed differently away from these elements.
- **Mendeleev's Periodic Table :** Dmitri Ivanovich Mendeleev, a Russian chemist, was the most important contributor to the early development of a periodic table of elements where in the elements were arranged on the basis of their atomic mass and chemical properties.
- **Characteristics of Mendeleev's Periodic Table :**
  - **(i)** Mendeleev arranged all the 63 known elements in increasing order of their atomic masses.
  - **(ii)** The table consists of vertical columns called 'groups' and horizontal rows called 'periods'.
  - **(iii)** The elements with similar physical and chemical properties came under same groups.
- **Mendeleev's Periodic Law :** The properties of elements are the periodic functions of their atomic masses.
- **Merits of Mendeleev's Periodic Table**
  - **(i)** Mendeleev left some blank spaces for undiscovered elements.
  - **(ii)** Mendeleev predicted the discovery of some elements and named them as eka-boron, eka aluminium and eka-silicon.
  - **(iii)** Noble gases discovered later could be placed without disturbing the existing order.
- **Limitations of Mendeleev's periodic table :**
  - **(i) Position of Hydrogen :** Could not assign a correct position to hydrogen as hydrogen resembles alkali metals as well as halogens.
  - **(ii) Position of Isotopes :** Isotopes are places in same position though they have different atomic masses.
  - **(iii)** Separation of chemically similar elements while dissimilar elements are placed in the same group.
- **Modern Periodic Table :** Henry Moseley gave a new property of elements, 'atomic numbers' and this was adopted as the basis of Modern Periodic Table.
- **Modern Periodic Law :** Properties of elements are the periodic functions of their atomic numbers.
- **Position of elements in modern periodic table :**
  - **(i)** The Modern Periodic Table consists of 18 groups and 7 periods.
  - **(ii)** Elements present in any one group have the same number of valence electrons. Also, the number of shells increases as we go down the group.
  - **(iii)** Elements present in any one period, contain the same number of shells. Also, with increase in atomic number by one unit on moving from left to right, the valence shell electron increases by one unit.
  - **(iv)** Each period marks a new electronic shell getting filled.
- **Trends in the Modern Periodic Table :**
  - **(i) Periodicity in Properties :** The properties of elements depend upon the electronic configuration which changes along a period and down a group in the periodic table. The periodicity properties i.e. repetition of properties after a regular interval is due to similarity in electronic configuration.
  - **(ii) Tendency to lose or gain electron :** Chemical reactivity of an element depends upon the ability of its atoms to donate or accept electrons.
  - **(iii) Variations of tendency to lose electron down the group :** Tendency to lose electron goes on increasing down the group.

Reason : It is due to the increase in the distance between the valence electrons and the nucleus as the atomic size increases down the group, the force of attraction between the nucleus and the valence electrons decreases, therefore, tendency to lose electron also increases down the group.

(iv) Variation of tendency to lose electron along a period : It goes on decreasing generally along a period from left to right with decrease in atomic size.

Reason : Due to decrease in the atomic size, the force of attraction between the valence electrons and the nucleus increases and, therefore, electrons cannot be removed easily.

(v) Variation of tendency to gain electron down the group : It goes on decreasing down the group in general.

Reason : Due to increase in atomic size, the force of attraction between the nucleus and the electron to be added becomes less.

(vi) Variation of tendency to gain electron along a period : It increases left to right in a period.

Reason : It is due to decrease in the atomic size which leads to an increase in the force of attraction between the nucleus and the electron to be added.

- **Metallic and non-metallic character :** Group 1 to 12 are metals. Group 13 to 18 comprises non-metals, metalloids and metals.
- **Properties of Metals :**
  - **(i)** They are malleable.
  - **(ii)** They are ductile.
  - **(iii)** They are good conductors of heat and electricity.
  - **(iv)** They have generally 1 to 3 valence electrons.
  - **(v)** They have the same or less number of electrons in their outermost shell than the number of shells.
  - **(vi)** They are mostly solids.
- **Properties of Non-metals :**
  - **(i)** They exist in solid, liquid or gaseous state.
  - **(ii)** Non-metals are generally brittle.
  - **(iii)** They are non-conductors.
  - **(iv)** They have 4 to 8 valence electrons.

Know the Terms

- **Mendeleev's Periodic Law :** This law states that the properties of elements are the periodic function of their atomic masses.
- Anomalies in arrangement of elements based on increasing atomic mass could be removed when the elements were arranged in order of increasing atomic number, a fundamental property of the element discovered by Moseley in 1913.
- **Modern Periodic Law :** According to this law, the properties of elements are periodic function of their atomic number.
- The 18 vertical columns in modern periodic table are known as groups whereas 7 horizontal rows in modern periodic table are called periods.
- **Periodicity :** When the elements are arranged in order of increasing atomic numbers, elements with similar chemical properties are repeated at definite intervals. This is known as periodicity.
- **Atomic Radius :** Atomic radius is defined as the distance from the centre of the nucleus of an atom to the outermost shell of electrons.
- **Covalent Radii :** It is defined as half of the distance between the centre of nuclei of two atoms (bond length) bonded by a single covalent bond *e.g.,* bond length in case of H—H is 74 pm.

  Covalent radius : $\frac{1}{2} \times 74 = 37$ pm

  It can be measured in case of diatomic molecules of non-metals.
- **Metallic Radii :** It is defined as half of the internuclear distance between the two metal ions in a metallic crystal.
- **Metalloids :** Those elements which resemble both metals and non-metals are called metalloids. They are also called semi-metals. *e.g.,* Boron, Silicon, Germanium, Arsenic, Antimony, Tellurium and Polonium.

➢ **Isotopes :** Elements which have same atomic number but different mass number are called isotopes.

Example : $^{35.5}_{17}Cl$, $^{37.5}_{17}Cl$, or $^{1}_{1}H$, $^{2}_{1}H$, $^{3}_{1}H$.

Periodic Table of Elements

Key: Atomic # / **Symbol** / Name / Atomic Mass

State: C – Solid; Hg – Liquid; H – Gas; Rf – Unknown

Metals: Alkali metal; Alkaline earth metal; Lanthanoids; Actinoids; Transition; Poor metals

Non-metals: Other non-metals; Noble gases

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
1	1 **H** Hydrogen 1.0079																	2 **He** Helium 4.0026	K
2	3 **Li** Lithium 6.941	4 **Be** Beryllium 9.0122											5 **B** Boron 10.811	6 **C** Carbon 12.011	7 **N** Nitrogen 14.007	8 **O** Oxygen 15.999	9 **F** Fluorine 18.998	10 **Ne** Neon 20.180	K L
3	11 **Na** Sodium 22.990	12 **Mg** Magnesium 24.305											13 **Al** Aluminium 26.982	14 **Si** Silicon 28.086	15 **P** Phosphorus 30.974	16 **S** Sulphur 32.065	17 **Cl** Chlorine 35.453	18 **Ar** Argon 39.948	K L M
4	19 **K** Potassium 39.098	20 **Ca** Calcium 40.078	21 **Sc** Scandium 44.956	22 **Ti** Titanium 47.867	23 **V** Vanadium 50.942	24 **Cr** Chromium 51.996	25 **Mn** Manganese 54.938	26 **Fe** Iron 55.845	27 **Co** Cobalt 58.933	28 **Ni** Nickel 58.693	29 **Cu** Copper 63.546	30 **Zn** Zinc 65.39	31 **Ga** Gallium 69.723	32 **Ge** Germanium 72.64	33 **As** Arsenic 74.922	34 **Se** Selenium 78.96	35 **Br** Bromine 79.904	36 **Kr** Kypton 83.798	K L M N
5	37 **Rb** Rubidium 85.468	38 **Sr** Strontium 87.62	39 **Y** Yttrium 88.905	40 **Zr** Zirconium 91.224	41 **Nb** Niobium 92.906	42 **Mo** Molybdenum 95.96	43 **Tc** Technetium (98)	44 **Ru** Ruthenium 101.07	45 **Rh** Rhodium 102.91	46 **Pd** Palladium 106.42	47 **Ag** Silver 107.87	48 **Cd** Cadmium 112.41	49 **In** Indium 114.82	50 **Sn** Tin 118.71	51 **Sb** Antimony 121.76	52 **Te** Tellurium 127.60	53 **I** Iodine 126.90	54 **Xe** Xenon 131.29	K L M N O
6	55 **Cs** Caesium 132.91	56 **Ba** Barium 137.33	57-71 **La-Lu** Lanthanide	72 **Hf** Hafnium 178.49	73 **Ta** Tantalum 180.95	74 **W** Tungsten 183.21	75 **Re** Rhenium 186.21	76 **Os** Osmium 190.23	77 **Ir** Iridium 192.22	78 **Pt** Platinum 195.08	79 **Au** Gold 196.97	80 **Hg** Hercury 200.59	81 **Tl** Thallium 204.38	82 **Pb** Lead 207.2	83 **Bi** Bismuth 209.98	84 **Po** Polonium 208.98	85 **At** Astatine (210)	86 **Rn** Radon (222)	K L M N O P
7	87 **Fr** Francium (223)	88 **Ra** Radum (226)	89-103 **Ac-Lr** Actinide	104 **Rf** Rutherfordium (267)	105 **Db** Dubnium (268)	106 **Sg** Seaborgium (271)	107 **Bh** Bohrium (272)	108 **Hs** Hassium (277)	109 **Mt** Meitnerium (276)	110 **Ds** Darmstadtium (281)	111 **Rg** Roentgenium (280)	112 **Cn** Copernicium (285)	113 **Uni** Ununtrium	114 **Fi** Flerovium	115 **UuP** Ununpentium	116 **Lv** Livermorium (291)	117 **Uus** Ununesptium	118 **Uno** Ununoctium	K L M N O P Q

For elements with no stable isotopes, the mass number of the isotope with the longest half-life is in parentheses.

58 **Ce** Cerium 140.12	59 **Pe** Praseodymium 140.91	60 **Nd** Neodymium 144.24	61 **Pm** Promethium (145)	62 **Sm** Samarium 150.36	63 **Eu** Europium 151.96	64 **Gd** Gadolinium 157.25	65 **Tb** Terbium 158.93	66 **Dy** Dysprosium 162.50	67 **Ho** Holmium 164.93	68 **Er** Erbium 167.26	69 **Tm** Thulium 168.93	70 **Yb** Ytterbium 173.05	71 **Lu** Lutetium 174.97
90 **Th** Thorium 232.04	91 **Pa** Protactinium 231.04	92 **U** Uranium 238.03	93 **Np** Neptunium (237)	94 **Pu** Plutonium (244)	95 **Am** Americium (243)	96 **Cm** Curium (247)	97 **Bk** Berkelium (247)	98 **Cf** Californium (251)	99 **Es** Einsteinium (252)	100 **Fm** Fermium (257)	101 **Md** Mendelevium (258)	102 **No** NObelium (259)	103 **Lr** Lawrencium (262)

Atomic radii increase down the group.

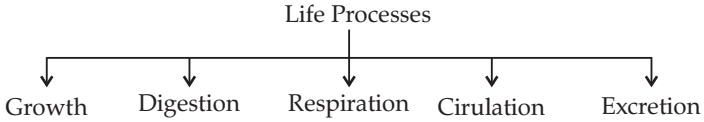
Atomic number	Elements	Symbol electrons	Electronic configuration	Valence electrons	Valency
1	Hydrogen	H	(1)	1	1
2	Helium	He	(2)	2	0
3	Lithium	Li	(2, 1)	1	1
4	Beryllium	Be	(2, 2)	2	2
5	Boron	B	(2, 3)	3	3
6	Carbon	C	(2, 4)	4	4
7	Nitrogen	N	(2, 5)	5	3
8	Oxygen	O	(2, 6)	6	2
9	Fluorine	F	(2, 7)	7	1
10	Neon	Ne	(2, 8)	8	0
11	Sodium	Na	(2, 8, 1)	1	1
12	Magnesium	Mg	(2, 8, 2)	2	2
13	Aluminium	Al	(2, 8, 3)	3	3
14	Silicon	Si	(2, 8, 4)	4	4
15	Phosphorus	P	(2, 8, 5)	5	3
16	Sulphur	S	(2, 8, 6)	6	2
17	Chlorine	Cl	(2, 8, 7)	7	1
18	Argon	Ar	(2, 8, 8)	8	0
19	Potassium	K	(2, 8, 8, 1)	1	1
20	Calcium	Ca	(2, 8, 8, 2)	2	2

Unit -II : World of Living

Chapter - 6 : Life Processes

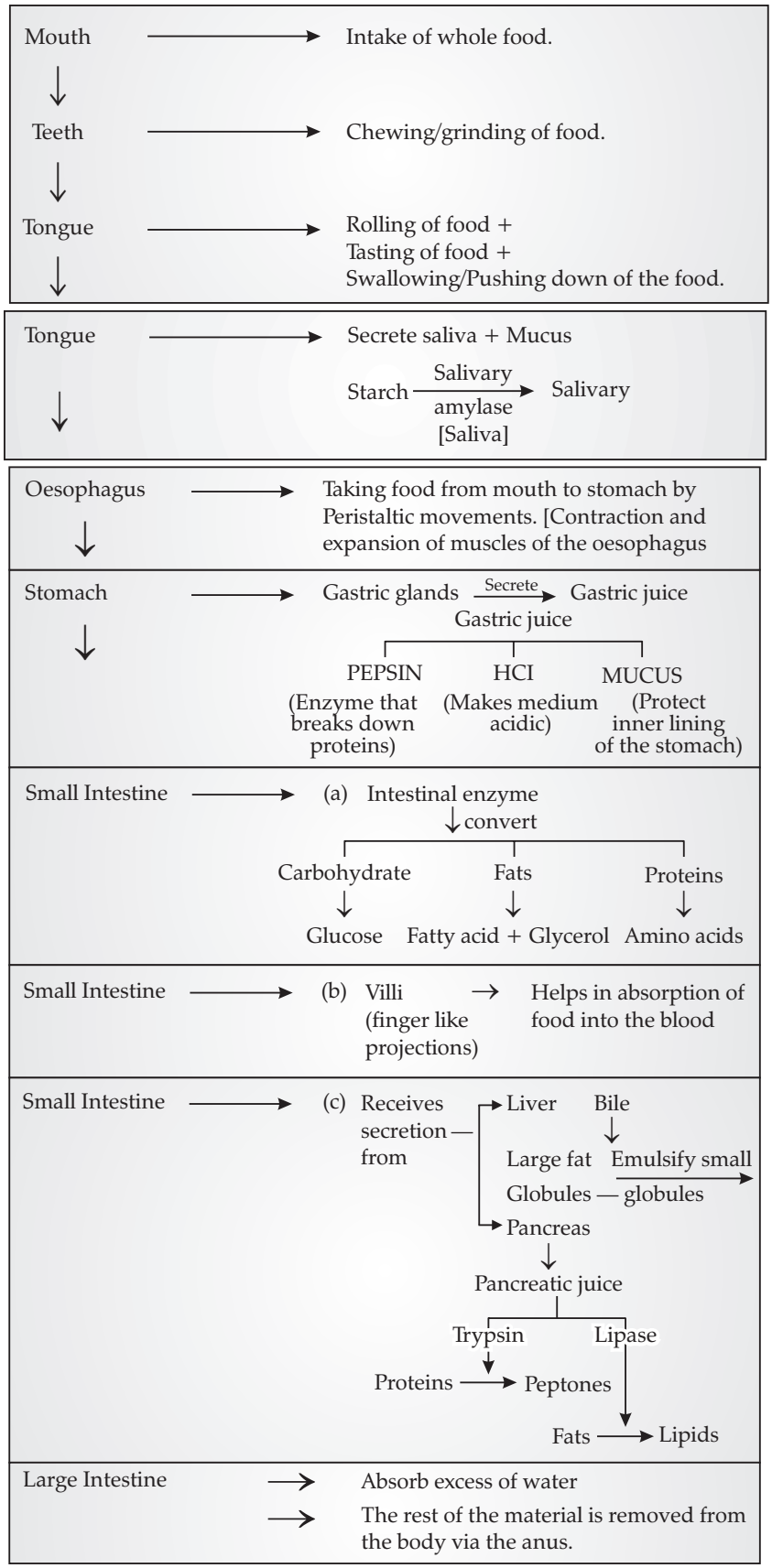
Quick Review

- All living things perform certain life processes like growth, excretion, respiration, circulation etc.
  All the processes like respiration, digestion, which together keep the living organisms alive and perform the job of body maintenance are called life processes.
  Examples :



- Energy required to carry out the different life processes, is obtained from carbon-based food sources through nutrition.
- Depending on the mode of obtaining nutrition, organisms are classified as autotrophs or heterotrophs.
  (i) Autotrophs can prepare their own food from simple inorganic sources like carbon dioxide and water (e.g., green plants, some bacteria).
  (ii) Heterotrophs cannot synthesise their own food and is dependent on the autotrophs for obtaining complex organic substance for nutrition. (*e.g.*, animals)
- Green plants prepare their food by the process of **photosynthesis**. Here, they utilise CO_2, H_2O and sunlight, with the help of chlorophyll, giving out O_2 as a by product.
- In the light reaction of photosynthesis, light energy is absorbed and converted to chemical energy in the form of ATP. Also water molecules split into hydrogen and oxygen.

- Carbon dioxide is reduced to carbohydrates in the dark phase of photosynthesis.
- Plants carry out gaseous exchange with surrounding through stomata.
- In humans, digestion of food takes place in the alimentary canal, made up of various organs and glands.
- Liver secretes bile which emulsifies fat.



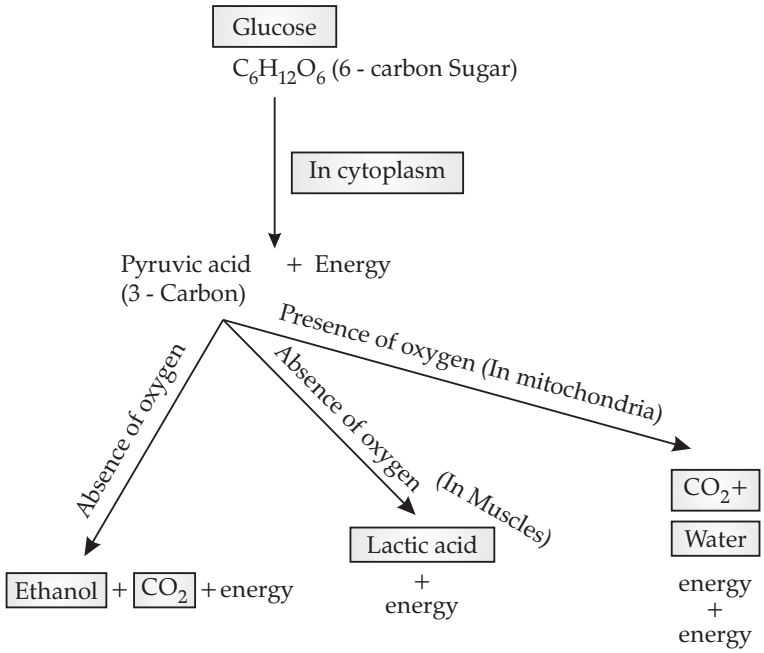
RESPIRATION

Respiration involves :

(i) Gaseous exchange : Intake of oxygen from the atmosphere and release of CO_2 → Breathing

(ii) Breakdown of simple food in order to release energy inside the cell → Cellular respiration

Breakdown of Glucose by Various Pathways



Respiration	
Aerobic	**Anaerobic**
Takes place in the presence of oxygen	Takes place in the absence of oxygen
Occurs in mitochondria	Occurs in cytoplasm
End products are CO_2 and H_2O	End products are alcohol or lactic acid
More amount of energy is released	Less amount of energy is released

- Plants release CO_2 at night and oxygen during the day.
- In humans, air takes the following path on entering the nostrils.

  Nostrils → Nasal passage → Pharynx → Larynx → Trachea → Bronchus → Bronchiole → Alveolus.
- The alveoli of lungs are richly supplied with blood and are the sites where exchange of gases (O_2 and CO_2) occurs between blood and atmosphere.
- In humans, the respiratory pigment haemoglobin, carry oxygen from lungs to different tissues of the body.
- Human heart has 4 chambers -2 atria (right and left) and 2 ventricles (right and left). Right half of the heart receives deoxygenated blood whereas the left half receives oxygenated blood.
- Arteries carry blood from heart to different parts of the body whereas veins deliver the blood back to the heart. Arteries are connected to veins by thin capillaries, where materials are exchanged between blood and cells.
- Blood platelets are essential for clotting of blood at the place of injury and thus preventing blood loss.
- Lymphatic system consists of lymph, lymph nodes, lymphatic capillaries and lymph vessels which drain into larger veins. Lymph is also important in the process of transportation.

Double circulation

- Blood travels twice through the heart in one complete cycle of the body.
- **Pulmonary Circulation :** Blood moves from the heart to the lungs and back to the heart.
- **Systemic Circulation :** Blood moves from the heart to rest of the body and back to the heart.

Blood Vessels

Arteries		Veins	
1.	Carry oxygenated blood from heart to body parts except pulmonary artery.	**1.**	Carry deoxygenated blood from body parts to heart except pulmonary vein.
2.	Also called distributing vessel.	**2.**	Also called collecting vessel.
3.	Thick and elastic.	**3.**	Thin and less elastic.
4.	Deep seated	**4.**	Superficial as compared to arteries

Transportation in plants

There are two main conducting pathways in plant.

Xylem		Phloem	
1.	Carries water & minerals from the roots to other parts of the plant.	**1.**	Carries product of photosynthesis from leaves to the other parts of the plant.
2.	No energy is used.	**2.**	Energy is used from ATP.

Transpiration : is the process of loss of water as vapour from aerial parts of the plant.

- During excretion, the harmful metabolic nitrogenous wastes generated are removed from the body.
- Nephrons are the basic filtration units of kidneys. They carry out filtration, selective reabsorption and tubular secretion to from urine in kidney, which is then passed out through the urethra, via the ureters and urinary bladder.

Formation of Urine

- Each kidney contains many filtration units called as nephrons.
- Nephrons are made up of a cluster of thin walled capillaries called as glomerulus which is associated with a cup like structure called as Bowman's capsule and the long tube which terminates through this capsule.
- The renal artery brings oxygenated blood to the kidneys along with the nitrogenous wastes like urea and uric acid and many other substances.
- The blood gets filtered through the glomerulus and this filtrate enters the tubular part of nephron.
- As this filtrate moves down the tubular part, glucose, amino acids, salts and excess of water gets selectively reabsorded by the blood vessels surrounding tubules.
- The amount of water reabsorded depends upon :

  *How much excess of water is there in the body and,

  *How much nitrogenous wastes need to be excreted out.
- So the fluid now flowing in the tubular part is urine which gets collected in collecting ducts of nephrons.
- These collecting ducts together leave the kidney at a common point by forming the ureter.
- Each ureter drains the urine in the urinary bladder where it is stored until the pressure of expanded bladder leads to an urge to pass it out through urethra.
- This bladder is a muscular structure which is under nervous control.
- 180 litres of filtrate is formed daily but only 2 litres is excreted out as urine so the rest is reabsorbed in the body.

Know the Terms

- **Metabolism** : It is the sum total of all the chemical reactions which occur in a living being due to interaction amongst its molecules. It has two components—Anabolism (build-up reactions) and Catabolism (breakdown reactions).
- **Nutrition** : It is the process by which living beings procure food for obtaining energy and body building materials.
- **Autotrophic Nutrition** : It is one in which an organism is able to build up its own organic food from inorganic raw materials with the help of energy.
- **Photosynthesis** : It is the synthesis of organic food from inorganic raw materials with the help of light energy inside chlorophyll containing cells.
- **Photolysis** : Photolysis of water is photocatalytic splitting of water into its components, hydrogen and oxygen.

$$2H_2O \longrightarrow 4H^+ + 4e^- + O_2$$

- **Photo-phosphorylation :** It is the synthesis of energy rich molecules of ATP from ADP and inorganic phosphate with the help of light energy.
- **Compensation Point :** It is that value of a factor (*e.g.* light, carbon dioxide) at which the photosynthetic consumption of carbon dioxide exactly matches the liberation of CO_2 in respiration.

- **Heterotrophic Nutrition :** It is that mode of nutrition in which the organisms obtain food from outside sources.
- **Digestion :** It is the enzyme mediated breakdown of complex insoluble components of food into simple soluble and absorbable forms.
- **Lysozyme :** It is an antimicrobial enzyme found in saliva, tears, egg white and many animal fluids that causes breakdown of peptidoglycan and chitin covering of microbes.
- **Peristalsis :** It is a wave of contraction behind the food and expansion in the region of contained food that occurs in the alimentary canal for pushing the food from anterior to posterior ends.
- **Succus Entericus :** It is the name of digestive juice of small intestine also known as intestinal juice.
- **Emulsification :** Emulsification of fats is conversion of large fat pieces into very fine fat globules.
- **Phagocytosis :** This is the process of ingestion of solid food particle by a cell or unicellular organism.
- **Circumvallation :** This is the method of intake of food when *Amoeba* comes in contact with a food particle or prey, it throws pseudopodia all around the same. The tips of encircling pseudopodia fuse and the prey comes to lie in a vesicle or phagosome.
- **Respiration :** It is an enzyme controlled biochemical process of stepwise oxidative breakdown of organic compounds releasing energy at various steps.
- **Cutaneous Respiration :** It is the mode of exchange of respiratory gases that occurs through skin which is thin, permeable, moist and vascularised for this function.
- **Branchial Respiration :** It is the respiration performed with the help of gills.
- **Breathing :** It is a physical process of alternate inhalation of fresh air and exhalation of foul air.
- **Aerobic respiration :** It is the stepwise complete oxidative breakdown of respiratory substrate into carbon dioxide and water with the help of oxygen that act as terminal oxidant.
- **Glycolysis (EMP) :** It is the first step of breakdown of respiratory substrate which occurs in cytoplasm and produces two molecules of pyruvate from a molecule of glucose.
- **Kreb's Cycle :** It is a cyclic series of metabolic reactions of aerobic respiration that occur inside mitochondria Acetyl-CoA is completely oxidised into carbon dioxide and reduced coenzymes $NADH_2$ as well as $FADH_2$ are produced.
- **Terminal Oxidation :** It is the combining of oxygen with hydrogen released from reduced coenzymes during oxidative phosphorylation.
- **Transportation :** It is the movement of materials from one part to another, usually from the region of their availability to the region of their use, storage or elimination.
- **Circulatory System :** It is a system of organs, tubes and a blood-like fluid that circulates various materials inside the body.
- **Haemolysis :** It is the process of destruction of RBC's.
- **Serum :** It is a whitish water fluid that is squeezed out from contracting blood clot.
- **Diapedesis :** It is the crawling of white blood corpuscles out of blood capillaries into surrounding tissues.
- **Pulse :** It is a repeated throb felt in a superficial artery of the body due to forceful pumping of the blood.
- **Translocation :** It is the movement of materials in solution form within an organism especially in phloem of plants.
- **Transpiration :** It is the loss of water in vapour form from the exposed parts of a plant.
- **Ascent of Sap :** It is the upward movement of absorbed water or sap from root to the top of the plant.
- **Excretion :** It is the process of throwing out of waste products and other harmful chemicals from the body.
- **Nephric Filtrate :** It is the fluid passed out of glomerulus due to ultrafiltration in the Malpighian capsule of a nephron.
- **Ultrafiltration :** It is the filtration under pressure of small particles, solutes and solvents, through a finely porous membrane.
- **Glomerulus :** It is a bunch of fine blood vessels or capillaries present in the depression of Bowman's capsule where ultrafiltration occurs.
- **Micturition :** It is the expulsion of urine from the body.
- **Bowman's Capsule :** It is a broad, blind cup-shaped, proximal end of a nephron in which glomerulus is located for ultrafiltration.
- **Osmoregulation :** It is the maintenance of a fixed osmotic concentration of body fluids by controlling the amount of water and salts.

Chapter - 7 : Control and Co-ordination

Quick Review

- All the living organisms respond and react to changes in the environment around them.
- The changes in the environment to which the organisms respond and react are called stimuli such as light, heat, cold, smell, touch etc.
- Both plants and animals respond to stimuli but in a different manner.

Control and Coordination in Animals

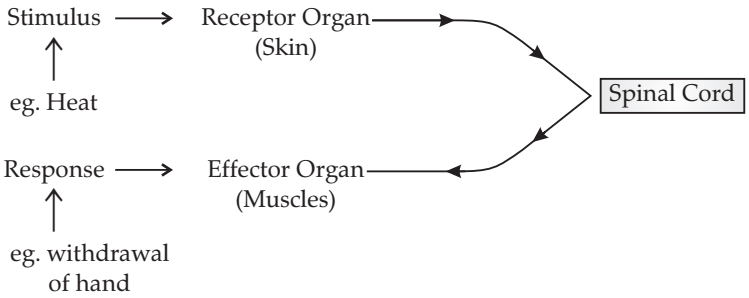
- It is brought about in all animals with the help of two main systems :
  (a) Nervous system
  (b) Endocrine system

Nervous System

- Control and coordination are provided by nervous and muscular tissues.
- Nervous tissue is made up of an organized network of nerve cells or neurons, and it specialized for conduction information via electrical impulses from one part of the body to another.
- **Nervous system** is the system of conducting tissues that receives the stimulus and transmits it to other parts of the body forming a network of nerves.
- The units which makes up the nervous system are called **nerve cells or neurons**.
- The **receptors** pass the information to the brain through a type of nerve cells called sensory neurons.
- **Motor neurons** transmit the information from the brain to the effector organs, mainly muscles and glands.
- **Nerve Impulse :** It is the information in the form of chemical and electrical signals passing through neurons. These impulses are carried by dendrites towards the cell body.
- **Neuromuscular Junction :** It is the point where a muscle fibre comes in contact with a motor neuron carrying nerve impulses from the central nervous system. The impulses travel from the neuron to the muscle fibres by means of neurotransmitter in the same way as the transmission of impulses across a synapse between two neurons.
- **Voluntary Action :** These are the actions which need thinking and are performed knowingly *i.e.* these are controlled by conscious thought.
  Example : Speaking to a friend, writing a letter etc.
- **Involuntary Action :** These are not under the control of the will of an individual and are automatic response to a stimulus which is not under the voluntary control of the brain.
  Example : Touching a hot plate unknowingly.

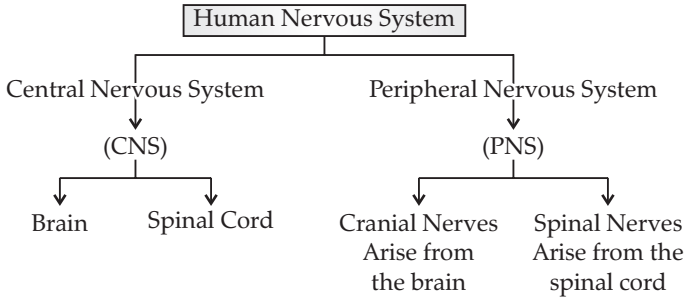
Reflex Action

- Reflex action is quick, sudden and immediate response of the body to a stimulus. E.g., Knee jerk, withdrawal of hand on touching hot object.
- **Reflex arc :** The pathway through which nerve impulse pass during reflex action is called reflex arc.



- **Response :** Responses are of three main types :
  (a) Voluntary : Controlled by fore brain. E.g., talking, writing.
  (b) Involuntary : Controlled by mid and hind brain. E.g., heartbeat, vomiting, respiration.
  (c) Reflex action : Controlled by spinal cord. E.g., withdrawal of hand on touching a hot object.

- **Need of Reflex Actions :** In some situations such as touching a hot object, pinching etc. we need to act quickly, otherwise our body would be harmed. Here response is generated from spinal cord instead of brain.



HUMAN BRAIN

- Brain is the main coordinating centre of the body. It has three major parts :

  (a) Fore-brain (b) Mid-brain (c) Hind-brain

  (a) Fore-brain : It is the most complex or specialized part of the brain. It consists of cerebrum.

Functions :

(i) Thinking part of the brain.

(ii) Control the voluntary actions.

(iii) Store information (Memory).

(iv) Receives sensory impulses from various parts of the body and integrate it.

(v) Centre associated with hunger.

(b) Mid-brain : Controls involuntary actions such as :

(c) Hind-brain : It has three parts :

(i) Cerebellum : Controls posture and balance. Precision of voluntary actions e.g., picking pen.

(ii) Medulla : Controls involuntary actions e.g., blood pressure, salivation, vomiting.

(iii) Pons : Involuntary actions, regulation of respiration.

- Autonomic Nervous System means 'Self governing nervous system', consists of a pair of chain of nerves and ganglia found on both the sides of the vertebral column.
- Spinal cord is a cylindrical structure and a part of the central nervous system. It is made up of nerves which supply information to think.
- **Plant Movements :** The movements of the individual plant parts or organs of a plant like shoot, root etc. are due to some external stimuli like light, force of gravity, chemical substance, water etc.
- **Tropic Movement :** It is the directional growth or movement of a plant organ in response to an external stimulus. Growth towards the stimulus is positive tropism and growth away from the stimulus is negative tropism.
- **Hormones** are the chemical substances which co-ordinate and control the activities of living organisms and also their growth.

No.	Gland	Hormones	Functions	Target Site
1.	Hypothalamus	(i) Releasing hormones (RH) (ii) Inhibiting hormones	Regulates secretion of pituitary hormones.	Pituitary gland
2.	Pituitary Gland	(i) Growth hormone (GH)	Controls growth-dwarfism & gigantism.	Most tissues
3.	Thyroid Gland	(i) Thyroxin (ii) Triiodothyronine (iii) Thyrocalcitonin (TCT)	Basal metabolic rate, RBC formation. Regulated Ca level.	Body tissues
4.	Adrenal Gland	(i) Adrenaline (ii) Nor adrenaline (iii) Corticoids	Increase alertness, pupillary dilation, piloerection, sweating and heart beat.	Body tissues
5.	Pancreas	(i) Insulin	Regulates glucose homeostasis, stimulates glycogenesis, controls carbohydrate metabolism	Tissues

		(ii) Glucagon	Maintains glucose levels, stimulates gluconeogenesis. Release of sugar from liver.	
6.	Testis	(i) Testosterone (ii) Androgens	Develops male reproduction organs & accessory sexual characters. Influence male sexual behaviour.	Male body tissues
7.	Ovary	(i) Estrogen	Develops female reproductive organs, accessory sexual characters & female secondary behaviour.	Female body tissues
		(ii) Progesterone	Support pregnancy, stimulates milk secretion.	

- **Plant Hormones :** Are chemical compounds which help to coordinate growth, development and responses to the environment.

  Main plant hormones are :

  (a) Auxin : Synthesized at shoot tip,
  Helps the cells to grow longer
  Involved in phototropism

  (b) Gibberellin : Helps in the growth of the stem

  (c) Cytokinins : Promotes cell division
  Present in greater concentration in fruits and seeds

  (d) Abscisic Acid : Inhibits growth
  Cause wilting of leaves
  Stress hormone

Chapter - 8 : How do Organisms Reproduce?

Quick Review

- Reproduction is the process by which living organisms produce new individuals similar to themselves. It ensures continuity of life on earth.
- Nucleus of the cell contains DNA (Deoxyribose Nucleic Acid) which is the heredity material.
- DNA replicates and forms new cells causing variation. So, these new cells will be similar but may not be identical to original cell.
- Variations are useful for the survival of the individual and species over time as well as basis for evolution.

Types of Reproduction

(a) Asexual Reproduction

- A single individual give rise to new individual.
- Gametes are not formed.
- New individual is identical to parent.
- Adopted by lower organisms.

(b) Sexual Reproduction

- Two individuals i.e., one male and one female are needed to give rise to new individual.
- Gametes are formed.
- New individual is genetically similar but not identical to parents.
- It is use ful to generate more variations in species.
- Adopted by higher organisms.
- **Asexual reproduction** takes place through fission, fragmentation, regeneration, budding vegetative propagation, spore formation. These modes of reproduction depend on the body design of the organisms.
- Fission is of two types - binary fission and multiple fission.
- **Binary fission is** the division of one cell into two similar or identical cells. The nucleus first divides amitotically into two, followed by the division of the cytoplasm. The cell finally splits into two daughter cells. ***e.g.,*** *Amoeba*
- In **multiple fission,** many individuals are formed from a single individual. ***e.g.,*** *Plasmodium*
- The nucleus divides repeatedly, producing many nuclei and many daughter cells are formed.

- **Fragmentation :** Multicellular organisms with simple body organisation such as filamentous algae—*Spirogyra* breaks up into two or more small pieces of fragments upon maturation. These fragments grow into new individuals.
- **Regeneration :** It is the ability of a fully differentiated organism to give rise to new individual organisms from its body parts. Small cut or broken parts of the organism's body grow or regenerate into separate individuals. For **example :** *Planaria* and *Hydra*.
- In *budding*, a small part of the body of the parent grows out as a bud which then detaches and becomes a new organism. *Hydra* reproduces by budding using the regenerative cells.

Vegetative Propagation : In many plants, new plants develops from vegetative parts such as :

- By roots : *E.g.,* dahlias, sweet potato.
- By stem : *E.g.,* potato, ginger.
- By leaves : *E.g., bryophyllum* (leaf notches bear buds which develop into plants).
- Artificial methods :
  - **(a)** Grafting : *E.g.,* Mango
  - **(b)** Cutting : *E.g.,* Rose
  - **(c)** Layering : *E.g.,* Jasmine
  - **(d) Tissue culture :** New plants are grown by using growing tip of a plant. These growing cells are kept in a culture medium which leads to the formation of callus. Callus is then transferred to hormone medium which causes growth and differentiation. *E.g.,* ornamental plants, orchid.

Benefits of tissue culture :

- We can grow plants like banana, rose, jasmine etc. that have lost the capacity to produce seeds.
- New plants are genetically similar to parents.
- **Spore Formation :** Spores are small bulb like structures which are covered by thick walls. Under favourable conditions, they germinate and produce new organism.
- Sexual reproduction in flowering plants takes place in the phylum angiosperm. The gametes are produced within the flowers and the ovules are enclosed in a carpel.
- The flowers are usually bisexual *i.e.,* male and female reproductive parts are present in the same plant. The main parts of a flower are : sepals, petals, stamens and carpel.
- Stamens and carpels are the reproductive parts of a flower which contain the germ cells. The male organ of a flower called 'stamen' makes the male gamete which are present in the pollen grain. The female organ of a flower called 'carpel' or 'pistil' makes the female gamete, which are present in ovules of the plant.
- **Pollination** is the transfer of pollen grain from the anther of a stamen to the stigma of a carpel. Pollination is of two types : Self pollination and cross pollination.
- **Embryo :** It is the stage of development between the zygote or fertilized egg and the newly formed offspring.

Reproduction in Human Beings

- Humans use sexual mode of reproduction.
- **Sexual maturation :** The period of life when production of germ cells *i.e.,* ova (female) and sperm (male) start in the body. This period of sexual maturation is called puberty.

Changes at Puberty

(a) Common in male and female

- Thick hair growth in armpits and genital area.
- Skin becomes oily, may result in pimples.

(b) In girls

- Breast size begin to increase.
- Girls begin to menstruate.

(c) In boys

- Thick hair growth on face.
- Voice begin to crack.

These changes signals that sexual maturity is taking place.

Male Reproductive System

- **(a) Testes :** A pair of testes are located inside scrotum which is present outside the abdominal cavity. Scrotum has a relatively lower temperature needed for the production of sperms.
- Male germ cell *i.e.,* sperms are formed here.
- Testes release male sex hormone (testosterone). Its function is :
  - **(i)** Regulate production of sperms.
  - **(ii)** Bring changes at puberty.
  - **(b) Vas deferens :** It passes sperms from testes up to urethra.
  - **(c) Urethra :** It is a common passage for both sperms and urine. Its outer covering is called penis.
  - **(d) Associated glands :** Seminal vesicles and prostate gland add their secretion to the sperms. This fluid provide nourishment to sperms and make their transport easy.

    Sperm along with secretion of glands form semen.

Female Reproductive System

(a) Ovary : A pair of ovary is located in both sides of abdomen.

- Female germ cells *i.e.,* eggs are produced here.
- At the time of birth of a girl, thousands of immature eggs are present in the ovary.
- At the onset of puberty, some of these eggs start maturing.

(b) Oviduct or Fallopian tube

- Receives the egg produced by the ovary and transfer it to the uterus.
- Fertilisation *i.e.,* fusion of gametes takes place here.

(c) Uterus : It is a bag-like structure where development of the baby takes place.

- Uterus opens into vagina through cervix.
- The embryo moves down to reach the uterus. The embedding of the embryo in the thick inner lining of the uterus is called **implantation**.
- The time period from the development of foetus inside the uterus till birth is called **gestation period**. The act of giving birth to the fully developed foetus at the end of gestation period is termed as **parturition**.
- The breakdown and removal of the inner, thick and soft lining of the uterus along with its blood vessels in the form of vaginal bleeding is called **menstrual flow** or **menstruation**.
- Reproductive health is all those aspects of general health which help a person to lead a normal, safe and satisfying reproductive life.
- **Sexually Transmitted Diseases (STDs)** are the diseases which are spread by sexual contact from an infected person to a healthy person. Some common STDs are Gonorrhoea, syphilis, trichomoniasis, AIDS.
- There are different methods which are developed to prevent and control pregnancy such as mechanical methods, chemical methods, oral pills and surgical methods.

Contraception

- It is the avoidance of pregnancy, can be achieved by preventing the fertilisation of ova.

Methods of contraception

(a) Physical barrier

- To prevent union of egg and sperm.
- Use of condoms, cervical caps and diaphragm.

(b) Chemical methods

- Use of oral pills
- These change hormonal balance of body so that eggs are not released.
- May have side effects.

(c) Intrauterine contraceptive device (IUCD)

- Copper-T or loop is placed in uterus to prevent pregnancy.

(d) Surgical methods

- In males the vas deferens is blocked to prevent sperm transfer called vasectomy.
- In females, the fallopian tube is blocked to prevent egg transfer called tubectomy.

Know the Terms

- **Reproduction :** It is the process of producing new individuals of the same species by existing organisms of a species *i.e.* parents.
- **Asexual reproduction :** It is the process of producing new organisms from a single parent without the involvement of sex cells or gametes.
- **Fission :** It is the simplest method of asexual reproduction in unicellular forms of life such as *Amoeba, Paramecium* and other protozoan.
- **Binary fission :** It is the division of one cell into two similar or identical cells. The nucleus first divides amitotically into two, followed by the division of the cytoplasm. The cells finally splits into two daughter cells.
- **Fragmentation :** It is an asexual reproduction in which a multicellular organisms breaks up into two or more small pieces of fragment upon maturation.
- **Regeneration :** It is the ability of a fully differentiated organism to give rise to new individual organism from its body parts.
- In vegetative propagation, new plants are obtained from the parts of old plants such as stem, roots and leaves, without help of any reproductive organs.
- **Tissue culture :** It is the production or propagation of new plants from isolated plant cells or small pieces of plant tissue in a synthetic medium of culture solution. This technique is also known as micropropagation, and In vitro culture because it takes place outside the body of the parent plant in a test tube using an artificial environment.

- **Micropropagation technique :** It is being used for the production of ornamental plants like orchids, *Dahlia* and carnation.
- **Sexual reproduction :** It is the process in which two sexes male and female are involved. The male sexual unit is known as male gamete or sperm while female sexual unit is termed as female gamete or ova.
- **Pollination :** It is the transfer of pollen grain from the anther of a stamen to the stigma of a carpel. The pollen grains are transferred by many agents as insects, birds, man, wind and water.
- **Fertilization :** It is defined as the fusion of a male gamete (sperm) with a female gamete (an ovum) to form a zygote during sexual reproduction.
- **Zygote :** The cell which is formed by the fusion of a male gamete and female gamete is called **Zygote**, *i.e.* it is a 'fertilised ovum' or 'fertilized egg.'
- **Sex ratio :** It is the ratio of the number of females to per thousand males in a population. The female-male sex ratio must be maintained for a healthy society.
- **Population size :** Organisms increase their population with the help of reproduction. The rates of birth and death in a given population determines its size.

Chapter - 9 : Heredity and Evolution

Quick Review

- Variations arise during the process of reproduction. They may be few in asexual reproduction, but many in case of sexual reproduction.
- The minor variations arising during Sexual reproduction are caused by slight inaccuracies in DNA copying. In sexual reproduction, variations are also caused by crossing over process of meiosis.
- Beneficial variations help the species to survive better in the environment.
- Nature selects the beneficial variations thereby leading to evolution.
- Reproduction produces offsprings with similar body design of the parents. However the offsprings are not identical, but show a great deal of variation from the parents.

Importance of Variation :

(i) Depending upon the nature of variations different individuals would have different kinds of advantages. Example, Bacteria that can withstand heat will survive better in a heat wave.

(ii) Main advantage of variation to species is that it increases the changes of its survival in a changing environment.

- Sexually reproducing organisms such as humans have two (or more) versions of genes for each trait, called alleles.
- **Gregor Johann Mendel** carried out several experiments on pea plants. He carried out large number of monohybrid and dihybrid crosses using many contrasting characteristics and put forward several important conclusions.

Mendel and His Work on Inheritance

- **Gregor Johann Mendel (1833 & 1884) :** Started his experiments on plant breeding and hybridisation. He proposed the laws of inheritance in living organisms.

  Mendel was known as **Father of Genetics.**
- **Plant selected by Mendel :** *Pisum sativum* (garden pea). Mendel used a number of contrasting characters for garden pea.

  Seven pairs of contrasting characters in Garden Pea.

Character	Dominant Trait	Recessive Trait
Flower colour	Violet	White
Flower position	Axial	Terminal
Seed colour	Yellow	Green
Seed shape	Round	Wrinkled
Pod shape	Inflated	Constricted
Pod colour	Green	Yellow
Height of plant	Tall	Dwarf/Short

- In case of monohybrid cross with pure variety of plants, the phenotypic ratio obtained in F_2 generation is 3 : 1.
- In case of dihybrid cross involving two pairs of contrasting characters, the phenotypic ratio obtained in F_2 generation is 9 : 3 : 3 : 1.
- Mendel concluded that out of any pair of contrasting characters, one is dominant and the other is recessive.

- The homozygous dominant trait is denoted by two capital letters whereas the homozygous recessive trait is denoted by two small letters.
- The factors or genes controlling a particular trait separate from each other during gamete formation. Hence gamete is always pure as far as contrasting characters are considered. Each gamete will possess only one gene set.
- In crossing if two or more traits are involved, their genes assort independently, irrespective of the combinations present in the parents.
- Genes carry information for producing proteins, which in turn control the various body characteristics.
- For a particular trait, the offspring receives one allele from the father and one allele from the mother.
- The combination of the male and female germ cells gives a diploid zygote. Thus the normal diploid number of chromosomes in the offspring is restored.
- Different mechanisms are used for sex determination in different species.

Determination of sex of an offspring.

FACTORS

Responsible for sex Determination

Environmental	Genetic
In some animals, the temperature at which the fertilized eggs are kept, decides the gender. E.g., in turtle	In some animals like humans gender or individual is determined by a pair of chromosomes called sex chromosomes. XY – Female XY – Male

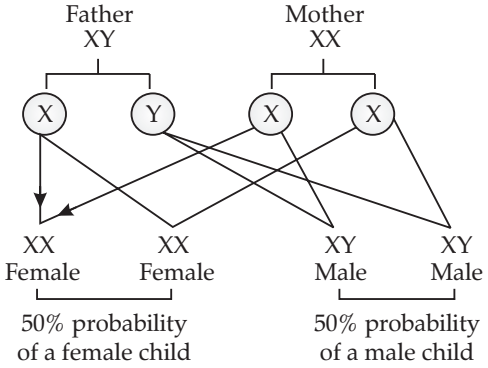
Sex Chromosomes : In human beings, there are 23 pairs of chromosome. Out of these 22 chromosomes pairs are called autosomes and the last pair of chromosome which helps in deciding gender of the individual is called sex chromosome.

XX – Female

XY – Male

SEX DETERMINATION IN HUMAN BEINGS

Sex determination in Human Beings



Evolution

- Evolution is the sequence of gradual changes which takes place in the primitive organisms, over millions of years, in which new species are produced.
- Genetic drift can alter gene frequencies in small population and provide diversity without any survival benefits.
- Several factors such as environment, mutations, reproduction, etc can cause alterations in gene frequencies in a population over generations, leading to evolution.
- Changes occurring in the DNA of germ cells are heritable whereas changes taking place in the non-reproductive tissues are not inherited.
- Charles Darwin proposed that evolution of species occurred by natural selection, but he did not know the underlying mechanism.
- Natural selection, genetic drift, variations and geographical isolation can lead to speciation in sexually reproducing organisms.
- Gene flow between the members of a population prevents speciation.

- **The fundamental characteristics used to classify organisms are :**
  (i) presence of prokaryotic or eukaryotic cells.
  (ii) whether the organism is unicellular or multicellular.
  (iii) ability to perform photosynthesis.
  (iv) presence of endoskeleton or exoskeleton in heterotrophic organisms.
- Classification of living organisms is closely related to their evolution.

Evolution and Classification

Both evolution and classification are interlinked.

1. Classification of species is reflection of their evolutionary relationship.
2. The more characteristics two species have in common the more closely they are related.
3. The more closely they are related, the more recently they have a common ancestor.
4. Similarities among organisms allow us to group them together and to study their characteristics.

I. Homologous Organs : (Morphological and anatomical evidences). These are the organs that have same structural plan and origin but different functions.

Homologous organs provides evidence for evolution by telling us that they are derived from the same ancestor.

Example :

Forelimb of horse	(Running)	
wings of bat	(Flying)	Same basic structural plan, but perform
Paw of a cat	(Walk/scratch/attack)	different functions

II. Analogous Organs : These are the organs that have different origin and structural plant but same function.

Example : Analogous organs provide mechanism for evolution.

Wings of bat →	Elongated fingers with skin folds	Different basic structure, but perform similar
Wings of bird → the arm	Feathery covering along	function *i.e.*, flight.

- Fossils help in tracing evolutionary pathways.
- The age of fossils can be determined by using the relative method or the isotope dating method.
- Evolution is not a one-step process, but a continuous process occurring in several stages.
- Complex organs are formed slowly over many generations, sometimes with intermediate forms playing an important role.
- Sometimes the use of certain features gets modified with time. For example : Feathers may have provided insulation initially, but later became associated with flight.
- Evolutionary studies have shown that birds are closely related to reptiles.
- Humans have carried out artificial selection for various features of cabbage and produced different vegetables.

Vegetable produced	Selected feature
Broccoli	Arrested flower development
Cauliflower	Sterile flowers
Kohlrabi	Swollen parts
Kale	Larger leaves

- Molecular phylogeny can also be used to trace evolutionary relationships. Here the DNA of different species is compared. Greater the differences in DNA, more distantly related are the species.
- Disappearance of the existing species is not a requirement for formation of new species.
- The new species formed are better adapted to the environment but they need not be superior to the existing species.
- The common ancestor of humans and chimpanzees evolved in different ways to produce the present forms.
- Evolution produces more diverse and complex body forms over a period of time, but the newly formed species are not more progressive than the already existing ones. So it is wrong to say that evolution produces progressive higher forms from lower ones.
- All human beings, whether fair skinned or dark skinned, belong to the same species *i.e.*, *Homo sapiens* that originated in Africa.
- The human ancestors gradually migrated from Africa to various parts of the world such as Asia, Europe, Australia and America. Thus they spread to different parts of the earth and adapted as best as they could to their environmental conditions.

Know the Terms

- **F_1 generations :** The generations resulting immediately from a cross of the first set of parents (parental generation).
- **F_2 generations :** Offsprings resulting from a cross of the members of F_1 generation.
- **Dominant :** The gene which expresses itself if F_1 generation is known as dominant gene.
- **Recessive :** The gene which is unable to express itself in presence of the dominant gene.
- **Genotype :** It is the genetic constitution of an organism which determines the characters.
- **Phenotype :** It is the appearance of an individual.
- **Progeny :** The offspring produced as a result of reproduction of the parents.
- **Dominant trait :** A genetic trait is considered dominant if it is expressed in a person who has only one copy of that gene.
- **Recessive trait :** A genetic trait is considered recessive if it is expressed only when two copies of the gene are present.
- **Homozygous :** Having two identical alleles of the same gene.
- **Heterozygous :** Having dissimilar alleles at corresponding chromosomal loci.
- **Monohybrid cross :** A type of cross in which only one pair of contrasting characters are considered.
- **Dihybrid cross :** A type of cross that involves two sets of characteristics.
- **Allele :** Either of a pair (or series) of alternative forms of a gene that can occupy the same locus on a particular chromosome and that control the same character.
- **Somatic cells :** All cells forming the body of an organism, except the reproductive cells.
- **Sex chromosomes :** Either of a pair of chromosomes, usually designated X or Y, in the germ cells of most animals, that combine to determine the sex and sex-linked characteristics of an individual.
- **Gene :** A segment of DNA that is involved in producing a polypeptide chain and forms the basic unit of heredity.
- **Trait :** A trait is a distinct variant of a phenotypic character of an organism that may be inherited or environmentally determined.
- **Haploid cell :** Cell that has only one complete set of chromosomes.
- **Diploid cell :** Cell that has two sets of chromosomes, one of paternal origin, the other of maternal origin.
- **Micro-evolution :** Evolution resulting from small specific genetic changes that can lead to a new sub-species.
- **Genetic drift :** It refers to the random change in gene frequencies in a small population, presumably owing to change rather than natural selection, thereby providing diversity without any adaptations.
- **Speciation :** The process of formation of a new species.
- **Homologous organs :** Organs of different organisms which may be dissimilar externally and in function, but are similar in origin and in fundamental structural plan.
- **Analogous organs :** Organs of different organisms which are similar in function and external appearance, but dissimilar in origin and structural plan.
- **Fossils :** All preserved traces of living organisms.
- **Molecular phylogeny :** The use of a gene's molecular characteristics to trace the evolutionary history of organisms.

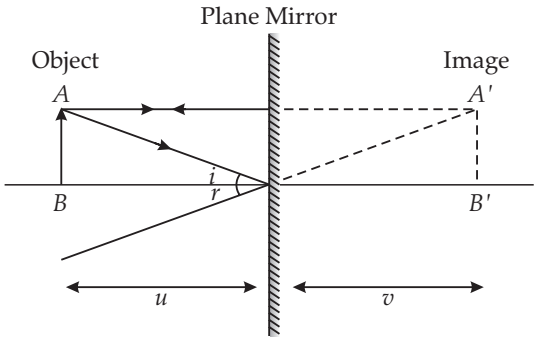
Unit -III : Natural Phenomena

Chapter - 10 : Light Reflection and Refraction

Quick Review

- When light fall on a body, it may be absorbed, may be transmitted or light may get reflected back to the same medium.
- **Reflection of light** means light waves are neither transmitted nor absorbed but are deflected from the surface of the medium back into the same medium.
- **Laws of Reflection :**
  (i) The incident ray, the normal to the surface at the point of incidence and the reflected ray, all lie in the same plane.
  (ii) The angle of incidence is equal to the angle of reflection.
- Real image is obtained when the rays of light after reflection, actually converge at a point. It can be obtained on the screen and can be seen with the eye.

- Virtual image forms when rays of light do not actually meet, but appear to meet when produced backwards. It cannot be obtained on the screen.
- **Image Formed by plane Mirror**



- **Characteristics of Image**

  (i) Virtual and erect.

  (ii) Size of image is equal to the size of object.

  (iii) Image is formed as far behind the mirror as the object is in front of it.

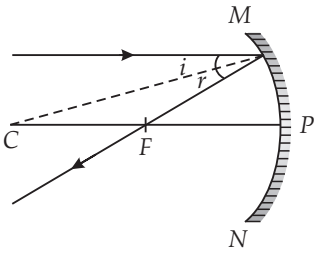
  (iv) Laterally inverted.
- **Lateral Inversion :** The phenomenon due to which the right side of the object appears as left and the left side of the object appears as right. *i.e.,* the image is inverted sideways.
- A spherical mirror whose reflecting surface is curved inwards and polished on the outer spherical surface is concave mirror.
- A spherical mirror whose reflecting surface is curved outwards and polished on the inner spherical surface is convex mirror.
- Concave mirror mostly forms real images, which can be received on the screen. Convex mirror always forms virtual images, which cannot be received on the screen.
- **Differentiating between a plane mirror, a concave mirror and a convex mirror, without touching them :**

  (i) If the image formed is erect and is of same size as in reality then it is a plane mirror.

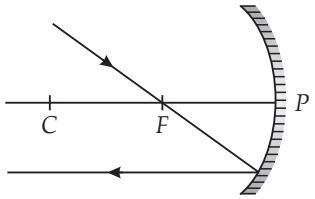
  (ii) If the image formed is still erect but smaller in size then it is a convex mirror.

  (iii) If the image formed is erect but magnified when the mirror is close to the object, then it is a concave mirror.
- Solar concentrations use huge concave mirrors to focus large amount of solar energy thereby producing high temperature conditions in a solar power plant.
- The centre of the reflecting surface of a spherical mirror is a point called the pole of the mirror and is usually represented by P.
- The horizontal line passing through the centre of curvature and pole of the spherical mirror is known as principal axis.
- The centre of curvature of a spherical mirror is the centre of the hollow sphere of glass, of which the spherical mirror is a part and is usually represented by C.
- The radius of curvature of a spherical mirror is the radius of the hollow sphere of glass, of which the spherical mirror is a part and is usually represented by R.
- The diameter of the reflecting surface, *i.e.,* twice the radius is called its aperture.
- Radius of curvature (R) = 2 × focal length (f).
- **Rules for making ray diagrams by concave mirror**

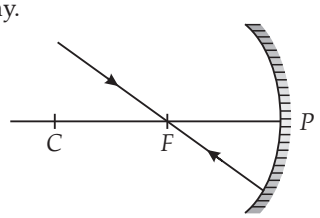
  (i) A ray parallel to the principal axis will pass through the principal focus, after reflection.



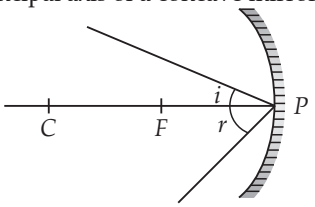
(ii) A ray passing through the principal focus of concave mirror will emerge parallel to principal axis after reflection.



(iii) A ray of light passing through the centre of curvature of a concave mirror is reflected back along the same path as it is a normally incident ray.



(iv) A ray incident obliquely to the principal axis of a concave mirror is reflected obliquely making equal angle.



➢ **Image formation by a concave mirror for different positions of the object :**

Position of Object	Position of Image	Size of Image	Nature of Image
At infinity	At focus F	Highly diminished, point-sized	Real and inverted
Beyond C	Between F and C	Diminished	Real and inverted
At C	At C	Same size	Real and inverted
Between C and F	Beyond C	Enlarged	Real and inverted
At F	At infinity	Highly enlarged	Real and inverted
Between P and F	Behind mirror	Enlarged	Virtual and erect

➢ **Nature, position and relative size of the image formed by a convex mirror :**

Position of Object	Position of Image	Size of Image	Nature of Image
At infinity	At focus F behind the mirror	Highly diminished, point-sized	Virtual and erect
Between infinity and pole of the mirror	Between P and F behind the mirror	Diminished	Virtual and erect

➢ **Mirror Formula :**

$$\frac{1}{v}+\frac{1}{v}=\frac{1}{f}$$

Where, v = image distance
u = Object distance
f = Focal length

➢ **Magnification of Spherical Mirrors**

It is the ratio of the height of image to the height of object.

$$m = \frac{\text{Height of image}}{\text{Height of object}}$$

$$m = \frac{h_i}{h_o}$$

Also,

$$m = -\frac{v}{u}$$

If 'm' is negative, image is real.
If 'm' is positive, image is virtual.
If $h_i = h_o$ then $m = 1$, *i.e.*, image is equal to object.
If $h_i > h_i$ then $m > 1$ *i.e.*, image is enlarged.
If $h_i < h_o$ then $m < 1$ *i.e.*, image is diminished.

- Magnification of plane mirror is always + 1.
  '+' sign indicates that virtual image.
  '1' indicates that image is equal to object's size.
- If 'm' is '+ve' and less than 1, it is a convex mirror.
- If 'm' is '+ve' and more than 1, it is a convex mirror.
- If 'm' is '–ve', it is a concave mirror.
- The phenomenon of change in the path of light from one medium to another is called refraction of light.
- The angle formed between the incident ray and the normal is called angle of incidence and the angle formed between the refracted ray and the normal is called angle of refraction.
- The cause of refraction is the change in the speed of light as it goes from one medium to another medium.
- Larger the difference in speed of light between the two media across the interface, the greater will be the angle of bending and vice-versa.
- When a ray of light passes from a rarer medium to a denser medium, it bends towards the normal. Also, the angle of incidence is greater than the angle of refraction.
- When a ray of light passes from a denser medium to a rarer medium, it bends away from the normal. Also, the angle of incidence is less than the angle of refraction.
- **Laws of refraction :**
  First law : The incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.
- **Refractive index (n) :** The ratio of speed of light in a given pair of media

$$n = \frac{\text{Velocity of light in medium 1}}{\text{Velocity of light in medium 2}}$$

n_{21} means refractive index of second medium with respect to first medium, and

$$n_{21} = \frac{v_1}{v_2}$$

n_{12} means refractive index of first medium with respect to second medium.

$$n_{12} = \frac{v_2}{v_1}$$

- **Absolute Refractive Index :** Refractive index of a medium with respect to vacuum or air.

$$n = \frac{c}{v} \quad c = 3 \times 10^8 \text{ ms}^{-1}$$

- Refractive index of one medium is reciprocal of other's refractive index in a given pair.

$$n_{12} = \frac{1}{n_{21}}$$

If refractive index of medium 1 w.r.t. air is given as ${}_1\text{n}^{\text{air}}$, and
If refractive index of medium 2 w.r.t. air is given as ${}_2\text{n}^{\text{air}}$

Then, refractive index of medium 1 w.r.t. medium 2 $= \frac{{}_1n^{\text{air}}}{{}_2n^{\text{air}}}$

- Refractive index of diamond is the highest till date. It is 2.42. It means speed of light is $\frac{1}{2.42}$ times less in diamond than in vacuum.
- **Lens Formula :** $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$
- **Magnification :** $m = \frac{h_i}{h_o}$

Also,

$$m = \frac{v}{u}$$

- **Power of a lens :**
  It is defined as the reciprocal of focal length in meter.
  The degree of convergence or divergence of light rays is expressed in terms of power.

$$\text{Power} = \frac{1}{\text{focal length (in meter)}} \text{ or } P = \frac{1}{f}$$

- SI unit of Power = dioptre = D

$$1\ D = 1\ m^{-1}$$

  1 dioptre is the power of lens whose focal length is one meter.

Know the Terms

- **Ray and beam :** Light travels in a straight line–Rectilinear propagation. The straight line indicating the path of the light (arrow–direction) is called a ray. A bundle of rays originating from the same source of light in a particular direction is called a beam of light.
- **Parallel beam :** When the rays which constitute the beam are parallel to one–another, then it is called a parallel beam of light.
- **Convergent beam :** When the rays actually meet or appear to meet at a point, then the beam containing such rays are called convergent beam and rays are called convergent rays.
- **Divergent beam :** When the rays actually diverge or appear to diverge from a point, then the beam containing such rays are called divergent beam and rays are called divergent rays.
- **Image :** The point of convergence or the point from where the light appears to diverge after reflection or refraction is called image.
- **Aperture :** The width of the reflecting surface from which reflection takes place is called aperture.
- **Pole :** The central point of the reflecting spherical surface is called pole (P). It lies on the surface of the mirror.
- **Centre of curvature :** The centre of the hollow sphere of which the spherical mirror is a part, is called centre of curvature (C).
- **Radius of curvature :** The separation between the pole and the centre of curvature cut of the hollow sphere, of which the mirror is a part, is called radius of curvature (R).
- **Principal axis :** The straight line joining the pole and the centre of curvature is called principal axis.
- **Focus :** The point F on the principal axis, where a beam of light parallel to the principal axis actually meet after reflection or appear to come it from it is called its principal focus.
- **Focal length :** The length or separation between the pole and the focus is called focal length.

Chapter - 11 : Human Eye and Colourful World

Quick Review

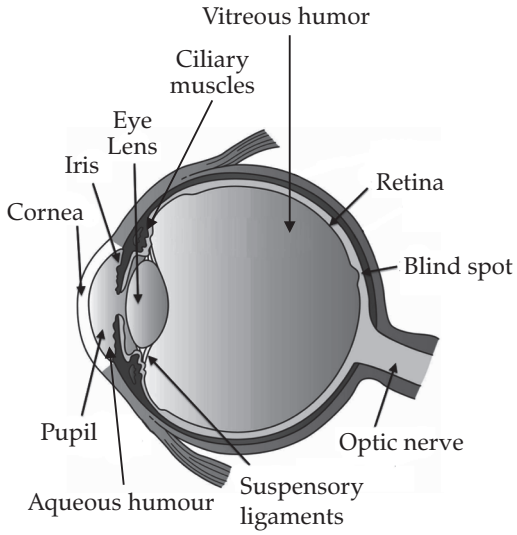
- Eye is a natural optical device using which man could see objects around him. It forms an inverted, real image on a light sensitive surface called retina.
- Rods and cones are the cells in retina, which are light sensitive. Rods respond to the intensity of light. Cones respond to the illumination colours. There are around 125 million cells-rods and cones. The cells generate signals which are transmitted to the brain through optical nerve.

Parts of Human Eye

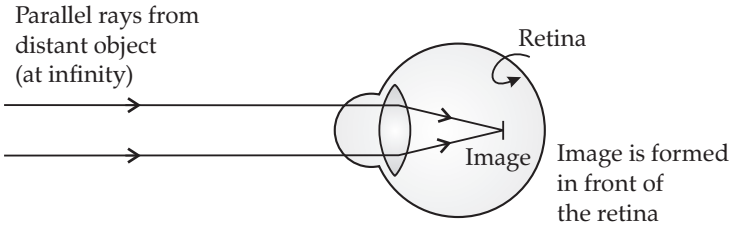
- **Cornea :** It is the outermost, transparent part. It provides most of the refraction of light.
- **Lens :** It is composed of a fibrous, jelly like material. Provides the focused real and inverted image of the object on the retina. This convex lens that converges light at retina.
- **Iris :** It is a dark muscular diaphragm that controls the size of the pupil.
- **Pupil :** It is the window of the eye. It is the central aperture in iris. It regulates and controls the amount of light entering the eye.
- **Retina :** It is a delicate membrane having enormous number of light sensitive cells.
- **Far point :** The maximum distance at which object can be seen clearly is far point of the eye. For a normal adult eye, its value is infinity.

Near point or Least distance of distinct vision

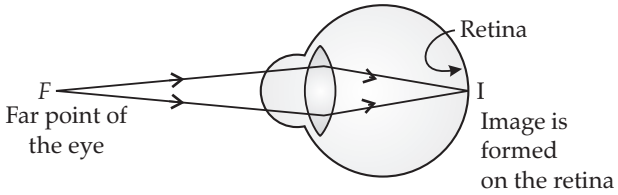
- The minimum distance at which objects can be seen most distinctively without strain.
  - For a normal adult eye, its value is 25 cm.
  - Range of human vision – 25 cm to infinity.
- **Accommodation :** The ability of the eye lens to adjust its focal length is called accommodation. Focal length can be changed with help of ciliary muscles.



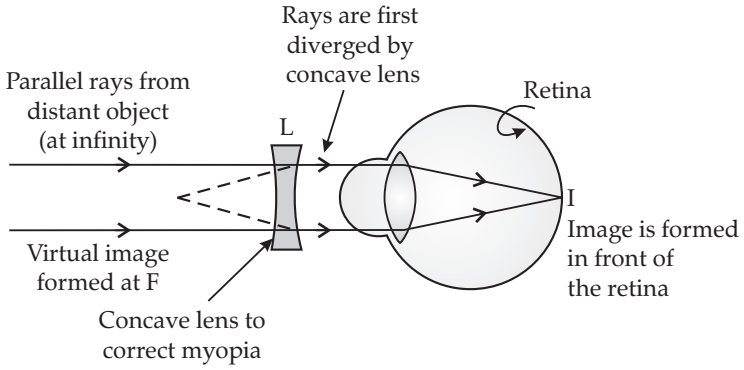
- **Myopia (Near Sightedness) :** Distant objects are not clearly visible. It is corrected by using concave lens.



(a) In a myopic eye, image of distance object is formed in front of the retina (and not on the retina)



(b) The far point (F) of a myopic eye is less than infinity.



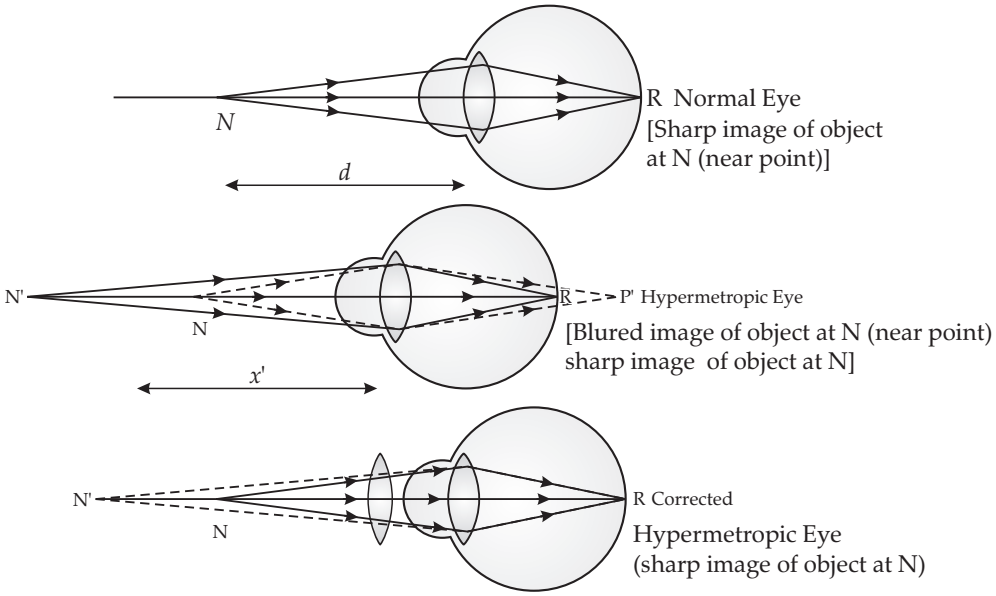
(c) Correction of myopia. The concave lens placed in front of the eye forms a virtual image of distant object at far point (F) of myopic eye.

Hypermetropia (Far sightedness)

- Affected person can see far objects clearly but cannot see nearby objects clearly.
- The near point of the eye moves away.
- Image is formed behind the retina.

Correction

- Use of convex lens of suitable power can correct the defect.



Presbyopia (Old age Hypermetropia)

- It is the defect of vision due to which an old person cannot see the nearby objects clearly due to less power of accommodation of the eye.
  - The near-point of old person having presbyopia gradually recedes and becomes much more than 25 cm away.
- The phenomenon of splitting of white light into its constituent seven colours on passing through a glass prism is called **dispersion of light**.
- Different colours undergo different deviations on passing through prism.
- If a second identical prism is placed in an inverted position with respect to the first prism, all the seven colours recombine to form white light.
- **Atmospheric refraction** is the phenomenon of bending of light on passing through earth's atmosphere.
- As we move above the surface of earth, density of air goes on decreasing.
- Light travelling from rarer to denser layers always bends towards the normal.
- Stars twinkle on account of atmospheric refraction.
- Sun appears to rise 2 minutes earlier and set 2 minutes later due to atmospheric refraction.
- The phenomenon in which a part of the light incident on a particle is redirected in different directions is called **scattering of light.**
- Very small particles scatter light of shorter wavelengths better than longer wavelengths.
- The scattering of longer wavelengths of light increases as the size of the particle increases.
- Larger particles scatter light of all wavelengths equally well.

Know the Terms

- **Range of Vision :** The distance between far point and near point of the eye is called the range of vision.
- **Accommodation :** The ability of an eye lens to adjust its focal length by the action of ciliary muscles to get a clear and sharp image of the distant object as well as nearby object is called accommodation. For a person having normal vision, it is about 4 dioptres.
- **Power of Accommodation :** The maximum variation in the converging power (focal length) of eye lens so that the far–off and nearby objects are viewed clearly is called power of accommodation.
- **Persistence of vision :** The time for which the impression or sensation of an object continues in the eye is called the persistence of vision. It is about $1/16^{th}$ of a second.
- **Prism :** Prism is a homogenous, transparent, refracting material, such as glass, enclosed by two inclined plane refracting surfaces, at some fixed angle, called refracting angle or angle of prism. It has two triangular bases and three rectangular lateral surfaces which are inclined to each other.
- **Angle of Refraction :** The angle between the refracted ray and the normal is called angle of refraction ($\angle$n).
- **Angle of Emergence :** The angle between the emergent ray and normal at the second refracting face of the prism is called angle of emergence ($\angle$e).

- **Angle of Deviation :** The angle formed between the incident ray produced in the forward direction and emergent ray produced in the backward direction in the refraction through the prism is called angle of deviation ($\angle\delta$).
- **Dispersion :** The splitting up of white light into its constituent colours is called dispersion. It occurs because refraction or bending differs with the colour.
- **Atmospheric Refraction :** Change in the direction of propagation of light rays travelling through the atmosphere due to change in density of the different layers of air is called atmospheric refraction.
- **Scattering of Light :** The phenomenon of change in the direction of propagation of light caused by the large number of molecules, such as smoke, tiny water droplets, suspended particles of dust and molecules of air present in the earth's atmosphere is called scattering of light.
- **Tyndall effect :** The phenomenon of scattering of light by the colloidal particles is known as tyndall effect.

Unit -IV : Effects of Current

Chapter - 12 : Electricity

Quick Review

- Electric charge is the property of matter due to which it produces and experience electrical and magnetic effects. There exist two types of charge in nature :

  (i) Positive charge **(ii)** Negative charge

  SI unit of charge is coulomb (C).
- **Fundamental law of electrostatics :** Like charges repel and unlike charges attract each other.
- **Coulomb's Law :** The force of attraction or repulsion between two point charges is **(i)** directly proportional to the product ($q_1\ q_2$) of the two charges and **(ii)** inversely proportional to the square of the distance (r) between them.

  Mathematically,

$$F = \frac{Kq_1q_2}{r^2}$$

  The value of K depends on the nature of the medium between the two charges and the system of units chosen. For charges in vacuum, $K = 9 \times 10^9\ Nm^2/C^2$.
- **Law of Conservation of Charge :** Electric charges can neither be created nor destroyed, they can only be transferred from one body to another.
- **Static and Current Electricity :** Static electricity deals with the electric charges at rest while the current electricity deals with the electric charges in motion.
- **Electric Current :** The electric current is defined as the rate of flow of electric charge through any section of a conductor.

$$\text{Electric current} = \frac{\text{Charge}}{\text{Time}} \text{ or } I = \frac{Q}{t}$$

  Electric current is a scalar quantity.
- **Ampere :** It is the SI unit of current. If one coulomb of charge flows through any section of a conductor in one second, then current through is said to be of one ampere.
- **Electric circuit :** The closed path along which an electric current flows is called an 'electric circuit'.
- **Conventional direction of current :** Conventionally, the direction of motion of positive charges through the conductor is taken as the direction of current. The direction of conventional current is opposite to that of the negatively charged electrons.
- **Electric field :** It is the region around a charged body within which its influence can be experienced.
- **Potential Difference (V) :** Work done to move a unit charge from one point to another.

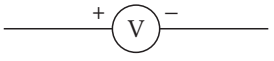
$$V = \frac{W}{Q}$$

- **1 Volt :** When 1 joule work is done in carrying one Coulomb charge then potential difference is called 1 volt.

  S. I. unit of Potential difference = Volt (V)

$$1\ V = 1\ JC$$

- Voltmeter has high resistance and always connected in parallel. Symbol is



- **Potential difference between two points :** The potential difference between two points in an electric field is the amount of work done in bringing a unit positive charge from one point to another.

$$\text{Potential difference} = \frac{\text{Work done}}{\text{Charge}} \quad \text{or} \quad V = \frac{W}{Q}$$

- **One volt potential difference :** The potential difference between two points in an electric field is said to one volt if one joule of work has to be done in bringing a positive charge of one coulomb from one point to another.

$$1 \text{ volt} = \frac{1 \text{ joule}}{1 \text{ coulomb}} \quad \text{or} \quad 1\,V = \frac{1\,J}{1\,C}$$

- **Electrochemical or voltaic cell :** It is a device which converts chemical energy into electrical energy.
- **Galvanometer :** It is a device to detect current in an electric circuit.
- **Ammeter :** It is a device to measure current in a circuit. It is a low resistance galvanometer and is always connected in series in a circuit.
- **Voltmeter :** It is a device to measure the potential difference. It is a high resistance galvanometer and is always connected in parallel to the component across which the potential difference is to be measured.
- **Ohm's Law :** Potential difference across the two points of a metallic conductor is directly proportional to current through the circuit provided that temperature remains constant.

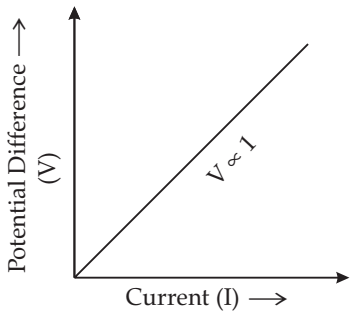
  (i) Mathematical expression for Ohm's law :

  $V \propto I$

  $V = IR$

  R is a constant called resistance for a given metal.

  (ii) V-I graph for Ohm's law :



- **Resistance (R) :** It is the property of a conductor to resist the flow of charges through it.

  (i) Ohm (Ω) : S. I. unit of resistance.

  (ii)
$$\text{ohm} = \frac{1 \text{ volt}}{1 \text{ ampere}}$$

- When potential difference is 1 V and current through the circuit is 1 A, then resistance is 1 ohm.
- **Rheostat :** Variable resistance is a component used to regulate current without changing the source of voltage.
- **Factors on which the Resistance of a Conductor depends :** Resistance of a uniform metallic conductor is
  - **(i)** directly proportional to the length of conductor,
  - **(ii)** inversely proportional to the area of cross-section,
  - **(iii)** directly proportional to the temperature and
  - (iv) depend on nature of the material.
- **Resistivity (P) :** It is defined as the resistance offered by a cube of a material of side 1 m when current flows perpendicular to its opposite faces.
  - **(i)** Its S.I. unit is ohm-metre (Ωm).
  - **(ii)** Resistivity does not change with change in length or area of cross-section but it changes with change in temperature.
  - **(iii)** Range of resistivity of metals and alloys is 10^{-8} to 10^{-6} Ωm.
  - **(iv)** Range of resistivity of insulators is 10^{12} to 10^{17} Ωm.
  - **(v)** Resistivity of alloy is generally higher than that of its constituent metals.
  - **(vi)** Alloys do not oxidize (burn) readily at high temperature, so they are commonly used in electrical heating devices.
  - **(vii)** Copper and aluminium are used for electrical transmission lines as they have low resistivity.
- **Resistances in series :** When two or more resistances are joined end to end so that same current flows through each one of them in turn, they are said to be connected in series. Here, the total resistance is equal to the sum of the individual resistances.

$$R_s = R_1 + R_2 + R_3 + ...$$

- **Resistances in parallel :** When two or more resistances are connected across two points so that each one of them provides a separate path for current, they are said to be connected in parallel. Here the reciprocal of their combined resistance is equal to the sum of the reciprocals of the individual resistances.

$$\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + ...$$

- **Heating effect of current** : When an electric current is passed through a conductor, heat is produced in it. This is known as heating effect of current.
- **Joule's law of heating :** It states that the heat produced in a conductor is directly proportional to **(i)** the square of the current I through it, **(ii)** its resistance R and **(iii)** the time *t*, for which current is passed. Mathematically, it can be expressed as

$$H = I^2 Rt \text{ joule} = \frac{I^2 Rt}{4.18} \text{cal}$$

or

$$H = VIt \text{ joule} = \frac{VIt}{4.18} \text{cal}$$

- **Practical application of the heating effect of electric current :**
  It is utilised in the electrical heating appliances such as electric iron, room heaters, water heaters etc. The electric heating is also used to produce light as in an electric-bulb.
- **Electric energy :** It is the total work done in maintaining an electric current in an electric circuit for a given time.
  Electric energy, $W = VIt = I^2Rt$ joule
- **Electric Fuse :** It is a safety device that protects our electrical appliances in case of short circuit or overloading.
  (i) Fuse is made up of pure tin or alloy of copper and tin.
  (ii) Fuse is always connected in series with live wire.
  (iii) Fuse has low melting point.
  (iv) Current capacity of fuse is slightly higher than of the appliance.
- **Electric Power :** The rate at which electric energy is consumed or dissipated in an electric circuit.

$$P = VI$$

$$P = I^2R = \frac{V^2}{R}$$

- S.I. unit of power = Watt (W)
  1 Watt = 1 Volt × 1 ampere
- Commercial unit of electric energy = Kilo Watt hour (KWh)
  1 KWh = 3.6×10^6 J
  1 KWh = 1 unit of electric energy
- **Electrical power :** Electrical power is the rate at which electric energy is consumed by an appliance.

$$P = \frac{W}{t} = VI = I^2R = \frac{V^2}{R}$$

- **Watt :** It is the SI unit of power. The power of an appliance is 1 watt if one ampere of current flows through it on applying a potential difference of 1 volt across its ends.

$$1 \text{ watt} = \frac{1 \text{ joule}}{1 \text{ second}} = 1 \text{ volt} \times 1 \text{ ampere}$$

or

$$1 \text{ W} = \text{Js}^{-1} = 1\text{VA}$$

$$1 \text{ kilowatt} = 1000 \text{ W.}$$

- **Kilowatt hour :** It is the commercial unit of electrical energy. One kilowatt hour is the electrical energy consumed by an appliance of 1000 watts when used for one hour.

$$1 \text{ kilowatt hour (kWh)} = 3{\cdot}6 \times 10^6 \text{ J}$$

- **Power rating :** The power rating of an appliance is the electric energy consumed per second by the appliance when connected across the marked voltage of the mains.
- **Efficiency of an electrical device :** It is the ratio of the output power to the input power.

$$\text{Efficiency, } \eta = \frac{\text{Output power}}{\text{Input power}}$$

Know the Terms

- **Frictional Electricity :** It is the electricity produced by rubbing two suitable bodies and flow of electrons from one body to other.
- **Electricity :** A fundamental form of energy observable in positive and negative forms that occurs naturally (as in lightning) or is produced (as in a generator) and that is expressed in terms of the movement and interaction of electrons.
- **Positive and Negative Charges :** The charge acquired by a glass rod when rubbed with silk is called positive charge and the charge acquired by an ebonite rod when rubbed with wool is called negative charge.
- **Charge Conservation :** When a glass rod is rubbed on silk, the glass rod acquires positive charge. But it is not created. The negative charges from glass rod are shifted to silk leaving a net positive charge on glass rod. The net charge in them remains the same. So, charges are not created or destroyed but can be transferred from one place to another or remain conserved.
- **Coulomb :** It is the SI unit of charge. One coulomb is defined as that amount of charge which repels an equal and similar charge with a force of 9×10^9 N when placed in vacuum at a distance of 1 meter from it. Charge on an electron = 1.6×10^{-19} coulomb.
- **Conductor :** A substance which allows passage of electric charges through it easily is called a conductor. A conductor offers very low resistance to the flow of current. For example, Copper, Silver, Aluminium etc.
- **Insulator :** A substance that has infinitely high resistance does not allow electric current to flow through it. It is called insulator.
- **Electric Potential Energy :** It is defined as the work required to be done to bring the charges to their respective location against the electric field with the help of a source of energy. This work done gets stored in the form of potential energy of charge.
- **Ohm :** It is the SI unit of resistance. A conductor has a resistance of one ohm if a current of one ampere flows through it on applying a potential difference of 1 volt across its ends.

$$1 \text{ ohm} = \frac{1 \text{volt}}{1 \text{ ampere}} \quad \text{or} \quad 1\,\Omega = \frac{1\text{V}}{1\text{ A}}$$

- **Resistor :** A conductor which has some appreciable resistance is called a 'resistor'.
- **Resistivity :** It is defined as the resistance offered by a cube of a material of side 1m, when current flows perpendicular to its opposite faces. Its SI unit is ohm-metre (Ωm).

Resistivity, $$\rho = \frac{RA}{L}$$

- For a material irrespective of length and area, the resistivity is constant. It is otherwise called specific resistance of the material. It is also defined as the resistance offered by a cube of a material of side 1m when current flows perpendicular to the opposite faces.
- Rheostat is a device which changes the magnitude of current in the circuit, by changing the resistance. It is connected in series in the circuit. It is also used as a potential divider in the circuit.
- **Semiconductors :** Materials having resistivity between that of an insulator and a conductor are called semiconductors. They are used in making integrated circuits.
- **Superconductors :** These are certain materials that lose their resistivity at low temperature. Such materials are called as superconductors. The phenomenon of complete loss of resistivity by substances below a certain temperature is called superconductivity.
- **Fuse Wire :** The wire which melts, breaks the circuit and prevents the damage of various appliances in the household connections. It is connected in series and its thickness determines the maximum current that can be drawn. It is made of an alloy of Aluminium, Copper, Iron and Lead.

Chapter - 13 : Magnetic Effects of Electric Current

Quick Review

- The black ore of iron (Fe_3O_4) called magnetite, capable of attracting similar pieces of iron is called lodestone. They are naturally existing magnets used by man to find the directions.
- There are two basic laws of magnetism. There are two poles of a magnet namely North pole and South pole. Like poles repel each other, while unlike poles attract each other.
- H.C. Oersted, a Danish physicist first noticed the magnetic effect of electric current. According to him, a needle kept near the wire carrying current will deflect due to the magnetic field produced. Any change in the direction of current will show variation in the deflection.
- Magnet is any substance that attracts iron or iron-like substances.

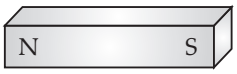
Properties of magnet

(i) Every magnet has two poles i.e., North and South.

(ii) Like poles repel each other.

(iii) Unlike poles attract each other.

(iv) A freely suspended bar magnet aligns itself in nearly north-south direction, with its north pole towards north direction.



- The substances which are attracted by a magnet are called **magnetic substances**. **Examples :** Iron, nickel, cobalt, steel. The substances which are not attracted by a magnet are called non-magnetic substances. Examples : wood, glass, copper, aluminium, brass, paper etc.
- **Magnetic Field :** The area around a magnet in which its magnetic force can be experienced.
  - Its SI unit is tesla (T).
  - Magnetic field has both magnitude and direction.
  - Magnetic field can be described with help of a magnetic compass.
  - The needle of a magnetic compass is a freely suspended bar magnet.
- **Characteristics of Field Lines**

(i) Field lines arise from North pole and end into South pole of the magnet.

(ii) Field lines are closed curves.

(iii) Field lines are closer in stronger magnetic field.

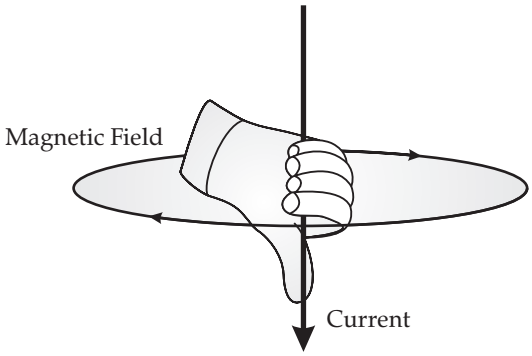
(iv) Field lines never intersect each other as for two lines to intersect, there must be two north directions at a point, which is not possible.

(v) Direction of field lines inside a magnet is from South to North.

(vi) The relative strength of magnetic field is shown by degree of closeness of field lines.

Right Hand Thumb Rule

- Imagine you are holding a current carrying straight conductor in your right hand such that the thumb is pointing towards the direction of current. Then the fingers wrapped around the conductor give the direction of magnetic field.



Magnetic Field Due to Current Through a Straight Conductor

- It can be represented by concentric circles at every point on conductor.
- Direction can be given by right hand thumb rule or compass.
- Circles are closer near the conductor.
- Magnetic field $\propto$ Strength of current
- Magnetic field $\propto \frac{1}{\text{Distance from conductor}}$

Magnetic Field Due to Current Through a Circular Loop

- It can be represented by concentric circle at every point.
- Circles become larger and larger as we move away.
- Every point on wire carrying current would give rise to magnetic field appearing as straight line at centre of the loop.
- The direction of magnetic field inside the loop is same.

Factors affecting magnetic field of a circular current carrying conductor

- Magnetic field $\propto$ Current passing through the conductor

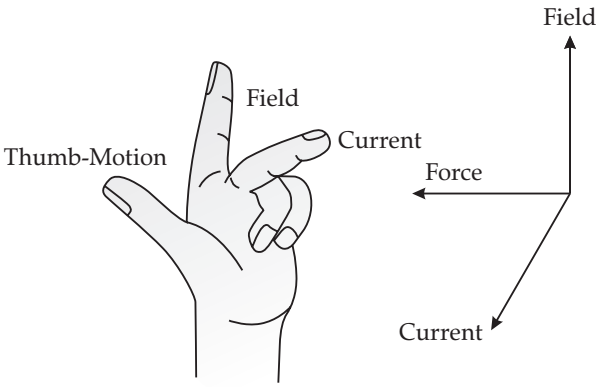
  $$\text{Magnetic field} \propto \frac{1}{\text{Distance from conductor}}$$

  Magnetic field $\propto$ No. of turns in the coil

  Magnetic field is additive in nature *i.e.*, magnetic field of one loop adds up to magnetic field to another loop. This is because the current in each circular turn has some direction.
- A coil of large number of turns closely wound on a hollow cylinder of insulated material or otherwise is called a **solenoid**. The end of the solenoid having clockwise current will act as south pole-field enters into, while on the other hand having anti-clockwise current will act as north pole-field comes out. Thus, a solenoid acts as a normal magnet.
- **Permanent magnets** are made of carbon steel, chromium steel, tungsten steel and some alloys like Alnico and Nipermag. Alnico is an alloy of aluminium, nickel and cobalt.
- When a material is placed inside a coil carrying current, it will get magnetised. A bunch of nails or an iron rod placed along the axis of the coil can be magnetised by the current allowed to pass through the coil. Such magnets are called electromagnets.
- **Ampere** suggested that when a current I passes through a conductor of length l placed in a perpendicular magnetic field B, then the force experienced is given by $F = IBl \sin\theta$, where θ is the angle between the length of the conductor and magnetic field.

Fleming's Left Hand Rule

- Stretch the thumb, fore finger and middle finger of your left hand such that they are mutually perpendicular. If fore finger points in the direction of magnetic field, middle finger in the direction of current then thumb will point in the direction of motion or force.

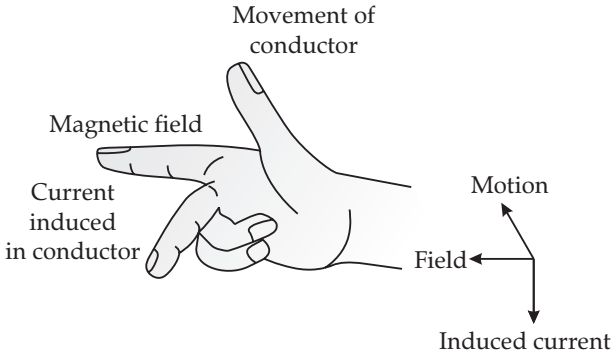


- **Electric motor** is a device used to convert electrical energy to mechanical energy. It works on the principle of force experienced by a current carrying conductor in a magnetic field. The two forces in the opposite sides are equal and opposite.
- **Faraday's Law :** The rate at which the magnetic flux linked with a coil changes, produces the induced emf or current. More the rate, more the current and vice-versa.

$$I = \frac{e}{R \times t} = \frac{\text{Change in flux}}{\text{Resistance} \times \text{Time}}$$

Fleming's Right Hand Rule

- Hold the thumb, the fore finger and the middle finger of right hand at right angles to each other. If the fore finger is in the direction of magnetic field and the thumb points in the direction of motion of conductor, then the direction of induced current is indicated by middle finger.
  - Working principle of electric generator.
  - Used to find direction of induced current.



- Generator works on the principle of Electromagnetic Induction. It converts the mechanical energy available into electrical energy. A.C. Generator produces potential which reverses after every 180° rotation of the coil. D.C. Generator means the generator which produces unidirectional current.

Domestic Electric Circuits

- An electric circuit consist of three main wiring components :
  (i) Live wire (positive) with red insulation cover.
  (ii) Neutral wire (negative) with black insulation cover.
  (iii) Earth wire with green insulation cover.
- The potential difference between live and neutral wire in India is 220 V.
- Pole → Main supply → Fuse → Electricity meter → Distribution box → To separate circuits.

Know the Terms

- When a bar magnet is placed on a cardboard and iron-filings are sprinkled, they will arrange themselves in a pattern of lines known as **magnetic field lines**.
- The area around a magnet in which its effect can be experienced is called **magnetic field.**
- When electric current flows through a conductor, a magnetic field is produced around it. This is called **magnetic effect of current**.
- An **electromagnet** is a solenoid coil that attains magnetism due to the flow of current. It works on the principle of magnetic effect of current.
- The production of electric current due to relative motion between a conductor and a magnetic field is called **electromagnetic induction.** Electric current produced due to this phenomenon is called **induced current.**
- When the current flowing through a coil changes, then the current is induced in the coil itself. This phenomena is called **self induction**.
- **Magnetic flux** is defined as the product of the magnetic field and the area through which magnetic field passes perpendicularly. $\phi = NBA$, when field passes perpendicular to the plane of the coil. It is measured in weber. If B and A are at angle θ, $\phi = NBA \cos\theta$, where N is the number of turns.
- If the current always flows in the same direction, it is called **direct current**. DC can be obtained from a cell or a battery. The positive and negative polarities of DC are fixed.
- If the current changes direction after equal intervals of time it is called **alternating current**. The positive and negative polarities of AC are not fixed.
- Connecting the outer frame of an appliance to earth to avoid any shock caused by fault or current leakage is called **earthing**.
- The coil having many turns used in electric motor or generator is called **armature**.
- **Fuse** is a safety device commonly used in electric circuits. It is connected in the live wire.

Unit -V : Natural Resources

Chapter - 14 : Sources of Energy

Quick Review

- Any system from where energy can be trapped is called a source of energy. Source of energy is capable of providing adequate amount of energy. It should be convenient to use and easy to store and transport.
- **Law of conservation of energy :** Energy can neither be created nor be destroyed, but can be transformed from one form to another.
- **Qualities of a Good Source of Energy :**
  - **(i)** Which would do a large amount of work unit mass.
  - **(ii)** Cheap and easily available.
  - **(iii)** Easy to store and transport.
  - **(iv)** Safe to handle and use.
  - **(v)** Does not cause environmental pollution.
- **Fuel :** The material which are burnt to produce heat energy are known as fuels. E.g., wood, coal, LPG, kerosene.
- **Characteristics of a Good Fuel :**
  - **(i)** High calorific value (give more heat per unit mass).
  - **(ii)** Burn without giving out any smoke or harmful gases.
  - **(iii)** Proper ignition temperature.
  - **(iv)** Easy to handle, safe to transport.
  - **(v)** Convenient to store.
  - **(vi)** Burn smoothly.

Sources of Energy

S. No.	Conventional Sources of Energy	Non-conventional Sources of Energy
(a)	Fossil fuels (Coal, Petroleum)	Solar energy (e.g, solar cooker, solar cell panel)
(b)	Thermal power plant	Energy from the sea (tidal wave, OT energy)
(c)	Hydro power plants	Biomass-plant
(d)	Geothermal energy	Nuclear energy

Conventional Sources of Energy

- Sources of energy which are known to most of the people *e.g.*, fossil fuels, biomass etc.

I. Fossil Fuels :

- Fuels developed from the fossils *e.g.*, coal, petroleum.
- Take million of years to form.
- Available in very limited amount.
- These are non-renewable sources of energy.
- India has about 60% share in the world reserved coal, that may last 250 years more at the present rate of consumption.
- In power stations, one needs energy to run turbines. Large quantity of fossil fuels like coal are burnt to produce heat energy. This produces steam which is used to rotate turbines to produce electricity. The flow of energy is as listed below :

  Fossil fuels—Heat Energy—Mechanical Energy—Electrical Energy.
- The energy of water flowing through rivers or stored in dam is another potential source of energy. It is also indirect source of solar energy. It is the solar energy which recycles water in nature from oceans and the earth's surface through rain and snow. The energy of water flowing through rivers has been used for rotating the wheels of watermills which are still operating in remote hilly areas.
- The material contained in the bodies of plants and animals is called biomass. It act as a fuel. It includes waste from tree and grass crops, forestry agricultural and urban wastes. The excreta of living organisms and their bodies after death also contribute to the biomass.

I. Biomass :

- The dead part of plants and trees and the waste materials of animals and man are called **Biomass.**

(1) Wood : It is a biomass and used as a fuel for a long time.

Disadvantages :

- Produces a lot of smoke on burning.
- Do not produce much heat.

(2) Charcoal : When wood is burnt in limited supply of air, then water and other volatile materials gets removed and charcoal is formed.

$$\text{Wood} \xrightarrow{\text{Limited Supply of } O_2} \text{Charcoal}$$

Charcoal is better fuel then wood because :

(i) It has higher calorific value than wood.

(ii) Does not produce smoke while burning.

(iii) It is a compact fuel, easy to handle and convenient to use.

(3) Cowdung : It is a biomass but it is not good to burn cowdung directly as fuel because :

- it produces lot of smoke.
- cowdung does not burn completely, produces lot of ash as residue.
- low calorific value.
- by making bio gas (or gobar gas) from cow dung, we get a smokeless fuel.

(4) Bio gas : It is produced in a biogas plant. Anaerobic micro organisms decomposes the complex compound of the cow dung + water slurry. It takes few day for the decomposition process and generate gases like methane, CO_2, hydrogen and hydrogen sulphide. Bio gas is stored in the gas tank above the digester from which they are drawn through pipes of use.

Alternate or Non-conventional Sources of Energy

- Day by day, our demand for energy is increasing, so there is a need for another sources of energy.

Reasons for alternate source of energy

(i) The fossil fuel reserves in the earth are limited which may get exhausted soon if we use them at the current rate.

(ii) To reduce the pressure on fossil fuels making them last for a much longer time.

(iii) To reduce the pollution level and to save the environment.

III. Solar Energy :

- Sun is the ultimate source of energy.
- Energy obtained from the sun is called solar energy.

$$\text{Solar constant} = 1.4 \text{ KJ/s/m}^2$$

- Outer edge of the earth receives solar energy equal to 1.4 KJ/s/m^2 or 1.4 KW/m^2 [1 KJ/s = 1 KW]
- **Electrical energy** is one of the widely used energies. It is generated by harnessing different sources of energy. In any conventional power plant, turbines of generators are rotated by using steam arrived by heating water from one source of energy.
- Indirectly or directly all forms of energy originate from the solar energy. Besides heat energy, ultraviolet, gamma rays and visible light also come from solar energy.
- **Solar cell** is a device which converts solar energy *i.e.*, light energy directly into electricity. They are made up of semi-conductors like–silicon, germanium and selenium.
- **Solar cell panel** comprises of a large number of solar cells and can provide much higher power for many uses.
- The blowing wind has energy which is called **wind energy**. Wind is associated with kinetic energy. Solar energy is responsible for the blowing of the wind. The three factors which help in blowing of wind are :
  (i) The uneven heating of equatorial region and polar region of earth by sun rays.
  (ii) Rotation of earth.
  (iii) Local conditions.
- **Ocean Thermal Energy (OTE)** : There is always a temperature difference between water at the surface and at deeper level up to 20°C. This form of energy is called ocean thermal energy which can be converted into electricity.
- Energy from oceans is also available in the form of sea-waves. Due to blowing of wind on the surface of ocean, very fast sea-waves move on its surface. It has lot of kinetic energy due to high speed.
- The rise of ocean water due to attraction of moon is called '**high tides**' whereas fall of ocean water is called '**low tides**'. The tidal waves rise and fall twice a day. Tidal energy can be harnessed by constructing a tidal barrage or tidal dam.

- The heat from inside the earth heats up the water below the surface. This hot water can be used under favourable conditions as a source of energy. This energy with hot water below the earth is called geothermal energy.
- **Atomic mass unit** is defined as $\frac{1}{12}$ th of the mass of carbon atom ${}^{12}_{6}C$. 1 amu = 1.66×10^{-27} kg.
- Unit for energy is associated with electrons accelerated through a potential of 1 volt.
  1 eV = 1.6×10^{-19} joule, 1 MeV = 1.6×10^{-13} joule.
- According to Einstein, the mass and energy are inter-convertible. They are related by the relation $E = mc^2$, where c is the velocity of light. (3×10^8 ms^{-1}).
- When nuclear fission reaction takes place, it also releases neutrons which are capable of creating further fission. For continuous production of energy, fission should be continuous. The neutrons released are made to bombard other uranium nuclei to produce more fission. Such self-sustained reactions are called chain reactions.
- In order to make a chain reaction possible there should exist sufficient ^{235}U nuclei. The minimum mass of fissionable material required in order to make a chain reaction possible is called critical mass.

Know the Terms

- The fuels which are obtained from the remains of plants and animals are called fossil fuels, *e.g.*, coal, petroleum and natural gas.
- The material contained in the bodies of plants and animals is called biomass. It acts as a fuel.
- **Bagasse** is the residue of sugarcane after extracting (taking out) juice from them. It is used as fuel in industries.
- **Conventional or Non-Renewable Sources** : Energy sources which are used traditionally for many years and are to deplete over a period of time are called conventional or non-renewable sources. *e.g.*, coal, petroleum, natural gas etc.
- **Non-Conventional or Renewable Sources :** Energy sources which do not deplete and are scarcely used by the population are called non-conventional or renewable sources *e.g.*, Solar energy, wind energy etc.
- The amount of solar energy received per square meter per second on the surface of earth is called solar constant. It is approximately 1.4 (kJ/m^2s).
- **Wavelength :** Length of a wave or separation between two points in successive waves which are in same phase is called wavelength. It is expressed in meter.
- **Frequency :** The number of wave motions in one second is called frequency. It is expressed in Hertz (Hz).
- The light of wavelength which is greater than the wavelength of red are called Infra-red (IR) radiations. They are not visible to human eye but have the property to heat the bodies on its way. All hot bodies radiate infra-red radiations.
- **Semiconductors** are those substances which have very low electrical conductivity. They are between the good conductors and insulators. If certain impurities are added,their electrical conductivity is increased when sunlight falls on semi-conducting material, their conductance increases.
- An electric motor is a rotating device that converts electrical energy to mechanical energy.
- A generator is the machine that converts mechanical energy into electrical energy. It works on the basis of electromagnetic induction.
- The concentration of salts in water of different seas is different. The difference in concentration of salts in the water of two different seas is called **'salinity gradient'**.
- The projectile (say neutron) should have some minimum energy, in order to create fission. This minimum energy is called **threshold energy**.
- There action in which a heavy nucleus splits into two or more smaller nucleus, with the evolution of large amount of energy when it is bombarded with slow moving neutron is called **nuclear fission**.
- A nuclear reaction in which the bombarding particle is obtained as one of the product, due to which the reaction once initiated proceeds on its own is called a **chain reaction**.
- In order to make a chain reaction possible there should exist sufficient ^{235}U nuclei. The minimum mass of fissionable material required in order to make a chain reaction possible is called **Critical mass**. The Critical mass of ^{235}U is approximately 1 kg.
- A reaction in which two or more lighter nuclei fuse to form a heavy nucleus and large amount of energy is given out is called nuclear **fusion reaction**.
- The phenomena of emission of α, β particles and γ rays by unstable heavier nuclei is called **radioactivity**.

Chapter - 15 : Our Environment

Quick Review

- Everything that surrounds us is environment. It includes both living (biotic) and non-living (abiotic) components.
- Interaction between these biotic and abiotic components form an ecosystem.
- In an ecosystem living components depend on each other for their food which give rise to food chains and food webs in nature.
- Human activities lead to environment problems such as depletion of ozone layer and production of huge amount of garbage.

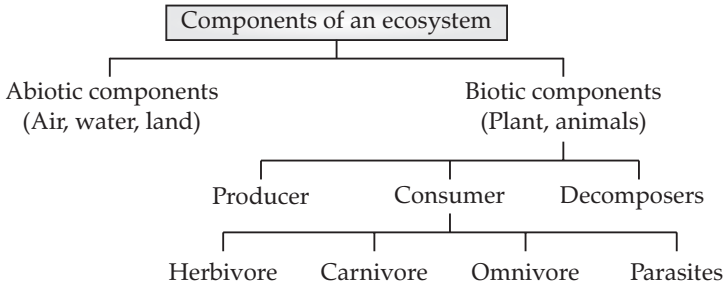
Ecosystem

- All the interacting organisms in an area together with the non-living constituents of the environment form an ecosystem. E.g., forest, pond etc.

  Types of ecosystem : It is of two types :

  (a) Natural ecosystem : The ecosystem which exist in nature on its own. e.g., forest, lake, ocean.

  (b) Artificial ecosystem : Man-made ecosystem are called artificial ecosystem. e.g., crop field, aquarium, garden.



- Herbivores, carnivores, omnivores and parasites are the various type of consumers.
- **Consumers** are those organisms which depend upon the producers for food, either directly or indirectly by feeding on other consumers for their sustenance. They are also called heterotrophs.
- **Parasites** are those organisms that live on (ectoparasites) or in (endoparasites) the body of another organism, *i.e.*, host from which it obtain its nutrients, *e.g.*, parasites of man includes fleas and lice.
- **Decomposers** are those micro-organisms that obtain energy from the chemical break down of dead organisms or animals or plant wastes. Decomposers break down the complex organic substances into simple inorganic substances that go into the soil and are used up once more by the plants.
- **Food chain** is sequence of organisms through which energy is transferred in the form of food by the process of one organism consuming the other.

  Examples :

Grass	→	Grasshopper	→	Frog	→	Snake	→	Eagle
(Producer)		(Herbivore)		(Carnivore)		(Carnivore)		(Top Carnivore)

- **Trophic levels** are the various steps or levels in the food chain where transfer of food or energy takes place. Producers are the first trophic level, herbivores are second trophic level, carnivores or secondary consumers are third trophic level and large carnivores or tertiary consumers are the fourth trophic level.
- **Food web** is the network of various food chains which are interconnected at various tropic levels. Since an organism can occupy position in more than one food chain, in a food web it occupies more than one trophic level.
- The flow of energy through different steps in the food chain is unidirectional. This means that energy captured by autotroph does not revert back to the solar input and it passes to the herbivores.

Flow of energy between trophic levels

- Flow of energy in a food chain is unidirectional.
- Green plants capture 1% of sunlight and convert it into food energy.
- **10 percent law :** Only 10% of energy is transferred to the next trophic level. The remaining 90% energy is used is life processes (digestion, growth, reproduction etc.) by present trophic level.
- Due to this gradual decrease in energy, food chains contain 3-4 trophic levels.

- **Biological magnification :** The concentration of harmful chemicals increases with every next trophic level in a food chain. This is called biological magnification.
- Maximum concentration of such chemicals get accumulated in human bodies as human occupy the top level in any food chain.
- Ozone (O_3) is an isotope of oxygen *i.e.*, it is a molecule formed by three atoms of oxygen. Ozone performs an essential function of shielding the surface of the earth from ultraviolet radiation of the sun.

$$O_2 + O \longrightarrow O_3$$

- Ozone layer is a layer of the earth's atmosphere in which most of the atmosphere's Ozone is concentrated.
- Ozone layer protects the earth from harmful radiations.
- There are several reasons for depletion of ozone layer.
- The foremost is the use of chlorofluorocarbons (CFCs). The other factor responsible for ozone destruction is the pollutant nitrogen monoxide (NO).
- When the harmful chemicals like chlorofluorocarbons (CFCs) are released into the air, it accumulates in the upper atmosphere and reacts with ozone resulting in reduction in thickness of the ozone layer.
- Thus, the ozone layer in the atmosphere becomes thinner and gets depleted allowing more ultraviolet rays to pass through it.
- The Antarctic hole in ozone layer is caused due to chlorine molecules present in chlorofluorocarbons (CFCs), that are used by human being.

Garbage disposal

- Improvements in lifestyle have resulted in accumulation of large amounts of waste materials.
- Garbage contains following type of materials :

  (a) Biodegradable wastes : Substances which can be decomposed by the action of micro-organisms are called biodegradable wastes.

  E.g., fruit and vegetable peels, cotton, jute, dung, paper, etc.

  (b) Non-biodegradable wastes : Substances which cannot be decomposed by the action of micro-organisms are called non-biodegradable wastes.

  E.g., plastic, polythene, metals, synthetic fibres, radioactive wastes, pesticides etc.

  Micro-organisms release enzymes which decompose the materials but these enzymes are specific in their action that's why enzymes cannot decompose all the materials.

Some methods of waste disposal

(a) Biogas plant : Biodegradable waste can be used in biogas plant to produce biogas and manure.
(b) Sewage treatment plant : The drain water can be cleaned in sewage treatment plant before adding it to rivers.
(c) Land fillings : The wastes are buried in low lying areas and are compacted by rolling with bulldozers.
(d) Composting : Organic wastes are filled in a compost pit and covered with a layer of soil, after about three months garbage changes to manure.
(e) Recycling : Non-biodegradable waste are recycled to make new items.
(f) Reuse : It is a conventional technique to use an item again *e.g.*, newspaper for making envelops.

Know the Terms

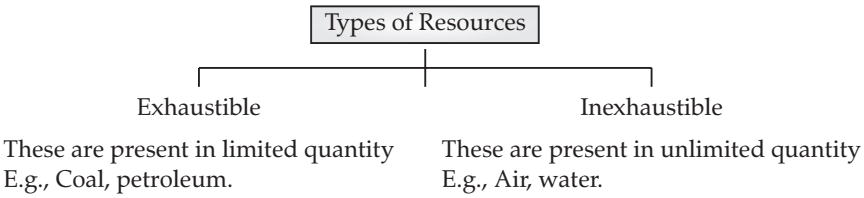
- **Environment :** It is the sum total of all external conditions and influences that affect the life and development of an organism, *i.e.* the environment includes all the physical or abiotic and biological or biotic factors.
- **Biodegradable substances** are those substance which are broken down into simpler, harmless substances in nature in due course of time by the biological processes such as action of micro-organisms.
- **Non–biodegradable substances** are those substance which cannot be broken down into simpler, harmless substances in nature. These substances may be in solid, liquid or gaseous form and may be inert and accumulate in the environment or may concentrate in the food chain and harm the organisms.
- **Ecosystem :** It is the structural and functional unit of biosphere, comprising of all the interacting organisms in an area together with the non–living constituents of the environment. Thus, an ecosystem is a self sustaining system where energy and matter are exchanged between living and non-living components.
- **Producers :** Those organisms which produce food by photosynthesis *i.e.* organisms which can make organic compounds like sugar and starch from inorganic substances using the radiant energy of the sun in presence of chlorophyll.
- **Consumers :** Those organisms which depend upon the producers for food, either directly or indirectly by feeding on other consumers for their sustenance. Consumers therefore, feed upon those below it in a food chain and are called heterotrophs.

- **Decomposers :** They are those micro-organisms that obtain energy from the chemical breakdown of dead organisms or animals or plant wastes. These micro-organisms are decomposers as they breakdown the complex organic substances into simple inorganic substances that go into the soil and are used up once more by the plants.
- **Food Chain :** It is the sequence of organisms through which energy is transferred in the form of food by the process of one organism consuming the other. It shows the relationship of producer and consumer *i.e.* 'who eats whom'. Thus, it is a series of organisms taking part at various biotic level from the producer and ends in consumer.
- **Trophic Levels :** These are the various steps or levels in the food chain where transfer of food or energy takes place. The producers or autotrophs are the first trophic level, the herbivores or primary consumers are the second trophic level, the carnivores or secondary consumers are the third trophic level and the large carnivores or tertiary consumers are the fourth trophic level of the food chain.
- **Food Web :** It is the network of various food chains which are interconnected at various trophic levels. Since, an organism can occupy position in more than one food chain, in a food web it occupies more than one trophic level.
- **Flow of Energy :** The flow of energy through different steps in the food chain is unidirectional. This means that energy captured by autotroph does not revert back to the solar input and it passes to the herbivores. It moves progressively through various trophic level

Chapter - 16 : Management of Natural Resources

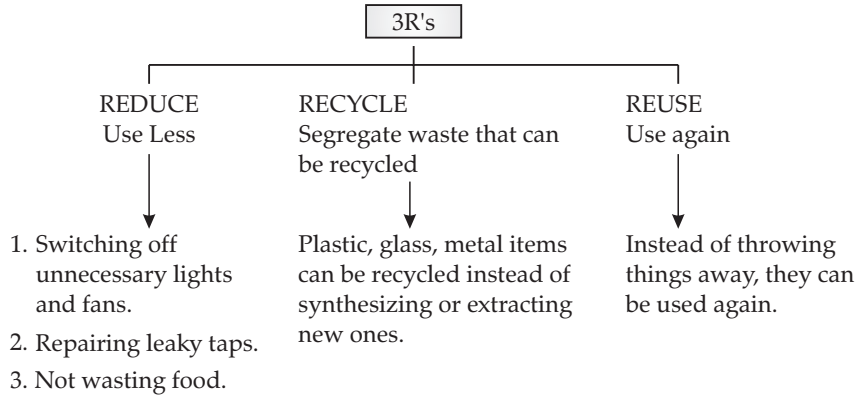
Quick Review

- **Natural Resources :** Anything in the environment 'which can be used' is called natural resource. For example, soil, air, water, forests, wildlife, coal and petroleum.



- Coliform is a group of gram-negative rod-shaped bacteria that are found in human intestine. Their presence in water is an indicator of contamination by disease-causing micro-organisms indicating faecal pollution. It includes *Salmonella* and *Escherichia coli*.
- Largely untreated sewage such as garbage and excreta are dumped into Ganga. Pollution is also caused by human activities such as bathing, washing and immersion of ashes or unburnt corpses.
- Industries also contribute in Ganga's pollution by loading chemical effluents and making the water toxic, killing aquatic organisms.
- Ganga Action Plan is a massive multi-core project launched in 1985, which has been undertaken to clean the excess pollution from river Ganga.
- **Management of Natural resources**

  Three R's to save the environment :



- **Sustainable Management**
  Management of resource wisely so they meet current basic human needs while preserving them for the needs of future generations.
- The management of natural resources require :
  (a) Long term perspective so that these will last for generations to come.
  (b) Ensure equitable distribution of resources so that all economic sections benefit from these resources.
  (c) Safe disposal of waste.
- The objective of sustainable development is to provide the economic well being to the present and the future generations and to maintain a healthy environment and life support system.
- pH stands for 'Potential of Hydrogen'. It is negative logarithm (base 10) of the hydrogen ion concentration in moles per litres.
- The acidic and basic character of aqueous solutions can be described in terms of hydrogen ion and hydroxide ion concentration.
- Pollutant is the substance that causes a harmful change in the environment, thereby producing adverse effects on living organisms. Some of the common pollutants include pesticides, industrial wastes and emissions, exhaust fumes from vehicles and sewage.
- Biodiversity is the existence of a wide variety of species of plants, animals and micro-organisms in a natural habitat within a particular environment or of genetic variation within a species.
- Forest is a 'biodiversity hotspot' because it is an area where number of species or range of different life form exists.
- Wildlife means all those naturally occurring animals, plants and their species which are not cultivated, domesticated and tamed.
- Conservation is the sensible use of the earth's natural resources in order to avoid excessive degradation and betterment of the environment.
- Afforestation is the practice of transforming an area into forest, usually when trees have not grown there, and involves three types of forestry programmes.
- Social and environmental forestry involves raising of trees for firewood, fodder, agricultural implements for the benefits of rural and tribal community.
- Agro-Forestry is an absolute commercial forestry developed to fulfil the need of various forest-based industries. It is done on the fallow land or free-grazing lands.
- Urban forestry involves growing of ornamental trees along roads, vacant lands and common parts of urban areas.
- Large reservoirs of petroleum have been preserved by nature for millions of years between porous rocks beneath the earth.
- Non-renewable energy sources are energy sources which cannot be replaced easily when they get exhausted and are also called conventional sources of energy. They are used traditionally for many years and take millions of years to form fossil fuels.
- The fossil fuels, coal and petroleum get exhausted and their combustion pollutes our environment, so a judicious use of these resources is necessary.
- Necessity of judicious use of coal and petroleum : The fossil fuels, coal and petroleum will get exhausted and their combustion pollutes our environment, so a judicious use of these resources is necessary.
- When combustion takes place, oxides of carbon, hydrogen, nitrogen and sulphur are formed.
- Carbon monoxide is formed instead of carbon dioxide if there is insufficient air.
- The oxides of sulphur, nitrogen and carbon monoxide are poisonous at high concentrations.
- Carbon dioxide is a greenhouse gas which leads to global warming.
- **Water for all**
  (a) Water is the basic necessity for all terrestrial forms of life.
  (b) Rain is an important source of water.
  (c) Irrigation methods like dams, tanks and canals have been used in various parts of India.
- **Dams**
  Dams ensure the storage of adequate water for irrigation and are also used for generating electricity.
  Various dams have built on rivers to regulate the flow of water.
  E.g., (a) Tehri Dam — On river Ganga
  (b) Sardar Sarovar Dam — On river Narmada
  (c) Bhakra Nangal Dam — On river Satluj
- **Advantages of Dams**
  (a) Ensures adequate water for irrigation.

(b) To generate electricity.
(c) Continuous supply of water to cities and towns.

- **Disadvantages of Dams**
  (a) Social problems :
  (i) Many tribals and peasants are displaced and rendered homeless.
  (ii) They do not get adequate compensation or rehabilitation.
  (a) Environmental problems :
  (i) Deforestation
  (ii) Loss of biodiversity
  (iii) Disturb ecological balance
  (c) Economic problems :
  (i) Huge amount of public money is used.
  (ii) No proportionate benefit to people.
  (iii) No equitable distribution of water.
- **Rain Water Harvesting**
  Rain water harvesting is to make rain water percolate under the ground so as to recharge 'groundwater'.

Know the Terms

- **Natural resources :** They are the stock of the nature such as air, water, soil, minerals, coal, petroleum, forest and wildlife that are useful to mankind in many ways.
- **Pollution :** It is defined as the undesirable change in physical, chemical or biological characteristics of our soil, air or water, which harmfully affect human lives or the lives of other species.
- **Pollutant :** It is the substance that causes a harmful change in the environment, thereby producing adverse effects on living organisms. Some of the common pollutants include pesticides, industrial wastes and emissions, exhaust fumes from vehicles and sewage.
- **Sustainable Development :** It is the development which can be maintained for a long time without undue damage to the environment.
- **Biodiversity :** It is the existence of a wide variety of species of plants, animals and micro-organisms in a natural habitat with in a particular environment or of genetic variation with in a species.
- **Wildlife :** It means all those naturally occurring animals, plants and their species that are not cultivated, domesticated and tamed.
- **Conservation :** It is the sensible use of the earth's natural resources in order to avoid excessive degradation and betterment of the environment.