UNIT – I: CHEMICAL SUBSTANCES—NATURE AND BEHAVIOR

CHAPTER-1

CHEMICAL REACTIONS AND EQUATIONS

Topic-1 Chemical Reaction and Equations

Concepts Covered • *Chemical reaction and examples,* • *Skeletal and balanced chemical equation,* • *Steps to balance a chemical equation.*

Revision Notes

A chemical reaction

- A chemical reaction is a process in which the original substance(s) loses its nature and identity and forms new substance(s) with different properties.
- Breaking of the chemical bonds and formation of new chemical bonds is responsible for the occurrence of a chemical reaction.
- The substances which take part in a chemical reaction are called Reactants.
- The substances which are formed in a chemical reaction are called Products.
- **Examples of chemical reaction:**
  - **(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:

S. No.	Characteristics	Examples
1.	Change in state	The combustion reaction of candle wax is characterized by a change in state from solid to liquid and gas.
2.	Change in colour	The chemical reaction between citric acid and purple coloured potassium permanganate solution is characterized by a change in colour from purple to colourless.
3.	Evolution of gas	The chemical reaction between zinc and dilute sulphuric acid is characterized by hydrogen gas. $Zn(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2(g)$
4.	Change in temperature	The reaction between quicklime and water to form slaked lime is characterized by an increase in temperature.
5.	Formation of a precipitate	When an aqueous solution of sodium sulphate is mixed with the aqueous solution of barium chloride, barium sulphate comes in the form of white precipitate
		$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(\downarrow) + 2NaCl(aq)$

Chemical equations

- A chemical equation is the symbolic representation of a chemical reaction in the form of symbols and formulae.
- It is a way to represent the chemical reaction in a concise and informative way.
- For example,

$$\underset{\text{(Reactants)}}{\text{Magnesium} + \text{Oxygen}} \rightarrow \underset{\text{(Product)}}{\text{Magnesium oxide}}$$

  This equation is called word equation.
- The word equation can be written into chemical equation by writing symbols and formulae of the substance in place of their name.

$$2Mg + O_2 \rightarrow 2MgO$$

Writing a chemical equation

(i) The symbols of elements and the formulae of reacting substances (reactants) are written on the left hand side of the equation, with a plus (+) sign between them.

(ii) The symbols and formulae of the substances formed (products) are written on the right hand side of the equation, 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.

- **Skeletal chemical equation:** A chemical equation which simply represents the symbols and formulas of reactants and products taking part in the reaction is known as skeletal chemical equation for a reaction.

For example: For the burning of Magnesium in the air, $Mg + O_2 \rightarrow MgO$ is the skeletal equation.

- **Balanced Equation:** The equation 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 example of balanced chemical equation :

(i) $CO(g) + 2H_2(g) \xrightarrow{340\ atm} CH_3OH(l)$

(ii) $6CO_2(g) + 6H_2O(l) \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \underset{\text{Glucose}}{C_6H_{12}O_6(aq)} + 6O_2(g)$

- The process of equalizing the atoms of various elements both on either sides of an equation is called the balancing of chemical equation. This is known as hit and trial method. Let us understand this with the help of an example given below:

Key Word

Law of conservation of mass: It states that, "The matter can neither be created nor destroyed in a chemical reaction. " OR "
the total mass of reactants = total mass of products".

Example 1

Balancing a chemical equation :

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

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

Step 2. Count the number of atoms of each element on both the sides of the arrow :

	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. Equalize the number of the atoms of element which has the maximum number of atoms (oxygen).

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

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 at above or below the arrow.

Topic-2 Types of Chemical Reactions

Concepts Covered • ***Combination reaction,*** • ***Decomposition reaction,*** • ***Displacement reaction,*** • ***Double displacement reaction,*** • ***Redox reaction,*** • ***Oxidation and reduction reaction,*** • ***Exothermic and endothermic reaction.***

Revision Notes

- **Types of Chemical Reactions**

I. Combination Reaction: The reaction in which two or more reactants 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) $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(aq) + Heat$

(Quick lime) (Slaked lime)

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

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

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

(ii) Respiration is also an exothermic reaction.

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

(Glucose)

II. Decomposition Reaction:

The reaction in which a compound splits into two or more simpler substances is called decomposition reaction.

$$A \rightarrow B + C$$

(a) 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) Green colour — (Ferric oxide) Red-brown colour

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

(Lime stone) (Quick lime)

(b) Electrolytic Decomposition: When decomposition is carried out by passing electricity.

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

(c) Photolytic Decomposition: When decomposition is carried out in presence of sunlight.

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

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

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.

e.g., (i) $Fe(s) + CuSO_4(aq) \rightarrow FeSO_4(aq) + Cu(s)$

(Iron) (Copper sulphate) (Ferrous sulphate) (Copper)

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

(ii) Zinc displaces copper forming zinc sulphate. Zn is more reactive than copper.

$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

(Zinc Sulphate)

IV. Double Displacement Reaction: A reaction in which new compounds are formed by mutual exchange of ions between two compounds.

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

(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: Loss of electrons

Reduction: Gain of electrons

Mnemonics

Concept: Types of decomposition reaction
Mnemonics: PET
Interpretations:
Photolytic reaction, **E**lectrolytic reaction, **T**hermal reaction

Concept: Oxidation and reduction reaction
Mnemonics: OIL RIG
Interpretations:
Oxidation **I**s **L**oss of electrons, **R**eduction **I**s **G**ain of electrons

Concept: Types of chemical reactions
Mnemonics: ROC.D^3
Interpretations:
Reduction, **O**xidation, **C**ombination, **D**ecomposition, **D**isplacement, **D**ouble Displacement

Oxidation: It is a process of gaining oxygen during a reaction by an atom, molecule or ion.

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

Reduction: It is the gain of electrons or a decrease in the oxidation state of an atom by another atom, an ion or a molecule.

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

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

VI. Important equation

Redox (Oxidation and Reduction) Reaction :

Oxidation (HCl isoxidized)

$$MnO_2(s) + 4HCl(conc.) \longrightarrow MnCl_2(aq)_2 + Cl\ (g) + 2H_2O$$

Reduction(MnO_2 is reduced)

VII. Some usually asked equations in exams for balancing :

- $2CO(g) + O_2(g) \longrightarrow 2CO_2(g)$
  (Carbon monoxide) (Oxygen) (Carbon dioxide)
- $ZnCO_3 \xrightarrow{Heat} ZnO + CO_2$
- $2FeSO_4(s) + \longrightarrow Fe_2O_3(s) + SO_2(g) + SO_3(g)$
- $Pb(NO_3)_2 + 2KI \longrightarrow 2KNO_3 + PbI_2$
  (Lead nitrate) (Potassium iodide) (Potassium nitrate) (Lead Iodide)
- $CaO(s) + H_2O \longrightarrow Ca(OH)_2 + Heat$
  (Quick lime) (Slaked lime)
- $NaCl + AgNO_3 \longrightarrow AgCl + NaNO_3$
  (Sodium chloride) (Silver nitrate) (Silver chloride) (Sodium nitrate)
- $Ca + 2HNO_3 \longrightarrow Ca(NO_3)_2 + H_2\uparrow$
- $2Al + 3H_2SO_4 \longrightarrow Al_2(SO_4)_3 + 3H_2\uparrow$
- $Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$
- $Zn + 2HCl \longrightarrow ZnCl_2 + H_2\uparrow$
- $Zn + 2NaOH \xrightarrow{Heat} Na_2ZnO_2 + H_2\uparrow$
- $Mg + 2HNO_3 \longrightarrow Mg(NO_3)_2 + H_2\uparrow$
- $Na_2CO_3 + 2HCl \longrightarrow 2NaCl + H_2O + CO_2$
- $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$
- $4Zn + 10\ HNO_3 \longrightarrow 4Zn(NO_3)_2 + 5H_2O + N_2O$

Effects of oxidation reactions in everyday life :

1. **Corrosion:** Corrosion is a process in which metals are deteriorated by action of air, moisture, chemicals, etc. It is a redox reaction where metal gets oxidised to metal oxide and oxygen gets reduced to oxide ion.
   Examples:
   (a) Corrosion of iron is called rusting. Iron objects when left in moist open air for sometime get coated with a reddish brown powder. The process is known as rusting.
   (b) Green coating on Copper articles and black coating on silver ornaments are another example of corrosion.
   Effects of corrosion :
   (a) Rusting causes damage to ships, car bodies, bridges, railings.
   (b) Corrosion is a wasteful process because it leads to wastage of tonnes of various metals every year and lot of money is spent to repair or replace it.
   Prevention of Rusting:
   (a) The iron articles should be painted.
   (b) The machine parts should be oiled and greased.
   (c) Galvanised iron pipes should be used for water supply.
   (d) Iron can be coated with chromium to prevent rusting.

Mnemonics

Concept: Preventive ways of rusting	**Interpretations:**
Mnemonics: POGG	**P**ainting **O**iling **G**reasing **G**alvanising

2. **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.

Rancidity can be prevented by the following ways :

(a) Storing the food in refrigerator.

(b) Storing the food in air-tight container.

(c) Addition of anti-oxidants to food.

(d) Storing the food in flush bags with gas, such as nitrogen to prevent the oxidation process.

CHAPTER-2

ACIDS, BASES AND SALTS

Topic-1 Acids and Bases

Concepts Covered • Definition of acids and bases, • Properties of acids and bases, • Indicators and its type, • pH scale and importance of pH in everyday life.

Revision Notes

Acids

- Acids are the substances that furnish H^+ ions in aqueous solution. Acids are sour in taste. They turn blue litmus red.
- The example includes Sulphuric acid (H_2SO_4), Acetic acid (CH_3COOH), Nitric acid (HNO_3) etc.
- 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**.
- Those acids which dissociates into ions completely are called strong acids, e.g., H_2SO_4, HCl.
- Those acids which do not dissociate into ions completely are called weak acids, e.g., citric acid, acetic acid.

> **Note:**
> Although we talk of 'taste' of acids and bases, it is not advisable to taste any acid or base. Most of them are harmful. Similarly touching the solutions of strong acids and bases should be avoided. They may harm the skin.

Some Naturally occurring acids :

Natural source	Acid	Natural source	Acid
Vinegar	Acetic acid	Sour milk (Curd)	Lactic acid
Orange	Citric acid	Lemon	Citric acid
Tamarind	Tartaric acid	Ant sting	Methanoic acid
Tomato	Oxalic acid	Nettle sting	Methanoic acid

Bases

- Bases are those chemical compounds which are bitter in taste, soapy in touch, turn red litmus blue and give OH^- ions in aqueous solution.
- The examples include Sodium hydroxide (NaOH), Potassium hydroxide (KOH), etc.
- 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.
- 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.
- Chemical compounds can cause harm to our body, some are very lethal, and therefore, we cannot rely on physical tests such as taste and appearance. In laboratory, to test whether a compound has acidic character or basic character, indicators are used.
- **Indicators:** These are the substances which change their colour / smell in different types of substances.

Types of Indicators:

	S. No.	Indicator	Smell/Colour In Acid Solution	Smell/Colour In Basic Solution
Natural Indicator	1.	Litmus	Red	Blue
	2.	Red cabbage leaf extract	Red	Green
	3.	Flowers 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:

1. Reaction of Metals with:

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

Test for H_2 gas: Hydrogen gas released can be tested by bringing a burning candle near gas bubbles, it bursts with pop sound.

2. Reaction of Metal Carbonates / Metal Hydrogen Carbonates with:

Acids	Bases
Acid + Metal Carbonate / Metal hydrogen Carbonate ↓ Salt + CO_2 + H_2O	Base + Metal Carbonate / Metal Hydrogen Carbonate ↓ No Reaction

e.g., $2HCl + Na_2CO_3 \rightarrow 2NaCl + CO_2 + H_2O$

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

Test for CO_2: CO_2 can be tested by passing it through lime water. Lime water turns milky.

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

When excess CO_2 is passed, milkiness disappears.

$CaCO_3 + CO_2 + H_2O \rightarrow Ca(HCO_3)_2$

3. Reaction of Acids and Bases With Each Other

When an acid reacts with base, the hydrogen ion of acid combines with hydroxide ion of base and forms water. As these ions combine together, they form water instead of remaining free, thus both neutralize each other.

Acid + Base → Salt + Water

H X + MOH →MX + HOH

$H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$

Since, in the reaction between an acid and a base both neutralize each other, it is also known as neutralization reaction.

Example : Sodium hydroxide (a strong base) reacts with hydrochloric acid to form sodium chloride and water.

$NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O(l)$

Dilution of Acid and Base

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.

Key Facts

- We add acid to water. If we add water to acid, the high concentration of acid may produce a violent exothermic reaction.
- Concentrated acids and bases are corrosive; no person should touch it with bare hand or skin. In case a few drops spill on the body, a person should wash it with plenty of water.

Common property between all acids and all bases

- Acids give hydrogen gas when they react with metal. This shows that all acids contain hydrogen.
- When acids are dissolved in water they dissociate as H^+ ions. The dissociation as hydrogen ions in aqueous solution is the common property of all acids. As a result, an acid shows acidic behavior.

  $HCl\,(aq) \rightarrow H^+(aq) + Cl^-(aq)$

  $HNO_3(aq) \rightarrow H^+(aq) + NO_3^-(aq)$

  $CH_3COOH\,(aq) \rightarrow H^+\,(aq) + CH_3COO^-(aq)$
- As H^+ ion cannot exist alone so it combines with water molecules and forms H_3O^+ (hydronium) ions.

  Example :

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

  $H^+ + H_2O \rightarrow H_3O^+$

  Thus, acids can also be defined as 'Substances which when dissolved in water ionize to produce hydrogen ions, H^+ (aq).
- Similarly, substances which when dissolved in water ionize to produce hydroxide ions, OH^- (aq).

  Examples : When sodium hydroxide is dissolved in water, it dissociates into hydroxide and sodium ion.

  $$NaOH(s) \xrightarrow{H_2O} Na^+(aq) + OH^-(aq)$$

4. Reaction of acids with metal oxides :

Metal oxides react with acids to give salt and water.

Metal oxide + Acid → Salt + Water

Example : Copper oxide reacts with dil. hydrochloric acid to form copper chloride (salt) and water.

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

Copper oxide Copper chloride

Copper oxide is black in colour. When dilute hydrochloric acid is added in it, the colour of the solution becomes blue green due to formation of copper chloride.

▶ **How strong are acid or base solutions?**

- Strength of an acid or base depends on the number of H^+ ions or OH^- ions produced by them respectively.
- Based on its ability to dissociate into ions in solution, acids and bases are classified as strong acid or base and weak acid or base.

(i) Strong acids : Acid which completely dissociates in water to produce large amount of hydrogen ions are called strong acids. For example hydrochloric acid (HCl), sulphuric acid (H_2SO_4), nitric acid (HNO_3) are strong acids as they get completely ionized in water to form ions.

$$HCl\,(aq) \rightarrow H^+(aq) + Cl^-(aq)$$

(ii) Weak acids : Acids which are partially ionized in water to produces small amount of hydrogen ions are known as weak acids. For example, acetic acid partially dissociates in water to produce small amount of hydrogen ions.

$$CH_3COOH\,(aq) \rightarrow H^+\,(aq) + CH_3COO^-(aq)$$

(iii) Strong bases : Bases which completely ionize in water to produce large amount of hydroxide ions are called strong bases. Examples include NaOH, KOH, etc.

(iv) Weak bases : Bases which partially dissociate in water to furnish lesser amount of hydroxide ions are called weak bases. Examples include ammonium hydroxide (NH_4OH) and calcium hydroxide $Ca(OH)_2$

pH

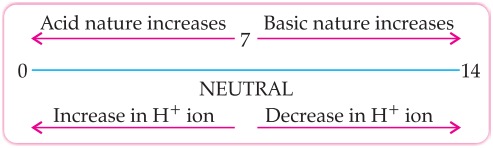
▶ A scale for measuring H^+ ion concentration in a solution.

▶ 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.

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

- pH = 7 → neutral solution
- pH < 7 → acidic solution
- pH > 7 → basic solution
- On diluting an acid: pH increases ↑
- On diluting a base: pH decreases ↓

Key Diagram



- **Importance of pH in everyday life:**
  - 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.**
  - Plants require a specific pH range for their healthy growth.

Key Fact

p in pH stands for 'potentz', a German word which means power.

- pH of stomach is 1.5-3.0 due to secretion of HCl. In case of indigestion, acidity increases, which can be neutralised by antacids like milk of magnesia.
- Tooth decay starts when pH of the mouth is lower than 5.5. To protect tooth decay, toothpastes which are basic in nature are used to neutralize the excess acid.
- Many plants and animals produce certain acids to defend themselves. For example, Bee stings leave an acid into the skin, which causes pain and irritation. If a mild base like baking soda is applied on the stung area, it gives relief.

Key Word

Acid rain: Acid rain is rain or any other form of precipitation that is unusually acidic, meaning that it has elevated levels of hydrogen ions (low pH).

- **Important Reaction of different solutions with different indicators :**

S. No.	Name of the solution	Colour change (if any) Phenolphthalein	Colour change (if any) Blue litmus
1.	Sodium carbonate	turns pink	no change
2.	Hydrochlroic acid	no change	turns red
3.	Sodium chloride	no change	no change

Topic-2

Salts, their Properties and Uses

Concepts Covered • **Salts,** • **Types of salts,** • **Preparation and uses of Sodium Hydroxide, Bleaching powder, Baking soda, Washing soda and Plaster of Paris..**

Revision Notes

- **Salts:** A salt is an ionic compound that results from the **neutralisation reaction** of an acid and a base. Salts are composed of related numbers of cations and anions, so that, the product is electrically neutral.
- **Types of Salts:**

(i) Neutral salts : Salts produced by reaction of strong acid and strong base are neutral in nature with pH value 7. For example, sodium chloride formed by reaction between sodium hydroxide (strong base) and hydrochloric acid (strong acid).

$$NaOH\ (aq) + HCl\ (aq) \rightarrow NaCl\ (aq) + H_2O\ (l)$$

(ii) Acidic salts : Salts formed by reaction between a strong acid and weak base are acidic in nature with pH value less than 7. For example, ammonium hydroxide. It is a salt of hydrochloric acid (strong acid) and ammonium hydroxide (weak base).

$$NH_4OH\ (aq) + HCl(aq) \rightarrow NH_4Cl\ (aq) + H_2O\ (l)$$

Key Word

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

Example : $NaOH(aq) + HCl(aq) \rightarrow NaCl(aq) + H_2O$.

(iii) Basic salts : Salts formed by reaction of strong base and weak acid are basic in nature with pH value more than 7. For example, sodium carbonates. It is a salt of carbonic acid (weak acid) and sodium hydroxide (strong base).

$$H_2CO_3\,(aq) + 2NaOH\,(aq) \rightarrow Na_2CO_3 + 2H_2O\,(l)$$

- **Common Salt (NaCl):**

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

Properties: $2NaCl\,(aq) + 2H_2O\,(l) \rightarrow 2NaOH\,(aq) + Cl_2\,(g) + H_2\,(g)$

Users of common salt:

(a) Used as daily food.

(b) Used as preservative.

(c) Used in manufacture of metal (Na) and gas (Cl_2) in molten state by electrolysis

- **Sodium hydroxide (NaOH)**

Preparation : $2NaCl\,(aq) + 2H_2O\,(l) \rightarrow 2NaOH\,(aq) + Cl_2\,(g) + H_2\,(g)$

The process is called chlor - alkali process because of the products formed- Chlor for chlorine and alkali for sodium hydroxide.

Uses :

(a) Sodium hydroxide is used in making of paper, soap and detergents, for de-greasing metals, etc.

(b) Chlorine gas is used in water treatment, manufacturing of PVC, pesticides, etc.

(c) liquid hydrogen is used as rocket fuel, in hydrogenation process of oil to produce vegetable *ghee* (margarine) and in making of ammonia for fertilizers..

- **Bleaching Powder ($CaOCl_2$):**

Preparation: It is produced by the action of chlorine on dry slaked lime.

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

Properties:

(a) It has a strong smell of chlorine.

(b) Soluble in water.

(c) It loses Chlorine by the action of carbon di oxide.

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.

- **Baking Soda** (Sodium hydrogen carbonate) **($NaHCO_3$):**

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

Baking soda

Properties:

(a) It is mild non-corrosive base.

(b) When it is heated during cooking, the following reaction takes place.

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

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.

$NaHCO_3 + H^+ \rightarrow CO_2 + H_2O$ + Sodium salt of an acid

(b) An ingredient in antacid.

(c) Used in soda acids, fire extinguishers.

- **Washing Soda ($Na_2CO_3.10H_2O$):**

Preparation: Re-crystallization of sodium carbonate gives washing soda. It is a basic salt.

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

Properties:

(a) Transparent crystalline solid.

(b) It has 10 molecules of water of crystallisation.

(c) It dissolves in water and the aqueous solution is alkaline.

(d) It liberates Carbon dioxide when treated with Hydrochloric acid and Sulphuric acid.

Uses:

(a) In glass, soap and paper industry.

(b) Manufacture of borax.

(c) It can be used as cleaning agent.

(d) It can be used for removing permanent hardness of water.

- **Plaster of Paris (Calcium sulphate hemihydrates) ($CaSO_4.½H_2O$):**

Preparation: 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.

$$CaSO_4.2H_2O \rightarrow CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O$$

Properties: $CaSO_4.\frac{1}{2}H_2O + 1\frac{1}{2}H_2O \rightarrow CaSO_4.2H_2O$

Uses:

(a) Doctors use POP for supporting fractured bones.

(b) For making toys and material for decoration.

Important salts :

Common name	Chemical name	Chemical formula	Uses
Washing soda	Sodium carbonate decahydrate	$Na_2CO_3.10H_2O$	Manufacture of borax, caustic soda, softening of hard water.
Baking soda	Sodium hydrogen carbonate	$NaHCO_2$	Used as antacid, ingredient of baking powder.
Bleaching powder	Calcium oxychloride	$CaOCl_2$	Bleaching clothes, used as oxidising agent, disinfecting water, manufacture of chloroform.
Plaster of Paris	Calcium sulphate hemihydrate	$CaSO_4.1/2\ H_2O$	Plastering fractured bones, making toys, decorative materials, statues.

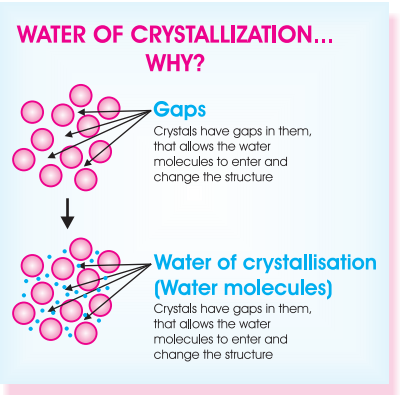
Water of crystallization

- Water molecules present in the crystal structure of salt are called water of crystallization and such salts are called hydrated salts. Water of crystallization is the fixed number of water molecule present in one formula unit of a salt.

Examples:

- **Copper sulphate pentahydrate ($CuSO_4.5H_2O$) :** It has five water molecules in one formula unit of copper sulphate (blue vitriol).
- **Sodium carbonate ($Na_2CO_3.10H_2O$) :** It has ten molecules of water as water of crystallization.
- **Gypsum ($CaSO_4.2H_2O$) :** It has two molecules of water as water of crystallization.

Key Diagram



CHAPTER-3
METALS AND NON-METALS

Topic-1 Properties of Metals and Non-Metals

Concepts Covered • Physical properties of Metals and non-metals, • Chemical properties of Metals and non-metals:, • Reaction with oxygen, • Reaction with water, • Reaction with acids, • Reaction with other metal salt solutions, • Reaction between metals and non-metals (ionic bond formation).

Revision Notes

Physical Properties of Metals and Non-metals :

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 easily cut with knife.	Generally soft. • Except Diamond, a form of carbon which is the hardest natural substance.
3. State	Exist as solids. • Except Mercury that exists as liquid.	Exist as solids or gases • Except Bromine that exists as liquid.
4. Malleability	Metals can be beaten into thin sheets. • Gold, Silver and Aluminium are the most malleable metals.	Non-metals are non-malleable. • They are brittle.
5. Ductility	Metals can be drawn into thin wires.	They are non-ductile.
6. Conductor of heat & electricity	Metals are good conductors of heat and electricity.	Non-metals are poor conductors of heat and electricity. • Except Graphite.
7. Density and Melting point	Generally metals have high density and high melting point. • Except Sodium and Potassium	Non metals 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.

Chemical Properties of Metals :

(A)Reaction of Metals with Air: Metals combine with oxygen to form metal oxide.

Metals + $O_2 \rightarrow$ Metal oxide

Examples:

(i) $2Cu + O_2 \rightarrow 2CuO$
Copper (II) oxide (black)

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

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

Different metals show different reactivity towards O_2.

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

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

Examples: $Al_2O_3 + 6HCl \rightarrow \underset{\text{Aluminium chloride}}{2AlCl_3} + 3H_2O$

$Al_2O_3 + 2NaOH \rightarrow \underset{\text{Sodium aluminate}}{2NaAlO_2} + H_2O$

(B)Reaction of Metals with Water: Metals react with water to produce metal hydroxide and hydrogen gas.

Metal + Water → Metal oxide + Hydrogen

Examples:

Metal oxide + Water → Metal hydroxide

$2Mg + 2H_2O \rightarrow \underset{\text{Magnesium oxide}}{2MgO} + 2H_2\uparrow$

$MgO + H_2O \rightarrow \underset{\text{Magnesium hydroxide}}{Mg(OH)_2}$

- Sodium and Potassium react vigorously with water.
- Magnesium metal reacts with hot water to produce magnesium hydroxide and hydrogen gas.

$$Mg + 2H_2O \longrightarrow Mg(OH)_2 + H_2$$

- Aluminium and zinc react with steam to produce metal oxide and hydrogen gas.
- Metals like silver, gold, copper and lead do not react with water.

(C) Reactions of Metals with Acid:

- Metal + Dil. Acid ⟶ Salt + Hydrogen gas
  e.g., $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$
- Copper, mercury and silver don't react with dilute acids.

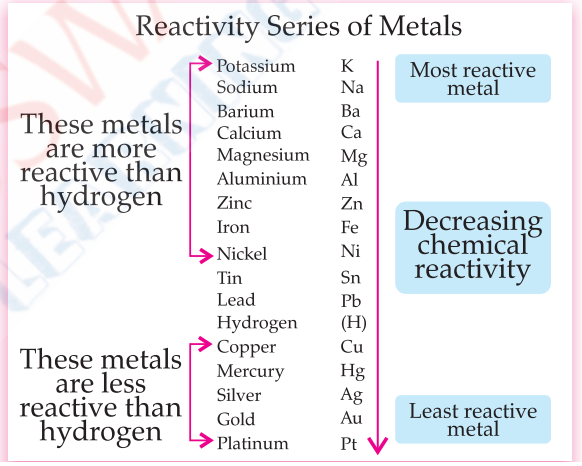
(D)Reaction of Metals with solutions of other Metal Salts:

Metal A + Salt solution B → Salt solution A + Metal B

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

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

- **Reactivity or activity series of metals :** 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 (K at the top most) are most reactive whereas metals at the bottom (Pt at the extreme bottom) are least reactive.



Mnemonics

Concept: Activity series of metals
Mnemonics: Popular **S**cientists **C**an **M**ake **A** **Z**oo **I**n**T**he **L**ow **H**umid **C**ountry **M**ore **S**atisfactorily
Interpretations:

P: Potassium	**S:** Sodium
C: Calcium	**M:** Magnesium
A: Aluminium	**Z:** Zinc
I: Iron	**T:** Tin
L: Lead	**H:** Hydrogen
C: Copper	**M:** Mercury
S: Silver	

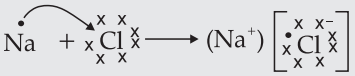
- **Reaction of Non-Metals:**
  - **Reaction with oxygen:** Non- metals react with oxygen to form acidic oxides.
    e.g., $C + O_2 \longrightarrow CO_2$
  - Reaction with water: Non-metals do not react with water because they do not release any electrons.
  - Reaction with dil. acids: No reaction.
  - Reaction with salt solutions: A more reactive non-metals will displace less reactive non-metal from its salt solution.
  - Reaction with chlorine: Non-metals react with chlorine to form their respective Chlorides.
    e.g., $H_2 + Cl_2 \longrightarrow 2HCl$
  - Reaction with hydrogen: Non-metals react with hydrogen to form their respective hydrides.
    e.g., $H_2 + S \longrightarrow H_2S$
- **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 oxidizing agent due to the formation of NOCl (Nitrosyl chloride) and chlorine produced by reaction of two acids.
- **Reaction between metal and non-metals:**
  - Reactivity of an element is the tendency to attain completely filled valence shells.
  - Atoms of metals can lose electrons from valence shells to form cations while atoms of non-metals can gain electrons in valence shell to form anions.
  - Opposite charged ions attract each other and held by strong electrostatic forces of attraction.
  - Let us understand formation of NaCl with the help of an example :

Example 1

Step 1: Atomic number of sodium (Na) is 1. Atoms in last shell are 1.
Step 2: Atomic number of chlorine (Cl) is 17. Atoms in last shell are 7.
Step 3: So, Na gives 1 atom to chlorine.
Step 4: This is complete transfer of electrons. So, it is ionic compound.

$Na \rightarrow Na^+ + e^-$
2,8,1 2, 8
(Sodium cation)

$Cl + e^- \rightarrow Cl^-$
2,8,7 2,8,8
(Chloride anion)



Topic-2 Ionic compounds, Metallurgy and Corrosion

Concepts Covered • Ionic compounds • Occurrence of Metals • Extraction of Metals • Corrosion • Alloy.

Revision Notes

- **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**
  (i) Physical nature: They are solid and hard, generally **brittle**.

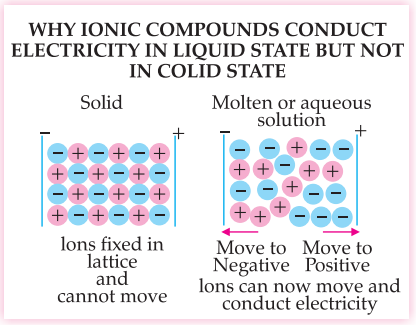
Key Word

Brittle: The property of a substance to get easily broken or cracked when hammered.

(ii) Melting and Boiling Point: They have high melting and boiling points.
(iii) Solubility: Generally soluble in water and insoluble in solvents such as kerosene, petrol, etc.
(iv) 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.



Metals on the basis of reactivity, can be grouped into three categories:

- Metals at the bottom of the activity series are least reactive and are often found in free state. For e.g., Gold, silver, platinum and copper.

  These metals are very unreactive. The oxides of these metals can be reduced to metals by heating alone. For example, cinnabar (HgS) (an ore of mercury). When it is heated in air, it is first converted into mercuric oxide which is further reduced to mercury on heating.

  $2HgS(s) + 3O_2(g) \xrightarrow{\Delta} 2HgO(s) + 2SO_2(g)$

  $2HgO(s) \xrightarrow{\Delta} 2Hg(l) + O_2(g)$
- Metals at the top of the activity series are so reactive that they are not found in nature as free state. e.g., K, Na, Ca, Mg and Al.
- Metals in the middle of the activity series are moderately reactive. They are found in the earth's crust as oxides, sulphides and carbonates. e.g., Zn, Fe, Pb, etc.

  The highly reactive metals are used as reducing agents because they can displace metals of lower reactivity from their compounds.

  For example: $3MnO_2(s) + 4Al(s) \longrightarrow 3Mn(l) + 2Al_2O_3(s) + Heat$

  Thermit reaction: $Fe_2O_3(s) + 2Al(s) \longrightarrow 2Fe(l) + Al_2O_3(s) + Heat$

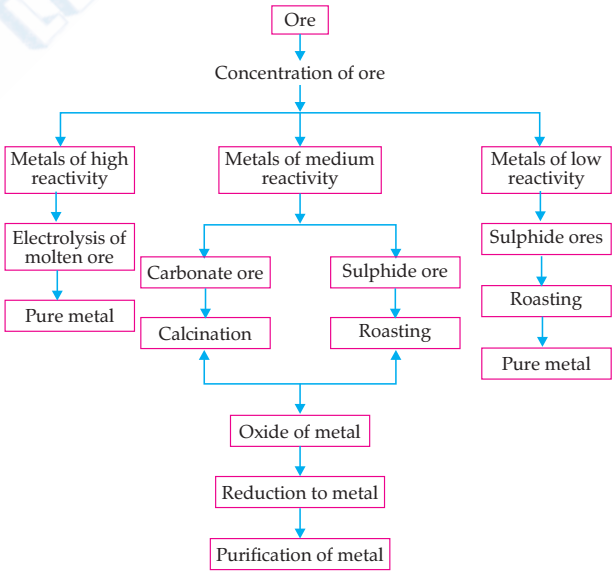
  The amount of heat evolved is so large that the metals are produced in the molten state. This reaction is used to join railway tracks or cracked machine parts.

Extraction of metals : It is the process of obtaining pure metal from its ore. Extraction of metal can be classified into three steps :

(1) Enrichment of ores or concentration of ores.

(2) Extraction of metal from the concentrated ores.

(3) Refining of metal.



- **Steps involved in extraction of metals from ores are as follows:**
- **Metallurgy:** The extraction of metals from their ores and then refining them for use is known as metallurgy.
- **Corrosion:** It is the deterioration of a metal as a result of chemical reactions between it and surrounding environment. For example,
  - Silver reacts with sulphur in air to form silver sulphide and articles become black.
  - Copper reacts with moist carbon dioxide in air and forms green coat of copper carbonate.
  - Iron acquires a coating of brown flaky substance called rust.
  - Rust is hydrated Iron (III) oxide, i.e., $Fe_2O_3.xH_2O$
- **Prevention of corrosion:** By painting, oiling, greasing, galvanizing and by making alloys.
- **Galvanization:** It is the process which involves coating of iron with zinc. The oxide thus formed is impervious to air and moisture thus protects further layers from getting corroded.
- **Alloys:** These are homogeneous mixture of metals with metals and non-metals. For example,
  - **Stainless steel:** Alloy of iron, nickel, chromium
  - **Brass:** Alloy of copper and zinc
  - **Bronze:** Alloy of copper and tin
  - **Solder:** Alloy of lead and tin
- **Amalgam:** If one of the metals is mercury, then the alloy is known as amalgam. E.g, Sodium amalgam and silver amalgam.

CHAPTER-4
CARBON COMPOUNDS

Topic-1
Carbon and its Properties, Homologous Series and IUPAC Names

Concepts Covered • *Covalent bonding in carbon compounds,* • *Versatile nature of carbon,* • *Homologous series,* • *Nomenclature of carbon compounds containing functional groups,* • *Difference between saturated and unsaturated hydrocarbons,* • *Chemical properties of carbon compounds*

Revision Notes

- **Properties of Carbon**
  - The element carbon is non-metal. Its symbol is C.
  - Carbon is a versatile element. The percentage of carbon present in earth's crust in form of mineral is 0.02% and in atmosphere as CO_2 is 0.03%.
  - All the living things, like plants and animals are made up of carbon based compounds.
  - Carbon always forms 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 in nature. It does not form ionic bond because it has 4 valence electrons, half of an octet. To form ionic bonds, carbon molecules must either gain or lose 4 electrons. It is because, that 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, nitrogen and chlorine also form bonds by sharing of electrons.

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

Key Word

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.

- **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 not gain electrons readily.
  - **(iv)** The difference in electronegativity of two bonded atoms should be low.
- **Properties of covalent compounds:**
  - **(i) Physical state:** They are generally liquids 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 is more apt word instead of 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.

Key Word

Lewis dot structures reflect the electronic structures of the elements, including how the electrons are paired. In Lewis dot structures each dot represents an electron. A pair of dots between chemical symbols for atoms represents a bond.

Let us understand this with the help of examples:

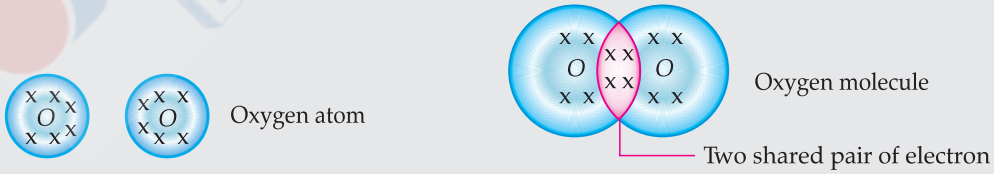
Example 1

(i) H_2



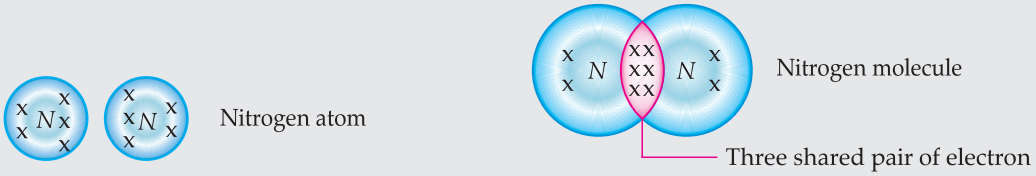
H – H: Single bond between hydrogen atoms

(ii) O_2



O = O: Double bond between oxygen atoms

(iii) N_2



N ≡ N: Triple bond between nitrogen atoms

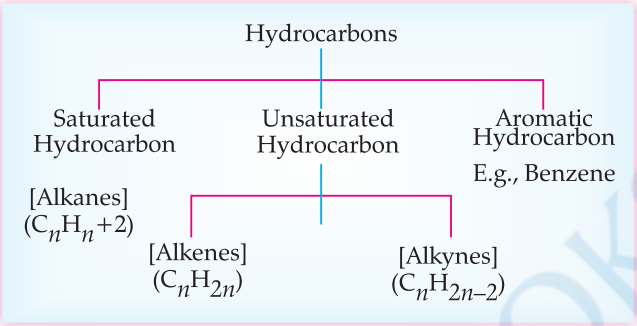
- **Versatile Nature of Carbon:** Carbon can form large number of carbon compounds. The factors that enable carbon to form large number of compounds are **catenation** and **tetravalency**.

Key Words

Catenation: It is the unique ability of elements to form long, straight or branched chains and rings of different sizes. Carbon shows maximum catenation in the periodic table.

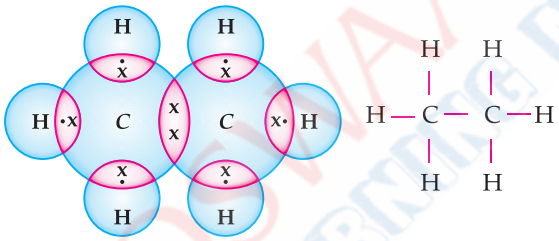
Tetravalency: It is the state of an atom in which there are four electrons available with the atom for covalent chemical bonding.

- **Hydrocarbon:** Compounds made up of hydrogen and carbon are called hydrocarbon.



- **Electron dot structure of saturated hydrocarbons:**

Ethane C_2H_6



Mnemonics

Concept: Saturated and unsaturate compounds

Mnemonics: **T**hank **Y**ou **De**S**a**.

Interpretation:

T: **T**riple bond

Y: Alk**y**ne

D: **D**ouble bond

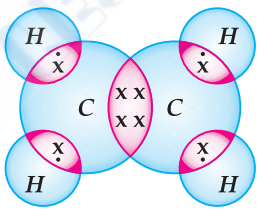
e: Alk**e**ne

S: **S**ingle bond

A: **A**lkane

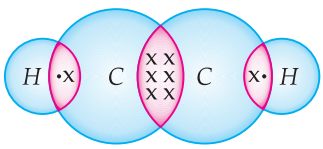
- **Electron dot structure of unsaturated hydrocarbons:**

Ethene: C_2H_4





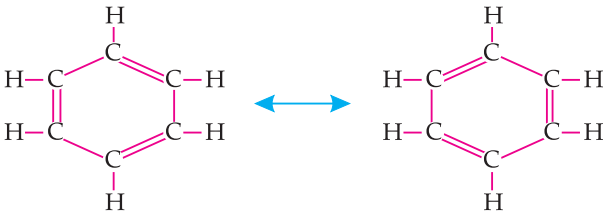
Ethyne: C_2H_2



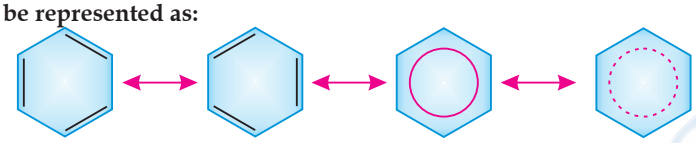
H – C ≡ C – H

- **On the basis of structures, hydrocarbons can be:**
  - (i) **Straight chain hydrocarbons:** Propane, butane, etc.
  - (ii) **Branched chain hydrocarbon:** Iso-butane, iso-pentane, etc.
  - (iii) **Cyclic hydrocarbons:** Cyclohexane C_6H_{12}, benzene C_6H_6, etc.
- **Cyclic or Closed Chain Hydrocarbons:** These are the hydrocarbons which 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:** 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.

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

Some important functional groups in carbon compounds are:

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

Key Word

Heteroatoms: An atom other than carbon or hydrogen atom.

- **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.

- **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.

Mnemonics

Concept 1: Homologous series
Mnemonics: **M**onkeys **E**at **P**eeled **B**ananas
Interpretations:
M: Methane (1C), **E: E**thane (2C), **P: P**ropane (3C), **B: B**utane (4C)
Concept 2: Reaction in saturated and Unsaturated compounds
Mnemonics: SaSUnA
Interpretations:
Sa: Saturated, **S: S**ubstitution, **Un: Un**saturated, **A: A**ddition

- **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: Carbon compounds burn in air to give carbon dioxide, water, heat and light.

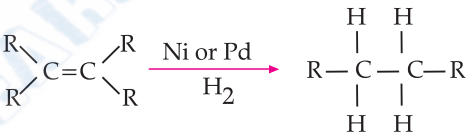
$$CH_4 + 2O_2 \xrightarrow{\text{Combustion}} CO_2 + 2H_2O + \text{Heat} + \text{Light}$$

- 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 into carboxylic acid in the presence of oxidizing agent like alkaline $KMnO_4$ (potassium permanganate) or acidic potassium dichromate $K_2Cr_2O_7$.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} \xrightarrow[\text{Acidic } K_2Cr_2O_7]{\text{Alkaline } KMnO_4 \text{ Or}} \underset{\text{Ethanoic acid}}{CH_3COOH}$$

(c) Addition Reaction: Unsaturated hydrocarbons (alkene, alkyne) undergo addition reactions.



In unsaturated hydrocarbon, hydrogen added 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: Saturated hydrocarbons undergo substitution reaction in the presence of sunlight.

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

Topic-2 Ethanol, Ethanoic acid, Soaps and Detergents

Concepts Covered • *Properties and uses of ethanol and ethanoic acid,* • *Soap and Detergents.*

Revision Notes

- **Ethanol:** Ethanol is commonly known as alcohol. It is the second member of the alcohol series. The molecular formula of ethanol is C_2H_5OH.
  - **Chemical Properties:**

(i) Reaction with sodium: Formation of sodium ethoxide and hydrogen.

$$2CH_3CH_2OH + 2Na \rightarrow 2CH_3CH_2ONa + H_2$$

(ii) Reaction with acid: Formation of ester (ethyl ethanoate) – a sweet smelling ester. This process is called esterification.

$$CH_3COOH + C_2H_5OH \underset{}{\overset{\text{conc. } H_2SO_4}{\rightleftharpoons}} CH_3COOCH_2CH_3 + H_2O$$

- **Uses:** In preparation of soap, cosmetics, in alcoholic beverages, in medicines, in laboratory reagent.

Ethanoic acid: The common name of ethanoic acid is acetic acid and it belongs to the group of acids called carboxylic acid. It is the second member of the series. The molecular formula of the compound is CH_3COOH.

- Vinegar — 5-8 % solution of acetic acid in water.
- Glacial acetic acid — Pure acetic acid
- **Chemical Properties of ethanoic acid**

(i) Reaction with sodium carbonate:

$2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$

(ii) Reaction with sodium hydrogen carbonate:

$CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$

Brisk effervescence marks the presence of carbon dioxide.

(iii) Reaction with NaOH:

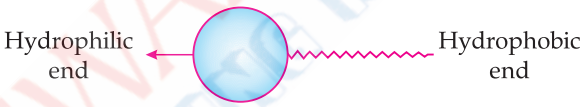
$CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O$

(iv) Reaction with ethanol (Esterification):

$$CH_3COOH + CH_3CH_2OH \underset{}{\overset{\text{conc. } H_2SO_4}{\rightleftharpoons}} CH_3COOC_2H_5 + H_2O$$

Soap and detergents

- Soap is sodium or potassium salt of long chain carboxylic acid. e.g., $C_{17}H_{35}COONa^+$
- On hydrolysis, **ester** gives parent alcohol and sodium salt of carboxylic acid. Alkaline hydrolysis of ester is called saponification.
- 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



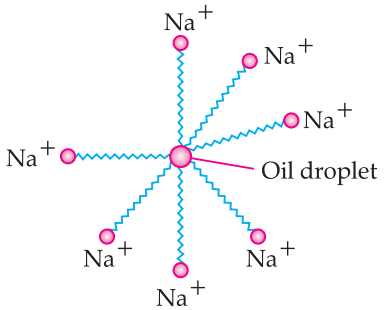
Structure of soap molecule

Key Word

Ester: Esters is generally sweet-smelling substances and is produced as a result of the reaction of an acid such as ethanoic acid and an alcohol such as ethanol in the presence of an acid catalyst. It is used in making perfumes and as flavouring agents.

Cleansing Action of Soap: Most dirt is oily in nature. The hydrophobic end of soap molecule 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 reacts 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 clothes get cleaned effectively.

UNIT – II: WORLD OF LIVING

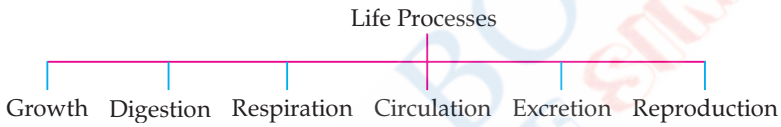
CHAPTER-5
LIFE PROCESSES

Topic-1 Nutrition

Concepts Covered • ***Modes of nutrition- Autotrophic and heterotrophic*** • ***Process of photosynthesis*** • ***Nutrition in human beings*** • ***Human digestive system***

Revision Notes

- All living things perform certain life processes like growth, excretion, respiration, circulation and reproduction etc.
- The basic functions performed by living organisms for their survival and body maintenance are called life processes.
- **Basic life processes are:**



- Energy required to carry out the different life processes, is obtained from carbon-based food sources through nutrition.
- There are two modes of nutrition:
  - **(i) Autotrophic nutrition:** It is a kind of nutrition in which organism prepare its own food by a process called photosynthesis for e.g., Green plants and some photosynthetic bacteria.
  - **(ii) Heterotrophic nutrition:** It is a kind of nutrition in which an organism takes food from another organism for e.g., Animals and fungi. It is of three types: Holozoic (e.g. *Amoeba*, animals), Saprophytic (e.g., fungi) and Parasitic (e.g., *Cuscuta*, ticks and mites)
- Depending on the mode of nutrition, organisms are classified as autotrophs and 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 are dependent on the autotrophs for obtaining complex organic substances for nutrition. (e.g., animals)
- Green plants manufacture their own food by the process of **photosynthesis**. Here, they utilise CO_2 and H_2O in presence of sunlight, with the help of chlorophyll and gives out O_2 as a by-product.
- **Main Events of Photosynthesis are:**
  - **(i)** Absorption of light energy by chlorophyll.
  - **(ii)** Conversion of light energy to chemical energy and splitting of water molecules into hydrogen and oxygen.
  - **(iii)** Reduction of CO_2 to form carbohydrates.
- Site of photosynthesis in the leaf is chloroplast. It contains a green colour pigment called chlorophyll**.**
- *Amoeba* is a unicellular organism, which follows holozoic mode of nutrition. *Amoeba* captures food with the help of temporary finger-like processes called pseudopodia.
- Plants carry out exchange of gases with surrounding atmosphere through stomata.
  The opening and closing of stomatal pores are controlled by the turgidity of guard cells.
  - **(i)** When guard cells uptake water from surrounding cells, they swell to become a turgid body. This enlarges the pore in between and causes stomatal opening.
  - **(ii)** When water is released, guard cells become flaccid. This closes the pore in between causing stomatal closing.
- **Nutrition in human beings:** The human digestive system comprises of alimentary canal and associated digestive glands.
- The alimentary canal is a long muscular tube extending from the mouth to the anus. Various regions are specialised to perform different functions.
- Associated glands include **salivary gland,** gastric gland, Liver and Pancreas.

Mnemonics

Concept: Parts of an alimentary canal in humans.

Mnemonics: MOSS DJ I LA – remember this as "Kate MOSS is a DJ In LA"

Interpretations:

M = Mouth
O = Oesophagus
S = Stomach
S = Small Intestine
D = Duodenum
J = Jejunum
I = Ileum
L = Large Intestine
A = Anus

Mouth → Intake of whole food.

↓

Teeth → Chewing/grinding of food.

↓

Tongue → Rolling of food + Tasting of food + Swallowing/Pushing down of the food.

↓

Tongue → Secrete saliva + Mucus

↓

Starch —(Salivary amylase [Saliva])→ Sugar

Oesophagus → Taking food from mouth to stomach by **peristaltic movements.**

↓

Stomach → Gastric glands —(Secrete)→ Gastric juice

Gastric juice:
- Pepsin (Enzyme that breaks down proteins)
- HCl (Makes medium acidic)
- Mucus (Protect inner lining of the stomach)

Small Intestine → **(a)** Intestinal enzyme ↓ convert

- Carbohydrate → Glucose
- Fats → Fatty acid + Glycerol
- Proteins → Amino acids

Small Intestine → **(b)** Villi (finger like projections) → Helps in absorption of food into the blood

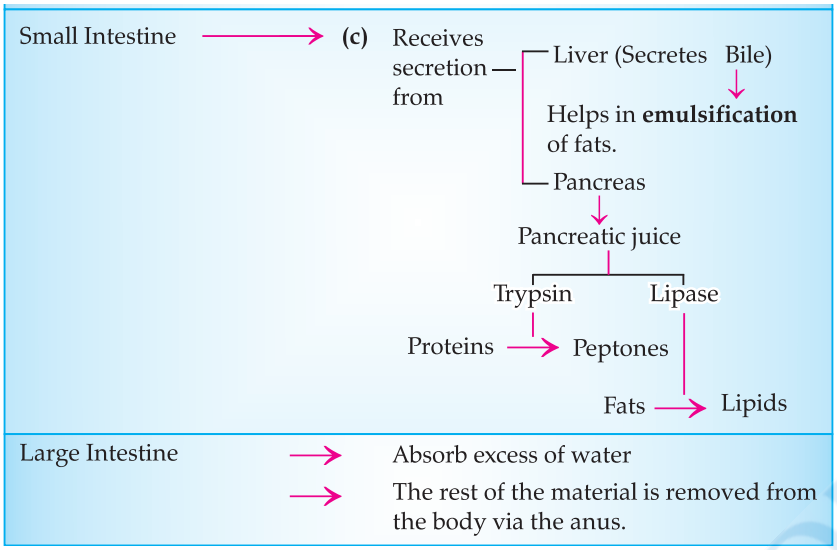
Key Words

Salivary glands: Secretes an enzyme called salivary amylase or ptyalin. It degrades starch into simple sugar.

Peristaltic movement: 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.

Key Facts

- Small intestine is the site of the complete digestion of carbohydrates, proteins and fats.
- Bile is secreted by liver and stored in gall bladder.



Key Word

Emulsification of fats is conversion of large fat pieces into very fine fat globules.

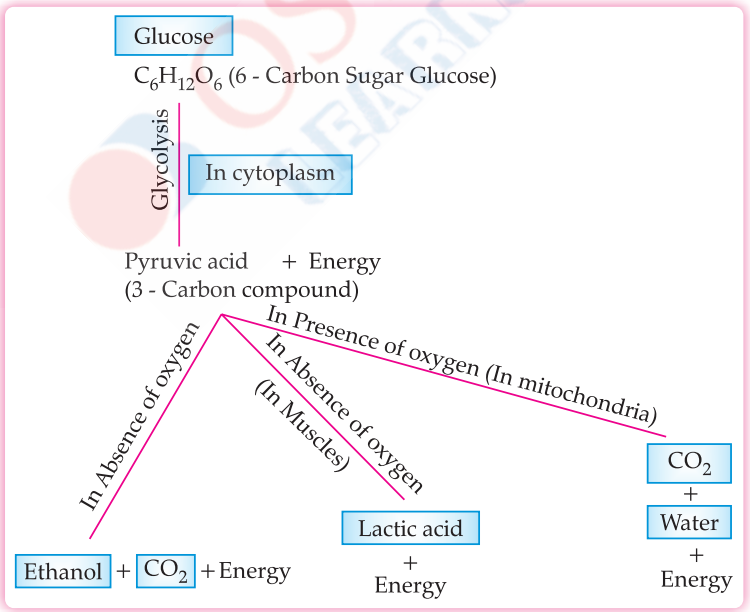
Topic-2 Respiration

Concepts Covered • ***Breakdown of glucose by various pathways*** • ***Types of respiration*** • ***Human respiratory system*** • ***Process of Breathing*** • ***Respiration in plants*** • ***Respiration in animals.***

Revision Notes

- Respiration is the process in living organisms, which involves:
  - **(i) Breathing (Gaseous exchange):** Intake of oxygen from the atmosphere and release of CO_2
  - **(ii)** Breakdown of simple food in order to release energy inside the cell
- **Important Flowchart:**

Breakdown of Glucose by Various Pathways:



Key Facts

- The breakdown of sugars by yeast to make alcohol in the absence of air is called fermentation.
- The accumulation of lactic acid causes muscle cramps.
- Pharynx contains rings of cartilage which ensure that air passage does not collapse.
- Respiration in plants occurs all through the day, but the photosynthesis process occurs in the daytime, in the presence of sunlight only.

- **Types of Respiration:**

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.
Examples: Most plants and animals.	Examples: Muscles, bacteria, yeast and parasitic worms etc.

- **Human Respiratory system:** Respiratory system in human serves to provide fresh oxygen to all body cells and removes harmful carbon dioxide from the body.
- It comprises Nostrils, Nasal cavity, Pharynx, Larynx, Trachea, Bronchi, Bronchiole, Alveoli, Blood capillaries and Lungs.
- **Breathing involves two main processes:**
  - **(a) Inspiration (Breathing IN):** Inspiration is the active intake of air from atmosphere into lungs.
    - The path followed by fresh air (oxygen) is:
      External nares → Nasal cavity → Internal nares → Pharynx → Glottis → Larynx → Trachea → Bronchi → Bronchioles → Alveolar duct → Alveoli
  - **(b) Expiration (Breathing OUT):** It is the passive expelling of air from the lungs.
    - The path followed by foul air (carbon dioxide) is:
      Alveoli → Alveolar duct → Bronchioles → Bronchi → Trachea → Larynx → Glottis → Pharynx → Internal nares → Nasal cavities → External nares → Outside
- 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 carries oxygen from lungs to different tissues of the body.
- In plants, gaseous exchange takes place through stomata in leaves, lenticel in stems, general surface of roots and transpiration.
- **Respiration in Animals:**
  - **(i)** Unicellular animals: **Diffusion**
  - **(ii) Earthworm:** Breathe through the skin.
  - **(iii) Aquatic animals:** Gills which extract dissolved oxygen in water.
  - **(iv) Insects:** Tiny holes called spiracles
  - **(v) Land animals:** Lungs
    - Terrestrial organisms use atmospheric oxygen for respiration.
    - Aquatic organisms use oxygen dissolved in water.
- The rate of breathing in aquatic organisms is much faster than that seen in terrestrial organisms.

Topic-3 Circulation and Transportation

Concepts Covered • ***Human circulatory system,*** • ***Double circulation system in humans,*** • ***Circulation of blood in animals,*** • ***Transportation in Plants*** • ***Transpiration.***

Human Circulatory System

- The circulatory system in human beings consists of: A circulatory medium (blood and lymph), blood vessels (veins, arteries and capillaries) and heart.
- Heart is a muscular organ which is composed of cardiac muscles. It is the main pumping organ which pumps the blood to all parts of the body.
- Human heart is four chambered i.e., it is composed of four chambers: right atrium, right ventricle, left ventricle and left atrium. The chambers are separated by a muscular wall that prevents the mixing of the blood rich in oxygen with the blood rich in carbon dioxide.
- Blood pressure is the force that the blood exerts on the blood vessels.
- Humans have double circulation system. 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 is a fluid connective tissue. It comprises four components- Plasma, RBCs, WBCs, and platelets.
- Lymph is a yellowish fluid that escapes from the blood capillaries into the intercellular spaces.
- **Blood Vessels:** There are three types of blood vessels:Arteries, veins and capillaries.

Key Facts

- Ventricles have thicker muscular walls as they pump blood into various organs.
- A healthy normal blood pressure reading is less than 120 mm Hg systolic and 80 mm Hg diastolic. A blood pressure of 140/90 mmHg or higher indicates high blood pressure.
- Valves ensures that blood does not flow backwards when the atria and ventricles contracts.

Differences between arteries and veins:

	Arteries		Veins
1.	Carry oxygenated blood from heart to different body parts except pulmonary artery.	1.	Carry deoxygenated blood from different body parts to the heart except pulmonary vein.
2.	Also called distributing vessel.	2.	Also called collecting vessel.
3.	Walls thick, elastic and muscular.	3.	Thin, non-muscular and less elastic.
4.	Deep seated	4.	Superficial as compared to arteries.
5.	Have no valves	5.	Have valves, which prevent backward flow of blood.

Transportation in plants:

There are two main conducting channels in vascular plants. These are Xylem and Phloem.

	Xylem		Phloem
1.	Transports water and minerals from the roots to upper parts of the plant.	1.	Transports product of photosynthesis from leaves to the non-photosynthesising parts of the plants such as root & stem.
2.	No energy is used for transport.	2.	Energy is used from ATP for transport.
3.	On maturity, the xylem becomes dead tissue and gives mechanical support to the plant.	3.	Phloem exists as living soft tissue.

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

Translocation: Transport of food from leaves (food factory) to different parts of the plant is called translocation.

Topic-4 Excretion

Concepts Covered • ***Excretion in human,*** • ***Structure of Nephron,*** • ***Urine formation,*** • ***Artificial Kidney,*** • ***Excretion in plants.***

Excretion in Human beings:

During **excretion**, the harmful metabolic nitrogenous wastes like urea and uric acid generated are removed from the body.

Key Word

Excretion is the process of the removal of the harmful metabolic wastes from the body.

- Excretory system of human beings includes a pair of Kidney, a Urinary Bladder, a pair of Ureter and a Urethra.
- Each kidney contains many filtration units called nephrons. Nephrons are the basic filtration units of kidneys. They carry out filtration, selective reabsorption and tubular secretion to form urine in kidney, which is then passed out through the urethra, via the ureters and urinary bladder..
- A Nephron is made up of a cluster of thin walled capillaries called glomerulus which is associated with a cup like structure called as Bowman's capsule and a 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 re-absorbed by the blood vessels surrounding the tubules.

- **The amount of water re-absorbed depends upon:**
  - How much excess of water is there in the body and,
  - How much nitrogenous wastes need to be excreted out.
- 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.

Key Fact

The expulsion of urine from the body is known as micturition.

- 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 re-absorbed in the body.
- **Urine formation in Kidneys:**

  Urine formation involves three steps:

  (i) **Glomerular filtration:** Nitrogenous wastes, glucose, water, amino acids filter from the blood into Bowman's capsule of the nephron.

  (ii) **Tubular reabsorption:** Useful substances from the filtrate are re-absorbed back by capillaries surrounding the nephron.

  (iii) **Secretion:** Urea, extra water and salts are secreted in the tubule which open up into the collecting duct and then into the ureter.
- **Haemodialysis:** In case of kidney failure, haemodialysis is the process of purifying blood by an artificial kidney.
- **Excretion in plants:** In plants, excretion of oxygen, CO_2 and water takes place through stomata by the process of transpiration.

CHAPTER-6
CONTROL AND CO-ORDINATION

Topic-1 Control and Co-ordination in Plants

Concepts Covered • **Tropic movements in plants,** • **Plants hormones- Auxins, Gibberellins, Cytokinins, Abscisic acid and Ethylene.**

Revision Notes

Introduction

- All the living organisms respond and react to the changes that happen 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.
- **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 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.
- Plants show two different types of movement:

  (A) Movement dependent on growth: It is of four types:

  (i) **Phototropism**: Growth movements of plants towards light e.g., shoots bend toward light (positively phototropic) and roots move away from light (negatively phototropic).

  (ii) **Geotropism:** Movement towards gravity. e.g., Roots of a plant are positively geotropic while shoots of a plant are negatively geotropic.

  (iii) **Chemotropism:** Movement towards chemicals. e.g., Growth of pollen tube towards ovule.

(iv) Hydrotropism:
Movement towards water.

(B) Movement independent of growth: These are immediate response to stimulus. e.g., Drooping of leaves of "Touch me not plant" on touching it. This is known as thigmotropism.

Key Fact

Thermotropism is a type of growth movement in plants in response to temperature, e.g., seedlings curve towards warm side.

- **Plant Hormones:** They are the chemical compounds produced naturally in plants which control the growth and other physiological functions' at a site, far away from the place of secretion are called plant **hormones** or phytohormones.. They are required in very small amount and help to coordinate growth, development and responses to the environment.

Key Word

Hormones: They are the chemical substances which co-ordinate and control the activities of living organisms and also their growth. They are functional in small concentration at the remote site from their production.

- **Main plant hormones are:**

(a)	**Auxins**	Synthesized at shoot tip. Helps the cells to grow longer. Involved in tropic movements of plants.
(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. Also called as Stress hormone.
(e)	**Ethylene ($H_2C=CH_2$)**	A gaseous hormone which helps in artificial ripening of fruits. Promotes senescence and abscission of leaves.

Mnemonics

Concept: Plant Hormone
Mnemonics: A CAGE
Interpretations:
A - Auxins
C - Cytokinins
A - ABA (Abscisic Acid)
G - Gibberellins
E - Ethylene

Topic-2 Control and Co-ordination in Animals

Concepts Covered • **Nervous System,** • **Voluntary and involuntary action,** • **Reflex action,** • **Animal hormones.**

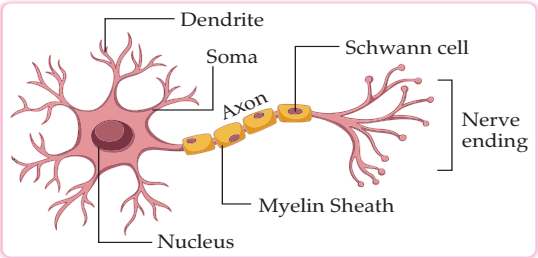
Revision Notes

- Control and coordination is brought about in all animals with the help of two main systems: Nervous system and Endocrine system.
- **Nervous system:** It is the system of conducting tissues that receives the stimulus and transmits it to other parts of the body forming a network of nerves. It is involved in receiving information (sensation) and generating responses to that information (motor response).
- A typical **neuron** consists of following parts:
  (i) Cyton or Cell body: It is star shaped which contains nucleus with abundant cytoplasm called neuroplasm. The information acquired by it travels as an electrical impulse.
  (ii) Dendrite: The hair like structure protruding out from margins of cell body is called dendrite. It receives the nerve impulses.

(iii) Axon: It is the longest fiber on the cell body. It ends in several hairs like structures called axon terminals, which transmits electrical impulse from cell body to dendrite of next neuron.

(iv) Myelin sheath: It is an insulator covered around the axon.

(v) Synapse: It is the point of contact between the nerve ending of one neuron and dendrite of other neuron. It is the part where electrical signal is converted into chemical signal for onward transmission to next neuron.



Structure of a Neuron

Important term:

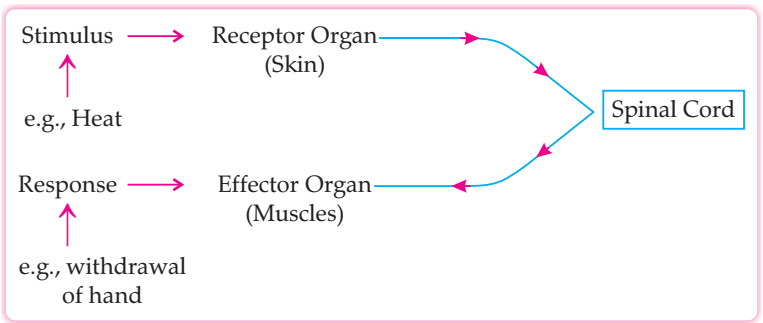
A chemical synapse formed by the contact between a motor neuron and a muscle fiber is called a neuromuscular junction.

- **Functioning of neuron:** Dendrites → Cell body → Axon → Nerve endings at the tip of axon → Synapse → Dendrite of next neuron
- The units which make 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 transmits 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.

Key Words

Neurons are structural and functional unit of nervous system.
Receptors are the chemical structures made up of proteins that receive signals from both external and internal environment.
Sensory neurons: The neurons which transmit impulses towards central nervous system.

- **Synapse:** The point of contact between the terminal branches of axon of one neuron with the dendrite of another neuron is called synapse.
- **Voluntary Action:** These are the actions which need thinking and are performed knowingly i.e., these are controlled by conscious thought. e.g.,: 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. It occurs without the conscious choice of an organism. e.g.,: Touching a hot plate unknowingly.
- **Reflex action:** It 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 passes during reflex action is called reflex arc. i.e., it is a pathway through which the reflex action occurs.

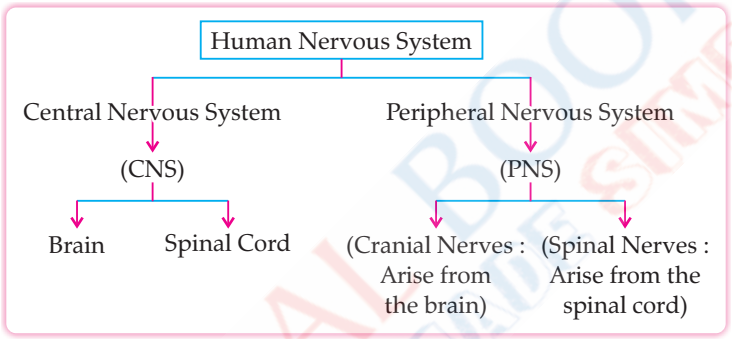


- **Stimulus and Response:** Stimulus is an observable or detectable change in the external or internal environment to which an organism reacts while response is the final reaction after reflex action.

Mnemonics

Concept: Reflex Arc
Mnemonics: RACEE
Interpretations:
R: Receptor
A: Afferent or Sensory Nerve
C: Centre (Brain or Spinal cord)
E: Efferent or Motor Nerve
E: Effector

- Responses are of three main types:
  - **(a) Voluntary:** Controlled by fore brain for e.g., talking, writing.
  - **(b) Involuntary:** Controlled by mid and hind brain for e.g., heartbeat, vomiting, respiration.
  - **(c) Reflex action:** Controlled by spinal cord for 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. Hence, this response is generated from spinal cord instead of brain.
- **Human nervous system:** The nervous system of vertebrates (including humans) is divided into the central nervous system (CNS) and the peripheral nervous system (PNS).



- Human brain is the main coordinating centre of the body. It has three major parts: Forebrain, midbrain and hind brain.
  - **(a) Fore-brain:** It is the most complex or specialized part of the brain. It consists of cerebrum. The main functions of forebrain are as follows:
    - **(i)** Main thinking part of the brain.
    - **(ii)** Controls the voluntary actions.
    - **(iii)** Stores information (memory).
    - **(iv)** Receives sensory impulses from various parts of the body and integrate it.
    - **(v)** It is the centre associated with hunger.

    The brain is protected by the skull called the cranium and is surrounded by three membranes called the meninges.

Key Fact

The space between meninges is filled with a fluid called Cerebro-Spinal Fluid (CSF). The brain floats in CSF, which acts as a cushion and shock absorber, making the brain neutrally buoyant.

Medulla oblongata, pons varolii and mid brain are collectively called the brain stem.

Pituitary gland is the master gland which controls all other endocrine glands.

  - **(b) Mid-brain:** Controls involuntary actions.
  - **(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:** Controls voluntary actions and helps in regulation of respiration.
- There are 31 pairs of spinal nerves and 12 pairs of cranial nerves in humans.
- Spinal cord is a cylindrical structure and a part of the central nervous system. It is made up of nervous tissue that extends from medulla oblongata in the brain stem to the lumbar region of vertebral column. It functions primarily in the transmission of nerve signals.

- **Endocrine system:** Endocrine system comprises endocrine glands and its secretion is called hormones.
- Hormones are chemical messengers secreted in very small amounts by specialized tissue called ductless glands. They act on target tissues/organs usually away from their source.
- Hormones assist the nervous system in control and coordination.
- **Endocrine glands with the hormones names and their secretions in humans are:**

No.	Gland	Hormones	Functions	Target Site
1.	Hypothalamus	(i) Releasing hormones (RH) (ii) Growth inhibiting hormones	Regulates secretion of pituitary hormones.	Pituitary gland
2.	Pituitary Gland	(i) Growth hormone (GH)	Controls growth-dwarfism and gigantism.	Various body cells which undergo growth
3.	Thyroid Gland	(i) Thyroxin (ii) Triiodothyronine (iii) Thyrocalcitonin (TCT)	Regulate basal metabolic rate, RBC formation. Regulate Calcium 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.	
6.	Testis	(i) Testosterone (ii) Androgens	Plays a role in development of male reproductive tissues and promotes secondary sexual characters in male.	Male body tissues
7.	Ovary	(i) Estrogen (ii) Progesterone	Helps in development of female secondary sexual characters. Support pregnancy.	Female body tissues

- **Hormonal Disorders:** All hormones are secreted in precise quantities. Its hypo (less) or hyper (more) secretion may lead to different disorders. For example:
  - **(a) Dwarfism:** Hyposecretion (Deficiency) of growth hormone causes a disease called dwarfism.
  - **(b) Gigantism:** Hypersecretion of growth hormone causes a disease called gigantism or excessive growth.
  - **(c) Goitre:** Deficiency of iodine causes a disease called goitre.

  Importance of iodine: Thyroid gland needs iodine to make thyroxine, which helps in regulating the metabolism of carbohydrates, fats and proteins.
  - **(d) Diabetes:** Deficiency of insulin hormone causes diabetes. Diabetes can be treated by injecting insulin hormone in the patient's body.
- **Feedback mechanisms:** The excess or deficiency of hormones have a harmful effect on our body. Feedback mechanism makes sure that hormones are secreted in precise quantities and at the right time.

  For example, blood is detected by the cells of the pancreas which respond by producing more insulin. As the blood sugar level falls, insulin secretion is reduced.

CHAPTER-7
REPRODUCTION

Topic-1 Asexual Reproduction and Vegetative Propagation.

Concepts Covered • Reproduction and its type, • Various Types of Asexual reproduction

Revision Notes

- 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 (Deoxyribonucleic acid), which is the hereditary 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. It is the base of evolution.
- **Types of Reproduction**

I Asexual Reproduction

- A single individual give rise to new individual.
- Gametes are not formed.
- New individuals are identical to their parents.
- Asexual reproduction is seen in most of the lower organisms and plants as well.

II 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 useful to generate more variations in species.
- Adopted by higher organisms.

I. Asexual reproduction takes place through fission, fragmentation, regeneration, budding, vegetative propagation, and spore formation. These modes of reproduction depend on the body design of the organisms.

(a) Fission: It is of two types - Binary fission and Multiple fission.

(i) 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 cell finally splits into two daughter cells. e.g., *Amoeba*

(ii) Multiple fission: 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.

(b) Fragmentation: It takes place in multicellular organisms with simple body organisation such as in *Spirogyra*. In this, the body breaks up into two or more small pieces of fragments upon maturation. These fragments grow into new individuals.

(c) 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*.

(d) Budding: 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.

(e) Vegetative Propagation: In many plants, new plantlets develops from vegetative parts of a plant's body such as stem, roots, leaves, etc.

- **Methods of vegetative propagation:**

(i) Natural methods are:

(a) By roots: e.g., *Dahlia*, sweet potato.

(b) By stems: e.g., Potato, ginger.

(c) By leaves: e.g., *Bryophyllum* (leaf margins bear buds which develop into plants).

(ii) Artificial methods:
- **(a)** Grafting: e.g., Mango
- **(b)** Cutting: e.g., Rose
- **(c)** Layering: e.g., Jasmine
- **(d)** Tissue culture: e.g., Ornamental plants, orchid.

Mnemonics

Concept: Vegetative Reproduction
Mnemonics: **P**ositive **E**xample **B**ased **L**earning
Interpretation:
P - Potato
E - Eyes
B - *Bryophyllum*
L - Leaf buds

Key Word

Vegetative propagation is a mode of asexual reproduction in which new plants are obtained from the vegetative parts of plants such as roots, stem, and leaves.

(f) Spore Formation: Spores are small bulb like structures which are covered by thick walls. Under favourable conditions, they germinate and produce new organisms. e.g., *Rhizopus.*

Key Fact

Tissue culture: It is the production or propagation of new plants from isolated plant cells or small pieces of plant tissue in a nutrient medium. This technique is also known as **micro-propagation**, and *in vitro* culture because it takes place outside the body of the parent plant in a test tube in an artificial environment.

Topic-2 Sexual Reproduction in Plants

Concepts Covered • Flower and its various parts • Pollination • Process of fertilization • Double fertilization.

Revision Notes

- **Parts of Flower**
  - Flowers are main reproductive part of a plant. The main parts of a flower are: sepals, petals, stamens and carpels.
  - 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**' makes the female gamete, which are present in ovules of the plant.
  - Flowers may be unisexual (e.g., papaya and watermelon) or bisexual (e.g., *Hibiscus* and mustard).
- **Pollination:** It is the transfer of pollen grains from the anther of a stamen to the stigma of a carpel. Pollination is of two types: Self pollination and Cross pollination.

Mnemonics

Concept: Reproductive parts of a Flower
Mnemonics: a **CAR** belongs to **W**omen but **ST**eering belongs to **Men**
Interpretation:
CARpel : Female organ of the plant.
STaMEN : Male part of the plant

- Self Pollination is the transfer of pollen in the same flower. In cross pollination, pollen is transferred from one flower to another.
- Cross-pollination introduces variations in plants because of the mixing of different genes. These variations further increase the adaptability of plants towards the environment or surroundings.
- The transfer of pollens takes place by agents like wind, water or animals.

- After pollination, a pollen tube grows out of pollen grains, through which male germ cell reaches the ovary and fuses with the female germ cell.
- Fertilisation is the process of fusion of male and female gamete to produce zygote. It occurs inside the ovary.

Post fertilization Changes :

- The outer layers of the ovule become impervious and hard and function as a seed coat.
- An ovule with an embryo inside is called a seed.
- The ovary enlarges and ripens to become a fruit.
- Other floral parts such as sepals, petals, stamens, styles and stigma may fall off. However, in some cases, they remain degenerated persistent in the fruit.

Double fertilisation:

- It is a characteristic feature of flowering plants. In this process, out of the two sperm nuclei, one sperm nucleus fuses with the egg nucleus to form an embryo (process is called syngamy) and another fuses with the secondary nucleus to form an endosperm (process is called triple fusion). Because two kinds of fusion, syngamy and triple fusion take place, the process is known as double fertilisation.
- Seed is the final (last) product of sexual reproduction in angiosperms. It is the fertilised ovule that is developed inside a fruit.
- Seed protects the future plant i.e., embryo.
- A seed consists of seed coat(s), cotyledon(s) and an embryonal axis.
- **Embryo axis has two parts :** Plumule and radical. Plumule develops into shoot and radicle develops into root.
- The process of development of seedling from the embryo under suitable conditions such as air, moisture etc., is known as germination.

Topic-3 Reproduction in Human Beings

Concepts Covered • **Puberty** • **Male and female reproductive system** • **Process of fertilisation** • **Menstrual cycle** • **Sexually Transmitted Diseases** • **Methods of contraception.**

Revision Notes

Humans have sexual mode of reproduction.

It needs sexual maturation, which is the period of life when production of germ cells i.e., ova (female) and sperm (male) start in the body. This period of sexual maturity is called **puberty**.

Changes at Puberty are:

Common in male and female

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

(a) In girls:

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

(b) In boys:

- Thick hair grows on face.
- Voice begins 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.

Functions of testes:

- Produce male germ cells i.e., sperms are formed here.
- Testes release male sex hormone (testosterone). Its function is to:
  - **(i)** Regulate production of sperms.
  - **(ii)** Bring changes at puberty.

Mnemonics

Concept 1: Parts of Male Reproductive System
Mnemonics: SEVEn UP
Interpretation:
S: Seminiferous tubules, **E:** Epididymis, **V:** Vas deferens, **E:** Ejaculatory duct, **U:** Urethra, **P:** Penis

Concept 1: Accessory glands in Males
Mnemonics: Saint **P**eters
Interpretation:
S: Seminal vesicle, **P:** Prostate gland

Concept 3: Accessory Ducts in Females
Mnemonics: Our **U**nited **V**illages
Interpretation:
Oviduct, Uterus, Vagina

(b) **Vas deferens:** It passes sperms from testes towards the urethra.

(c) **Urethra:** It is a common passage for both sperms and urine. Its outer covering is called **penis**. It is like a fibromuscular long tube which travels through 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.

Key Words

Embryo: It is the stage of development between the zygote or fertilised egg and the newly formed offspring.

Fertilisation : The process of fusion of sperm and the ovum to from a single cell called zygote is called fertilisation. It occurs in fallopian tube (oviduct).

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 'fertilised egg.'

Contraception: It is the avoidance of pregnancy, which can be achieved by preventing the fertilisation of ova.

(c) **Uterus:** It is a bag-like structure where development of the foetus 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**.
  Placenta is a specialised tissue embedded in the uterine wall. It contains villi on the embryo's side and blood spaces on the mother's side.
- 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;**
  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 spread by sexual contact from an infected person to a healthy person. Some common STDs are Gonorrhoea, syphilis, warts, HIV-AIDS.
- **Birth Control Methods:** There are different methods which are developed to prevent and control pregnancy such as mechanical methods, chemical methods, oral pills and surgical methods. These are also known as methods of **contraception**.

Methods of contraception

(a) Physical barrier

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

Mnemonics

Concept 1: Birth control Methods

Mnemonics: SON Is Born

Interpretations:
S: Surgical; **O: O**ral contraceptive; **N: N**atural; **I: I**UD; **B: B**arrier

Concept 2: Barrier Methods

Mnemonics: CDC Volunteered **S**tudent's **J**unior **F**ellowship

Interpretation:
Condoms, **D**iaphragm, **C**ervical caps, **V**aults, **S**permicidal creams, **J**ellies, **F**oams

(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**.

CHAPTER-8
HEREDITY AND EVOLUTION

Revision Notes

Introduction

- Variations arise usually during the process of sexual 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 during meiosis.
- Beneficial variations help the species to survive better in the environment.
- Nature selects the beneficial variations thereby leading to evolution.
- Sexual reproduction produces offspring with similar body design of the parents. However, the offsprings are not identical and 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. e.g., Bacteria that can withstand heat will survive better in a heat wave.
  - **(ii)** Main advantage of variation to species is that it increases the chances of its survival in a changing environment.

Mendel and His Work on Inheritance

- **Gregor Johann Mendel (1833 & 1884)** started his experiments on plant breeding and hybridization. He proposed the laws of inheritance in living organisms.
- Mendel was known as the **Father of Genetics.**
- Plant selected by Mendel was *Pisum sativum* (garden pea). Mendel used a number of varieties of garden pea to study the inheritance of seven pairs of contrasting characters.

- **Seven pairs of** contrasting characters in garden plant, selected by Mendel were:

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

- Mendel conducted a series of experiments in which he crossed the pollinated plants to study one character (at a time).

Key Word

Monohybrid cross is a cross between two pea plants with one pair of contrasting characters. e.g., Cross between a tall and a dwarf plant (short)

- In case of **monohybrid cross** with pure line breeding varieties of plants, the **phenotypic** ratio obtained in F_2 generation was 3:1.

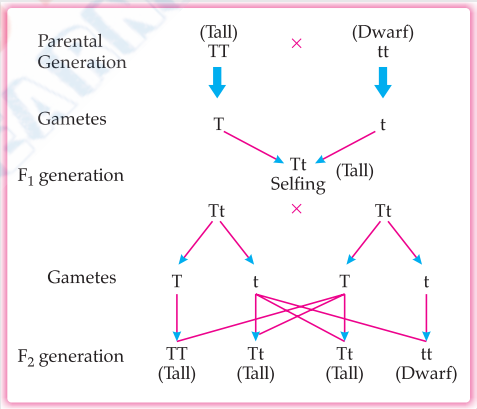
Key Words

Phenotype is the characteristic which is visible in an organism whereas genotype is the genetic composition of an individual.

Dihybrid cross is a cross between two plants having two pairs of contrasting characters.
e.g., Cross between green round seed with a yellow wrinkled seed.

Example 1

Cross between tall and dwarf pea plants :

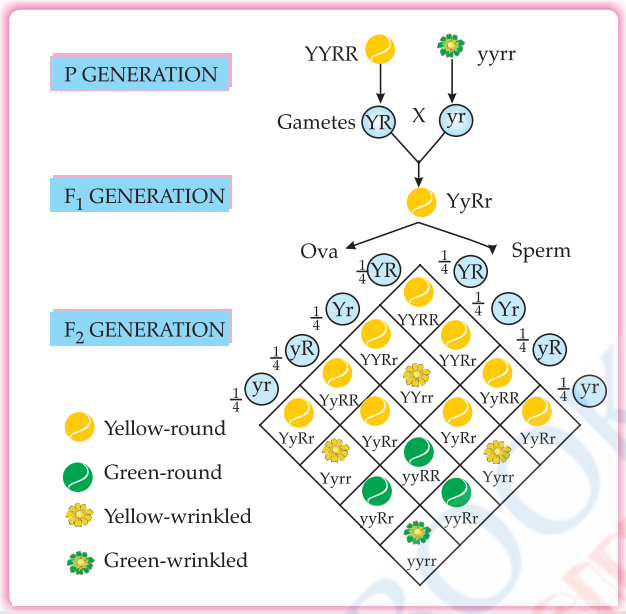


(a) Phenotypic ratio:-Tall: Dwarf (3:1), **(b)** Genotypic ratio:-Pure Tall: Hybrid Tall: Pure Dwarf (1:2:1)

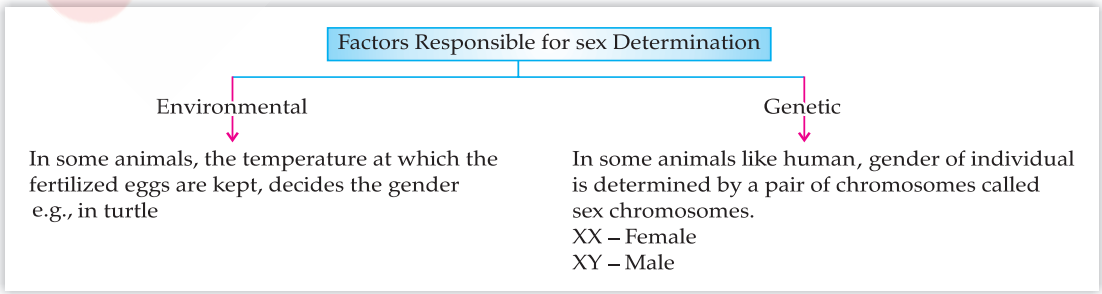
- In case of **dihybrid cross** *i.e.*, involving two pairs of contrasting characters, the phenotypic ratio obtained in F_2 generation was 9:3:3:1.

Example 2

Cross between pea plants bearing round green seeds with plants bearing wrinkled and yellow seeds:

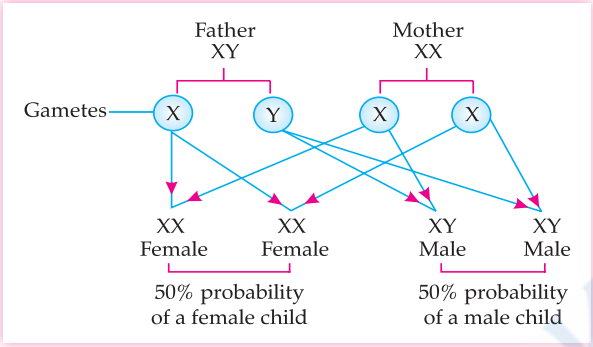


- Based on above monohybrid cross, he proposed Law of Dominance, which states that "When parents having pure contrasting characters are crossed then only one character expresses itself in F_1 generation. This character is the dominant character and the character which cannot express itself is called recessive character".
- The homozygous dominant trait is denoted by two capital letters whereas the homozygous recessive trait is denoted by two small letters.
- Alleles are alternate forms of genes. For e.g., The gene for eye color has several alleles. Two major alleles are: brown and blue.
- A dominant allele expresses itself in the presence or absence of a recessive trait whereas a recessive allele is able to express itself only in the absence of a dominant trait.
- **Law of Segregation:** It states that every individual possesses a pair of alleles for a particular trait. During gamete formation, a gamete receives only one trait from the alleles. A particular trait can be dominant or recessive in a particular generation.
- **Law of Independent Assortment :** It states that alleles of different characters separates from each other during gamete formation.
- 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.



- The process by which sex of a new born individual is determined is called sex determination.
- **Sex Chromosomes:** In human beings, there are 23 pairs of chromosomes. Out of these, 22 chromosome pairs are called **autosomes** and the last pair of chromosome which helps in deciding sex of the individual is called **sex chromosome**.
- Autosomes are pairs of chromosomes that are identical in appearance and are not involved in sex determination.
- Sex chromosomes are pairs of chromosomes involved in sex determination and are not identical in appearance (e.g., X and Y chromosome in humans).

- **Sex determination in human beings:**
- A male has one X and Y sex chromosomes (XY) while a female has two X-sex chromosomes (XX).
- An egg fertilised by X-carrying sperm result into girl child.
- An egg fertilised by Y carrying sperm results into a boy child.
- Thus, sex of the child is determined by the type of sperm that fuses with egg.



- **Acquired traits:** e.g., low weight of beetles.
- **Inherited traits:** e.g., Colour of eyes and hair, shape of nose, ear lobes.

UNIT – III: NATURAL PHENOMENA

CHAPTER-9
LIGHT REFLECTION AND REFRACTION

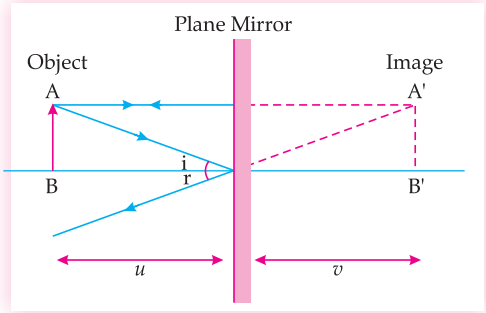
Topic-1 Reflection of Light, Images Formed by Spherical Mirrors

Concepts Covered • Reflection of light, • Laws of reflection of light, • Images formed by plane mirror and spherical mirrors.

Revision Notes

Introduction

- When light falls on a body, it may be absorbed, may be transmitted or light may get reflected back to the same medium.
- **Reflection of light** is the phenomenon of bouncing back off the light rays in the same medium.
- **Laws of Reflection:**
  - **(i)** The incident ray, the reflected ray and the normal, all lie on the same plane at the point of inci-dence.
  - **(ii)** The angle of incidence is equal to the angle of reflection.
- **Real image** is obtained when the rays of light after reflection or refraction actually meet at some 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.

Key Words

Spherical mirror: A mirror having a surface which either bulges out or recesses inward and which forms a portion of a sphere.

Solar power plant: It is the device which converts the energy from the Sun into electricity mainly.

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

(iii) Image is formed as far as 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 recessed inward, is **concave** mirror.
- The spherical mirror, whose reflecting surface bulges towards light source, is a **convex** mirror.
- Concave mirror mostly forms real images, which can be obtained on the screen. Convex mirror always form virtual images, which cannot be obtained on the screen.
- **Differentiating between a plane mirror, a concave mirror and a convex mirror, without touching them:**

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

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

(iii) If the formed image is erect, real and magnified when the mirror is close to the object, then it is a concave mirror.

Key Words

Pole: The centre of reflecting surface of spherical mirror.

Principal axis: The straight line passing through the pole and centre of curvature.

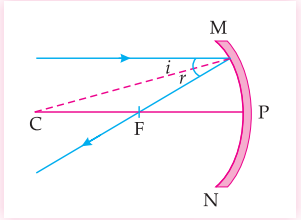
Centre of curvature: It is the centre of sphere of which the given mirror is a part.

- Solar concentrators 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 called the **pole** of the mirror and it 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).

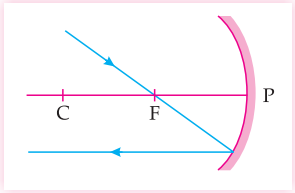
Principal focus: It is the point on principal axis through which the rays of light which are parallel to it pass after reflection or they appear to be arising from this point.

- **Rules for making ray diagrams by concave mirror:**

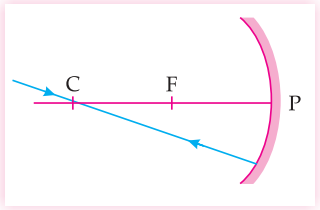
(i) A ray parallel to the principal axis will pass through the principal focus, after reflection.



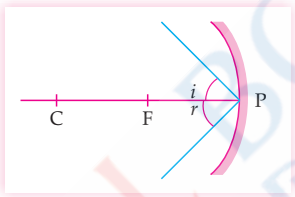
(ii) A ray passing through the principal focus of concave mirror will be parallel to principal axis after reflection.



(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 the 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 the mirror	Enlarged	Virtual and erect

▶ **Image formation by a convex mirror for different positions of the object:**

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

▶ **Mirror Formula:**

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

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.

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

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

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 $h_i > h_o$ 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 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 concave mirror.
- If 'm' is '–ve', it is a concave mirror.

Topic-2 Refraction, Lenses and Power of Lens

Concepts Covered • Refraction, • Laws of refraction, • Refractive index, • Lens formula • Magnification • Power of lens

Revision Notes

- 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 deviation 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 on the same plane.

  Second law: The ratio of sine of angle of incidence to the sine of angle of refraction is a constant, for the light of a given color and for the given pair of media. This law is also known as **Snell's law** of refraction.

$$n = \frac{\sin i}{\sin r}$$

- **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.

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

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

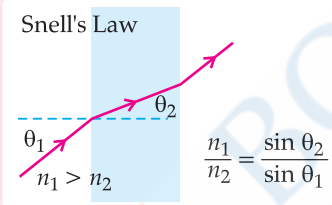
$$n_{12} = \frac{1}{n_{21}}$$

- If refractive index of medium 1 w.r.t. air is given as ${}_1n^{air}$ and if refractive index of medium 2 w.r.t. air is given as ${}_2n^{air}$, then refractive index of medium 1 w.r.t. medium 2 $= \frac{{}_1n^{air}}{{}_2n^{air}} = {}_1n^2$

- 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:** $\frac{1}{v} - \frac{1}{u} = \frac{1}{f}$

Key Diagram



- **Magnification:** $m = \frac{h_i}{h_o} = \frac{v}{u}$
- **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.

$$\text{Power} = \frac{1}{\text{Focal length (in meter)}}$$

$$\text{or, } P = \frac{1}{f}$$

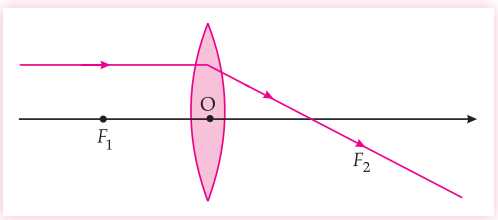
- SI unit of Power is dioptre = (D), 1 D = 1 m^{-1}
- 1 dioptre is the power of lens whose focal length is one meter.

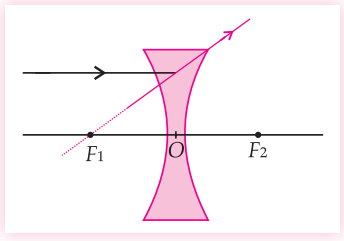
Key Words

Convergence of light rays: Light rays coming together.
Divergence of light rays: Light rays moving away from each other.
Magnification: The measure of the size of image compared to the size of object creating it.

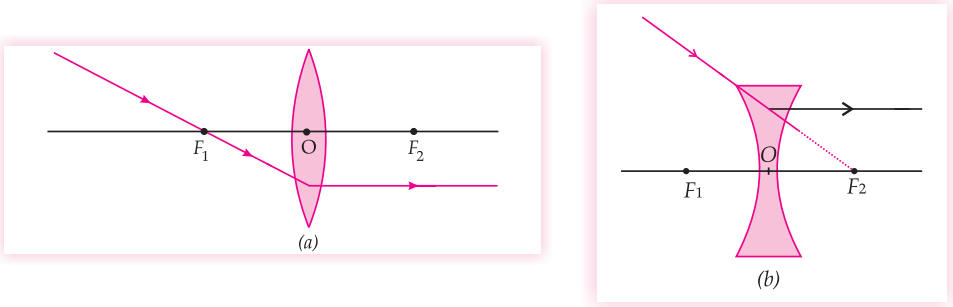
Rules for making ray diagrams by convex and concave lens

(i) A ray of light from the object parallel to the principal axis passes through the focus after refraction.

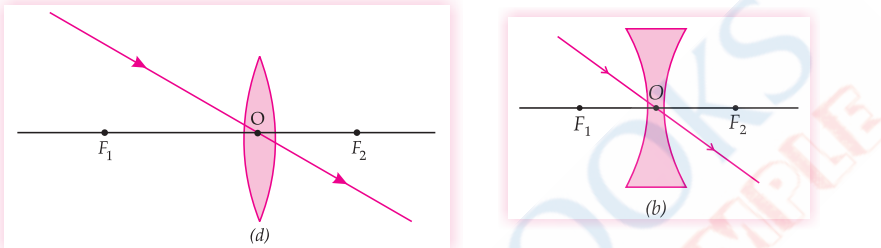




(ii) A ray of light passing through a principal focus becomes parallel to the principal axis after refraction.



(iii) A ray of light passing through the optical centre travels undeviated even after refraction.



▶ **Nature, position and relative size of the image formed by a convex lens for various positions of the object:**

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_2	Highly diminished, point-sized	Real and inverted
Beyond $2F_1$	Between F_2 and $2F_2$	Diminished	Real and inverted
At $2F_1$	At $2F_2$	Same size	Real and inverted
Between F_1 and $2F_1$	Beyond $2F_2$	Enlarged	Real and inverted
At focus F_1	At infinity	Infinitely large or highly enlarged	Real and inverted
Between focus F_1 and optical centre	On the same side of the lens as the object	Enlarged	Virtual and erect

▶ **Nature, position and relative size of the image formed by a concave lens for various positions of the object:**

Position of the object	Position of the image	Relative size of the image	Nature of the image
At infinity	At focus F_1	Highly diminished, point-sized	Virtual and erect
Between infinity and optical centre O of the lens	Between focus F_1 and optical centre O	Diminished	Virtual and erect

Mnemonics

Concept: Image formation by concave mirror
Mnemonics: 54321 to be converted in 12345

At F	1
Between C and F	2
At C	3
Beyond C	4
Infinity	5
Between F and P	Exception

Object	1	2	3	4	5
Image	5	4	3	2	1

Interpretations: If object is at infinity (5) , image will be formed at F (1)
If object is at beyond C (4), image will be formed at between C and F (2) And so on.

CHAPTER-10
HUMAN EYE AND COLOURFUL WORLD

Topic-1 Human eye, Defects of vision and its corrections

Concepts Covered • *Human eye,* • *Defects of vision and its Corrections.*

Revision Notes

Human Eye

- Eye is a natural **optical** device using which human 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** of colours. There are around 125 million rods and cones cells. The cells generate signals which are transmitted to the brain through optic 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. It provides the focused, real and inverted image of the object on the retina. This convex lens 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.
- **Ciliary muscles :** These muscles change the shape and size of the eye lens for focussing.
- **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.

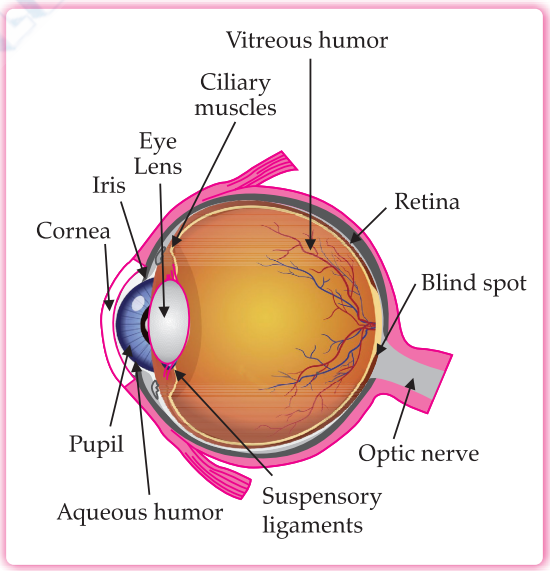
Key Words

Optical: Relating to sight.

Illumination: To make shining or luminous.

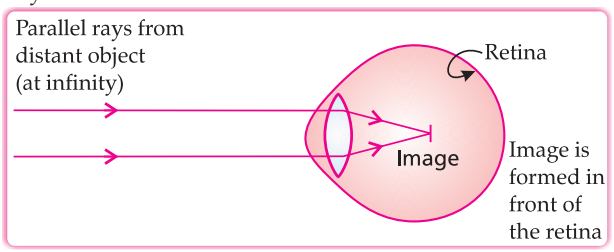
- **Optic Nerve :** The optic nerve sends the electrical impulses from the retina, at the back of the eyes to the brain.
- **Near point or Least distance of distinct vision**
  The minimum distance at which objects can be seen most distinctively without strain.
  - For a normal adult eye, its value is 25 cm.
  - Range of human vision is 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 the help of ciliary muscles.

Structure of an Human Eye :

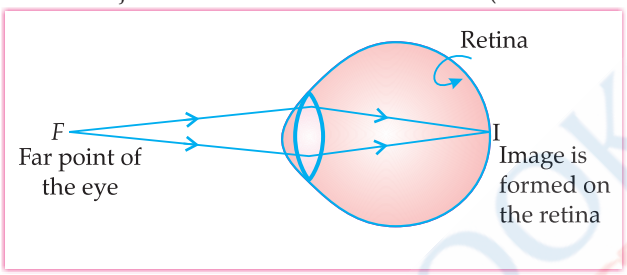


Myopia (Nearsightedness) :

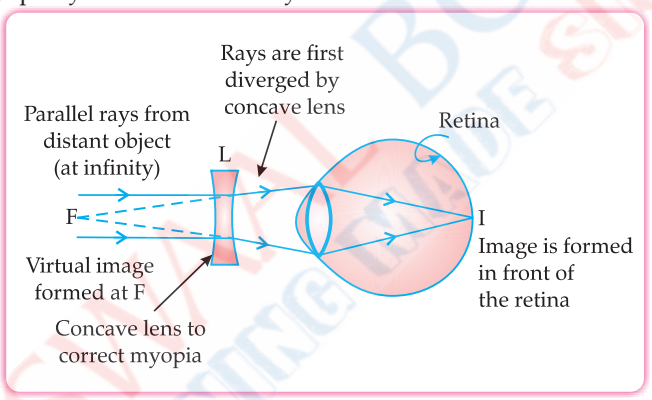
- Distant objects are not clearly visible.



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



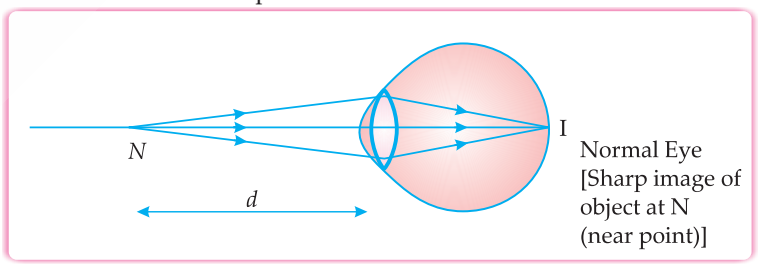
- The far point (F) of a myopic eye is less than infinity.

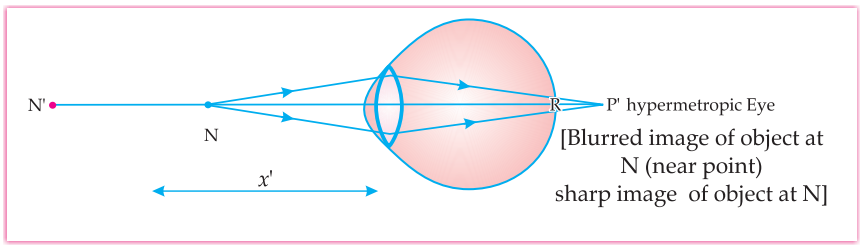


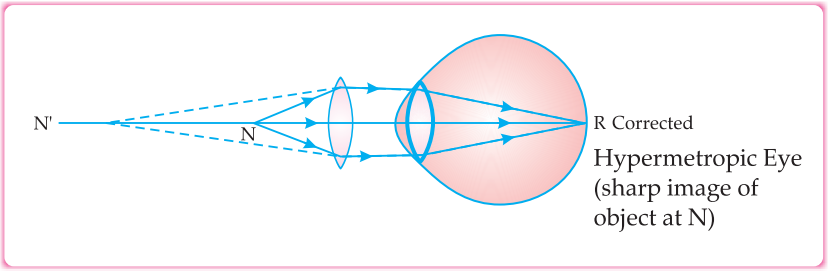
- **Correction :** The concave lens placed in front of the eye forms a virtual image of distant object at far point (F) of myopic eye.

Hypermetropia (Farsightedness) :

- Affected person can see far objects clearly but cannot see nearby objects clearly.
- The near point of the eye moves away from 25 cm.
- Image is formed behind the retina.
- **Correction :** Use of convex lens of suitable power can correct this 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.

Topic-2 Refraction of light through prism, Dispersion of Light and Scattering of Light

Concepts Covered • ***Dispersion of light,*** • ***Atmospheric refraction,*** • ***Refraction of light using prism,*** • ***Scattering of light.***

Revision Notes

- The phenomenon of splitting of white light into its constituent colours on passing through a glass prism is called **dispersion of light**.

  Spectrum: Band of colored components of a light beam is known as spectrum.
- 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 colours recombine to form white light.
- **Atmospheric refraction** is the phenomenon of bending of light on passing through the Earth's atmosphere.
- As we move above the surface of the 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.**
- The sun appears to rise two minutes earlier and set two 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.

Key Words

Wavelength: The distance between two successive crests or troughs of a light wave
Scattering: Throwing in various random directions
Deviation: Action of departing from the original path

- Larger particles scatter light of all wavelengths equally well.

Mnemonics

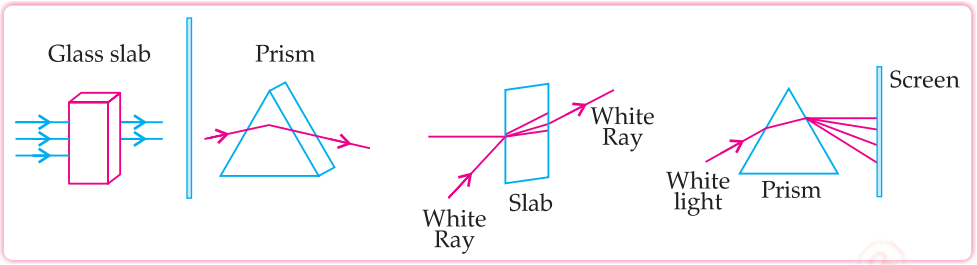
Concept: Colors of spectrum
Interpretation:

V: Violet	**I:** Indigo
B: Blue	**G:** Green
Y: Yellow	**O:** Orange
R: Red	

A prism causes dispersion, Stars twinkle due to refraction, Scattering causes redirection, All have their own attraction.

Key Diagrams

Difference in refraction of light by a glass slab and a glass prism:



UNIT – IV: EFFECTS OF CURRENT

CHAPTER-11
ELECTRICITY

Topic-1 Electric Current, Ohm's Law

Concepts Covered • Electric current and Electric potential, • Electric circuit and symbols of some commonly used component in circuit, • Ohm's law, • Resistance and resistivity

Revision Notes

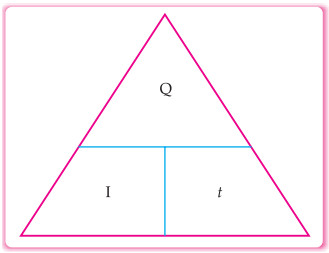
- **Charge** is a fundamental particle of matter. It may be positive and negative.
  - S.I. unit of charge is Coulomb (C).
- **Static and Current Electricity:** Static electricity deals with the electric charges at rest while the current electricity deals with the electric charges in motion.
- **Electric Current:** The electric current is defined as the rate of flow of electric charge through any cross section of a conductor.

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

  - Electric current is a scalar quantity.

Mnemonics

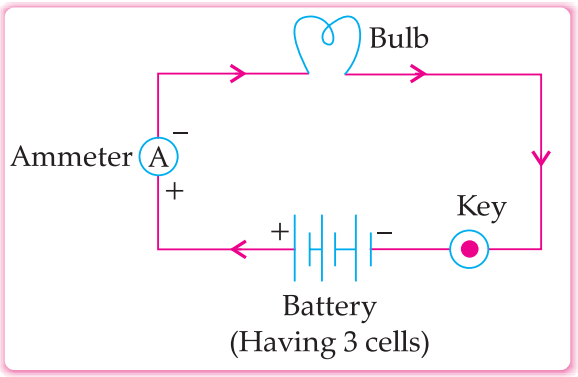
Concept: Current Formula



Interpretation:
I=Q/t
Q=I x t
t=Q /I

- **Ampere:** It is the SI unit of current. If one Coulomb of charge flows through any cross-section of a conductor in one second, then current through it is said to be one ampere.

- **Electric circuit:** The closed path along which an electric current flows is called an 'electric circuit'.
  - The schematic diagram of a typical electric circuit is



S.No.	Components	Symbol
(i)	An electric or Electronic cell	
(ii)	A battery or a combination of cells	
(iii)	Plug key of switch (open)	
(iv)	Plug key or switch (closed)	
(v)	A wire joint	
(vi)	Wire crossing without joining	
(vii)	Electric bulb	
(viii)	A resistor of resistance R	
(ix)	Variable resistance or rheostat	or
(x)	Ammeter	+ A –
(xi)	Voltmeter	+ V –

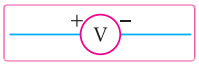
- **Conventional direction of current:** Conventionally, the direction of motion of positive charges through the conductor is taken as the direction of current. The direction of conventional current is opposite to that of the negatively charged electrons.
- **Electrochemical or voltaic cell:** It is 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.
- **Electric potential** is the amount of electric potential energy at a point while **Potential difference** is the difference in the amount of electric potential energy between two points in an electric circuit.
  - It is known as voltage, which is equal to the work done to move a unit charge from one point to another against static field.

$$\text{Voltage (V)} = \frac{\text{Work done (W)}}{\text{Charge (Q)}}$$

- S.I unit of potential difference is Volt (V).
- **1 Volt :** When 1 Joule of work is done in carrying one Coulomb charge then potential difference is called 1 Volt.

$$1\ V = 1\ JC^{-1}$$

▶ **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. Symbol is,



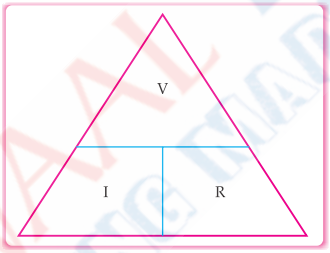
Mnemonics

Concept: Connection of ammeter and voltmeter
Mnemonics: I **A**m **S**leeping **V**ery **P**atiently
Interpretation:
Ammeter is connected in **S**eries **V**oltmeter is connected in **P**arallel

▶ **Ohm's Law:** It states that "the current through a conductor between two points is directly proportional to the voltage across the two points provided external conditions remain constant".

Mnemonics

Concept: Ohm's Law



Interpretation:
To find **V**=Multiply I and R
To find **I**=Divide V and R
To find **R**=Divide V and I

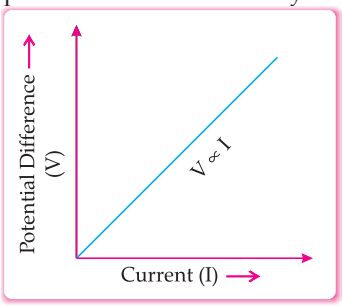
(i) Mathematical expression for Ohm's law:

$I \propto V$

$V = IR$

(where, R = Resistance)

(ii) *V-I* graph for Ohm's law : The graph between V and I is always straight line with slope equals to R



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

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

(ii) $1\ \text{Ohm} = \frac{1\ \text{Volt}}{1\ \text{Ampere}}$

- When potential difference is 1 V and current through the circuit is 1 A, then resistance will be 1 ohm.

- **Rheostat:** Rheostat is a variable **resistor** used to regulate current without changing the source of voltage.

Key Word

Resistor is a conductor which has some appreciable resistance.

- **Factors on which the Resistance of a Conductor depends:** Resistance of a uniform metallic conductor is,
  - **(i)** Directly proportional to the length of the conductor.
  - **(ii)** Inversely proportional to the area of cross-section.
  - **(iii)** Directly proportional to the temperature.
  - **(iv)** Depends on nature of the material.

- **Resistivity (ρ):** The resistance offered by a wire of unit length and unit cross-sectional area is called resistivity.
  - Its S.I. unit is Ohm-metre (Ωm).
  - Resistivity does not change with change in length or area of cross-section but it changes with change in temperature.
  - Range of resistivity of metals and alloys is 10^{-8} to 10^{-6} Ωm.
  - Range of resistivity of insulators is 10^{12} to 10^{17} Ωm.
  - Resistivity of alloy is generally higher than that of its constituent metals.
  - Alloys do not oxidize (burn) readily at high temperature, so they are commonly used in electrical heating devices.
  - Copper and aluminium are used for electrical transmission lines as they have low resistivity.

Topic-2 Resistance in Series and Parallel Combination, Electric Power and Heating Effect

Concepts Covered • **Resistance in series and in parallel combinations** • **Electric Power** • **Heating effect of electric current (Joule's law)** • **Applications of heating effect of electric current**

Revision Notes

- **Resistances in series:** When two or more resistances are connected 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

$$H = \text{V}It \text{ Joule} = \frac{\text{V}It}{4.18} \text{cal}$$

- **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.

Key Fact

Tungsten filament is used for making bulb. The bulbs are filled with inert nitrogen and argon gas.

- **Electric energy:** It is the total work done in maintaining an electric current in an electric circuit for a given time.
  Electric energy, $W = VIt = \text{I}^2Rt$ 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 that of the appliance.
- **Electric Power:** The rate at which electric energy is consumed or dissipated in an electric circuit :

$$P = VI$$

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

Mnemonics

Concept: Formula of power
Mnemonics: 2 Iron men have Super Power.
Interpretation:
2 represents square of I.
IRon - I and 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.
- **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 $1 \text{ W} = 1 \text{Js}^{-1} = 1 \text{VA}$

1 kilowatt = 1000 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 kilowatt hour (kWh) = $3{\cdot}6 \times 10^6$ 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.

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

CHAPTER-12
MAGNETIC EFFECTS OF ELECTRIC CURRENT

Topic-1 Magnetic Effects

Concepts Covered • **Magnetic field and Magnetic field lines** • **Magnetic fields due to current through a straight conductor** • **Magnetic field due to current through a circular loop** • **Magnetic field due to current in a Solenoid** • **Force on a current carrying conductor in a magnetic field** • **Right hand thumb rule** • **Fleming's left hand rule**

Revision Notes

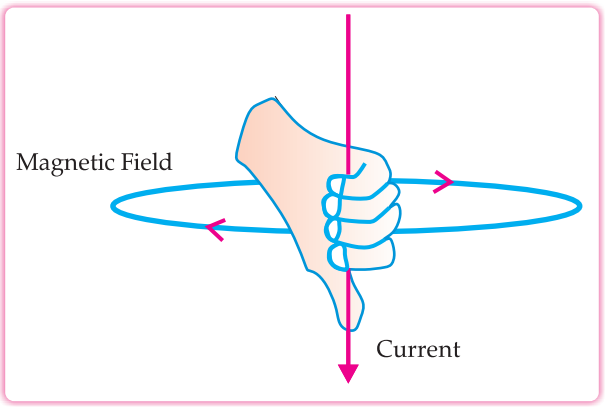
Magnet:

- 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 human to find the directions.

- 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 thet 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 geographical south direction.

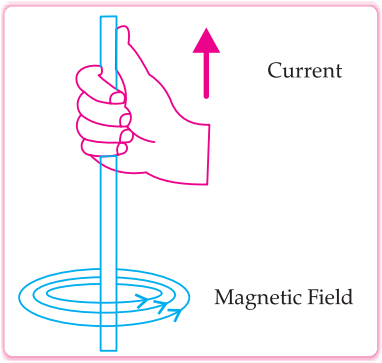


- The substances which are attracted by a magnet are called **magnetic substances**. **Examples:** Iron, nickel, cobalt, steel. The substances which are not attracted by a magnet are called **non-magnetic substances. Examples:** wood, glass, copper, aluminium, brass, paper etc.
- **Magnetic Field:** The area around a magnet in which its magnetic force can be experienced.
  - **(i)** Its SI unit is Tesla (T).
  - **(ii)** Magnetic field has both magnitude and direction. It is a vector quantity.
  - **(ii)** Magnetic field can be described with help of a magnetic compass. The needle of a magnetic compass is a freely suspended bar magnet.
- **Magnetic field lines :** The imaginary lines of magnetic field around a magnet are called magnetic field lines.
- **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 directions of magnetic field 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. Closer the lines, more will be the strength and farther the lines, less will be the magnetic field strength.
- **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.



Mnemonics

Concept: Right Hand Thumb Rule
Mnemonics: When current move upwards, wrap magnetic field
Interpretations:



Concept: Direction of field lines
Mnemonics: O Maria **M**r. **F**ox is moving from **N**orth to **S**outh
Interpretation: Outside, **M**agnet, **M**agnetic, **F**ield, **N**orth, **S**outh

Magnetic Field Due to Current through a Straight Conductor

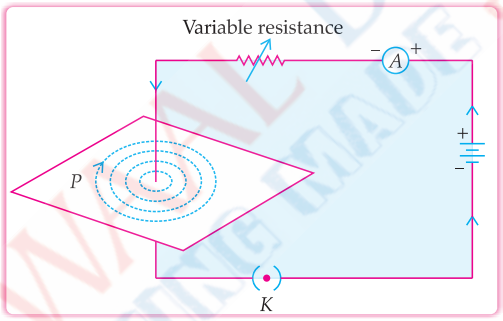
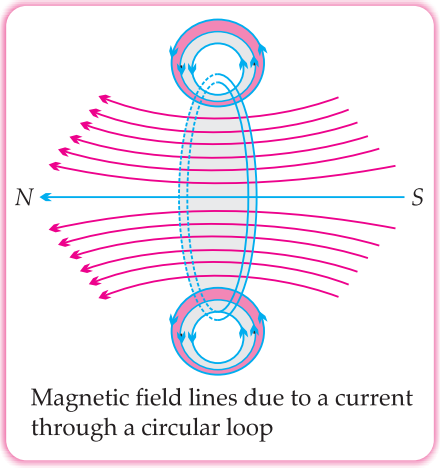


Fig : *A pattern of concentric circles indicating the field lines of a magnetic field around a straight conducting wire. The arrows in the circles show the direction of the field lines.*

- 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 ∝ Strength of current
- Magnetic field $\propto \frac{1}{\text{Distance from the conductor}}$



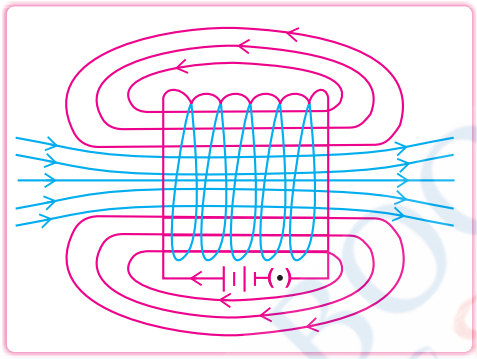
Magnetic field lines due to a current through a circular loop

- **Magnetic Field Due to Current through a Circular Loop**
  - It can be represented by concentric circles 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**

  (i) Magnetic field $\propto$ Current passing through the conductor

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

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



- **Factors affecting magnetic field of a circular current carrying conductor**
- 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 same direction.
- The strength of magnetic field produced by a current carrying circular coil can be increased by

  (a) Increasing the number of turns of the coil.

  (b) Increasing the current flowing through the coil.
- **Magnetic field due to current in a Solenoid :** Solenoid is a coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder. The end of the solenoid having clockwise current will act as south while on the other hand having anti-clockwise current will act as north pole. Thus, a solenoid acts as a normal magnet.

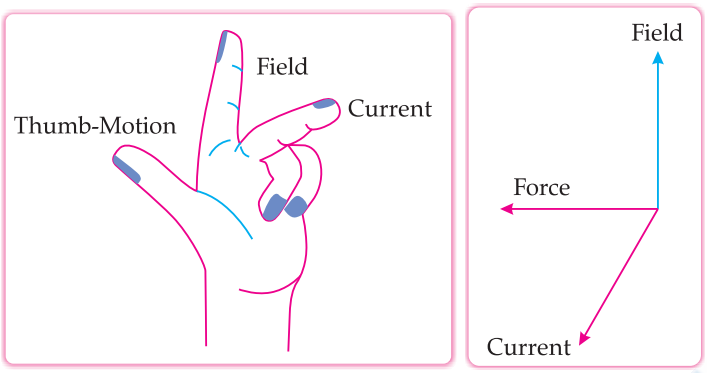
  Direction of magnetic field

  (i) Outside the solenoid : North to South

  (ii) Inside the solenoid : South to North
- **Permanent magnets:** They 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. Nipermag is an alloy of iron that contains nickel, aluminium and titanium..
- 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 when allowed to pass through the coil. Such magnets are called electromagnets.
- **Force on a current carrying conductor in a magnetic field :** 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, forefinger and middle finger of your left hand such that they are mutually perpendicular. If forefinger 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.

Key Facts

- Right hand thumb rule is a convenient way of finding the direction of magnetic field associated with current carrying conductor.
- Many devices such as electric motor, electric generator, loudspeaker etc. work on Fleming's left Hand rule.



Fleming's left hand rule

Topic-2 Domestic Electric Circuits

Concepts Covered • Direct current and alternating current, • Domestic electric circuits.

Revision Notes

- Direct Current (DC) and Alternating Current (AC)
  (i) Alternate current (AC) : The current which reverses its direction periodically. In India, most of the power stations generate alternate current. The direction of current changes after every 1/100 second in India. i.e.,
  Frequency = 1/ Time period
  = 1/50 Hz
  (ii) Direct Current (DC) : The current which does not reverse its direction and flows in one direction is called direct current. Source of DC are cell, battery, and storage cells. DC can be stored. Loss of energy during transmission over long distance is high.
- **Domestic Electric Circuits :** We receive electric supply through main supported through the poles. In our houses, we receive AC electric power of 220 V with a frequency of 50 Hz.

Mnemonics

Concept: Electrical wiring
Mnemonics: Rare **L**awn **B**eautiful **N**ature **G**reen **E**arth
Interpretation: Red: Live; **Black:** Neutral; **Green:** Earth

- An electric circuit consists 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. It protects us from electric shock in case of leakage of current especially in metallic body appliances. It provides a low resistance path for current in case of leakage of current.
- **Faults and Safety Measures in Domestic Electric circuit**
  (i) Short Circuiting : It is caused by touching of live wire and neutral wire either directly or via conducting wire.
  (ii) Overloading of an electric circuit : The overheating of electrical wire in any circuit due to flow of a large current through it is called overloading of the electrical circuit.
- **Safety measures are :**
  (i) Electric fuse : It is a protective device which is used for protecting the circuit from short-circuiting and overloading.
  It is a piece of thin wire of material having a low melting and high resistance. Fuse is always connected in series to live wire and works on the principal of heating effect.
  (ii) Earth wire : The metallic body of electric appliances is connected to the Earth by means of earth wire so that any leakage of electric current is transferred to the ground. This prevents any electric shock to the user.

Key Fact

The potential difference between live and neutral wire in India is 220 V.

CHAPTER-13
Our Environment

Topic-1 Ecosystem and Food Chain

Concepts Covered • *Ecosystem and its components,* • *Food chain, food web, trophic levels,* • *Energy flow,* • *Ten percent law,* • *Biological magnification*

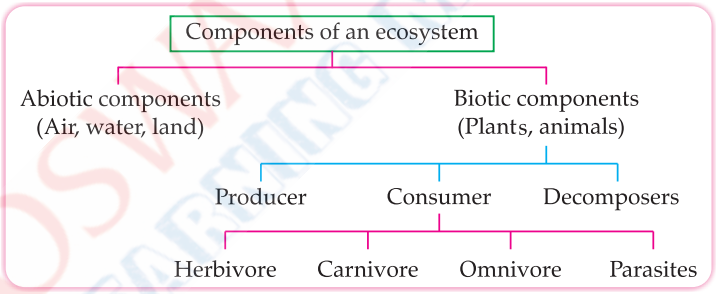
Revision Notes

- Everything that surrounds us is environment. It includes both living (biotic) and non-living (abiotic) components.

Mnemonics

Concept: Major components of environment
Mnemonics: WASAP
Interpretation:
W: Water
S: Soil
P: Plants
A: Air
A: Animals

- Interaction between these biotic and abiotic components forms an ecosystem.
- **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 exists in nature on its own. e.g., forest, lake, ocean, etc.
  (b) Artificial Ecosystem: Man-made ecosystem is called artificial ecosystem. Example:- crop field, aquarium, garden, etc.



- Producers includes green plants and algae. They contain chlorophyll pigment which helps them to carry out the process of photosynthesis in the presence of light. Thus, they are also called as converters or transducers.
- Herbivores, carnivores, omnivores and parasites are the various types 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 outside (ectoparasites) or inside (endoparasites) the body of another organisms, i.e., host. e.g., parasites of human include fleas and lice.
- **Decomposers** are those micro-organisms that obtain energy from the chemical breakdown 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 again by the plants. They help in the replenishment of natural resources.
- **Food chain** is the sequence of organisms through which food energy flows in an ecosystem. It is a succession of organisms that eat other organisms and may, in turn, be eaten themselves.

  Example:

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

Key Facts

- The first link in a food chain is always a producer (green plants) as they have the ability to trap solar energy with the help of chlorophyll. The last link is always a decomposer.
- Maximum concentration of such chemicals is found to accumulate in human body as human occupies the top level in any food chain.

- **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 the second trophic level, carnivores or secondary consumers are the 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 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. It represents the feeding relationship within the community.
- **Energy Flow:** The flow of energy through different steps in the food chain is unidirectional. This means that the energy that is captured by the autotrophs does not revert back to the solar input and the energy which passes to the herbivores does not come back to autotrophs.
- **The entire process of energy flow can be summarised in the following four steps:**
  - The flow of energy in an ecosystem is always linear or unidirectional. The energy captured from producers does not revert to the solar input. Also, the energy which passes to the herbivores does not come back to autotrophs.
  - At every step in a food chain the energy received by the organism is also used for its own metabolism and maintenance. The left over is passed to next higher trophic level. Thus, energy flow decreases with successive trophic levels.
  - The number of trophic levels in a food chain is restricted by 10% flow of energy, very less amount of energy is available to the last trophic level.

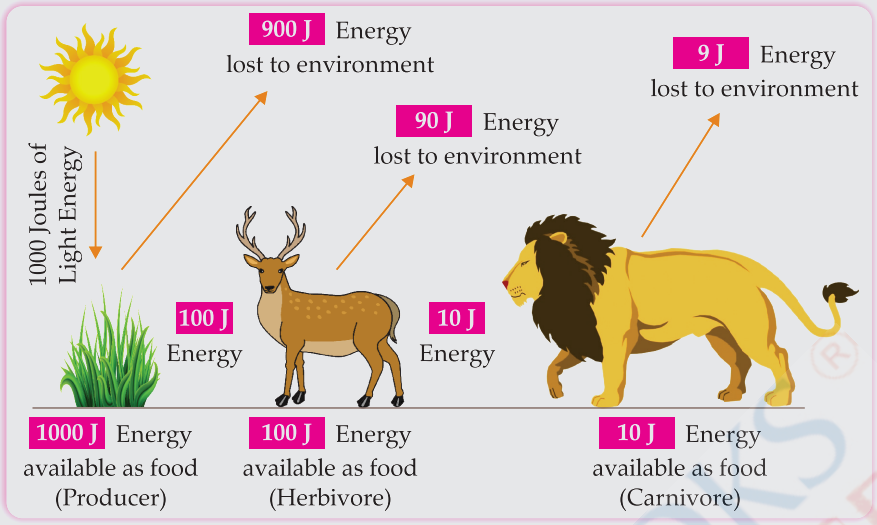
Key Word

Food chain describes relationship of organism about 'who eats whom'.

  - The number of steps is limited to four or five in a food chain for the transfer of energy.
- **10 Percent Law**: It states that only 10 per cent of food energy is transferred from one trophic level to the next level. The remaining 90 per cent energy is used in life processes (digestion, growth, reproduction, etc.) by the present trophic level.
- Due to this gradual decrease in energy, food chains contain 3 - 4 trophic levels.
- **Biological Magnification:** The concentration of harmful chemicals goes on increasing with every next trophic level in a food chain. This is called as biological magnification.

Example-1

Suppose that 1000 J of solar energy is received by green plants then only 1% of solar energy available on earth is utilized by plants. So, only 10 J i.e. 1% of 1000 J is trapped by plants and rest 990 J of energy is lost to the environment. So, plants utilise only 10 J of energy. Next, only 10% of the 10 J energy of plant i.e. 1 J is available to the herbivores while 9 J is lost to the environment. Again, just 10 % of the 1 J of energy of herbivore is utilized by carnivore animals. Thus, carnivore animal have only 0.1 J of energy while 0.9 J is lost to the environment.



Topic-2 Biodegradable and Non-Biodegradable Substances and Global Warming

Concepts Covered • *Methods of waste disposal,* • *Environmental problems caused by humans,* • *Ozone depletion.*

Revision Notes

- **Environmental problems caused by humans are:**
  (i) Pollution due to mismanagement of waste disposal.
  (ii) Depletion of the Ozone Layer and waste disposal.
- **Waste Materials:** Unwanted or unusable materials which are discarded after primary use, or is worthless, defective and of no use.
- **Garbage contains following type of materials:**
  (a) Biodegradable Wastes: Substances which can be decomposed by the action of micro-organisms are called as biodegradable wastes. e.g., fruit and vegetable peels, cotton, jute, cow-dung, paper, etc.
  (b) Non-biodegradable Wastes: Substances which cannot be decomposed by the action of micro-organisms are called as non-biodegradable wastes. e.g., plastic, polythene, metals, synthetic fibres, radioactive wastes, pesticides, etc.
- **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.
  (g) Biodegradable and non-biodegradable wastes should be discarded in two different dustbins. It is because:
  (i) It saves time/ energy in segregation.
  (ii) Biodegradable items can be sent directly for composting.
  (iii) Non-biodegradable items can be sent for an appropriate reuse/recycle.
- **Formation of ozone in Atmosphere :**
  Ozone is continuously formed by the action of UV rays on molecular oxygen, and also degraded into molecular oxygen in the stratosphere. The high energy ultraviolet radiations split ozone into molecular and atomic oxygen with release of large amount of heat. This heat is used in warming of the stratosphere.

$$O_3 \rightarrow O_2 + [O] + \text{Heat}$$

This oxygen atom then recombine with oxygen (O_2) molecule to form ozone molecule.

- Ozone (O_3) : 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.
- Ozone layer is a layer of the earth's atmosphere in which most of the atmosphere's ozone is concentrated.
- **Ozone Depletion :** Ozone depletion is the reduction in concentration of ozone layer.
- There are several reasons for depletion of the 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. This phenomenon is referred as the Ozone hole.
- The Antarctic hole in ozone layer is caused due to chlorine molecules present in chlorofluorocarbons (CFCs), that are used by human beings.
- **Ozone layer can be protected by :**

  (a) Stopping the release of Chlorofluorocarbons (CFCs).

  (b) Removing the pollutant nitrogen monoxide.

  (c) Reducing the usage of air conditioners.
- The **Montreal Protocol** (an international treaty in Canada, 1987) was signed to control the emission of ozone depleting substances. Subsequently many more efforts have been made and protocols have been laid down to define roadmaps, separately for developed and developing countries, for reducing the emission of CFCs and other ozone depleting chemicals.

  United Nations Environment Programme (UNEP) succeeded in forging an agreement to stop CFC production at 1986 levels by all the countries. (KYOTO Protocol).

Key Facts

- Ozone is present in stratosphere part of the atmosphere i.e. 20- 30 km above the earth.
- The decrease in the thickness of ozone layer over Antarctica was first observed in 1985 and was termed as ozone hole.

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Both teachers and students can also benefit from Artham educational resources which are free and openly licensed educational materials that can be used and shared for teaching and learning. Artham resource material include textbooks, courses, lesson plans, and multimedia resources that are available online.

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