Chapter - 1 : Chemical Reactions and Equations

Quick Review

- A chemical reaction is a process in which the original substance(s) lose their nature and identity and form new substance(s) with different properties.
- Breaking of the chemical bonds and formation of the new chemical bonds is responsible for the occurrence of a chemical reaction.
- **Examples where chemical reactions take place are :**
  - **(i)** Digestion of food
  - **(ii)** Rusting of iron
  - **(iii)** Photosynthesis
  - **(iv)** Respiration
  - **(v)** Burning of fuels etc.
- **A chemical reaction can be identified by either of the following observations :**
  - **(i)** Change in state
  - **(ii)** Change in colour
  - **(iii)** Evolution of gas
  - **(iv)** Change in temperature
  - **(v)** Formation of a precipitate
- **Writing a chemical equation :**
  - **(i)** The symbols of elements and the formulae of reacting substances are written on the left hand side with a plus (+) sign between them.
  - **(ii)** The symbols and formulae of the substances formed are written on the right hand side with a plus sign (+) between them.
  - **(iii)** An arrow (→) sign is put between the reactants and the products.
  - **(iv)** The physical states of the reactants and products are also mentioned in a chemical equation.
- **Balanced Equations :** The equations in which atoms of various elements on both sides of a chemical equation are equal in accordance with the law of conservation of mass.
- The process of making atoms of various elements equal on either side of an equation is called balancing of chemical equation. This method of balancing the equation is known as hit and trial method.
- The chemical reactions are classified into various categories depending upon the types of changes taking place.
- The different types of reactions are as follows :
  - **(i)** Combination Reaction
  - **(ii)** Decomposition Reaction
  - **(iii)** Displacement Reaction
  - **(iv)** Neutralisation Reaction
  - **(v)** Redox (Oxidation and Reduction) Reaction
- **Corrosion :** The surface of the reactive metals are attacked by air, water and other substances around it, and corrodes, this process is called corrosion. It is a redox reaction where metal gets oxidised to metal oxide and oxygen gets reduced to oxide ion.
- Rust is mainly hydrated iron (III) oxide $Fe_2O_3.xH_2O$. Rusting weakens the structure of the body of vehicles, bridges, iron railing etc.
- **Prevention of Rusting :**
  - **(i)** The iron articles should be painted.
  - **(ii)** The machine parts should be oiled and greased.
  - **(iii)** Galvanised iron pipes are used for water supply.
  - **(iv)** Iron can be coated with chromium to prevent rusting.
- **Rancidity :** Rancidity is the process of slow oxidation of oil and fat present in the food materials resulting in the production of foul odour and taste in them.
- When cooked food items are placed for a long time, they become rancid and unsuitable for the consumption.
- **Methods to prevent Rancidity :**
  - **(i)** Packing of food materials in air tight containers.
  - **(ii)** Refrigeration of cooked food at low temperature.

Know the Terms

- **Chemical equation :** It is a complete symbolic representation of a chemical reaction involving reactants and products.
- **Balanced equation :** It is the equation in which atoms of various elements on the reactants and the products side are equal. The number of atoms of elements on both the sides of a chemical equation should be equal in accordance with the law of conservation of mass.
- **Combination reaction :** In a **combination reaction**, two or more reactants combine to give a single product.

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

  (Quick lime) (Slaked lime)

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

  For example : $2Pb(NO_3)_2(s) \xrightarrow{\text{Heat}} 2PbO(s) + 4NO_2(g) + O_2(g)$

  (Lead nitrate) (Lead oxide) (Nitrogen dioxide) (Oxygen)
- **Thermal decomposition reaction :** When a decomposition reaction is carried out by heating, it is called **thermal decomposition reaction**.

  For example : $CaCO_3(s) \xrightarrow{\text{Heat}} CaO(s) + CO_2(g)$

  (Calcium carbonate) (Quick lime) (Carbon dioxide)
- **Photochemical decomposition reaction :** When a decomposition reaction is carried out in the presence of sunlight, the process is called as **photochemical decomposition**.

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

  (Silver bromide) (Silver) (Bromine)

  This decomposition is used in black and white photography.
- **Electrolysis :** When a decomposition reaction is carried out with the help of electric current, the process is called electrolysis.

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

  $2H_2O(l) \xrightarrow{\text{Electric current}} 2H_2(g) + O_2(g)$

  (Water) (Hydrogen gas) (Oxygen gas)
- **Displacement reaction :** In a **displacement reaction**, a more reactive element displaces a less reactive element from a compound.

  For example : $Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$

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

  Here, more reactive element (Iron) displaces the less reactive element (Copper) from the salt of copper.
- **Double displacement reaction :** The reactions in which the different atoms or group of atoms are displaced by other atoms or group of atoms, *i.e.* two compounds exchange their ions and one of the products formed is insoluble, are said to be **double displacement reactions**.

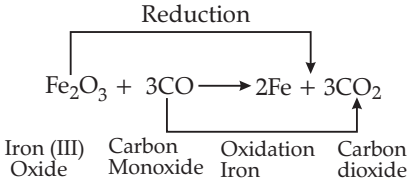
  For example : $Na_2SO_4(aq) + BaCl_2(aq) \longrightarrow BaSO_4(s) + 2NaCl(aq)$

  (Sodium sulphate) (Barium chloride) (Barium sulphate) (Sodium chloride)
- **Neutralisation reactions :** The reactions in which acid or acidic oxide reacts with base or basic oxide to form salt and water are called **neutralization reactions.**

  For example : $2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O$

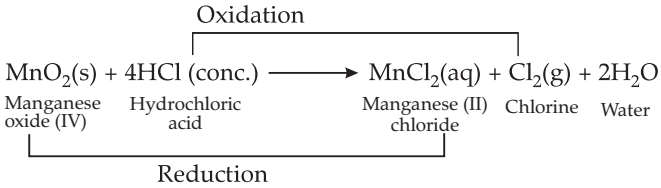
  (Sodium hydroxide) (Sulphuric acid) (Sodium sulphate) (Water)
- **Oxidation :** It is a process in which oxygen or an electronegative element is added. It can also be defined as a process in which hydrogen or an electropositive element is removed. In terms of electronic concept, oxidation is a process in which loss of electrons takes place.
- **Reduction :** It is a process in which addition of hydrogen or an electropositive element takes place. It is also defined as a process in which oxygen or an electronegative element is removed. In electronic concept, reduction process involves the gain of electrons.

For example :



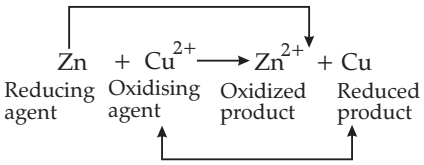
- **Redox reaction :** Those reactions in which oxidation and reduction take place simultaneously are called **redox reactions**.

For example :



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

For example :



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Chapter - 2 : Acids, Bases and Salts

Quick Review

- Acids are sour in taste. They turn blue litmus red. Acids are the substances that furnish H^+ ions in aqueous solution.
- If in an aqueous solution, concentration of acid is low, it is called **dilute solution** and if concentration of acid is high, it is called **concentrated solution**.
- Hydrochloric acid is released in stomach to make medium acidic in nature. It leads to coagulation of protein and helps in their digestion. HCl kills bacteria coming to the stomach along with the food.
- When a burning matchstick is brought near the hydrogen gas, it burns with a pop sound.
- When CO_2 gas is passed through lime water, it turns milky. If CO_2 is passed in excess, milkiness disappears.
- There are many natural substances like red onion peels, red cabbage leaves, beetroot extract, coloured petals of some flowers. They are called indicators because they indicate the presence of acid or base by showing the change in colour.
- Acids reacts with certain metal oxides to form salt and water. Acids react with metal carbonates and hydrogen carbonates to produce carbon dioxide gas.
- Strong bases react with active metals to produce hydrogen gas. Bases react with non-metallic oxides to produce salt and water.
- Both acids and bases conduct free electric current in their aqueous solution due to the presence of free ions.
- Strength of an acid or base depends on the number of H^+ ions or OH^- ions produced by them respectively. More the H^+ ions produced by an acid, stronger is the acid. More the OH^- ions produced by a base, stronger is the base.
- Synthetic indicators like phenolphthalein and methyl orange are used to test for acidic and basic solutions. Phenolphthalein is colourless in acidic solution while pink in basic solution. Methyl orange gives red colour in acidic and yellow in basic solution.
- When hydrogen of an acid is replaced by metal in displacement reaction, the compounds formed are called salts and hydrogen gas is liberated.

$$\text{Metal} + \text{Acid} \longrightarrow \text{Metal salt} + \text{Hydrogen gas.}$$

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

Know the Terms

- **Acid :** Those substances which turn blue litmus solution red are called acidic. The term 'acid' has been derived from the Latin word 'Acidus' which means sour. Acids are sour in taste. They give H^+ ions in aqueous solution.
  Example : HCl, H_2SO_4, HNO_3, CH_3COOH.
- **Indicators :** Those substances which change their colour (or odour) in acidic or basic solutions are called **indicators**.
- **Mineral Acids :** The acids which are obtained from minerals are called mineral acids.
- **Organic acids :** Those acids which are obtained from plants and animals are called organic acids.
- **Concentrated acids :** Those acids which contain minimum amount of water are called concentrated acids.
- **Strong acids :** The acids which ionise almost completely are called **strong acids**, *e.g.*, mineral acids.
- **Weak acids :** The acids which ionise only partially or to a lesser extent are called **weak acids**, *e.g.*, organic acids.
- **Bases :** Substances that furnish hydroxide ions (OH^-) in aqueous solution are called **bases**. Bases have bitter taste and produce blue colour in litmus solution.
- **Strong Bases :** The substances / bases which ionise completely to furnish OH^- ions are called **strong bases**, *e.g.*, KOH, NaOH etc.
- **Weak bases :** The bases which ionise only partially are called **weak bases**, *e.g.*, $Mg(OH)_2$, $Cu(OH)_2$ etc.
- **Alkalies :** Water soluble bases are called **alkalies**, *e.g.*, NaOH, KOH. Thus, all alkalies are bases but all bases are not alkali.
- **Dilution :** 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.
- **Ionisation :** 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.
- **Universal indication :** A **universal indicator** is a mixture of many different indicators which shows a gradual but well marked series of colour changes over a very wide range of change in concentration of H^+ ions.
- **pH :** pH is the scale for measuring hydrogen ion concentration. The concentrations of H^+ are generally small, therefore concentrations of H^+ are expressed in terms of pH. pH is defined as negative logarithm of H^+ concentration or H_3O^+ concentration.
  $$pH = -\log [H^+] \quad \text{or} \quad pH = -\log [H_3O^+]$$
- **Neutralisation reaction :** The reaction in which base or basic oxide reacts with acid or acidic oxide is called **neutralisation reaction**.
  Example : $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O$.
- **Salt :** A salt is an ionic compound that results from the neutralization reaction of an acid and a base. Salts are composed of related numbers of cations and anions, so that, the product is electrically neutral.

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Chapter - 3 : Metals and Non-Metals

Quick Review

- **Metals** are mostly solids, possess high density. They have high melting and boiling points. They have lustre and they are sonorous. They are good conductors of heat and electricity.
- Most of the metals are hard. However some of the metals like sodium, potassium are soft metals and can be cut with knife easily.

- All metals are solids except Mercury, Caesium, Francium, Germanium and Gallium which have low melting Points. Gallium becomes liquid if kept on palm. But Gallium has very high boiling point which makes it useful for high temperature thermometers.
- Metals react with O_2 to form metal oxides which are either basic or amphoteric. Basic oxides turn red litmus blue whereas amphoteric oxides are acidic as well as basic. They turn red litmus blue as well as blue litmus red.
- Most of the chemical properties of metals are due to their electropositive nature. Metals are known as electro positive elements because they can form positive ion by losing electrons.

$$M \longrightarrow M^+ + e^-$$

(Metal atom)

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

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

- Metals react with dilute acids to form salt and hydrogen gas. The metal replaces hydrogen of the acid to form salt.
- **Aqua Regia** is a mixture of conc. HCl and conc. HNO_3 in the ratio of 3 : 1. It can dissolve gold and platinum. Aqua Regia is a strong oxidising agent due to the formation of NOCl (Nitrosyl chloride) and chlorine produced by reaction of two acids.
- In electronic configuration of elements, all metals try to lose electrons to acquire nearest noble gas configuration Non-metals gain electrons to form negative ions so as to acquire stable noble gas configuration.
- **Alloys** are homogenous mixture of two or more metals. One of them can be non-metal also, *e.g.,* Brass is an alloy of copper and zinc. When a metal is alloyed with mercury, it is called amalgam.
- The natural materials in which metals occur in the form of their compounds are called minerals. They are mostly found in the earth's crust. Some minerals are also found in sea water, *e.g.,* NaCl.
- Ores are the minerals from which metals are extracted profitably, *e.g.,* Haematite (Fe_2O_3) is an ore of iron, Bauxite ($Al_2O_3.2H_2O$) is an ore of aluminium.
- Metal, in reactivity series, if placed above hydrogen, can displace hydrogen from dilute acids (HCl and H_2SO_4).
- Metals placed above another metal in this series can displace it from the solutions of its salt, as the metal towards top is more reactive than a metal placed below it.
- Metals have low ionisation energies and have great tendency to lose electrons and get oxidised. These electrons are utilised by some other species which undergo reduction. Hence, metals behave as reducing agents.
- **Non-metals** are electronegative in nature so they do not have a tendency to donate electrons to the H^+ ions present in the acid so that they get reduced to H_2 gas. That's why, they do not displace hydrogen from dilute acids.

Know the Terms

- **Malleability :** The ability of a metal due to which it can be beaten into sheets is called **malleability**. Iron, copper, zinc and aluminium are available in the form of a sheets. Aluminium, steel, copper, brass and bronze are used in making utensils.
- **Ductility :** Ductility is the ability of metal due to which it can be drawn into wires. Copper, aluminium and iron can be drawn into wires. Silver, gold and platinum are highly ductile metals.
- **Electrical conductance :** It is the property due to which electric current can pass through the metal. It is due to presence of free electrons or mobile electrons. Copper, silver, gold and aluminium are good conductors of electricity.
- **Thermal conductivity :** It is the property due to which metals can conduct heat. *e.g.,* Copper, silver, aluminium, gold and iron are good conductors of heat.
- **Anodising :** The process of forming oxide layer on the surface of metal is called **anodising,** *e.g.,* Aluminium forms an oxide layer on its surface when it is exposed to air. It is non-penetrating layer which protects it from corrosion.
- **Metallic lustre :** Metals in their pure state have bright shining surfaces. This property is called **metallic lustre**.
- **Sonorous :** When metals are struck with a hard substance, they produce sound. This property is called **sonority** and the metals are said to be **sonorous**.
- **Alkalies :** Those bases, which are soluble in water are called alkalies.
  Examples : NaOH, KOH, $Ca(OH)_2$.
- **Basic Oxides :** The Oxides which react with acids oxides to form salt and water are called Basic Oxides.
  Examples : Na_2O, CaO, K_2O, MgO
- **Acidic Oxides :** The Oxides which react with bases or basic oxides to form salt and water are called.
  Examples : CO_2, SO_2, SO_3, P_2O_3, etc.

- **Amphoteric oxide :** The oxides which are both acidic or basic in nature and react both with acids and bases to form salt and water are called as **Amphoteric oxide**. Example, ZnO, Al_2O_3 etc.
- **Neutral Oxides :** The oxides which are neither acidic nor basic in nature, are known as **Neutral oxides**. They neither react with acids nor with bases. Some non-metals form neutral oxides. Example, CO, NO, N_2O etc.
- **Electrovalent Compounds :** The compounds in which metal loses electrons and non-metal gains electrons are called **electrovalent compounds or ionic compounds**. Example, NaCl, KCl etc.

$$\underset{\text{Sodium}}{2Na} + \underset{\text{Chlorine}}{Cl_2} \longrightarrow \underset{\text{Sodium chloride}}{2NaCl}$$

- **Octet :** A stable group of eight electrons in the outermost orbit of the atom is known as **Octet**.
- **Ionic bond :** The bond which is formed by loss and gain of electrons is called **ionic** or **electrovalent bond**.
- **Corrosion :** It is a process in which metal reacts with substance present in the atmosphere to form surface compounds *e.g.*, silver metal turns black due to formation of Ag_2S, iron forms reddish brown coating of hydrated ferric oxide, $Fe_2O_3.xH_2O$.
- **Galvanisation :** The process of coating iron articles with zinc which is more reactive than iron is called **Galvanisation**.
- **Metallurgy :** All the processes involved in the extraction of metals from their ores and refining them for use, is called metallurgy.
- **Ore-dressing :** It is a process of removing unwanted substances from the ore. This is also known as concentration of the ore or enrichment of ore. It is usually done by hydraulic washing, magnetic separation or froth floatation process.
- **Froth floatation process :** It is based on the principle that the mineral particles are more wetted by the oil, whereas the gangue particles are more wetted by water. Compressed air is bubbled through the mixture. As a result of agitation, oil froth is formed which contains minerals which float on the top of water and can be separated easily.
- **Gangue :** The unwanted material present in the ores mined from earth is called **Gangue**. It needs to be removed prior to the extraction process.
- **Roasting :** It is the process in which ore is heated in the presence of air so as to obtain metal oxides, which can be reduced easily to get free metal. Sulphide ores are converted into oxides by roasting.

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

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

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

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

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

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

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Chapter - 4 : Carbon and Its Compounds

Quick Review

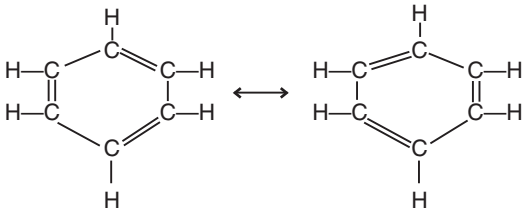
- **Covalent Bond :** A covalent bond is formed by sharing of electrons between atoms. In a covalent bond, the shared pair of electrons belongs to the valence shell of both the atoms.
- Carbon forms covalent bonds.
- **Conditions for Formation of a Covalent Bond :**
  - **(i)** The combining atoms should have 4 to 7 electrons in their valence shell.
  - **(ii)** The combining atoms should not lose electrons easily.
  - **(iii)** The combining atoms should gain electrons readily.
  - **(iv)** The difference in electronegativities of two bonded atoms should be low.

- **Properties of Covalent Compounds :**
  - **(i) Physical states :** They are generally liquid or gases. Some covalent compounds may exist as solid.
  - **(ii) Solubility :** They are generally insoluble in water and other polar solvents but soluble in organic solvents such as benzene, toluene etc.
  - **(iii) Melting and boiling points :** They generally have low melting and boiling points.
  - **(iv) Electrical conductivity :** They do not conduct electrical current.
- **Steps for Writing the Lewis Dot Structures of a Covalent Compound :**
  - **(i)** Write the electronic configuration of all the atoms present in the molecule.
  - **(ii)** Identify how many electrons are needed by each atom to attain noble gas configuration.
  - **(iii)** Share the electrons between atoms in such a way that all the atoms in a molecule have noble gas configuration.
  - **(iv)** Keep in mind that the shared electrons are counted in the valence shell of both the atoms sharing it.
- **Electronic Configuration of Some Non-metals :**

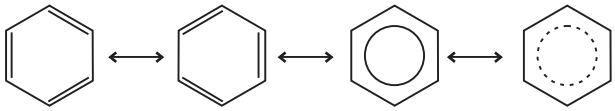
Name of the element	Symbol	Atomic No.	Electrons	Distribution of electrons	Valency	Type of element
Hydrogen	H	1	1	1	1	Non-metal
Carbon	C	6	6	2, 4	4	Non-metal
Nitrogen	N	7	7	2, 5	3	Non-metal
Oxygen	O	8	8	2, 6	2	Non-metal
Fluorine	F	9	9	2, 7	1	Non-metal
Phosphorus	P	15	15	2, 8, 5	3	Non-metal
Sulphur	S	16	16	2, 8, 6	2	Non-metal
Chlorine	Cl	17	17	2, 8, 7	1	Non-metal
Argon	Ar	18	18	2, 8, 8	0	Noble gas

- **Steps for writing the Lewis Dot structures of Hydrocarbons :**
  - **(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)** First complete the noble gas configuration of all the hydrogen atoms by bonding each hydrogen atom with a carbon atom by a single bond.
  - **(iv)** The remaining valency of each carbon is completed by forming carbon - carbon single, double or triple bonds.
  - **(v)** Keep in mind that the shared electrons are counted in the valence shell of both the atoms sharing it.
- **Classification of Hydrocarbons :**
  - **(1) Aliphatic or open chain hydrocarbons :** These are the carbon compounds which have carbon-carbon long open chains. They are classified as :
    - **(i) Saturated hydrocarbons :** These hydrocarbons have all carbon-carbon single bonds.
    - **(ii) Unsaturated hydrocarbons : (a)** These hydrocarbons have at least one carbon-carbon double or triple bond. C = C or C ≡ C.
    - **(b)** Hydrocarbons with at least one carbon-carbon double bond are called **alkenes**.
      General formula = C_nH_{2n}, where n = number of carbon atoms.
    - **(c)** Hydrocarbons with at least one carbon-carbon triple bond are called **alkynes**.
      General formula = C_nH_{2n-2}, where n = number of carbon atoms.
  - **(2) Cyclic or Closed Chain Hydrocarbons :** These are the hydrocarbons which contain close chains or rings of carbon atoms in their molecules.

  They are classified as :
    - **(i) Alicyclic hydrocarbons :** These are the hydrocarbons which do not have benzene ring in their structures.
    - **(ii) Aromatic hydrocarbons :** These are the hydrocarbons which have benzene ring in their structures.
- **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.
- **Conditions for Isomerism :**
  - **(i)** Only alkanes with more than three carbon atoms can have isomers.
  - **(ii)** The side chains cannot be present on the terminal carbons.
- **How to write Different Chain Isomers of Hydrocarbons :**
  - **(i)** First draw the different carbon chains keeping in mind the conditions for isomerism.
  - **(ii)** Complete the tetravalency of carbon by forming single covalent bonds with hydrogens.
  - **(iii)** Check that the molecular formula of each isomer should be same.
- **How to write Different Position Isomers of Unsaturated Hydrocarbons :**
  - **(i)** First draw the different carbon chains keeping in mind the conditions for isomerism.
  - **(ii)** If it is an alkene, draw the first isomer always by drawing a double bond between C_1 and C_2. If it is an alkyne draw the first isomer always by drawing a triple bond between C_1 and C_2.
  - **(iii)** The next isomers will be drawn by drawing the same chain and changing the positions of the double and triple bonds in alkenes and alkynes respectively.
  - **(iv)** Complete the tetravalency of carbon by forming single covalent bonds with hydrogens.
  - **(v)** Check that the molecular formula of each isomer should be same.
- **Homologous Series :** A series of organic compounds in which every succeeding member differs from the previous one by – CH_2 or 14 a.m.u. is called homologous series. The molecular formula of all the members of a homologous series can be derived from a general formula.
- **Properties of a homologous series :** As the molecular mass increases in a series, physical properties of the compounds show a variation, but chemical properties which are determined by a functional group remain the same within a series.
- **Homologous series of alkanes :** General formula : C_nH_{2n+2}, where n = number of carbon atoms.
- **Homologous series of alkenes :** General formula : C_nH_{2n}, where n = number of carbon atoms.
- **Homologous series of alkynes :** General formula : C_nH_{2n-2}, where n = number of carbon atoms.
- **Functional Group :** An atom or a group of atoms which when present in a compound gives specific properties to it, regardless of the length and nature of the carbon chain is called functional group.
- Free valency or valencies of the group are shown by a single line.
- The functional group is attached to the carbon chain by replacing one hydrogen atom or atoms.
- Replacement of a hydrogen atom by a functional group is always in such a manner that valency of carbon remains satisfied.
- The functional group, replacing the hydrogen is also called as hetero atom because it is different from carbon, and can be nitrogen, sulphur or halogen, etc.

Know the Terms

- **Catenation :** The self linking property of carbon atoms through covalent bonds to form long chains and rings is called catenation.
- **Tetravalency :** Tetravalency is the state of an atom in which there are four electrons available with the atom for covalent chemical bonding. Carbon has a valency of four. So, it is capable of making bonds with four other atoms of carbon or any other element.
- **Electronegativity :** It is the ability of an atom to attract a shared pairs of electrons towards itself.
- **Isomerism :** The compounds which possess the same molecular formula but different structural formulae, are called isomers, and the phenomenon is known as isomerism. For example, butane with a molecular formula C_4H_{10} has two isomers.

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

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

Iso-butane

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

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

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

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

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

$$CH_3COOC_2H_5 \xrightarrow{NaOH} CH_3COONa + C_2H_5OH.$$

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

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Chapter - 5 : Periodic Classification of Elements

Quick Review

- **Dobereiner's triads :** Johann Wolfgang Dobereiner, a German chemist classified the known elements in groups of three elements on the basis of similarities in their properties. These groups were called triads.
- **Characteristics of Dobereiner's triads**
  - **(i)** Properties of elements in each triad were similar.
  - **(ii)** Dobereiner showed that when three elements in a triad were written in the order of increasing atomic masses, the atomic mass of the middle element was roughly the average of the atomic masses of the other two elements.
- **Examples of Dobereiner's Triads :**

Triad 1	Triad 2	Triad 3
Lithium (Li)	Calcium (Ca)	Chlorine (Cl)
Sodium (Na)	Strontium (Sr)	Bromine (Br)
Potassium (K)	Barium (Ba)	Iodine (I)

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

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

- **Table showing Newlands' Octaves :**

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

- **Limitations of Newlands' law of octaves :**
  - **(i)** The law was applicable to elements upto calcium (Ca) only.
  - **(ii)** It contained only 56 elements. Further it was assumed by Newlands, that only 56 elements existed in nature and no more elements would be discovered in the future.
  - **(iii)** In order to fit elements into the table, Newland adjusted two elements in the same column as fluorine, chlorine and bromine which have very different properties than these elements. Iron, which resemble cobalt and nickel in properties, has been placed differently away from these elements.
- **Mendeleev's Periodic Table :** Dmitri Ivanovich Mendeleev, a Russian chemist, was the most important contributor to the early development of a periodic table of elements where in the elements were arranged on the basis of their atomic mass and chemical properties.
- **Characteristics of Mendeleev's Periodic Table :**
  - **(i)** Mendeleev arranged all the 63 known elements in increasing order of their atomic masses.
  - **(ii)** The table consists of vertical columns called 'groups' and horizontal rows called 'periods'.
  - **(iii)** The elements with similar physical and chemical properties came under same groups.
- **Mendeleev's Periodic Law :** The properties of elements are the periodic functions of their atomic masses.
- **Achievements of Mendeleev's Periodic Table :**
  - **(i)** Through this table, it was very easy to study the physical and chemical properties of various elements.
  - **(ii)** Mendeleev adjusted few elements with a slightly greater atomic mass before the elements with slightly lower atomic mass, so that elements with similar properties could be grouped together. For example – aluminium appeared before silicon and cobalt appeared before nickel.
  - **(iii)** Mendeleev left some gaps in his periodic table. He predicted the existence of some elements that had not been discovered at that time. His predictions were quite true as elements such as scandium; gallium and germanium were discovered later.
  - **(iv)** The gases such as helium, neon and argon, which were discovered later, were placed in a new group without disturbing the existing order.
- **Limitations of Mendeleev's periodic table :**
  - **(i)** He could not assign a correct position to hydrogen in the periodic table.
  - **(ii)** Positions of isotopes of all elements were not certain according to Mendeleev's periodic table.
  - **(iii)** Atomic masses did not increase in a regular manner in going from one element to the next. So it was not possible to predict how many elements could be discovered between two elements.
- **Modern Periodic Table :** Henry Moseley gave a new property of elements, 'atomic number's and this was adopted as the basis of Modern Periodic Table.
- **Modern Periodic Law :** Properties of elements are the periodic functions of their atomic numbers.
- **Position of elements in modern periodic table :**
  - **(i)** The 18 vertical columns in modern periodic table are known as groups whereas 7 horizontal rows in modern periodic table are called periods.
  - **(ii)** Elements present in any one group have the same number of valence electrons. Also, the number of shells increases as we go down the group.
  - **(iii)** Elements present in any one period, contain the same number of shells. Also, with increase in atomic number by one unit on moving from left to right, the valence shell electron increases by one unit.
  - **(iv)** Each period marks a new electronic shell getting filled.
- **Trends in the Modern Periodic Table :**
  - **(i) Periodicity in Properties :** The properties of elements depend upon the electronic configuration which changes along a period and down a group in the periodic table. The periodicity properties *i.e.* repetition of properties after a regular interval is due to similarity in electronic configuration.

(ii) Tendency to lose or gain electron : Chemical reactivity of an element depends upon the ability of its atoms to donate or accept electrons.

(iii) Variations of tendency to lose electron down the group : Tendency to lose electron goes on increasing down the group.

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

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

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

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

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

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

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

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

Know the Terms

- **Mendeleev's Periodic Law :** This law states that the properties of elements are the periodic function of their atomic masses.
- **Modern Periodic Law :** According to this law, the properties of elements are periodic function of their atomic number.
- **Periodicity :** When the elements are arranged in order of increasing atomic numbers, elements with similar chemical properties are repeated at definite intervals. This is known as periodicity.
- **Atomic Radius :** Atomic radius is defined as the distance from the centre of the nucleus of an atom to the outermost shell of electrons.
- **Covalent Radii :** It is defined as half of the distance between the centre of nuclei of two atoms (bond length) bonded by a single covalent bond *e.g.*, bond length in case of H—H is 74 pm.

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

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

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

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Chapter - 6 : Life Processes

Quick Review

- The ability to perform the basic life processes distinguishes a living organism from a non-living one.
- **Life processes** are the vital processes carried out by living organisms in order to maintain and sustain life Molecular movements are essential to carry out the various life processes.
- Specialized body parts perform the various life processes in multicellular organisms. No such organs are present in unicellular organisms.
- Energy required to carry out the different life processes, is obtained from carbon-based food sources through nutrition.
- Depending on the mode of obtaining nutrition, organisms are classified as autotrophs or heterotrophs.
  - **(i)** **Autotrophs** can prepare their own food from simple inorganic sources like carbon dioxide and water (e.g., green plants, some bacteria).
  - **(ii)** **Heterotrophs** cannot synthesise their own food and is dependent on the autotrophs for obtaining complex organic substance for nutrition. (*e.g.*, animals)
- Green plants prepare their food by the process of **photosynthesis**. Here, they utilise CO_2, H_2O and sunlight, with the help of chlorophyll, giving out O_2 as a by product.
- In the light reaction of photosynthesis, light energy is absorbed and converted to chemical energy in the form of ATP. Also water molecules split into hydrogen and oxygen.
- Carbon dioxide is reduced to carbohydrates in the dark phase of photosynthesis.
- Plants carry out gaseous exchange with surrounding through stomata.
- In humans, digestion of food takes place in the alimentary canal, made up of various organs and glands.
- Liver secretes bile which emulsifies fat.
- Depending on the requirement of oxygen, respiration may be :
  - **(i)** **Aerobic** : occurring in presence of oxygen or
  - **(ii)** **Anaerobic** : occurring in absence of oxygen.
- The end-products are lactic acid or ethanol + CO_2 in anaerobic respiration while CO_2 and water in aerobic respiration. Large amount of energy is released in aerobic respiration as compared to anaerobic respiration.
- Plants release CO_2 at night and oxygen during the day.
- In humans, air takes the following path on entering the nostrils.

  Nostrils → Nasal passage → Pharynx → Larynx → Trachea → Bronchus → Bronchiole → Alveolus.
- The alveoli of lungs are richly supplied with blood and are the sites where exchange of gases (O_2 and CO_2) occurs between blood and atmosphere.
- In humans, the respiratory pigment haemoglobin, carry oxygen from lungs to different tissues of the body.
- Human heart has 4 chambers -2 atria (right and left) and 2 ventricles (right and left). Right half of the heart receives deoxygenated blood whereas the left half receives oxygenated blood.
- Arteries carry blood from heart to different parts of the body whereas veins deliver the blood back to the heart. Arteries are connected to veins by thin capillaries, where materials are exchanged between blood and cells.
- Blood platelets are essential for clotting of blood at the place of injury and thus preventing blood loss.
- Lymphatic system consists of lymph, lymph nodes, lymphatic capillaries and lymph vessels which drain into larger veins. Lymph is also important in the process of transportation.
- In plants, water is transported through the xylem tissue, from roots to the aerial parts of the plant. Root pressure and transpiration pull are the major forces involved in pulling water up the xylem.
- Translocation of food is carried out through phloem tissue from leaves and storage organs to other parts of the plant. This process requires energy from ATP.
- During excretion, the harmful metabolic nitrogenous wastes generated are removed from the body.
- Nephrons are the basic filtration units of kidneys. They carry out filtration, selective reabsorption and tubular secretion to form urine in kidney, which is then passed out through the urethra, via the ureters and urinary bladder.

Know the Terms

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

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

- **Photo-phosphorylation :** It is the synthesis of energy rich molecules of ATP from ADP and inorganic phosphate with the help of light energy.
- **Compensation Point :** It is that value of a factor (*e.g.* light, carbon dioxide) at which the photosynthetic consumption of carbon dioxide exactly matches the liberation of CO_2 in respiration.
- **Heterotrophic Nutrition :** It is that mode of nutrition in which the organisms obtain food from outside sources.
- **Digestion :** It is the enzyme mediated breakdown of complex insoluble components of food into simple soluble and absorbable forms.
- **Lysozyme :** It is an antimicrobial enzyme found in saliva, tears, egg white and many animal fluids that causes breakdown of peptidoglycan and chitin covering of microbes.
- **Peristalsis :** It is a wave of contraction behind the food and expansion in the region of contained food that occurs in the alimentary canal for pushing the food from anterior to posterior ends.
- **Succus Entericus :** It is the name of digestive juice of small intestine, also known as intestinal juice.
- **Emulsification :** Emulsification of fats is conversion of large fat pieces into very fine fat globules.
- **Phagocytosis :** This is the process of ingestion of solid food particle by a cell or unicellular organism.
- **Circumvallation :** This is the method of intake of food when *Amoeba* comes in contact with a food particle or prey, it throws pseudopodia all around the same. The tips of encircling pseudopodia fuse and the prey comes to lie in a vesicle or phagosome.
- **Respiration :** It is an enzyme controlled biochemical process of stepwise oxidative breakdown of organic compounds releasing energy at various steps.
- **Cutaneous Respiration :** It is the mode of exchange of respiratory gases that occurs through skin which is thin, permeable, moist and vascularised for this function.
- **Branchial Respiration :** It is the respiration performed with the help of gills.
- **Breathing :** It is a physical process of alternate inhalation of fresh air and exhalation of foul air.
- **Aerobic respiration :** It is the stepwise complete oxidative breakdown of respiratory substrate into carbon dioxide and water with the help of oxygen that act as terminal oxidant.
- **Glycolysis (EMP) :** It is the first step of breakdown of respiratory substrate which occurs in cytoplasm and produces two molecules of pyruvate from a molecule of glucose.
- **Kreb's Cycle :** It is a cyclic series of metabolic reactions of aerobic respiration that occur inside mitochondria. Acetyl-CoA is completely oxidised into carbon dioxide and reduced coenzymes $NADH_2$ as well as $FADH_2$ are produced.
- **Terminal Oxidation :** It is the combining of oxygen with hydrogen released from reduced coenzymes during oxidative phosphorylation.
- **Transportation :** It is the movement of materials from one part to another, usually from the region of their availability to the region of their use, storage or elimination.
- **Circulatory System :** It is a system of organs, tubes and a blood-like fluid that circulates various materials inside the body.
- **Haemolysis :** It is the process of destruction of RBC's.
- **Serum :** It is a whitish water fluid that is squeezed out from contracting blood clot.
- **Diapedesis :** It is the crawling of white blood corpuscles out of blood capillaries into surrounding tissues.
- **Pulse :** It is a repeated throb felt in a superficial artery of the body due to forceful pumping of the blood.
- **Translocation :** It is the movement of materials in solution form within an organism especially in phloem of plants.
- **Transpiration :** It is the loss of water in vapour form from the exposed parts of a plant.
- **Ascent of Sap :** It is the upward movement of absorbed water or sap from root to the top of the plant.
- **Excretion :** It is the process of throwing out of waste products and other harmful chemicals from the body.
- **Nephric Filtrate :** It is the fluid passed out of glomerulus due to ultrafiltration in the Malpighian capsule of a nephron.

- **Ultrafiltration :** It is the filtration under pressure of small particles, solutes and solvents, through a finely porous membrane.
- **Glomerulus :** It is a bunch of fine blood vessels or capillaries present in the depression of Bowman's capsule where ultrafiltration occurs.
- **Micturition :** It is the expulsion of urine from the body.
- **Bowman's Capsule :** It is a broad, blind cup-shaped, proximal end of a nephron in which glomerulus is located for ultrafiltration.
- **Osmoregulation :** It is the maintenance of a fixed osmotic concentration of body fluids by controlling the amount of water and salts.

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Chapter - 7 : Control and Co-ordination

Quick Review

- **Nervous system** is the system of conducting tissues that receives the stimulus and transmits it to other parts of the body forming a network of nerves.
- The units which makes up the nervous system are called **nerve cells or neurons**.
- The **receptors** pass the information to the brain through a type of nerve cells called sensory neurons.\
- **Motor neurons** transmit the information from the brain to the effector organs, mainly muscles and glands.
- **Nerve Impulse :** It is the information in the form of chemical and electrical signals passing through neurons. These impulses are carried by dendrites towards the cell body.
- **Neuromuscular Junction :** It is the point where a muscle fibre comes in contact with a motor neuron carrying nerve impulses from the central nervous system. The impulses travel from the neuron to the muscle fibres by means of neurotransmitter in the same way as the transmission of impulses across a synapse between two neurons.
- **Voluntary Action :** These are the actions which need thinking and are performed knowingly *i.e.* these are controlled by conscious thought.
  Example : Speaking to a friend, writing a letter etc.
- **Involuntary Action :** These are not under the control of the will of an individual and are automatic response to a stimulus which is not under the voluntary control of the brain.
  Example : Touching a hot plate unknowingly.
- **Reflex Action :** It is defined as an unconscious, automatic and involuntary response of effectors, *i.e.* muscles and glands, to a stimulus, which is monitored through the spinal cord.
- Central nervous system consists of the brain and the spinal cord. Peripheral Nervous System constitute the cranial and spinal nerves along with their branches.
- Autonomic Nervous System means 'Self governing nervous system', consists of a pair of chain of nerves and ganglia found on both the sides of the vertebral column.
- **Spinal cord** is a cylindrical structure and a part of the central nervous system. It is made up of nerves which supply information to think.
- **Plant Movements :** The movements of the individual plant parts or organs of a plant like shoot, root etc. are due to some external stimuli like light, force of gravity, chemical substance, water etc.
- **Tropic Movement :** It is the directional growth or movement of a plant organ in response to an external stimulus. Growth towards the stimulus is positive tropism and growth away from the stimulus is negative tropism.
- **Hormones** are the chemical substances which co-ordinate and control the activities of living organisms and also their growth.
- **Endocrine glands** are a structure or a group of cells or tissues which manufacture hormones and secretes them directly into the blood stream to act at distant sites in the body known as target organs or cells.
- **Pituitary glands** is present at the base of the brain. It is also known as the master gland, as it controls the other endocrine glands.

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Chapter - 8 : How do Organisms Reproduce?

Quick Review

- **Reproduction** allows perpetuation of species and increases the population of a species. It plays an important role in evolution by transmitting favourable variations from one generation to another generation.
- A basic event in reproduction is the creation of a DNA copy. DNA copying is accompanied by a cell division giving rise to two cells.

- There are two main methods by which organisms give rise to new individuals—Asexual reproduction and Sexual reproduction.
- **Asexual reproduction** takes place through fission, fragmentation, regeneration, budding, vegetative propagation, spore formation. These modes of reproduction depend on the body design of the organisms.
- Fission is of two types - binary fission and multiple fission.
- **Binary fission** is the division of one cell into two similar or identical cells. The nucleus first divides amitotically into two, followed by the division of the cytoplasm. The cell finally splits into two daughter cells. ***e.g.,*** *Amoeba*
- In **multiple fission,** many individuals are formed from a single individual. *e.g., Plasmodium*. The nucleus divides repeatedly, producing many nuclei and many daughter cells are formed.
- The nucleus divides repeatedly, producing many nuclei and many daughter cells are formed.
- **Fragmentation :** Multicellular organisms with simple body organisation such as filamentous algae—*Spirogyra* breaks up into two or more small pieces of fragments upon maturation. These fragments grow into new individuals.
- **Regeneration :** It is the ability of a fully differentiated organism to give rise to new individual organisms from its body parts. Small cut or broken parts of the organism's body grow or regenerate into separate individuals. For **example :** *Planaria* and *Hydra*.
- In *budding*, a small part of the body of the parent grows out as a bud which then detaches and becomes a new organism. *Hydra* reproduces by budding using the regenerative cells.
- In *vegetative propagation,* new plants are obtained from the parts of old plants such as stems, roots and leaves, without the help of any reproductive organ.
- **There are two ways of vegetative propagation :**
  (i) Natural vegetative propagation
  (ii) Artificial vegetative propagation.
- Various structures that take part in natural vegetative propagation are roots, stems and leaves.
- Artificial vegetative propagation takes place through cutting, layering and grafting which are used in agriculture and horticulture.
- **Cutting :** In this type of propagation, any part of the plant root, stem or leaf is cut and buried partly in the moist soil.
- **Layering :** The adventitious roots are produced in the branch of the stem before the plant is detached from the parent plant. The branch of stem is called a layer. This process is utilised in the propagation and called as layering. For example Jasmine and *Bougainvillea*.
- **Grafting :** In this method of reproduction, two plants of closely related varieties are joined together so that they live as one plant.
- The portion of a plant that is grafted on the other plant is called scion, and the plant in which grafting is performed is called stock. This method is applied to improve variety of fruits such as mango, apple, peas, citrus and guava.
- Sexual reproduction in flowering plants takes place in the phylum angiosperm. The gametes are produced within the flowers and the ovules are enclosed in a carpel.
- The main parts of a flower are : sepals, petals, stamens and carpel.
- Stamens and carpels are the reproductive parts of a flower which contain the germ cells. The male organ of a flower called 'stamen' comprises the male gamete which are present in the pollen grain. The female organ of a flower called 'carpel' or 'pistil' comprises female gamete, which are present in ovules of the plant.
- **Pollination** is the transfer of pollen grain from the anther of a stamen to the stigma of a carpel. Pollination is of two types : Self pollination and cross pollination.
- **Embryo :** It is the stage of development between the zygote or fertilized egg and the newly formed offspring.
- The reproductive organs of human beings *i.e.,*testis in male and ovary in females become functional only after attaining sexual maturity. In males, sexual maturity is attained at the age of 13-14 years while in females it is attained at the age of 10-12 yrs. This is known as the age of puberty.
- The **human male reproductive system** consists of testes, epididymis, vas deferens, urethra, penis, accessory glands, prostate glands and sperms.
- The **human female reproductive system** consists of ovaries, fallopian tubes or oviducts, uterus and vagina.
- In humans, fertilization takes place in female's fallopian tube where only one sperm fertilises the ovum to form a zygote.
- The embryo moves down to reach the uterus. The embedding of the embryo in the thick inner lining of the uterus is called **implantation**.
- The time period from the development of foetus inside the uterus till birth is called **gestation period**. The act of giving birth to the fully developed foetus at the end of gestation period is termed as **parturition**.
- The breakdown and removal of the inner, thick and soft lining of the uterus along with its blood vessels in the form of vaginal bleeding is called **menstrual flow** or **menstruation**.
- Reproductive health is all those aspects of general health which help a person to lead a normal, safe and satisfying reproductive life.

- **Sexually Transmitted Diseases (STDs)** are the diseases which spread by sexual contact from an infected person to a healthy person. Some common STDs are Gonorrhoea, syphilis, trichomoniasis, AIDS.
- There are different methods which are developed to prevent and control pregnancy such as mechanical methods, chemical methods, oral pills and surgical methods.

Know the Terms

- **Reproduction :** It is the process of producing new individuals of the same species by existing organisms of a species *i.e.* parents.
- **Asexual reproduction :** It is the process of producing new organisms from a single parent without the involvement of sex cells or gametes.
- **Fission :** It is the simplest method of asexual reproduction in unicellular forms of life such as *Amoeba, Paramecium* and other protozoan.
- **Binary fission :** It is the division of one cell into two similar or identical cells. The nucleus first divides amitotically into two, followed by the division of the cytoplasm. The cells finally splits into two daughter cells.
- **Fragmentation :** It is an asexual reproduction in which a multicellular organisms breaks up into two or more small pieces of fragment upon maturation.
- **Regeneration :** It is the ability of a fully differentiated organism to give rise to new individual organism from its body parts.
- **Vegetative propagation :** It is a method of propagation, in which new plants are obtained from the parts of old plants such as stem, roots and leaves, without help of any reproductive organs.
- **Tissue culture :** It is the production or propagation of new plants from isolated plant cells or small pieces of plant tissue in a synthetic medium of culture solution. This technique is also known as micropropagation, and in vitro culture because it takes place outside the body of the parent plant in a test tube using an artificial environment.
- **Micropropagation :** It is a technique used for the production of ornamental plants like orchids, *Dahlia* and carnation.
- **Sexual reproduction :** It is the process in which two sexes male and female are involved. The male sexual unit is known as male gamete or sperm while female sexual unit is termed as female gamete or ova.
- **Pollination :** It is the transfer of pollen grain from the anther of a stamen to the stigma of a carpel. The pollen grains are transferred by many agents as insects, birds, man, wind and water.
- **Fertilization :** It is defined as the fusion of a male gamete (sperm) with a female gamete (an ovum) to form a zygote during sexual reproduction.
- **Zygote :** The cell which is formed by the fusion of a male gamete and female gamete is called **Zygote**, *i.e.* it is a 'fertilised ovum' or 'fertilized egg.'
- **Sex ratio :** It is the ratio of the number of females to per thousand males in a population. The female-male sex ratio must be maintained for a healthy society.
- **Population size :** Organisms increase their population with the help of reproduction. The rates of birth and death in a given population determines its size.

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Chapter - 9 : Heredity and Evolution

Quick Review

- Variations arise during the process of reproduction. They may be few in asexual reproduction, but many in case of sexual reproduction.
- The minor variations arising during Sexual reproduction are caused by slight inaccuracies in DNA copying. In sexual reproduction, variations are also caused by crossing over process of meiosis.
- Beneficial variations help the species to survive better in the environment.
- Nature selects the beneficial variations thereby leading to evolution.
- Reproduction produces offsprings with similar body design of the parents. However the offsprings are not identical, but show a great deal of variation from the parents.
- Sexually reproducing organisms such as humans have two (or more) versions of genes for each trait, called alleles.
- **Gregor Johann Mendel** carried out several experiments on pea plants. He carried out large number of monohybrid and dihybrid crosses using many contrasting characteristics and put forward several important conclusions.
- In case of monohybrid cross with pure variety of plants, the phenotypic ratio obtained in F_2 generation is 3 : 1.
- In case of dihybrid cross involving two pairs of contrasting characters, the phenotypic ratio obtained in F_2 generation is 9 : 3 : 3 : 1.
- Mendel concluded that out of any pair of contrasting characters, one is dominant and the other is recessive.

- The homozygous dominant trait is denoted by two capital letters whereas the homozygous recessive trait is denoted by two small letters.
- The factors or genes controlling a particular trait separate from each other during gamete formation. Hence gamete is always pure as far as contrasting characters are considered. Each gamete will possess only one gene set.
- During crossing, if two or more traits are involved, their genes assort independently, irrespective of the combinations present in the parents.
- Genes carry information for producing proteins, which in turn control the various body characteristics.
- For a particular trait, the offspring receives one allele from the father and one allele from the mother.
- The combination of the male and female germ cells gives a diploid zygote. Thus the normal diploid number of chromosomes in the offspring is restored.
- Different mechanisms are used for sex determination in different species.
- The sex of human offspring is genetically determined.
- Humans have 22 pairs of autosomes and one pair of sex chromosomes.
- Female have similar sex chromosomes XX, whereas males have an imperfect pair *i.e.*, XY. All eggs carry X chromosome.
- The sex of the child depends on whether the egg fuses with the sperm carrying X chromosome (resulting in a girl) or with the sperm carrying Y chromosome (resulting in a boy).
- Variations are beneficial to a species having a greater chance of flourishing in the species than the harmful or neutral variations.
- Genetic drift can alter gene frequencies in small population and provide diversity without any survival benefits.
- Several factors such as environment, mutations, reproduction, etc can cause alterations in gene frequencies in a population over generations, leading to evolution.
- Changes occurring in the DNA of germ cells are heritable whereas changes taking place in the non-reproductive tissues are not inherited.
- Charles Darwin proposed that evolution of species occurred by natural selection, but he did not know the underlying mechanism.
- Natural selection, genetic drift, variations and geographical isolation can lead to speciation in sexually reproducing organisms.
- Gene flow between the members of a population prevents speciation.
- **The fundamental characteristics used to classify organisms are :**
  - **(i)** presence of prokaryotic or eukaryotic cells.
  - **(ii)** whether the organism is unicellular or multicellular.
  - **(iii)** ability to perform photosynthesis.
  - **(iv)** presence of endoskeleton or exoskeleton in heterotrophic organisms.
- Classification of living organisms is closely related to their evolution.
- As we go back in time to trace common ancestors, we find that all organisms must have arisen and radiated from a single species, which in turn originated from non-living material. Thus life arose from non-living matter.
- Study of homologous organs, *e.g.*, hand of man and wing of bird, helps in tracing the evolutionary relationship between different species.
- Analogous organs, *e.g.*, wing of insects and wing of birds, do not have common origins, but arose in different species to fulfil similar functions.
- Fossils help in tracing evolutionary pathways.
- The age of fossils can be determined by using the relative method or the isotope dating method.
- Evolution is not a one-step process, but a continuous process occurring in several stages.
- Complex organs are formed slowly over many generations, sometimes with intermediate forms playing an important role.
- Sometimes the use of certain features gets modified with time. For example : Feathers may have provided insulation initially, but later became associated with flight.
- Evolutionary studies have shown that birds are closely related to reptiles.
- Humans have carried out artificial selection for various features of cabbage and produced different vegetables.

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

- Molecular phylogeny can also be used to trace evolutionary relationships. Here the DNA of different species is compared. Greater the differences in DNA, more distantly related are the species.
- Disappearance of the existing species is not a requirement for formation of new species.

- The new species formed are better adapted to the environment but they need not be superior to the existing species.
- The common ancestor of humans and chimpanzees evolved in different ways to produce the present forms.
- Evolution produces more diverse and complex body forms over a period of time, but the newly formed species are not more progressive than the already existing ones. So it is wrong to say that evolution produces progressive higher forms from lower ones.
- The human ancestors gradually migrated from Africa to various parts of the world such as Asia, Europe, Australia and America. Thus they spread to different parts of the earth and adapted as best as they could to their environmental conditions.

Know the Terms

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

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Chapter - 10 : Light Reflection and Refraction

Quick Review

- When light fall on a body, it may be absorbed, may be transmitted or light may get reflected back to the same medium.
- **Reflection of light** means light waves are neither transmitted nor absorbed but are deflected from the surface of the medium back into the same medium.
- **Laws of Reflection :**
  (i) The incident ray, the normal to the surface at the point of incidence and the reflected ray, all lie in the same plane.
  (ii) The angle of incidence is equal to the angle of reflection.
- Real image is obtained when the rays of light after reflection, actually converge at a point. It can be obtained on the screen and can be seen with the eye.
- Virtual image forms when rays of light do not actually meet, but appear to meet when produced backwards. It cannot be obtained on the screen.

- **Characteristics of the image formed by the plane mirror :**
  (i) The image formed by a plane mirror is always virtual and erect.
  (ii) Size of the image = Size of the object and the image is laterally inverted.
  (iii) The image formed by the plane mirror is far behind the mirror as the object is in the front.
- **Lateral Inversion :** The phenomenon due to which the right side of the object appears as left and the left side of the object appears as right. *i.e.,* the image is inverted sideways.
- A spherical mirror whose reflecting surface is curved inwards and polished on the outer spherical surface is concave mirror.
- A spherical mirror whose reflecting surface is curved outwards and polished on the inner spherical surface is convex mirror.
- Concave mirror mostly forms real images, which can be received on the screen. Convex mirror always forms virtual images, which cannot be received on the screen.
- **Differentiating between a plane mirror, a concave mirror and a convex mirror, without touching them :**
  (i) If the image formed is erect and is of same size as in reality then it is a plane mirror.
  (ii) If the image formed is still erect but smaller in size then it is a convex mirror.
  (iii) If the image formed is erect but magnified when the mirror is close to the object, then it is a concave mirror.
- Solar concentrations use huge concave mirrors to focus large amount of solar energy thereby producing high temperature conditions in a solar power plant.
- The centre of the reflecting surface of a spherical mirror is a point called the pole of the mirror and is usually represented by P.
- The horizontal line passing through the centre of curvature and pole of the spherical mirror is known as principal axis.
- The centre of curvature of a spherical mirror is the centre of the hollow sphere of glass, of which the spherical mirror is a part and is usually represented by C.
- The radius of curvature of a spherical mirror is the radius of the hollow sphere of glass, of which the spherical mirror is a part and is usually represented by R.
- The diameter of the reflecting surface, *i.e.,* twice the radius is called its aperture.
- Radius of curvature (R) = 2 × focal length (f).
- **Rules for ray diagram :**
  (i) The path of the reflected light ray depends upon how incident ray is oriented with respect to the principal axis.
  (ii) A ray of light passing through the principal focus of a mirror becomes parallel to the principal axis of the mirror, on reflection.
  (iii) A ray of light parallel to the principal axis, after reflection passes through the principal focus.
  (iv) A ray of light incident obliquely towards the pole of the mirror is reflected obliquely as per the laws of reflection.
  (v) A ray of light passing through centre of curvature of a mirror is reflected back along the same path.
- **Image formation by a concave mirror for different positions of the object :**

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

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

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

- The ratio of the height of the image to the height of the object is known as the magnification.
- Magnification is positive for virtual image and negative for real image.
- The phenomenon of change in the path of light from one medium to another is called refraction of light.
- The angle formed between the incident ray and the normal is called angle of incidence and the angle formed between the refracted ray and the normal is called angle of refraction.

- The cause of refraction is the change in the speed of light as it goes from one medium to another medium.
- Larger the difference in speed of light between the two media across the interface, the greater will be the angle of bending and vice-versa.
- When a ray of light passes from a rarer medium to a denser medium, it bends towards the normal. Also, the angle of incidence is greater than the angle of refraction.
- When a ray of light passes from a denser medium to a rarer medium, it bends away from the normal. Also, the angle of incidence is less than the angle of refraction.
- **Laws of refraction :**
  First law : The incident ray, the refracted ray and the normal at the point of incidence all lie in the same plane.
  Second law : The ratio of the sine of angle of incidence in the first medium to the sine of angle of refraction in the second medium is a constant for a given pair of medium and for a given wavelength of light.

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

  where n is a constant known as refractive index of the second medium with respect to the first medium. This law is also called Snell's law.
- The ratio of speed of light in vacuum to the speed of light in a medium is called the refractive index of the medium. It has no unit.
- When a ray of light travels from a rarer to a denser medium it slows down and bends towards the normal.
- When a ray of light travels from a denser medium to a rarer medium, it speeds up and bends away from the normal.
- The shifting of emergent ray sideways from the direction of original incident ray is called lateral displacement or lateral shift.
- **The extent of the lateral shift produced due to refraction across parallel slab depends on :**
  (i) the angle of incidence,
  (ii) the thickness of slab, and
  (iii) refractive index of the glass slab.
- Lateral displacement is produced during refraction through a glass slab and not through a glass prism. Prism produces angular deviation.
- The angle through which a ray of light deviates on passing through a prism is called the angle of deviation.
- Convex lens is thicker at the middle than at the edges.
- Concave lens is thicker at the edges than at the middle.
- Convex lens converges the rays of light while concave lens diverges.
- As the object moves towards the optical centre of convex lens, the image moves away from the optical centre except when the object is placed between focus and optical centre of the lens.

Know the Terms

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

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Chapter - 11 : The Human Eye and The Colourful World

Quick Review

- Eye is a natural optical device using which man could see objects around him. It forms an inverted, real image on a light sensitive surface called retina.
- Retina is the light sensitive surface of eye in which image is formed. It is equivalent to the photographic film in a camera. It contains rods and cones.
- Rods and cones are the cells in retina, which are light sensitive. Rods respond to the intensity of light. Cones respond to the illumination colours. There are around 125 million cells-rods and cones. The cells generate signals which are transmitted to the brain through optical nerve.
- The ability of the ciliary muscles to adjust the curvature and thereby the focal length to get clear view of objects is called **accommodation**.
- The maximum variation in power of the lens so that the far-off and nearby objects are viewed is called power of accommodation. For a person having normal vision it is about 4 dioptres.
- The minimum distance between the object and the eye so that a clear image is formed on the retina is called the least distance for clear vision or near point of the eye. This distance is 25 cm for human eye.
- The farthest point upto which the eye can see objects clearly is called the far point of the eye. For a normal eye, it is infinity.
- The time for which the impression or sensation (of an object) continues in the eye is called persistence of vision. It is about 1/16th of a second.
- Motion picture is done to create clear impression of an event. The event is projected at the rate of 24 frames per second.
- Cones with specific colours are in the retina. If some cones are absent, the distinction of colours is not possible. In such case, the person is said to be colour-blind. This defect arises due to **(i)** absence of colour responding cone cells in the retina **(ii)** due to genetic disorder. This inability to identify colours is called colour blindness.
- Some persons have difficulty to see the objects in dim light during night. This defect of eye is called night blindness.
- In **myopia**, distant objects are not clearly visible. It is corrected by using concave lens.
- In **hypermetropia**, nearby objects are not clearly visible. It is corrected by using convex lens.
- **Presbyopia** arises due to weakening of ciliary muscles in old age. It can be corrected by using bifocal lenses.
- The phenomenon of splitting of white light into its constituent seven colours on passing through a glass prism is called **dispersion of light**.
- Different colours undergo different deviations on passing through prism.
- If a second identical prism is placed in an inverted position with respect to the first prism, all the seven colours recombine to form white light.
- **Atmospheric refraction** is the phenomenon of bending of light on passing through earth's atmosphere.
- As we move above the surface of earth, density of air goes on decreasing.
- Light travelling from rarer to denser layers always bends towards the normal.
- Stars twinkle on account of atmospheric refraction.
- Sun appears to rise 2 minutes earlier and set 2 minutes later due to atmospheric refraction.
- The phenomenon in which a part of the light incident on a particle is redirected in different directions is called **scattering of light.**
- Very small particles scatter light of shorter wavelengths better than longer wavelengths.
- The scattering of longer wavelengths of light increases as the size of the particle increases.
- Larger particles scatter light of all wavelengths equally well.

Know the Terms

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

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

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Chapter - 12 : Electricity

Quick Review

- Electric charge is the property of matter due to which it produces and experiences electrical and magnetic effects. There exist two types of charge in nature :
  (i) Positive charge **(ii)** Negative charge
  SI unit of charge is coulomb (C).
- **Fundamental law of electrostatics :** Like charges repel and unlike charges attract each other.
- **Coulomb's Law :** The force of attraction or repulsion between two point charges is **(i)** directly proportional to the product ($q_1\, q_2$) of the two charges and **(ii)** inversely proportional to the square of the distance (r) between them.
  Mathematically,

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

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

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

  Electric current is a scalar quantity.
- **Ampere :** It is the SI unit of current. If one coulomb of charge flows through any section of a conductor in one second, then current through it is said to be of one ampere.
- **Electric circuit :** The closed path along which an electric current flows is called an 'electric circuit'.
- **Conventional direction of current :** Conventionally, the direction of motion of positive charges through the conductor is taken as the direction of current. The direction of conventional current is opposite to that of the negatively charged electrons.
- **Electric field :** It is the region around a charged body within which its influence can be experienced.
- **Electrostatic potential :** Electrostatic potential at any point in an electric field is defined as the amount of work done in bringing a unit positive charge from infinity to that point. Its unit is volt.
- **One volt potential :** The electrostatic potential at a point in an electric field is said to be one volt if one joule of work has to be done in bringing a positive charge of one coulomb from infinity to that point.
- **Potential difference between two points :** The potential difference between two points in an electric field is the amount of work done in bringing a unit positive charge from one point to another.

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

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

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

- **Electrochemical or voltaic cell :** It is a device which converts chemical energy into electrical energy.
- **Galvanometer :** It is a device to detect current in an electric circuit.
- **Ammeter :** It is a device to measure current in a circuit. It is a low resistance galvanometer and is always connected in series in a circuit.
- **Voltmeter :** It is a device to measure the potential difference. It is a high resistance galvanometer and is always connected in parallel to the component across which the potential difference is to be measured.
- **Ohm's law :** This law states that the current passing through a conductor is directly proportional to the potential difference across its ends, provided the physical conditions like temperature, density etc., remain unchanged.

$$I \propto V \text{ or } I = (1/R)V$$

R is called resistance of the conductor.

- **Resistance :** It is the property of a conductor by virtue of which it opposes the flow of current through it. It is equal to the ratio of the potential difference applied across its ends and the current flowing through it.

$$\text{Resistance} = \frac{\text{Potential difference}}{\text{Current}} \quad \text{or} \quad R = \frac{V}{I}$$

- **Laws of resistance :**

(i) Resistance of a conductor depends upon the nature of the material of the conductor.

(ii) Resistance of a conductor is directly proportional to the length of the conductor.

(iii) Resistance of a conductor is inversely proportional to the cross-section of the conductor.

(iv) Resistivity of metallic conductor increases with the increase of temperature.

- **Factors on which resistance of a conductor depends :** The resistance R of a conductor depends on its length L, area of cross-section A and the nature of its material. It is given by

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

The proportionality constant ρ is called resistivity of the conductor.

- **Resistances in series :** When two or more resistances are joined end to end so that same current flows through each one of them in turn, they are said to be connected in series. Here, the total resistance is equal to the sum of the individual resistances.

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

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

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

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

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

or

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

- **Practical application of the heating effect of electric current :**

It is utilised in the electrical heating appliances such as electric iron, room heaters, water heaters etc. The electric heating is also used to produce light as in an electric-bulb.

- **Electric energy :** It is the total work done in maintaining an electric current in an electric circuit for a given time.

Electric energy, $W = VIt = I^2Rt$ joule

- **Electrical power :** Electrical power is the rate at which electric energy is consumed by an appliance.

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

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

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

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

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

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

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

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

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

Know the Terms

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

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

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

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

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

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Chapter - 13 : Magnetic Effects of Electric Current

Quick Review

- An electric current carrying with behave like a magnet and generates magnetic field.
- The black ore of iron (Fe_3O_4) called magnetite, capable of attracting similar pieces of iron is called lodestone. They are naturally existing magnets used by man to find the directions.
- There are two poles of a magnet namely North pole and South pole. Like poles repel each other, while unlike poles attract each other.
- H.C. Oersted, a Danish physicist first noticed the magnetic effect of electric current. According to him, a needle kept near the wire carrying current will deflect due to the magnetic field produced. Any change in the direction of current will show variation in the deflection.
- 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.
- The strength of magnetic filed is expressed by the closeness of magnetic filed lines. Closer the lines, more will be the strength and farther the lines, less will be the magnetic field strength.
- When a magnet is placed in a magnetic field, it aligns along the field lines with the north pole in the direction of the magnetic field. On the surface of earth, there exists a magnetic field due to the contents of the earth, making it to behave as a magnet.
- **Right Hand Thumb Rule :** Hold the current carrying wire in your right hand, such that the thumb indicates the direction of current, then the folded fingers will indicate the presence of magnetic field (lines) surrounding the wire.
- Magnetic field due to a straight wire depends directly on the length of the wire, and on the current passing through the wire and inversely on the distance from the wire.
- The magnetic field at the centre of the circular coil due to a current is dependent directly on the current and on the number of turns. It is inversely dependent on the radius of the coil.
- A coil of large number of turns closely wound on a hollow cylinder of insulated material or otherwise is called a **solenoid**. The end of the solenoid having clockwise current will act as south pole-field enters into, while on the other hand having anti clockwise current will act as north pole-field comes out. Thus, a solenoid acts as a normal magnet.
- **Permanent magnets** are made of carbon steel, chromium steel, tungsten steel and some alloys like Alnico and Nipermag. Alnico is an alloy of aluminium, nickel and cobalt.
- When a material is placed inside a coil carrying current, it will get magnetised. A bunch of nails or an iron rod placed along the axis of the coil can be magnetised by the current allowed to pass through the coil. Such magnets are called electromagnets.
- **Ampere** suggested that when a current I passes through a conductor of length l placed in a perpendicular magnetic field B, then the force experienced is given by $F = IBl \sin\theta$, where θ is the angle between the length of the conductor and magnetic field.
- **Fleming's Left Hand Rule :** Stretch the first three fingers of the left hand mutually perpendicular to each other such that the forefinger points the direction of magnetic field, the middle finger points the direction of current, then the thumb will indicate the direction of force experienced by the conductor. It is applied to the direction of the current and field perpendicular to each other.
- **Electric motor** is a device used to convert electrical energy to mechanical energy. It works on the principle of force experienced by a current carrying conductor in a magnetic field. The two forces in the opposite sides are equal and opposite.
- **Faraday's Law :** The rate at which the magnetic flux linked with a coil changes, produces the induced emf or current. More the rate, more the current and vice-versa.

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

- **Fleming's Right Hand Rule :** Stretch the first three fingers of the right hand mutually perpendicular to each other such that the forefinger gives the direction of magnetic field and the thumb points the direction of the motion of a conductor, then the middle finger will give the direction of the induced current.
- Generator works on the principle of Electromagnetic Induction. It converts the mechanical energy available into electrical energy. A.C. Generator produces potential which reverses after every 180° rotation of the coil. D.C. Generator means the generator which produces unidirectional current.

Know the Terms

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

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Chapter - 14 : Sources of Energy

Quick Review

- Any system from where energy can be trapped is called a source of energy. Source of energy is capable of providing adequate amount of energy. It should be convenient to use and easy to store and transport.
- **Law of conservation of energy :** Energy can neither be created nor destroyed, but can be transformed from one form to another.
- In power stations, one needs energy to run turbines. Large quantity of fossil fuels like coal are burnt to produce heat energy. This produces steam which is used to rotate turbines to produce electricity. The flow of energy in power station is as listed below :

  Fossil fuels—Heat Energy—Mechanical Energy—Electrical Energy.
- The energy of water flowing through rivers or stored in dam is another potential source of energy. It is also indirect source of solar energy. It is the solar energy which recycles water in nature from oceans and the earth's surface through rain and snow. The energy of water flowing through rivers has been used for rotating the wheels of water mills which are still operating in remote hilly areas.
- The material contained in the bodies of plants and animals is called biomass. It acts as a fuel. It includes waste from tree and grass crops, forestry, agricultural and urban wastes. The excreta of living organisms and their bodies after death also contribute to the biomass.
- **Biogas** is a mixture of gases such as methane (75%), carbon dioxide, hydrogen, hydrogen sulphide etc., which is obtained by the decomposition of animal and plant wastes like animal dung etc., with the help of micro-organisms in the presence of water.
- **Electrical energy** is one of the widely used energies. It is generated by harnessing different sources of energy. In any conventional power plant, turbines of generators are rotated by using steam arrived by heating water from one source of energy.
- Indirectly or directly all forms of energy originate from the solar energy. Besides heat energy, ultraviolet, gamma rays and visible light also come from solar energy.
- Length of a wave or separation between two points in successive waves which are in the same phase is called **wavelength**. It is expressed in metre.

- **Solar cell** is a device which converts solar energy *i.e.*, light energy directly into electricity. They are made up of semi-conductors like–silicon, germanium and selenium.
- **Solar cell panel** comprises a large number of solar cells and can provide much higher power for many uses.
- The blowing wind has energy which is called **wind energy**. Wind is associated with kinetic energy. Solar energy is responsible for the blowing of the wind.

  The three factors which help in blowing of wind are :

  (i) The uneven heating of equatorial region and polar region of earth by sun rays.

  (ii) Rotation of earth.

  (iii) Local conditions.
- **Ocean Thermal Energy (OTE)** : There is always a temperature difference between water at the surface and at deeper level upto 20°C. This form of energy is called ocean thermal energy which can be converted into electricity.
- Energy from oceans is also available in the form of sea-waves. Due to blowing of wind on the surface of ocean, very fast sea-waves move on its surface. It has lot of kinetic energy due to high speed.
- The rise of ocean water due to attraction of moon is called '**high tides**' whereas fall of ocean water is called '**low tides**'. The tidal waves rise and fall twice a day. Tidal energy can be harnessed by constructing a tidal barrage or tidal dam.
- The heat from inside the earth heats up the water below the surface. This hot water can be used under favourable conditions as a source of energy. This energy with hot water below the earth is called geothermal energy.
- **Atomic mass unit** is defined as $\frac{1}{12}$ th of the mass of carbon atom $^{12}_{6}C$. 1 amu = 1.66×10^{-27} kg.
- Unit for energy is associated with electrons accelerated through a potential of 1 volt.

  1 eV = 1.6×10^{-19} joule, 1 MeV = 1.6×10^{-13} joule.
- According to Einstein, the mass and energy are inter-convertible. They are related by the relation $E = mc^2$, where c is the velocity of light. (3×10^8 ms^{-1}).
- When nuclear fission reaction takes place, it also releases neutrons which are capable of creating further fission. For continuous production of energy, fission should be continuous. The neutrons released are made to bombard other uranium nuclei to produce more fission. Such self-sustained reactions are called chain reactions.
- In order to make a chain reaction possible, there should be sufficient ^{235}U nuclei. The minimum mass of fissionable material required in order to make a chain reaction possible is called critical mass.

Know the Terms

- **Fossil fuels :** The fuels which are obtained from the remains of plants and animals are called fossil fuels, *e.g.*, coal, petroleum and natural gas.
- **Biomass :** The material contained in the bodies of plants and animals is called biomass. It acts as a fuel.
- **Bagasse :** It is the residue of sugarcane after extracting (taking out) juice from them. It is used as fuel in industries.
- **Conventional or Non-Renewable Sources** : Energy sources which are used traditionally for many years and are about to deplete over a period of time are called conventional or non-renewable sources. *e.g.*, coal, petroleum, natural gas etc.
- **Non-Conventional or Renewable Sources :** Energy sources which do not deplete and are scarcely used by the population are called non-conventional or renewable sources *e.g.*, Solar energy, wind energy etc.
- **Solar constant :** The amount of solar energy received per square meter per second on the surface of earth is called solar constant. It is approximately 1.4 (kJ/m^2s).
- **Wavelength :** Length of a wave or separation between two points in successive waves which are in same phase is called wavelength. It is expressed in meter.
- **Frequency :** The number of wave motions in one second is called frequency. It is expressed in Hertz (Hz).
- **Electric motor :** An electric motor is a rotating device that converts electrical energy to mechanical energy.
- **Generator :** A generator is the machine that converts mechanical energy into electrical energy. It works on the basis of electromagnetic induction.
- **Threshold energy :** The projectile (say neutron) should have some minimum energy, in order to create fission. This minimum energy is called **threshold energy**.
- **Nuclear fission :** The action in which a heavy nucleus splits into two or more smaller nucleus, with the evolution of large amount of energy when it is bombarded with slow moving neutron is called **nuclear fission**.
- **Critical mass :** The minimum mass of fissionable material required in order to make a chain reaction possible is called **Critical mass**. The Critical mass of ^{235}U is approximately 1 kg.

- **Nuclear fusion reaction :** A reaction in which two or more lighter nuclei fuse to form a heavy nucleus and large amount of energy is given out is called nuclear **fusion reaction**.
- **Radioactivity :** The phenomena of emission of α, β particles and γ rays by unstable heavier nuclei is called **radioactivity**.

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Chapter - 15 : Our Environment

Quick Review

- Our environment is composed of various biotic and abiotic factors which interact with each other. Human activities have a great impact on the functioning of the environment.
- Ecosystem is the structural and functional unit of biosphere, comprising of all the interacting organisms in an area together with the non-living constituents of the environment.
- The size of an ecosystem ranges in size from as small as a pond or a backyard garden to as large as an entire rain forest.
- The biotic factors may be classified as producers, consumers and decomposers depending on their mode of nutrition.
- The food manufactured by the producers from simple inorganic substance is utilised by consumers.
- Abiotic component means the non-living part of the environment *i.e.,* air, water, soil and minerals, the climatic or physical factors such as sunlight, temperature, rainfall, humidity, pressure and wind etc.
- The food manufactured by the producers from simple inorganic substances is utilized directly or indirectly by the consumers.
- Herbivores, carnivores, omnivores and parasites are the various type of consumers.
- **Consumers** are those organisms which depend upon the producers for food, either directly or indirectly by feeding on other consumers for their sustenance. They are also called heterotrophs.
- **Parasites** are those organisms that live on (ectoparasites) or in (endoparasites) the body of another organism, *i.e.*, host from which it obtain its nutrients, *e.g.*, parasites of man includes fleas and lice.
- **Decomposers** are those micro-organisms that obtain energy from the chemical break down of dead organisms or animals or plant wastes. Decomposers break down the complex organic substances into simple inorganic substances that go into the soil and are used up once more by the plants.
- **Food chain** is sequence of organisms through which energy is transferred in the form of food by the process of one organism consuming the other.

  Examples :

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

- **Trophic levels** are the various steps or levels in the food chain where transfer of food or energy takes place. Producers are the first trophic level, herbivores are second trophic level, carnivores or secondary consumers are third trophic level and large carnivores or tertiary consumers are the fourth trophic level.
- **Food web** is the network of various food chains which are interconnected at various tropic levels. Since an organism can occupy position in more than one food chain, in a food web it occupies more than one trophic level.
- The flow of energy through different steps in the food chain is unidirectional. This means that energy captured by autotroph does not revert back to the solar input and it passes to the herbivores.➢ About 1% of solar energy falling on leaves is utilized by plants in photosynthesis to produce food. A large amount of energy loss occurs when the organisms of the higher trophic level feeds on the lower trophic level organisms.
- There is only 10% flow of energy from one trophic level to the next higher level. Due to this energy loss, only 4 or 5 trophic levels are present in each chain. It is known as Ten percent law.
- Large amount of energy is lost in the form of heat maintaining metabolic activities at different trophic levels. The amount of heat lost is generally 90 percent and the amount of energy retained is 10 percent by every trophic level.
- Pesticides refers to a chemical that is used to kill a pest organism which includes insecticides, weedicides, fungicides, nematicides and rodenticides.
- **Biological magnification** refers to the process of increase in the concentration of a toxic chemical with increasing trophic level in a food chain. Harmful or poisonous substance such as DDT sprinkled to kill pest on plants enter the food chain.
- Ozone (O_3) is an isotope of oxygen *i.e.*, it is a molecule formed by three atoms of oxygen. Ozone performs an essential function of shielding the surface of the earth from ultraviolet radiation of the sun.

$$O_2 + O \longrightarrow O_3$$

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

Know the Terms

- **Environment :** It is the sum total of all external conditions that affect the life and development of an organism, *i.e.* the environment includes all the physical or abiotic and biological or biotic factors.
- **Biodegradable substances :** Those substances which are broken down into simpler, harmless substances in nature in due course of time by the biological processes such as action of micro-organisms.
- **Non–Biodegradable substances :** Those substances which cannot be broken down into simpler, harmless substances in nature. These substances may be in solid, liquid or gaseous form and may be inert and accumulate in the environment or may concentrate in the food chain and harm the organisms.
- **Ecosystem :** It is the structural and functional unit of biosphere, comprising of all the interacting organisms in an area together with the non–living constituents of the environment. Thus, an ecosystem is a self sustaining system where energy and matter are exchanged between living and non-living components.
- **Producers :** Those organisms which produce food by photosynthesis *i.e.* organisms which can make organic compounds like sugar and starch from inorganic substances using the radiant energy of the sun in presence of chlorophyll.
- **Consumers :** Those organisms which depend upon the producers for food, either directly or indirectly by feeding on other consumers for their sustenance. Consumers therefore, feed upon those below it in a food chain and are called heterotrophs.
- **Decomposers :** They are those micro-organisms that obtain energy from the chemical breakdown of dead organisms or animals or plant wastes. These micro-organisms are decomposers as they breakdown the complex organic substances into simple inorganic substances that go into the soil and are used up once more by the plants.
- **Food Chain :** It is the sequence of organisms through which energy is transferred in the form of food by the process of one organism consuming the other.
- **Trophic Levels :** These are the various steps or levels in the food chain where transfer of food or energy takes place. The producers or autotrophs are the first trophic level, the herbivores or primary consumers are the second trophic level, the carnivores or secondary consumers are the third trophic level and the large carnivores or tertiary consumers are the fourth trophic level of the food chain.
- **Food Web :** It is the network of various food chains which are interconnected at various trophic levels. Since, an organism can occupy position in more than one food chain, in a food web it occupies more than one trophic level.
- **Flow of Energy :** The flow of energy through different steps in the food chain is unidirectional. This means that energy captured by autotroph does not revert back to the solar input and it passes to the herbivores. It moves progressively through various trophic levels.

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Chapter - 16 : Sustainable Management of Natural Resources

Quick Review

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

- Sustainable development is the development which can be maintained for a long time without undue damage to the environment.
- The objective of sustainable development is to provide the economic well being to the present and the future generations and to maintain a healthy environment and life support system.
- Pollutant is the substance that causes a harmful change in the environment, thereby producing adverse effects on living organisms. Some of the common pollutants include pesticides, industrial wastes and emissions, exhaust fumes from vehicles and sewage.
- We can save environment by using 3 R's, *i.e.*, 'Reduce, Recycle and Reuse' in our lives.
- Reduce means 'to use less' *i.e.*,
  (i) By switching off unnecessary lights and fans to save electricity.
  (ii) By repairing leak taps to save water.
  (iii) By not wasting food.
- Recycle means to collect plastics, paper, glass and metal items and recycle these materials to make required things. In order to recycle, firstly segregation of waste is necessary so that materials which can be recycled are not dumped along with other wastes.
- Reuse means to use things again and again.
  (i) The used envelopes can be reversed and used again instead of throwing away.
  (ii) The plastic bottles of food items such as jam or pickle can be used for storing things in the kitchen.
- Biodiversity is the existence of a wide variety of species of plants, animals and micro-organisms in a natural habitat within a particular environment or of genetic variation within a species.
- Forest is a 'biodiversity hotspot' because it is an area where number of species or range of different life form exists.
- Wildlife means all those naturally occurring animals, plants and their species which are not cultivated, domesticated and tamed.
- Conservation is the sensible use of the earth's natural resources in order to avoid excessive degradation and betterment of the environment.
- Afforestation is the practice of transforming an area into forest, usually when trees have not grown there, and involves three types of forestry programmes.
- Social and environmental forestry involves raising of trees for firewood, fodder, agricultural implements for the benefits of rural and tribal community.
- Agro-Forestry is an absolute commercial forestry developed to fulfil the need of various forest-based industries. It is done on the fallow land or free-grazing lands.
- Water is a basic necessity for all terrestrial forms of life.
- Large dams ensure the storage of adequate water for irrigation and for generating electricity.
- Coal and petroleum are non-renewable natural resources.
- Urban forestry involves growing of ornamental trees along roads, vacant lands and common parts of urban areas.
  (i) Large reservoirs of petroleum have been preserved by nature of millions of years between porous rocks beneath the earth.
  (ii) Non-renewable energy sources are energy sources which be replaced easily when they get exhausted and are also called conventional sources of energy. They are used traditionally for many years and take millions of years to form fossil fuels.
  (iii) The fossil fuels, coal and petroleum get exhausted and their combustion pollutes our environment, so a judicious use of these resources is necessary.
- **Harmful effects of using fossil fuels are :**
  (i) Combustion of coal and hydrocarbons release a large amount of harmful gases like carbon monoxide, carbon dioxide, sulphur dioxide, oxides of nitrogen, etc. These cause air pollution and various diseases like respiratory and throat problems congestion etc.
  (ii) Excessive emission of greenhouse gases like carbon dioxide leads to global warming.

Know the Terms

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

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