CLASS 10 - SCIENCE

FORMULA BOOK FOR CBSE BOARD

1. CHEMICAL REACTIONS AND EQUATIONS

➤ **Characteristics of Chemical Reactions :**

- change in state
- change in colour
- evolution of a gas
- change in temperature
- formation of a precipitate

➤ **Types of Chemical Reactions :**

– **Combination reactions :**

When two or more substances (elements or compounds) combine to form a single product, the reactions are called **combination reactions.**

$$\underset{\text{Carbon}}{C_{(s)}} + \underset{\text{Oxygen}}{O_{2(g)}} \longrightarrow \underset{\text{Carbon dioxide}}{CO_{2(g)}}$$

– **Decomposition reactions :**

When a single reactant breaks down to give two or more simpler products, the reactions are called **decomposition reactions**. Decomposition reactions require energy either in the form of heat, light or electricity for breaking down the reactants.

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

$$\underset{\text{Limestone}}{CaCO_{3(s)}} \xrightarrow{\text{Heat}} \underset{\text{Quick lime}}{CaO_{(s)}} + CO_{2(g)}$$

When a substance in the molten state or in aqueous solution is decomposed by passing electric current, it is called **electrolytic decomposition reaction or** simply **electrolysis**.

$$\underset{\text{Water}}{2H_2O_{(l)}} \xrightarrow{\text{Electric current}} \underset{\text{Hydrogen}}{2H_{2(g)}} + \underset{\text{Oxygen}}{O_{2(g)}}$$

When a substance is decomposed by absorbing light energy, it is called **photodecomposition reaction** or simply **photolysis**.

$$\underset{\substack{\text{Silver chloride}\\\text{(White)}}}{2AgCl_{(s)}} \xrightarrow{\text{Sunlight}} \underset{\substack{\text{Silver}\\\text{(Grey)}}}{2Ag_{(s)}} + \underset{\text{Chlorine}}{Cl_{2(g)}}$$

– **Displacement reactions :**

The chemical reactions in which one element takes the position or place of another element present in a compound are called **displacement reactions**.

These reactions occur mostly in solution form and a more active metal displaces or removes less active metal from its salt solution.

$$\underset{\text{Zinc}}{Zn_{(s)}} + \underset{\substack{\text{Copper}\\\text{sulphate}}}{CuSO_{4(aq)}} \longrightarrow \underset{\substack{\text{Zinc}\\\text{sulphate}}}{ZnSO_{4(aq)}} + \underset{\text{Copper}}{Cu_{(s)}}$$

– **Double displacement reactions :**

Reactions in which there is an exchange of ions between the reactants are called **double displacement reactions.**

$$\underset{\text{Silver nitrate}}{AgNO_{3(aq)}} + \underset{\substack{\text{Sodium}\\\text{chloride}}}{NaCl_{(aq)}} \longrightarrow \underset{\substack{\text{Silver chloride}\\\text{(White ppt.)}}}{AgCl_{(s)}} + \underset{\text{Sodium nitrate}}{NaNO_{3(aq)}}$$

– **Precipitation reactions :**

Reaction that produces a precipitate is called a **precipitation reaction**.

The insoluble substance formed is known as a **precipitate**.

$$\underset{\substack{\text{Lead}\\\text{nitrate}\\\text{(Colourless)}}}{Pb(NO_3)_{2(aq)}} + \underset{\substack{\text{Potassium}\\\text{iodide}\\\text{(Colourless)}}}{2KI_{(aq)}} \longrightarrow \underset{\substack{\text{Lead}\\\text{iodide}\\\text{(Yellow ppt.)}}}{PbI_{2(s)}} + \underset{\substack{\text{Potassium}\\\text{nitrate}}}{2KNO_{3(aq)}}$$

➤ **Oxidation and reduction Reactions :**

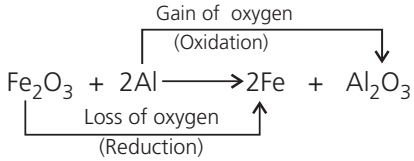
– Reactions in which one reactant gets oxidised while the other gets reduced are called **oxidation-reduction reactions** or **redox reactions.**

– **Oxidation** is defined as the **addition of oxygen** to a substance or **removal of hydrogen** from a substance in a chemical reaction.

– **Reduction** is defined as the **addition of hydrogen** to a substance or **removal of oxygen** from a substance in a chemical reaction.

– The substance which either gives oxygen or gains hydrogen in a reaction, is known as an **oxidising agent**.

– The substance which either gives hydrogen or gains oxygen in a reaction, is known as a **reducing agent**.



Fe_2O_3 — Oxidising agent

Al — Reducing agent

➤ **Exothermic and Endothermic Reactions :**

– **Exothermic reactions :** Reactions in which heat is released along with the formation of products are called **exothermic reactions.**

– **Endothermic reactions :** Reactions in which energy is absorbed during the chemical reaction are known as **endothermic reactions**.

2. ACIDS, BASES AND SALTS

COLOURS OF SOME COMMON INDICATORS IN ACIDIC AND BASIC SOLUTIONS

Nature of substance	Indicators						
	Blue litmus	Red litmus	Methyl orange	Phenolphthalein	Turmeric	China rose	Red cabbage
Acidic	Red	No change	Red	Colourless	No change	Dark pink	Red
Basic	No change	Blue	Yellow	Pink	Red	Green	Green

➤ Chemical properties of Acids and Bases

Metal + Dilute acid → Metal salt + Hydrogen

Metal carbonate/Metal hydrogencarbonate + Acid → Salt + Carbon dioxide + Water

Neutralization reaction :

Base + Acid → Salt + Water

Metallic oxides are basic oxides :

Metal oxide + Acid → Salt + water

Non-metallic oxides are acidic oxides

Non-metallic oxide + Base ⟶ Salt + Water

➤ **pH scale**

pH can be defined as logarithm of reciprocal of H_3O^+ ions in aqueous solution.

or

$$pH = \log \frac{1}{[H_3O^+]} \quad \text{or} \quad pH = -\log [H_3O^+]$$

or $[H^+] = 10^{-pH}$

In pH scale, less is the value of pH more is the acidic nature of the substance. In pH scale :

– pH = 0-7, Acids

– pH = 7, Neutral

– pH = 7-14, Bases

Some Important Acids, Bases and Salts

➤ **Sodium Hydroxide :**

– **Chemical formula :** NaOH, **Common name:** Caustic soda, **Action on litmus :** Turns red litmus blue, **Solubility :** Soluble in water (Highly alkaline)

➤ **Bleaching Powder :**

– **Chemical formula :** $CaOCl_2$ (Actual composition is quite complex), **Chemical name :** Calcium oxychloride, **Solubility :** Soluble in water

➤ **Baking Soda :**

– **Chemical formula :** $NaHCO_3$, **Chemical name :** Sodium hydrogencarbonate or Sodium bicarbonate, **Action on litmus :** Turns red litmus blue, **Solubility :** Sparingly soluble in water (Weakly basic)

➤ **Washing Soda :**

– **Chemical formula :** $Na_2CO_3 \cdot 10H_2O$, **Chemical name :** Sodium carbonate decahydrate, **Action on litmus :** Turns red litmus blue, **Solubility :** Sparingly soluble in water (Weakly basic)

➤ **Water of Crystallization :**

– It is the fixed number of water molecules present in one formula unit of a salt.

Name	Formula
Hydrated copper sulphate	$CuSO_4 \cdot 5H_2O$
Washing soda	$Na_2CO_3 \cdot 10H_2O$
Gypsum	$CaSO_4 \cdot 2H_2O$
Plaster of Paris	$CaSO_4 \cdot \frac{1}{2}H_2O$
Zinc sulphate	$ZnSO_4 \cdot 7H_2O$
Magnesium sulphate	$MgSO_4 \cdot 7H_2O$

3. METALS AND NON-METALS

COMPARISON OF PHYSICAL PROPERTIES OF METALS AND NON-METALS

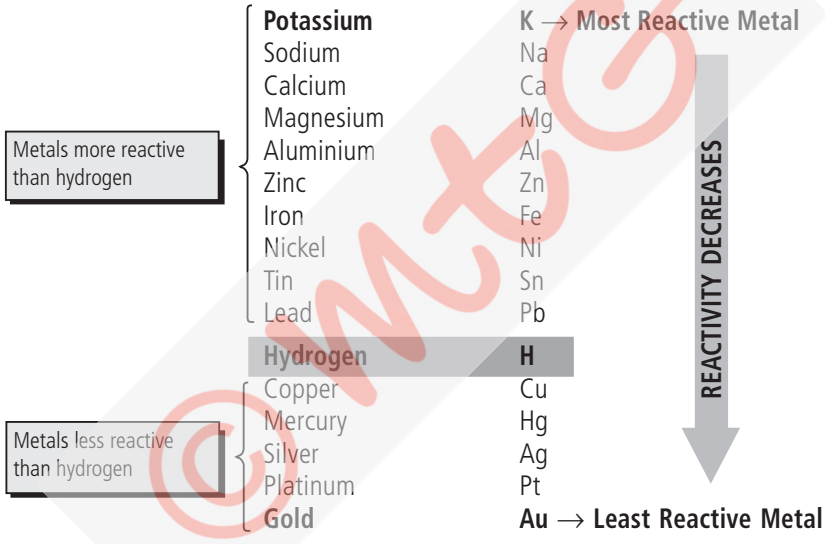
Property	Metals	Non-metals
Physical state	Metals are generally solids (except mercury and gallium which are liquids) at room temperature.	Non-metals (except bromine which is a liquid) are either solids or gases at room temperature.
Lustre	Metals have lustre and can also be polished.	Non-metals (except iodine and graphite) do not have lustre and also cannot be polished.
Hardness	Metals (except lithium, sodium and potassium) are generally hard.	Non-metals (except diamond and boron) are generally soft.
Malleability and ductility	Metals are malleable (can be hammered into thin sheets) and ductile (can be drawn into wires).	Non-metals are neither malleable nor ductile. They are actually brittle.
Melting points and boiling points	Metals (except mercury and gallium) generally have high melting and boiling points.	Non-metals (except graphite and boron) have low melting and boiling points.
Density	Metals generally have high densities.	Non-metals generally have low densities.
Conductivity	Metals are good conductors of heat and electricity.	Non-metals (except graphite and gas carbon) are bad conductors of heat and electricity.
Sonorosity	Metals are sonorous (*i.e.*, produce sound when hit with a hard object).	Non-metals are non-sonorous (*i.e.*, do not produce any sound when hit with a hard object).

COMPARISON OF CHEMICAL PROPERTIES OF METALS AND NON-METALS

Property	Metals	Non-metals
Nature of ions	Metals are electropositive elements and hence, lose one or more electrons to form positive ions.	Non-metals are electronegative elements and hence, gain one or more electrons to form negative ions.
Nature of oxides	Metals mostly form basic oxides. Some metals such as Zn and Al form amphoteric oxides.	Non-metals form either acidic or neutral oxides.
Reaction with water	Most of the metals displace hydrogen from water or steam.	Non-metals (except fluorine) generally do not react with water or steam.

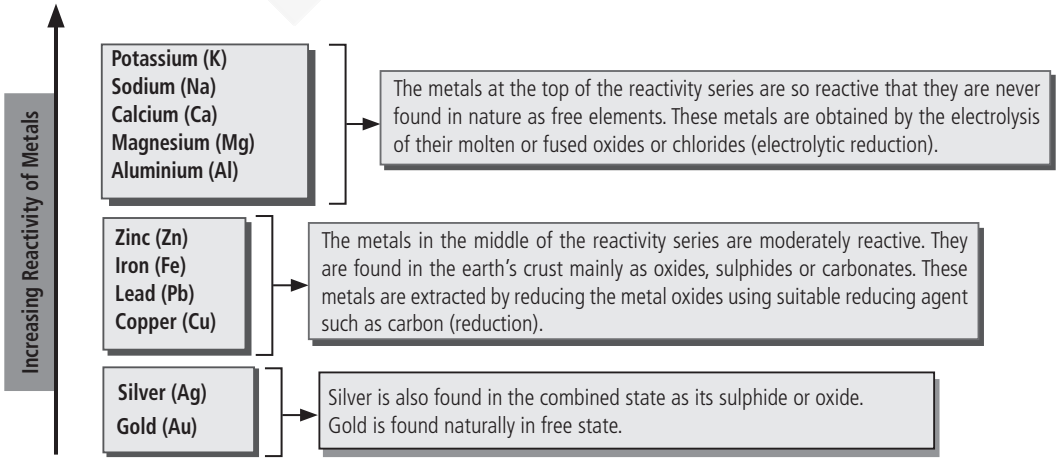
Reaction with dilute acids	Metals which lie above hydrogen in the reactivity series displace hydrogen from dilute acids.	Non-metals do not react with dilute acids and hence, do not displace hydrogen from dilute acids.
Nature of hydrides	Highly electropositive elements (*i.e.*, K, Na, Ca, etc.,) react with hydrogen to form ionic hydrides which are generally unstable.	Non-metals form covalent hydrides which are quite stable.
Nature of chlorides	Metals generally combine with chlorine to form solid ionic chlorides which conduct electricity in the aqueous solution or in the molten state.	Non-metals combine with chlorine to form covalent chlorides. These are either gases or liquids. Non-metal chlorides do not contain ions, therefore, they do not conduct electricity.
Oxidizing and reducing behaviour	Metals have a strong tendency to lose electrons and hence they behave as reducing agents.	Non-metals have a strong tendency to accept electrons and hence they behave as oxidizing agents.

➤ The **reactivity series** is a list of metals arranged in the order of their decreasing activities.

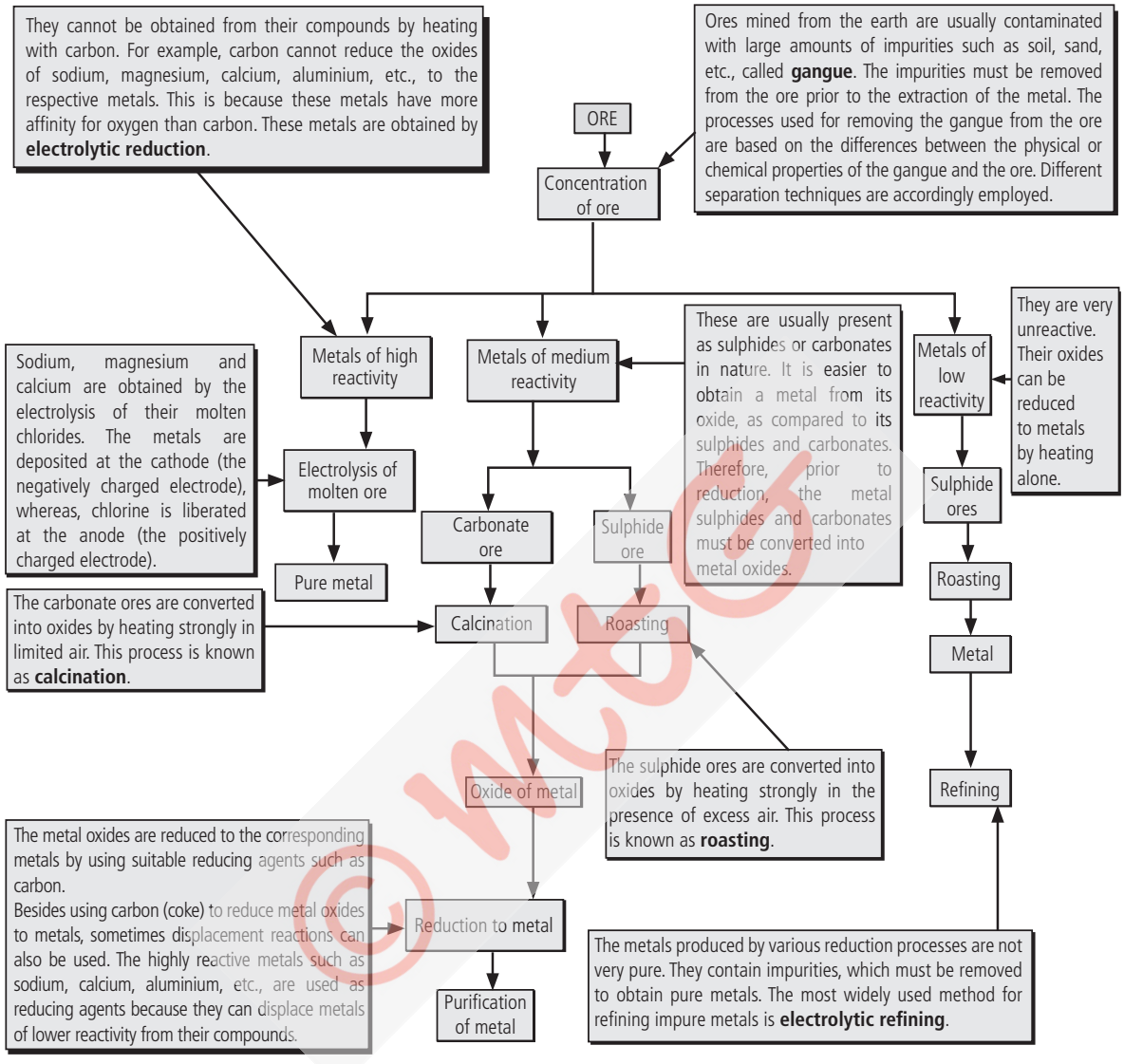


➤ **Extraction of Metals :**

– The position of a metal in the reactivity series determines the method used for its extraction.



– **Several steps are involved in the extraction of pure metal from ores :**



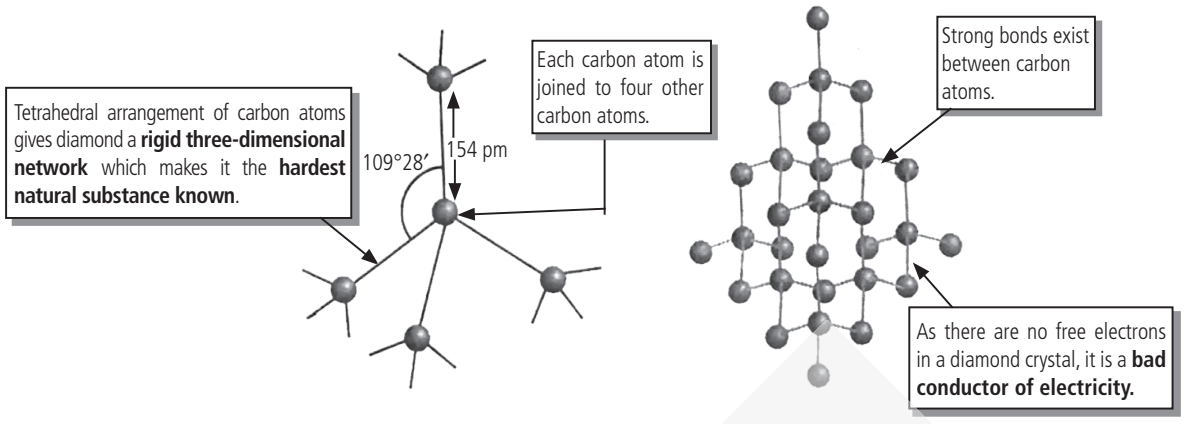
4. CARBON AND ITS COMPOUNDS

➤ Comparison of Properties of Ionic and Covalent Compounds :

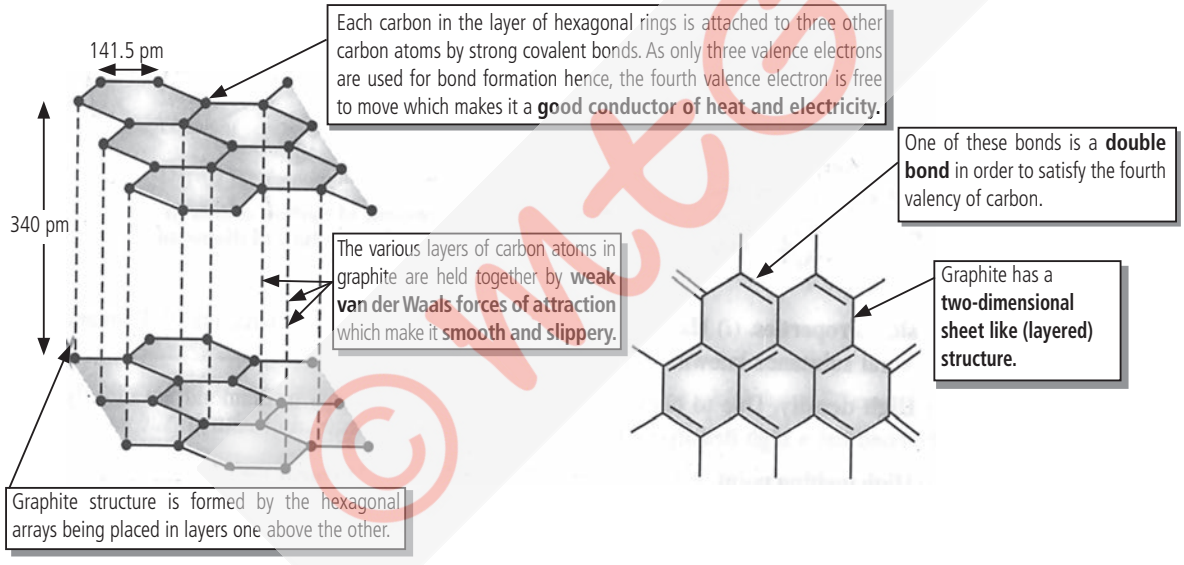
Covalent compounds	Ionic Compounds
1. They consist of true molecules.	They do not have true molecules, but are aggregates of + ve and – ve ions.
2. They are usually gaseous or liquids or soft solids.	They are usually crystalline solids.
3. They have low melting and boiling points.	They have usually high melting and boiling points.
4. They are usually soluble in organic solvents.	They are usually insoluble in organic solvents.
5. They are usually insoluble in water.	They are usually soluble in water.
6. They are bad conductors of electricity in aqueous solution or in molten form.	Their aqueous solutions are good conductors of electricity. They also conduct electricity in molten state.

➤ Allotropes of Carbon :

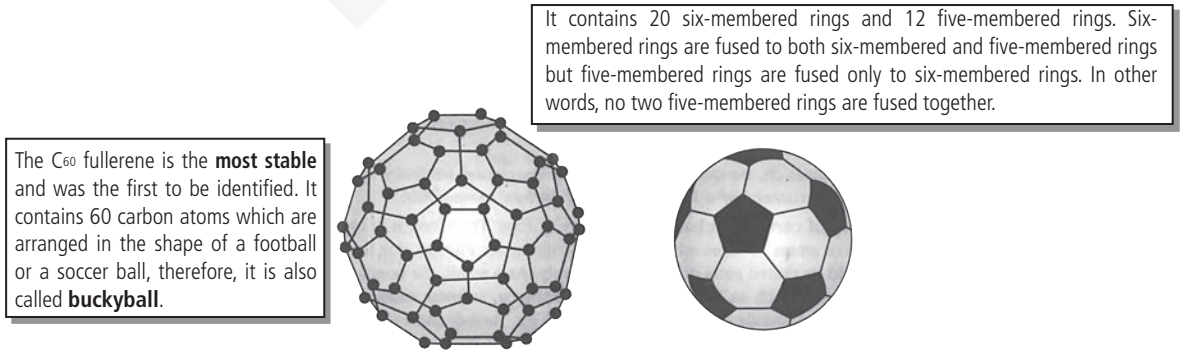
DIAMOND



GRAPHITE

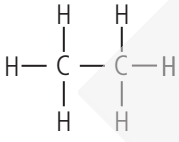
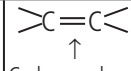
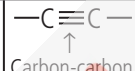


FULLERENES

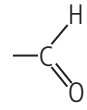
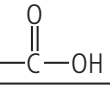


➤ **Differences between Diamond and Graphite :**

Diamond	Graphite
1. Diamond has three dimensional rigid structure.	Graphite has layer structure. The layers can slip over one another.
2. Diamond is hard. It is hardest substance known.	Graphite is soft and greasy.
3. Diamond is a bad conductor of electricity but good conductor of heat.	Graphite is a good conductor of both electricity and heat.
4. Diamond has very high density (3.514 g/cm^3).	Graphite is less dense (density = 2.226 g/cm^3) than diamond.
5. Diamond is a transparent substance.	Graphite is an opaque.

	Alkanes	Alkenes	Alkynes
Functional group	Alkanes do not have any functional group. They have only C — C and C — H bonds. 	 Carbon-carbon double bond	 Carbon-carbon triple bond
General formula	C_nH_{2n+2}	C_nH_{2n}	C_nH_{2n-2}
Example	Methane, ethane, propane, etc.	Ethene, propene, butene, etc.	Ethyne, propyne, butyne, etc.

Some functional groups in carbon compounds

Heteroatom	Functional group	Formula of functional group
Cl/Br/I	Halo- (Chloro/ Bromo/Iodo)	—Cl, —Br, —I (substitutes for hydrogen atom)
Oxygen	1. Alcohol	—OH
	2. Aldehyde	
	3. Ketone	
	4. Carboxylic acid	

➤ **Nomenclature of Carbon Compounds :**

– The name of an organic compound is divided into two parts :

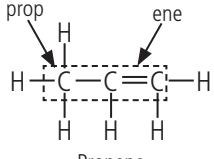
– The first part (prefix) tells us the number of carbon atoms in a compound.

First part of the name	meth-	eth-	prop-	but-
Number of carbon atoms in a compound	one	two	three	four

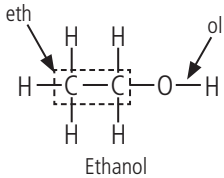
– The second part (suffix) of the name tells us the homologous series of the compound.

Name of ending	-ane	-ene	-yne	-ol	-al	-one	-oic acid
Homologous series	alkane	alkene	alkyne	alcohol	aldehyde	ketone	carboxylic acid

Examples :



Propene



Ethanol

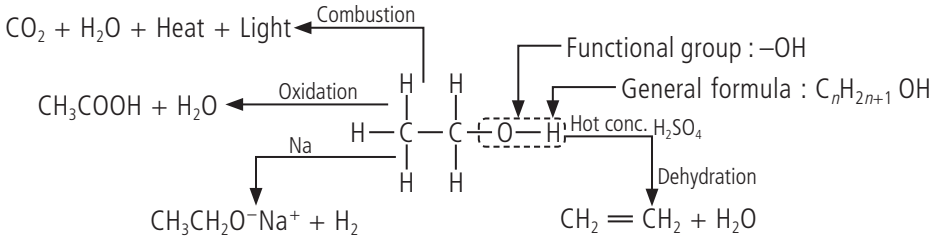
If functional group is halogen we use prefix as chloro, bromo, etc.

Thus, propene is an alkene with three carbon atoms and ethanol is an alcohol with two carbon atoms.

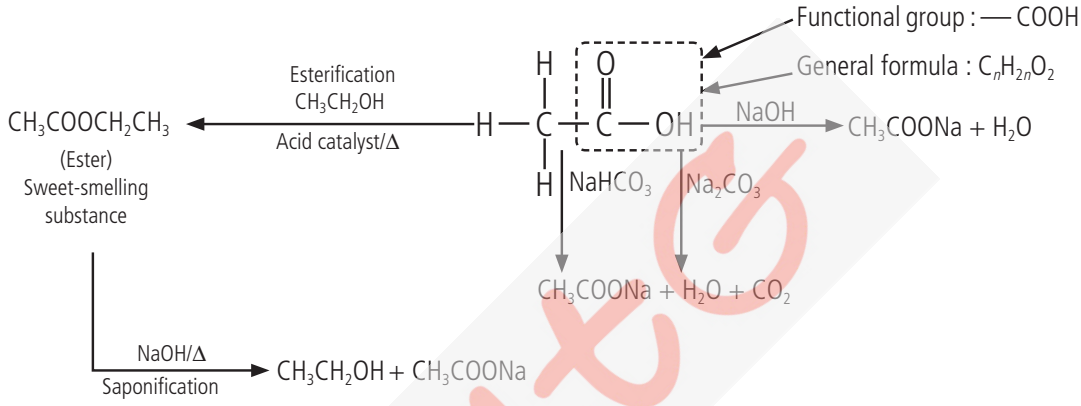
➤ **Chemical properties of Carbon Compounds :**

– Combustion
– Oxidation
– Addition Reaction
– Substitution Reaction

➤ **Properties of Ethanol :**



➤ **Properties of Ethanoic Acid :**



5. PERIODIC CLASSIFICATION OF ELEMENTS

➤ **The Modern Periodic Table :**

– Position of Elements in the Modern Periodic Table

The groups – The Modern Periodic Table has 18 vertical columns known as **groups**.

- The elements in a group have similar properties.
- They have similar properties because their atoms have the same number of valence electrons.

Group	I	II	III	IV	V	VI	VII	0
Number of valence electrons	1	2	3	4	5	6	7	8 (or 2)

- The group number is the same as the number of valence electrons except for group 0, where the 0 tells that the atoms have a stable arrangement of 8 valence electrons (or 2 for helium).
- Groups in the periodic table signify an identical outershell electronic configuration. On the other hand, the number of shells increases as we go down the group.

The periods – The Modern Periodic Table has 7 horizontal rows known as **periods**.

- As you go along a period from left to right, the number of valence shell electrons increases by one unit.
- Atoms of different elements with the same number of occupied shells are placed in the same period.
- The elements in a period do not have similar properties. Infact, there is a trend (gradual change) in properties from metal to non-metal along the period from left to right.
- The properties change because the number of valence electrons increases.

The zig-zag line
• This separates the metals from the non-metals, having metals on the left hand side. (There are far more metals than non-metals.) • The elements in groups I and II are all metals; those in groups VII and 0 are all non-metals. • There is a change from non-metal to metal as we go down the group, in groups III to VI. (The zig-zag line goes through these groups.)

➤ **Variation of Properties in a Group and a Period :**

The properties of elements across a period and down a group can be summarised as follows.

Properties	Variation in a Group	Variation in a Period
• Valence electrons	Remains same	Increases
• Valency	Remains same	Increases from 1 to 4 then decreases from 4 to 1
• Metallic character	Increases	Decreases
• Non-metallic character	Decreases	Increases
• Electropositive character	Increases	Decreases
• Atomic size	Increases	Decreases
• Ionisation energy	Decreases	Increases
• Electron negativity	Decreases	Increases

6. LIFE PROCESSES

	Autotrophic nutrition	Heterotrophic nutrition
1.	It occurs in green plants, some bacteria and in some protists.	It occurs in animals and in plants which lack chlorophyll.
2.	Chlorophyll is necessary for trapping solar energy.	Chlorophyll is absent; as such they do not trap solar energy.
3.	Food is self-manufactured using CO_2 and water as raw materials.	Food is obtained directly or indirectly by consuming autotrophs.
4.	Digestion of food does not occur.	Digestion is required to convert complex organic substances present in food into simpler and soluble forms.
5.	They are placed at the bottom of the food chain as producers.	They are placed above producers in the food chain as consumers.

Table : Differences between light and dark phase

	Light phase	Dark phase
1.	It occurs over thylakoids.	It occurs in matrix of chloroplasts.
2.	The phase is dependent on light.	The phase does not require light.
3.	Temperature has little effect over it.	It is influenced by temperature.
4.	It produces NADPH and ATP (assimilatory power).	It consumes NADPH and ATP.
5.	Oxygen is evolved.	Glucose is the end product.

Table : Differences between inhalation and exhalation

	Inhalation (Inspiration)	Exhalation (Expiration)
1.	Intercostal muscles of the ribs contract pulling the ribs and sternum upwards and outwards.	Intercostal muscles of the ribs relax allowing the ribs and the sternum to return to their original.
2.	The radial muscles of diaphragm contract, and diaphragm is pulled down and flattened.	The radial muscles of diaphragm relax and diaphragm is pushed back to its original dome-like position.
3.	Volume inside the thorax increases.	Volume inside the thorax decreases.
4.	Intrathoracic pressure of the lungs decreases and outside air rich in oxygen rushes in through the nostrils.	Intrathoracic pressure of the lungs increases and the inside air rich in CO_2 and water-vapour is forced out through the nostrils.

- **Blood pressure** is the pressure against the wall of blood vessels produced by the discharge of blood into them by contraction of the left ventricle.
  Blood pressure is generally measured by determining the millimetres of mercury (Hg) displaced in a pressure gauge called **sphygmomanometer.**
- The sound of blood flow can be heard through a **stethoscope.** This sound of blood rushing through the arteries at peak pressure is due to ventricular contraction. This indicates **systolic blood pressure** (120 mm of Hg). A screw is used for releasing pressure, and pressure in cuff continues to drop. The sound fades, until it stops. The reading indicates the **diastolic blood pressure** (80 mm of Hg). The normal blood pressure of a human being is written as $\frac{120}{80}$.

Table : Differences between blood and lymph.

	Characteristic	Blood	Lymph
1.	Colour	Red in colour	Colourless
2.	Components	• Consists of plasma, erythrocytes, leucocytes and platelets. • Contains several plasma proteins and high concentration of calcium and phosphorus.	• Consists of plasma and leucocytes only. • Contains fewer plasma proteins and low concentration of calcium and phosphorus.
3.	Flow	Flow rapidly.	Flow is very slow.
4.	Direction of flow	Path of circulation is heart to body organs and from body organs back to heart.	Path of circulation is body tissues to heart.

	Aerobic respiration	Anaerobic respiration
1.	Takes place in presence of oxygen.	Take place in absence of oxygen.
2.	Its end products are carbon dioxide and water.	Its end products are ethanol and carbon dioxide.
3.	More energy is released.	Less energy is released.
4.	It takes place in cytoplasm and mitochondria.	It takes place only in the cytoplasm.
5.	Complete oxidation of glucose takes place.	Incomplete oxidation of glucose takes place.

- In the **kidney,** the wastes are converted in urine by three processes :

(i) **Ultrafiltration :** In it, large amount of water along with certain harmful substances like urea, uric acid, K^+, ammonium salts, creatinine, etc. and certain useful substances like glucose, amino acids, Na^+, etc. pass through glomerular capillaries and glomerular membrane into cavity of Bowman's capsule of nephrons under pressure. The filtrate so formed is called nephric filtrate which is moved towards ureter.

(ii) **Selective reabsorption :** In it, large amount of water and sodium; whole of glucose and amino acids and small amount of urea are passed back from nephric filtrate into blood capillaries. It occurs either by back diffusion (*i.e.* water and urea) or active transport (*i.e.* Na^+, glucose and amino acids). It generally occurs in PCT of nephrons.

(iii) **Tubular secretion :** In this, certain harmful chemicals like uric acid, creatinine, K^+, etc. are passed from blood capillaries surrounding the nephron into nephric filtrate by active transport. It generally occurs in DCT of nephrons.

Now, the fluid is termed as **urine** and is excreted out of the excretory organs.

7. CONTROL AND COORDINATION

- **Nervous system** in humans consists of three parts:

(i) **Central nervous system** (CNS) consisting of brain and spinal cord. The brain and spinal cord receive information from all parts of the body and integrate it.

(ii) **Peripheral nervous system** (PNS) consisting of nerves that arise from brain (cranial nerves) and from spinal cord (spinal nerves). Through the nerves, the nervous system communicates with the muscles.

(iii) **Autonomic nervous system** (ANS) made up of parasympathetic and sympathetic nervous systems. Though connected with the CNS, it works independently and regulates involuntary activities of the body like heart beat, and peristaltic movements of alimentary canal.

- The central nervous system (CNS) in human beings consists of the **brain** and **spinal cord.** Brain is the highest coordinating centre in the body. The brain is broadly divided into three regions: **fore brain, mid brain,** and **hind brain.** Fore brain includes cerebrum and olfactory lobes. Mid brain connects the fore brain to hind brain. Hind brain consists of three parts called cerebellum, pons and medulla oblongata.

  Spinal cord is a cylindrical structure and a part of the CNS. It begins in continuation with medulla oblongata and extends downwards, enclosed within vertebral column.

Table : Types of plant hormones

	Plant hormones	Physiological effects on plant growth and development
1.	Auxin	Promotes cell division, root formation, control apical dominance.
2.	Gibberellins	Stimulates cell division, cell elongation, counteract dormancy, induce flowering, bring about increase in size of fruits, flower, etc.
3.	Cytokinins	Induce and control cell enlargement, cell differentiation, delay aging, break dormancy.
4.	Ethylene	Induce fruit ripening, flowering, break dormancy.
5.	Abscisic Acid (ABA)	Inhibits growth, reverse the growth providing effects of auxins and gibberellins.

Table : Types of endocrine glands

Endocrine glands and their locations	Hormones secreted	Principal functions
NECK & CHEST REGION **1. Thyroid gland** • It is situated in the neck region on the ventral side of the body. It has two lateral lobes, one on either side of the trachea.	**(a)** Thyroxine or T_4 **(b)** Triiodothyronine or T_3 **(c)** Calcitonin.	T_3 & T_4 stimulates the rate of cellular oxidation and metabolism. Calcitonin lowers calcium level when by suppressing release of calcium ions from the bones, calcium level is high in blood.
2. Parathyroid gland • These are four small oval bodies which lie embedded in the lobes of the thyroid gland.	Parathyroid hormone (PTH) or parathormone.	Regulates calcium and phosphate levels in the blood. When blood calcium level is below normal, it mobilises the release of calcium into the blood from bones. **It has an action opposite to that of calcitonin on calcium metabolism.**
3. Thymus gland • It is situated in the upper chest near the front side of the heart. • It **atrophies in the adult**.	Thymosin	Stimulates the development and differentiation of lymphocytes (white blood cells).
ABDOMINAL REGION **4. Adrenal gland** • In human beings, a pair of adrenal glands are present, one on top of each kidney, so, also called suprarenals. Each adrenal gland has an outer part called the **cortex** and an inner part, **medulla**.		
(i) Adrenal cortex • It secretes 3 groups of steroid hormones.	**(a)** Glucocorticoids **(b)** Mineralocorticoids (Aldosterone)	Regulates the metabolism of protein, fats and carbohydrates in the body and the level of blood sugar. Regulates heart rate and blood pressure. Regulates water and mineral balance in body.

	(c) Sex corticoids	Stimulates the development of secondary sexual characters both in males and females.
(ii) Adrenal medulla • It secretes 2 hormones.	Adrenaline (Epinephrine) and Nor-adrenaline (Nor-epinephrine)	Both these hormones together control emotions, fear, anger, blood pressure, heart beat, respiration and relaxation of smooth muscles.
5. Pancreas • It is a compound gland in the abdominal region located posterior to the stomach. Its **endocrine part is Islets of Langerhans**, which secretes 2 hormones.	**(a)** Insulin	Regulates the conversion of glucose to glycogen; *i.e.*, it lowers blood glucose level.
	(b) Glucagon	Regulates the conversion of glycogen back to glucose *i.e.*, it increases blood glucose level.

	Endocrine gland	Exocrine gland	Heterocrine gland
1.	These are ductless.	These have ducts.	Partly exocrine part with duct and partly endocrine or ductless part.
2.	These secrete hormones generally into the blood-stream. *E.g.*, thyroid, pituitary, adrenal, etc.	These secrete their secretions in ducts. *E.g.*, liver, salivary and sweat glands.	Exocrine part releases secretions in some duct, while endocrine part secretes hormones into the bloodstream. *E.g.*, pancreas.

- **Reflex arc** is the nerve path involved in a reflex action for quick responses. A message from the receptor is taken by sensory nerves to spinal cord, which sends information for response by a motor nerve to the effector. *E.g.*, touching of hot object by hand.

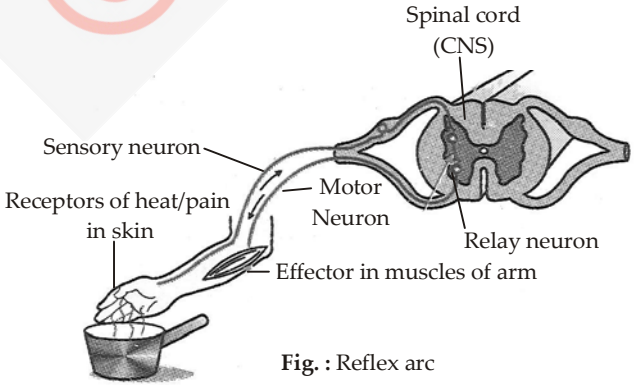


Fig. : Reflex arc

8. HOW DO ORGANISMS REPRODUCE?

Table : Differences between self pollination and cross pollination

Characteristic	Self pollination	Cross pollination
Occurrence	Occurs within a flower or between two flowers of the same plant.	Occurs between two flowers of two different plants of the same species.
Agent of pollination	No external agent of pollination required (usually).	External agents such as wind, water, insects and birds required.
Production of pollen grains	Produced in small numbers, thus no wastage of pollen grains occurs.	Produced in large numbers (usually), thus, wastage of pollen grains occurs.
Appearance of flowers	Flowers are not attractive (usually).	Flowers are attractive with coloured petals.
Fragrance and nectar	Flowers do not (usually) produce scent or nectar.	Flowers generally produce scent and nectar.
Nature of offsprings produced	Offsprings produced have genetic make-up identical to the parent plant, purity of race maintained, no variation occurs.	Offsprings produced may differ in genetic make-up, and variations occur.

- **Methods of contraception**

– **Barrier method:** These are physical devices to prevent the entry of sperm into the female genital tract during copulation. They also protect against sexually transmitted diseases *e.g.*, condoms.

– **Chemical method:** Foam tablets, jellies, pastes, creams and spermicides are some common chemicals used by females. These are placed in vagina. These chemicals adhere to the mucous membrane and immobilise and kill the sperms.

– **Surgical method:** Surgical methods are safe in the long run but they may cause infections and other problems if not done properly. These methods include – (i) **Vasectomy** and (ii) **Tubectomy.**

(i) Vasectomy is a small surgical operation performed in males. It involves removal of a small portion of the sperm duct (or vas deferens) by surgical operation. The two cut ends are then ligated (tied) with threads. This prevents the sperms from coming out.

(ii) Tubectomy is done in females where oviducts are cut and cut ends tied with threads.

9. HEREDITY AND EVOLUTION

	Genetic drift	Natural selection
(i)	It is a sudden and quick process.	It is gradual and slow process.
(ii)	It selects harmful or useful variations by chance.	It selects only adaptatively useful variations.

- Both **connecting** link and **missing** link are intermediate stages between the two groups of organisms. Missing link is referred to such intermediate form which is now extinct, while connecting link is that intermediate form which still exists.

  Example of missing link-*Archaeopteryx* (link between class Reptilia and Aves)

  Example of connecting link-*Peripatus* (link between phylum Annelida and Arthropoda), *Euglena* (connecting link between plants and animals).

	Inherited traits	Acquired traits
1.	These are obtained from the parents.	These are developed during the life of an individual.
2.	These are genetic variations.	These are somatic variations.
3.	These develop due to crossing over phenomenon and mutations.	These develop due to use and disuse of organs and direct effect of environment.
4.	These are passed on from one generation to the other.	These are lost with the death of the individual.

	Artificial selection	Natural selection
1.	It is an artificial process.	It is a natural phenomenon.
2.	It is conducted by man on limited scale in specific laboratories.	It is conducted on large scale all over the earth.
3.	Traits selected for improvement are beneficial to man.	Traits selected for evolution are beneficial to species.
4.	Results are achieved in a short period.	Results are achieved over a long period.

	Homologous organs	Analogous organs
1.	Homologous organs have similar origin and internal structure.	Analogous organ have different origin and anatomy.
2.	Homologous organs perform different functions.	Analogous organs perform similar functions.
3.	Homologous organs are morphologically different.	Analogous organs are morphologically similar.
4.	They give evidence of divergent evolution (*i.e.*, evolution in closely related species to adapt them for different habitat.)	They give evidence of convergent evolution (*i.e.*, evolution in different species to adapt them for similar habitat).

10. LIGHT - REFLECTION AND REFRACTION

➤ Reflection

The phenomenon of bouncing back of light in the same medium after striking the surface is called reflection of light.

➤ Laws of reflection of light :

– **First law :** The incident ray, the reflected ray, and the normal (at the point of incidence), all lie in the same plane.

– **Second law :** The angle of reflection is always equal to the angle of incidence.

➤ Relation between focal length and radius of curvature :

– The focal length of the spherical mirror is equal to half of its radius of curvature, *i.e.*, $f = \frac{R}{2}$.

Position of Images with respect to object concave Mirror

➤ Formation of image by a concave mirror :

	Object position	Image position	Nature of image
(a)	at infinity	at *F*	real, inverted and point sized
(b)	between infinity and the centre of curvature *C*	between *F* and *C*	real, smaller than the object, inverted
(c)	at *C*	at *C*	real, same size of object, inverted
(d)	between *C* and *F*	between *C* and infinity	real, enlarged, inverted
(e)	at *F*	at infinity	real, infinitely large, inverted
(f)	between the pole *P* and *F*	behind the mirror	virtual, enlarged, erect

Position of Images with respect to object convex mirror

➤ Formation of image by a convex mirror:

	Object position	Image position	Nature of image
(a)	between infinity and the pole	between the focus and the pole	virtual, smaller and erect
(b)	at infinity	at the focus	virtual, point-sized

➤ Mirror formula : $\frac{1}{v}+\frac{1}{u}=\frac{1}{f}$, where v = distance of image from mirror,

u = distance of object from mirror,

f = focal length of the mirror.

➤ Magnification (*m*) :

$m = \frac{h_e}{h_o} = \frac{-v}{u}$, where h_e and h_o are heights of image and object.

➤ Refraction

The change in direction of light when it passes from one medium to another obliquely, is called refraction of light.

➤ **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 sine angle of incidence to the sine angle of refraction is constant for a given pair of media.

i.e., $\frac{\sin i}{\sin r} = \text{constant}$ or $\frac{\sin i}{\sin r} = n$,

where n = refractive index.

➤ **Absolute Refractive Index**

Absolute refractive index of a medium is defined as the ratio of the speed of light in vacuum or air to the speed of light in the medium. It is denoted by n.

Then, $n = \frac{\text{speed of light in air}}{\text{speed of light in medium}} = \frac{c}{v}$

It has no unit.

FORMATION OF IMAGE BY CONVEX AND CONCAVE LENSES

	Convex Lens			Concave Lens		
	Position of the object	**Position of the image**	**Nature and size**	**Position of the object**	**Position of the image**	**Nature and size**
(a)	at infinity	at F	real, point-sized	at infinity	at F	virtual, point-sized and erect
(b)	between infinity and $2F$	between F and $2F$	real, diminished inverted	between infinity and O	between F and O	virtual, erect and smaller
(c)	at $2F$	at $2F$	real, same-sized, inverted			
(d)	between $2F$ and F	between $2F$ and infinity	real, enlarged inverted			
➤ One can also say that the image is formed on the side of the object, and is virtual and erect. In fact, this is more practical from the observer's point of view.						
(e)	at F	at infinity	real, infinitely large, inverted			
(f)	between F and O	on the same side of the object	virtual, enlarged erect			

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

where, v and u are image distance and object distance from the lens respectively and f is the focal length of the lens.

➤ **Magnification produced by lenses :**

– **Magnification** $= \frac{\text{height of image}}{\text{height of object}}$ or $m = \frac{h_e}{h_o} = \frac{v}{u}$

➤ **Power of a lens (*P*) :** $P = \frac{1}{f(metre)}$ or $\frac{1}{f}$ dioptre

➤ **Lenses in contact :**

– **Focal length of two lenses :** $\frac{1}{F}=\frac{1}{f_1}+\frac{1}{f_2}$

– **Power of two lenses :** $P = P_1 + P_2$

11. HUMAN EYE AND COLOURFUL WORLD

The human eye works on the refraction of light through a natural convex lens made of transparent living material and enables us to see things around us.

Power of Accommodation

➤ The ability of an eye to adjust the focal length of the eye-lens with the help of ciliary muscles so as to see nearby as well as distant objects is called the power of accommodation.

– Far point of human eye is infinity.

– Near point or least distance of distinct vision of human eye is 25 cm.

Defects of vision and their correction

➤ **Myopia (Short-sightedness) :** Myopia (short-sightedness) is a defect in which a human eye can see nearby objects clearly but is unable to see distant objects distinctly.

– Myopia is corrected by placing a concave lens of appropriate power before the eye.

➤ **Hypermetropia (Long-sightedness) :** Hypermetropia (long-sightedness) is a defect in which a human eye can see far off object clearly, but is unable to see nearby object distinctly.

– Hypermetropia is corrected by placing a convex lens of appropriate power before the eye.

➤ **Presbyopia :** The power of accommodation of the eye usually decreasing with ageing and ciliary muscles lose the capacity to change the focal length of a lens.

– Presbyopia is corrected by placing convex lens of appropriate power before the eye.

➤ **Astigmatism :** Cannot focus on both horizontal and vertical lines simultaneously.

– It can be corrected by using cylindrical lens.

➤ **Dispersion :** Splitting of white light into seven component colours.

➤ **Atmospheric Refraction :**

– Twinkling of stars

– Advanced service and delayed sunset.

– Sun appears oval at sunset and sunrise but circular at noon.

➤ **Scattering of light :** Absorption of light and then re-radiating it in different directions.

➤ **Tyndall effect :** It deals with the phenomenon of scattering of light by colloidal particles.

➤ **Rainbow :** A rainbow is a natural spectrum of sunlight in the form of bows appearing in the sky when the sun shines on raindrops after the rain. The raindrops act like small prisms.

12. ELECTRICITY

➤ Electricity is a controllable and convenient form of energy in homes, hospitals, industries and so on.

➤ **Electric current :** It is the rate of flow of electric charges. i.e., $I = q/t$. SI unit of electric current is Ampere (A).

➤ **Electric potential :** Work done in moving a positive unit charge from infinity to that point.

– $\text{Electric potential} = \frac{\text{Work}}{\text{Charge}}$ or $V = \frac{W}{Q}$

– SI unit of electric potential is volt.

➤ **Potential difference :** Amount of work done in moving a unit positive charge from one point to the other. $V = \frac{W}{Q}$.

– The SI unit of electric potential difference is volt (V).

➤ **Ohm's Law**

At constant temperature, current flowing through a conductor is directly proportional to the potential difference across its ends.

$$R = \frac{V}{I};\ V = IR$$

➤ **Resistance :** Opposition to flow of current.

$R = \rho\frac{l}{A}$ [ρ (rho = resistivity of the conductor]

Resistance of a System of resistors

➤ **Resistors in series :** When a number of resistors are joined end to end so that same current flows through each.

Equivalent resistance is given by, $R_s = R_1 + R_2 + R_3$

➤ **Resistors in parallel :** Two or more resistors are said to be connected in parallel if the same potential difference exists across these resistors.

– Equivalent resistance is given by

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

Joule's heating effects

➤ The heat produced in a resistor is directly proportional to the square of current for a given resistance, to resistance for a given current and to the time for which the current flows through the resistor.

$$H = I^2 Rt = \frac{V^2}{R} \times t = VIt$$

Electric Power

➤ The rate at which electric energy is dissipated or consumed in an electrical appliance or circuit is called the electric power.

$$i.e.,\ \text{Power} = \frac{\text{Work}}{\text{Time}} = \frac{\text{Energy}}{\text{Time}}$$

$$\text{or} \quad P = \frac{W}{t} = \frac{I^2Rt}{t} \Rightarrow P = I^2R$$

$$\text{or} \quad P = \frac{V^2}{R} \Rightarrow P = VI$$

13. MAGNETIC EFFECTS OF ELECTRIC CURRENT

Magnet

Substances which have tendency to attract other magnetic substances e.g. iron, cobalt and nickel.

Properties of the magnet :

➤ A magnet has two poles, north pole and south pole.

➤ A freely suspended magnet always align itself in north-south direction.

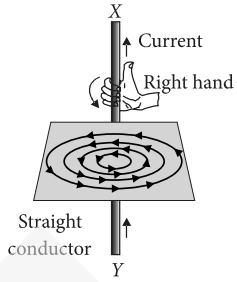
➤ Like poles repel, while unlike poles of different magnets attract each other.

➤ **Magnetic field lines**

– The path along which a free magnetic north pole will move in a magnetic field, is called magnetic field lines.

– Magnetic field lines always repel each other and do not intersect.

➤ **Right hand thumb rule :** According to it, imagine a straight conductor in your right hand such that the thumb points in the direction of current. The direction of curl of fingers of the right hand gives the direction of magnetic field lines.



Solenoid

➤ A coil of many circular turns of insulated copper wire wrapped closely in the shape of a cylinder is called a solenoid.

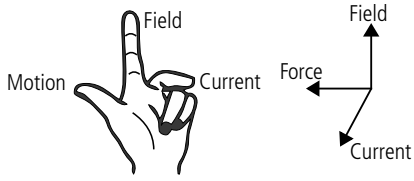
– The magnetic field inside a solenoid is uniform.

– A current-carrying solenoid behaves like a bar magnet with fixed polarities at its ends.

Electromagnet

➤ An electromagnet is a temporary strong magnet and is just a solenoid with its winding on a soft iron core.

➤ **Fleming's Left Hand Rule:** The direction of the force experienced by a current-carrying conductor placed in a magnetic field is determined by Fleming's left-hand rule.



➤ **Electric Motor**

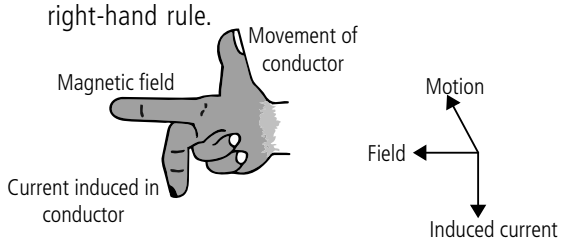
– Device which converts electrical energy into mechanical energy.

– Works on the principle that a current-carrying conductor placed perpendicular to the magnetic field, experiences a force.

➤ **Electromagnetic Induction**

– The phenomenon in which electric current is generated by varying magnetic field is called electromagnetic induction.

- **Fleming's Right Hand Rule:** Direction of induced current in a conductor is determined by Fleming's right-hand rule.



- **Electric Generator**
  - A device which converts mechanical energy into electrical energy.
  - Works on the principle of electromagnetic induction.
- **Electric motor** is a device which converts electrical energy into mechanical energy.
- **Principle of electric motor :** Electric motor works on the principle that a current carrying conductor placed perpendicular to a magnetic field experiences a force.
- **Electric fuse :** A safety device used to save the electrical appliances from burning when large amount of current flows in the circuit.
  - Made of a material of low melting point.
  - Works on the principle of heating effect of current.

14. SOURCES OF ENERGY

Good Source of Energy

- A good source of energy is one which can provide adequate amount of energy in a convenient form over long period of time.
- **Conventional sources of energy :** The sources which are used extensively since ancient times and major portion of our energy requirement are met by them *e.g.*, fossil fuels and hydroenergy are known as conventional sources of energy.
- **Fossil fuels :** Fossil fuels are the non-renewable sources of energy like coal, petroleum and natural gas.
- There are limited reserves of fossil fuels, so we need to conserve them.

Thermal power Plant

- Thermal power plants are usually set up near coal or oil fields for the convenience of transportation.

Hydro power Plant

- Potential energy of water (conventional and renewable source of energy) stored in a dam is converted into kinetic energy of falling water and then, kinetic energy is converted into the electrical energy.

Biomass

- It is an organic matter which is used as a fuel to produce energy.
- This includes wood, agricultural wastes, cow dung, dead parts of plants etc.

Wind Energy

- Wind is caused by unequal heating of the atmospheric air near the surface of the Earth.
- **Non-conventional sources of energy :** The sources which are not used extensively i.e., are limited in use are called non-conventional sources. For example, Solar energy, sea energy, geothermal energy and nuclear energy, etc. These are called as alternative sources of energy.

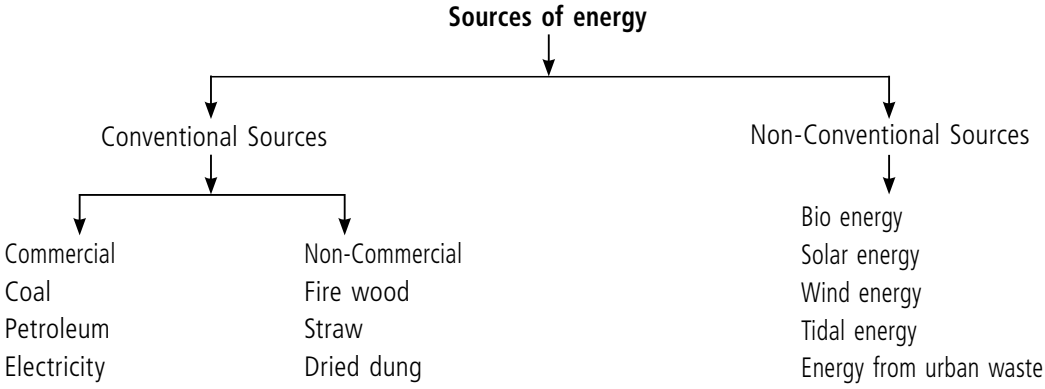


Table : Differences between autotrophs and heterotrophs.

	Autotrophs	Heterotrophs
1.	They are producer organisms.	They are consumer organisms.
2.	They prepare their organic nutrients themselves.	They do not prepare their organic nutrients themselves.
3.	They get only inorganic materials from outside, using which they synthesize organic materials inside their body.	They get both organic and inorganic materials from outside.
4.	These obtain energy from sunlight or inorganic chemical reactions.	These obtain energy from organic nutrients.
5.	These usually add O_2 to the environment.	These add CO_2 to the environment.
6.	These include plants and blue green algae.	These include animals, many protists, bacteria and fungi.
7.	These possess photosynthetic pigments (*e.g.*, chlorophyll).	Photosynthetic pigments are lacking in them.
8.	They constitute the first trophic level.	They belong to second and higher trophic levels.

- **Decomposers** are microbes (bacteria and fungi), which act on the dead bodies of producers and consumers to break the complex organic substances into simpler ones. They absorb some of the substances and release others into the environment to be recycled and to be used in future by the producers.
  In this way, decomposers have a **very important role in cycling the materials** in the biosphere and maintaining the food chain by providing raw materials for producers. They also make the soil fertile and have become the integral part of ecosystem.

Table: Various sources of wastes.

	Sources of wastes	Types of wastes
1.	**Industrial wastes**	• CO, CO_2, SO_2, H_2S and hydrocarbons (air released from automobiles also). • Hydrochloric acid, chlorine, nitrogen oxides, etc. • Heavy metals like mercury, lead, cadmium, nickel, etc. • Many organic compounds like phenol, naphtha, aromatic compounds, etc.
2.	**Domestic wastes**	• Sewage of sanitary facilities of residential, commercial, institutional and other public places. • Sewage with many types of pathogenic organisms like bacteria, encysted protozoans, viruses, eggs of helminthes, etc.
3.	**Agricultural wastes**	• CO_2, Methane (from paddy fields), organopesticides and chlorinated hydrocarbons, etc. • Traces of fertilizers with nitrates, phosphates and sulphates of potassium.
4.	**Commercial wastes**	• Building wastes, printing press wastes, biomedical wastes of medical institutions and hospitals, etc.

	Food chain	Food web
1.	It represents series of organisms feeding on one another.	It is made up of number of interlinked food chains.
2.	Members of higher trophic level feed upon single type of organism of lower trophic level.	Members of higher trophic level can feed upon organisms of lower trophic levels of other food chains also.

	Character	Biodegradable wastes	Nonbiodegradable wastes
1.	**Microbial decomposition**	Undergo microbial degradation.	Do not undergo microbial degradation.
2.	**Main sources**	Living organisms	Industries, hospitals, nursing homes etc.
3.	**Examples**	Domestic sewage, animal wastes, agricultural wastes, etc.	Pesticides, plastics, aluminium cans, synthetic polymers, heavy metals etc.

- **Biomagnification** or **biological concentration** or **biological amplification** is increase in the amount of non-biodegradable substances in successive trophic levels of a food chain.
- **Harmful effects of biomagnification:**

(i) DDT interferes with the egg-shell formation in many birds. The shells remain thin and break by bird's weight during incubation. Dieldrin is about 5 times more toxic than DDT when ingested and 40 times more poisonous when absorbed.

(ii) The chlorinated hydrocarbons are known to **affect CNS** (central nervous system), cause softening of brain, cerebral haemorrhage, cirrhosis of liver, hypertension, cancer, malformation of sex hormones, etc.

(iii) Biomagnification of mercury into fish through the food chain was responsible for large number of deaths due to **Minamata disease in Japan.**

(iv) Selenium accumulates in the plants growing on selenium-rich soils. Through food chain, such plants cause stunted growth, loss of appetite, gastro-intestinal disorders, etc. in the animals grazing on such plants.

16. MANAGEMENT OF NATURAL RESOURCES

- For **conservation of forests :**
  - (i) It should be checked that illegal cutting of trees is banned and made a punishable act.
  - (ii) Stakeholders should take care of the maintenance of the forest.
  - (iii) Forest fires should be checked and controlled.
  - (iv) Nearby villages or people should be trained and educated to manage forests.
  - (v) Over-grazing in the forest should be presented.
  - (vi) Afforestation, social forestry and agroforestry should be promoted..
  - (vii) Soil erosion must be prevented.

- **Strict application of conservation strategies** may lead to strick ban on tree felling, wood cutting etc. But such bans will adversely affect human economy. Besides we have been using forest products and other resources from such a long period that now life seems impossible without them *e.g.,* in absence of timber we will not get furniture. To solve this problem idea of **sustainable development** has been developed that harmonises human growth and resource conservation *E.g.,* it says that we should plant at least as many plants as we cut to maintain that plant population. hence, it is considered to be an advanced idea of conservation.

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