Chemical Reactions and Equ.

1. What is chemical reactions?

- Chemical reactions are the processes in which new substance with new properties are form which involve chemical changes.
- It involves breaking of old chemical bonds which exist between the ato of substance which act to form new chemical bonds.

- old bonds
- New bonds

- During a chemical reactions, atoms of one elements do not change in those of another elements.

Ex- Hydrogen react with oxygen to form water.

$$2H_2 + O_2 \longrightarrow 2H_2O$$

Hydrogen oxygen water

2. what is Reactants?

The substance which takes part in chemical reactions are called reactants

3. What is Products?

The new substance produced as a result of chemical reactions.

- EX- $C_{(s)} + O_{2\,(g)} \longrightarrow CO_{2\,(g)}$

Reactants Products

∴ Here reactants are trans -fer into products.

- The products thus formed have properties entierly differents from those of the reactants.

- EXPERIMENTS REGARDING CHEMICAL RNX -

- Magnesium ribbon experiment -

1. Before experiment please note that magnesium is silvery white metal It is available in the form of magnesium ribbion or wire

2. When magnesium ribbon is heated, it burns in air with dazzling white flame to form white powder called magnesium oxide.

3. Actually, on heating, magnesium combines with oxygen present in air to 2 form magnesium oxide.

- Magnesium (As ribbon) + Oxygen (from air) $\xrightarrow{\text{Heat}}$ Magnesium oxide (white powder)

In these magnesium and oxygen are reactant, but only one product MgO_2 (magnesium oxide)

4. The magnesium ribbon which we use usually has a coating of magnesium oxide, on its surface which is formed by slow action of oxygen of air on it.

Que- Why the magnesium ribbon is cleaned by rubbing with sand paper before burning in air? (1 mark)

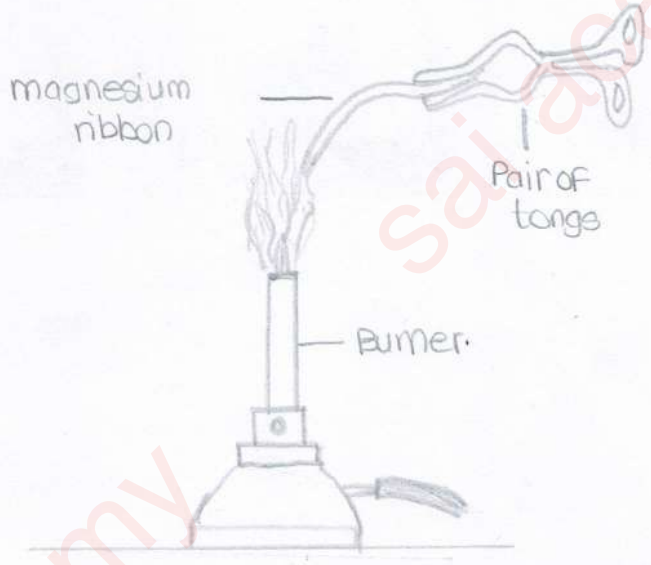
→ • This is done to remove the protective layer of magnesium oxide from the surface of magnesium ribbon before burning in air.

• During burning the dazzling white light given out during the burning of magnesium ribbon is harmful to eyes.

• So, the magnesium ribbon should be burned by keeping it far as possible from the eyes.

EXPERIMENT- (2M|3M)

1. Take about 2cm long magnesium ribbon and clean it by rubbing its surface with sand paper.
2. Hold mg ribbon with a pair of tongs at one end, and heats its others end over a burner.
3. The magnesium ribbon start burning with dazzling white flame.
4. Hold the burning magnesium ribbon over a watch glass so that the magnesium oxide powder calect in the watch glass.



a) magnesium ribbon being heated over a burner

b) Magnesium ribbon burns in air to form magnesium oxide.

Example of chemical reaction occure in daily life -

1. Souring of milk
2. Formation of curd from milk.
3. cooking of food.
4. Digestion of food in our body
5. Process of Respiration
6. Rusting of iron
7. Burning of fuels
8. Buming of candle wax

- These all example involve chemical change.

• Characteristics of Chemical Reactions - (2M)

Important characteristics of chemical rx are -

1. Evolution of gas.
2. Formation of a precipitate
3. change in colour
4. change in temperature
5. change in state

1. Evolution of Gas -

Some chemical reactions are characteristics of some substance that react and evolve gas with some product.

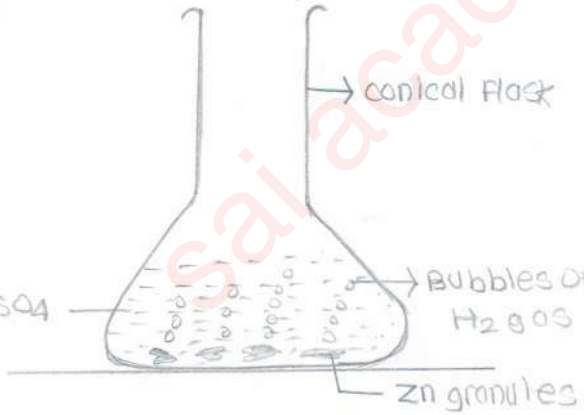
- Example - When zinc granules react with Dilute sulphuric acid, then the bubbles of hydrogen gas produce.

- EXPERIMENT -

1. Take some zinc granule in conical flask, and add zn over dilute sulphuric acid or dilute HCl.
2. we will see the bubbles of hydrogen gas formed around zn granules.
3. By touching flask, we can find it is somewhat hot, here change in temperature also occurs in chemical reaction.

- $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2\uparrow$

zinc — dilute sulphuric acid — zinc sulphate — Hydrogen gas



- Example - 2 - when magnesium react with dilute acid (H_2SO_4 or HCl), then hydrogen gas evolved.

- $Mg + HCl \longrightarrow MgCl + H_2$ (evolve)

Example - 3 when sodium carbonate and dilute Hydrochloric acid is characteris by evolution of CO_2 gas.

- $Na_2CO_3 + HCl \longrightarrow NaCl + H_2O + CO_2$

- sodium carbonate — sodium chloride — carbondioxide

- What is Precipitate?
- Precipitate is a 'solid state' which seperates out the from the solution during a chemical reaction.
- Precipitate usually seen under testtube at bottom part.
- It can form by passing a gas in aqueous solution of a substance (like passing carbon dioxide gas into lime water)
- Formation of insoluble solid precipitate is called Precipitation.

2. Formation of Precipitate-

Example - When potassium iodide solution is added to solution of lead nitrate, then yellow precipitate of lead iodide is formed.

Experiment - we can carry out this chemical reaction as follows -

1. Take some lead nitrate solution in a test tube
2. Add potassium iodide solution to it.
3. A yellow precipitate of lead iodide is formed at once.
4. A change in colour (colourless to yellow) also takes in this chemical reactions.

- $Pb(NO_3)_{2(aq)} + 2KI_{(aq)} \longrightarrow PbI_{2(s)} + 2KNO_{3(aq)}$

lead nitrate | Potassium iodide | Lead iodide (Yellow) | Potassium nitrate

Example 2 - When sulphuric acid and Barium chloride solution is formed by a white precipitate of Barium sulphate.

- $H_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + 2HCl$

sulphuric acid | Barium chloride | Barium sulphate (white) | Hydrochloric acid.

3. Change in Colour-

Example - When citric acid reacts with potassium permaganate solution, then the purple colour of potassium permanganate solution, disappears (it becomes colourless).

- Purple $\xrightarrow{\Delta}$ Colourless

$3KMnO_4 + C_6H_8O_7 \xrightarrow{\Delta} 3HMnO_4 + C_6H_5K_3O_7$

(Purple) | citric acid | colourless

Experiment - we can carry out this reaction as follows-

1. Take some dilute potassium permanganate solution in test tube. It has purple colour.
2. Add some lemon juice with help of dropper and shake it.
3. The purple colour of potassium permanganate solution goes on fading and ultimately it becomes colourless.

Example 2 - when sulphur dioxide gas is passed through acidified potassium dichromoate solution by change in colour from orange to green.

$$SO_2 + K_2Cr_2O_7 + 3H_2SO_4 \longrightarrow K_2SO_4 + Cr_2(SO_4)_3 + 3H_2O$$

(orange) (green)

- **Change in Temperature** - • Exothermic reaction.

Example - When quicklime react with water, then slakedlime is formed and lot of heat energy is produced by a change in temperature. It is a exothermic reaction which means heat producing reaction.

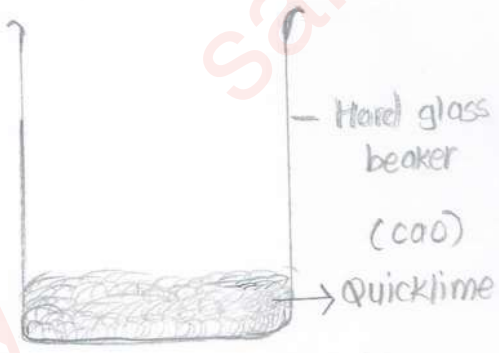
Experiment -

1. Take little of quicklime in hard glass beaker and add water to it slowly.
2. Touch the beaker carefully, the beaker feels to be quite hot its temp is high.

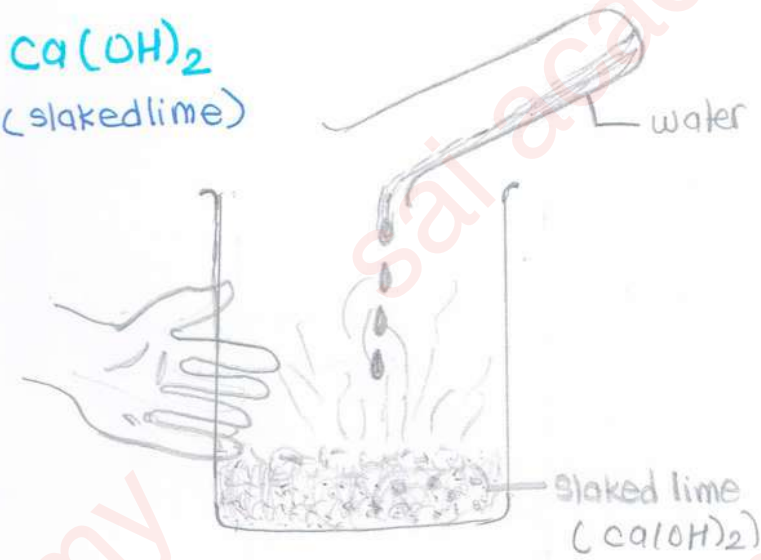
• Calcium oxide + water ⟶ calcium hydroxide

• $CaO + H_2O \longrightarrow Ca(OH)_2$

(quicklime) (slakedlime)



a. Quicklime reacts with water to form slaked lime release a lot of heat



b. The beaker becomes hot It temp. rises

Example 2 - The carbon burns in the air to form carbondioxide which also releases a large amount of heat.

$$C + O_2 \xrightarrow{\Delta} CO_2$$

carbon oxygen carbondioxide

2. Endothermic reaction - The reaction which absorbs the heat are called as Endothermic reaction.

Example - The reaction between barium hydroxide and ammonium chloride to form Barium chloride, ammonia and water by change in temperature.

$$Ba(OH)_2 + 2NH_4Cl \xrightarrow{\Delta} BaCl_2 + 2NH_4OH \downarrow \text{(absorb) heat}$$

Barium hydroxide — ammonium chloride — Barium chloride — ammonium hydroxide

5. Change in state-

Example - When wax is burned, then water and carbondioxide are formed

- Now, wax is solid, water is a liquid whereas carbondioxide is a gas.
- This means that during the combustion reaction of wax, the physical state changes from solid to liquid and gas.
- The combustion of candle wax is characterised by change in state.

• CHEMICAL EQUATIONS-

- The method of representing a chemical reaction with help of symbol and formula of the substance involve in it known as chemical Equations.
- For example- zinc metal react with dilute sulphuric acid to form zinc sulphate and hydrogen gas. This rnx can be written as-

$$\text{Zinc} + \text{Sulphuric acid} \longrightarrow \text{Zinc sulphate} + \text{Hydrogen}$$

- This is known as the word equation.
- We can change the word equation into symbol and formula of various substance.
- Putting the symbol and formulae of all substance in above word equation

$$\underbrace{Zn + H_2SO_4}_{\text{Reactants}} \longrightarrow \underbrace{ZnSO_4 + H_2}_{\text{Products}}$$

- Here, zinc and sulphuric acid are reactant. and reactant are always written on the left hand side in an equation with plus(+) sign between them.
- Here, zinc sulphate and hydrogen are products, and it is always written on the right hand side in an equation with plus sign between them.
- The arrow sign (⟶) pointing towards the right hand side is put between the reactant and products.
- Arrow also indicate that the substance written on the left hand side are combining to give substances written on the right hand side in the equation.
- chemical equation is a shorthand method of representing a chemical rnx.

Balanced and Unbalanced chemical Equations -

1. A balanced chemical equation has an equal number of atoms of different elements in the reactant and products.

Example - $Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$

- In other words, a balanced equation has equal number of atoms of diff. elements on both the side must be equal.
- Now,
- Let us count the number of atoms of all the elements in the reactant and product sepretely.

	In reactant	In product
No. of Zn atoms -	1	1
No. of H atoms -	2	2
No. of S atoms -	1	1
No. of O atoms -	4	4

- Since, above there is an equal number of atoms of different elements in reactant and products is equal, so above equation is balanced equation.

2. A unbalanced chemical equation has unequal number of atoms of one or more elements in the reactant and product.

- Example - Hydrogen reacts with oxygen to form water, this point will written as -

$$\cdot H_2 + O_2 \longrightarrow H_2O$$

- Let us count the number of hydrogen atoms and oxygen atoms in the reactant and product.

	In reactant	In Product
• No. of H atoms -	2	2
• No. of O atoms -	2	1

- In these equation thus, the no. of hydrogen atoms are equal, but the oxygen atoms are not equal on both side of reactant and product. So it is called unequal or unbalanced chemical equation.

$$\cdot \text{Reactant} = \text{Product (always)}$$

- Note - The chemical equation should be balanced because it satisfy the law of conservation of mass in a reaction..
- Some rules about the balancing the equation -
- We should never change the formula of an element or a compound to balance the equation.

2. We can only multiply a symbol or formula by figures like 2, 3 and 4
3. It will be good to note here that here the elements which exist as diamotic molecules are oxygen O_2, hydrogen H_2, nitrogen N_2, Fluorine F_2, chlorine Cl_2, bromine Br_2 and iodine I_2.
4. All other element are usually considered monoatomic in equation writing and represented by their symbols.

Balancing of Chemical Equation-

- The process of making the number of different types of atoms equal on both the side of the equation called balancing of equation.
- The simple equations are balanced by hit and trial method.
- Example of the balancing the equations -
- Hydrogen burns in oxygen to form water. The reaction can be written in an equation.

$$H_2 + O_2 \longrightarrow H_2O$$

- count the number of hydrogen and oxygen atoms in reactant and product.

	In reactant	In Product
No. of H atoms -	2	2
No. of O atoms-	2	1

- The no. of H_2 atoms is equal on both side, but the number of oxygen atoms are unequal.
- There are 2 oxygen atoms on left side and 1 oxygen atoms on right side to have 2 oxygen atoms on the right side, we multiply H_2O by 2 and write $2H_2O$ so that:

$$H_2 + O_2 \longrightarrow 2H_2O$$

- Let us count the number of various atoms on both sides -

	In reactant	In product
No. of H atoms -	2	4
No. of O atoms-	2	2

- Though the number of oxygen atoms has become equal, but the no. of hydrogen atoms has become unequal.
- There are 2 atoms hydrogen atoms on the left side but 4 hydrogen atoms on the right side., we multiply it H_2 by 2 and write $2H_2$:

$$2H_2 + O_2 \longrightarrow 2H_2O$$

- Let us count the no. of atoms on both side-

No. of H atoms -	4 (reactant)	4 (Product)
No. of O atoms -	2	2

• This chemical equations contains equal no. of atoms of hydrogen and oxygen on both the sides. so this is balanced equations.
• By these way we can balanced the equations.

• To make Equation More Informative -

• The chemical equations can be more informative - by three ways -
1. By indicating the "physical change or state" of the reactant and product.
2. By indicating the " heat change" taking place in the reaction.
3. By indicating the " conditions" under which the reaction takes place.

1. To indicate the physical change or state of the reactant and product -

The physical state for reactant and product of chemical reaction -
• solid • liquid • aqueous solution • gas
• solid state is indicated as - symbol (s).
• liquid state is indicated as - symbol (l)
• Aqueous state or solution is indicated as - symbol (aq).
• Gaseous state is indicated as - symbol (g).
• The physical state of the reactant and product are shown by putting the above " state symbol" just after their symbol or formulae in an eq. -

For Example -
zinc react with dilute sulphuric acid to form zinc sulphate solution and hydrogen gas.

$$Zn + H_2SO_4 \longrightarrow ZnSO_4 + H_2$$

Here,
• zinc metal is solid, so we write $Zn(s)$
• Dilute sulphuric acid is aqueous solution, so we can write $H_2SO_4(aq)$
• zinc sulphate is also an aqueous solution, so we can write $ZnSO_4(aq)$
• Hydrogen is gas, so we write hydrogen (g).
• The above equation written as -

$$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

• This equation is more informative because it tell us the physical state of the various substance involved in it.

• In same case 2 - Insoluble product called precipitate is formed by the mx. between solutions of reactants. and its is indicated by symbol "ppt."
• When calcium hydroxide solution (lime water) react with carbon-dioxide gas, a white precipitate of calcium carbonate is formed along with water.

$$Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$$

Calcium hydroxide — carbondioxide — calcium carbonate (white ppt) — water

2. To indicate the Heat change in an Equation -

There are two types of reaction on the basis of heat changes involve.

1. Exothermic reaction 2. Endothermic reactions.

1. Exothermic Reactions-

Those reactions in which heat is evolved called as Exothermic reactions.

For Example-1. carbon burns in oxygen to form carbondioxide, a lot of heat is produced in this reaction.

$$C(s) + O_2(g) \longrightarrow CO_2(g) + \text{Heat}$$

carbon oxygen carbondioxide

The burning of carbon in oxygen is an exothermic reaction because heat is evolved in this reaction.

An exothermic reaction is indicated by writing + Heat or + Heat energy or just " + Energy on the products side.

Example 2 -

Que - why Burning of natural gas is an exothermic reaction? (2M)

- Natural gas is mainly methane (CH_4), when natural gas burns in the oxygen of air, it forms carbondioxide and water vapour. a large amount of heat is produced.
- Heat is mainly produce so called Exothermic reaction.
- All the combustion reaction are exothermic reaction.

$$\circ\ CH_4(g) + 2O_2(g) \longrightarrow CO_2(g) + 2H_2O(g) + \text{Heat energy}$$

∘ Methane ∘ Oxygen carbondioxide water

Example 3 -

Que - why respiration is an exothermic reaction? Explain -

- It is exothermic reaction because energy is produced during this process.
- During digestion food is broken down into simpler substances.
- The carbohydrate which we get from the foods like chappati, bread rice and potato we eat broke down into simple form called glucose.
- This glucose then undergoes slow combustion by combining with oxygen in cells of our body to produce energy in a process called Respiration. these energy maintain our body heat.

$$\circ\ C_6H_{12}O_6(aq) + 6O_2(g) \longrightarrow 6CO_2(g) + 6H_2O(l) + \text{Energy}$$

Glucose Oxygen carbondioxide water

- It is also an combustion reaction.

2. Endothermic Reactions -

- Those reaction in which heat is absorbed are known as Endothermic reactions.
- Example - When nitrogen and oxygen are heated to a very high temperature (of about 3000°c) they combine to form nitrogen monoxide and lot of heat is absorbed. in this reaction.

$$N_2(g) + O_2(g) + \text{Heat} \longrightarrow 2NO(g)$$

Nitrogen Oxygen Nitrogen monoxide

- An endothermic reaction is usually indicated by writing + Heat or + Heat energy on the reactant side of an equation.
- It is used inside the engine of motor vechiles.

- All the decomposition reaction are endothermic reaction because - it require energy (in the form of heat, light or electricity) to take place.
- For example - The decomposition of calcium carbonate is endothermic reaction.
- When calcium carbonate is heated, it decomposes to form calcium carbonate and carbondioxide.

$$CaCO_3(s) + \text{Heat} \longrightarrow CaO(s) + CO_2(g)$$

- calcium carbonate - Calcium oxide - carbondioxide

- Example -

Que - Why Photosynthesis is an endothermic reaction?

It is endothermic reaction because sunlight energy is absorbed during the process of photosynthesis by green plants.

- Example -

The electrolysis of water to form hydrogen and oxygen is an also endothermic reaction. this is because energy is absorbed during the reaction.

1. $6CO_2(g) + 12H_2O(l) \xrightarrow[\text{Plant enzyme}]{\text{light}} \underset{\text{glucose}}{C_6H_{12}O_6(aq)} + 6O_2(g) + 6H_2O(l)$

2. - Cathode - Reduction

$$2H^+_{(aq)} + 2e^- \longrightarrow H_2(g)$$

- Electrolysis of water

- Anode - Oxidation

$$2OH^-_{(aq)} \longrightarrow H_2O_{(l)} + \tfrac{1}{2}O_{2(g)} + 2e^-$$

3. To indicate the conditions under which the mx takes place-

- If heat is require for a mx. to take place, then the heat sign delta (Δ) is put over the arrow of the mx. of equations.
- If the reaction takes place in the presence of a catalyst, then the symbol or formula of catalyst is also written above or below the arrow sign in the equation.

For example –

- $2KClO_3(s) \xrightarrow[MnO_2]{\Delta} 2KCl(s) + 3O_2(g)$

Potassium chlorate — Potassium chloride — oxygen

- Here, delta (Δ) stands for heat and MnO_2 is the catalyst.

2. The conditions of temperature and pressure at which reaction takes place can also be indicated on the above or below the arrow sign in the equation.

- For example – Methanoal or Methyl alcohol is manufactured from carbon monoxide and hydrogen.

- $CO(g) + 2H_2(g) \xrightarrow[ZnO + CrO_3]{300atm\ 300°C} CH_3OH(l)$

carbon monoxide — hydrogen — Methylalcohol

- Here 300 atm is pressure, $ZnO + CrO_3$ is catalyst, and 300°C is temp.

STEPS FOR WRITING EQUATIONS FOR CHEMICAL REACTION –

- Mainly four steps are for writing equation in chemical reaction :-
- Step 1 - Write the chemical reaction in the form of word equation, keeping the reactant on left side and product on right side.
- Step 2 – Put the symbols and formula of all the reactant and product in the word equation.
- Step 3 – Balance the equation by multiplying the symbols and formulae by the smallest possible figure. (Do not change the formulae to balance the equation.
- Step 4 - If possible, make the equation more informative by indicating the physical states of reactant and products, by indicating the heat changes, if any, taking place in the reaction, and by indicating the conditions under which the reaction takes places. If however, you do not have sufficient information regarding the physical state, heat changes and conditions of the reaction, this step can be avoided.

Sample Problem - 1

- Write a balanced equation for the following reaction -
- Methane burns in oxygen to form carbon dioxide and water

→ Reaction in form of word equation -

- Methane + oxygen ⟶ carbondioxide + water

- Writing the formulae of all substance given above -

- $CH_4 + O_2 \longrightarrow CO_2 + H_2O$

- Let us count the no. of various atom on reactant and product side-

	In reactant	In products
1. No. of C atoms -	1	1
2. No. of H atoms -	4	2
3. No. of O atoms -	2	3

- The no. of carbon atoms are equal on both sides, but H and O atoms are unequal on both sides.
- To have 4 hydrogen atoms on right side, we multiply H_2O by 2 and write $2H_2O$, Thus

- $CH_4 + O_2 \longrightarrow CO_2 + 2H_2O$

- Counting the no. of atom on both sides again -

	In reactant	In products
1. No. of C atoms -	1	1
2. No. of H atoms -	4	4
3. No. of O atoms -	2	4

- only the number of oxygen atoms is unequal now. To have 4 oxygen atoms on the left side, we multiply O_2 by 2 and write $2O_2$.

- $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$

- Let us count the number of various atoms on the both sides -

	In reactant	In products
1. No. of C atoms -	1	1
2. No. of H atoms -	4	4
3. No. of O atoms -	4	4

- This chemical equation contains an equal numbers of various types of atoms in the reactant and product so this is a Balanced equation.

- This are the steps to balance the equations →
- It is not mandatory to write whole steps we can do as directed.

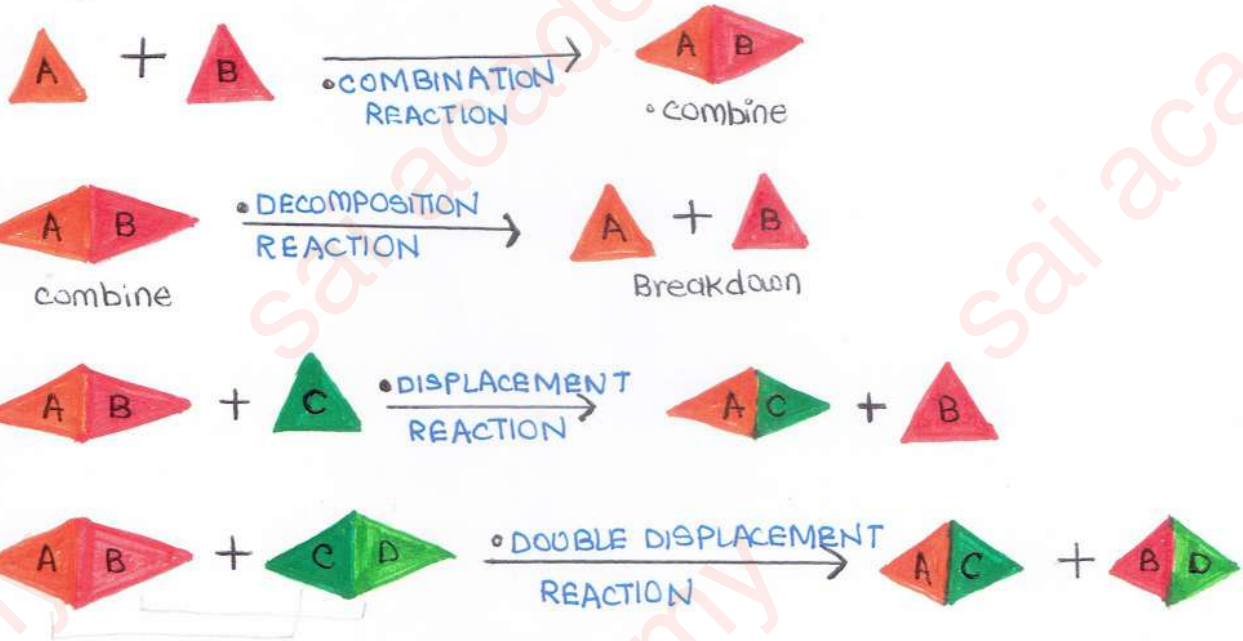
Oxides of Iron metal-

- Mainly two oxides of Iron -

1. Iron (II) oxide – FeO, it is the valency of iron in it is II (two). The common name is ferrous oxide (FeO).
2. Iron (III) oxide – Fe_2O_3, it is the valency of iron – III (three). The common name is ferric oxide.
3. Fe_3O_4 – This is the mixture of iron (II) oxide and iron (III) oxide. ($Fe_3O_4 = FeO + Fe_2O_3$). The common name is magnetic iron oxide.

• TYPES OF CHEMICAL REACTIONS-

- 4 main types of chemical reactions-



1. COMBINATION REACTION -

- Those reaction in which two or more substance combine to form a single substance.
- some examples of reaction -

1. Magnesium and oxygen combine, when heated to form magnesium oxide.

$$2Mg(s) + O_2(g) \xrightarrow{\text{combustion by combination}} 2MgO(s)$$

Magnesium oxygen Magnesium oxide

2. sodium metal burns in medium of chloride to form sodiumchloride.

$$2Na(s) + Cl_2(g) \xrightarrow{\text{combination}} 2NaCl(s)$$

sodium chlorine sodium chloride

3. carbon (coal) burns in air to form carbon dioxide.

$$C(s) + O_2(g) \xrightarrow{\text{combination}} CO_2(g)$$

carbon air carbon dioxide

4. Ammonia reacts with hydrogen chloride to form ammonium chloride-

- $NH_3(g) + HCl(g) \xrightarrow{\text{combination}} NH_4Cl(s)$

Ammonia — hydrogen chloride — Ammonium chloride

5. Sulphur dioxide reacts with oxygen to produce sulphur trioxide-

- $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

Sulphur dioxide — oxygen — sulphur trioxide

6. The calcium hydroxide solution, when applied to the walls, reacts slowly with the carbondioxide gas present in air to form a thin, shining layer of calcium carbonate on the walls of the house:

- $Ca(OH)_2(aq) + CO_2(g) \longrightarrow CaCO_3(s) + H_2O(l)$

calcium hydroxide — carbondioxide — calcium carbonate — water

This process gives a white, shiny apperance to the walls of a house, it is called white-washing. The $CaCO_3$ is actually formed after two to three days of white-washing and gives a shiny finish to the walls.

2. DECOMPOSITION REACTIONS -

- Those reaction in which a compound splite up into two or more simpler substance are known as decomposition reaction.
- It is just the opposite of a combination reaction.
- Some examples of decomposition reactions -

1. When calcium carbonate isheated, it decomposes to give calcium oxide and carbondioxide.

- $CaCO_3(s) \xrightarrow[\text{decomp.}]{\text{Heat}} CaO(s) + CO_2(g)$

calcium carbonate (limestone) — calciumoxide (lime) — carbondioxide

- calcium oxide (or lime) is used on a large scale in the manufacture of cement and glass.
- When a decomposition reaction is carried out by heating, it is called 'thermal decomposition. (thermal means releasing of heat)

2. When potassium chlorate is heated in the presence of manganese dioxide catalyst, it decomposes to give potassium chloride and oxygen.

$2KClO_3(s) \xrightarrow[\text{decomp.}]{\text{Heat}} 2KCl(s) + 3O_2(g)$

Potassium chlorate — Potassium chloride — oxygen

- This decomposition process is used for preparing oxygen gas in laboratory.

Example 3- When ferrous sulphate is heated strongly, it decomposes to form ferric oxide, sulphur dioxide and sulphur trioxide.

- $2FeSO_4(s) \xrightarrow[\text{Decomposition}]{\text{Heat}} Fe_2O_3(s) + SO_2(g) + SO_3(g)$

Ferrous sulphate (Green colour) | Ferric oxide (Brown colour) | sulphur dioxide | Sulphur trioxide

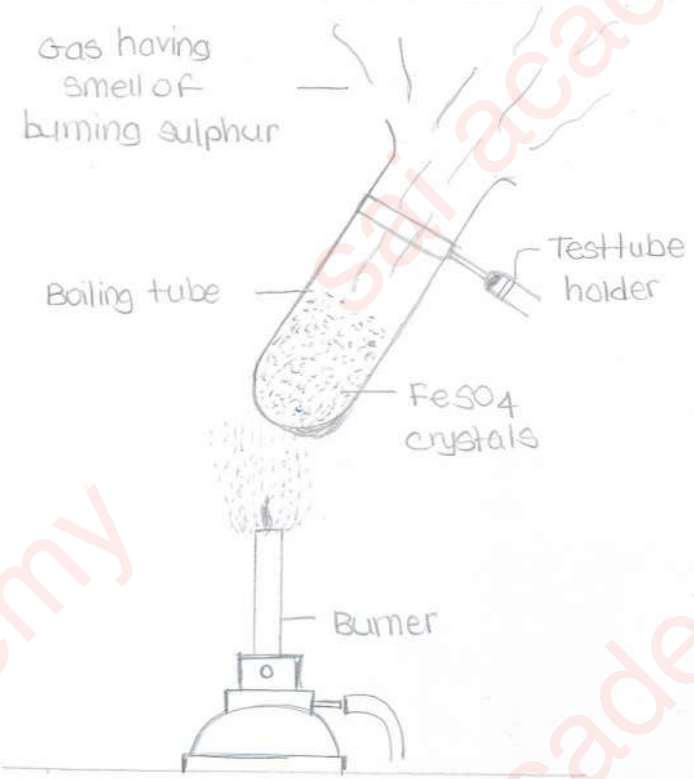
- Note- The ferrous sulphate is also known as iron(II) sulphate and ferric oxide is also known as iron(III) oxide.
- The ferrous sulphate crystals which are available in ferrous sulphate heptahydrate $FeSO_4.7H_2O$. They contain 7 molecules of water of crystallation These crystals are green in colour.
- When green colour ferrous sulphate heptahydrate crystals ($FeSO_4.7H_2O$) are heated, they lose 7 molecules of water of crystalliation to form anhydrous ferrous sulphate ($FeSO_4$) which is white in colour.
- Decomposition of ferrous sulphate in the labroratory -
- Take 2 g of $2FeSO_4$ crystals in dry boiling tube. The ferrous sulphate crystals are green in colour.
- Heat the boiling tube over a burner
- The green colour of ferrous sulphate crystals first change into white and then brown solid is formed (which is ferric oxide).
- Gas having the smell of burning sulphur comes out of the boiling tube.

Example 4- When lead nitrate is heated strongly, it breaks down to form lead monoxide, nitrogen dioxide and oxygen -

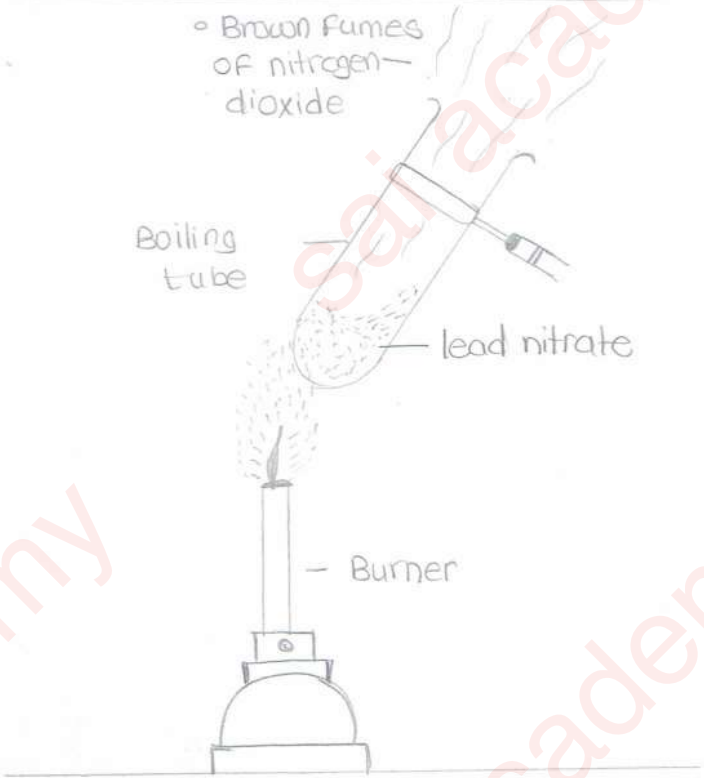
- $2Pb(NO_3)_2(s) \xrightarrow[\text{Decomposition}]{\text{Heat}} 2PbO(s) + 4NO_2(g) + O_2(g)$

- Lead nitrate (colourless) | Lead mono oxide (yellow) | Nitrogen dioxide (Brown fumes) | oxygen

- The decomposition of lead nitrate is brought about by heat, it is actually an example of thermal decomposition.
- Decomposition of lead nitrate in the labroratory -
- Take about 2g of lead nitrate powder in boiling tube. lead nitrate is a colourless compound.
- Hold the boiling tube in the hand test tube holder and it should be heat over burner.
- Brown fumes of nitrogen dioxide gas are evolved which fill the boiling tube
- If a glowing splinter is held over the mouth of the boiling tube, it catches fire and starts burning again. this shows that oxygen gas is also evolved during this reaction.
- A yellow solid is left behind in the boiling tube. This is lead monoxide. (lead monoxide is reddish-brown when hot but yellow when cold).



a. Decomposition of $FeSO_4$ crystals.



b. Decomposition of lead nitrate.

- Decomposition of water which are carried out by electricty? (3M)
- Example- When electric current is passed through acidified water, it decomposes to give hydrogen gas and oxygen gas.

$$2H_2O(l) \xrightarrow[\text{Decomposition}]{\text{Electricity}} 2H_2(g) + O_2(g)$$

water → Hydrogen + oxygen

- This is called Electrolysis of water.
- EXPERIMENT-

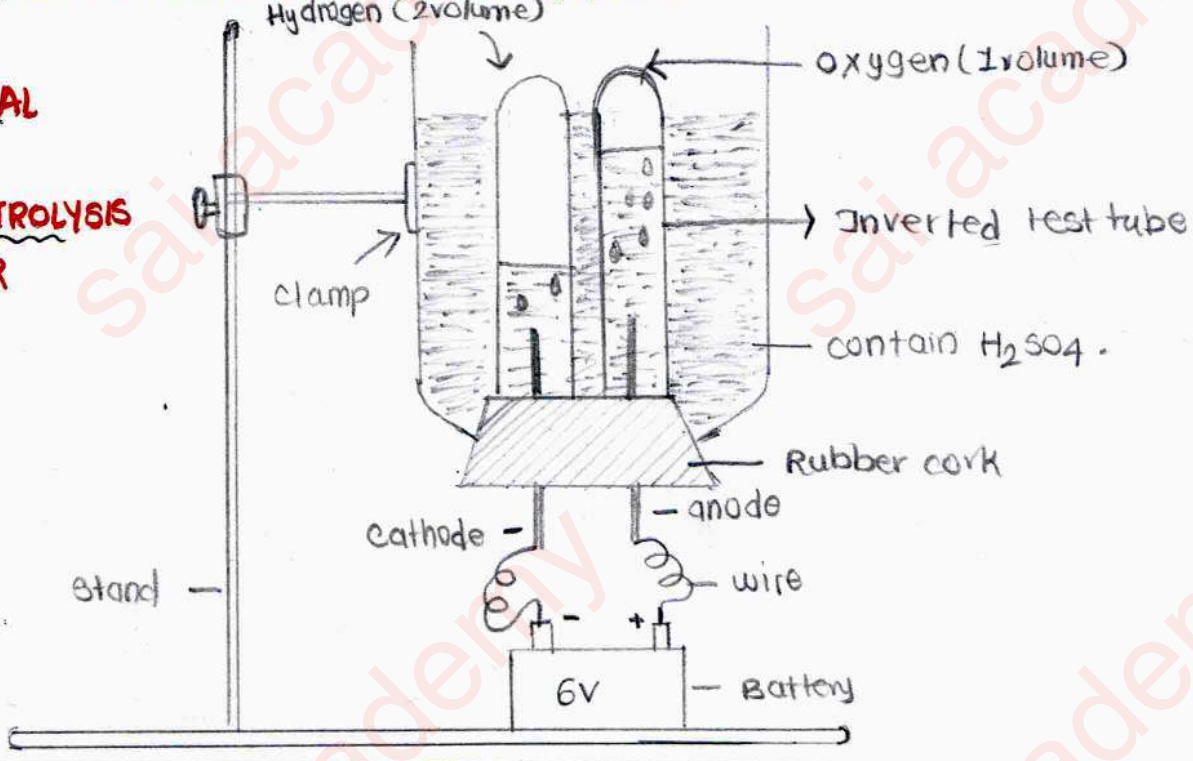
1. Take a wide-mouthed glass bottle. Fix with a inverted position on a stand.
2. A rubber cork having two holes is fitted in the neck of the bottle. Two carbon rods are fixed in two holes of cork tightly.
3. Fill the glass bottle two third with water. Add a few drops of dilute H_2SO_4 to water.
4. Two similar test tube filled with water inverted over the two carbon electrodes by keeping thumb over their mouth.
5. connect the outer ends of carbon rods to the two terminals of 6 volt battery by wires having a switch.
6. Negative terminal of battery is called cathode (negative terminal). The right side carbon connected to the positive terminal of battery called anode (positive electrode).
7. Pass the electric current through water by turning on the switch and leave the apparatus undistrubed for sometime.

8. We can see the bubbles of gases being formed at the both carbon electrodes inside test tube containing water
9. These gases are formed by decomposition of water on passing electricity.
10. The gases formed at two electrode go on collecting in the top parts of inverted test tubes.
11. The volume of gases are not same in both test tube. The volume of gas collected on negative electrode is double the volume of gas collected on positive electrode.
12. Keep on passing electric current till both the test tube completely filled with gases. Then remove the gas-filled test tube and test them one by one by bringing a burning candle close to the mouth of each test tube.
13. Bringing candle close to mouth burns rapidly and make "popupsound".
14. The gas collected in left test tube over negative electrode is hydrogen. and gas near the mouth of right test tube the candle burns brightly
15. We know that oxygen gas makes things burn brightly. So, the gas collected in the right side test tube over positive electrode is oxygen.
16. Since the electrolysis of water produces 2 volumes of hydrogen gas and 1 volume of oxygen gas we conclude that the ratio of hydrogen gas and oxygen gas is 2:1 by volume.
- It shows that water is a compound made up of 2 parts of hydrogen gas and 1 part of oxygen gas by volume.

Que- Why decomposition reaction is just opposite of combination reaction? (2M)
- In a combination reaction two or more substances are combined to form new substance
- In a decomposition reaction one substance decomposes into two or more substance

Hence, decomposition reaction is just opposite of combination rx.

- **EXPERIMENTAL SET-UP FOR THE ELECTROLYSIS OF WATER**



Example - When electric current is passed through molten sodium chloride, it decomposes to give sodium metal and chlorine gas.

$$2NaCl(l) \xrightarrow[\text{Decomposition}]{\text{Electricity}} 2Na(s) + Cl_2(g)$$

Sodium chloride → Sodium; Chlorine gas

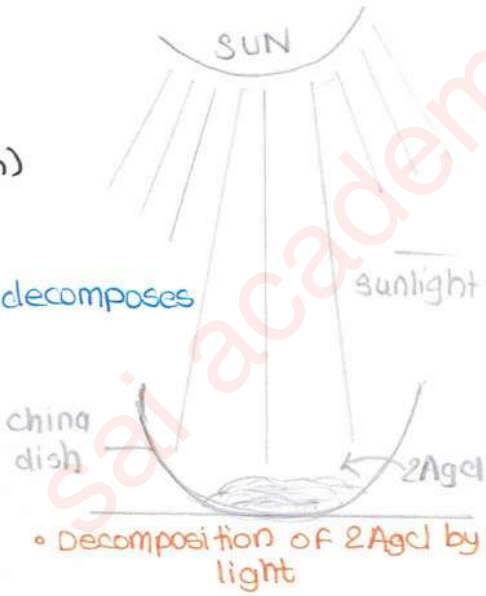
- This decomposition reaction is used to obtain sodium metal from sodium chloride. It is called Electrolysis of ~~to~~ molten sodium chloride. Sodium chloride is in the form of molten state.

- Decomposition reaction which brought out by light energy?

Example - When silver chloride is exposed to light, it decomposes to form silver metal and chlorine gas.

- $2AgCl(s) \xrightarrow[\text{Decomposition}]{\text{light}} 2Ag(s) + Cl_2(g)$

Silver chloride (white) → Silver (Greyish) white; Chlorine (Yellowish) green



- Decomposition of 2AgCl by light

Example - When silver bromide is exposed to light, it decomposes to form silver metal and bromine vapours.

$$2AgBr(s) \xrightarrow[\text{Decomposition}]{\text{Light}} 2Ag(s) + Br_2(g)$$

Silver bromide (Pale yellow) → Silver (Greyish white); Bromine (Red brown)

- It is also used in black and white photography.

- **Uses of Decomposition Reactions -**

1. The decomposition reaction carried out by electricity are used to extract several metals from their naturally occuring compounds like bromide and oxides.
2. When the fused metal chloride or metal oxide is decomposed by passing electricity, then metal is extracted at the cathode.

- **Decomposition reaction in our body -**

- The digestion of food in the body is an example of decomposition reaction.
- When we eat food like wheat, rice or potato, the strach present in them decomposes to give simple sugars like glucose in the body and the proteins decomposes to form amino acid.

- Strach $\xrightarrow[\text{Decom.}]{}$ Glucose $\xrightarrow[\text{Decomp.}]{}$ Proteins $\xrightarrow[\text{Decomp.}]{}$ Amino acid

3. DISPLACEMENT REACTIONS -

- Those reactions in which one element takes place of another element in a comp. are known as displacement reactions.
- A more reactive elements displaces a less reactive element from its compound.
- It is also called as single displacement reaction.

- Some examples of displacement reactions -
- Example 1 - When a strip of zinc metal is placed in copper sulphate solution, then zinc sulphate solution and copper are obtained.

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

copper sulphate	zinc	zinc sulphate	copper
(Blue solution)	(silvery white)	(colourless solution)	(Red-brown)

- This displacement reaction takes place because zinc is more reactive than copper.

- Example 2 - When a piece of ~~pep~~ magnesium metal is placed in copper sulphate solution, then magnesium sulphate solution and copper metal are formed.

$CuSO_4(aq) + Mg(s) \longrightarrow MgSO_4(aq) + Cu(s)$

copper sulphate	magnesium	Magnesium sulphate	copper
Blue solution	silvery white	colourless solution	Red-brown

- Magnesium is able to displace copper from copper sulphate solution because magnesium is more reactive than copper.

- Example 3 - When a piece of iron metal is placed in a copper sulphate solution, then iron sulphate solution and copper metal are formed.

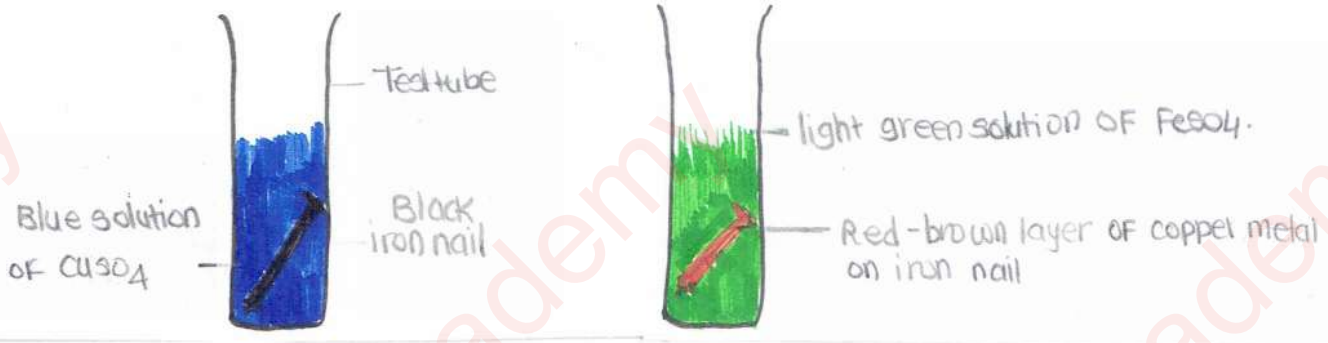
$CuSO_4(aq) + Fe(s) \longrightarrow FeSO_4(aq) + Cu(s)$

coppersulphate	Iron	Iron sulphate	copper
(Blue solution)	(Grey)	(Greenish sol)	(Red-brown)

- This is displacement reaction occurs because iron is more reactive than copper.

- We can perform the displacement reaction between iron and copper sulphate solution as follows -

1. Take about 10 mL of copper sulphate solution in a test tube. It is deep blue in colour.
2. Take a big iron nail and clean its surface by rubbing with a sand paper.
3. Put the cleaned iron nail in the test tube containing copper sulphate sol. Allow the iron nail to remain in copper sulphate solution for about half an hour.
4. After half and hour, take out the iron nail from copper sulphate solution. We will find that the iron nail is covered with brown layer of copper metal.
5. If we look at the test tube, we find the original deep blue colour of copper sulphate solution has faded. The solution turns light green due to formation of iron sulphate or ferrous sulphate.



Example 4 - When a strip of lead metal is placed in a solution of copper chloride, then lead chloride solution and copper metal are formed -

$CuCl_2(aq) + Pb(s) \longrightarrow PbCl_2(aq) + Cu(s)$

Copper chloride	lead	lead chloride	copper
Green solution	Bluish grey	colourless sol.	Red brown

- lead is able to displace copper from copper chloride solution because lead is more reactive than copper.
- Here $CuCl_2$ used in this reaction is actually copper(II) chloride.

Example 5 - Iron metal reacts with dilute hydrochloric acid to form iron(II) chloride and hydrogen gas.

- $Fe(s) + 2HCl(aq) \longrightarrow FeCl_2(aq) + H_2(g)$

Iron	Hydrochloric acid	Iron(II) chloride	Hydrogen

- Here iron is more reactive than hydrogen (Reason)

- Example 6 - Sodium metal reacts with water to form sodium hydroxide and hydrogen gas.

- $2Na(s) + H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$

Sodium	water	Sodium hydroxide	hydrogen

Here sodium is more reactive than water (hydrogen)

- In case of oxides -

Example 7 - when copper oxide is heated with magnesium powder, then magnesium oxide and copper is formed -

- $CuO(s) + Mg(s) \longrightarrow MgO(s) + Cu(s)$

Copper oxide	magnesium	magnesium oxide	copper.

Note - A more reactive metal displaces a less reactive metal from its oxide. Here, magnesium is displacing a less reactive metal, copper, from its oxide copper oxide.

Example 8 - When iron(III) oxide is heated with aluminium powder, then aluminium oxide and iron metal are formed -

$Fe_2O_3(s) + 2Al(s) \longrightarrow Al_2O_3(s) + 2Fe(l)$

Iron(III) oxide (Ferric oxide)	Aluminium	Aluminium oxide	Iron (molten)

Here, a more reactive metal, aluminium, is displacing a less reactive metal 'iron' from its oxide, iron(III) oxide.

- All the above examples of displacement reactions are actually 'single displacement reactions' This is because in all these reactions only 'one element' displaces 'another element' from its compound.
- Another type of displacement reactions called 'double displacement reactions'.

4. DOUBLE DISPLACEMENT REACTION -

- Those reactions in which two compounds react by an exchange of ions to form two new compounds are called double displacement reactions.
- Some examples of double displacement reactions -

Example 1 - When silver nitrate solution is added to sodium chloride solution, then a white precipitate displaces silver chloride with sodium nitrate solution.

- $AgNO_3(aq) + NaCl(aq) \longrightarrow AgCl(s) + NaNO_3(aq)$

Silver nitrate — Sodium chloride — Silver chloride (white ppt) — Sodium nitrate

- Here, silver chloride is formed as an insoluble white solid called as white precipitate.

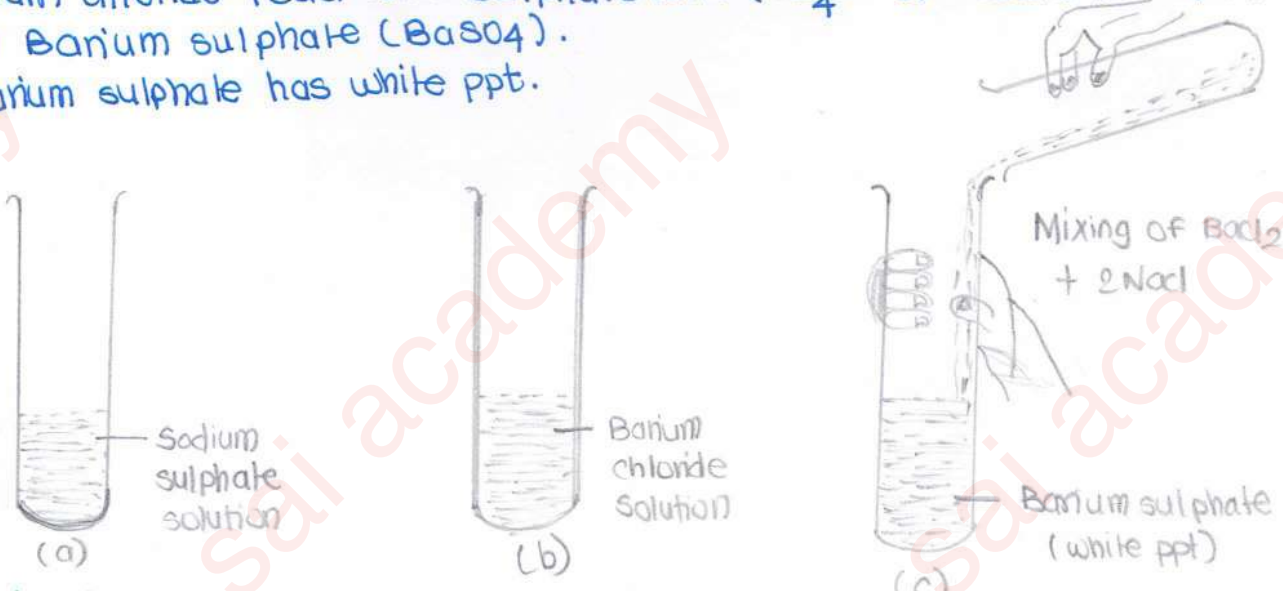
- What is Precipitation reaction?
- Any reaction in which an insoluble solid (called precipitate) is formed that separates from solution.

Example 2 - When barium chloride solution is added to sodium sulphate solution, then a white precipitate of Barium sulphate is formed along with sodium chloride solution.

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

Barium chloride — Sodium sulphate — Barium sulphate (white ppt) — Sodium chloride

- Here, exchange of ions takes place in this reaction. The barium ions (Ba^{+2}) of Barium chloride react with sulphate ions (SO_4^{2-}) of sodium sulphate to form Barium sulphate ($BaSO_4$).
- Here Barium sulphate has white ppt.



a. Take about 3ml of sodium sulphate in a test tube.
b. In another test tube, take 3ml of Barium chloride solution.
c. Add Barium chloride solution to sodium sulphate solution
d. A white precipitate of Barium sulphate is formed at once.

• Example 3- If barium chloride solution is added to copper sulphate solution then a white precipitate of barium sulphate is produced along with copper chloride solution.

$$Ba^{+}Cl_2^{-}(aq) + Cu^{+}SO_4^{-}(aq) \longrightarrow Ba^{+}SO_4^{-}(s) + Cu^{+}Cl_2^{-}(aq)$$

Barium chloride | copper sulphate | barium sulphate (white ppt) | copper chloride

• Example 4- When potassium iodide solution is added to lead nitrate sol. then yellow precipitate of lead iodide is produced alongwith potassium nitrate.

$$Pb^{+}(NO_3^{-})_2(aq) + 2K^{+}I^{-}(aq) \longrightarrow Pb^{+}I_2^{-}(s) + 2K^{+}NO_3^{-}(aq)$$

Lead nitrate | Potassium iodide | lead iodide (yellow ppt) | Potassium nitrate

• lead nitrate, $Pb(NO_3)_2$ is also written as lead(II) nitrate.

• Example 5- When ammonium hydroxide solution is added to ~~ammonium~~ aluminium chloride solution, then white precipitate of Aluminium hydroxide is formed alongwith ammonium chloride solution.

$$Al^{+}Cl_3^{-}(aq) + 3NH_4^{+}OH^{-}(aq) \longrightarrow Al^{+}(OH)_3^{-}(s) + 3NH_4^{+}Cl^{-}(aq)$$

Aluminium chloride | Ammonium hydroxide | Aluminium hydroxide (white ppt) | Ammonium chloride

• These are some few examples of double displacement reaction.

5. OXIDATION AND REDUCTION REACTION-

• Oxidation - • The addition of oxygen to a substance is called oxidation.
• The removal of hydrogen from a substance is called Oxidation.

• Reduction - • The addition of hydrogen to a substance is called Reduction.
• The removal of oxygen from a substance is called Reduction.

• The process of reduction is just opposite of oxidation. (Note)
Morever, oxidation and reduction occurs together. (Note).

• OXIDISING AGENT AND REDUCING AGENT-

• Oxidising agent - 1. The substance which gives oxygen for oxidation is called oxidising agent.
2. The substance which remove hydrogen is called oxidising agent.

• Reducing agent - 1. The substance which gives hydrogen for reduction is called reducing agent.
2. The substance which remove oxygen is called reducing agent.

NOTE- The oxidation and reduction reaction are also called REDOX REACTIONS.
Redox stands for red- reduction and ox- oxidation.

Example 1 - When copper oxide is heated with hydrogen, then copper metal and water are formed -

$$CuO_{(s)} + H_{2(g)} \xrightarrow{Heat} Cu_{(s)} + H_2O_{(l)}$$

copperoxide Hydrogen copper water

- In this reaction, CuO is changing into Cu. That is, oxygen is being removed from copperoxide so by definition, removal of oxygen from a substance is called reduction. copperoxide is being reduced to copper.
- In this reaction H_2 is changing into H_2O. That is oxygen is being added to hydrogen. By addition of oxygen to a substance is called oxidation. Hydrogen is being oxidised to water.

Removal of oxygen - Reduction

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

Addition of oxygen - oxidation

- In these reaction, CuO (copperoxide) is the oxidising agent. and H_2 is reducing agent.
- Substance oxidised - H_2
- substance reduced - CuO
- Oxidising agent - CuO
- Reducing agent - H_2
- The reaction between copperoxide and hydrogen to form copper and water is an oxidation-reduction reaction which is also a displacement reaction.

Example 2 - When hydrogen sulphide react with chlorine, then sulphur and hydrogen chloride are formed -

$$H_2S + Cl_2 \xrightarrow{Heat} S + 2HCl$$

Hydrogen sulphide chlorine sulphur hydrogenchloride

- Here, H_2S is changing into S. That is hydrogen is removed from hydrogen sulphide. By def. the removal of hydrogen compound is called oxidation Hydrogen sulphide is being oxidised to sulphur.
- Here, Cl_2 is changing into HCl. That is hydrogen is being added to chlorine. Now by def. the addition of hydrogen to a substance is called reduction. so, chlorine is being reduced to hydrogen chloride.

Removal of hydrogen - Oxidation

$$H_2S + Cl_2 \xrightarrow{Heat} S + 2HCl$$

Addition of hydrogen - Reduction

- Substance oxidised - H_2S
- substance reduced - Cl_2
- Oxidising agent - Cl_2
- Reducing agent - H_2S

a. The substance which gets oxidised is the reducing agent
b. The substance which gets reduced is the oxidising agent.

• Example 3 - When zinc oxide is heated with carbon, then zinc metal and carbon monoxide are formed -

$$ZnO + C \xrightarrow{Heat} Zn + CO$$

zinc oxide — carbon — zinc — carbon monoxide

• zinc oxide (ZnO) is losing oxygen, so it is being reduced to zinc. and carbon (C) is gaining oxygen, so it is being oxidised to carbon monoxide.
• Oxidising agent - ZnO • Reducing agent - C
• It is used in the production of zinc metal in industry.
• Carbon is used in the form of coke for the extraction of zinc metal.

• Example 4 - When manganese dioxide reacts with hydrochloric acid, then manganese dichlodride, chlorine and water are formed.

$$MnO_2 + 4HCl \xrightarrow{Heat} MnCl_2 + Cl_2 + 2H_2O$$

Manganese dioxide — hydrochloric acid — Manganese dichloride — chlorine — water

• Oxidising agent - MnO_2 • Reducing agent - HCl
• MnO_2 is losing oxygen to form $MnCl_2$, so magnese dioxide (mno_2) is reduced to manganese dichloride.
• Hcl is losing hydrogen to form Cl_2, so hydrochloric acid (HCl) is being oxidised to chlorine (Cl_2).

• Concept of oxidation and reduction in terms of metal and nonmetal -
• The addition of non-metallic element (or removal of metallic element) is called oxidation.
• The addition of metallic element (or removal of non-metallic element) is called reduction.

• Example 5 - When copper is heated in air, it reacts with the oxygen of air to form a black compound copper oxide.

$$2Cu(s) + O_2(g) \xrightarrow{Heat} 2CuO$$

• copper (Red-brown) — • Oxygen (From air) — • copper oxide (Black)

• Cu is changing into CuO. This is addition of oxygen. But addition of oxygen is called oxidation, so copper (Cu) is oxidised to copper oxide (CuO).
• O_2 is changing into CuO. This is addition of copper (Cu) which is a metal. But, addition of metal is called reduction, so in this reaction, oxygen (O_2) is reduced to copper oxide (CuO).
• Oxidising agent - O_2 • Reducing agent - Cu

• Reaction carried out as-

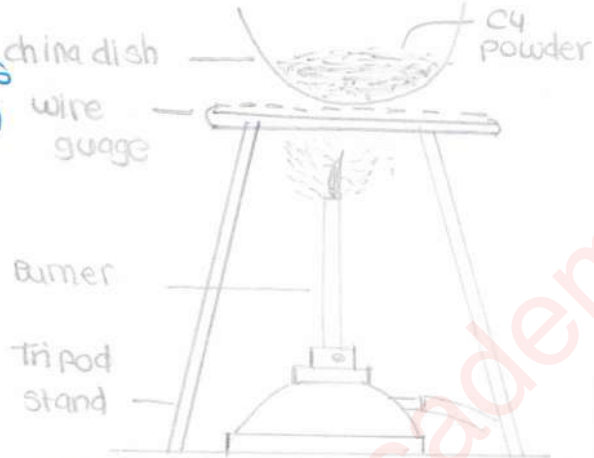
1. Take about 1g of Cu powder in a china dish. It is red-brown in colour.
2. Heat the china dish strongly over a burner.
3. A black substance is formed. The black substance is copper oxide.

• The oxidation of magnesium is similar to the oxidation of copper.

• In case of magnesium ribbon, oxygen is oxidising agent and magnesium is reducing agent.

• When copper metal is heated in air, it gets oxidised to form copper oxide. This reaction can be reversed by hydrogen gas (passed) over heated copper oxide to get back Cu metal.

• If hydrogen gas is passed over heated copper oxide, then black copper oxide is reduced and red brown copper metal is obtained.



• oxidation of copper to CuO.

• $CuO_{(s)} + H_{2(g)} \xrightarrow{Heat} Cu_{(s)} + H_2O_{(l)}$

copper oxide (Black) | hydrogen | copper (Red brown) | water

• Copper oxide reduced to copper metal, whereas hydrogen is oxidised to water.

• What are the effects of oxidation reaction in everyday life?

• Oxidation has damaging effects on metals as well as on food.

• There are two common effects of oxidation reactions which we observe in daily life-

1. Corrosion of metals
2. Rancidity of food

• The oxidation involved in the corrosion of metals as well as rancidity of food is caused naturally by the oxygen present in air.

• CORROSION -

• Corrosion is the process in which metal are eaten up gradually by the action of air, moisture or a chemical (such as an acid) on their surface

• It is caused mainly by the oxidation of metals by oxygen of air.

• **Rusting** of iron metal is the most common form of corrosion.

• When an iron object is left in damp air for considerable time, it gets covered with a red-brown flasky substance called **Rust**. and this is called **Rusting of iron**.

• Iron metal is oxidised by the oxygen of air in the presence of water to form hydrated iron (II) oxide called rust.

• $4Fe + 3O_2 + 2xH_2O \longrightarrow 2Fe_2O_3 . xH_2O$ (Rust)

Iron | oxygen | water | Hydrated iron (III) oxide

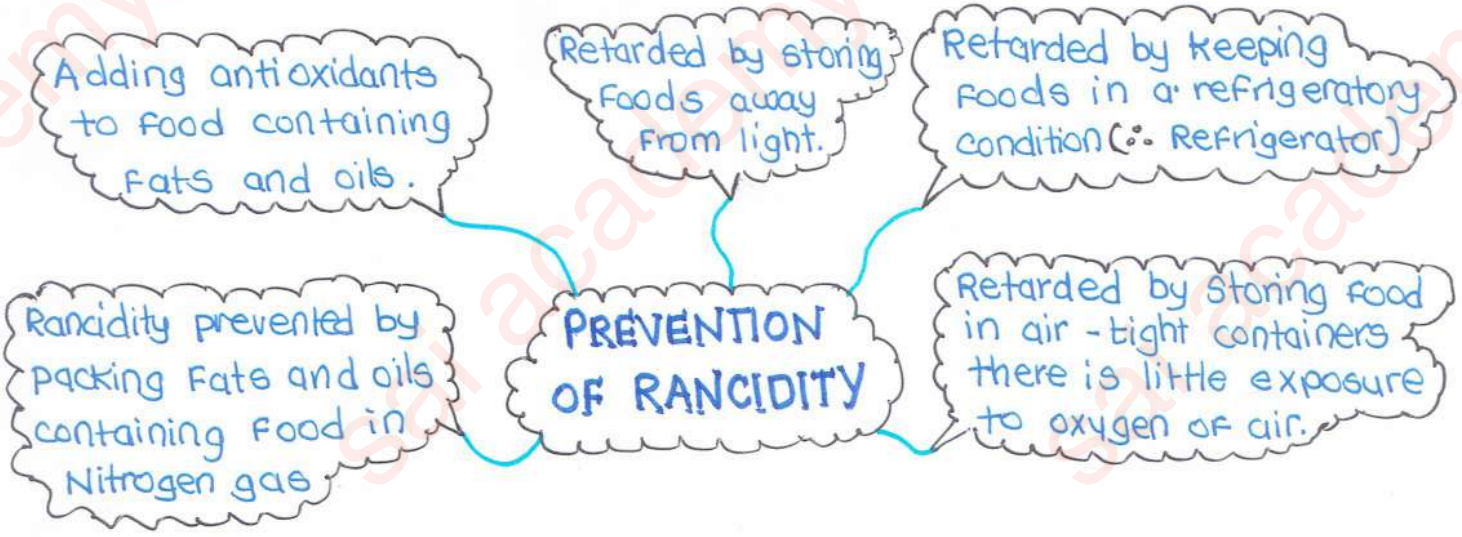
- The number of water molecules (x) in the rust varies, it is not fixed. The rusting of iron is a redox reactions.
- Rusting involves unwanted oxidation of iron metal which occurs in nature on its own.
- Rusting of iron is a continuous process, which, if not prevented in time eats up the whole iron object.
- Corrosion weakens the iron and steel objects and structure such as railings, car bodies, bridges and ships and cuts short their life.

METHODS OF PREVENTION -

- It can be prevented by painting.
- It can be prevented by applying grease or oil.
- It can be prevented by galvanisation.
- It can be prevented by tin plating and chromium plating
- It can be prevented by alloying to make stainless steel.
- It can be prevented by coating or depositing a thin layer of metal.

RANCIDITY -

- Oxidation also has damaging effects on foods containing fats and oils.
- When the food material prepared in fats and oils are kept for a long time, they starts giving unpleasant smell and taste. these are said to be rancid.
- The condition produced by aerial oxidation of fats and oils in foods marked by unpleasant smell and taste. is called Rancidity.
- Rancidity is called 'vikritgandhita' in Hindi.



- The antioxidant which are added to prevent rancidity are -
- BHA - Butylated Hydroxy - Anisole
- BHT - Butylated Hydroxy - Toluene
- By these way Food remains fresh and not become rancid.
- When the packed food is surrounded by unreactive gas nitrogen, there is no oxygen to cause its oxidation and make rancid.

- The refrigerator has a low temperature inside it. when the food is kept in refrigeratory, the oxidation of fats and oils in it slowed down due to low temperature.
- Due to absence of light, the oxidation of fats and oils present in food is slowed down and hence the development of rancidity is retarded.
- These are the some prevention methods-

- Is oxidation an exothermic or an endothermic reaction?

- Mostly oxidation reaction is exothermic reactions. but it can be both exo and endothermic reaction.

Ex- Photosynthesis in Plants, digestion of food.

• Metals and Nonmetals -

• on the basis of their properties, all the elements can be divided into two main groups.

• Metals • Nonmetals

• Malleable - means which can be beaten with hammer to form thin sheets.

• Ductile - means which can be stretched to form thin wires.

• Brittle - means which breaks into pieces on hammering or stretching.

• METALS -

• Metals are the element that conduct heat and electricity, and are malleable and ductile.

• Metals are lustrous (shiny), hard, strong, heavy and sonorous.

• Example - Iron, Aluminium, copper, silver, Gold, Platinium, Zinc, Calcium etc.

• All the metals are solid, except mercury which is a liquid metal

• Metals are the elements (except hydrogen) which form positive ions by losing electrons (or donating electrons).

• Ex- Aluminium (AL) is a metal which form +vely charged aluminium ion (AL^{+3}) by losing electrons.

• Why metals are known as electropositive elements?

• Bcoz they form positive ions by losing electrons.

• The most abundant metal in earth crust is Aluminium, constitues 7% of earth.

• The second most abundant metal in earth crust is iron, constitue 4% of earth crust.

• NON-METALS -

• Non metal are the element that do not conduct heat and electricity and are neither malleable nor ductile. and they are brittle.

• It is not lustrous (not shiny), they have dull appearance.

• They are generally soft and not strong they are light and non-sonorous

• Example- carbon, silicon, Phosphorus, Sulphur, Hydrogen, oxygen, Jodine etc.

• The two allotropic forms of carbon element - Diamond and graphite

• 22 nonmetals are present, in which 10 are non metal - solids, 1 are liquid and other all 11 are gases.

• Bromine is a liquid nonmetal at room temperature.

• Non metals are the elements which form -ve ions by gaining electrons

• Non metals are known as electronegative elements because they can form -ve ions by gaining electrons.
• Exception - H^+ (Hydrogen) is the only non-metal element which loses electrons to form +ve ions, H^+ ions.
• CARBON is one of the most important non metal because all life on this earth is based on carbon compound.
• OXYGEN is equally important for existence of life bcoz it is imp. for breathing to maintain life. necessary for the combustion of fuels.
• NITROGEN is an inert gaseous non metal whose presence in air reduces the rate of combustion.
• Most abundant non metal in earth crust - OXYGEN - 50% present.
• 2nd most abundant non metal in earth crust - SILICON - 26% present

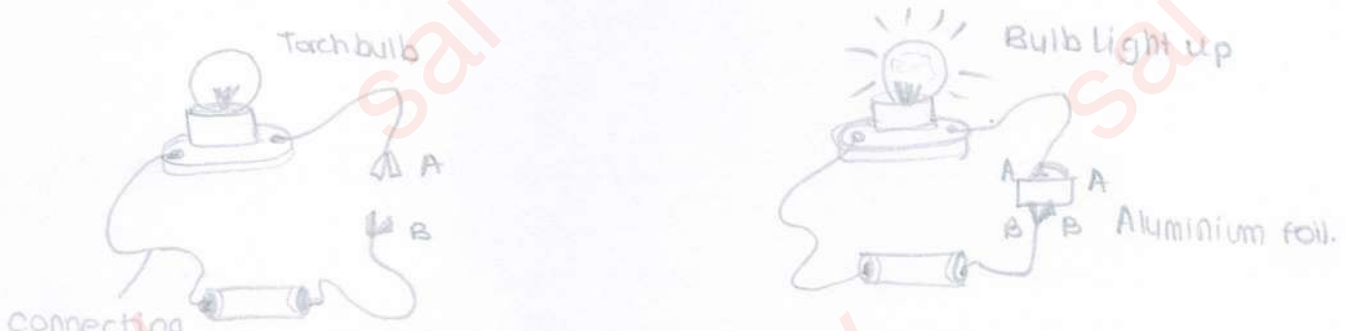
• PHYSICAL PROPERITIES OF METALS -

• Metals are mallaeble, that is metal beaten into thin sheets -
• Malleability - The property which allows the metal to be hammered into thin sheets. It is important characteristic of metal.
• Ex- Gold and silver metals are best malleable metals.
• Ex- Aluminium and copper metal are also highly malleable metals.
• foils are used for decorating sweets.
• Aluminium foils are used for packing food items like biscuit, cigarette and medicine. they all turn into thin sheets bcoz they are mallaeble

• Metals are ductile, that is metals turns into thin wires -
Ductility - The property which allows the metal to be drawn into thin wire
• Gold is the most ductile metal and silver are among the best ductile metal.
• copper and aluminium metals are very ductile and drawn into thin copper and Aluminium wires.
• Magnesium metals are used in experiment in the laboratory and Tungsten metal are used for making the filament of electric bulbs.

• Metals are good conductor of heat -
• Metal allows heat to pass through them easily.
• Experiment -
• Silver metal is the best conductor of heat. It has highest thermal conductivity
• copper and aluminium metal are also very good conductor of heat.
• The cooking utensil and water boilers are usually made of copper or aluminium metals bcoz they are good conductor of heat.
• Poorest conductor of heat - Lead, Mercury

- Metals are good conductor of electricity -
- Metals allows electricity to pass through them easily.
- Demonstrated as follows -
- we take a dry cell, a torch is fitted in a holder and some connecting wire with crocodile clips and connected them to make an electric circuit.
- There is gap between the ends of the crocodile clips A and B so no current flows in incomplete circuit and hence does not glow (bulb).
- Lets us now insert a piece of aluminium foil between the ends of crocodile clips A and B.
- We will now insert a piece of aluminium foil between the end of clip the bulb light up at once.
- The Aluminium foil allow electric current to pass through it.
- This conducts the electricity, so we conclude that the aluminium metal is good conductor of electricity.
- Silver metal is the best conductr of electricity and copper metal is the best conductor of electricity.
- Electrical conductivity is the characteristic of property of metals.



- conduct electricity -

5. Metal are lustrous or shiny and can be polished -
- lustrous means having a shining surface, the shiny apperance of the substance is called 'metallic lustre'.
- The shiny apperance of metals makes them useful in making jewelery and decoration pieces.
- The metal lose their shine or brightness on keeping in air for long time due to formation of a thin layer of oxide, carbonate and sulphide on their surface.

6. Metals are generally hard -
- Most of the metals like iron, copper and aluminium are very hard they cannot cut with knife.
- Sodium and potassium are soft metals which can be easily cut with knife. (Exception)

- Metals are strong-
- Metal can hold large weight without snapping (without breaking).
- Exception- Except sodium and potassium metal which are not strong
- iron metal used in construction of bridges, buildings and railway line.

- Metals are solids at room temperature-
- Metals a. iron, b. copper, c. silver, d. gold are solids at room temp. only one metal, Mercury is in liquid state at room temperature.

- Metals have high melting points and boiling point-
- Iron metal has high melting point of 1535°C, this means that solid iron melts and turns into liquid on heating to a high temp.
- Copper metal has high melting point of 1083°C.
- Exceptions- Sodium and potassium metal has low melting point of 98°C and 64°C.
- Gallium and cesium metal also has low melting point - 30°C and 28°C.

- Metal are sonorous, that is metal makes sound when hit an object.
- Sonorous means capable of producing a deep or ringing sound.
- The property of metals of being sonorous is called sonority.
- It is due to the property of sonorousness that metals are used for making bells and strings of musical instruement like sitar and violin

- Metals usually have a silver or grey colour-
- Copper has red-dish brown colour whereas gold has yellow colour.

- PHYSICAL PROPERTIES OF NON-METAL-
- Non metal are neither malleable nor ductile. Non metal are brittle-
- Non metal are not malleable, they cannot beaten into thin sheets. nor drawn into wires.
- Ex- Sulphur and phosphorus are beaten with hammer, they break into pieces, they do not form thin sheet.
- Carbon is a solid non-metal which is brittle, the brittleness is property of non metal.

- Non metal do not conduct heat and electricity-
- Bcoz, they have no electrons.
- Carbon in form of graphite is the only non-metal which is good conductor of electricity, it is used for making electrode.
- Sulphur do not conduct heat and electricity.

- Non metals are not lustrous. They are dull-
- Non metal do not have lustre, which means that non metal do not have a shining surface. and solid non-metal have a dull apperance
- Iodine is a non-metal having lustrous apperance. it has shining surface.

- Non metals are generally soft -
- Non metal are quite soft. Sulphur and phosphorus are solid non-metal, which are soft. (Exception).
- only Diamond is very hard and it is the hardest natural substance.
- Non metal are not strong. They are easily broken -
- Graphite is a non-metal which is not strong. It has low strength so, when a large weight is placed on graphite sheet.
- Non metal may be solid, liquid or gases at room temp.
- Sulphur and phosphorus - solid non-metal
- Bromine - a liquid non-metal
- Hydrogen, oxygen - Nitrogen and chlorine - gaseous non metal,
- Non metal have low melting points and boiling points -
- Melting point of sulphur - 115°c quite low.
- Melting point of Diamond - more than 3500°c, very high.
- Non metals are non-sonorous. They do not produce sound when hit with an objects.
- Non metals have many different colours - sulphur - yellow phosphorus - white or red, graphite - black, chlorine - yellowish green, oxygen and hydrogen - colourless.

- CHEMICAL PROPERTIES OF METAL -
- Reaction of metals with oxygen -
- When metal are burnt in air, they react with oxygen of air to form metal oxides -

Metal + oxygen ⟶ Metal oxide
(Basic oxide)

- Metal oxides, being basic turns red litmus solution blue.
- The vigour of reaction with oxygen depends on the chemical reactivity of metal -
- Sodium metal reacts with the oxygen of air at room temperature to form a basic oxide called sodium oxide.

$4Na(s) + O_2(g) \longrightarrow 2Na_2O(s)$
sodium oxygen sodium oxide

- Why potassium and sodium metal are stored under kerosene oil to?
- The potassium and sodium metal are so reactive that they react vigorously with oxygen (of air).
- They catch fire and start burning when kept in air.
- So, it is kept in kerosene to prevent their reaction with the O_2, moisture and CO_2 of air.

- Most of the metal oxides are insoluble in water. But some of the metal oxides dissolve in water to form alkalis.
- Sodium oxide and potassium oxide are the two metal oxide dissolve in water which are soluble in water.
- Sodium oxide is a basic oxide which react with water to form an alkali called sodium hydroxide.

$$Na_2O(s) + H_2O(l) \longrightarrow 2NaOH(aq)$$

Sodium oxide (Basic oxide) + water → sodium hydroxide (An alkali)

- Due to formation of NaOH alkali, a solution of sodium oxide in water turns red litmus to blue.
- Potassium oxide is also a basic oxide which reacts with water to form an alkali called potassium hydroxide.

$$K_2O(s) + H_2O(l) \longrightarrow 2KOH(aq)$$

Potassium oxide (Basic oxide) + water → Potassium hydroxide (An alkali)

- Turns red litmus to blue.
- Aluminium metal burns in air, on heating to form aluminium oxide-

$$4Al(s) + 3O_2(g) \longrightarrow 2Al_2O_3(s)$$

Aluminium (metal) + oxygen → Aluminium oxide (Amphoteric oxide)

- Aluminium is less reactive than magnesium.
- **Amphoteric oxide-**
- Those metal oxides which shows basic as well as acidic behaviour are called Amphoteric oxide.
- Aluminium metal and zinc metal form amphoteric oxide, aluminium oxide and zinc oxide are amphoteric in nature.
- React with both acids as well as bases to form salt and water.

a. **Aluminium oxide reacts with HCl to form aluminium chloride and water-**

$$Al_2O_3(s) + 6HCl(aq) \longrightarrow 2AlCl_3(aq) + 3H_2O(l)$$

Aluminium oxide + Hydrochloric acid (Acid) → Aluminium chloride (Salt) + water

- In this reaction, aluminium oxide behave as basic oxide

• Aluminium oxide reacts with sodium hydroxide to form sodium aluminate (salt) and water.

• $Al_2O_3(s) + 2NaOH(aq) \longrightarrow 2NaAlO_2(aq) + H_2O(l)$

Aluminium oxide — sodium hydroxide (Base) — Sodium aluminate (Salt) — water

• In this reaction aluminium oxide behave as an acidic oxide.

• zinc metal burns in air only on strong heating to form zinc oxide -

• $2Zn(s) + O_2(g) \longrightarrow 2ZnO(s)$ (Amphoteric oxide)

zinc — oxygen — zinc oxide

• zinc is less reactive than aluminium.

• zinc oxide reacts with hydrochloric acid to form zinc chloride and water -

a. • $ZnO(s) + 2HCl \longrightarrow ZnCl_2 + H_2O$

zincoxide — Hydrochloric acid (Acid) — zincchloride (salt) — water

• In this reaction, zinc oxide behaves a basic oxide.

b. zinc oxide reacts with sodium hydroxide to form sodium zincate and water -

• $ZnO + 2NaOH \longrightarrow Na_2ZnO_2 + H_2O$

• zinc oxide — • sodium hydroxide (Base) — sodium zincate (salt) — water

• In this reaction, zinc oxide behaves as an acidic oxide.

• Iron metal does not burn in air even on strong heating. Iron reacts with the oxygen on heating to form iron (II, III) oxide.

$3Fe(s) + 2O_2(g) \longrightarrow Fe_3O_4(s)$

Iron — oxygen — Iron (II, III) oxide

• The reaction between iron with oxygen takes place readily than that of zinc, so iron is less reactive than zinc.

2. Reaction of metals with water -

• Metal react with water to form a metal hydroxide and hydrogen gas.

a. when a metal react with water, then produce metal hydroxide and hydrogen gas.

Metal + water ⟶ Metal hydroxide + Hydrogen

b. Metal reacts with steam, then produces products such as metal oxide and hydrogen-

- Metal + steam ⟶ Metal oxide + Hydrogen

- Forexample-
- Potassium reacts violently with cold water to form potassium hydroxide and hydrogen gas -

- $2K(s) + 2H_2O(l) \longrightarrow 2KOH(aq) + H_2(g) + Heat$

- Potassium · water · Potassium hydroxide · Hydrogen

- It is highly exothermic due to which the hydrogen gas formed during the reaction catches fire immediately.
- Sodium reacts vigorously with cold water forming sodium hydroxide and hydrogen gas.

- $2Na(s) + 2H_2O(l) \longrightarrow 2NaOH + H_2 + Heat$

- Sodium · water (cold) · Sodium hydroxide · Hydrogen

- It is highly exothermic due to which the hydrogen gas formed during the reaction catches fire., bcoz sodium is also a very reactive metal.
- calcium reacts with cold water to form calcium hydroxide and hydrogen gas-

- $Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$

- Calcium · water (cold) · Calcium Hydroxide · Hydrogen

- The piece of calcium metal starts floating in water bcoz of the bubble the hydrogen gas formed during the reaction stick to surface.
- The reaction of calcium metal with water is less violent.
- calcium is less reactive than sodium.

- Metals like aluminium, zinc and iron do not react with either cold water or hot water. they react with steam to form a metal oxide and H_2.
- Aluminium reacts with steam to form aluminium oxide and hydrogen gas-

- $2Al(s) + 3H_2O(g) \longrightarrow Al_2O_3(s) + 3H_2(g)$

- Aluminium · steam · Aluminium oxide · Hydrogen

Aluminium metal does not react with water under ordinary condition bcoz of the presence of thin layer of aluminium oxide.

- zinc reacts with steam to form zinc oxide and hydrogen-

$Zn(s) + H_2O(g) \longrightarrow ZnO(s) + H_2(g)$

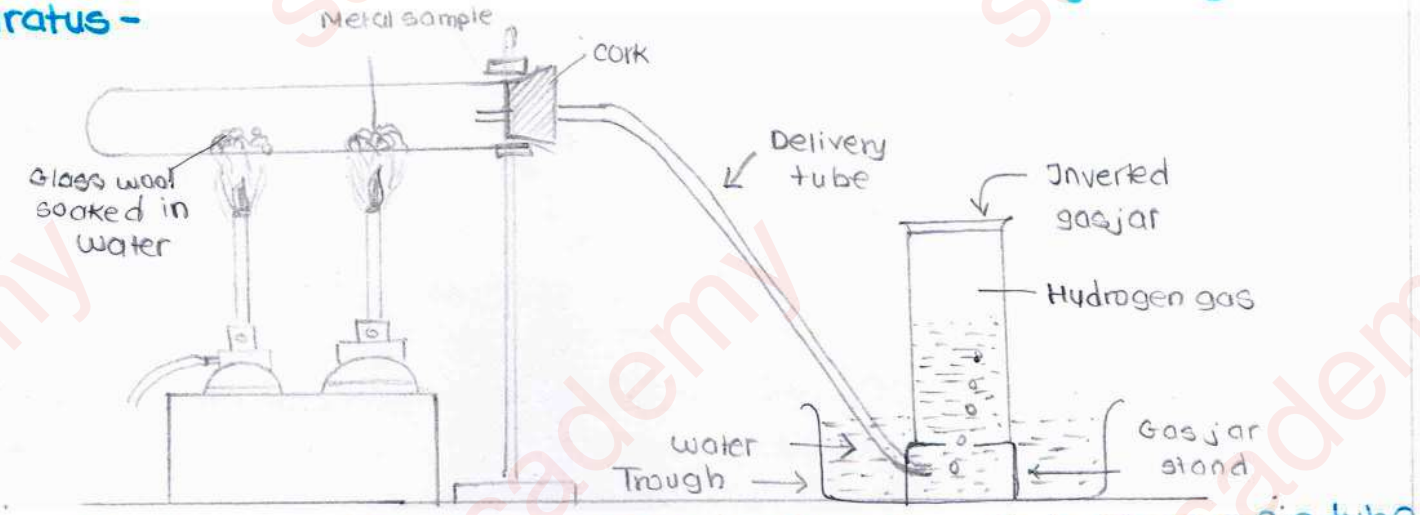
zinc · steam · zinc oxide · Hydrogen

- Red-hot iron reacts with steam to form iron(II, III) oxide and Hydrogen.

- $3Fe_{(s)} + 4H_2O_{(g)} \longrightarrow Fe_3O_{4(s)} + 4H_{2(g)}$

  Iron — Steam — iron(II, III) oxide — Hydrogen

- We can study the reaction of metals with steam by using the apparatus -



- A lump of glass wool soaked in water is placed at bottom of a tube The water in glass wool will form steam on heating.
- The sample of metal is placed in the middle of the horizontally kept boiling tube. The boiling tube containing water, soaked glass wool and metal sample is arranged in apparatus.
- To start the experiment, the metal sample is heated by using a burner when the metal gets hot, then the glass wool is heated by using other burner.
- The water present in glass wool forms steam on heating. this steam then passes over the hot metal. The metal react with steam to form the metal oxide and H_2 gas.
- The H_2 gas come out of the boiling tube and it is collected over water when a lighted match stick is applied to gas collected jar, the gas burns with a pop sound. indicating that it is hydrogen. The metal oxide formed remains behind in the boiling tube.
- This experiment is performed by taking magnesium, aluminium, zinc and iron as metal sample.
- It is found that the reaction of steam with magnesium is most vigorous followed by mx with aluminium and zinc, but mx with iron is slow.
- Magnesium is very reactive whereas the iron is least reactive.
- Decreasing order - Mg > Al > Zn > Fe
- Metals like lead, silver and gold do not react with water or even steam.
- Only those metals displace hydrogen from water which are hydrogen in the reactivity series.

- Reaction of metals with Dilute Acids -
- Metals usually displace hydrogen from dilute acids. only less reactive metals like copper, silver and gold do not displace hydrogen from dilute acids.

Metal + Dilute acid ⟶ Metal salt + Hydrogen

- All metals, do not react with dilute acids. the vigour of m x of metal with dilute acids depend on chemical reactivity.
- Metal react with dil HCl to give metal chloride and hydrogen gas -
- Sodium metal react violently with dil. HCl to form sodium chloride and hydrogen gas.

$2Na(s) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H_2(g)$

Sodium — Hydrochloric acid — sodium chloride — Hydrogen

- The reaction shows that sodium metal is very reactive.
- Zinc reacts with dil. HCl acid to give zinc chloride and hydrogen gas -

$Zn(s) + 2HCl(aq) \longrightarrow ZnCl_2(aq) + H_2(g)$

zinc — Hydrochloric acid — zinc chloride — Hydrogen.

- Zinc is less than reactive aluminium
- Note - Silver and gold also do not react with dilute acids.
- How metals displaces hydrogen from dilute reacts - **(2M|3M)**
- All those metals which are more reactive than hydrogen, that is those metal which lose electrons more easily than hydrogen displace hydrogen from dilute acids to produce hydrogen gas.
- The metals like copper and silver which are less reactive than hydrogen do not displace hydrogen from dilute acids. bcoz they do not give out electrons required for reduction of hydrogen ions present in acid.
- All the metal which are above hydrogen in the activity series, displace hydrogen from dilute acids.
- Those metals which are below hydrogen in activity series, do not displace hydrogen from dilute acids.
- Metals reacts with dil sulphuric acids to give metal sulphate and H_2 gas -

$2Na(s) + H_2SO_4(aq) \longrightarrow Na_2SO_4(aq) + H_2(g)$

Sodium — sulphuric acid — sodium sulphate — Hydrogen

$Cu + H_2SO_4 \longrightarrow CuSO_4 + H_2$ No reaction

copper — sulphuric acid

$Fe + H_2SO_4 \longrightarrow FeSO_4 + H_2$

Iron — sulphuric acid — Iron(II) sulphate — Hydrogen.

• When a metal reacts with dil. nitric acid, then hydrogen gas is not evolve.

• Explanation - Nitric acid is oxidising agent so, as soon as hydrogen gas is formed in the reaction between a metal and dil. nitric acid, the nitric acid oxidises this hydrogen to water.

• When nitric acid oxidises hydrogen to water, then nitric acid itself reduced to any of the nitrogen oxide.

• Dil. nitric acids, however reacts with magnesium and manganese metals to evolve hydrogen gas - this is bcoz the dil. nitric acid is a weak oxidising agent which is not able to oxidise hydrogen to water.

a. **Magnesium reacts with very dil. nitric acid to form magnesium nitrate and hydrogen gas.**

• $Mg(s) + 2HNO_3(aq) \longrightarrow Mg(NO_3)_2(aq) + H_2(g)$

Magnesium nitric acid magnesium nitrate Hydrogen.

b. **Manganese reacts with dil. nitric acid to form managanese nitrate and hydrogen gas.**

$Mn(s) + 2HNO_3(aq) \longrightarrow Mn(NO_3)_2(aq) + H_2(g)$

Manganese dil nitric acid Manganese nitrate hydrogen

• **Aqua - Regia -**

• Aqua - regia is freshly prepared mixture of 1 part of conc. nitric acid and 3 part of conc. HCl.

• Ratio - conc. HNO_3 : conc HCl - 1:3, it is a highly corrosive fuming liquid.

• Aqua regia can dissolve all metals.

• Aqua regia can dissolve even gold and platinum metals.

• **The reactivity series of metal -**

• Some metals are chemically very reactive whereas others are less reactive or unreactive.

• The arrangement of metals in a vertical column in order of decreasing reactivites is called reactivity of series of metals.

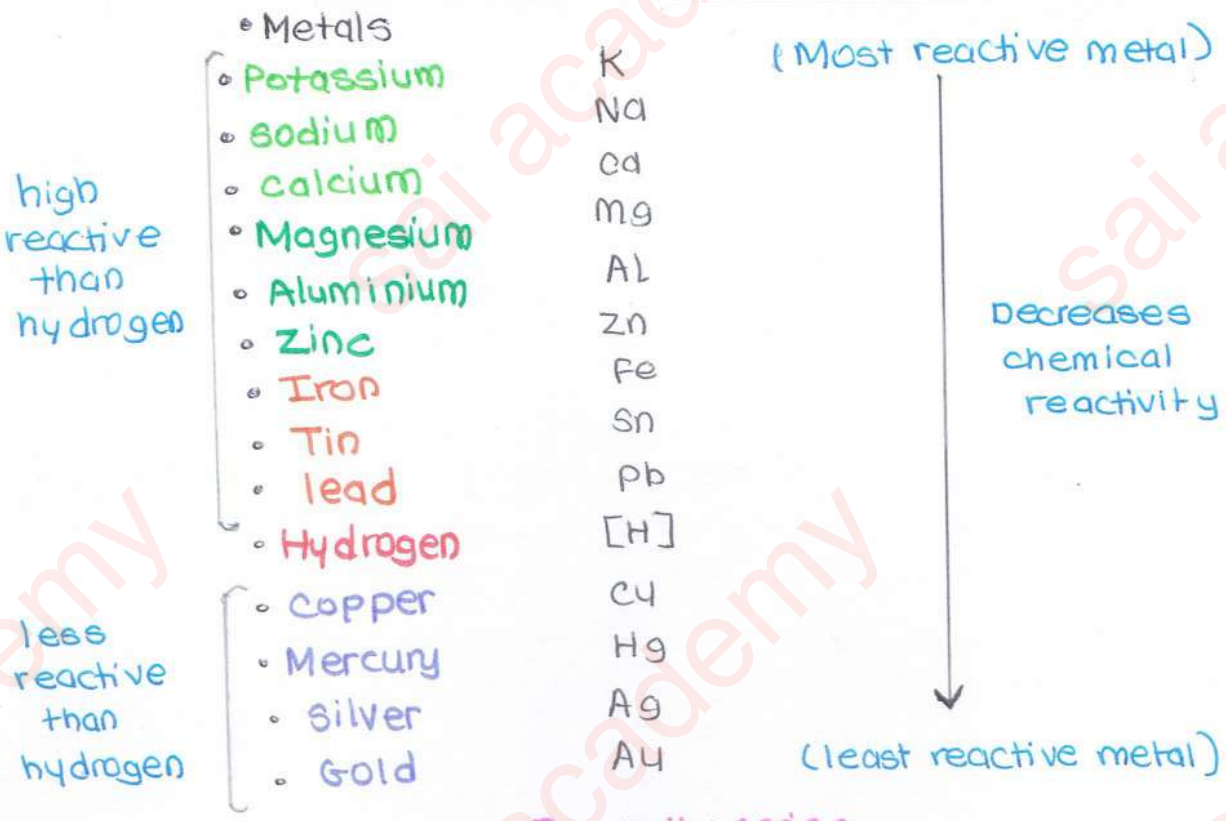
• The reactivity series, the most reactive metal is placed at the top whereas the least reactive metal is placed at bottom.

• As we come down in the series, the chemical reactivity of metal decreases.

• Most reactive metal - Potassium

• least reactive metal - Gold

• Hydrogen is also placed in reactivity series, as it is not a metal. it is usually places as it loses electrons and forms +ve ions.



• Reactivity series •

Q. Why some metals are more reactive and others less reactive

• When metal reacts, they lose electrons to form positive ions hence it will be a reactive metal.

• When metal reacts, they lose electrons less readily to form positive ions, it will react slowly. such metal is less reactive.

• Ex- Sodium, Potassium

Q. Why some metals are more reactive than hydrogen?

• Those metal which lose electrons more readily than hydrogen are said to be more reactive than hydrogen.

• The metal above hydrogen are lose electrons more readily than H_2 and hence they are more reactive

Q. why some metals are less reactive than hydrogen?

• Those metal which lose electrons less readily than hydrogen are said to be less reactive. than hydrogen.

• All metal below hydrogen are in reactivity series, lose electrons less readily than hydrogen, they are less reactive than hydrogen.

• Note- We should remember the reactivity series of metals to decide whether a particular displacement rnx will take place or not.

• Reaction of metal with salt solutions

• When a more reactive metal is put in the salt solution of a less reactive metal, then the more reactive metal displaces the less reactive metal from its salt solution.

• A more reactive metal displaces less reactive metal from its solution.

• Salt sol. of metal B + Metal A → Salt sol. of A + Metal B

- The reaction of zinc with copper sulphate solution -
  - $CuSO_4(aq) + Zn(s) \longrightarrow ZnSO_4(aq) + Cu(s)$

  copper sulphate (Blue) | zinc (silvery white) | zinc sulphate (colourless) | copper (Red brown)
- In this reaction zinc metal is displacing copper metal from its salt solution. copper sulphate solution.
- If however, a strip of copper metal is placed in zinc sulphate solution, then no rx occurs. bcoz copper metal is less reactive than zinc metal and hence cannot displace zinc from zinc sulphate solution.
- Reaction of copper with silver nitrate solution -
- When a strip of copper metal is kept immersed in silver nitrate for sometime, the solution graudaally becomes blue and shining greyish white deposit of silver metal form on copper strip.
  - $2AgNO_3(aq) + Cu(s) \longrightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

  silver nitrate (colourless) | copper (Red brown) | copper nitrate (Blue) | silver (Greyish white)
- This is because silver is less reactive than copper and hence cannot displace copper from copper nitrate solution.

- **Reaction of metals with chlorine -**
- Metals react with chlorine to form ionic chlorides because they can give electrons to chlorine atoms to form ions.
- Metal chlorides have high melting and boiling point. metal chlorides are usually solid and conduct electricity in the solution in molten state.
- Metal chloride are weak electrodytes. and are non volatile.
- Sodium is a metal. so sodium reacts with chlorine to form an ionic chloride.
  - $2Na(s) + Cl_2(g) \longrightarrow 2NaCl(s)$

  Sodium | chlorine | sodium chloride
- It is an ionic compound or electrovalent compound containing sodium ion Na^+ and chloride ions (Cl^-).
- Calcium is a metal which react with chlorine to form an ionic chloride called calcium chloride -
  - $Ca(s) + Cl_2(g) \longrightarrow CaCl_2(s)$

  calcium | chlorine | calcium chloride
- Magnesium on heating with chlorine form magnesium chloride which is an ionic chloride -

  $Mg(s) + Cl_2(g) \longrightarrow MgCl_2(s)$

  Magnesium | chlorine | magnesium chloride
- All these metal chlorides are ionic compounds.

5. Reaction of metals with hydrogen-

- Metals generally do not react with hydrogen bcoz metals form compounds by losing electrons and hydrogen also form compound by losing electron.
- Most of the metals do not combine with hydrogen. only a few reactive metals like sodium, potassium and magnesium react with hydrogen to form metal hydrides.
- In a metal hydride, the hydrogen present in the form of a negative ion (anion) called hydride ions H^-.
- when hydrogen gas is passed over heated sodium, then sodium hydride is formed:

$$2Na(s) + H_2(g) \longrightarrow 2NaH(s)$$

sodium hydrogen sodium hydride

- NaH is an ionic compound containing sodium ions (Na^+) and hydride ions, H^-. When hydrogen gas is passed over heated potassium, then (KH) is formed. Potassium hydride is also an ionic hydride.

- CHEMICAL PROPERTIES OF NONMETAL-

- **Reaction of non metal with oxygen-**
- Non metal reacts with oxygen to form acidic oxides or neutral oxides.
- carbon forms an acidic oxide CO_2 and hydrogen form a neutral oxide. H_2O.
- The non-metal oxides are covalent in nature which are formed by sharing of electrons. The acidic oxides of non-metals dissolve in water to form acids.
- The acidic oxides of non metal turns blue litmus solution to red.
- Carbon is non-metal. when carbon burns in air it reacts with the oxygen of air to form an acidic oxide called carbon dioxide.

$$C + O_2 \longrightarrow CO_2 \quad \text{(Acidic oxide)}$$

carbon oxygen carbondioxide

The acidic oxide, carbon dioxide, dissolve in water to form an acid called carbonic acid.

$$CO_2(g) + H_2O(l) \longrightarrow H_2CO_3(aq)$$

Acidic in nature

carbondioxide water carbonic acid.

- Turns blue litmus to red.

- sulphur is a nonmetal. when sulphur is burned in air, it reacts with the oxygen of air to form an acidic oxide called sulphur dioxide.

$$S(s) + O_2(g) \longrightarrow SO_2(g)$$

sulphur oxygen sulphurdioxide

$SO_2(g) + H_2O(l) \longrightarrow H_2SO_3(aq)$

sulphur dioxide · water · sulphurous acid

• Turns blue litmus to red.

• This shows that it is acidic in nature.

∴ The non metal oxides like CO_2, SO_2 turns blue litmus solution red, showing that they are acidic in nature. these acidic oxides are called acid anhydrides.

• Phosphorus is also an non-metal which reacts with oxygen to form acidic oxide, phosphorous pentoxide (P_2O_5)

$P + O_2 \longrightarrow P_2O_5$

phosphorus · oxygen · phosphorous pentoxide

$4P + 5O_2 \longrightarrow 2P_2O_5$

• Non metal oxides which are neutral, being acidic or basic –
Ex- carbon monoxide, water, nitrogen monoxide, dinitrogen monoxide.

• These oxides do not turn blue litmus to red litmus. or red to blue litmus

• Carbon is a nonmetal. when carbon burns in an supply of oxygen then it forms and neutral oxide called carbon monoxide-

$2C(s) + O_2(g) \longrightarrow 2CO(g)$ (neutral)

carbon · oxygen · carbon monoxide

• Does not produce an acid with water.

• Hydrogen is an non metal. when hydrogen combines with the oxygen of air, then it forms an neutral oxide.

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

Hydrogen · oxygen · water

• Water is actually a hydrogen oxide, Formed by sharing of electrons so they are covalent compounds. they not contain any oxide ion.

• **Reaction of non metal with water –**
Non metals do not react with water to evolve hydrogen gas bcoz non-metal cannot give electrons to reduce the hydrogen ions of water into hydrogen gas.

• **Reaction of non metal with salt solutions –**

• A more reactive nonmetal displaces a less reactive non metal from its salt solution.

• when chlorine is passed through a solution of sodium bromide, then sodium chloride and bromine.

$2NaBr(aq) + Cl_2(g) \longrightarrow 2NaCl(aq) + Br_2(aq)$

sodium bromide · chlorine · sodium chloride · Bromine

- Reaction of non metal with chlorine -
- Non metals reacts with chlorine to form covalent compounds which is chloride which are non electrolytes donot conduct electricity
- Non metal chloride are usually liquids or gases.
- Hydrogen reacts with chlorine to form a covalent chloride called hydrogen chloride -

$H_2 + Cl_2 \longrightarrow 2HCl$ (covalent chloride)

Hydrogen Chlorine Hydrochloric acid

- Phosphorous reacts with chlorine to form a covalent chloride called phosphorous chloride

$P_4(s) + 6Cl_2(g) \longrightarrow 4PCl_3(l)$ (covalent chloride)

phosphorus chlorine phosphorous trichloride

- Non metals form covalent chloride because they cannot give electrons to chlorine atoms to form chloride ions.

- Reaction of nonmetal with Hydrogen -
- Non metals react with hydrogen to form covalent hydrides. The hydrides are formed by the sharing of electrons that is non-metal hydrides are formed by covalent bonding.
- Sulphur is a nonmetal which combines com with hydrogen to form a covalent hydride called hydrogen sulphide

$H_2(g) + S(l) \longrightarrow H_2S(g)$ (covalent hydride)

Hydrogen sulphur Hydrogen sulphide

- The H_2S gas has a characteristics smell resembeling the smell of rotten eggs.
- Non metals form covalent hydrides because non metal atoms cannot give electrons to hydrogen atoms to form hydride ions.
- Non metal hydrides are liquids or gases. do not conduct ions, they do not conduct electricity and are stable compounds.
- Reaction of non-metal with Dilute Acids -
- Non metal do not react with dilute acids, they do not displace hydrogen from acids because in order to displace hydrogen ions of an acid and convert them into hydrogen gas, electrons should be supplied to the hydrogen of the acid. It's (nonmetal) being itself an acepptor of electrons, cannot give electrons to the hydrogen ions of the acid to reduce them to H_2 gas.
- If non metals like carbon, sulphur or phosphrous are put into test tube containing dil. H_2SO_4, then no hydrogen gas is evolve.

Uses of metal

- copper and aluminium metals are used to make wire to carry electric current
- Iron is used as a catalyst in the prep. of ammonia gas by Haber's process
- Iron, copper and Aluminium metals are used to make household utensils
- zinc is used as galvanizing iron to protect it from rusting
- Lead metal is used in making car battery
- Mercury used in thermometer
- zirconium metal is used for making bullet proof alloy steels.
- silver and gold used in making jewellery

Uses of Non metal

- carbon is used for making the electrodes of electrolytic cells and dry cells.
- Hydrogen is used as hydrogenation of vegetable oil to make vegetable ghee
- Nitrogen used to preserve food materials
- Hydrogen is used in the manufacture of ammonia
- Nitrogen is used in the manufacture of ammonia and fertilisers
- Liquid hydrogen used as a rocket fuel
- sulphur is used for manufacturing sulphuric acid
- sulphur is used as a fungicide and in making gunpowder.
- sulphur is used in the vulcanisation of rubber

- How do metal and nonmetal react -
- When metal react with nonmetals, they form ionic compounds.
- when non-metal react with other non-metal, they form covalent compound
- **chemical bond** - The force which links the atoms in a molecule is called a chemical bond.
- Noble gases are also called inert gases (bcoz they are chemically very inert or unreactive).

- **Inertness of Noble Gases** -
- There are some elements in group 18 of the periodic table which do not combine with other elements - Helium, Argon, Neon, krypton, xenon and Radon they are known as noble elements or gases because they are unreactive and do not react with other elements.
- Inert gases do not form chemical bonds. The noble gases are chemically unreactive, bcoz of the stable arrangement of atoms which do not allow the outermost electrons to take part in chemical reaction.

- Electronic configuration of Noble Gas -

Noble gas	Symbol	Atomic no.	Electronic config.	No. of e^- in outermost shell.
1. Helium	He	2	2	2
2. Neon	Ne	10	2,8	8
3. Argon	Ar	18	2,8,8	8
4. krypton	Kr	36	2,8,18,8	8
5. Xenon	Xe	54	2,8,18,18,8	8
6. Radon	Rn	86	2,8,18,32,18,8	8

- Here only one has - Helium - 2 electrons in outermost shell and all others have 8 electrons in outermost shells of their atoms.
- Outermost shell electrons are more stable arrangement of electrons. Atoms with 8 electrons are more stable and unreactive.
- Note - Though 8 electrons in the outermost shell always impart stability to an atom, but 2 electrons in the outermost shell impart stability only when the outermost shell is the first shell and no other shells are present in the atom.
- "8 electrons" in the outermost shell of an atom known as "octet of electrons"
- "2 electrons" in the outermost shell, outermost K shell is known as "duplet of electrons.
- The usual number of electrons in the outermost shell of the atom of a noble gas is 8. only in the case of one noble gas helium, the no. of outermost electrons is 2.

• we can explain the reactivity of elements as a tendency of their atoms to achieve a completely filled outermost shell or valence shell and becomes stable.

• **Cause of chemical Bonding -**

• Everything in this world wants to be stable. stability means having the electron arrangement and become more stable.

• Atoms form chemical bonds to achieve stability by acquiring the inert gas electron configuration.

• The atoms get 8 electron in valence shell are stable

• The atoms less than 8 electron in valence shell are unstable

• All atoms have tendency to achieve the inert gas electron arrangement of 8 electrons or 2 electrons in the outermost shell and become more stable.

• An atom can achiere the inert gas electron arrangement in 3ways-

• By losing one or more electrons.

• By gaining one or more electrons.

• By sharing one or more electrons.

• **Valence shell -** The outermost electron shell of an atom is known as valence shell.

• **Valence electrons-** The outermost electrons are also known as valence electrons

•IONS-

• An ion is an electrically charged atom.

Ex- sodium ions Na^+, chloride ions Cl^-, oxide ion O^{2-}

• An ion is formed by loss or gain of electrons by an atom, so it contains an unequal number of electrons and protons.

• **2 types -** • cation • Anion

• CATION - A positively charged ion known as cation

• Ex- sodium ions Na^+, magnesium ions Mg^{+2} are cation bcoz they are "+vely" charged.

• A cation is formed by the loss of one or more electrons by an atom.

• For example- sodium atom loses 1 electron to form a sodium ion Na^+.

$$Na - e^- \longrightarrow Na^+$$

Sodium — electron — sodium ion

• cation contain less electron than protons.

• It is formed by removal of electrons from an atom.

• cation is formed by loss of one or more electrons by an atoms.

• The ions of all metal element are called cation.

• cation

- A negatively charged ions is known as anion.
- Forexample- chloride ion Cl^- and oxide O^{2-} are anion bcoz they are negatively charged ions.
- An anion is formed by gaining of one or more electrons by an atom.
- EX- A chlorine atoms gains (accepts) 1 electron to form an chloride ion.

$$Cl + e^- \longrightarrow Cl^-$$

chlorine atom Electron Chloride ion.

- An anion contains more electrons than normal atom
- An anion contains more electrons than protons.
- The ions of all the nonmetal elements are anions (except H^+ ion and ammonium ions)

FORMATION OF IONS - CATIONS

If an element has 1, 2, 3 electrons in the outermost shell of its atoms, then it loses these elements to achieve the inert gas e^- arrangement of eight valence electrons and forms positively charged ion.

- Formation of sodium ions, Na^+ -
- Atomic No - 11, so atom contains 11 electrons.
- The electronic configuration of sodium is **K-2 L-8 M-1.**
- Sodium atoms has $1e^-$ in its outermost shell. it is not stable arrangement bcoz it does not have $8\ e^-$ in the outermost shell.
- In order to become more stable a sodium atom donates its outer 1 atom to get stable.
- The M shell, the e^- are removed and L shell becomes an outermost shell. By losing $1e^-$, the sodium atom gets 1 unit of +ve charge and become a sodium ion, Na^+.

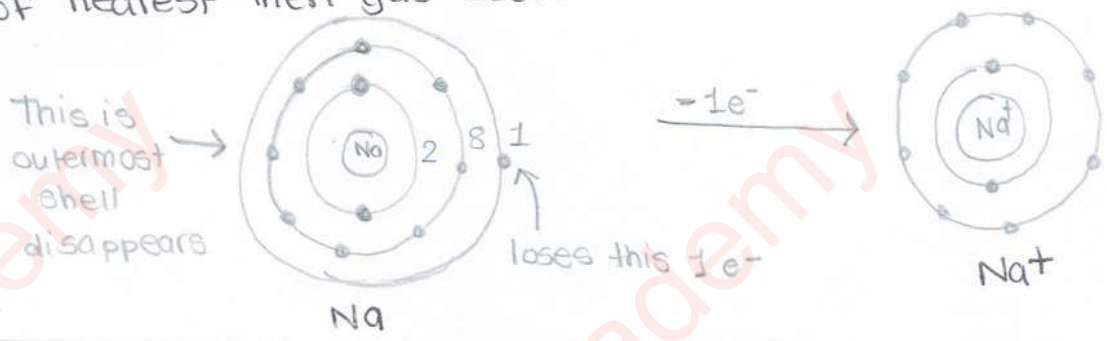
anion

$$Na - e^- \longrightarrow Na^+$$

Sodium atom Sodium ion.

Electronic confi -	K L M	K L (same as neon)
	2, 8, 1	2, 8
	unstable	stable

- The electronic configuration of the sodium ion is the same as that of nearest inert gas: neon.



• The formation of potassium ion (K^+) is similar to the formation of sodium ion because like sodium atom, the potassium atom has 1 electron in its outermost shell.

• The atomic no. of K is 19. Electronic configuration is K L M N
The noble gas nearest to potassium is argon having 2 8 8 1
18 and electronic configuration of K L M.
2 8 8

• **Formation of an Aluminium Ion, Al^{+3} -**

The atomic number of Aluminium is 13, so its electronic configuration K L M. The Al^{+3} atom has 3 electrons in its outermost shell which 2 8 3 it donates to some other atom and Al^{+3} having 3 units of positive charges.

• Al	—	$3e^-$	⟶	Al^{3+}
Aluminium		electron		Aluminium ion
• K L M				K L
2 8 3				2, 8

• The electronic configuration of an aluminium ion is the same as that of its nearest noble gas neon.

• Aluminium ion has 13 protons but only $10e^-$, that is it has 3 protons more than electrons. since an Al^{+3} has 3 protons more than electrons, it has 3 units of positive charge.

• **Electron - Dot - Representation -**

• The valence electrons in an atom are represented by putting (•) on the symbol of the element, one dot for each valence electron.

• Sodium atoms has 1 valence electron in its outermost shell, so we put the one dot with symbol of sodium and write Na•. sodium atom loses this 1 electron to form a sodium ion. so we write - Na^+

• Sodium atom loses this $1e^-$ to form sodium ion.

• Magnesium - atom has 2 valence electrons so we write. Mg:

• Aluminium - atom has 3 valence electrons so we write - •Al:

• Potassium - atom has 1 valence electron so we write - K•

• **FORMATION OF NEAGTIVE IONS (OR) ANIONS -**

• If an element has 5, 6, 7 electron in the outermost shell of its atom, then it gains electrons to achieve the stable, inert gas electron configuration of 8 valence electrons and form -vely charged ion called anion.

• Non metal atoms have usually 5, 6 or 7 electrons in their outermost shell, so the non-metal atoms accept electrons to form negative ions or anions.

• Fluorine, chlorine, bromine, iodine, oxygen are non-metals which accepts electron to form negative ions.

• The element carbon having four electrons in its outermost shell, is also an nonmetal but it neither lose 4 e^- nor gets gain 4 e^- due to energy considerations, so a carbon atom does not form ions.

• Note - An atom having 7 electrons in its outermost shell accepts 1 more electron to form an anion having 1 units negative charge.

• An atom having 6 electrons in its outermost shell accepts 2 more e^-'s to form an anion having two unit negative charge.

• **Formation of chloride ion, Cl^-**

• Atomic no - 17 , Electronic configuration - K L M
2 8 7

• Chlorine atom has 7 electrons in the outermost shell. It needs 1 more electron to achieve the stable configuration of an inert gas.

• In order to become stable, atom accepts 1 electron from other atom.

• $Cl + e^- \longrightarrow Cl^-$

Chlorine ion + Electron → chloride ion

Electronic config - K L M 2,8,7 unstable

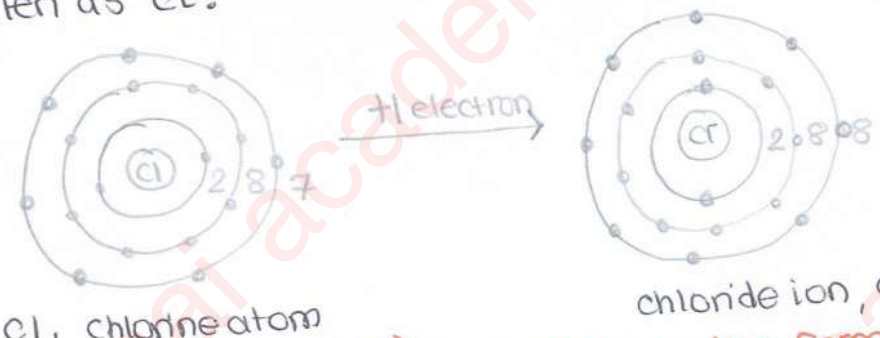
• Gain one electron

K L M 2,8,8 stable (same as Argon gas)

• It is stable than chlorine atom, it is the same as that of nearest inert gas **argon**.

• A chlorine, the no. of protons and electrons in a chlorine atom is equal, therefore it is electrically neutral, having no overall charge.

• Due to 1 more electron than protons, a chloride ion has 1 unit -ve charge. written as Cl^-.



Cl, chlorine atom — chloride ion, Cl^-

• The formation of fluoride ion (F^-) is similar to the formation of chloride ions because like chlorine atom, a fluorine atom (F) also has 7 electron in the outermost shell.

• The atomic number of fluorine is 9, and its electronic configuration is K L
2, 7 . The inert gas nearset to fluorine is neon having an electron and atomic number of 10 and electronic configuration K L. The
2 8
other halogen, bromine and iodine have also 7 valence electrons each in their atoms and accepts 1 e^- each to form bromide ion (Br^-).

- **Formation of an oxide Ion O^{2-} -**
- Atomic no. of oxygen - 8, so its electronic configuration K L 2, 6
- The oxygen atom has 6 electrons in its outermost shell, it needs 2 more electrons to achieve the stable.
- By taking 2 electrons from some other atom, the oxygen atom form an oxide ion, O^{2-}, having 2 units of negative charge.

$$O + 2e^- \longrightarrow O^{2-}$$

- O: oxygen atom — K L 2, 6 (unstable)
- $2e^-$: electrons
- O^{2-}: oxide ion — K L 2, 8 (stable) (same as neon atom)

- since an oxide ions has 2 electrons more than protons, it has 2 units of negative charge (as written as O^{2-}).
- **The formation of a sulphuide ion (S^{2-}) is similar to the formation of an oxide ion** - because like an oxygen atom, a sulphur atom has 6 e^- in its outermost shell.
- The atomic number of sulphur is 16. and electronic configuration K L M. 2 8 6
- The atomic number of 18 and electronic configuration. K L M 2 8 8. (Argon)

- **Formation of Nitride ion, N^{3-}**
- Atomic no - nitrogen - 7 • Electronic configuration - K L 2 5. Nitrogen atom has 5 valence electrons, so it needs more 3 electrons to get stable. So by taking 3 electrons from other atom a nitrogen atoms forms a nitride ion N^{3-} having 3 unit of negative charge.

$$N + 3e^- \longrightarrow N^{3-}$$

- N: Nitrogen — K L 2, 5 unstable
- $3e^-$: electron
- N^{3-}: Nitride ion — K L 2, 8 stable (same as neon)

- The electronic configuration of a nitride ion is same as that of neon atom. since a nitride ion contain 3 electrons more than protons it has 3 units of negative charge.
- **The formation of phosphide ion (P^{3-}) is similar to the formation of nitride ion.** because like a nitrogen atom, a phosphorus atom has 5 electrons in the outermost shell.
- Atomic number is 15 and electronic configuration is K L M. 2 8 5

• Electron Dot representation –

Non-metal	Symbol	Atomic no.	K L M	No. of outermost e⁻	Electron dot struc.	Ion formed
• Fluorine	F	9	2, 7	7	·F:	$[:\ddot{F}:]^-$
• chlorine	Cl	17	2, 8, 7	7	·Cl:	$[:\ddot{Cl}:]^-$
• oxygen	O	8	2, 6	6	:O:	$[:\ddot{O}:]^{-2}$
• sulphur	S	16	2, 8, 6	6	:S:	$[:\ddot{S}:]^{2-}$
• Nitrogen	N	7	2, 5	5	·N:	$[:\ddot{N}:]^{3-}$

• TYPES OF CHEMICAL BOND •

• There are two types –

• Ionic Bond • covalent bond.

• Ionic Bond – formed by transfer of electrons from one atom to another. also called as electrovalent bond.

• Covalent Bond – formed by the sharing of electrons between two atoms.

• Ionic Bond –

• The chemical bond formed by the transfer of electrons from one atom to another atom known as ionic bond.

• Transfer of electron takes place in such way that the ions formed have stable electron arrangement of inert gas.

• An ionic bond is formed when one of the atoms can donate electron to achieve inert gas configuration.

• When a metal reacts with non metal, transfer of electrons takes place from metal atoms to the non metal atoms and ionic bond is formed. Ionic compound made up of ions.

• The ions of metal and nonmetal attract each other, the strong force of attraction develop between the oppositely charged ions are known as Ionic bond.

• By losing electrons, the metal atoms forms a positively charged ion (cation). The non metal atoms forms or accepts electrons from a negatively charged ion (anion).

• Ions formed the stable chemical bond between oppositely charged ions.

• Ionic bonds are formed between metals and non metals.

- **Formation of sodium chloride -**
- Sodium is a metal whereas chlorine is a non metal.
- Sodium metals reacts with chlorine to form ionic compound, sodium chloride.
- The atomic number of sodium is 11, so electronic configuration 2,8,1. sodium atom only has 1 electron in outermost shell.

$$Na^+ \longleftarrow Na\cdot - e^-$$

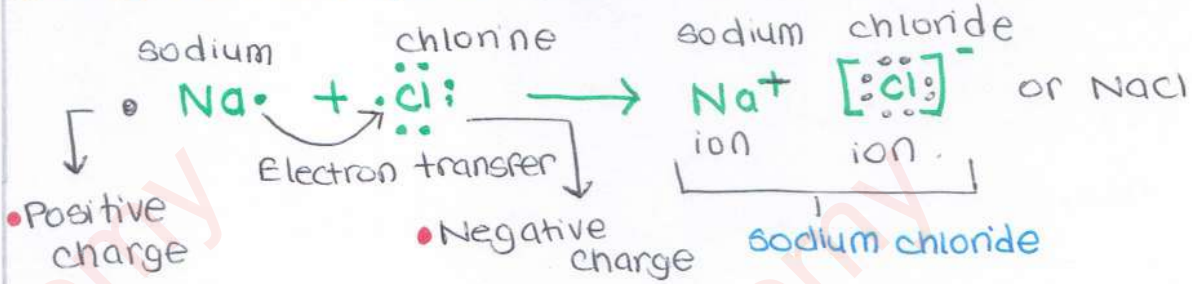
Sodium ion — Sodium atom 2,8,1 — electron

- The atomic number of chlorine is 17, so its electronic configuration is 2,8,7. chlorine atoms has 7 electrons in outer most shell and needs 1 electron to get stable.

$$\cdot\ddot{Cl}: + e^- \longrightarrow [:\ddot{Cl}:]^-$$

Chlorine 2,8,7 — electron — chloride ion

- When sodium react with chlorine, it transfers its 1 outermost electron to the chlorine atom.
- By losing 1 electron, sodium atoms forms a sodium ion (Na^+) and by gaining 1 electron, the chlorine atoms forms a chloride ion. (Cl^-).



- They held together by electro static force of attraction.
- Sodium ion resemble to inert gas neon. and chloride ion resemble inert gas argon. Due to this sodium chloride is very stable.
- Note- In formation of ionic bonds, the reacting atoms achieve the inert gas electron configuration by transfer of electrons.
- Note- The charges are not written in the formula- Ex- NaCl is correct, not the Na^+Cl^-.
- **Formation of magnesium chloride-**
- Atomic no. 7 of magnesium is 12, so electronic configuration is 2,8,2, it has two valence electrons - Mg^{+2}

$$Mg - 2e^- \longrightarrow Mg^{+2}$$

Magnesium 2,8,2 — Electron — Magnesium oxide

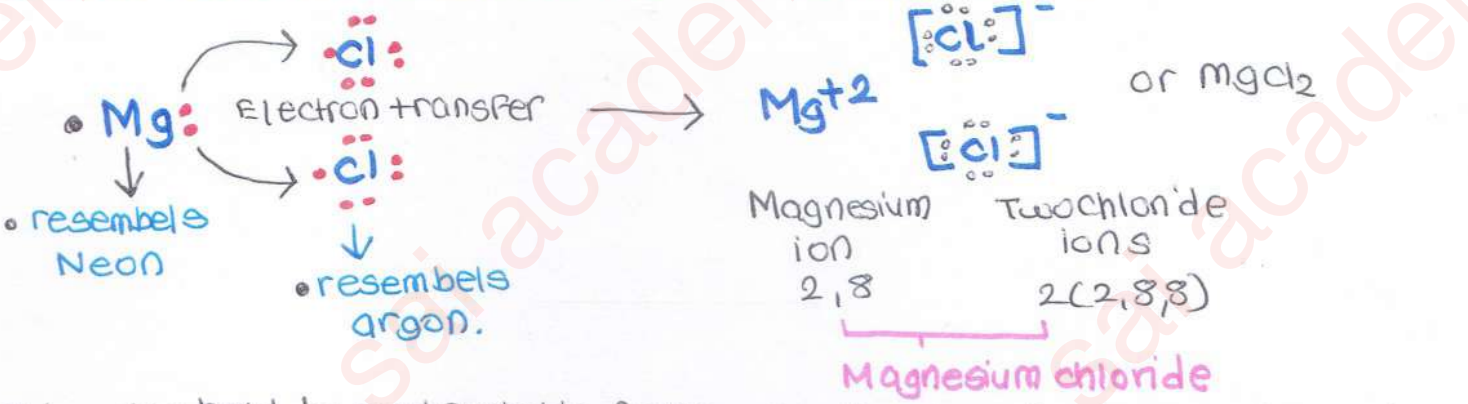
• The atomic no. of chlorine is 17, so electronic configuration is 2,8,7, it has 7 valence electrons. so it requires only 1 electron to complete its octet.

• $2 \cdot \ddot{Cl}: + 2e^- \longrightarrow 2[:\ddot{Cl}:]^-$

two chloride atoms 2(2,8,7) | electrons | Two chloride ions 2(2,8,8)

• since magnesium atoms has donates 2 electron, the two chlorine atoms take these two electrons and form two chloride ions.

• When magnesium reacts with chlorine, the magnesium atom transfers its two outermost electrons to two chlorine atoms-



• It is also held by electrostatic force of attraction to form compound. so formula becomes - $MgCl_2$. It contains ionic bonds. the force of attraction is very strong.

• The formation of calcium chloride ($CaCl_2$) is similar to formation of magnesium chloride.

• The atomic no. of calcium is 20 and chlorine is 17

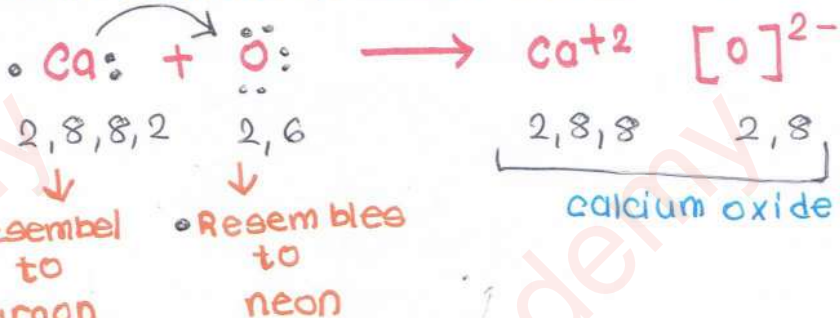
• $Ca: + 2 \cdot \ddot{Cl}: \longrightarrow Ca^{+2} \; 2[:\ddot{Cl}:]^-$ or $CaCl_2$

calcium atom 2,8,8,2 | Two chloride atoms 2(2,8,7) | 2,8,8 | 2(2,8,8)

Calcium chloride

• They held together by electrostatic force of attraction, $CaCl_2$ is an ionic bond.

• Calcium reacts with oxygen to form ionic compound calcium oxide. The atomic number is 20 of calcium and oxygen is 8.



Ionic compounds-

- The compounds containing ionic bonds are known as ionic compound.
- They are made up of positively charged ions (cation) and negatively ions (anion). Also known as electrovalent compound.
- The ionic compounds consist of ions and not molecule

Name	Formula	Ions present
• Sodium chloride	NaCl	$Na^+ - Cl^-$
• Potassium chloride	KCl	$K^+ - Cl^-$
• Calcium nitrate	$Ca(NO_3)_2$	$Ca^{+2} - NO_3^-$
• Copper sulphate	$CuSO_4$	$Cu^{+2} - SO_4^{2-}$
• Ammonium chloride	NH_4Cl	$NH_4^+ - Cl^-$
• Sodium oxide	Na_2O	$Na^+ - O^{2-}$
• Calcium chloride	$CaCl_2$	$Ca^{+2} - Cl^-$
• Magnesium chloride	$MgCl_2$	$Mg^{+2} - Cl^-$
• Sodium hydroxide	NaOH	$Na^+ - OH^-$
• Aluminium oxide.	Al_2O_3	$Al^{+3} - O^{2-}$

- Only Ammonium chloride which is an ionic compound made up of only non metals. (Exception)

• Covalent Bond-

- The chemical Bond formed by sharing of electrons between two atoms.
- The sharing of electrons takes place in a such a way that each atom in resulting molecule gets stable.
- Atoms share only their outermost electrons in formation of covalent bonds. they get stable by mutual sharing.
- Whenever a non-metal combines with another non-metal, sharing of e⁻'s takes place between their atoms. (e⁻'s - electrons)
- A covalent bond can also be formed between two atoms of the same nonmetal. Ex- Between two chlorine atoms to form Cl_2.
- Covalent bonds are of three types-
- single covalent bond • Double covalent bond • Triple covalent bond

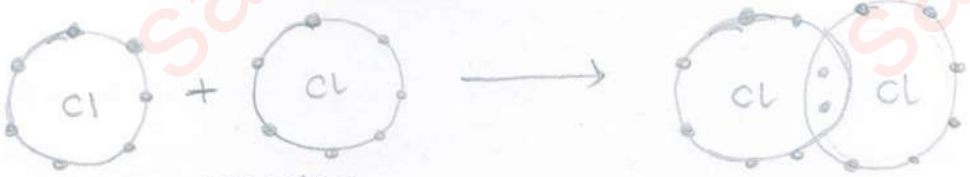
• SINGLE COVALENT BOND -

- A single bond is formed by sharing of one pair of electrons between two atoms.
- A shared electron pair is always drawn between the atoms.
- Ex- A hydrogen molecule H_2 contains a single covalent bond and written as- H:H. It is denoted by putting the a short line (—) between two atoms.
- H—H, it represented as. This short line re presents as a single bond between the two hydrogen atoms.

- Formation of chlorine molecule -
- chlorine atom is very reactive and cannot exist free because it does not have the stable electron arrangement of an inert gas.
- Each molecule of chlorine contains two chlorine atoms joined by a single covalent bond.
- The atomic number of chlorine is 17, so electronic configuration is 2,8,7. It has 7 electrons in outermost shell. and needs 1 more electron to get stable.
- Two chlorine atoms share one electrons each form a chlorine molecule

chlorine atom 2,8,7 — chlorine atom 2,8,7 — chlorine molecule (2,8,8)

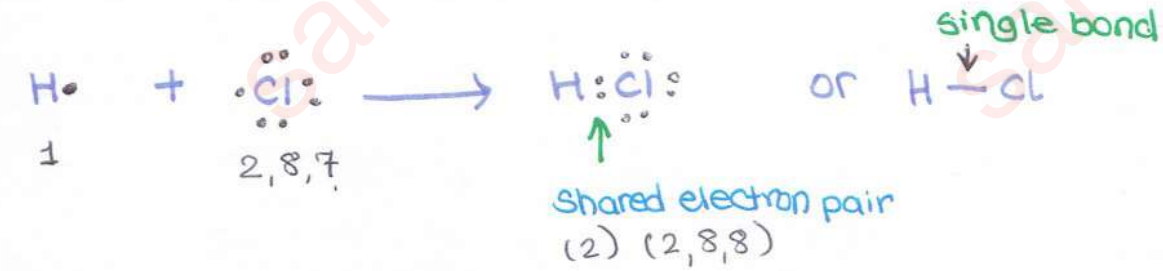
- Resemble to inert gas Argon
- Because the two chlorine atoms share electrons there is a strong force of attraction between them which hold them together.
- The two chlorine atoms share one pair of electrons, the bond between them is called single bond.



- Two chlorine atoms
- Cl_2 – shared electron

- Whenever two atoms of the same element combine to form a molecule a covalent bond in formed.

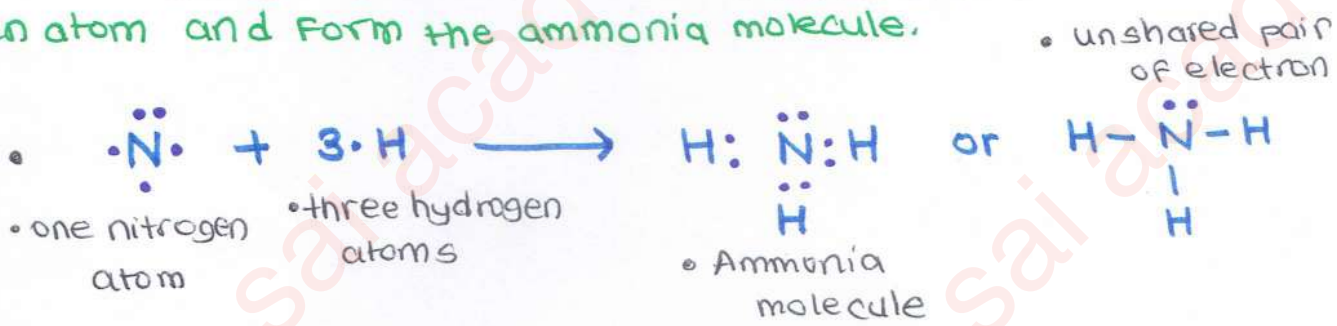
- **Formation of a Hydrogen chloride, HCl -**
- Hydrogen atom has 1 valence electron, so it needs 1 more electron to get 2 electron helium gas electrons and become stable.
- chlorine atom has 7 valence electrons, so it also needs 1 more electron to achieve the stable configuration.



1 — 2,8,7 — Shared electron pair (2) (2,8,8)

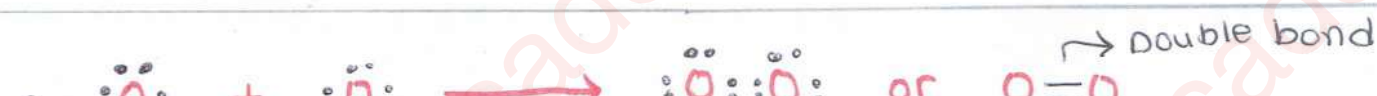
- Hydrogen gas resembels to Helium.
- chlorine gas resembels to Argon.
- Hydrogen chloride gas is a covalent compound containing covalent bond.

- Formation of Ammonia - NH_3
- Nitrogen combines with hydrogen to form covalent compound ammonia having covalent bond in it.
- Nitrogen has 5 valence electrons, so it needs 3 electrons to complete the octet and become stable.
- Hydrogen has 1 valence electrons, so it needs one more electrons to complele 2 electrons in its K shell and becomes stable.
- one atom of nitrogen shares its three valence electrons with three hydrogen atom and form the ammonia molecule.

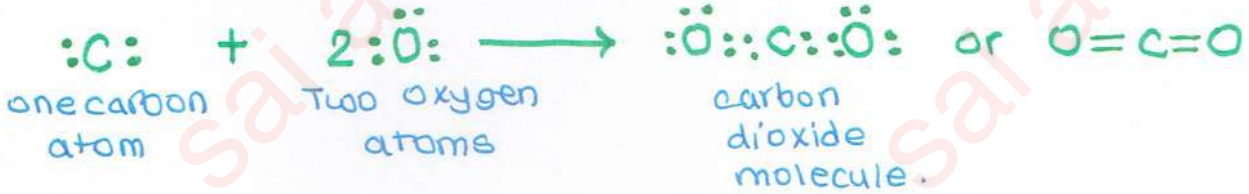


- Hydrogen resemble to Helium (inert gas)
- Nitrogen resemble to neon (inert gas)
- By combination of nitrogen and hydrogen, the ammonia molecule is Formed.

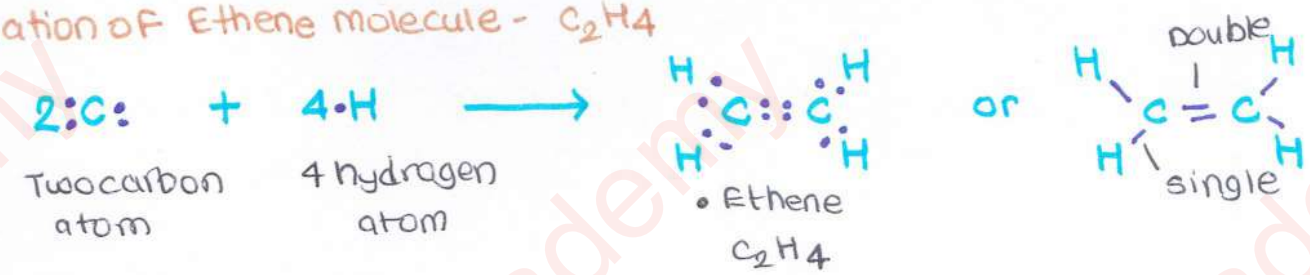
- DOUBLE BOND -
- A double covalent bond consist of two pairs of shared electrons.
- Bond is formed by sharing of two pairs of electrons between two atoms. It is represented by putting two short lines (=) between atom.
- A double covalent bond is formed by the sharing of four electrons between two atoms, each contributing two electrons for sharing.
- EX- Oxygen molecule O_2 contains a double bond between two atoms and it is written as - $O=O$.
- Formation of oxygen molecule, O_2
- Oxygen atom is very reactive and cannot exist free bcoz it does not have the stable, inert gas electron arrangement in its valence shell.
- If does not consist of single bond, it is more stable O_2 molecule.
- Oxygen atomic number is 8, its electronic configurgation is 2, 6. It has 6 valence electrons it require more 2 electrons to get fully stable.
- Two oxygen atoms share two electrons each and form a stable oxygen molecule.



- The oxygen molecule are held together by a double bond.
- Double bond is stronger than single bond
- oxygen atom resemble as - Neon inert gas configuration.
- **Formation of carbon dioxide - CO_2**
- Carbon dioxide is a covalent compound made up of carbon atom and oxygen element and it contains covalent bonds.
- Carbon has 4 valence electrons and oxygen atom has 6 valence electrons.
- Carbon needs more 4 electrons to get stable and oxygen need more 2 electrons to get stable inert gas configuration.
- One carbon atom shares its four electrons with two oxygen atoms and forms a carbon dioxide molecule.



- There are two double bonds in carbon dioxide molecule.
- Both atoms resembles to - Neon inert gas configuration.
- Formation of Ethene molecule - C_2H_4



- Ethene molecule have one carbon-carbon double bond and four carbon hydrogen single bond.

TRIPLET BOND

- A triple covalent bond consist of three pairs of shared electrons. A triple bond formed by sharing of three pairs of electrons between two atoms.
- Three pairs of electrons equal to six electrons. Triple atom is represent by putting (≡) between two atoms.
- Nitrogen - $N \equiv N$ $H-C \equiv C-H$

- **Formation of nitrogen molecule-**
- A nitrogen atom is very reactive and cannot exist free because it does not have the stable electron arrangement of inert gas.
- It does not consist single atoms, it consist of more stable N_2 molecule.
- Atomic number of nitrogen is 7 so electronic configuration 2,5.
- It has 5 valence electrons in its outermost shell, it needs 3 more electrons to achieve the stable configuration.
- Two nitrogen atoms combine together by sharing 3 electrons each to form a molecule of nitrogen gas.

- In the nitrogen gas molecule, the two nitrogen held by triple bond.
- It resembles to inert gas molecule- Neon.
- **Covalent compounds-**
- The compounds containing covalent bonds are called covalent compounds. covalent compound are formed by the sharing of electrons between them.
- The covalent compounds are made up of molecules, so they are also known as Molecular compounds.

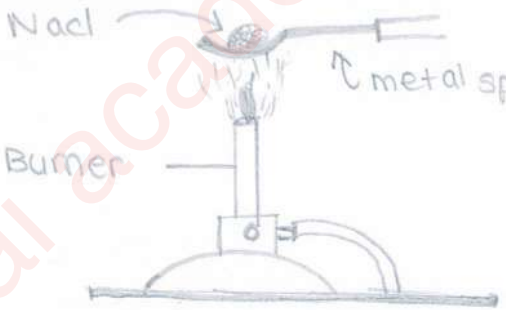
Name	Formula	Elements present
Methane	CH_4	C and H
Ethane	C_2H_5	C and H
Ethene	C_2 4	C and H
Ethyne	C_2H_2	C and H
water	H_2O	H and O
Ammonia	NH_3	N and H
Alcohol	C_2H_5OH	C, H, and O
HCl gas	HCl	H and Cl
H_2S gas	H_2S	H and S
Urea	$CO(NH_2)_2$	C, O, N and H
Glucose	$C_6H_{12}O_6$	C, H and O

- Note- Whenever we see a compound made up of two nonmetals we can say it is covalent compound.

PROPERTIES OF IONIC COMPOUNDS-

- Ionic compounds are usually crystalline solid because their oppositely charged ions attract one another strongly and form a regular crystal structure. The crystals of ionic compound are hard and brittle.
- Ionic compounds are having high melting and high boiling point. For example- NaCl has high melting point of 800°C and high boiling point 1413°C.
- There is a strong force of attraction between the oppositely charged ions, so a lot of heat energy is required to break the force of attraction between the bonds and melt and boil the ionic compound.
- **Ionic compound are usually soluble in water but insoluble in organic solvent.** NaCl is soluble in water but insoluble in solvent like ether, benzene or kerosene. bcoz water has high dielectric constant due to which it weakens the attraction between the ions.
- **Ionic compound conduct electricity when dissolved in water or when melted.** bcoz they contain charged particles called ions. it is conduct electricity because there are plently of free ions in the solution which are able to conduct electric current.

- **EXPERIMENTS-**
- The property of ionic compounds that they have high melting point-
- Take a small amount of NaCl on a metal spatula. Heat it directly over the burner.
- we can see that NaCl does not melt easily. It melts on strong heating. This shows that sodium chloride has high melting point.

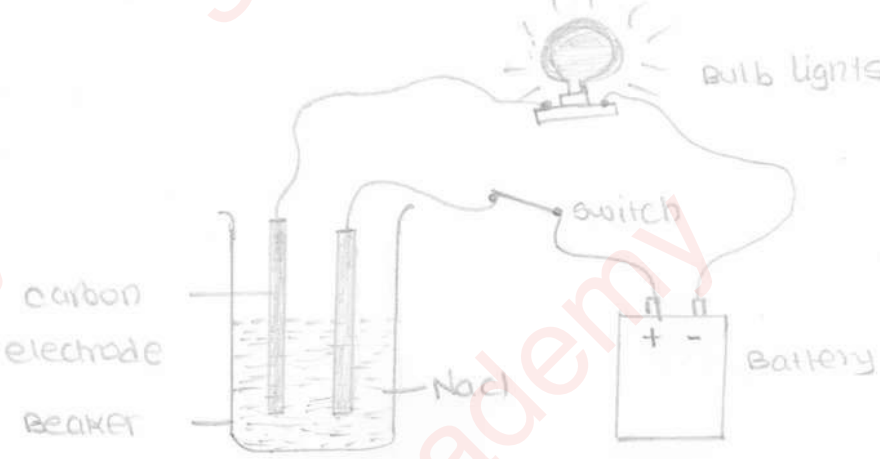


- The property of ionic compounds that they are soluble in water, but insoluble in other solvents -
- Take a water in a test tube and add pinch of NaCl to it. we can see NaCl get dissolve in water, but when a pinch of NaCl is put in other test tube with ether, cannot dissolve in ether. It remains same at bottom of test tube. NaCl is insoluble in organic solvent ether.

• The property of ionic compounds that they conducts electricity when dissolved in water -

• Fill a beaker with Nacl and dissolve some Nacl with water. Two carbon rods are placed in Nacl solution. A electric circuit is set then on pressing the switch, the bulb light up at once.

• Nacl taken in conducts electricity, when dissolve in water.



• PROPERTIES OF COVALENT COMPOUNDS -

• covalent compounds are usually liquids or gases. only some of them are solids.

◦ solids - Glucose, cane sugar, urea

◦ liquids - Alcohol, ether, benzene, carbon tetrachloride

◦ Gases - Methane, chlorine, ethane.

• covalent compounds are usually has low melting and boiling point -

• Naphthalene has low melting point of 80°C. and CCl_4 has low boiling point of 77°C.

• Covalent compounds are made up of electrically neutral molecules. The force of attraction between the molecules are very weak.

• covalent compounds are usually insoluble in water but they are soluble in solvent.

• Naphthalene insoluble in water but dissolves inorganic solvent like ether. some compounds like glucose, sugar, and urea. soluble in water.

• covalent compounds do not conduct electricity this means that they are non electrolytes. covalent compounds do not conduct electricity because they do not contain ions.

• sugar, urea, alcohol and CCl_4 - do not conduct electricity.

• HCl chemically reacts with water to form HCl containing ions.

Ionic compound	Covalent compound
• Ionic compound are usually crystalline solids.	• covalent compound are usually gas or liquids, only some are solids.
• They are usually soluble in water	• They are usually insoluble in water
• They conduct electricity when dissolve in water.	• They do not conduct electricity in water.
• They are insoluble in organic solvent	• They are soluble in organic solvent.
• They have high melting point and boiling point.	• They have low melting point and boiling point.

Occurrence of metals-

- Earth is main and major source of minerals, ores and some metals.
- Most of the metals are quite reactive and hence they do not occurs as free element in nature.
- only few less reactive metals are found in 'free state' as metal bcoz of their low chemical reactivity.
- When a metal is found in free state or element, it is said to occure in 'native state'. Ex- copper, silver, gold and platinum metals
- copper and silver metals occurs in free state as well as in the combined state (in form of compounds).
- The metals which are high up in reactivity, so reactive that they never found in nature as free elements. (Potassium, sodium) they find in combined state.
- All the metals which are placed above copper in the reactivity series are found in natue only in the form of their compounds.
- Minerals - The natural materials in which the metals or compounds are found in earth are called minerals.
- Ores - Minerals from which the metals can be extracted profitably are called ores. An ore contains a good percentage of metal

"All the ores are minerals, but all the minerals are not ores"

Metal	Ore name	Name of compo. in ore	formula of ore
• sodium	• Rock salt	• sodium chloride	NaCl
• Aluminium	• Bauxite	• Aluminium oxide	$Al_2O_3 . 2H_2O$
• Maganese	• Pyrolusite	• Manganese dioxide	MnO_2
• zinc	1. calamine	• zinc carbonate	$ZnCO_3$
	2. zinc blende	• zinc sulphide	ZnS
• Mercury	• cinnabar	• Mercury(II) sulphide	HgS

• Iron	• Haematite	• Iron (III) oxide	Fe_2O_3
• copper	1. cuprite	• copper(I) oxide	Cu_2O
	2. copper glance	• copper (I) sulphide	Cu_2S

• Extraction of metals-

• After the mining of the ore from the ground, it converted into pure metal. To obtain a metal from its ore is called the extraction of metal.

• Metallurgy - The various processes involved in the extraction of metal from their ores, and refining is called metallurgy.

• Note- No single process can be used for the extraction of all metal.

• Three major steps-

• concentration of ore.

• conversion of concentrated ore into metal.

• Refining of impure metal.

• concentration of ore -

• ore is an impure compound of metal containing a large amount of sand and rocky material.

• The unwanted impurities like sand, rocky material, limestone, mica present in an ore are called Gangue.

• Before extraction, the metal from an ore, it is necessary to remove these impurities. The methods used for removing gangue from an ore depend on some difference in physical properties of the ore and gangue.

• concentration of concentrated ore into metal-

• All the metals into following three categories-

• Metals of high reactivity or highly reactive metals.

• Metals of medium reactivity or moderately reactive metals.

• Metals of low reactivity or less reactive metals.

• Manganese metal (mn) lies just above zinc (zn) in reactivity series

• Manganese is obtained by the reduction of its oxide with aluminium powder and not carbon. this is because carbon is less reactive than manganese

• carbon can reduce the oxides of zinc and all other metals below zinc to form metals.

• Copper can extracted from by the reduction of oxide with carbon as well as by heating its sulphide ores.

• Carbon which is an non metal, is more reactive than zinc (Zn). so it placed just above Zn in reactivity series
• Tin metal (Sn) is more reactive than lead (Pb) so it is placed above the Pb in reactivity series.
• The extraction of a metal from its concentrated ore is essentially a process of reduction of metal compound present in the ore.

• Extraction of Highly reactive metals-

• Metals	• Method of extraction
K Na Ca Mg Al	Electrolysis of molten chloride or oxide
Zn Fe Pb Cu	Reduction of oxide with carbon
Cu Hg	Heating sulphide in air
Ag Au Pt	Found in native state

• The highly reactive metal such as potassium, sodium, chloride, mangnesium and Aluminium placed in high up in the reactivity series in upper part.
• Highly reactive metals cannot be extracted by reducing their oxides with carbon.
• The highly reactive metals are extracted by the electrolytic reduction of their molten chloride or oxides. Electrolytic reduction is brought about by passing electric current through the molten state.
• It is takes place by extraction of oxide and chlorides by the electrolysis.
• During electrolysis, the negatively charged electrode (cathode) acts as a powerful reducing agent by supplying electrons to reduce the metal ions into metal.
• During the electrolysis of molten salts, the metals are always produced at the cathode (negative electrodes) fact that the metal ion are always (+)vely charged and get attracted to the (−)vely charged electrode (cathode) when electricity is passed through it.

- The metals extracted by electrolysis methods are very pure. They do not contain any impurities.
- When a molten metal chloride is electrolysed by passing electric current, then pure metal is produced at the cathode (negative electrode) and chlorine gas is formed at anode (+ve electrode).
- When a molten metal oxide is electrolysed by passing electric current, then pure metal is produce at cathode (negative electrode) and oxygen gas is formed at anode (+ve electrode).

- **Extraction of Sodium metal-**
- Sodium metal is extracted by the electrolytic reduction of molten sodium chloride. When electric current is passed through molten sodium chloride, it decomposes to form sodium metal and chlorine gas.

- $2NaCl(l) \xrightarrow{\text{Electrolysis}} 2Na(s) + Cl_2(g)$
  - Sodium chloride → Sodium → Chlorine gas

- **Explanation-** During the electrolysis of molten sodium chloride the rxn takes place at the two electrodes.
- **At cathode-** Positive sodium ion (Na^+) are attracted to the cathode. The sodium take electrons from the cathode and get reduced to form sodium atoms.

- $2Na^+ + 2e^- \longrightarrow 2Na$
  - Sodium ion → electrons → Sodium atoms

- Produce at cathode (negative electrode).
- **At anode-** Negative chloride ion (Cl^-) are attracted to anode. The chloride ion give electron to the anode and get oxidised to form chlorine gas.

- $2Cl^- - 2e^- \longrightarrow Cl_2$
  - Chloride ion → electrons → Chlorine gas.

- The, chlorine gas is formed at anode (positive electrode).
- Potassium metal- is produced of molten potassium chloride
- calcium metal- is obtained by electrolysis of molten calcium chloride
- magnesium metal- is obtained by electrolysis of molten chloride

- **Extraction of Aluminium metal-**
- Aluminium metal is extracted by the electrolytic reduction of molten aluminium oxide. When electric current pass through molten aluminium oxide it decomposes to form aluminium metal and oxygen gas.

- $2Al_2O_3(l) \xrightarrow{\text{Electrolysis}} 4Al(l) + 3O_2(g)$
  - Aluminium oxide → Aluminium metal + oxygen

Explanation- Molten Aluminium oxide (Al_2O_3) contains free aluminium ions (Al^{+3}) and free oxide ions (O^{2-}).

- **At cathode-** The positively charged aluminium ions are attracted to the cathode (negative electrode).

$$Al^{3+} + 3e^- \longrightarrow Al$$

Aluminium ion — Electrons (From cathode) — Aluminium atom

- Aluminium atom form at cathode.
- **At anode-** The negatively charged oxide ions are attracted to the anode (positive electrode).

$$2O^{2-} - 4e^- \longrightarrow O_2$$

oxide ions — Electrons (at anode) — oxygen gas

- The oxygen gas form at anode.
- **Extraction of moderately reactive metals-** Placed in middle of the reactivity series.
- The reduction of their oxides with carbon, aluminium, sodium or calcium.
- It is easier to obtain metal from their oxides than from carbonate and sulphide.
- The concentrated ores can be converted into metal oxide by the process of calcination or roasting.
- A carbonate ore is converted into oxide by calcination.
- A sulphide ore is converted into oxide by roasting
- **Calcination -** is the process in which a carbonate ore is heated strongly in the absence of air to convert it into metal oxide.
- For example- Zinc occurs as zinc carbonate in calamine ore $ZnCO_3$.
- Zinc carbonate should be first converted into zinc oxide. This is done by calcination.
- When calamine ore is heated strongly in the absence of air, when calamine is calcined, it decomposes to form zinc oxide and carbon dioxide-

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

Zinc carbonate — calcination — zinc oxide — carbon dioxide

Thus, calcination converts zinc carbonate into zinc oxide.

- **Roasting -** It is the process in which a sulphide ore is strongly heated in presence of air to convert it into metal oxide.

- zinc occurs as sulphides ore in zinc blend ore ZnS.
- when zinc blend ore is strongly heated in air, it forms zinc oxide and sulphur dioxide-
  - $2ZnS(s) + 3O_2(g) \xrightarrow{\text{Roasting}} 2ZnO(s) + 2SO_2(g)$
    zinc sulphide (zinc blend), oxygen, zinc oxide, sulphur dioxide
- Roasting converts zinc sulphide into zinc oxide
- **Reduction of metal oxide with carbon-**
- The oxide of less reactive metals like iron, nickel, tin and lead are usually reduced by using carbon as the reducing agent.
- In the reduction by carbon, the metal oxide is mixed with carbon and heated in a furnace.
- carbon reduces the metal oxide to free metal.
- zinc metal is extracted by the reduction of its oxide with carbon (or coke). when zinc oxide heated with carbon, zinc metal is produce.
  - $ZnO(s) + C(s) \longrightarrow Zn(s) + CO(g)$
    zinc oxide, carbon (Reducing agent), zinc metal, carbon monoxide
- carbon is a cheap reducing agent, but it contaminates the metal.
- **Iron metal is extracted from its oxide ore 'Haematite'** (Fe_2O_3) by reduction with carbon
- **Tin and lead metal are also extracted by the reduction of their oxides with carbon.**
- Even the less reactive metal copper is extracted by the reduction of its oxide with carbon.
- **Thermite reaction-** The reduction of metal oxide to form metal by using aluminium powder as a reducing agent is called a thermite reaction. It is a exothermic reaction in which a large amount of heat is evolved.
- The amount of heat evolved is so large that metals are produce in molten state.
- The property of the reduction by aluminium is made use of in thermite welding for joining the broken pieces of heavy iron object like railway track or machine parts.
- Aluminium reduces iron oxide to produce iron metal with the evolution of lot of heat. Due to this heated, iron metal is produce in molten state. used for welding process is called thermite welding
  - $Fe_2O_3(s) + 2Al(s) \longrightarrow 2Fe(l) + Al_2O_3(s) + Heat$
    Iron (III) oxide, Aluminium powder, Iron metal, Aluminium oxide

• Extraction of less reactive metals-

• The less reactive metals such as mercury and copper are quite low in the reactivity series.

• The less reactive metals which are quite low in the activity series are extracted by the reduction of their oxides by heat alone.

• Mercury and copper metals are extracted by the reduction of their oxides by heat alone.

• Extraction of Mercury-

• Mercury is a less reactive metal which is quite low in the activity series. Mercury metal can be extracted by heating its sulphide ore in air.

• Mercury metal is produced from the sulphide ore called cinnabar. HgS which is actually mercury (II) sulphide.

• Extraction of mercury from cinnabar ore involves two steps

a. The concentrated mercury (II) sulphide ore is roasted in air when mercury (II) oxide is formed.

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

Mercury (II) sulphide (cinnabar ore) | oxygen | Mercury (II) oxide | Sulphur dioxide

b. when this mercury (II) oxide is heated over about 300°C, it decomposes to form mercury metal.

• $2HgO(s) \xrightarrow{\Delta} 2Hg(l) + O_2(g)$

Mercury (II) oxide | Mercury metal | oxygen

• Mercury (II) sulphide is also called mercuric sulphide and mercury (II) oxide is also known as mercuric oxide.

• Extraction of copper-

• copper is a less reactive metal which is quite low in the reactivity series. copper metal can be extracted just by heating its sulphide ore in air.

copper metal - copper glance - Cu_2S which is copper (I) sulphide.

• Extraction of copper from copper glance involve two steps-

a. The concentrated copper (I) sulphide ore (copper glance) is roasted in air when a part of copper (I) sulphide is oxidised to copper (I) oxide.

• $2Cu_2S + 3O_2 \xrightarrow{\text{Roasting}} 2Cu_2O + 2SO_2$

• copper glance ore | copper (I) sulphide | oxygen | copper (I) oxide | sulphur dioxide

b. When a good amount of copper (I) sulphide has been converted into copper (I) oxide, then the supply of air for roasting is stopped. In the absence of air, copper (I) oxide formed above reacts with copper (I) sulphide to form copper metal and sulphur dioxide -

- $2Cu_2O(s) + Cu_2S(s) \longrightarrow 6Cu(s) + SO_2(g)$

copper (I) oxide — copper (I) sulphide (unoxidised ore) — copper metal — sulphur dioxide

- They need a reducing agent for their reduction to the metals.
- **Refining of metals-**
- The process of purifying impure metals is called refining of metals. Thus refining of metals means purification of metals.
- The most important and most widely used method for refining impure metals is **Electrolytic Refining.**
- It means refining by electrolysis, many metals like tin, lead and chromium are refined electrolytically.
- **The refining of an impure metal by electrolysis -**

a. The thick block of the impure metal is made anode. connected to the positive terminal of battery.

b. The thin strip of the pure metal is made **cathode**. connected to the negative terminal of battery.

c. A water soluble salt is taken as electrolytes.

- On passing electric current, impure metal dissolve from the anode and goes on the electrolytic solution. and puremetal from the electrolyte deposit at the cathode.
- The soluble impurities present in the impure metal go into the solution whereas insoluble impurities settle at the bottom of the anode as "anode mud."
- **Electrolytic Refining of copper-**
- The apparatus consist of an electrolytic tank containing acidified copper sulphate solution as an electrolyte. ($CuSO_4$ with dil H_2SO_4)
- A thick block of impure copper metal is made anode (connect with the +ve terminal of battery).
- A thin strip of pure copper metal is made cathode (connected to the -ve terminal of battery).
- On passing electric current impure copper from the anode dissolves and goes into copper sulphate solution. and pure copper from copper sulphate solution deposit on cathode.
- The soluble impurities goes into solution, insoluble collect below the anode as anode mud.

Explanation - $CuSO_4$ solution contains copper ions, Cu^{+2} and sulphate ions SO_4^{2-}. on passing the electric current through copper sulphate.

- The positively charged copper ions, Cu^{+2} from the copper sulphate solution go to the negative electrode cathode and by taking electrons from the cathode, get reduced to copper atoms

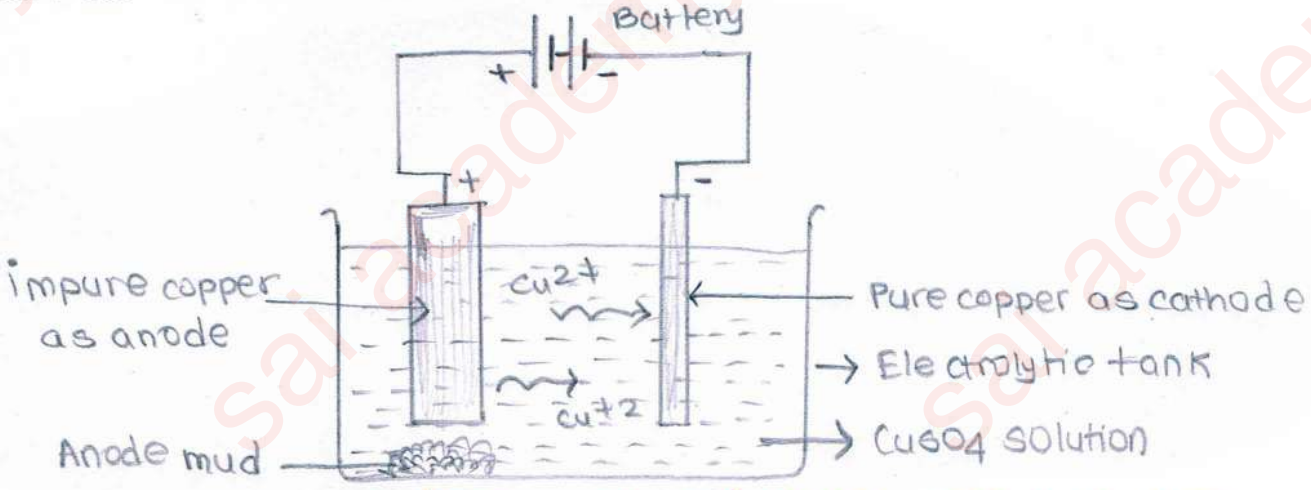
- At cathode- $Cu^{+2} + 2e^- \longrightarrow Cu$

  Copper atom (from electrolyte) | Electrons (from cathode) | Copper atom (Deposit on cathode)

- These copper atoms get deposited on the cathode giving pure copper metal.
- Copper atoms of the impure anode lose two electrons each to anode and form copper ions Cu^{+2}, which go into the electrolyte solution.
- At anode- $Cu - 2e^- \longrightarrow Cu^{+2}$

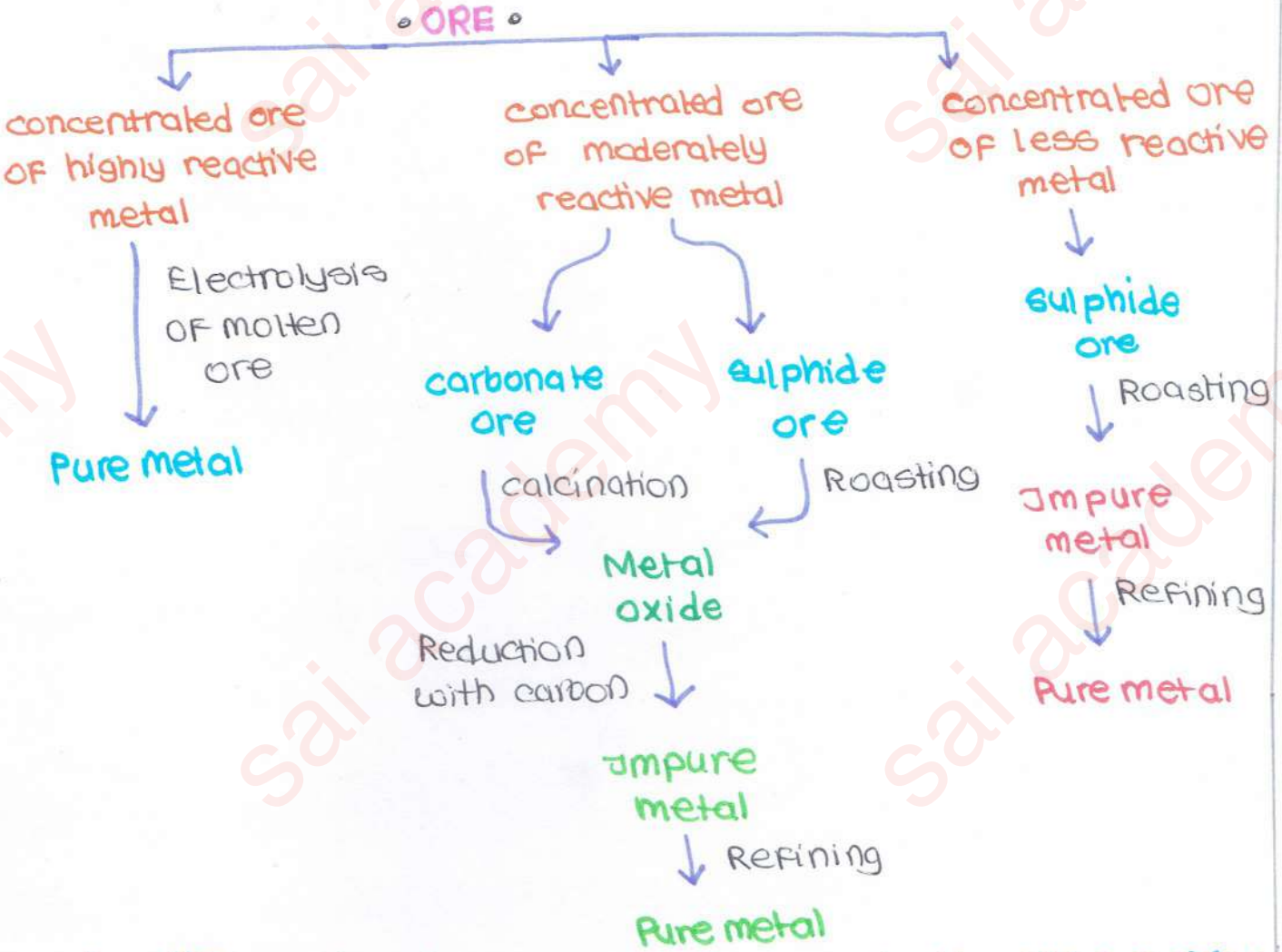
  Copper atom (from impure) anode | Electrons (Give to) anode | copper ion (Goes into) electrolyte

- copper sulphate solution at the cathode and put into the solution at the anode.
- As process goes on, impure anode becomes thinner and thinner whereas pure cathode becomes thicker and thicker. Thus copper is obtained at the cathode.



- The less reactive metals like gold and silver present in the impure copper collect at the bottom of the electrolytic cells below the anode in the form of anode mud.
- Gold and silver metals can be recovered from the anode mud.
- The electrolytic refining of metal serve two purpose-
- It refines the metal concerned.

• It enable to recover the other valuable metals present as impurities in the metal being refined.



• CO_2 on heating on treatment of a dilute acid, it will be a carbonate ore.
• SO_2 on heating in air, then it will be sulphide ore.

• **CORROSION-**
• The eating up of metals by the action of air, moisture or a chemical on their surface is called corrosion.
• most of the metals corrode when they are exposed to damp air.
• Rust - It is soft and porous which gradually falls off from the surface of iron object and then the iron below starts corroding.
• corrosion of iron is continuous process which ultimately eats up the whole iron object.
• The corrosion of iron is called rusting while other metals are said to 'rust'.
• Rusting of iron-
• When an iron object is left in damp air for a considerable time it gets covered with a red-brown flaky substance called rust. this is called rusting of iron.

• During the rusting of iron, iron metal combines with the oxygen of air in the presence of water to form hydrated iron (III) oxide. $Fe_2O_3 \cdot xH_2O$. this hydrated iron(III) oxide is called rust.

• Rust is mainly hydrated iron (III) oxide $Fe_2O_3 . xH_2O$

• Rust is brown-red in colour.

• Steel rusts less than iron.

• condition necessary for rusting of iron-

• Rusting of iron, needs both air and water, two conditions are necessary for rusting of iron.-

1. Presence of air 2. Presence of water

• The damp air alone supplies both the things air and water required for the rusting of iron.

• The ordinary water alone also supplies both the things, air and water, needed for rusting.

• Experiment to show that rusting of iron requires both air and water-

• In the first test tube containing iron nail, we put anhydrous $CaCl_2$ and close its mouth with cork. The anhydrous $CaCl_2$ is added to absorb water from the damp air present in the test tube and make it dry.

• The iron nail in the first test tube is kept in dry air (having no water vapour in it. The test tube kept aside for one week.

• In the second test tube containing iron nail, we put boiled distilled water. Boiled water does not contain any dissolved air in it. A layer of oil is put over boiled water. In this way, the iron nail in the second test tube is kept in air-free boiled water. The mouth of this test tube is closed with a cork and kept aside for one week.

• In the third test tube containing iron nail, we put unboiled water so that about two-third of nail is immersed in water and the rest is above the water, exposed to damp air. in this way, the iron nail in the third test tube has been placed in air and water together. the mouth of cork is closed and kept aside for about one week.

Conclusions-

• Test tube 1- No rust is seen on the surface of iron kept in dry air. This tells us rusting of iron does not takes place alone in air.

• Test tube 2- No rust is seen on the surface of nail kept in air free, boiled water in the second test tube. this tell us that rusting of iron does not take place in water alone.

Test tube 3- Red-brown rust is seen on the surface of iron nail kept in presence of both air and water together in third test tube . this tell us that rusting of iron takes place in presence of both air and water together.

Hence, in above experiment shows that for the rusting of iron to take place, both air and water is essential. this means that the rusting of iron objects can be prevented if damp air is not allowed to come in contact with iron objects.

- **Corrosion of Aluminium-**
- when a shining aluminium vessels is exposed to moist air, the oxygen of air reacts with aluminium to form a thin dull layer of aluminium oxide. all over the vessels.
- **Aluminium is more reactive than iron** so fresh aluminium metal begins to corrode quickly when it comes in contact with moist air.
- The action of moist air on aluminium metals forms a thin layer of aluminium oxide all over the aluminium metals
- The aluminium oxide layer is very tough and prevents the metal underneath from corrosion which will be further can be done.
- This means that the sometimes corrosion is useful.
- **The common metal which is highly resistant to corrosion is Aluminium.**
- The tough layer of aluminium oxide over aluminium metal, this can done by a process called 'anodising' it can be done thicker by electrolysis process.
- **In this Electrolysis process-**
- **Aluminium object made an- anode (+ve electrode) in an electrolytic tank in which dil H_2SO_4 is electrolysed.**
- During electrolysis of dil. H_2SO_4 acid, oxygen gas is liberated at anode and react with aluminium object and form a thickcer layer of Aluminium oxide on the surface.
- **Anodising-** It is the process of forming thick layer of Aluminium oxide on aluminium object by making it anode during electrolysis of dil H_2SO_4 acid.

- **corrosion of copper-**
- copper oxide layer formation takes place on copper objects by which they lose there shine. after some day.
- copper reacts with air in considerable manner, then copper reacts with carbondioxide and water slowly to form a "**green coating of basic $CuCO_3$ on surface**"

- The green coating of basic copper carbonate is a mixture of of copper carbonate and copper hydroxide. $CuCO_3 \cdot Cu(OH)_2$
- Since copper metal is low in the reactivity series, therefore corrosion of copper is very slow.
- The corroded copper vessels can cleaned with dilute acid solution.
- The acid solution dissolves green coloured basic copper carbonate present on the corroded copper vessels and looks them shinky. Red brown again.

- **Corrosion of silver-**
- When a shining metal objects loses its shine they become dull we can say that it has been tarnished.
- **When silver objects kept in air they graudally be come black colour.**
- Explanation- silver is very highly unreactive metal it does not react with oxygen of air easily. But air contains a little of sulphur compounds such as hydrogen sulphide gas (H_2S)
- The silver objects combine slowly with H_2S to form a black coating of silver sulphide. (Ag_2S)
- It graudally turns black due to formation of thin silver sulphide layer on their surface by the action of H_2S gas present in air.
- silver metal used for making silver coins, jewellery and silver-ware because its bright shiny surface and resistance to corrosion.

- **Corrosion of Gold and Platinum-**
- Gold metal does not corrode when exposed in air. because it is very unreactive metal which remains unaffected by air water and other gases.
- Gold is used for making jewellery because of its bright shiny surface and high resistance to corrosion.
- Note- Gold dissolves only in aqua-regia solution.
- Platinum is highly resistant to corrosion
- Platinum also dissolves in aqua regia solution. it is a white metal with a silvery shine.
- Platinum used to make jewellery bcoz of its bright shiny surface and high resistance to corrosion.
- Titanium is also very resistant to corrosion. (Note)

•ALLOYS-

• An alloy is a homogenous mixture of two or more metals.

• For example- • Brass is an alloy of two metals- copper and zinc.

• Steel is an alloy of a metal and non metals - iron and carbon.

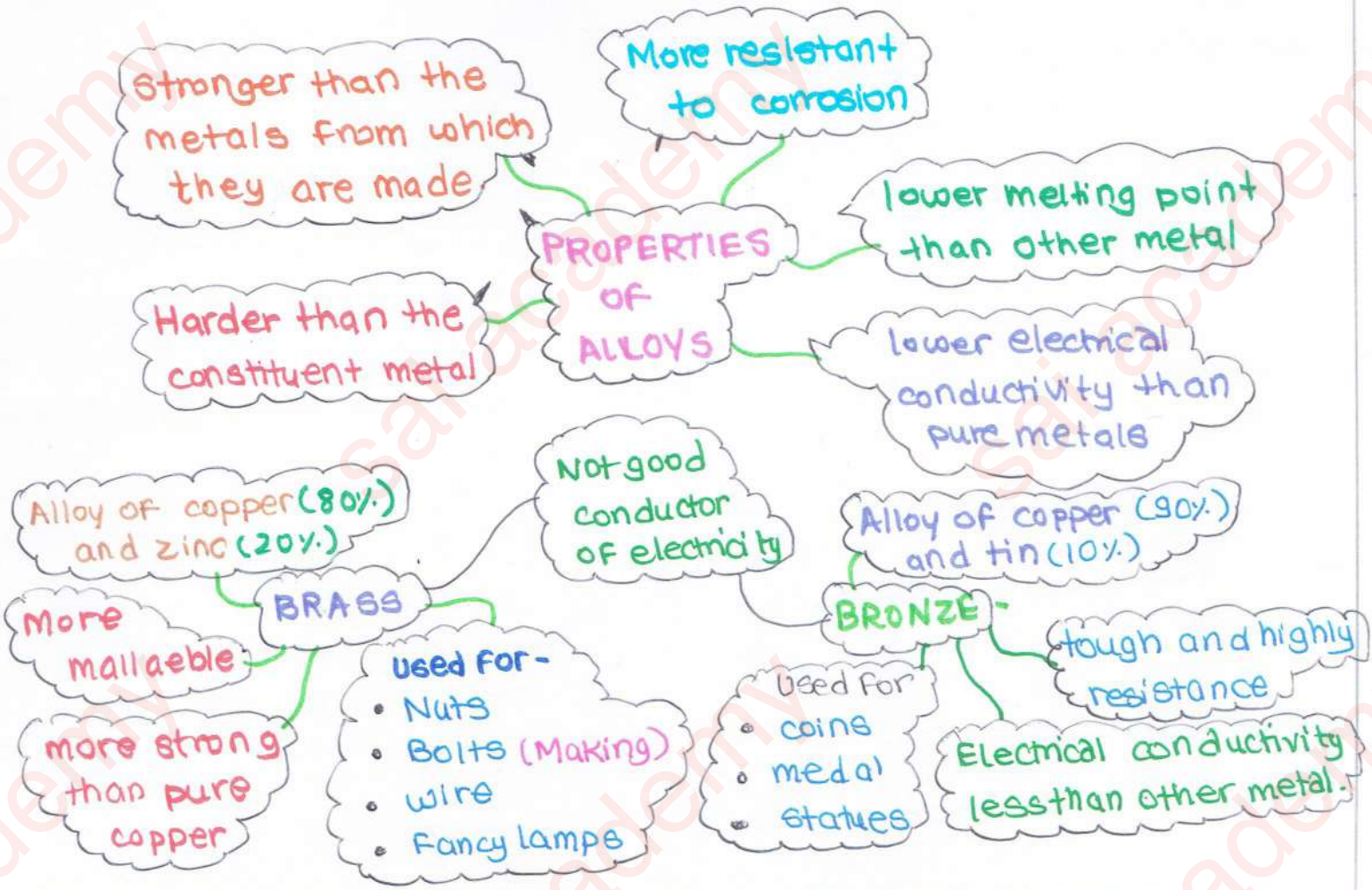
• An alloy is prepared by mixing the various metals in molten state in required proportions and then cooling their mixture to the room temperature.

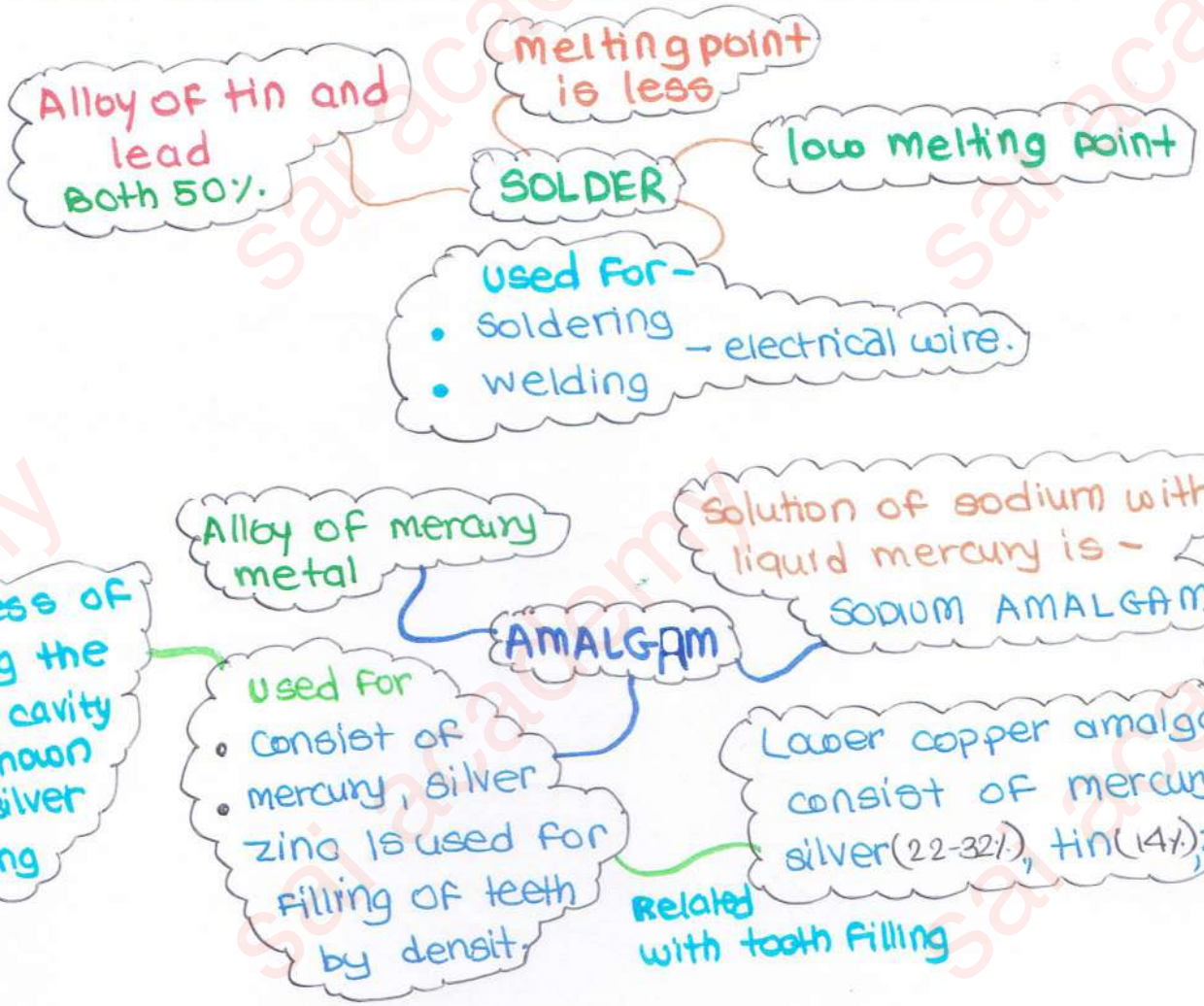
• Duralumin - An alloy of aluminium with copper, mangesium and manganese is light as well as strong.

• it is used in making aircraft bodies, space satellite and pressure cookers. (Aluminium metal is light but not strong).

• Magnalium - An alloy of aluminium with magnesium, is light as well as hard. (Aluminium metal is light but not hard)
It is used to make balance beams and light instruement.

• stainless steel - Alloy of chromium and nickel with iron we get an alloy stainless steel. (which is strong, tough and does not rust at all.
EX- cooking utensils, knives, scissors, tools and ornamental pieces.
used for making surgical instruement.





- Alloy of gold - The purity of gold in terms of carats.
- Pure gold is said to be of 24 carats
- Pure gold is very soft due to which it is not suitable for making jewellery
- Gold alloyed with a small amount of silver or copper to make it hard. The harder alloy of gold make it suitable for making ornaments.
- In india, gold ornaments usually made up of 22 carat gold. It means that 22 parts of pure gold is alloyed with 2 parts of either silver or copper.

Q. How rusting of Qutab minar in Delhi has been prevented-

- The rusting of iron has been prevented because of formation of thin film of magnetic oxide to form on its surface. (Fe_3O_4) as the result of treatment given to the pillar, painting with the mixture of many salts, then heating and quenching. bcoz of the good treatment it is the wonder of ancient indian metallurgy. bcoz of good knowledge of alloys.

• CARBON AND ITS COMPOUNDS •

• Carbon is an element. The symbol of carbon is C. It is a non-metal The name carbon is derived from the Latin word 'carbo' which means 'coal'.

• Carbon is the main constituent of coal

Forex- • **Earth crust** - only 0.02% carbon in Form of minerals (like carbonates, coal and petroleum)

• **Atmosphere** - only 0.03% of carbon dioxide gas.

• **Organic compounds** - All the living thing, plant and animals are made up of carbon based compound.

• A large number of things which we use in our day life are made of carbon compounds.

• Ex- Food, wood, silk, nylon, LPG, CNG-gas, drugs, plastics.

• It plays an important role in our daily life.

• we can test the presence of carbon in a material on the basis of the Fact that carbon and its compound burn in air to give carbon dioxide gas which turns lime water milky.

• This test can be performed as Follows-

• Burn the given material in air. Pass the gas formed through lime water

• If the lime water turns milky, then the given material contain carbon.

• Carbon always forms covalent Bonds-

K	L
2	4

• The atomic number of carbon is 6. Electronic configuration

• carbon has 4 electrons in the outermost shell.

• It is not possible to remove 4 electrons From a carbon atom to give it the inert gas electron arrangement.

• It is also not possible to add as many as 4 electrons to carbon atom due to energy consideration and acquire inert gas confinugation.

• They achieve stability by sharing of electrons, carbon always forms covalent bond.

• **carbon is Tetravalent** -

• A carbon atom requires 4 electrons to achieve the eight-electron inert gas structure. therefore valency of carbon is 4. that is carbon is tetravalent.

symbol- (By putting 4 lines)

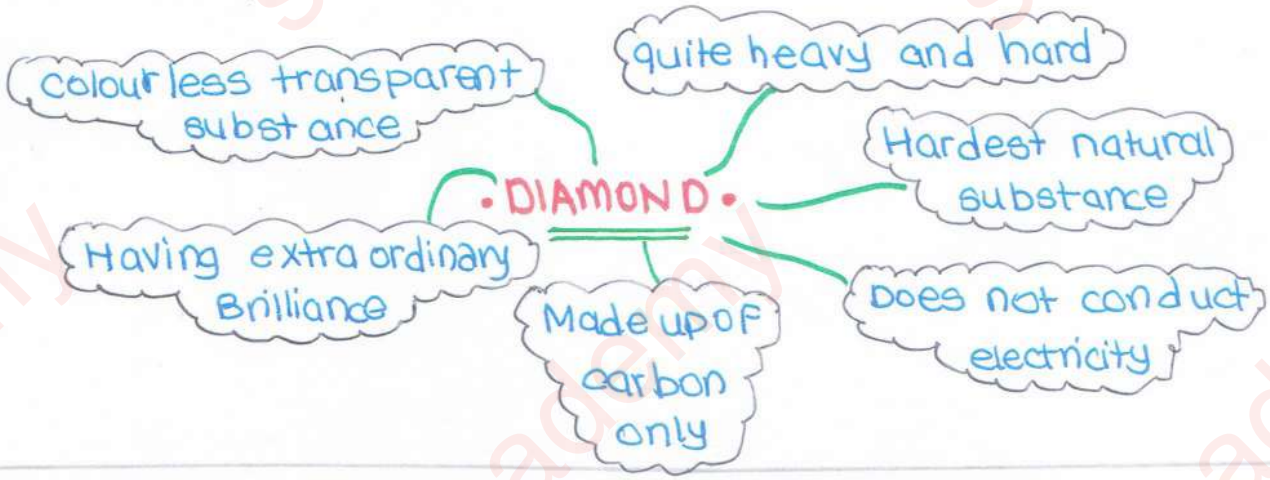
• self combination-
• The property of self combination of carbon atoms to form long chains is useful to us because it give rise to an extremly large number of carbon compound because a long chain of carbon atom act as a backbone.
• The formation of strong bonds by carbon atoms among themselve and with other element makes the carbon compounds exceptionally stable.
• The property of self combination known as- catenation.
• Silicon show some catenation property due to which it form compounds with hydrogen having chains of up to seven or eight silicon atoms. But due to weak bonds, these compounds are unstable.

• Occurrence of carbon-

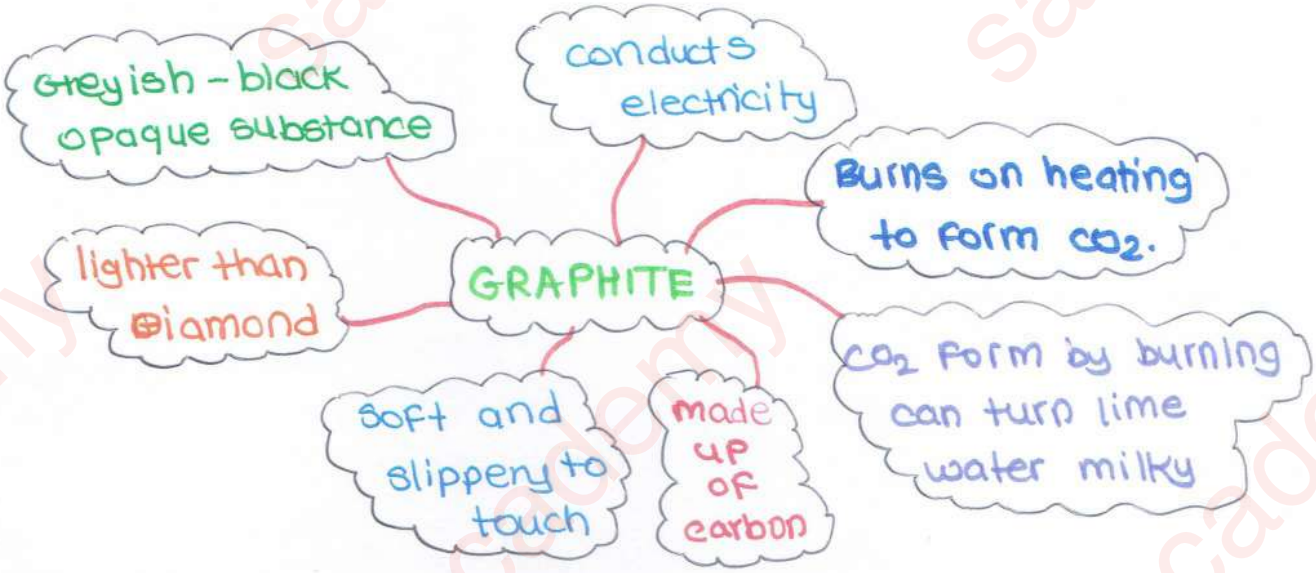
• carbon occure in nature in "free state" as well as in "combined state".
• Free state- carbon occure in nature mainly in two forms-
• Diamond • Graphite
• Naturally occuring form of carbon is- Buckminsterfullerene.
• combined state-
• carbon dioxide gas in air.
• Carbonates (limestone, marble, chalk)
• Fossil fuels (coal, petroleum)
• organic compound (protein, Fats, carbohydrate)

• Allotropes of carbon-

• The physical forms in which an element can exist are called allotropes of carbon.
• Three allotropes-
• Diamond • Graphite • Buckminsterfullerence (new)
↳ • olds ← alltrope
• allotropes



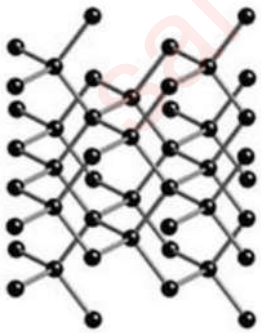
- Diamond burns on strong heating to form carbon dioxide if we burn diamond in oxygen, then CO_2 is left behind.
- The CO_2 formed by burning diamond can turn lime water milky.



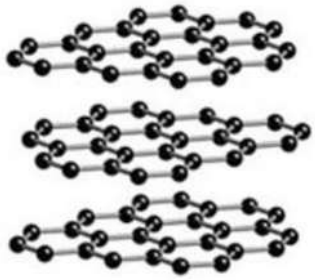
- structure of Diamond -
- A Diamond crystal is a gaint molecule of carbon atoms.
- Each carbon atom in the diamond crystal is linked to four other carbon atom by strong covalent bond.
- The four sarrounding carbon atoms are at the four vertices of a regular tetrahedron.
- The diamond crystal, is therefore, made up of carbon atoms which are powerfully bonded to one another by network of covalent bonds. due to this diamond is very rigid.
- Diamond crystal has a tetrahedral arrangement of C atoms, due to 3D arrangement it gives it a high density.
- Diamond does not conduct electricity - bcoz of 'no free electron in a diamond crystal.

- STRUCTURE OF GRAPHITE -
- Each carbon atom in a graphite layer is joined to three other carbon atoms by strong covalent bonds to form flat of hexagonal rings.
- The various layer of carbon atom in graphite are held by weak van der Waals forces. due to weak forces, the sheet like structure, graphite is comparatively soft substance. which makes useful as dry lubricant for machine parts.
- Graphite is a good conductor of electricity due to presence of free electron in graphite crystal.

A New Form of Carbon



Diamond



Graphite

C_{60} Buckyball

Uses of Diamond

- Used in cutting instruement like glass cutters → for cutting marble
- sharp edge diamond use for eye surgeon as tool to remove cataract from eye
- Manucfature of fine wire those used in toaster
- Diamond 'dies' are used for drawing thin wire like tungsten filament of Bulb.
- Used for making jewellery due to brilliance

Uses of Graphite

- Used as lubricant for fast moving parts of machinery — used as graphite powder
- Used in making pencil leads
- Due to property of black substance
  - Graphite is usually mixed with clay
- carbon brushes of electric motor
- The black electrode in the dry cell is made of graphite, as it is a good conductor of electricity

- **Buckminster Fullerence -**
- An allotrope of carbon containing cluster of 60 carbon atom joined together to form spherical molecules.
- The formula - C_{60} - 60 carbon atoms.
- Football - shaped spherical molecule in which 60 carbon atoms are interlocked hexagonal and pentagonal rings.
- 20 hexagon, 12 pentagon of carbon atoms. in one molecule of Buckminster Fullerence.
- Named after the American archiet Buckminister Fuller because its structure resembled the frame work of dome shaped halls designed by Fuller for large international exhibition.
- **Buckminster fullerene is a dark solid at room temperature.**
- It neither very hard nor soft.

- **ORGANIC COMPOUNDS -**
- The compounds of carbon known as organic compound.
- Most of the organic compound are hydrocarbon - only hydrogen and carbon.
- Examples - Methane - CH_4 Ethane - C_2H_6 Ethene - C_2H_4 Ethanol - C_2H_5OH CH_3COOH - Ethanoic acid.
- The low melting point and boiling point of the above carbon compound show that the forces of attraction between their molecules are not very strong. so they are covalent compound.
- carbon compound are non - conductor of electricity as they do not contain ions.
- **Organic compounds occurs in living things likes plant and animals.**
- Theory of **organic compound was disproved by** - Freidrich Wohler in 1828.
- Urea is an organic compound which was thought to be made inside the body of living being only.
- Wohler proposed the organic compound urea ($CO(NH_2)_2$) in the labratory from inorganic compound '**ammonium cynate**' **(NH_4CNO)**.
- This lead to the rejection of vital force theory for synthesis of organic compound.

- The study of carbon compounds is called - ORGANIC CHEMISTRY
- Though oxides of carbon, carbonate and carbides are also carbon compound but they are not considered to be organic compound.

• Reason for the large amount or number of organic compound compounds-

• Two characteristics-

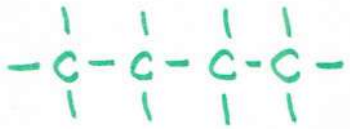
• catenation (self linking) • Tetravalency (four valency).

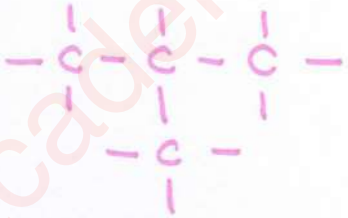
• carbon atoms linked with one another by means of covalent bond to form long chain of carbon atoms-

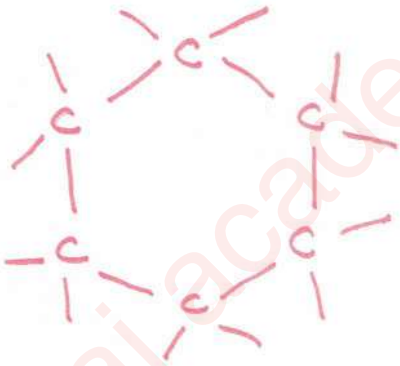
• The property of carbon element due to which atoms can join with one another to form long carbon chains - called catenation.

• three types of chains formed-

• straight chain • branched chain • ring type chain.







• Tetravalency -

The existence of large number of organic compounds is that the valency of carbon is 4 (which is quite large). Due to its large valency of 4, a carbon atoms form covalent bond.

• TYPES OF ORGANIC COMPOUNDS-

• common types-

• Hydrocarbon • Haloalkane • Alcohol • Aldehyde

• ketone • carboxylic acids

• HYDROCARBON - (Hydrogen + carbon = Hydrocarbon)

• A compound made up of hydrogen and carbon is called Hydrocarbon.

• The most important natural source of hydrocarbon is petroleum or (crude oil), which is obtained from underground oil deposits by drilling oil wells.

• TYPES OF HYDROCARBON-

• saturated hydrocarbon • unsaturated hydrocarbon.

• Saturated hydrocarbon - (Alkanes)

• A hydrocarbon in which the carbon atoms are connected by only single bonds.

• Bcoz ethene contains double bond and ethyne contains triple bond.

• The unsaturated hydrocarbon are obtained mostly from petroleum by process called cracking.

• **Alkenes-**

• An unsaturated hydrocarbon in which the two carbon atoms are connected by a double bond.

• Alkene contains- $\backslash C = C /$ group.

• Ethene and propene are two alkene because they contain double bond between two carbon atoms.

• There can be no alkene having only one carbon.

• **The general formula of alkene is C_nH_{2n}.**

• The common name of ethene is Ethylene

Name of alkene	No. of n atoms	Molecular for.
• Ethene	2	C_2H_4
• Propene	3	C_3H_6
• Butene	4	C_4H_8

• **Alkynes-**

• An unsaturated hydrocarbon in which the two carbon atoms are connected by triple bond.

• Alkynes contains —— $C \equiv C$ ——

• Ethyne, propyne and Butyne are alkynes because they contain triple bond between two carbon atoms.

• There is no alkyne having only one carbon atom.

• General formula of alkynes is - C_nH_{2n-2}.

• The common name of alkynes is - Acetylene.

• unsaturated hydrocarbons are more reactive than saturated hydrocarbons.

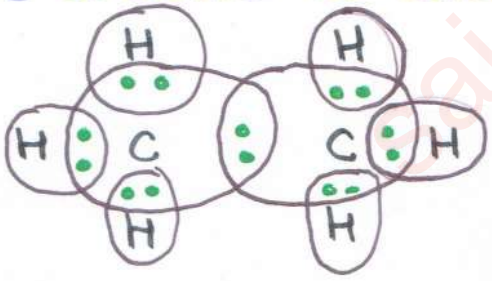
• **Unsaturated hydrocarbon > Saturated hydrocarbon**

• Alkene and Alkynes are chemically more reactive than Alkane.

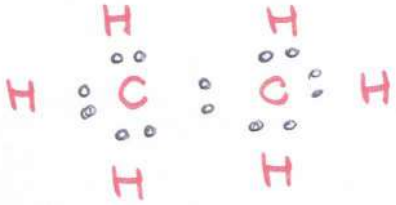
• **Alkene, Alkynes > Alkane**

- Ethane, ethene, ethyne are covalent molecules which are formed by sharing of electrons between various atom.

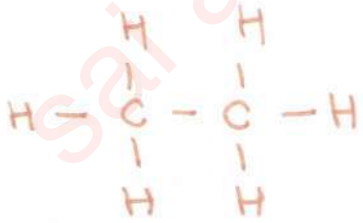
- Structure of ethane molecule - C_2H_6



C_2H_6



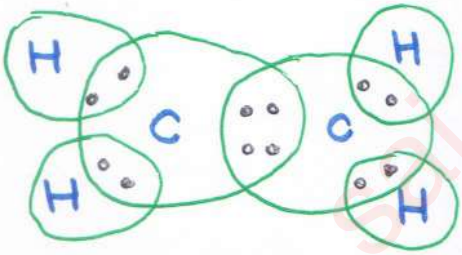
- Electron dot structure



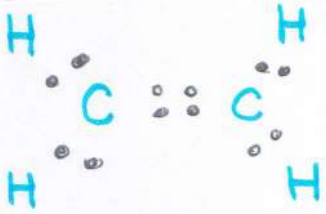
structural Formula

- In ethane → 1 carbon - carbon single bond and 6 carbon - hydrogen single covalent bonds so - number of covalent bond in ethane molecule is - 1 + 6 = 7

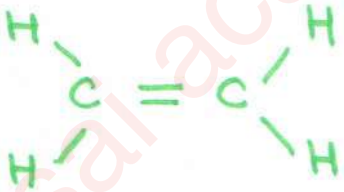
- Structure of ethene molecule - C_2H_4



- C_2H_4



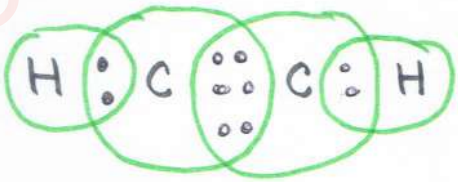
- Electron dot structure



- structural formula.

- In ethene, the total number of carbon - hydrogen single bonds in ethene is - 2 + 2 = 4

- Structure of ethyne molecule - C_2H_2



C_2H_2

- Electron dot structure

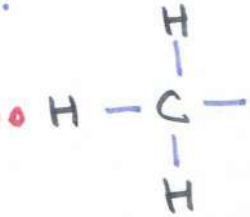
- structural formula

- single bond - 2 dots
- double bond - 4 dots
- Triple bond - 6 dots.

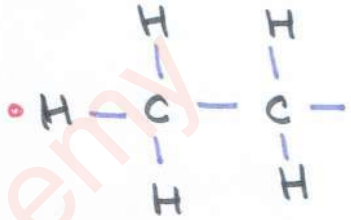
- **Alkyl Groups-**

- The group formed by the removal of one hydrogen atom from an alkane molecule.
- Ex - Methyl group (CH_3-) and ethyl group (C_2H_5-).
- Methyl group (CH_3-) is formed by the removal of one H atom from methane (CH_4).

- Ethyl group (C_2H_5-) is formed by the removal of one H atom from ethane (C_2H_6).
- The structural formula of the methyl and ethyl group are given on right hand side.
- Free line (—) show on the carbon atom of an alkyl group means that the one valency of carbon atom is free in an alkyl group.
- The general formula of an alkyl group - C_nH_{2n+1}, denoted by letter R.



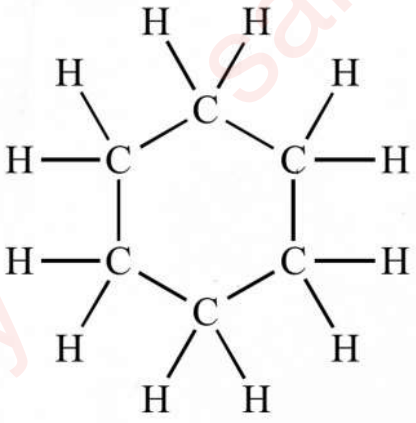
- Methyl group

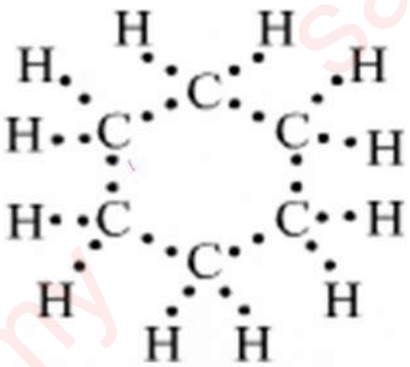


- Ethyl group

• CYCLIC HYDROCARBON -

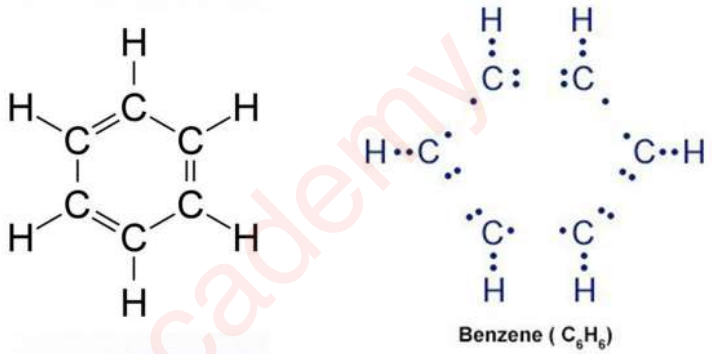
- The hydrocarbon in which the carbon atom are arranged in form of a ring. such hydrocarbon is called cyclic hydrocarbon.
- It can be saturated or unsaturated.
- A saturated cyclic hydrocarbon is 'cyclohexane'.
- Formula of cyclohexane - C_6H_{12}.
- The electron dot structure of cyclohexane has been obtained by putting two electron dots in place of every single bond this is becauee every single bond consist of two shared electron.
- The saturated cyclic hydro carbon are called - 'cycloalkane'
- Cycloalkane having 3 carbon atom in ring - cyclopropane (C_3H_6)
- cyclo alkane having 4 carbon atom in ring - cyclobutane (C_4H_8)
- The general Formula of cyclo alkane is - C_nH_{2n}.





STRUCTURAL FORMULA OF CYCLOHEXANE & ELECTRON DOT STRUCTURE

- An unsaturated cyclic hydrocarbon is benzene-
- Formula is benzene - C_6H_6
- A molecule of benzene is made up of 6 carbon atoms and 6 hydrogen atom.
- 3 carbon - carbon double bond. and 3 - carbon - carbon single bond and. 6 carbon - hydrogen single bonds.
- The **unsaturated cyclic compounds like benzene are called-** Aromatic compound.



Benzene (C_6H_6)

- **Naming of Hydrocarbon-**
- The official name or systematic name of organic compound were given by - **IUPAC- International uniun of pure and Applied chemistry.** in 1958, so they are called IUPAC nomenclature. and common name.
- The number of carbon atom in a hydrocarbon is indicated by using the following stems-
- one carbon atom is indicating by writing - 'Meth'
- Two carbon atom is indicating by writing - 'Eth'
- Three carbon atom is indicating by writing - 'Prop'
- four carbon atom is indicating by writing - 'But'
- Five carbon atom is indicating by writing - 'Pent'
- six carbon atom is indicating by writing - 'Hex'
- Seven carbon atom is indicating by writing - 'Hept'
- Eight carbon atom is indicating by writing - 'Oct'
- Nine carbon atom are indicating by writing - 'Non'
- Ten carbon atom is indicating by writing - 'Dec'

- Prefix of alkane (single bond) - 'ane'
- Prefix of alkene (double bond) - 'ene'
- Prefix of alkyne (triple bond) - 'yne'

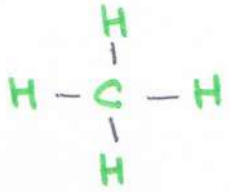
• Naming of saturated hydrocarbon -

1. Naming of CH_4 -

- 1 carbon atom indicate - meth, all single bond so, it is saturated
- The compound hydrocarbon is indicated by ending - ane.
- on joining 'meth' and 'ane' - meth + ane - methane.

CH_4

Methane



IUPAC - Methane

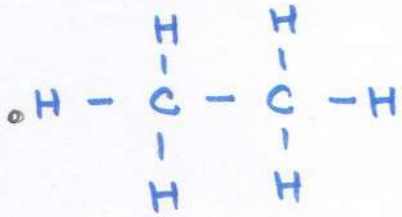
common name - Methane

2. Naming of C_2H_6 -

- 2 carbon atom indicate - eth
- The saturated hydrocarbon is indicated by using the suffix or ending 'ane'.
- Now joining 'eth' and 'ane' - ethane
- IUPAC name - Ethane common name - Ethane.

C_2H_6

Ethane



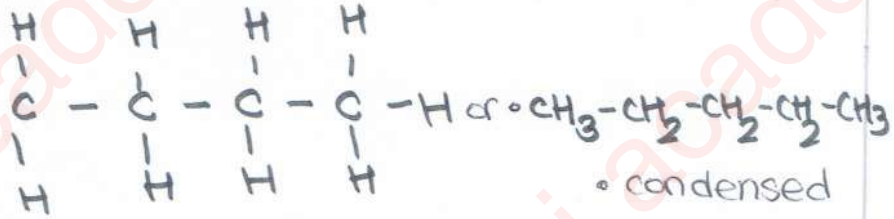
or $CH_3 - CH_3$

- condensed Formula.

• Naming of C_4H_{10} -

- 4 carbon atoms indicate - but
- Now joining 'but' and 'ane' - butane
- IUPAC name - Butane
- common name - n-butane

- C_4H_{10}
- Pentane



- n-pentane

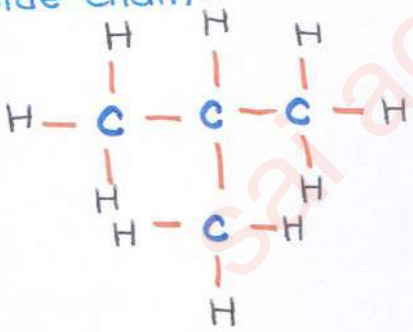
or $CH_3-CH_2-CH_2-CH_2-CH_3$

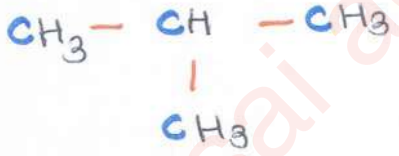
- condensed Formula

- IUPAC nomenclature for Branched-chain saturated hydrocarbon.
- Result -
- The longest chain of carbon atoms in the structure of the compound is found first. The compound is the named as derative of the alkane hydrocarbon which corresponds to the longest chain of carbon atoms. (Parent hydrocarbon).

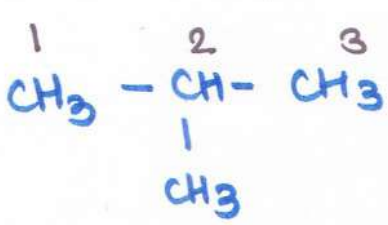
- The alkyl groups present as side chains are considered as substituents and named seperately as methyl (CH_3-) or ethyl (C_2H_5-) groups
- The carbon atoms of the longest carbon chain are numbered in a such way that the alkyl group get the lowest possible number (smallest possible number).
- The position of alkyl group is indicated by writing the number of carbon atom to which it is attached.
- The IUPAC name of the compound is obtained by writing the position and name of alkyl group just before the name of parent hydrocarbon.

- **C_4H_{10} - Butane -**
- Three atoms in the straight chain and the fourth carbon atom in the side chain.



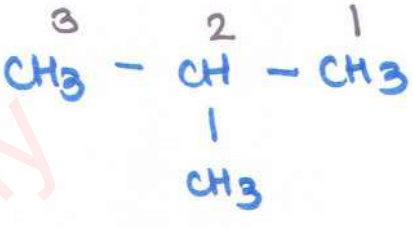


- There are 3 carbon in straight chain so, it is propane. so it is compound is to be named as derivative of propane.
- one methyl group (CH_3) is present in the side chain of propane so, the above compound is - **methyl derivative of propane.**
- The carbon chain in such a way that the methyl group gets the lowest possible number.
- Here we number the chain from left to right or right to left the position of methyl group remain the same.
- The methyl group falls on carbon number 2, so it is actually as '2 methyl group.
- If we join '2 methyl' and 'propane' - The IUPAC name becomes- **2 methyl propane.** The common name isobutane.



left to right

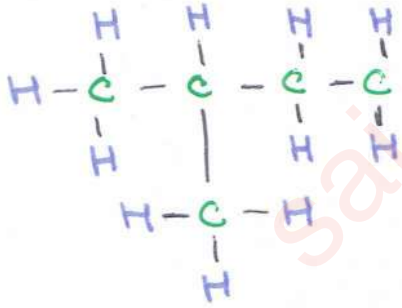
2 methyl propane



right to left.

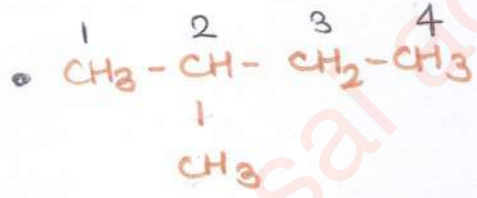
2 methyl propane

Example 2- C_5H_{12}

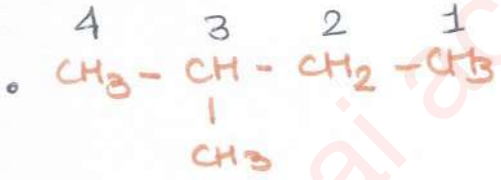


or $CH_3-CH(CH_3)-CH_2-CH_3$

- If we number the carbon chains from left hand side to right hand side, then the methyl group comes on carbon number 2.
- Above compound is butane having methyl group. IUPAC name will be - 2 methyl butane.
- As we number the carbon chains from right hand to left hand then methyl group falls on - carbon number 3 and hence the name becomes 3 methyl butane.



- 2 methyl butane (correct name)

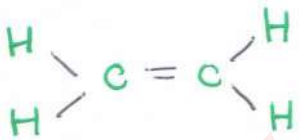


- 3 methyl butane (wrong name)

- IUPAC name - 2 methyl butane.
- common name - Iso pentane.

- Naming of unsaturated Hydrocarbon containing an double bond- The presence of double bond is indicated by using the ending 'ene'.
- Naming of C_2H_4 - The hydrocarbon contains 2 carbon atoms which are indicated by writing 'eth'. and double bond indicated by using the ending - 'ene'.
- IUPAC name - eth + ene = ethene
- common name - ethylene ($CH_2 = CH_2$)

- C_2H_4



or $H_2C = CH_2$

- IUPAC - Ethene
- common name - Ethylene

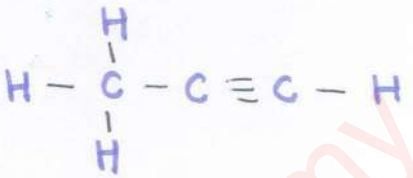
• **Naming of unsaturated hydrocarbon containing triple bond -**
• The presence of triple bond is indicated that word 'yne' after the stem.
• **Naming of C_2H_2 -**
• Hydrocarbon contains 2 carbon atoms which are indicated by writing 'eth'.
• **Triple bond suffix - yne**
• Now joining 'eth' with yne we get ethyne **eth + yne = ethyne**
• IUPAC name - ethyne • common **name** - acetylene.

• C_2H_2 • $H-C\equiv C-H$ • $CH\equiv CH$

• Acetylene • Ethyne

• **Naming of C_3H_4 -**
Hydrocarbon contains 3 atoms which are indicated by writing 'prop'.
• **Triple bon suffix -** yne
• Now join with yne we get - prop + yne = propyne
• **IUPAC name -** Propyne • **common name -** methyl acetylene

C_3H_4



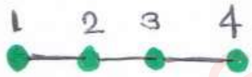
or $CH_3-C\equiv CH$

• Propyne

• Methyl acetylene

• **ISOMERS -**
• The organic compound having the same molecular formula but different structure.
• Ex - Normal butane and isobutane are example of isomer bcoz they same molecular formula, but different structure.
• Normal butane - **straight chain.**
• Isobutane - **Branched chain.**
• IUPAC name is -
• **n butane -** Butane • **isobutane -** 2 methyl propane.
• **Isomerism -** The existence of two or different organic compound having the same molecular formula but different structure is called Isomerism.

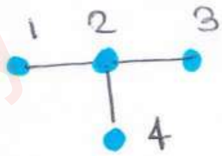
- Isomerism is possible only with hydrocarbon having 4 or more carbon atoms because only then we can have two or more different arrangement of carbon atoms is possible.
- No isomerism is possible in hydrocarbon containing 1, 2 or 3 carbon atoms per molecule because then only one arrangement of carbon atom is possible.
- No isomerism is possible in methane, ethane and propane becoz they contain only one, two or three carbon atoms.
- Butane (C_4H_{10}) – Two isomers are possible
- Pentane (C_5H_{12}) – three isomers are possible.
- Hexane (C_6H_{14}) – five isomers are possible.
- **As the no. of carbon atoms in an alkane molecule increases, the no. of possible isomer increases rapidly.**
- First, all the four carbon atoms are joined in a continous straight chain to give the following structure –



$\overset{1}{CH_3} - \overset{2}{CH_2} - \overset{3}{CH_2} - \overset{4}{CH_3}$ (n-butane)

This structure represents the compound normal butane.

- second, all the three carbons atoms can be put in straight chain and fouth carbon atom can be joined in the side chain –



$\overset{1}{CH_3} - \underset{|\atop CH_3\,4}{\overset{2}{CH}} - \overset{3}{CH_3}$ (Iso-butane)

- The compound having this structure is called isobutane.

- **Homologous series –**
- A homologous series is a group of organic compound having similar structure and similar chemical properties in which the successive compounds differ by CH_2 group.
- It is clear that the two adjacent homologus differe by 1 carbon atom and 2 hydrogen atom – CH_2 group.

- **Homologous series of alkane –**

Alkane	molecular formula
Methane	CH_4
Ethane	C_2H_6
Propane	C_3H_8
Butane	C_4H_{10}

- General formula of the homologous series of alkane –
  - C_nH_{2n+2}

- Characteristic of a homologous series-
- All the members of homologous series can be represented by the general formula- C_nH_{2n+2}.
- Any two adjacent homologues differ by 1 carbon atom and 2 hydrogen atoms in their molecular formulae. two adjacent homologues differ by $-CH_2$ group. The difference between CH_4 and C_2H_6 is CH_2.
- The difference in the molecular masses of any two adjacent homologues is 14u.
- molecular mass of CH_4 (methane) is 16u, ethane (C_2H_6) is 30u.
- Difference in molecular masses of ethane and methane is- 30 − 16 = 14u.
- All the compounds of homologous series show similar chemical properties. All compound of alkane undergo substitution rnx with chlorine.
- The members of homologous series show a gradual change in physical properties with increase in molecular mass
  - No. of carbon atom increase, the melting, boiling point and density of its members increase gradually.

- Homologous series of Alkenes-
- General Formula- C_nH_{2n}.

Alkene	Molecular Formula
Ethene	C_2H_4
Propene	C_3H_6
Butene	C_4H_8
Pentene	C_5H_{10}

- Ethene is used as- ripening new raw fruits Bananas and other fruits have been ripened.

- Homologous series of Alkynes-
- General Formula- C_nH_{2n-2}

Alkynes	Molecular Formula
Ethyne	C_2H_2
Propyne	C_3H_4
Butyne	C_4H_6
Pentyne	C_5H_8

• The organic compounds such as haloalkane, alcohol, ketone, aldehyde, and carboxylic acids also form the homologous series.

• Heteroatom - Any atom other than carbon and hydrogen. (hetero - other or different)

• Some of the common heteroatom are halogen atoms - chlorine (Cl), bromine (Br) and iodine (I), oxygen (O) atom.

• The Functional groups of organic compound containing two types of heteroatom - Halogen atom, oxygen atom.

• FUNCTIONAL GROUPS -

• An atom or group of atoms which makes a carbon compound reactive and decides its properties (or function) is called Functional group.

• Ex- Alcohol group, -OH present in ethanol, C_2H_5OH is an example of Functional group.

• Halo group - X (X can be Cl, Br or I).

• Halo group can be chloro -Cl, bromo -Br, iodo- -I depending upon whether a chlorine, bromine is linked to carbon atom of the compound.

• Chloromethane - CH_3Cl - chloro group is present.

• Bromomethane - CH_3Br - Bromo group is present.

• Bromine, chlorine and Iodine are collectively called Halogen.

• Represented by - symbol X. It is written as R-X (where R is an alkyl group and X is halogen atom).

• Alcohol group :- -OH.

• Made up of one oxygen and one hydrogen atom joined together.

• The alcohol group is also known as alcoholic group or OH group.

• Ex - CH_3OH - Methanol C_2H_5-OH - Ethanol

• General Formula - R-OH. (R - alkyl group, OH - alcohol group). (R is CH_3, C_2H_5).

• carboxylic group - -COOH or $-\overset{O}{\overset{\|}{C}}-OH$

• Methanoic acid - H-COOH

• Ethanoic acid - CH_3-COOH

• The organic compound containing -COOH group are called organic acid or carboxylic acid.

- Aldehyde group - $-CHO$ or $-\overset{\overset{O}{\|}}{C}-H$ or $-\overset{\overset{H}{|}}{C}=O$
- Also called aldehydic group.
- Example - Methanal $HCHO$, Ethanal CH_3CHO. The aldehyde group always occurs at end of a carbon chain.
- General Formula - R-CHO (R is an alkyl group).

- Ketone - $\diagdown C=O$ or $-\overset{\overset{O}{\|}}{C}-$ or $-CO-$
- consist of one carbon and oxygen atom. attached to two alkyl groups. The ketone group is called ketonic group.
- Examples - Propanone - CH_3COCH_3, Butanone - $CH_3COCH_2CH_3$
- Ketone group can occur only in middle of carbon chain. A ketone group can never occur at end of a carbon chain.

- Alkene group - $\diagdown C=C \diagup$ - it is carbon - carbon double bond.
- Ethene - $CH_2=CH_2$ • propene - $CH_3-CH=CH_2$.

- Alkyne group - $-C\equiv C-$ carbon - carbon triple bond.
- Ethyne - $CH\equiv CH$, propyne - $CH_3-C\equiv CH$
- compound containing alkyne group are known as alkyne.
- All the organic compound having an functional group show similar chemical property.

- HALOALKANE -

- When one hydrogen atom of an alkane is replaced by a halogen atom we get haloalkane.

Ex - when one hydrogen atom of methane is replaced by a chlorine atom we get chloromethane.

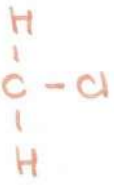
- $CH_4 \xrightarrow[\text{by Cl}]{\text{Replace H}} CH_3Cl$

Methane. chloromethane

- General formula - $C_nH_{2n+1}-X$, where X represent Cl, Br, I.

IUPAC name of Haloalkane	Formula
chloromethane	CH_3Cl
chloroethane	C_2H_5Cl
chloropropane	C_3H_7Cl

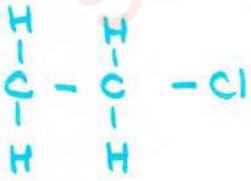
Naming of Haloalkane -

- In the IUPAC method, Haloalkane are named after the parent alkane by using prefix or suffixes to show the presence of halo group such as chloro (–Cl), Bromo (–Br).
- CH_3Cl by IUPAC method -
- CH_3Cl or CH_3-Cl or 
- Parent alkane - Methane (CH_4)
- Compound contains - chloro group (–Cl group).
- chloro + methane = chloromethane – IUPAC name
- common name = methyl chloride
- CH_3Br will be – Bromo methane • common - name - methyl bromide

- C_2H_5Cl by IUPAC method -
- Parent alkane - ethane
- chloro group present - IUPAC name - Chloroethane
- common name - Ethyl chloride
- C_2H_5Br will be - Bromo ethane • common name – Ethyl bromide.

- C_2H_5Cl
- CH_3-CH_2-Cl

Chloroethane

- 

ALCOHOLS -

- Alcohol are the organic compounds containing hydroxyl group (–OH group) attached to carbon atom.
- –OH group is the functional group of alcohol.
- Two simple alcohol - • CH_3OH - methyl alcohol also known as methanol.
- C_2H_5OH - ethyl alcohol also known as ethanol.
- Ex - By replacing one hydrogen atom of methane by a hydroxyl group we get an alcohol called methyl alcohol or methanol.

$$CH_4 \xrightarrow[\text{by OH}]{\text{Replace H}} CH_3-OH$$

- General Formula - $C_nH_{2n+1}-OH$

• IUPAC name of alcohol	• Formula
• Methanol	CH_3OH.
• Ethanol	C_2H_5OH.
• Propanol	C_3H_7OH.

• Naming of Alcohols-

• All alcohol compound contain alcohol group -OH at end of the parent alkane.

• 'ol' is used as suffix to show the presence of alcohol group in an organic compound.

• The last word of parent 'alkane', e is replaced by 'ol' to indicate the presence of OH group.

• The compound CH_3OH by IUPAC method-

• 1 carbon atom- so it is parent alkane is methane.

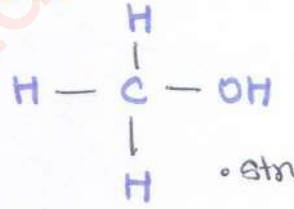
• Methane, here e is replaced by 'ol' - Methanol.

• Methan + ol = Methanol.

• IUPAC name of CH_3OH - Methanol

• common name - methyl alcohol

CH_3OH or



• Methanol • structure

• The compound C_2H_5OH by IUPAC method.

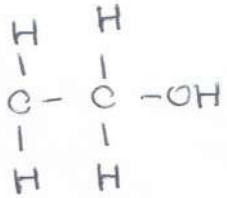
• Compound 2 atom - so it is parent alkane is ethane.

• Ethane, here e is replaced by 'ol' - Ethanol.

• Ethan + ol = Ethanol

• common name - ethyl alcohol.

• C_2H_5OH or • CH_3-CH_2-OH or



• Ethanol

— ALDEHYDES —

• Aldehydes are the carbon compounds containing an aldehydes group -CHO attach to a carbon atom.

• Ex- Formaldehyde - HCHO also called as methanal.

Acetaldehyde - CH_3CHO also called as ethanal.

• General formula- $C_nH_{2n}O$. - $C_1H_{2\times1}O$ - CH_2O - CHOH

IUPAC name	Formula
• Methanal	HCHO
• Ethanal	CH_3CHO
• Propanal	CH_3CH_2CHO

• Naming of Aldehydes-

• Aldehydes are the compound containing -CHO group.

• The name 'aldehyde' the first two letters make 'al'.

• The last 'e' of the parent alkane is replaced by 'al' to indicate the presence of aldehyde group.

• HCHO by IUPAC method -

• HCHO contains 1 carbon atom so its parent alkane is methane.

• The replacing the last 'e' of the methane by 'al' we get the name - methanal - methan + al = Methanal. (IUPAC).

• common name - HCHO - Formaldehyde.

• CH_3CHO by IUPAC method -

• CH_3CHO contains 2 carbon, so its parent is - Ethane

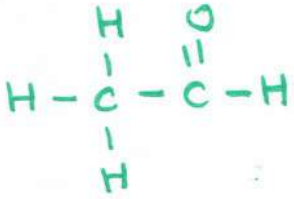
• CH_3CHO also contains an aldehyde group which is indicated by using 'al' as ending

• IUPAC - Ethan + al - Ethanal (IUPAC)

• common name - acetaldehyde. - CH_3CHO

• HCHO or • H - CHO or • 

• Methanal

• CH_3CHO or $CH_3 - CHO$ or 

• Ethanal

• KETONE •

• Ketone are the carbon compound containing the Ketone group — CO — group.

• It always occurs in the middle of a carbon chain, it must be least three carbon atoms in its molecule.

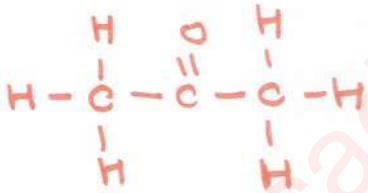
• Molecular Formula - $C_nH_{2n}O$

• IUPAC name	• Formula of ketone
• Propanone	CH_3COCH_3
• Butanone	$CH_3COCH_2CH_3$
• Pentanone	$CH_3COCH_2CH_2CH_3$
• Hexanone	$CH_3COCH_2CH_2CH_2CH_3$

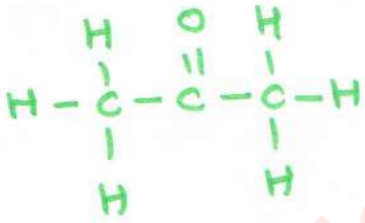
Naming of Ketones-

- Ketone are compound containing the ketone group- —CO- group.
- 'one' is used as a prefix, suffix to show the presence of ketone group.
- 'Here' e is replaced by 'one' to indicate the presence of a ketone group.

- **CH_3COCH_3 by IUPAC name -**
- The 3 carbon atoms, so its parent alkane is propane.
- By replacing the last 'e' of propane by one - propan + one = propanone. (IUPAC) - simplest ketone.
- common name - Acetone

- CH_3COCH_3 or $CH_3-\overset{\overset{O}{\|}}{C}-CH_3$ or 
- Propanone
- Acetone

- **$CH_3COCH_2CH_3$ by IUPAC name-**
- The 4 carbon atoms, so its parent alkane is Butane.
- By replacing the last 'e' of butane by one - Butan + one = Butanone. (IUPAC name)
- common name - Ethyl methyl ketone

$CH_3COCH_2CH_3$ or $CH_3-\overset{\overset{O}{\|}}{C}-CH_2-CH_3$ or 

- Butanone

- CARBOXYLIC ACIDS -

- The compounds containing carboxylic acids (-COOH) are called carboxylic acids. commonly known as organic acids.
- **Name For -COOH for carboxylic acids is -** alkanoic acids.
- made up of three atoms- carbon, oxygen, hydrogen.
- General Formula of homologous series- is R-COOH. where R is an alkyl group.

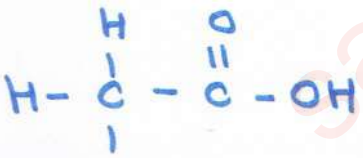
IUPAC name	Formula of acid.
• Methanoic acid	$HCOOH$
• Ethanoic acid	CH_3COOH
• Propanoic acid	CH_3CH_2COOH

- Naming of COOH group -
- IUPAC name obtain by replacing the last 'e' of the parent alkane by 'oic' acid.
- HCOOH by IUPAC name -
- The compound contains 1 carbon atom so, its parent alkane is methane.
- Methan + oic acid = Methanoic acid. (IUPAC)
- common name - Formic acid.

HCOOH or or 

- Methanoic acid.

- CH_3COOH by IUPAC name -
- The compound contains 2 carbon atoms, so its parent alkane is - Ethane.
- **Ethan + oic acid = Ethanoic acid** (IUPAC name).
- common name - acetic acid

- CH_3COOH or 

Acetic acid

• COAL AND PETROLEUM •

- When fuel is burnted, the energy is released mainly as heat. these energy used for many purpose such as cooking food, heating water. machines in factories.
- Most of the common fuels are either free compound or carbon compound
- Forexample - coke, coal and charcoal contain free carbon whereas the fuels such as kerosene, petrol, LPG and natural gas are all carbon compounds.
- When carbon in any form is burned in the oxygen in the oxygen it forms carbon dioxide gas and releases a large amount of heat and some light.

- $C + O_2 \longrightarrow CO_2$ + Heat + light
- carbon · oxygen · carbon dioxide

- Most of the fuels which we use today are obtained from coal, petrol and natural gas are known as Fossil fuels.

- Fossils are the remains of the pre-historic animals or plant buried under the earth, million of years ago.
- Coal, petroleum and natural gas are known as fossil fuel bcoz they were formed by the decomposition of the remains of prehistoric plant and animals (buried) under the earth, long, long ago.
- Coal is a complex mixture of compounds of carbon, hydrogen and oxygen and some free carbon. small amount of nitrogen and sulphur compounds are present in coal.

- **How coal was formed -**
- coal was formed by the decomposition of large land plants and trees buried under the earth million years ago.
- It is believed that million of years ago, due to earthquake and volcanoes the forest were buried under the surface of the earth and get covered with sand, clay and water.
- due to high temp. and high pressure inside earth, and in the absence of air, wood was converted into coal.

- Petroleum is a dark viscous and foul smelling crude oil. The petroleum means rock oil. It is called petroleum bcoz it is found under the crust of earth trapped in the rocks.
- The crude oil petroleum is a complex mixture of several solids, liquid and gaseous hydrocarbon mixed with water, salt and earth particles.
- The fuel such as petrol, kerosene, diesel and LPG are obtained from petroleum.

- **How petroleum was formed -**
- Petroleum oil (and natural gas) were formed by the decomposition of remains of extremely small plants and animals buried under the sea millions year ago.
- It is believed that millions of years ago the microscopic plants and animals which lived in seas, died. Their bodies sank to the bottom of sea.
- The chemical effect of pressure and heat and bacteria converted the remains of microscopic plants and animals into petroleum oil and natural gas just converted forest into coal. conversion of these took place in absence of oxygen.
- The petroleum thus formed got trapped between two layers of impervious rocks forming an oil trap.
- When coal and petroleum fuels are burnt, they lead to the formation of oxides of nitrogen and sulphur which go into air.

- These oxides of nitrogen and sulphur are major pollutant in the air.
- Why do substance burn with a flame or without flame -
- A candle, LPG and kerosene oil, all burn with a flame.
- A flame is the region where combustion of gaseous substance takes place. Flame is produced only when gaseos substance burn.
- All the gaseous fuels burns with flame, but only those solid and liquid fuel which vaporise on heating.
- Flames are of two types - Blue flame and yellow flame.
- When the oxygen supply is sufficent, then fuels burns completely producing a blue flame -
- The blue flame does not produce much light, so it is said to be non-luminous flame. In gas stove, cooking gas (LPG) burns with a blue non-luminous flame.
- Explanation - The gas stove has holes for air to mix properly with cooking gas. The cooking gas gets sufficent oxygen from this air and hence burns completely producing a blue flame. Thus, complete combustion of cooking gas takes place in a gas stove.

- When the oxygen supply is insufficent then the fuel burn incompletely producing mainly yellow flame. due to incomplete combustion of fuel. this yellow flame produces light so it is to be luminous light flame. incomplete combustion of wax takes place in a candle.
- Those solid and liquid fuels which do not vaporise on heating, burn without producing a flame - coal and charcoal burn in 'angithi' without producing flame. They just glow and produce heat. coal and charcoal are ignited, the volatile substance present in them vaporise and they burn with a flame in the begining.

- CHEMICAL PROPERTIES OF CARBON COMPOUND-
- COMBUSTION - BURNING-
- The process of burning of a carbon compound in air to give CO_2 water, heat and light is known as combustion.
- Most of the carbon compound burns in air to produce a lot of heat
- Ex - Alkanes burn in air to produce a lot of heat due to which alkanes are excellent fuels.
- When methane burns in an sufficent supply of air, then CO_2 and water vapour are formed a lot of heat is also produced.

- CH_4 + $2O_2$ ⟶ CO_2 + $2H_2O$ + Heat + light
  methane, oxygen, carbon dioxide, water
- Natural gas produces a lot of heat on burning, so it is used as fuels in homes, transport and in industry.
- The cooking gas (LPG) which we use in our homes is mainly an alkane called butane C_4H_{10}.
- When butane burns in air in the burner of a gas stove, then it forms carbon dioxide and water vapour with the evolution of a lot of heat. Due to this, butane is an excellent fuel.
- Carbon and its compounds are used as fuels - bcoz they burns in air releasing a lot of energy.
- The saturated hydrocarbon generally burn in air with a blue, non-sooty flame - this is because the percentage of carbon in saturated hydrocarbon comparatively low which get oxidised completely by the oxygen present in air.
- The supply of air for burning is reduced then incomplete combustion of even saturated hydrocarbon will take place and they will burn producing a sooty flame.
- The gas stove used in our homes have tiny holes of air so that sufficient oxygen of air is available for the complete burning of fuel to produce a smokeless blue flame.
- If the bottom of the cooking utensils in our homes are getting blocked and fuel is not burning completely.
- The unsaturated hydrocarbon burn in air with yellow, sooty flame (producing black smoke).
- The unsaturated hydrocarbon burn with a sooty flame bcoz the % of carbon in unsaturated hydrocarbon is comparatively higher which does not get oxidised completely in the oxygen of air.
- If unsaturated hydrocarbon are burned in pure oxygen, then they will burn completely producing a blue flame (without any smoke at all).
- The oxygen - acetylene flame is extremely hot and produces a very high temperature which is used for welding metals.
- A mixture of acetylene and air is not used for welding bcoz the burning of acetylene in air produces a sooty flame which is not hot enough to melt metals for welding.

• The incomplete combustion of fuels has the disadvantages-
• Incomplete combustion in insufficient supply of air leads to unburnt carbon in the form of soot which pollutes the atmosphere, blackens cooking utensils and blocks chimney in factory.
• Incomplete combustion also leads to the formation of an extremely poisonous gas called carbon-monoxide.

• Substitution Reactions-
• saturated hydrocarbon undergo substitution reaction with Cl_2 in the presence of sunlight.
• The reaction in which one hydrogen atom of a hydrocarbon are replaced by some other atoms is called- substitution rx.
• If the substitution of hydrogen atoms takes by chlorine it is also called- chlorination.
• Substitution reaction are a characteristic property of saturated hydrocarbon., unsaturated hydrocarbon donot give substitution reaction with halogens (Alkenes and Alkynes).
• Substitution reaction of methane with chlorine-
• Methane reacts with chlorine in the presence of sunlight to form chloromethane and hydrogen chloride.

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

Methane chlorine chloromethane Hydrogenchloride

• Three compounds-
• Dichloromethane or methylene dichloride CH_2Cl_2, Trichloromethane $CHCl_3$, Tetrachloromethane CCl_4 are all saturated hydrocarbons. so, all these compound will give substitution reaction.

• Addition Reactions-
• The reaction in which an unsaturated hydrocarbon combines with another substance to give a single product.
• Addition reaction are characteristic property of unsaturated hydrocarbon. it contains double and triple bond. that is addition reaction are given by all the alkenes and alkynes.
• Addition reaction of Ethene with hydrogen-
Ethene reacts with hydrogen when heated in the presence of Ni (Nickel) catalyst. to form ethane.

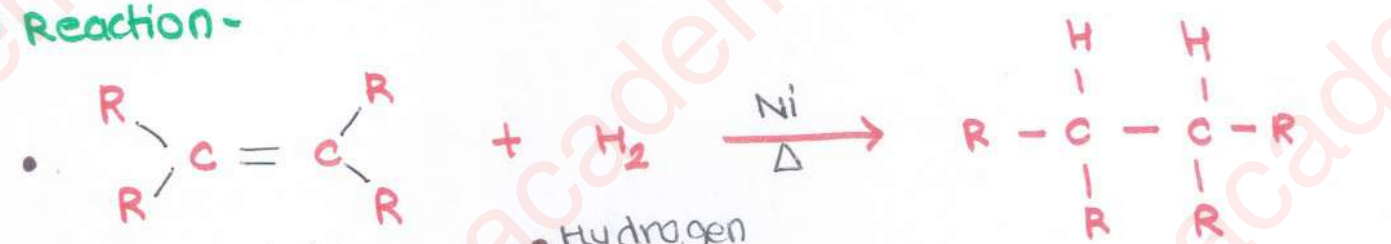
$$CH_2 = CH_2 + H_2 \xrightarrow[\Delta]{\text{Ni catalyst}} CH_3 - CH_3$$

Ethene Hydrogen ethane

• Hydrogenation of Oils-

- The addition of hydrogen to an unsaturated hydrocarbon to obtain a saturated hydrocarbon is called Hydrogenation.
- It takes place in the presence of nickel or palladium metal as a catalyst.
- It is used to prepare vegetable ghee from vegetable oils.
- The vegetable oils are unsaturated compounds containing double bond. they are in the liquid state at room temperature. due to presence of double bond, vegetable ghee undergo addition of hydrogen to form saturated product called vanaspti ghee. which is solid at room temperature.

• **Reaction-**



(liquid) • vegetable oil — unsaturated Fat

• Hydrogen

(solid) Vegetable ghee — saturated Fat

- Vegetable oils containing unsaturated fatty acid are good for our health. The saturated ghee like vegetable ghee obtained by the hydrogenation of oils, are not good for health.
- Brand name- **Dalda, Rath and Panghat.**
- **The addition of bromine is used in form of bromine water** bromine water has red-brown colour due to presence of bromine in it. if an organic compound decolourises bromine water, then it will be an unsaturated compound.
- **All the unsaturated compound decolourises bromine water but saturated compound do not decolourises bromine water.**
- we will distinguish chemically between a cooking oil and butter taken in seperate test tube-
- **cooking oil** - decolourses bromine water (showing that it's an unsaturated compound.
- **Butter** - does not decolourises bromine water (showing that it is an saturated compound.

- some important carbon compounds-
- **Ethanol** - or ethyl alcohol
- Ethanol is the second member of homologous series of alcohol.
- Formula - C_2H_5OH, common name - ethylalcohol.

Physical Properties of Ethanol

- Colorless liquid having pleasant smell and burning taste
- Volatile liquid having a low boiling point
- No effect on litmus paper
- It is lighter than water
- Solubility of ethanol in water is due to presence of -OH group
- 100% pure ethanol is called absolute alcohol
- Ethanol contain 5% of water is called rectified spirit
- Covalent compound
- It is neutral compound bcoz does not contain any H+ions.

- CHEMICAL PROPETIES OF ALCOHOL -

• COMBUSTION

- It is the burning of an organic compound in the oxygen.
- The organic compound reacts rapidly with oxygen and breaks up completely to form CO_2 and water vapour and a lot of heat and light are also produced.

• OXIDATION

- It's a kind of controlled combustion.
- The organic compound combines with oxygen to form a new compound,
Here, the organic compound does not break down completely with low amount of heat and light.

- **combustion** - Ethanol is a highly inflammable liquid. It catches fire easily and starts burning. Ethanol burns readily in air to form CO_2 and water vapour and releasing a lot of heat and light.

$$C_2H_5OH + 3O_2 \xrightarrow{\text{combustion}} 2CO_2 + 3H_2O + \text{Heat} + \text{light}$$

ethanol — oxygen — carbon dioxide

- **Ethanol as Fuel-**
- A material which is burnt to obtain heat is called a fuel. since, ethanol burns with a clear flame giving a lot of energy and heat, it is used as fuel.
- **Used as an additive in petrol.**
- It is a clean fuel because it gives harmless products carbon dioxide and water vapour on burning. does not produce any harmful gas like carbonmonoxide.
- Ethanol is produced on large scale from sugar cane crop the juice is used to obtain sugar by process of crystallisation
- After the crystallisation of sugar from conc. sugar canejuice, a thick, dark brown liquid called - Molasses.
- Molasses still contain about 30% of sugar which could not be seprated by crystallisation.
- **Ethanol is produced by the fermentation of the cane sugar present in molasses.** Ethanol produced by the ferementation of sugar is mixed with petrol and used as fuel for running cars.

- Alkaline potassium permanganate and acidified potassium dichromate are **strong oxidising agent**. Nascent oxygen is freshly generated atomic oxygen which is very, very reactive.

- **Oxidation** - Oxidation means "controlled combustion" when ethanol is heated with alkaline potassium permanganate solution, it gets oxidised to ethanoic acid.

$$\underset{\text{Ethanol}}{CH_3CH_2OH} + \underset{\text{Nascent oxygen}}{2[O]} \xrightarrow[\cdot K_2Cr_2O_7]{\cdot KMnO_4} \underset{\text{ethanoic acid}}{CH_3COOH} + \underset{\text{water}}{H_2O}$$

- By adding 5% aqueous solution of $KMnO_4$ in sodium hydroxide solution to ethanol dropwise till purple colour of $KMnO_4$ solution.
- Ethanoic acid is formed by oxidation of ethanol by using strong oxidising agent.
- The ethanoic acid formed by the oxidation of ethanol can turn blue litmus to red.

• **Reaction with sodium metal-**

• Ethanol reacts with sodium to form sodium ethoxide and hydrogen gas-

$$2C_2H_5OH + 2Na \longrightarrow 2C_2H_5O^-Na^+ + H_2$$

Ethanol — Sodium — Sodium ethoxide — Hydrogen

• This reaction is used as a test for ethanol.

• when a small piece of sodium metal is put into ethanol in dry test tube rapid effervescene due to the evolution of H_2 gas. The hydrogen gas produced can be tested by burning.

• When burning splinter is brought near the mouth of the test tube, the gas burns with 'pop' sound which is characteristics of hydrogen gas.

• **All the alcohol react with sodium metal to evolve hydrogen gas.**

• **Dehydration-**

• means removal of water molecule from it. when ethanol is heated with excess of conc. H_2SO_4 at 170°C, it gets dehydrated to form ethene.

$$CH_3-CH_2OH \xrightarrow{\text{conc } H_2SO_4} CH_2=CH_2 + H_2O$$

Ethanol — Ethene — water

• During dehydration of ethanol molecule, H from the CH_3 group and OH from CH_2OH group are removed in the form of a water molecule resulting in the formation of ethene molecule.

"conc. H_2SO_4 act as a dehydrating agent"

• **Reaction with Ethanoic acid - Formation of Ester-**

• Ethanol reacts with ethanoic acid on warming in the presence of a few drops of conc. H_2SO_4 acid to form sweet smelling ester, ethyl ethanoate.

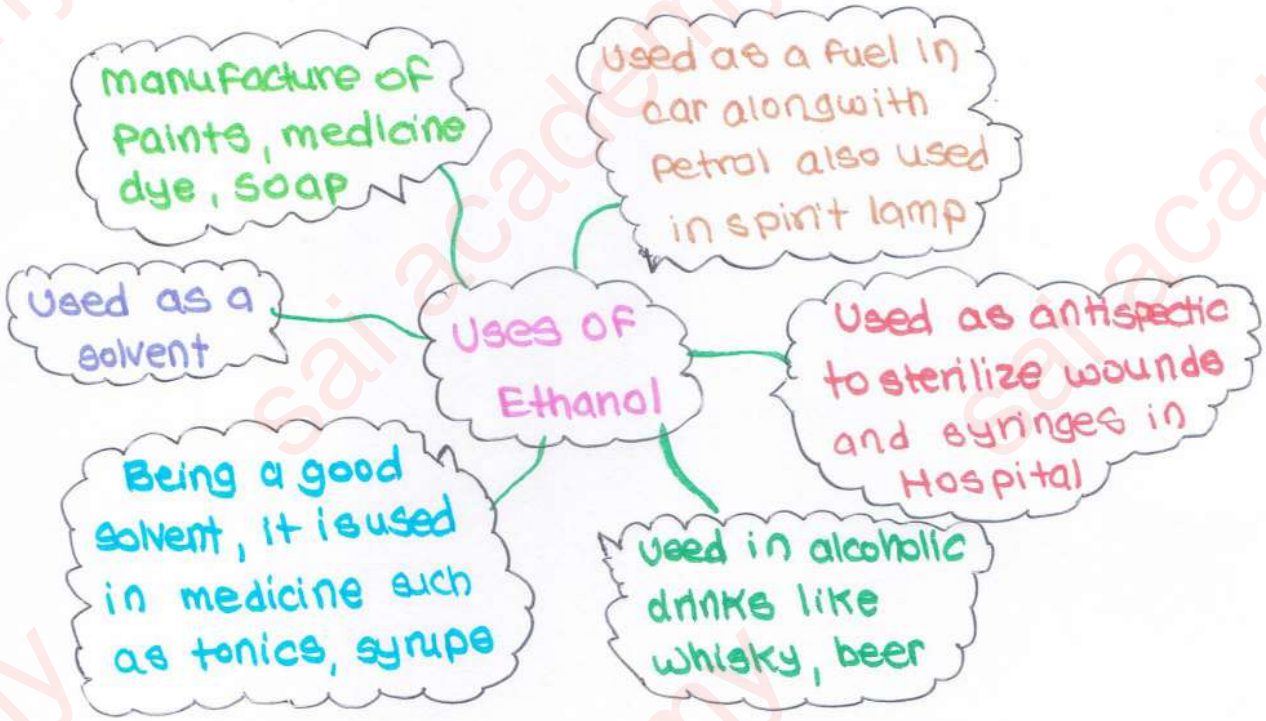
$$CH_3COOH + C_2H_5-OH \xrightarrow{\text{Conc } H_2SO_4} CH_3COOC_2H_5 + H_2O$$

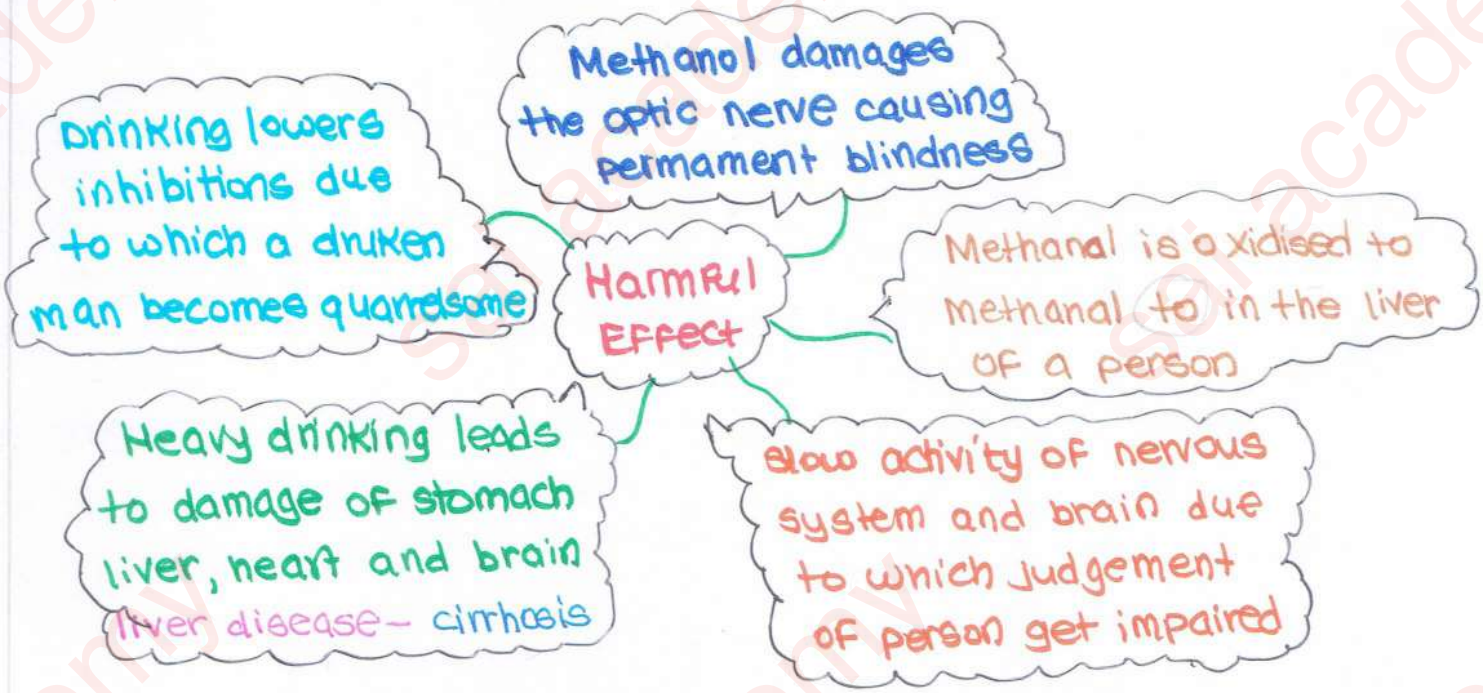
Ethanoic acid — Ethanol — Ethyl ethanoate (sweet smelling ester) — water

• The reaction in which -COOH (carboxylic acid) combines with an alcohol to form an ester - called **esterification.**

• It takes place in the presence of a catalyst like H_2SO_4.

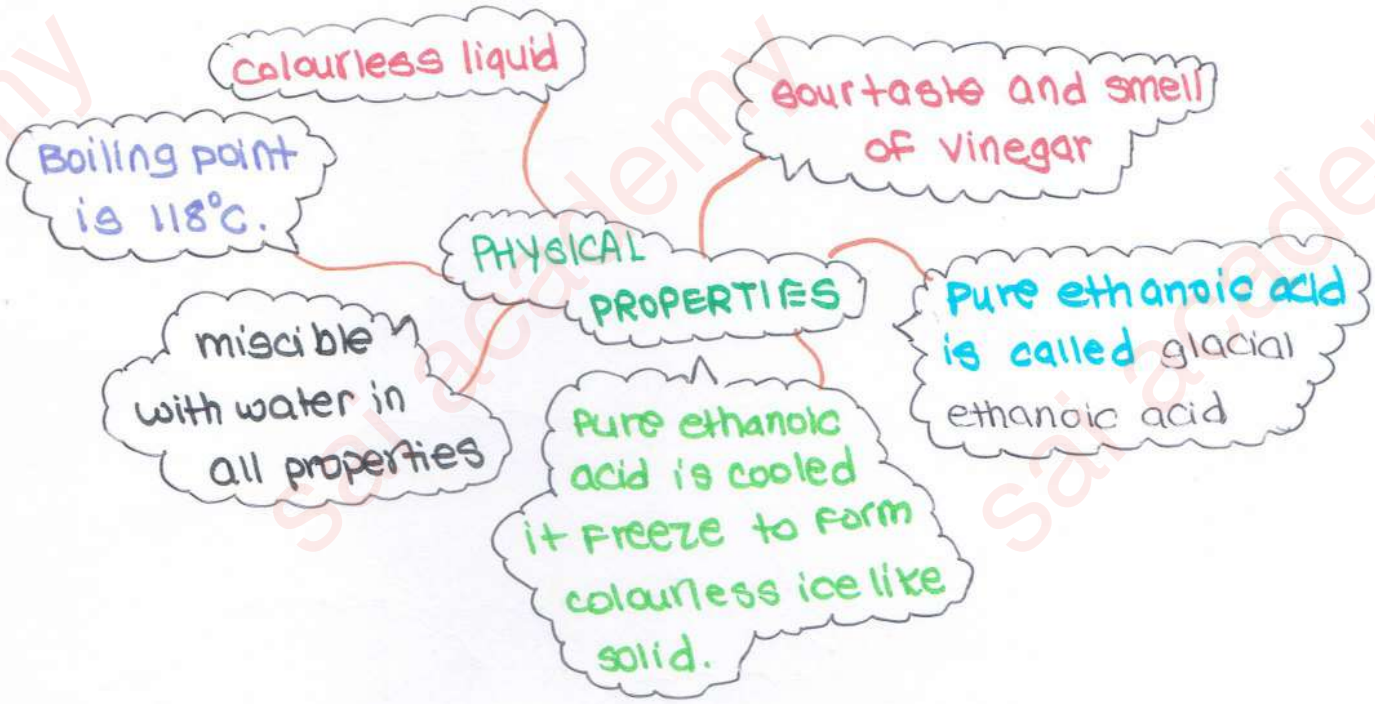
- We can carry out the reaction between ethanol and ethanoic acid to form an ester -
- Take 1ml of pure ethanol, in a test tube and add 1ml of glacial ethanoic acid to it. Then add 2 or 3 drops of conc. H_2SO_4 acid to the mixture.
- Warm the test tube containing above reaction mixture in hot water bath for about 5 minutes.
- Pour the content of the test tube in about 50ml of water taken in another beaker and smell it.
- Sweet smell is obtained indicating the formation of an ester.





• ETHANOIC ACID - ACETIC ACID

- Ethanoic acid is the second member of homlogous series of carboxylic acid.
- Formula- CH_3COOH , common name – Acetic acid.
- Dilute solution of ethanoic acid in water is called - vinegar
- Vinegar contains about 5 to 8 percent ethanoic acid. It is widely used as preservative in picklies.



• CHEMICAL PROPERTIES-

- Reaction with carbonates and Hydrogen carbonate-

Ethanoic acid reacts with carbonate and hydrogencarbonate to evolve carbon dioxide gas along with formation of salt and water.

- Reaction with sodium carbonate – Ethanoic acids reacts with sodium carbonate to form sodium ethanoate and CO_2 gas.

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

- Ethanoic acid
- Sodium carbonate
- Sodium ethanoate
- carbon dioxide
- water

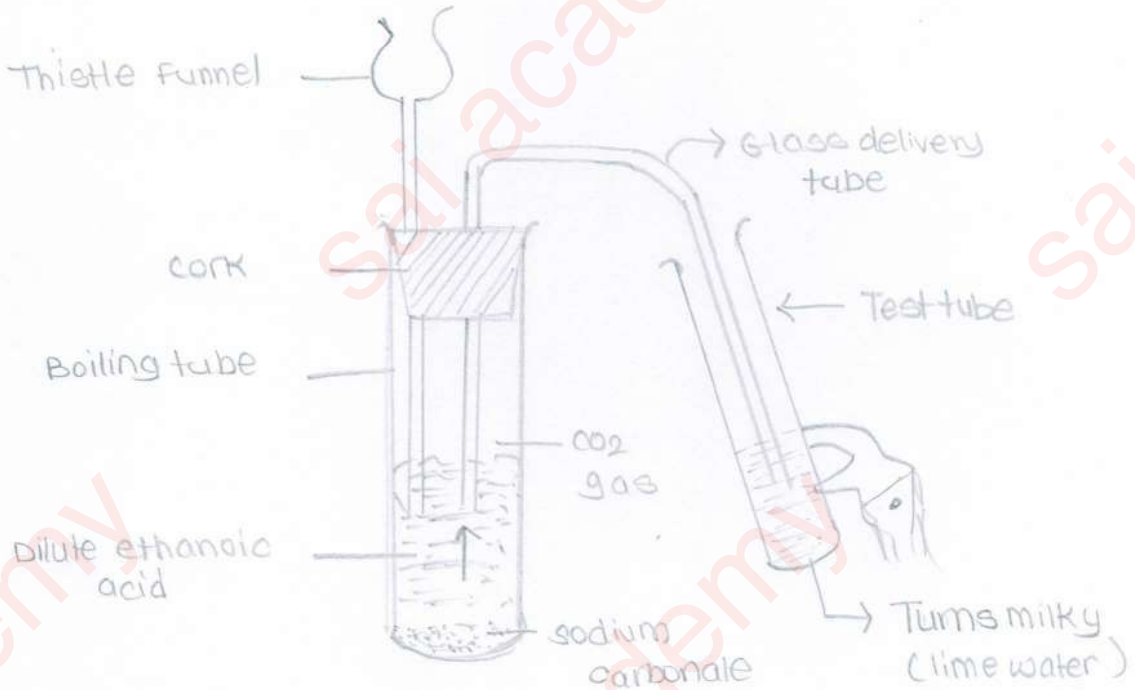
- When sodium carbonate is added to solution of ethanoic acid, brisk effervescene of carbon dioxide given off. The salt formed in this reaction is sodium ethanoate.
- common name of sodium ethanoate - Sodium acetate

• Reaction with sodium hydrogen carbonate- Ethanoic acid react with sodium hydrogen carbonate to evolve brisk effervescene of CO_2 gas.

• $CH_3COOH + NaHCO_3 \longrightarrow CH_3COONa + CO_2 + H_2O$

Ethanoic acid — Sodium hydrogen carbonate — Sodium ethanoate — Carbon dioxide — Water

• Take a boiling tube and put about 0.5g of sodium carbonate in it.
• Add 2 ml of dilute ethanoic acid to the boiling tube.
• We will observe that brisk effervescene of CO_2 gas is produced.
• Pass this gas through lime water taken in a test tube.
• The lime water turns milky.
• Conclusion- This experiment proves that when ethanoic acid react with sodium carbononate, then CO_2 gas is produced.



• Reaction with sodium hydroxide-
• Ethanoic acid reacts with bases to form salts and water.
• Ethanoic acids react with sodium hydroxide to form salt called sodium ethanoate and water.

• $CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$ (salt)

Ethanoic acid — Sodium hydroxide — Sodium ethanoate — Water

• Reaction with Alcohols - Formation of ester-
• Ethanoic acids react with presence of little conc. H_2SO_4 acid to form ester. When ethanoic acids is warmed with ethanol in the presence of few drops of conc. H_2SO_4, a sweet smelling ester is called Ethyl ethanoate.

- CH_3COOH + C_2H_5OH ⟶ $CH_3COOC_2H_5$ + H_2O

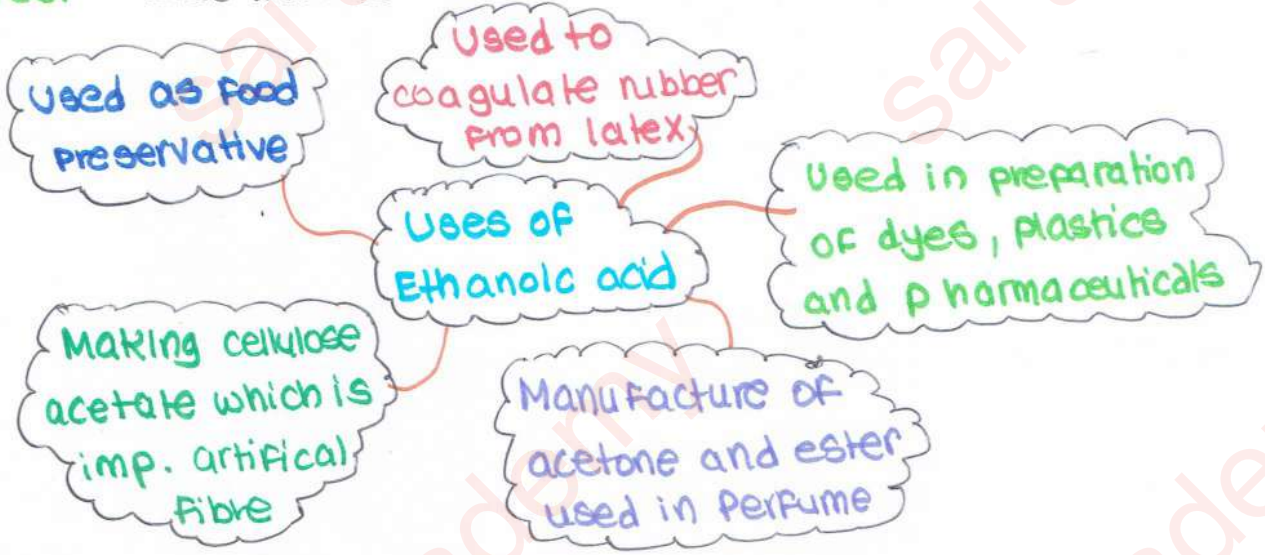
Ethanoic acid (Acetic acid) | ethanol | Ethyl ethanoate (sweet smell) | water

- The reaction in which a sweet smelling ester is formed is used as a test for ethanoic acid.
- Esterification- **The reaction of a carboxylic acid with an alcohol to form an ester.**
- Ester are usually volatile liquids having sweet smell and pleasant smell.
- Ester used as flavouring agent. it used in icecream, sweets and cold brinks.
- **Hydrolysis of Ester-**
- when an ester is heated with sodium hydroxide solution then the ester get hydrolysed to form the parent alcohol and sodium salts of -COOH acid.
- Ex- when ethyl ethanoate ester is boiled with sodium ethanoate solution, then sodium ethanoate and ethanol are produce.

- $CH_3COOC_2H_5$ + $NaOH$ ⟶ CH_3COONa + C_2H_5-OH

Ethyl Ethanoate (Ethyl acetate) | sodium hydroxide | sodium ethanoate (sodium acetate) | ethanol (ethyl alcohol)

- **Hydrolysis of Ester is known as -** SAPONIFICATION (soap making). bcoz this reaction is used for preparation of soaps.
- when the esters of higher fatty acids with glycerol (oil and fats) are hydrolysed with sodium hydroxide solution, we get sodium salts of higher fatty acid which are called SOAPS.
- **Litmus test -** Blue litmus solution turns red litmus.



• SOAPS AND DETERGENTS -

• SOAP -

• Soap is the sodium salt of long chain carboxylic acid (fatty acid) which has cleaning properties in water.

• Soap has a large non-ionic hydrocarbon group and ionic group COO^-Na^+.

• EX- Sodium stearate and sodium palmitate

• SODIUM STEARATE - $C_{17}H_{35}COO^-Na^+$

• Sodium stearate 'soap' is the sodium salt of long chain saturated fatty acid called - stearic acid.

• long alkyl group - $C_{17}H_{35}$, • ionic carboxylate group - COO^-Na^+

• SODIUM PALMITATE - $C_{15}H_{31}COO^-Na^+$

• Sodium palminate 'soap' is the sodium salt of along chain saturated fatty acid called - Palmitic acid.

• **Solution of soap in water is basic in nature.**

• A soap solution turns red litmus paper to blue.

• Manufacture of soap -

• Soap is made from animal fat or vegetable oils.

• Fats and vegetable oil are naturally occuring esters of higher fatty acids. and an alcohol called - glycerol.

• **when fats and oils are heated with sodium hydroxide solution they split to form sodium salts of higher fatty acids and glycerol.**

• Fat or oil (An ester) + sodium hydroxide (An alkali) $\xrightarrow{\text{Heat}}$ soap (Fatty acid.) + Glycerol (An alcohol)

• The process of making soap by hydrolysis of fats and oils with an alkaline is called - SAPONIFICATION

• Preparation of soap in the laboratory -

• The main raw material required for preparing soap in a school laboratory or at home -

• vegetable oil • sodium hydroxide (caustic) • sodium chloride (common salt)

Procedure -

• Take about 20ml of castor oil in a beaker. Add 30ml of 20% NaOH solution to it.

• Heat the mixture with constant stirring till paste of soap is formed.

• Then add 5 to 10 grams of common salt -
• Stir the mixture well and allow it to cool. On cooling the solution, solid soap seprates out.
• When the soap sets, it can be cut intopieces called 'soap bars'
• Why common salt is added in soap making-
• common salt is added to the mixture to make the soap come out of solution.
• common salt is added to precipitate out all the soap from the aqueous solution, when we add common salt to the solution, then the solubility of soap present in it decreases.
• The soap which is used for washing clothes works by making the oil and grease particles dissolve in water.

• **STRUCTURE OF A SOAP MOLECULE-**
• A soap solution molecule is made up of two parts- a long hydrocarbon part and a short ionic part containing- $-COO^-Na^+$ group.
• The soap molecule is said to have a tadpole structure.
• The long hydrocarbon chains is - hydrophobic (water repelling) so part of soap molecule is insoluble in water but soluble in oil and grease.
• The ionic portion of the soap molecule is - hydrophilic (water-attracting) due to polar nature of water molecule. It is soluble in water, but insoluble in oil and grease.
• The short ionic part of the soap molecule in soluble in water, so it can attach to the water particles.
• **Micelle** - A spherical aggregate of a soap molecule in the soap solution in water is called micelle. (soap solution is colloidal solution).

• structure of soap molecule

• cleansing action of soap-
• When soap is dissolved in water, it forms a colloidal suspension in water in which the soap molecule cluster together to form spherical micelles.
• In a soap micelle- the soap molecule are radially arranged with hydrocarbon ends directed towards the center and ionic ends directed outwards.

• Micelle formation will not takes place when soap is added to organic solvents like ethanol because - the hydrocarbon chains of soap molecules are soluble in organic solvents like ethanol.

• **When a dirty cloth is put in water containing dissolved soap, then the hydrocarbon ends of soap molecule in the micelle attach to the oil or grease particle by using its hydrocarbon ends.**

• When the dirty cloth is agitated in the soap solution, the oily and greasy particles present on its surface and entrapped by soap micelles get dispersed in water due to which the soap water become dirty, but the cloth gets cleaned.

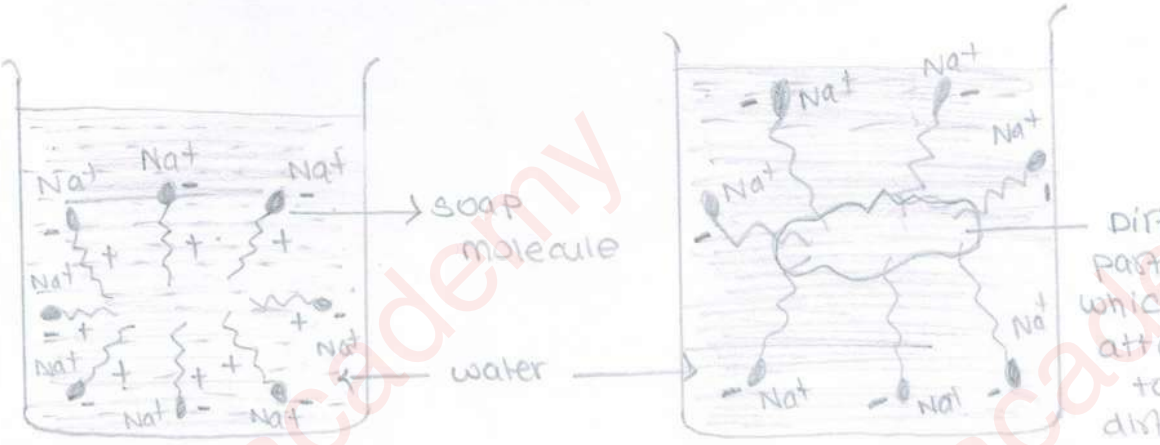
• **The fact that soap acts by making oily and greasy particles mix with water can be demonstrated as follows -**

• Take about 10 ml of water in a test tube and add a little cooking oil to it. The oil does not mix with water. It floats on water.

• **Put a cork on the test tube and shake it well for few minutes. Even the oil floats on water and does not mix in it.**

• Now add a little of soap and shake it again.

• This time the oil and water mix and form a milky emulsion, From this we conclude that soap has made the oil mix in water.



a. Soap micelle

b. Soap micelle entrap the dirt particle

• **limitation of soap -**

• Hard water contains calcium and magnesium salts.

• why soap is not suitable for washing clothes with hard water bcoz -

• When soap is used for washing clothes with hard water, a large amount of soap is wasted in reacting with calcium and magnesium ions of hard water to form insoluble precipitate called **scum**. a large amount of soap is needed for washing clothes when the water is hard.

• The scum formed by the action of hard water on soap, sticks to the clothes being washed and interfers with the cleaning ability to the additional soap. This makes the cleaning of clothes difficult.

• **Why soaps does not give lather easily with hard water?**

• Bcoz it first reacts with calcium ions and magnesium ions present in hard water to form insoluble precipitate of Ca^{++} and magnesium salts of fatty acids.

• **Why soaps does give lather easily with soft water?**

• Bcoz soft water does not contain calcium and magnesium ions then lather easily form when soap is added.

• The calcium and magnesium salts which can dissolve to obtain hard water are- calcium hydrogen carbonate, calcium sulphate, calcium chloride, magnesium hydrogen carbonate.

• **DETERGENTS-**

• The quite difficult to wash clothes with soap when the water is hard. These difficulty has been overcome by using another kind of cleansing agent called **Detergents.**

• Detergents are also called 'soapless soaps' bcoz though they act as like a soap in having the cleasning properties they do not contain the unusal 'soaps' like sodium stearate.

• **Detergents are better cleansing agents than soap** because they donot form insoluble caldum and magnesium salts with hard water and hence can be used for washing even with hard water.

• **A detergent forms lather easily even in hard water.**

• A detergent is the sodium salt of a long chain benzene sulphonic acid which has cleansing properties in water.

• **A detergent has a large non-ionic hydrocarbon group and ionic group like sulphonate group-** $SO_3^-Na^+$ or sulphate group - $SO_4^-Na^+$

• **Examples- Sodium n-dodecyl benzene sulphonate and sodium n-dodecyl sulphate.**

• $CH_3-(CH_2)_{11}-C_6H_4-SO_3^-Na^+$, • $CH_3-(CH_2)_{10}-CH_2-SO_4^-Na^+$

• Sodium n-dodecyl benzene sulphonate

• sodium n-dodecyl sulphate

• The structure of a detergent is similar to that of soaps-
• Two parts - • A long hydrocarbon chain which is water repelling and a short long part which is water attracting (hydrophillic).
• Detergents are made from long chain hydrocarbons obtain from petroleum.
• The cleansing action of detergent is similar to that of a soap.
• Detergents are usually used to make washing powder and shampoos

• A detergent forms lather easily even with Hard water

• SOAPS	• DETERGENTS
• Soaps are the sodium salts of the long chain carboxylic acids	• Detergents are sodium salts of long chain benzene sulphonic acids.
• Ionic group - $-COO^-Na^+$	• Ionic group - $-SO_3^-Na^+$ and $-SO_4^-Na^+$.
• Soaps are biodegradable	• Some detergents are not biodegradable.
• Soaps are relatively weak action of cleansing	• Detergent are strong cleansing action.

• Detergent have a number of advantages over soaps due to which they are replacing soaps as washing agents-
• Detergent can be used even with hard water whereas soaps are not suitable for use with hard water.
• Detergent are a strong cleansing action than soaps.
• Detergent are more soluble in water than soaps.
• Detergent cause water pollution as they cannot be decomposed by microorganism. whereas soaps can.

• PERIODIC CLASSIFICATION OF ELEMENTS •

- There are 118 elements known at present.
- All the elements have been divided into a few groups in such a way that elements in the same group have similar properties.

• DOBEREINER'S TRIADS -

- All the elements having similar properties were put in one group called a family.
- 1829, German chemist Dobereiners observed that certain elements had similar properties and that he could put them together in groups of three elements each.
- These groups of three elements were called – Traids.

• According to Dobereiner's traids -

- When elements are arranged in the order of increasing atomic masses, groups of three elements having similar chemical properties are obtained.
- The atomic mass of the middle element of the traid being equal to the arithmetic mean of the atomic masses of other two elements.

- According to Dobereiners trait -
- When elements are arranged in the order of increasing atomic masses, groups of three elements having similar chemical properties are obtained.
- The atomic mass of the middle element of the traid being equal to the arithmetic mean of the atomic masses of the other two elements.
- The alkali metal group - The elements lithium, sodium and potassium properties and form a traid.
- All these elements are metals. All of them react with water to form alkalis and hydrogen gas.
- All of them have a valency of 1 – monovalent.
- lithium is the first element of traid.
- Sodium is the second element of traid.
- Potassium is the third element of traid.

- Atomic mass of lithium = 7
- Atomic mass of potassium = 39

- Arithmetic mean of atomic mass = $\frac{7 + 39}{2} = \frac{46}{2} = 23$

- Actual atomic mass of Na is - 23

- The arithmetic mean of the atomic masses of lithium and potassium is equal to (23) the actual atomic mass of the middle element of the traid sodium.

- **The alkaline earth metal group-**
- The elements calcium, strontium and barium have similar chemical properties.
- All these elements are metals. The oxides of all of them are alkaline in nature.
- All these elements have a valency of 2 (they are divalent).
- The arithmetic mean of the atomic masses of the first and third members of this traid it will be come to be -
- $\frac{40 + 137}{2} = 88.5$ The actual atomic mass of the middle element is 88.5
- **Atomic mass of the element = Arithmetic mean of the atomic masses of 1st and 3rd elements.**

Element of traid	Symbol	Atomic masses	
Lithium	Li	7	
Sodium	Na	23	– Alkali metal group
Potassium	K	39	
Calcium	Ca	40	
Strontium	Sr	88	– Alkaline earth metal group
Barium	Ba	137	
Chlorine	Cl	35.5	
Bromine	Br	80	– Halogen group.
Iodine	I	127	

- **The Halogen group** - The elements chlorine, Bromine, Iodine have similar chemical property.
- All these elements are nonmetals. All these elements reacts with water to form acids.
- All these elements have valency of 1, they are monovalent.
- Arithmetic mean = $\frac{35.5 + 127}{2} = 81.2$
- **Halo** - salt **gen** - genrator or producer.

- The limitation of Dobereiner's classification -
- It failed to arrange all the then known elements in the form of traids of elements having similar chemical properties.
- He can identify only three traids from the element known at that time. so classification of the element was not much successful.

• NEWLAND LAW OF OCTAVES -

- In 1864, Newland arranged then known elements in the order of increasing atomic masses and found that the properties of every eight element are similar to the properties of the first element.
- According to the newlands law of octaves - **when elements are arranged in the order of increasing atomic masses, the properties of eight element are repetition of the properties of the first element.**
-

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 and Ni	Cu	Zn	Y	In	As	Se
Br	Rb	Sr	Ce and La	Zr	—	—

- Lithium as the first element, we find that the eight element from it is sodium (Na). lithium and sodium are similar chemical properties.
- Sodium (Na) as the first element, we find that the eight element from it is potassium (K). sodium and potassium have similar chemical properties.
- **All the three elements lithium, sodium and potassium posses similar chemical properties.**
- similary, all the three elements beryllium, magnesium and calcium possess similar chemical properties.
- **Newland could classify elements only upto calcium.**
- Limitations -
- It could capable upto calcium only. after calcium every elements (eight position) did not possess the properties similar to that of the first element.
- Newland assumed that only 56 elements existed in nature and no other elements would be discovered later but several new elements were discovered whose properties did not fit into octaves.
- In order to fit element into this table, Newlands put even two elements in one slot, example, the two elements cobalt and nickel were put together in one slot.

• Iron element (Fe) which resembles cobalt and nickel elements in properties, was far away from these elements.

• **Periodic table-**

• It is the chart of the elements prepared in a such way that the elements having similar properties occurs in the same vertical column or group.

• **Horizontal rows - Periods** • **Vertical columns - Groups**

• The general formula of the oxides and hydrides of element, the element represent by letter 'R'.

• If some elements form oxides having the same general formula, then they will have similar chemical properties.

• For example - the elements Li, Na and K form the oxides LiO_2, Na_2O and K_2O. having the general formula. R_2O.

• Other form oxides having general formula - **RO** - MgO, R_2O_3 - Al_2O_3

• **If some elements form hydrides, having the same general formula, then they will have similar chemical properties.**

For example - the elements Li, Na and K form the hydrides - **LiH, NaH and KH** having general formula - RH,

• The formula RH is of element hydrides such as - LiH, NaH and KH.

• **Mendelev's periodic table-**

• When elements are arranged in the order of increasing atomic masses, the element with similar properties occurs at intervals.

• According to the mendeleev's periodic table-

• A properties of element are periodic function of their atomic masses.

• **Seven periods** - Horizontal row **Eight group** - vertical columns

• first seven groups are normal elements, eight group is of transition elements.

• **The two main features of mendeleeve periodic classification-**

• Gaps in the periodic table • wrong order of atomic masses

• **Factors-**

• increasing atomic masses • grouping together of elements having similar properties

• Gaps are left in periodic table because - he thinks that the elements were discovered later on and found to be very close, undiscovered elements at that time for which gaps were left in periodic table.

• **Eka boron, Eka-aluminium and eka silicon by prefix - eka** means first. So eka-boron means, First comes boron and then unknown element.

- When these elements were discovered later on, the eka boron was named as - scandium (Sc).
- Eka-aluminium was named as- Gallium (Ga).
- Eka-silicon was named as- Germanium (Ge).
- Mendeleev placed a few elements in the wrong order of their atomic masses by keeping the element with higher atomic mass first and the lower atomic mass later.
- Example- Placed cobalt (58.9) before nickel (lower atomic mass 58.7)

- **Merits of mendeleev's classification**
- Mendeeleevs periodic law predicted the existence of some elements that had not been predicted at that time-
- Mendeleevs periodic table left proper gaps for then undiscovered elements like Gallium (Ga), scandium (Sc) and germanium (Ge). When these element were discovered later on, they were placed in these gaps, without disturbing the existing element.
- Mendeelev periodic table could predict the properties of several elements on the basis of their position in the periodic table-
- **Mendeleevs periodic table could accommodate noble gases when they were discovered** - The noble gas kept or placed in the separate group because they are chemically unreactive.

- **Anomalies or Limitations-**
- The position of isotopes could not be explained-
Isotopes are the atoms of the same element having similar chemical properties but different atomic masses.
- If the elements are arranged according to the atomic masses, the isotope should be placed in different atoms or groups of periodic table.
- Isotopes were not given seperate place in table.
For example - The element chlorine has two isotopes, Cl-35 and Cl-37 having atomic masses of 35 and 37.
- Placing of these two isotopes of chlorine in the same group of the periodic table could not be explained.
- **Wrong order of atomic masses of some elements could not be explain-**
- According to mendeleev's periodic law, the elements are arranged in the order of increasing atomic masses.
- The element with lower atomic mass should come first and the element higher than should come later.

• But it was found that the element with higher atomic mass comes first and the element with later comes.
• The element cobalt having higher atomic mase of 58.9 comes first and nickel element with slightly lower atomic mass of 58.7 comes later.
• A correct position could not be assigned to hydrogen in the periodic table. on the basis of its properties, hydrogen element could placed in alkali metal group as well as in halogen atom.

Groups Oxide: Hydride:	I R_2O RH	II RO RH_2	III R_2O_3 RH_3	IV RO_2 RH_4	V R_2O_5 RH_3	VI RO_3 RH_2	VII R_2O_7 RH	VIII RO_4
Periods ↓	A B	A B	A B	A B	A B	A B	A B	Transition series
1	H 1.008							
2	Li 6.939	Be 9.012	B 10.81	C 12.011	N 14.007	O 15.999	F 18.998	
3	Na 22.99	Mg 24.31	Al 26.98	Si 28.09	P 30.0974	S 32.06	Cl 35.453	
4 First series	K 39.102	Ca 40.08	Sc 44.96	Ti 47.90	V 50.94	Cr 52.20	Mn 54.94	Fe Co Ni 55.85 58.93 58.71
Second series	Cu 63.54	Zn 65.37	—	—	As 74.92	Se 78.96	Br 79.909	
5 First series	Rb 85.47	Sr 87.62	—	Zr 91.22	Nb 92.91	Mo 95.94	Tc 99	Ru Rh Pd 101.07 102.91 106.4
Second series	Ag 107.87	Cd 112.40	In 114.82	Sn 118.69	Sb 121.75	Te 127.60	I 126.90	
6 First series	Cs 132.90	Ba 137.34	La 138.91	Hf 178.49	Ta 180.95	W 183.85		Os Ir Pt 190.2 192.2 195.2
Second series	Au 196.97	Hg 200.59	Tl 204.37	Pb 207.19	Bi 208.98			

• MODERN PERIODIC LAW -

• It is based on the atomic number of elements.
• According to the modern periodic law -
• The properties of the element are periodic function of their atomic number.
• When elements are arranged according to increasing atomic no. there is a periodicity in the electronic configuration. of the element
• Periodicity in electronic configuration of elements leads to the periodicity in their chemical properties.
• Explanation of modern periodic law -
• Properties of elements depends on the number of valence electrons in their atoms.
• When the elements are arranged according to the increasing atomic number, then the elements are having same number of valence electrons occurs at regular intervals.

- The electronic configurations of the elements from lithium to neon and then from sodium to argon which have been arranged according to the increasing atomic number-

Atomic no.	3	4	5	6	7	8	9	10
Elements	Li	Be	B	C	N	O	F	Ne
Electronic confi.	2,1	2,2	2,3	2,4	2,5	2,6	2,7	2,8
Atomic no.	11	12	13	14	15	16	17	18
Elements	Na	Mg	Al	Si	P	S	Cl	Ar
Electronic confi	2,8,1	2,8,2	2,8,3	2,8,4	2,8,5	2,8,6	2,8,7	2,8,8

- lithium is 3 and its Electronic configuration is 2,1. Thus lithium has 1 valence electron increases from 1 in lithium to 8 in neon.
- Sodium is 11 and its electronic configuration is 2,8,1. Thus sodium has 1 valene electron increases from 1 in sodium to 8 in argon.
- The real significance of the modern periodic classification based on the atomic number is that it relates the periodicity in the properties of elements to the periodicity in their electronic configuration.

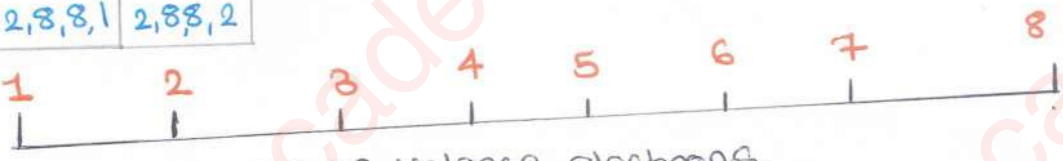
MODERN PERIODIC TABLE-

- The modern periodic table was prepared by Bohr
- All the elements in a particular group of the periodic table have similar properties.
- The arrangement of electrons in the modern periodic table is based on their electronic configuration.
- The horizontal rows of elements in a periodic table are called Periods. There are seven periods in long periodic table.
- The elements in a period have consecutive atomic number.
  - 1st period contains 2 element. it is very short period.
  - 2nd period contains 8 element. it is called short period.
  - 3rd period contains 8 element. it is also a short period.
  - 4th period contains 18 element. It is called long period.
  - 5th Period contains 18 element It is also called long period.
  - 6th period contains 32 element. It is very long period.
  - 7th Period contains 32 element. It is also a very long period.

- The number of elements in a period is fixed by the maximum number of electrons which can be accommodated in the various shell of an atom.
- First period has 2 elements bcoz the first shell of the atom can take a maximum of 2 electrons. (K shell).
- The second period has 8 elements bcoz the maximum no. of electrons which can be put in the second shell (L shell) of an is 8 electrons
- First period starts with hydrogen and ends with noble gas helium.
- All the other periods starts with alkali metals like lithium, sodium potassium and end with noble gases like neon, argon and krypton.
- First element of every period has 1 valence electron and last element helium only 2 valence electrons.
- The valence electrons in the atoms of elements that decides, which will be the first element and last element in the period.
- **The vertical columns in a periodic table are called - Groups.**
- There are 18 groups in the long form of periodic table
- element in a group donot have consecutive atomic number.
- The group 1 and 2, 13 to 17 contain normal element, in normal element, all inner shells are completely filled with electrons only outermost shell is incomplete.
- All elements in an a group have similar electronic configuration and show similar properties.
- **All having 1 valence electron in an atom, they show similar chemical properties.**
- **Group 17 contains halogen like fluorine, chlorine, bromine all have 7 valence electrons. all halogen show similar properties.**
- **Group 18 element contains noble gases have 8 valence shells electrons, they are completely filled with electrons Except helium which has only 2 electrons.**
- **Group 3 to 12 elements are called** transition element, the outer most shell as well as the next to outermost shell are incomplete and in the process of being filled with electrons.
- **The elements with atomic number 57 to 71 are called - lanthanide series (because their first element is lanthanium.**
- The elements with atomic number 89 to 103 are called as - actinide series (bcoz their first element is actinide.

- **Position of Hydrogen-**
- Hydrogen element has been placed at the top of group 1. above the alkali metals bcoz the electronic configuration of hydrogen is similar to those of alkali metals.
- Hydrogen atom is very small in size, many properties of H_2 are different from those of alkali metals.
- **Hydrogen is never induded in alkali metals.**
- Jnese eight groups are group 1 and 2 and groups 13 to 18.
- Elements having 1 valence electron placed in - Group 1
- Elements having 2 valence electron placed in - Group 2
- Elements having 3 valence electron placed in - Group 13
- Elements having 4 valence electron placed in - Group 14
- Elements having 5 valence electron placed in - Group 15
- Elements having 6 valence electron placed in - Group 16

	Group 1	Group 2	Grp 13	Grp 14	Grp 15	Grp 16	Grp 17	Grp 18
1st period →	H 1							He 2
2nd period →	Li 2,1	Be 2,2	B 2,3	C 2,4	N 2,5	O 2,6	F 2,7	Ne 2,8
3rd period →	Na 2,8,1	Mg 2,8,2	Al 2,8,3	Si 2,8,4	P 2,8,5	S 2,8,6	Cl 2,8,7	Ar 2,8,8
4th period →	K 2,8,8,1	Ca 2,88,2						

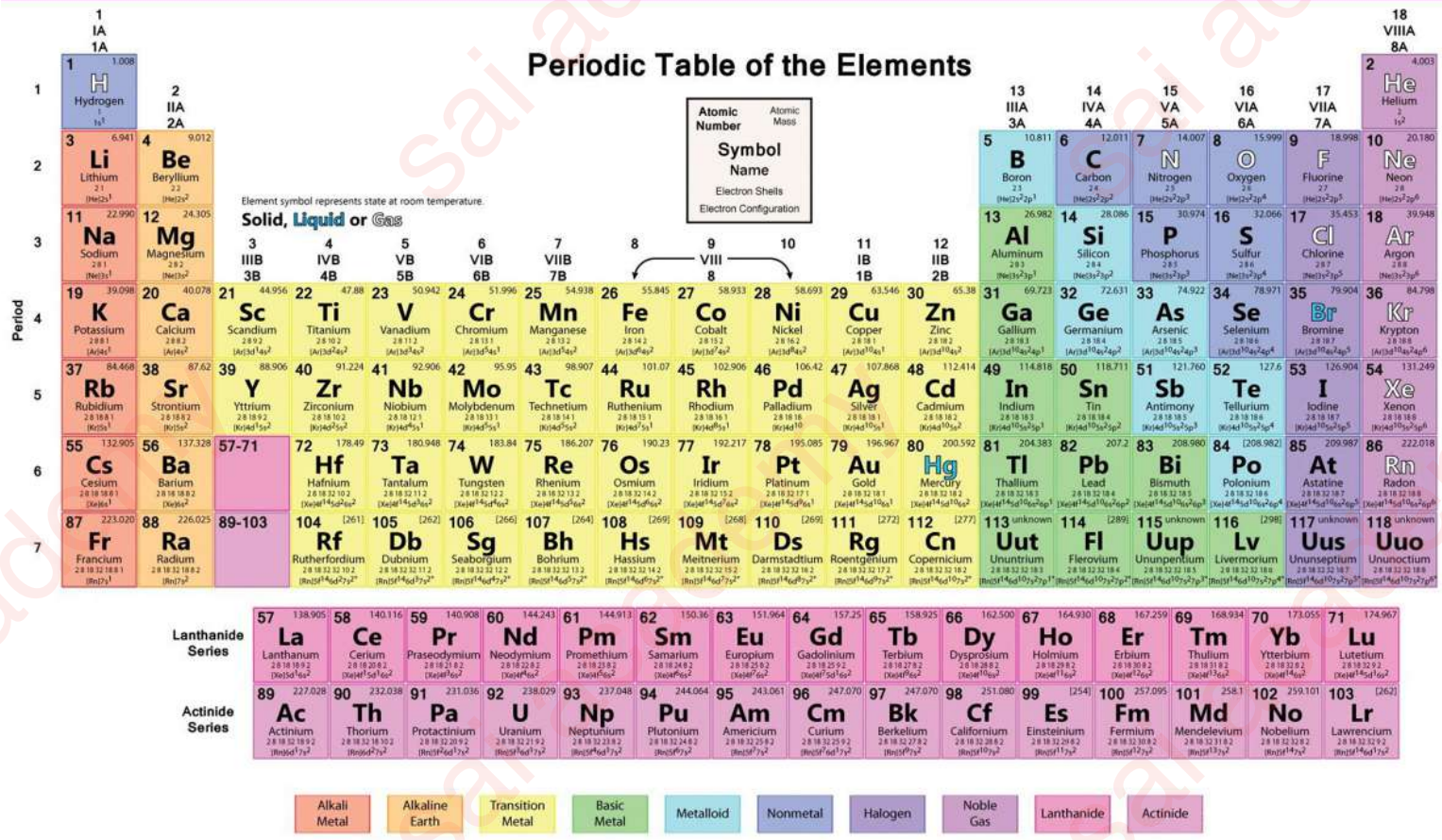


- No. of valence electrons.

- **CHARACTERISTICS OF PERIODS-**
- **Valence electrons-** on moving from left to right in a period, the number of valence electrons increase from 1 to 8.

Element of third period	11 Na	12 Mg	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
Electronic configuration	2,8,1	2,8,2	2,8,3	2,8,4	2,8,5	2,8,6	2,8,7	2,8,8
No of valence electrons	1	2	3	4	5	6	7	8

- The elements have been roughly divided into -
  - Metals
  - Non metals.
- The elements on the left side of the periodic table are metals.
- The elements on the right side of the periodic table are non-metal.
- Metals have been seprated from non-metals by some element called "metalloids".
- Metalloids are placed diagonally in the periodic table. These are Boron (B), Silicon (Si), Germanium (Ge), Arsenic (As), Antimony (Sb), Tellurium (Te).
- The properties of metalloids are intermediate between those of metals and non-metals.
- Metals lie on left side of metalloid., non metals lie on right side of metalloid. and noble gas are placed on the extereme right side of table.



- The first element in every period has 1 valence electron and last element in every period has 8 valence electrons.
- The elements in a period have consecutive atomic numbers. For example - elements in the third period from sodium to argon have continuous element number from 11 to 18.

- **Valency-**
on moving from left to right in each short period, the valency of elements from 1 to 4 and then decreases to 0 (zero).

Third period	Na	mg	Al	si	P	S	Cl	Ar
Valency -	1	2	3	4	3	2	1	0

- Elements in the same period have diff. valency.
- The valency of an element is determined by the number of valence electrons present in the atom.
- **The valency of an element is determined by the no. of e^-'s lost or gain by one atom of an element to achieve the nearest inert gas electron configuration.**
- Example- The atomic number of magnesium is 12, so its electronic configuration is 2,8,2. A magnesium atom can lose its 2 valence electron to achieve the nearest inert gas confi. 2,8 (neon), so its valency is 2.

- **Atomic size-** The size of the an atom is known as atomic size. It is also refer to as atomic radius of atom.
- The size of an atom is the distance between the center of nucleus and outer most electron shell of an isolated atom.
- Atomic radius is expressed in 'picometre' units whose symbol is 'pm'. $1pm = 10^{-12}\ m$

- **size of atoms -**
- **on moving from left to right in a period, the size of atoms decrease**

Third period element	Na	mg	Al	si	P	S	Cl
Atomic radii (Pm)	186	160	143	118	110	104	99

- decreases

- Due to large positive charge on the nucleus, the electrons are pulled in more closed to the nucleus and the size of atom decreases.
- Alkali metal atom - Biggest in size, Halogen atom - smallest in size
- The size of atom of an inert gas is bigger than that of the preceding halogen atom. bcoz due to the structural stability of its outermost shell consisting an octet of electrons

- **Metallic character -**
- on moving from left to right the metallic character - decreases non metallic character - increases.

Third period	Na	Mg	Al	Si	P	S	Cl
Nature of element	Metal			Metalloid	Non-metal		

- Greatest → left side • Metallic character - decreases
  → right side • Non metallic character - increases

- Metals lose electrons and forms positive ions, so metals called Electro positive elements.
- Non metals accept electrons to forms negeative ions, so non-metals called Electro negative elements.
- left to right - Electro positive element - decreases
  Electro negative element - increases

- Sodium is the most electro positive element, whereas Chlorine is most electronegative element.
- On moving from left to right in period, the tendency of atoms to lose electron decreases.
- On moving from left to right in a period, the tendency in a period, the tendency of atoms to gain electron increases.
- ↑ nuclear charge - the valence electrons are pulled more strongly by nucleus. and it becomes more and more difficult for atoms to lose electrons. due to increased nuclear charge, it becomes easier for the atoms to gain electrons.

• **Chemical Reactivity** - moving left to right in a period, the chemical reactivity of elements first decreases and then increases.

Na	Mg	Al	Si	P	S	Cl

• chemical reactivity — very reactive (Na) → least reactive (Si) → very reactive (Cl)

Decreases → Increases.

• The variation in chemical reactivity of element in a period can explained as-

• sodium, there is 1 valence electron which it can lose easily to react with other substance so it is very reactive.

• chlorine has 7 valence electron which it need to gain 1 electron to get stable, but it is very easy to gain a electron so reactivity increases from phosphorus to chlorine.

• **Nature of oxides-**

on moving left to right - the basic nature of oxides decreases and acidic nature of oxides increases.

Na	Mg	Al	Si	P	S	Cl

Highly basic — Amphoteric — Highly acidic

• Basic nature – decreases

• Acidic nature – increases

• Sodium oxide is highly basic in nature.

• Magnesium oxide is less basic

• Aluminium and silicon are amphoteric in nature.

• chlorine are highly acidic in nature

• Basic nature - ↓↓ Acidic nature - ↑↑

• CHARACTERISTICS OF GROUP -

• Valence electrons -

• All the elements of group 1 of the periodic table have the same of valence electrons - like lithium, sodium and potassium.

• The atoms of group 1 elements lithium, sodium, potassium ions like Li^+, Na^+ and K^+ having 1 unit positive charge.

• So, group 1 elements are monovalent (having valency 1).

• Moving down in a particular group of the periodic table, the number of valence electrons remains the same.

	Group	Electronic configurgation	No. of valence e⁻'s.
lithium	Li	2, 1	1
sodium	Na	2, 8, 1	1
potassium	K	2, 8, 8, 1	1

• All the elements of group 2 have 2 valence electrons in an atom

• Bereyllium, magnesium and calcium of group 2 has 2 valence e⁻s' in their atoms.

• Atoms of group 2 elements bereyllium, magnesium and calcium can lose their 2 valence electrons easily to form positive ions Be^{+2}, Mg^{+2}, Ca^{+2} so group 2 are divalent

	Group 2	Electronic configurgation	No. of valence e's.
Beryllium	Be	2, 2	2
magnesium	Mg	2, 8, 2	2
calcium	Ca	2, 8, 8, 2	2

• All the elements of group 17 has 7 valence electrons each in their atom, Halogen element of group 17 like Fluorine, chlorine bromine and iodine have 7 valence electrons. so group 17 accept 1 electron easiy to complete its octet and form negative ions like F^-, Cl^-, Br^- and I^- having 1unit of negative charge.

So, group 17 elements are - monovalent and form electronegative elements.

	Group 17	Electronic configuration	No. of. Valence electrons
Fluorine	F	2,7	7
chlorine	Cl	2,8,7	7
Bromine	Br	2,8,18,7	7
Iodine	I	2,8,18,18,7	7

- All the elements of group 18 have 8 valence electrons, except He which has only 2 valence electrons in its atom. the outermost shells of an atom of group 18 elements are already completely filled with electrons. These elements have no tendency to lose or gain electrons. due to this element of group 18 are zerovalent. and unreactive.
- If some elements have the same number of electrons in the outermost shell of their atoms, then they belong to the same group of the periodic table.
- The group number of elements having up to two valence electron is equal to the number of valence electrons.
- If number of valence electrons is 1, then group number is 1.
- If number of valence electrons is 2, then group number is 2.
- The group number of elements having up to two valence electron is equal to the number of valence electrons plus 10.
- If number of valence electrons is 3, then group number is 3+10=13
- If number of valence electrons is 4, then group number is 4+10=14
- If number of valence electrons is 5, then group number is 5+10=15
- If number of valence electrons is 6, then group number is 6+10=16.
- If number of valence electrons is 7, then group number is 7+10=17
- one exception to this rule. The noble gas 'helium' has 2 valence electrons, but its group number is 18.

Group 18		Electronic configuration	No. of valence electrons
Helium	He	2	2
Neon	Ne	2, 8	8
Argon	Ar	2, 8, 8	8
Krypton	Kr	2, 8, 18, 8	8

- **Valency-**
- The number of valence electrons in a group in the same, all the elements in a group have the same valency.
- Group 1 element like lithium, sodium and potassium all have 1 valence electron each, so all the elements of group 1 have the same valency of 1.
- The main of the periodic table and the valency-
- Valency of group 1 element is 1.
- Valency of group 13 element is 3.
- Valency of group 14 element is 4.
- Valency of group 15 element is 3.
- Valency of group 16 element is 2.
- Valency of group 17 element is 1.

- **Size of atoms-**
- On going down in a group of the periodic table, the size of the atom increases.
- For example-when we move down from top to bottom in group 1 of alkali metals, then size of atoms increases graudually from lithium to francium.
- **Smallest atomic size will be found at the top of a group.**
- **largest atomic size is found in the lowest part of a group.**
- Li is at the top - smallest atom
- Fr is at the bottom - Biggest atom.
- Potassium atom - Biggest atom.

Group 1	
lithium	Li
sodium	Na
Potassium	K
Rubidium	Rb
cesium	Cs
Francium	Fr

Atomic radii (pm)

152	Li	smallest atom
186	Na	
231	K	
244	Rb	
262	Cs	Biggest atom
270	Fr	

Group 17		(pm)	
• Fluorine	F	64	F (smallest atom.)
• chlorine	Cl	99	Cl
• Bromine	Br	114	Br
• Iodine	I	133	I (Biggest atom)

• Increase in size of the atoms on moving from top to bottom in a group of the periodic table - when we move from top to bottom in a group, a new shell of electrons is added to the atom at every step.

• The number of electron shell in the atom increase graudally due to which the size of atom increases.

• The decrease in size of atom due to increased attraction between nucleus and electrons is much less as compared to the increase attraction between nucleus and electron and increase in size due to the addition of an extra shell of electrons.

• The size of atom increase on going down in the group. In group 17 of halogens the atomic size increases on going down from fluorine to iodine.

• Fluorine atom is the smallest, iodine atom is the largest in size.

• Metallic Reactivity-

• on going down in a group of the periodic table, the metallic character increases.

• The metallic character increases from lithium to francium

• The greatest metallic character is found in the elements in the lowest part of a group.

• on going down in a group of periodic table, the electro positive character of element increases.

- lithium is least electropositive element and Francium is the most electropositive element. as we move down in a periodic table one more shell is added at every stage and size of atom increases.
- The valence electrons become more and more away from nucleus on valence electrons decreases.
- Due to this the atom can lose valence electrons more easily to form positive ions and hence the electropositive character increases.

- ongoing dow the non-metallic character of element decrease-
- Fluorine is an- most electronegative element.
- Jodine is an- least electronegative element.

bcoz - as we move down one more shell is added to every atom and size of atom goes on increasing

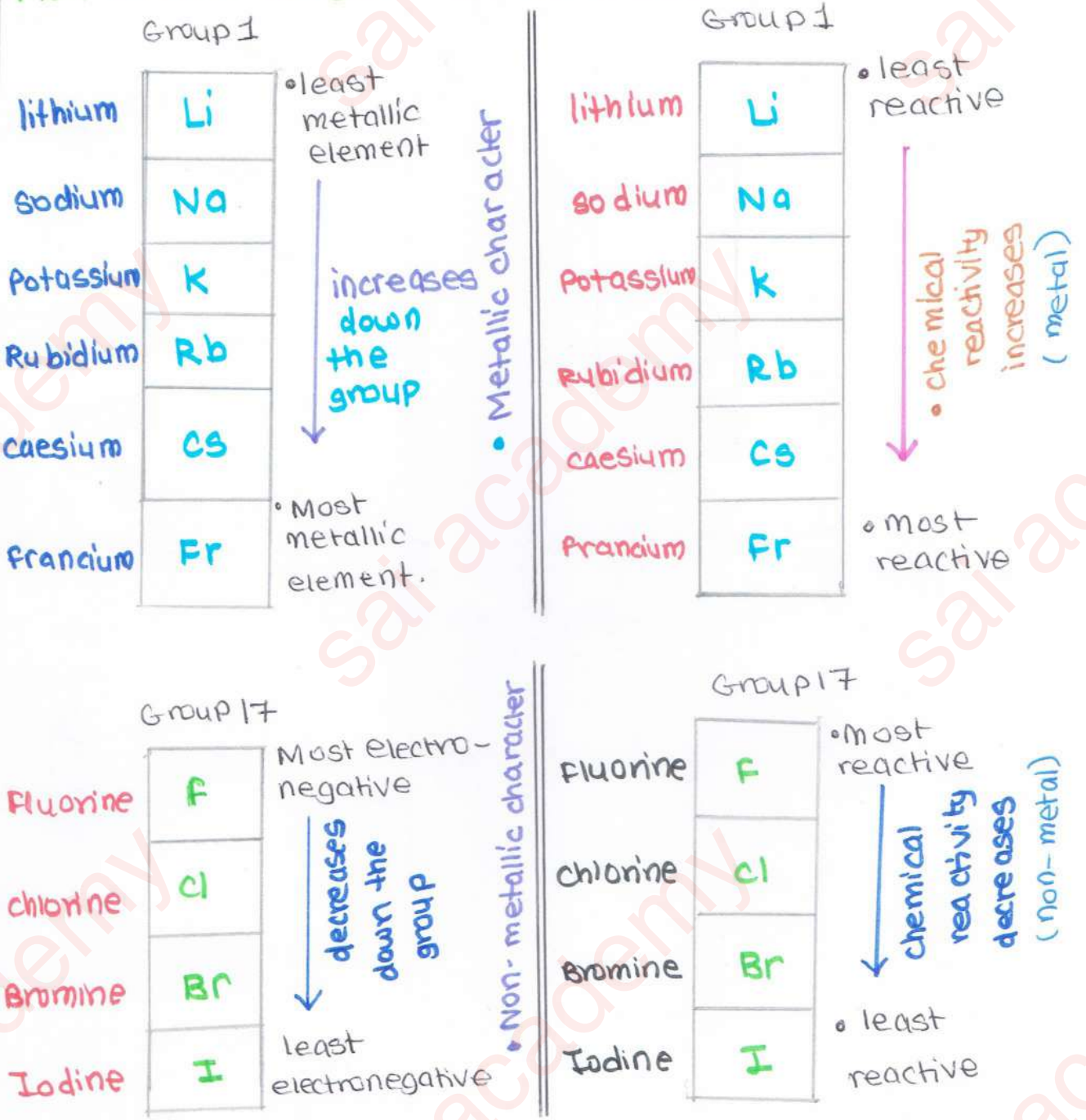
- the attraction of nucleus for the incoming electron decreases due to which, the atom cannot form negative ions. easily and electronegative character decreases.
- Francium - most electropositive element, Fluorine- most electronegative element.

- Chemical Reactivity-
- The chemical reactivity goes on increaseing on going down in a group.
- Li is the least reactive alkali, Fr is the most reactive alkali metal. bcoz as we move down in a group, the size of the atom goes on increasing.
- Due to increase in size of atom, the valence electrons of metal atom become more and more away from the nucleus and hence removed easily.
- As we move down in group of metals the tendency of (lose) atom to lose electrons and chemical reactivity increases.
- The order of reactivity of non-metals in a group just the opposite to that of metals.

- The chemical reactivity of non-metals decreases on going down in the group-
- In group 17, the chemical reactivity decreases from fluorine to iodine.
- Fluorine - most reactive, Jodine- least reactive.
- As we move down in a group of non-metal, the atom size goes on increasing. due to increase in size, the nucleus of atom

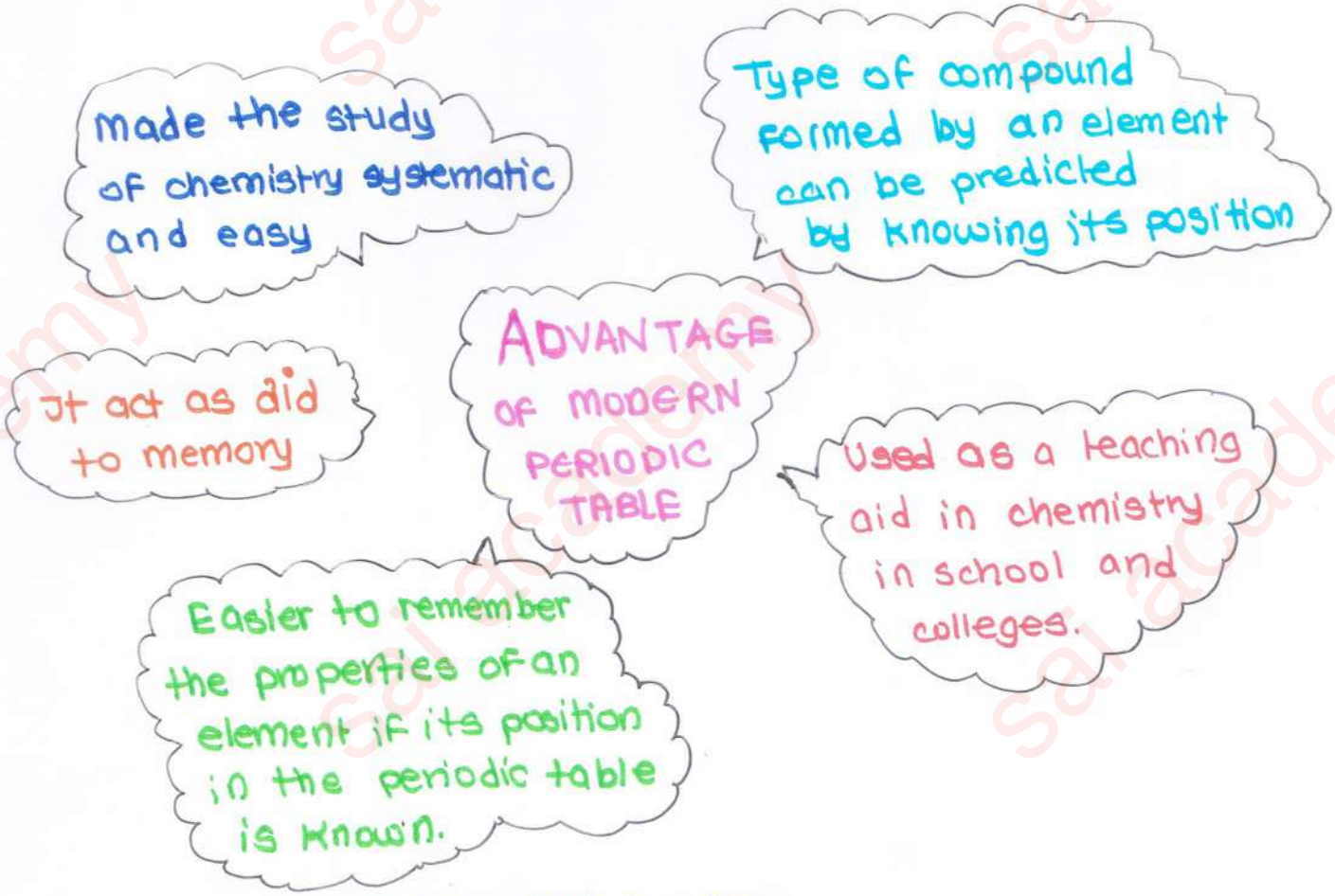
goes more and more deep inside it and hence its attraction for incoming electrons decreases.

- As we go down, the group of non-metals, the tendency of their atoms to gain electrons decreases.



- Nature of oxides —
- on going down the group, the periodic there is no change in nature of oxides. the nature of oxides of all element of a group is same.
- All group 1 element form - Basic oxides
- All group 17 element form - Acidic oxides.

- **Merits of modern periodic table -**
- The table is based on the atomic number of the element which is most fundamental property of element.
- It help us to understand why element in a group show similar properties but elements in different groups show different properties. its brings about the relationship between atomic structure and properties of element.
- The modern table explains the reasons for the periodicity of properties of the element. the electronic configuration of elements are repeated at regular intervals, so the properties of elements also increases or repeated at interval.
- It tells us why the properties of element are repeated after 2, 8, 18 and 32 elements.
- There are no anomalies in arrangement of elements.



- **Periodic table and chemical bonding -**
- When a nonmetal combines with metal, transfer of electrons takes place from metal atom to nonmetal atom then an ionic bond is formed.

Chapter :- Life Processes.

Life :- Earth happens to be the only known planet having a life. There are beings who live, die and become a part again. The living organisms can be differentiated from the inanimate entities on various parameters of life processes.

Life Processes :-

- Maintainance of living organisms is essential even if they are moving, resting or even sleeping since these maintainance processes are needed to prevent damage and breakdown energy is needed for them. This energy comes outside the body of the individual organism.
- The processes which together perform the function of maintanance of 'life' are called as life processes.
- Nutrition, respiration, circulation, excretion are examples of essential life processes.
- In unicellular organisms, all these processes are carried out by that single cell.
- In multicellular organisms, well-developed systems are present to carry out the processes.

Nutrition :-

The process of aquiring food that is needed for nourishment and sustenance of the organism is called nutrition.

- There are two main modes of nutrition, autotrophic and heterotrophic.
- Heterotrophic nutrition has subtypes :- holozoic, parasitic and saprophytic nutrition.

How do living things get their food?

- Some organisms use simple food material obtained from inorganic sources in the form of carbon dioxide and water.
- Autotrophs include green plants and some bacteria.
- Other organisms utilise complex substances.
- To achieve this, organisms use bio-catalysts called enzymes.
- The heterotrophs survival depends directly or indirectly on autotrophs.
- Heterotrophic organisms include animals and fungi.

Autotrophic Nutrition :-

If an organism can nourish itself by making its own food using sunlight or chemicals, such mode of nutrition is called as Autotrophic Nutrition.

- Plants photosynthesis (use of light energy) and are called photoautotrophs.
- Few bacteria use chemicals to derive energy and are called chemoautotrophs.

Photosynthesis :-

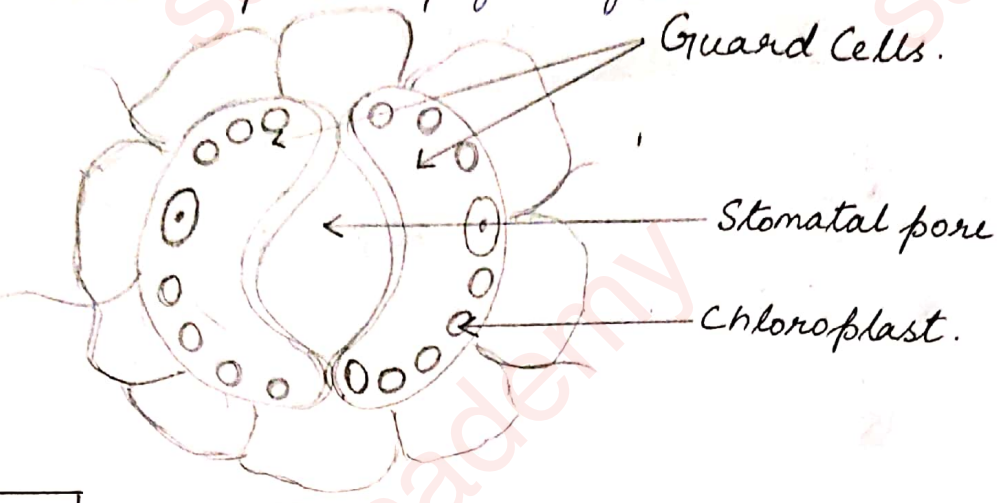
- Photosynthesis is an important process by which food is formed.
- Carbon and energy requirements of autotrophs are fulfilled.
- Autotrophs take in substance from outside and convert into stored forms of energy.
- Chlorophyll is present in the green parts absorbs light energy.
- This light energy is used to split water into H_2 and O_2.
- Carbohydrates are utilised to provide energy to the plant.
- Chlorophyll is essential for photosynthesis and stomata to facilitate intake of carbon dioxide.

$$6CO_2 + 12H_2O \xrightarrow[\text{sunlight}]{\text{Chlorophyll}} C_6H_{12}O_6 + 6O_2 + 6H_2O.$$
(glucose).

Raw Materials for Photosynthesis :- CO_2 and H_2O.

Site of Photosynthesis :- Chloroplast in the leaf.
Chloroplast contain chlorophyll.

Stomata:- Tiny pores present on the surface of leaves.
- It helps in the exchange of gases O_2 & CO_2.
- losses large amount of water during transpiration and helps in up flow of water.



Chloroplast:- It contains the green pigment chlorophyll which has a pivotal role in photosynthesis.

Heterotrophic Nutrition:-

There is a range of strategies by which the food is taken in and used by the organisms. Some organisms breakdown the food materials outside the body and and absorb it.

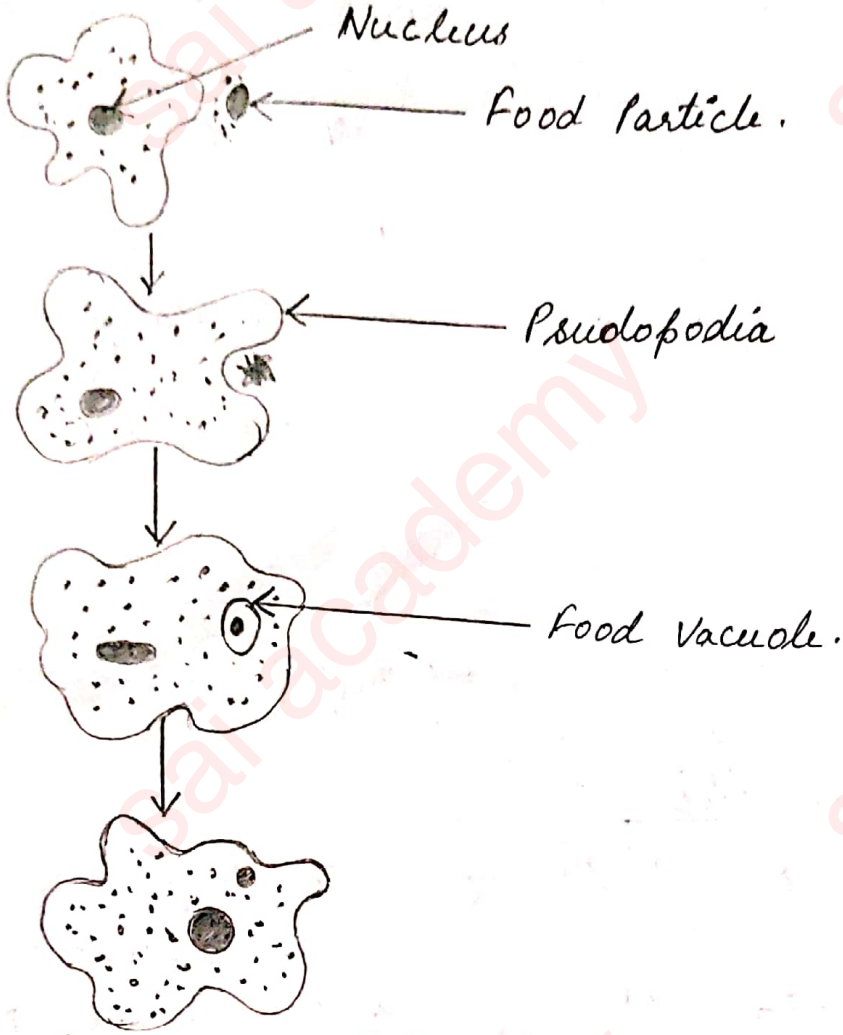
Holozoic Nutrition:- Animals take in solid food and break-down it inside the body. eg. Amoeba, animals.

Saprophytic Nutrition:- Organisms feed on dead and decaying organic matter. eg. Fungi and other saprophytes. The food is partially digested outside the body and then it is absorbed.

Parasitic Nutrition:- Parasites live inside or outside other organisms (host) and derive nutrition from it. Eg. Leech, Ascaris and Cuscuta.

Nutrition in Amoeba:-
- Amoeba feeds by holozoic mode of nutrition.
- It engulfs the food particles using pseudopodia, the process called phagocytosis. The engulfed food gets enclosed.

- food vacuole is formed.
- undigested food is thrown out.



Nutrition in Human Beings:- The Human digestive system comprises of alimentary canal and associated digestive glands.

- There are five stages in human nutrition:- Ingestion, Digestion Absorption, Assimilation and Egestion.
- Four stages i.e ingestion, digestion, absorption and egestion takes place in alimentary canal, while assimilation of food takes place in the whole body.

Human Digestive System:-

1. Mouth:- It is the opening of the alimentary canal and helps in ingestion of food. Buccal cavity is present behind the mouth and has teeth and tongue.

Salivary Glands → Secrete saliva (Salivary Amylasa).
Teeth → Chewing and Grinding of food.
Tongue → Rolling and Tasting of food.

2. Oesophagus :- The swallowed food passes into the oesophagus. It is a muscular tube, about 25 cm long with a sphincter (valve/opening) at each end). Takes food from mouth by peristatic movement. Function is :- contraction and expansion of alimentary canal.

3. Stomach :- It is a thick-walled bag like structure. It recieves food from oesophagus at one end and opens into the small intestine at other end.

Gastric Juices.

- **Pepsin** - breaks down protien
- **HCl** - Makes medium acidic
- **Mucus.** - Protects inner lining of stomach.

4. Small Intestine :- It is the longest part of the alimentary canal, about 20 feet long. It has three regions :- dudoneum, jejunum and ileum. Internal surface of small intestine is folded into finger like projections called villi.

Liver → Secretes bile

Pancrease → Secrete pancreatic juice.

Intestinal Enzyme

- **Carbohydrates** → Glucose
- **Fats** → Fatty acid + Glycerl
- **Protien.** → Amino acid.

Pancreatic Juice

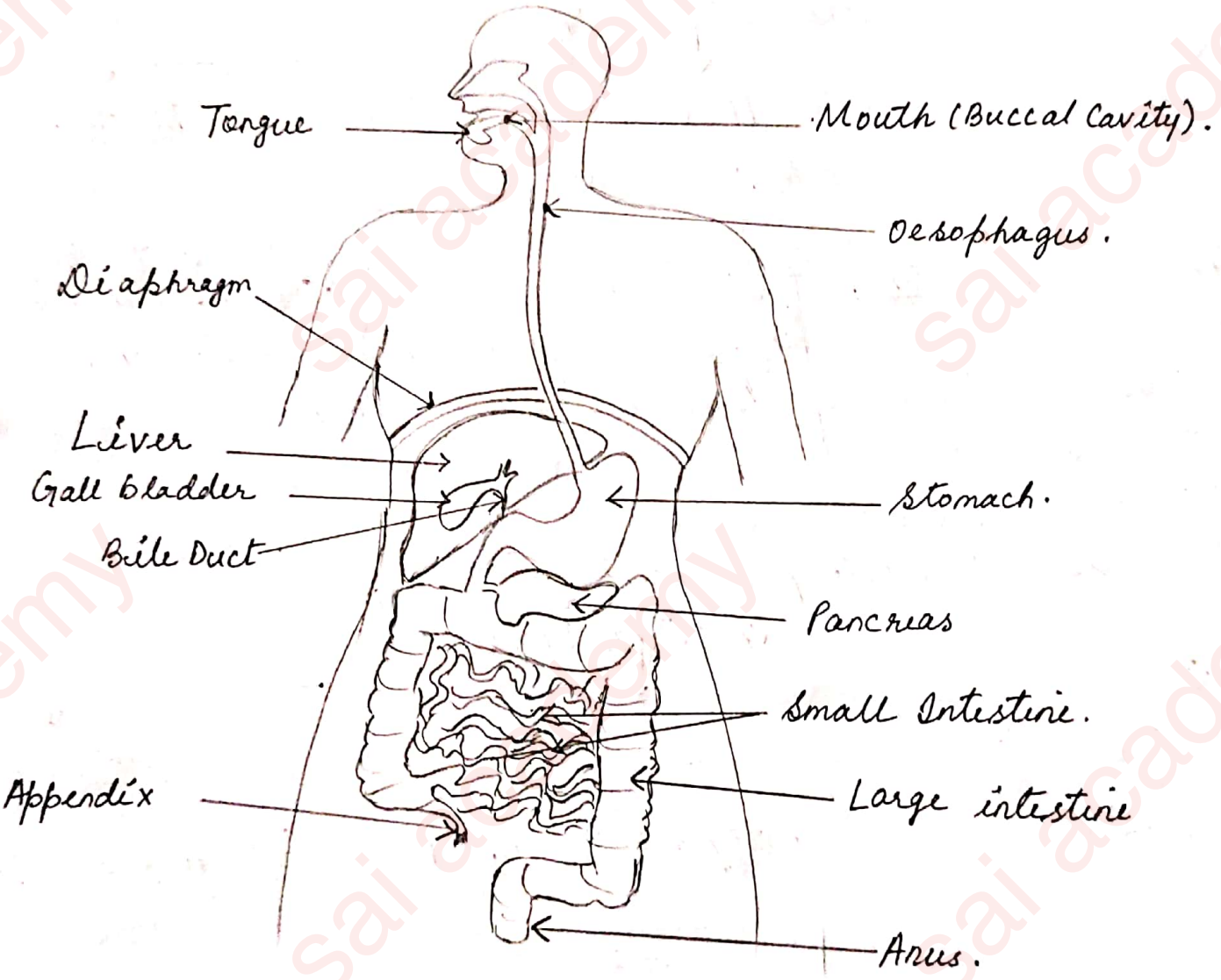
- **Trypsin** → Protiens → Peptones
- **Lipase.** → Emulsified Fats → Fatty Acid + Glycerol
- Large fat globules —Bile Juice.→ Small fat globules.

5. Large Intestine :- The region of large intestine after ileum is called the large intestine. The large intestine is about 5 feet long in humans.

- Absorbs excess of water.

6. Rectum :- Temporary collection of waste. It opens to outside the anus.

7. Anus :- The anus has internal and external anal sphincters. Helps in egestion.



Human Alimentary Canal.

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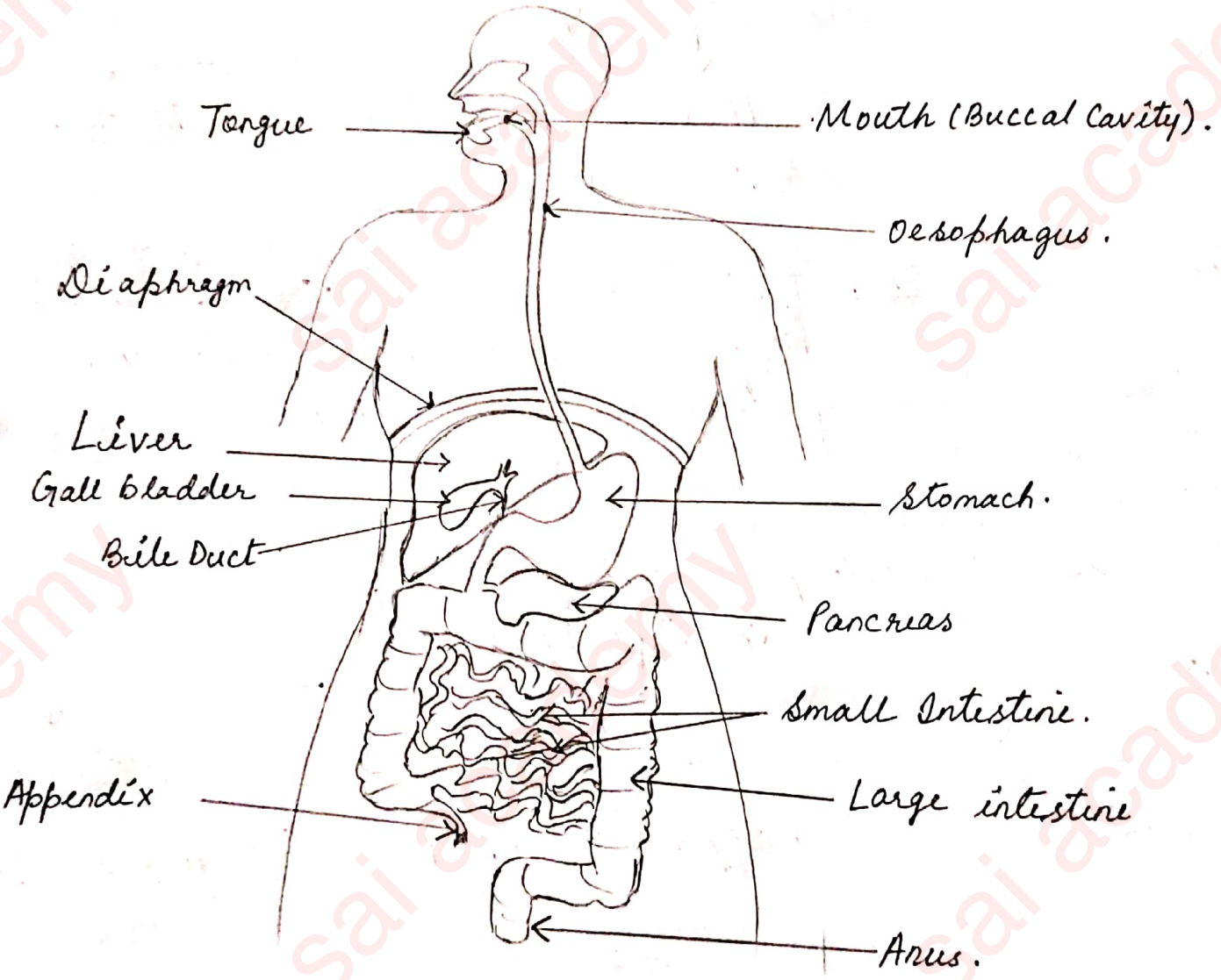


Human Alimentary Canal.

Respiration :- Respiration broadly means the exchange of gases, typically the intake of oxygen and release of carbon dioxide from oxidation of complex organic substances.

(2) **Gaseous Exchange :-** Intake of oxygen from atmosphere and release of carbondioxide.

Respiration

Aerobic	Anaerobic
• in the presence of oxygen.	• in the absence of oxygen.
• occurs in mitochondria	• occurs in cytoplasm.
• End products are CO_2 and H_2O	• end products :- alcohol
• More amount of energy released (38 ATP).	• less amount of energy released (2 ATP).

Human Respiratory System :-

- Passage of air through respiratory system.

• Nostril → Nasal Passage → Nasal Cavity → Pharynx → Larynx → Trachea → Bronchi → Lungs → Bronchioles → Alveolar Sac → Blood Capillaries.

Mechanism of Breathing :-

Breathing

Inhalation	Exhalation
1. During inhalation thoracic cavity expands.	1. Thoracic cavity contracts.
2. Ribs lift up	2. Ribs move downwards.
3. Diaphragm becomes flat	3. Diaphragm becomes dome shaped.
4. Volume of lungs increases and air enters the lungs.	4. Volume of lungs decrease and air exits from lungs.

Exchange of Gases between alveolus, blood and tissues :-

① Air (rich in O_2) (in alveolus) → Blood (through blood vessels) (capillaries) → O_2 Binds with Haemoglobin in RBC → O_2 is released in tissue

② CO_2 (from tissue) → CO_2 released into blood → CO_2 dissolved in blood. → Blood vessels (capillaries) (in alveoli). → CO_2 released in alveolar sac. → CO_2 sent out through nostrils.

Terrestrial Organism :- Use atmospheric oxygen for respiration.

Aquatic Organism :- Use oxygen dissolved in water.

Respiration in Plants :- Respiration in plants is similar than the respiration in animals. Gaseous exchange occur through :-

(1) Stomata in leaves.
(2) Lenticles in stems
(3) General surface of roots.

Diffusion :- Diffusion is the movement of molecules from high concentration area to the low concentration area without any energy.

Cellular Respiration :- Set of metabolic reactions occurring inside the cells to convert biochemical engy obtained from food into a compound called Adenosine triphosphate (ATP).

Catabolism :- process of breaking molecules into energy.

Anabolism :- process of synthesizing all compounds required by the cells.

Transportation :-

- Human beings like other multicellular organism need regular supply of food, oxygen etc. This function is performed by circulatory system or Transport System.

Circulatory system of human beings consists of :-

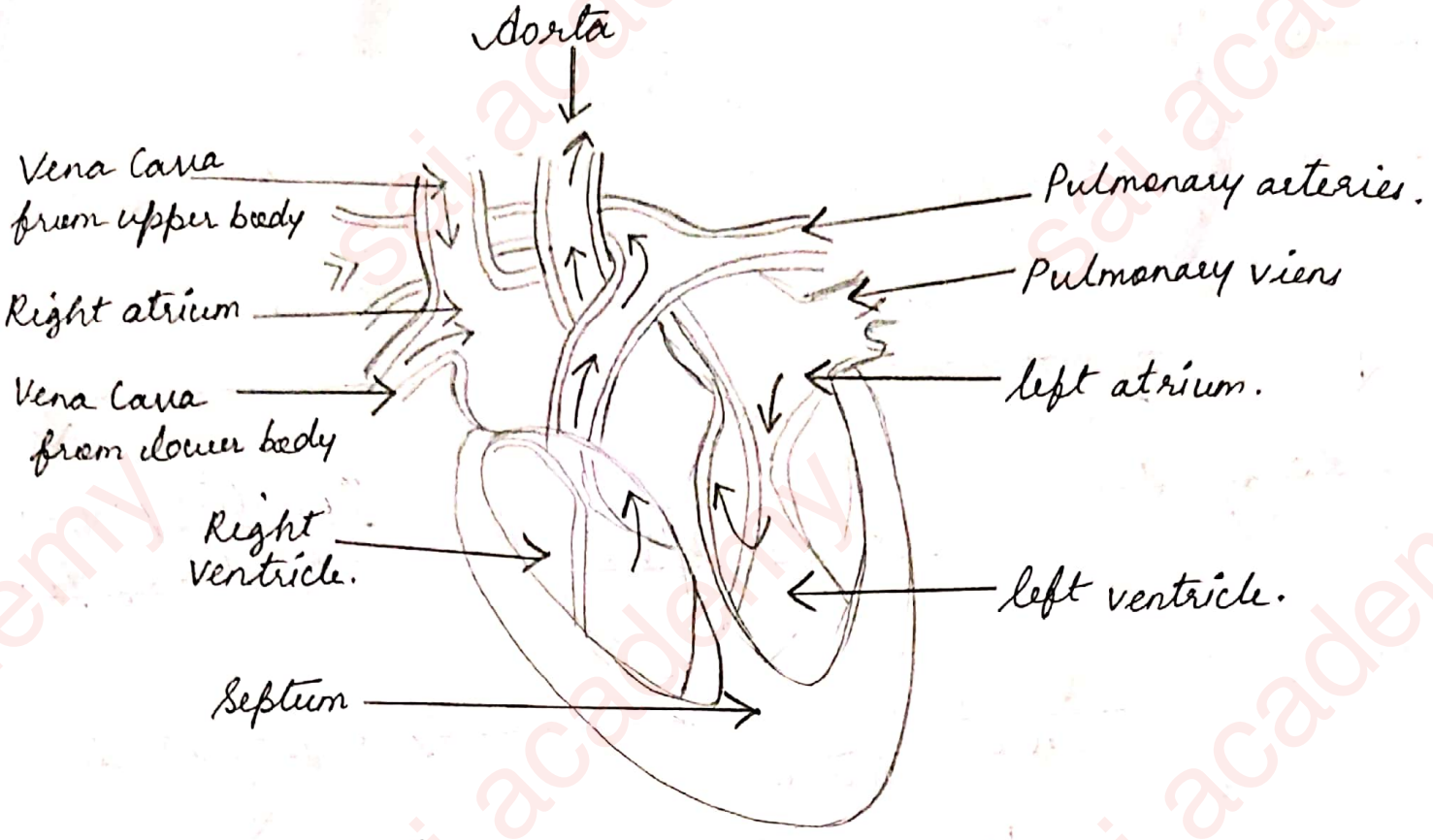
- A pumping organ - Heart
- Blood Vessels - Arteries & Veins
- Circulatory medium - Blood & Lymph.

Blood Circulation in Human Heart.

Deoxygenated blood (from body) → Vena Cava → Right Atrium → Right Ventricle → Lungs → Oxygenated blood → Left Atrium → Left Ventricle → AORTA → Body Parts.

Heart :- It is a muscular organ located near chest slightly towards the left in thoracic cavity. Heart is main pumping organ of the body. It has two upper chambers called atria and lower two chambers called ventricles.

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



Sectional view of Human Heart.

Blood.

- Solid Components
  - Blood Corpuscles.
    - RBCs
    - Platelets
    - WBCs
- Liquid Component.
  - Plasma.

RBCs:- - Carries respiratory gases (O_2, CO_2).
- Contains Haemoglobin
- impart red colour to the blood.

Platelets:- Helps in blood Clotting

WBCs:- Provide Body defence by engulfing the germs and producing antibodies.

Plasma:- A yellow fluid contain 90% water and 10% organic substances like Protiens, albumin, globulin, inorganic mineral ions etc.

Lymph :- A yellowish fluid that escapes from blood capillaries into the intercellular spaces. Lymph flows from the tissue to the heart assisting in transportation and destroying germs.

Blood Vessels

- Arteries
- Veins.

Arteries :-
1. Carry Oxygenated blood from heart
2. Also called distributing vessels.
3. Thick and elastic
4. Valves absent.
5. Deep seated.

Veins :-
1. Carry deoxygenated blood from body parts
2. Also called collecting vessels.
3. Thin and less elastic
4. Values present to prevent back flow of blood.
5. Superficial.

Transportation in Plants :- Two type of conducting tissue :-

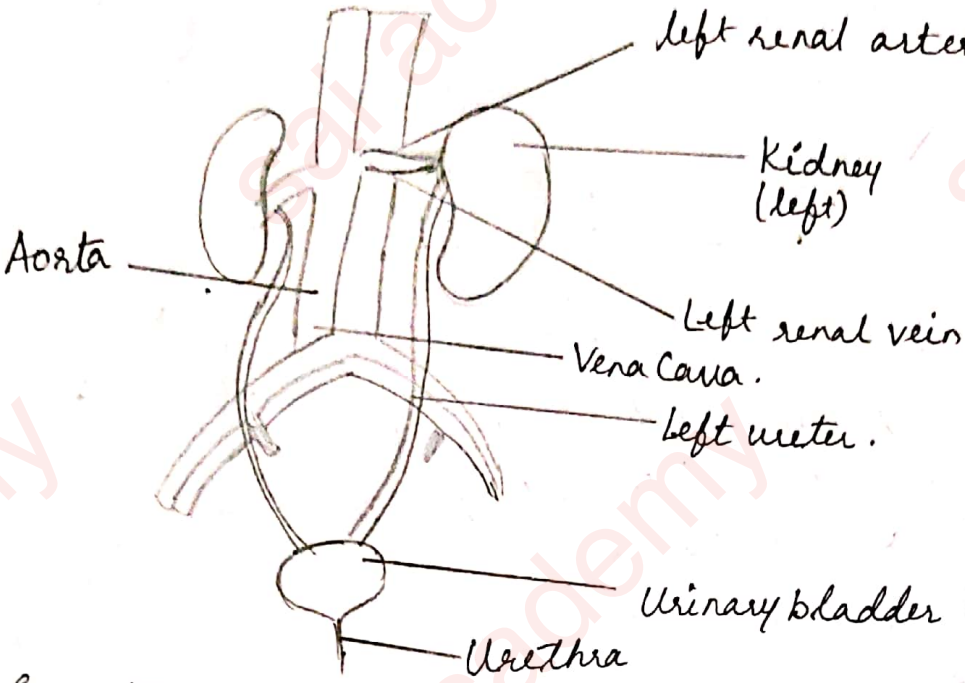
Xylem :- Carries water & minerals from the roots to other part of the plant. No energy used.

Phloem :- Carries product of photosynthesis from leaves. Energy is used from ATP.

Transpiration is the process by which plant lose water in the form of water vapours. Helps in temperature regulation in plants.

Translocation :- Transport of food from leaves to different part of the plant is called Translocation.

Excretion in Humans :- The process of removal of harmful wastes from the body of an is called excretion.



Excretory system in Human beings.

Excretory system consists of:- A pair of Kidney
A urinary bladder.
A pair of Ureter
A Urethra.

Process of Excretion:- Renal artery brings in blood containing waste substances to the kidneys. Kidney filters blood. Urine produced in kidney passes through the ureters into the urinary bladder until it is released through the urethra.

Functions of Kidney:- It removes waste product from blood, urea which is produced in liver.

Nephron:- Each kidney has a large number of filtrate units called nephrons. Nephron is a structural and functional unit of Kidney.

Mechanism of Urine Formation:-
- Glomerular Filtration
- Tubular re-absorption
- Secretion.

Chapter :- Control And Coordination.

- Human body is a complex machine performing tons of functions and processes to maintain and sustain life.
- Living Organisms respond to various stimuli like heat, light, cold, touch, pressure etc.

Movement in Organisms :- The ability of organisms to move certain body parts is movement.

- When they move from one place to another, it is locomotion.

Introduction to Control and Coordination :-

- Organisms move in response to stimuli like light, heat, food etc.
- All the activities in animals are controlled and coordinated by the nervous and endocrine system.
- Hormones are chemical messengers which assist the nervous system in carrying out various functions. They are secreted by endocrine glands.

Nervous System :- Consists of Brain, Spinal network and a huge network of nerves.

Functions :- (i) to recieve information from environment.
(ii) recieve information from various body parts.
(iii) to act accordingly through muscles and glands.

Stimulus :- Any change in environment to which the organism respond is called stimulus. Eg. touching hot plate.

Response :- The reaction of our body to a stimus.
Eg. withdrawal of our hand on touching hot plate.

Coordination :- The working together of various organs of the body of an organism in a proper manner to produce reaction to a stimus, is called coordination.

Receptors:- Specialized tips of some nerve cells that detect the formation from the environment.

Receptors are Sense Organs:-

Photoreceptors (Inner ear)	Photo receptors (Eyes)	Thermoreceptors (Skin)	Olfactory Receptors (Nose)	Gustatory receptors (Tongue).
- Hearing	- Visual stimulus	- Pain/Touch/ Heat.	- Smell	- Taste

The Nervous System:-

Neuron:- It is the structural and functional unit of nervous system. It is also known as nerve cells, neurons and nerve fibers.

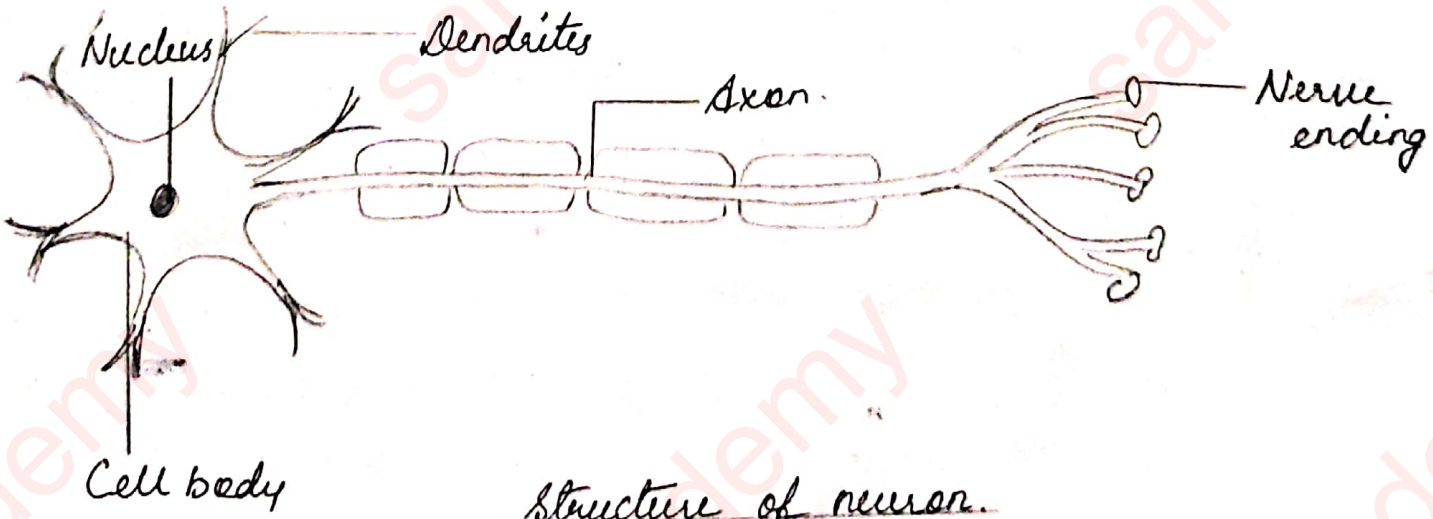
- Electrically excitable cells in the nervous system. Function to process and transmit information.
- Primary components of the neuron are the soma (cell body), axon (long slender projection), dendrites (tree-like structure) that recieves message from other neurons and synapses (specialised junctions between neurons).

Dendrites:- Recieves impulse from other neurons.

Cyton/Soma:- Processes the impulse.

Axon:- Transmit the impulse. Axon may be myelinated or non-myelinated.

Synapse:- The point of contact between the terminal branches of axon of one neuron with the dendrites



Structure of neuron.

Reflex Action :- Reflex action is a sudden, involuntary reaction of the body in response to stimuli. eg. withdrawal of hand, knee jerk etc, on touching hot plate.

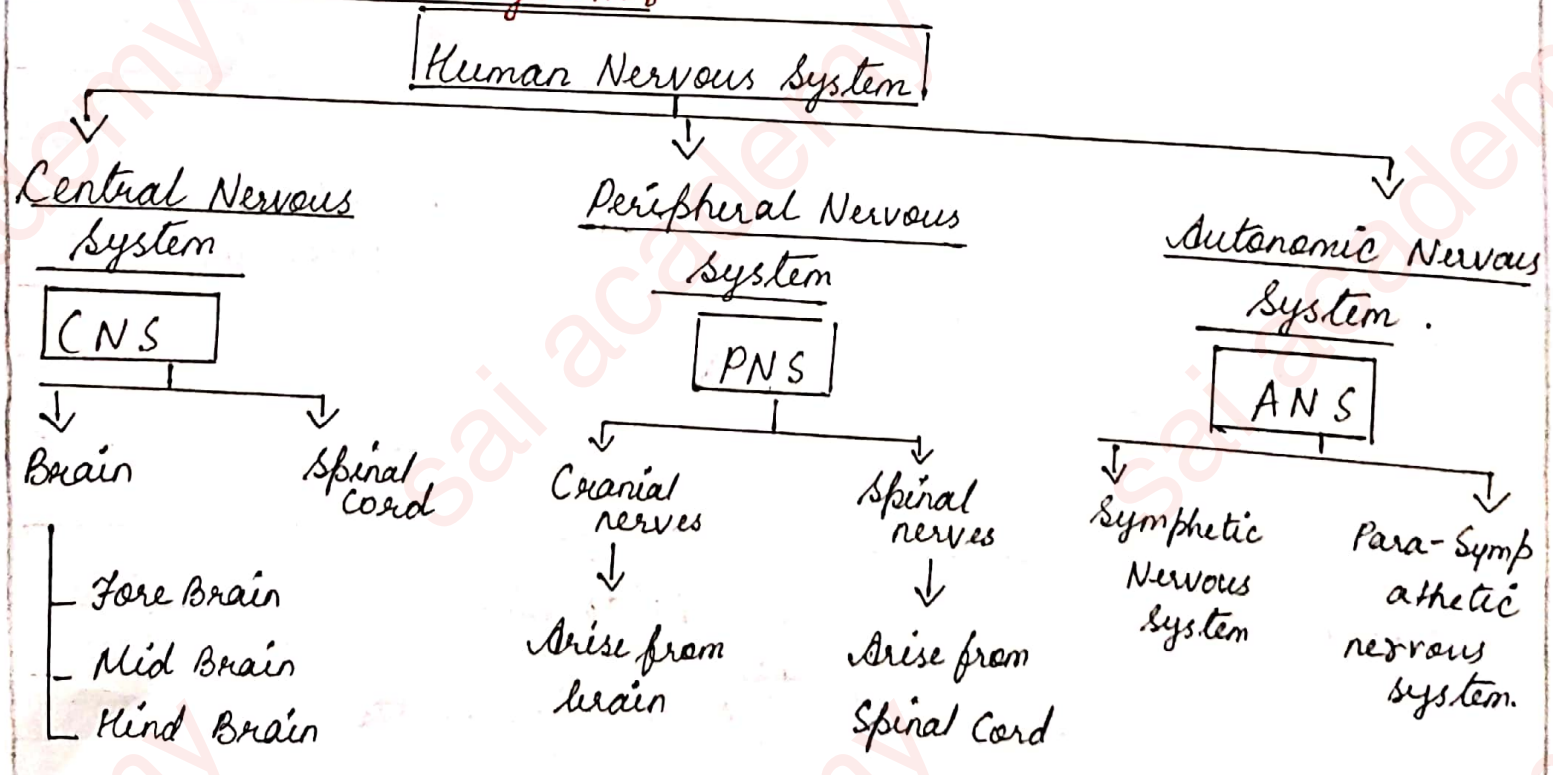
Reflex Arc :- The pathway taken by the nerve impulses in a reflex action is called reflex arc. Receptor organ, sensory / afferent neuron, motor / efferent neuron are components of reflex arc.

Voluntary :- means it is under the control of a person.

Involuntary :- means it is not under the control of a person (eg. heartbeat).

Mechanism of Reflex Action :- A receptors reflex mechanism involves a receptor organ, an effector organ, and some type of communication network. When a sensory receptor is stimulated, signals pass from it along a sensory neuron to spinal cord. The message travels out of the spinal cord along a motor neuron to the effector organ. Additional nerve cells capable of communicating with other parts of the body and present in reflex circuits.

Human Nervous System :-



Human Brain:- It is enclosed in cranium and is protected by cerebrospinal fluid which acts as a shock absorber.

- Human brain has three major parts:-

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

(a) Fore-Brain (Cerebrum):-

- Most complex / specialized part of brain is Cerebrum.

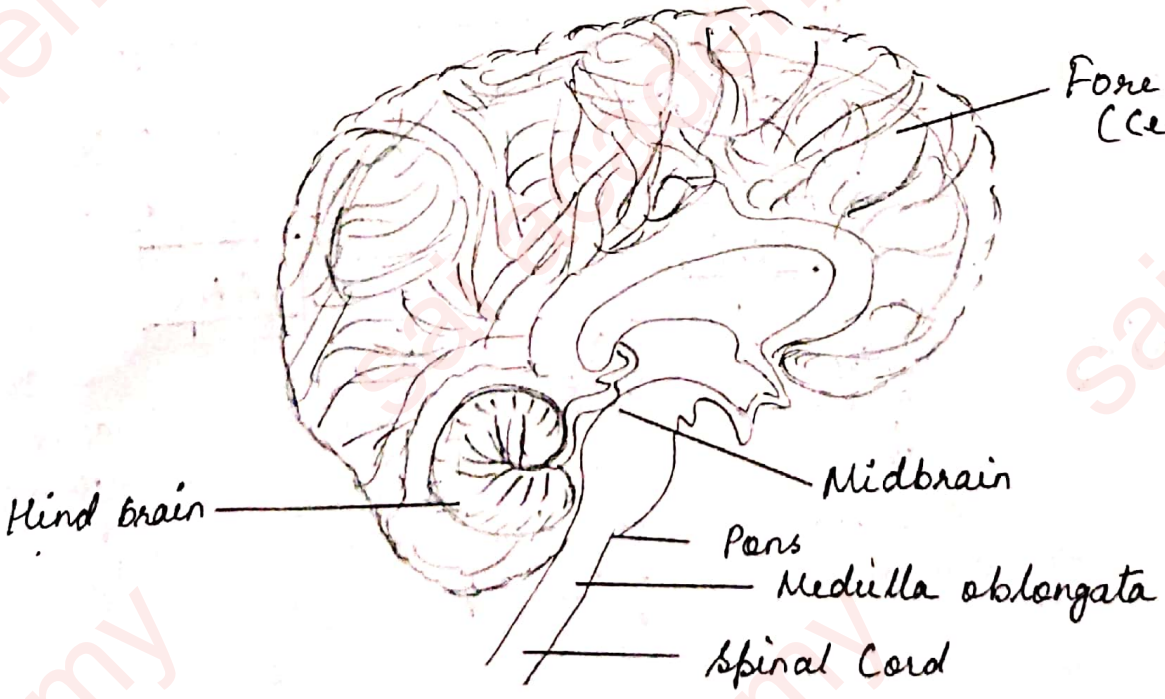
Functions:- 1. Thinking part of the brain
2. Control voluntary actions.
3. Store information (memory)
4. Centre associated with hunger.
5. Receives sensory impulse from various body parts.

(b) Mid Brain:- It connects the fore-brain with the hind brain.

It is the portion of the cranial nervous system associated with vision, hearing, motor control, sleep/wake and temperature etc.

(c) Hind Brain:-

Hind Brain comprises of:- ① Pons
② Cerebellum
③ Medulla Oblangata



Brain:- The human brain is the command center for human nervous system. It recieves input from the sensory organs and send output to the muscles.

- Brain is protected by a fluid called cerebrospinal fluid which acts as shock absorber. It has several layers called Meninges.

Spinal Cord:- Spinal Cord is enclosed in Vertebral Column.

Coordination in Plants:-

Hormones are chemical compounds which help to coordinate growth, development and responsibility to the environment.

- **Plant Hormones:-** Main plant hormones are:- Auxin, Gibberellin, Cytokinins, Abscisic acids.

Plant Hormone	Functions
1. Auxin ⟶	Helps in growth of plant tissue.
2. Cytokinen ⟶	Promotes Cell division
3. Gibberelins ⟶	Helps in growth of stems, germination, flowering, cell division and plant growth.
4. Abscisic acid ⟶	Inhibits growth and causes wilting of leaves, promotes dormancy of buds and seeds.

Growth independent movements:- The movements which are not growth related are called nastic movements. These movements occur in response to environmental stimuli but the response is not dependent on the stimulus. Eg. Touch-me-not plant.

Growth related movements:- The movements which are growth related are called tropic movement. These movements occur in response to environmental stimuli and the direction is dependent on the direction of stimulus.

Hormones In Animals :-

Hormones are the chemical substance secreted by the endocrine glands and transmitted by the blood to the tissue on which it has a specific effect.

Different types of Hormones in Human body :-

1. **Thyroxin** :- Located in the thyroid gland
   - Neck/Throat region
   - Regulation of metabolism of carbohydrates, fats and protiens.
2. **Growth Hormone** :- Located in pituitary Gland
   - Midbrain
   - Regulates growth and development.
3. **Adernaline** :- Located in the Adernal gland
   - Above both Kidneys
   - Regulation of blood pressure, heartbeat etc.
4. **Insulin** :- Located in pancreas.
   - Below stomach
   - reduce and regulates blood sugar level.
5. **Sex Hormone** :- Testosteron → males → testis
   Oestrogen → females → Ovaries.
   - located in genital/lower abdomen area.
   - Changes associated with puberty. (Sexual maturity)

Chapter :- How Do Organisms Reproduce ?

Reproduction :-

- Reproduction is the process by which all organisms multiply in number and increase their population.
- Reproduction ensures continuity of life on earth.
- Chromosomes in the cell contain the information for inheritance of features which are passed from generation to generation in the form of DNA molecules.
- So reproduction involves copying of DNA and other cell. The copy will be similar to original and not identical.
- This property is Variation which is the basis and necessary for evolution of living beings.
- Reproduction is of two types :- (a) Asexual Reproduction
  (b) Sexual Reproduction.

Asexual Reproduction :-

- It is a process in which a single parent is involved for producing new offsprings.
- Gametes not formed.
- Progeny is identical to their parent.
- Asexual reproduction is extremely useful as a mean of rapid multiplication. It is common in lower plants and animals.

Sexual Reproduction :-

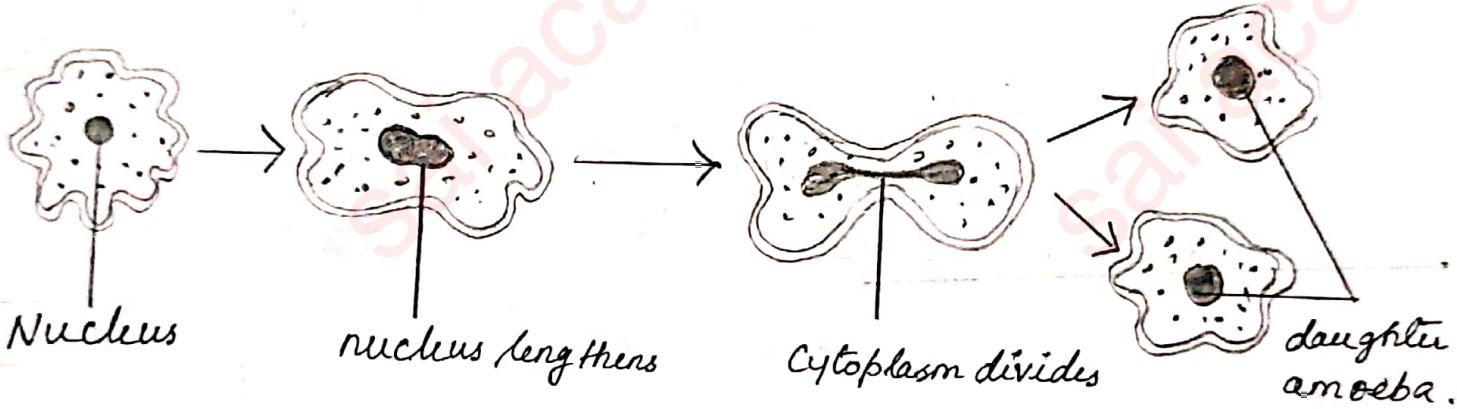
- It is a process in which both the parents are involved in producing new offspring.
- Gametes are formed. Fusion of gametes takes place.
- Progeny is not identical but only genetically similar to their parent.
- It is common mode in animals (mammals) & Humans.

Fission:- The parent cell divides / splits into two daughter cell - Binary Fission.

Splits into many daughter cells - Multiple Fission.

Binary Fission:-

- The parent cell divides into two equal halves (daughter cells) Eg. Amoeba follows transverse binary fission, ie fission in any plane.
- Leishmania has a whip-like structure at one end and binary fission occurs in a definite orientation.



Beriary fission in Amoeba.

- The process where nucleus lengthens is Nucleokinesis and where the cytoplasm lengthens is Cytokinesis.

Multiple Fission:-

The parent cell divides into many daughter cells simultaneously eg. Plasmodium.

Budding:- A bud develops as an outgrowth on parent body due to repeated cell division at specific sites. These buds detach from the parent body when they mature. Eg. Hydra

Regeneration:-

- Regeneration is the process of growing back the lost organ or body part by the organism (eg. lizard).

eg. Planaria

Regeneration in Planaria.

Hydra

Fragmentation :- Fragmentation is the process by which an organisms gets fragmented into smaller pieces and each piece grows into a whole new organism. Eg. Planaria, Hydra.
- It takes place in multicellular organism with simple body organisation.

Vegetative Propagation :-
- A mode of reproduction in which reproduction take place from the vegetative parts like the stem, root, leaves.

Methods of Vegetative Propagation :-
1. By Roots :- Eg. adventitious roots of Dahlias.
2. By Stems :- Eg. Potato (tuber), ginger (rhizome)
3. By leaves :- Eg. leaves of bryophyllum bear adventitious buds

Benefits of Vegetative Propagation :-
1. Plants can bear flowers, fruits earlier than those produced.
2. Growing plants like Banana, orange, rose, jasmine that have lost the capacity to produce seeds.
3. Genetically similarity is maintained
4. Help in growing seedless fruits.
5. Cheaper and easier method of growing plants.

Spore Formation :-

Spores which are present in sporangia are small, bulb like structure which are covered by thick walls that protect

them until they come in contact with suitable condition.
- Under favourable conditions, they germinate and produce new Rhizopus individual.

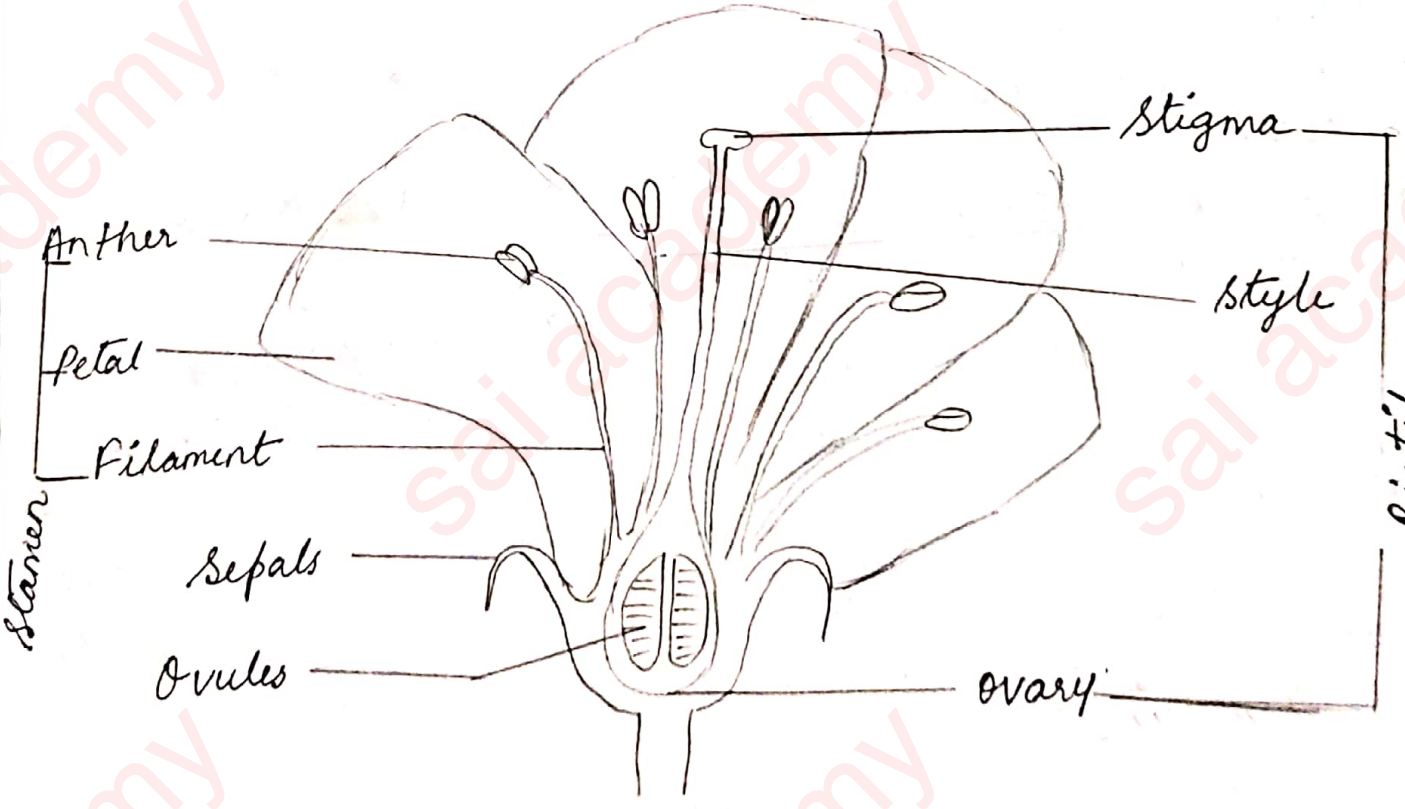
Sexual Reproduction:-

- When reproduction takes place as a result of fusion of two gametes, one from each parent, it is called sexual reproduction.
- The process of fusion of male and female gametes is called fertilisation.
- The formation of gametes involves exchange of chromosomal (genetic) fragments between homologous chromosomes causing genetic recombination which leads to variations.

Sexual Reproduction in Plants:-

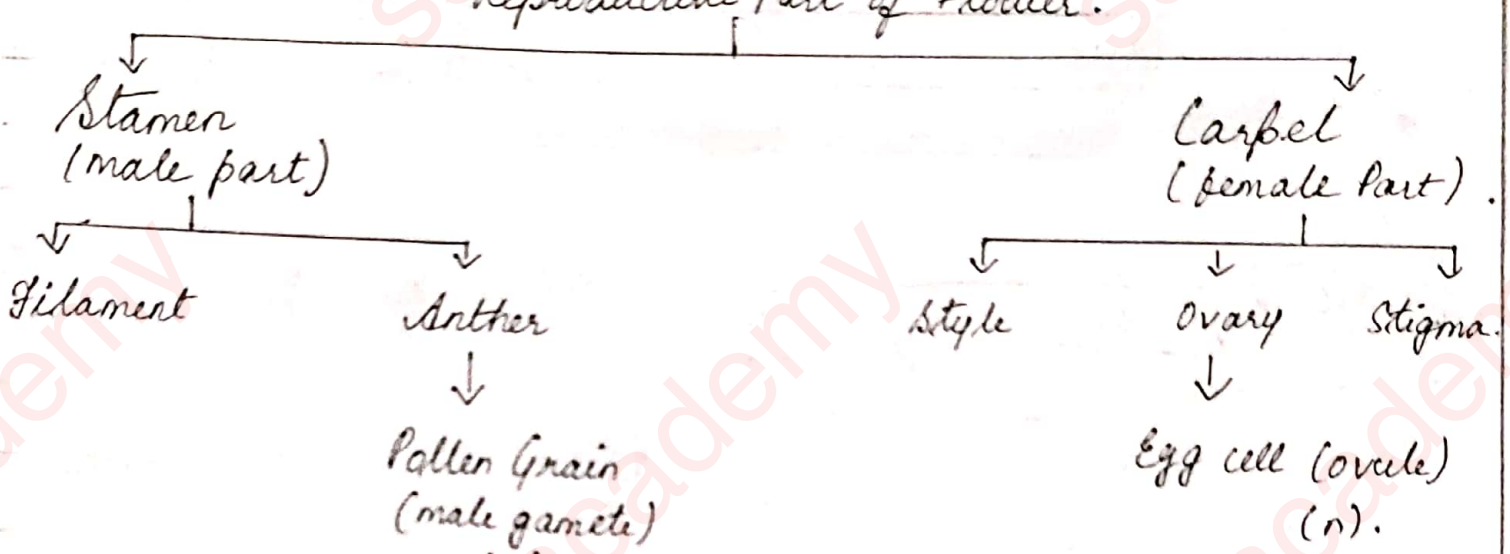
It occurs mostly in flowering plants. Flowers are the reproductive organ of plants.

Flowers:- Reproductive organ of plants.



Longitudinal section of flower.

Parts of Flower:- A flower consists of four main whorls namely calyx., Corolla (Petals), Androecium (Stamens) and Gynoecium (Carpels).



- Pollen grains of flower, transfer to the stigma of carpel of same flower (Self-Pollination) or to the stigma of carpel of another flower (Cross Pollination).
- Transfer of pollen is achieved by agents like wind, water, or animals.
- After Pollination, a pollen tube grows out of pollen grains, through which male germ cell reaches the ovary and fuses with the female germ cell.

Fertilisation:- The fusion of male and female gamete is called fertilization. It occurs inside the ovary.
- Zygote is produced in this process.

Ovary → Ovule → Egg Cell → Polar Nuclie.

- Zygote divides several times to form an embryo within ovule. The ovule develops into a seed.
- Ovary grows rapidly and ripens to form a fruit.
- Flowers can be unisexual (contain either stamen or carpel) or bisexual (contains both stamen and Carpel).

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  Bisexual flowers :- Hibiscus, Mustard.

Reproduction in Human Beings :-

- Humans use a sexual mode of Reproduction.
- It needs sexual maturation which includes creation of germ cells, ie, egg (ova) in female.
  sperm in male
- This period of sexual maturity is called Puberty.

Male Reproductive System :-

- The formation of male germ cell (sperms) takes place in testes.
- Testes is the main reproductive organ in male.
- They are present in scrotal sacs outside body in the abdominal cavity. Scrotum has relatively low temperature needed for production of sperms in testes.
- Testes release a male sex hormone called testosterone and its function is to :-
  1. Regulate the function and production of sperms.
  2. Brings about changes in appearance seen in body at the time of puberty.
- The sperms along with secretion of prostate gland and seminalvesicle, together constitute semen.
- This is released and made to enter the female genital tract during Copulation.
- Vas deferens and urethra are main ducts.
- Penis, having urethra passing through it, is called copulatory organ.
- Male sex, sperms are produced by seminiferous tubules which secrete hormone testosterone.

Female Reproductive System:-

- The main reproductive organ in a female is a pair of ovaries
- They produce the female sex cells called eggs or ova and also produce female sex organs producing sex hormones called estrogen and progesterone.
- Ovaries are located in both side of abdomen.
- When a girl is born, the ovaries already contain thousands of immature eggs.
- At puberty some of these eggs start maturing. One egg is produced every month by one of ovaries.
- The egg is carried from ovary to the womb through a fallopian tube. These two fallopian tube unite into an elastic bag like structure known as uterus.
- The Uterus opens into vagina through the cervix.
- Fertilisation occurs in the fallopian tube of female genitalia.
- **Menstruation:-**

The fertilized egg also called zygote (2n) gets implanted in the lining of the uterus, and start dividing. Uterus is richly supplied with blood to nourish the growing embryo. If zygote is not formed, the inner wall of uterus breaks which causes bleeding through vagina. This process is called Menstruation.

- It occurs at a 28 days cycle.
- The Embryo gets nutrition from the mother's blood with the help of special tissue called Placenta. It provides a large surface area for glucose and oxygen to pass from the mother to the embryo.
- The time from fertilisation upto the birth of baby is called Gestation period. It is about 9 months.

- The Menstruation Cycle in a woman continues upto the age of 45-50 yrs. This stage is called Menopause, in which ovaries do not release egg.
- Female sex hormone are oestrogen and progesterone which are produced by the ovary.

Reproductive Health :- Reproductive Health means a total well-being in all aspects of reproductive i.e physical, emotional, social and behavioural.
- Reproductive health deals with the prevention of STDs and unwanted pregnancy.
- **Contraception** :- It is avoidance of pregnancy and help to avoid STDs.
  - Contraceptions can be of various types such as mechanical/barriers, hormonal/chemical methods.

- Healthy society needs a balanced sex ratio that can be achieved by educating people to avoide malpractices like female foeticide and prenatal sex determination.

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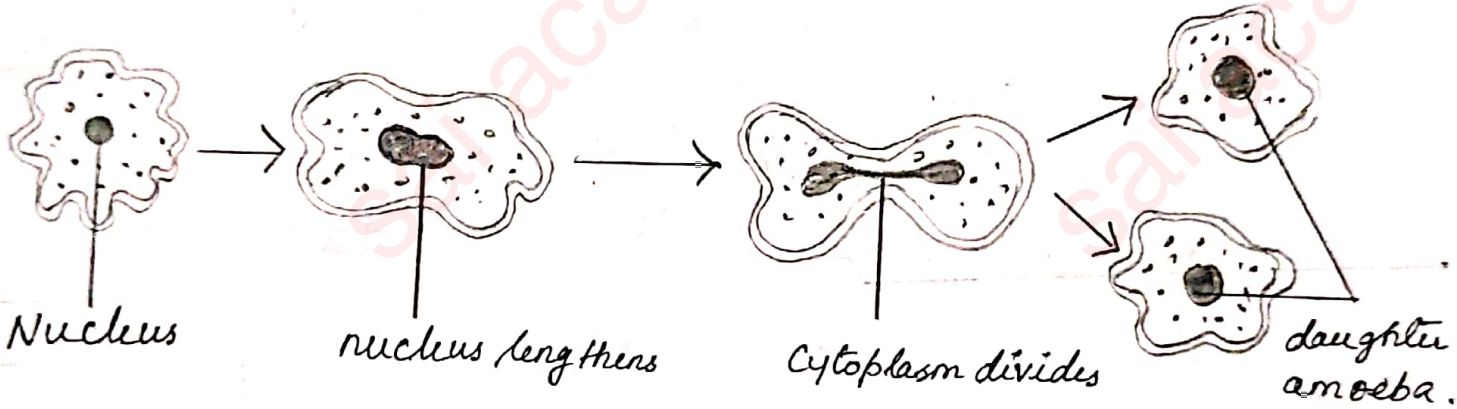

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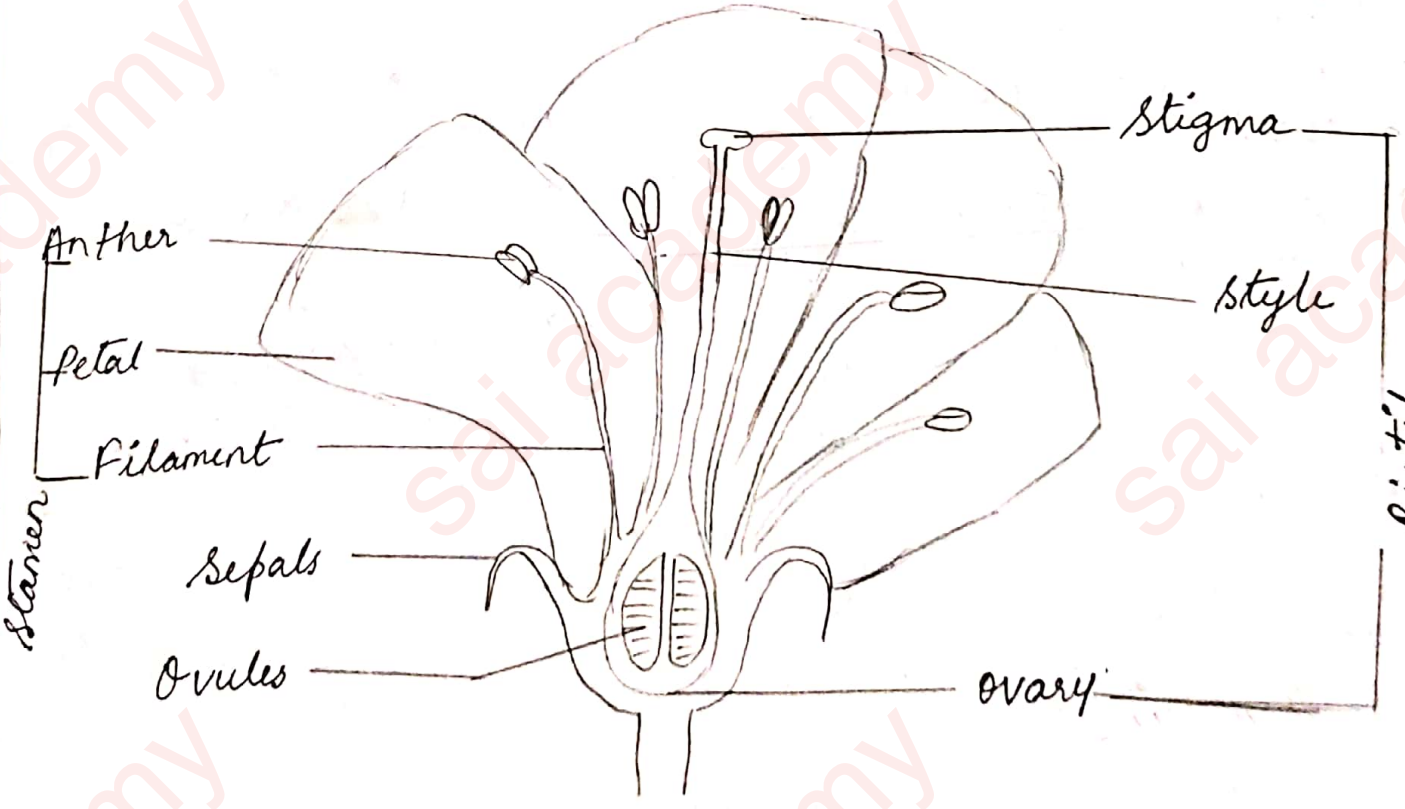

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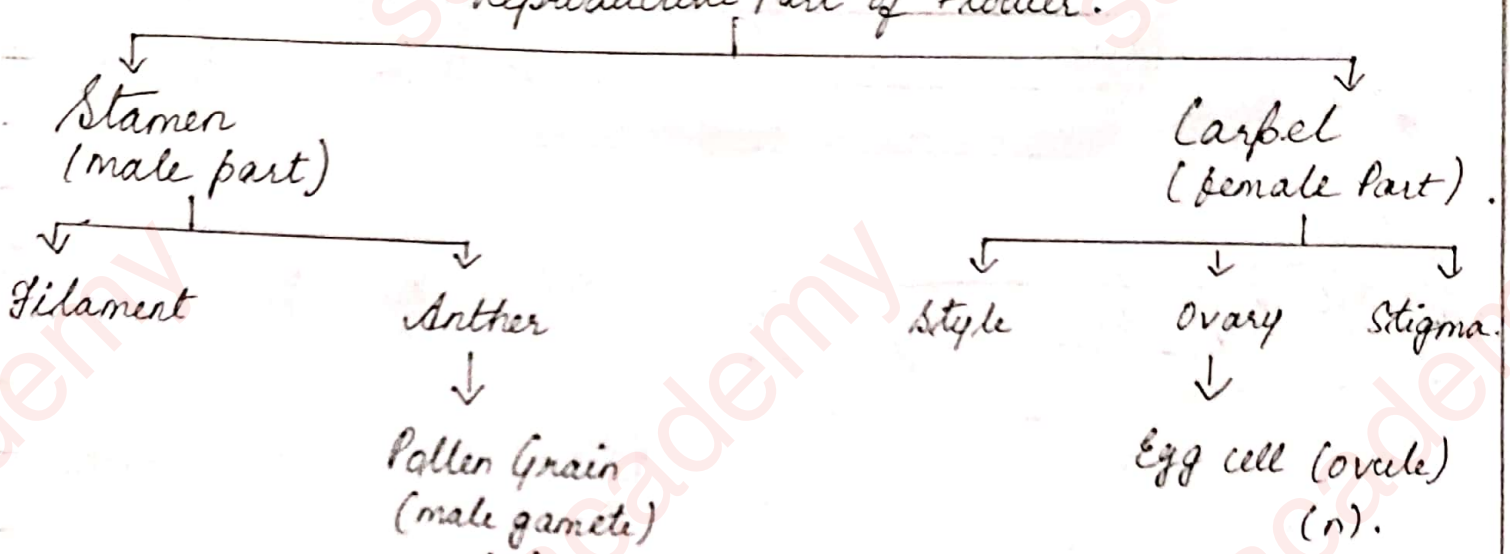

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LIGHT

Light :- It is a form of Energy that gives us a sensation of vision.
- It is a form of Electromagnetic radiation.
- It is a **transverse wave**. (disturbance produced in a wave is in 1^{n} direction to the direc^{n} of propogation of wave).

Sources of Light

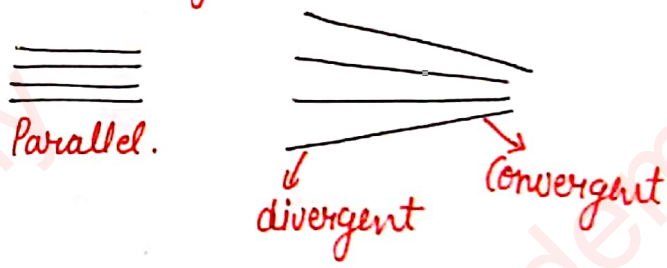
Self Luminous
These sources emit light of their own.
e.g. Sun, Stars, Candles etc.

Non-Luminous
These sources does not emit light of their own.
e.g. The moon, book, table etc.

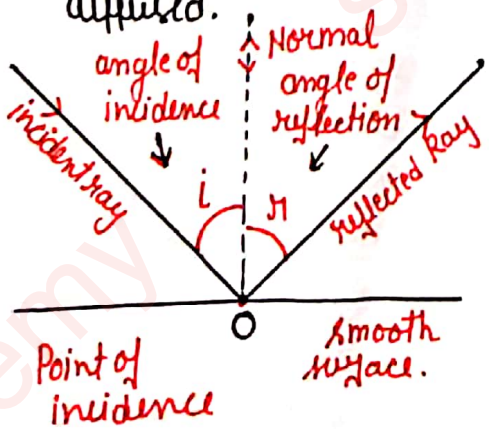
Medium of Light The substance through which light propogate or tries to do so is called medium.
- → **Transparent** Medium through which light propogates completely. Air.
- → **Translucent** through which light propogates partially. frosted glass.
- → **Opaque** through which light does not propogates. Metals, wood.

Ray of Light :- The linear path joining the one point from where light wave propogate to another is called Ray of Light.

Beam of Light :- A Bundle of rays of light is called beam of light.
- → Parallel beam of light.
- → Convergent beam of light
- → divergent beam of light.



Reflection of Light :- The phenomenon of bouncing back of light after falling on a polished smooth surfaces into the same medium is called Reflection of Light.
- → Regular Reflection. or specular
- → Irregular Reflection. or diffused.



Laws of Reflection There are two laws.

1. The angle of incidence (i) is equal to the angle of reflection. (r). i.e. $\boxed{\angle i = \angle r}$

2. The incident ray, the normal to the mirror at the point of incidence and the reflected ray, all lie in the same plane.

Images The point at which the reflected ray converge or appear to diverge is known as image.

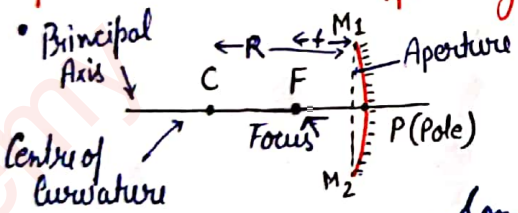
→ **Real** - If the light rays after reflection/refraction actually passes through the point where the image is located, it is called Real image.
- It can be obtained on a screen.
- Always Inverted.

→ **Virtual** - If the light appears to come from the point where the image is located, it is called Virtual Image.
- Can not be obtained on a screen.
- Always erect.

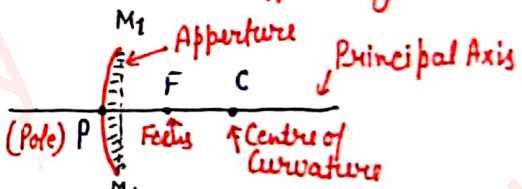
Mirrors → **Plane Mirrors** - It is flat and reflects the light in order they are recieved.
- Image is laterally inverted (reversed left to right.)
- Object's size and distance remains the same in plane mirror reflection.

Spherical Mirrors - Mirrors which have the shape of the piece cutout of a spherical surface. It's one side is silver polished.

Concave (Converging)
- A Spherical mirror whose outer side is polished & inner is reflecting one.



Convex (Diverging)
- A spherical mirror whose inner side is polished & outer is reflecting one.



Some terms Related to Spherical Mirrors

Pole (P) - It is the geometrical centre of spherical mirror's reflecting surface.

Centre of Curvature (C) - It is the centre of the imaginary sphere of which, mirror is a part.

Radius of Curvature (R) - It is the radius of the imaginary sphere of which mirror is a part.

Aperture - Diameter of the reflecting surface of spherical mirror is called its aperture.

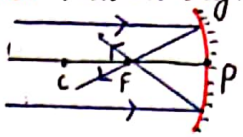
Principal Axis - The imaginary line joining the centre of curvature & the pole.

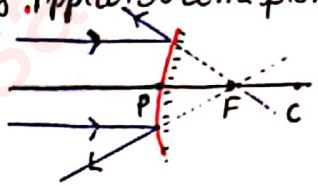
Focal length (f) - It is the distance between the principal focus and the pole.
If the apperture is small $\boxed{f = R/2}$

Principal Focus (F) - It is the point on the principal axis of which all the parallel rays coming from infinity actually converge (in case of concave) or appear to converge (in case of convex) after reflection from respective mirror.

Image Formation Rules

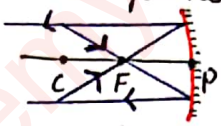
	Concave	Convex
1. The ray coming parallel to the principal Axis.	Pass through the focus	Appear to come from focus

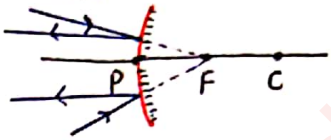




2. The ray coming through the focus of concave mirror. or coming towards focus of convex mirror.

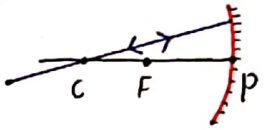
In both mirror it will become parallel to principal Axis.

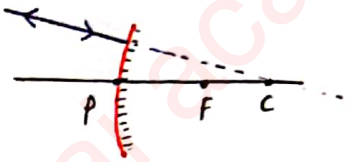




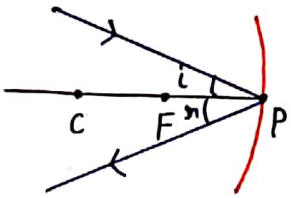
3. A ray coming through centre of Curvature of concave mirror or towards the direction of centre of curvature of a convex mirror.

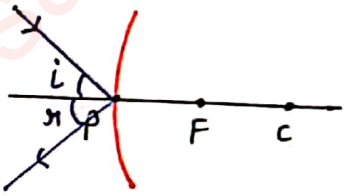
In both mirrors it reflects back along same path.





4. A ray incident obliquely to Principal axis, towards a pole P of a mirror is reflected obliquely following $\angle i = \angle r$ (Law of reflection).



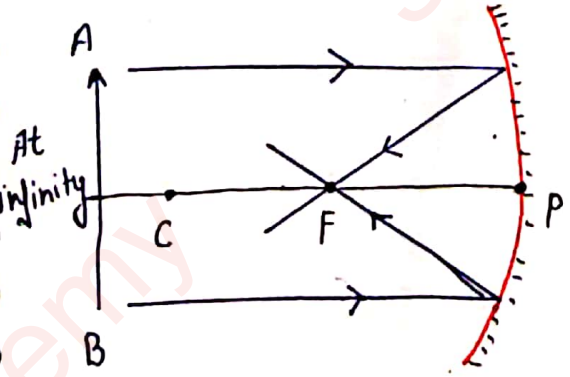


Formation of Image by a Concave Mirror

① When object is at infinity (∞) :

Position of Image : Image formed at the focus or in the focal plane.

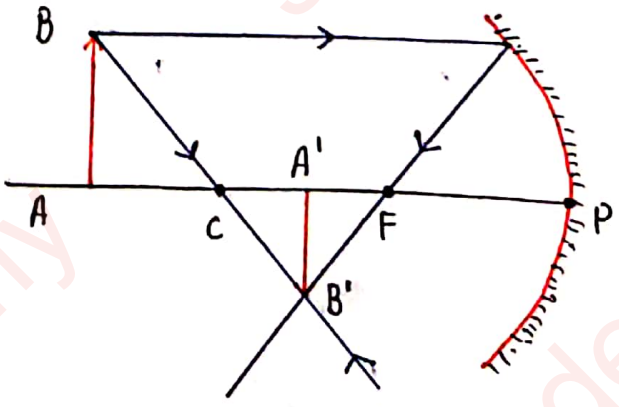
Nature & Size : Real, Inverted, extremely diminished.



② Object beyond the centre of curvature but at a finite distance.

Position of Image : between focus and centre of Curvature.

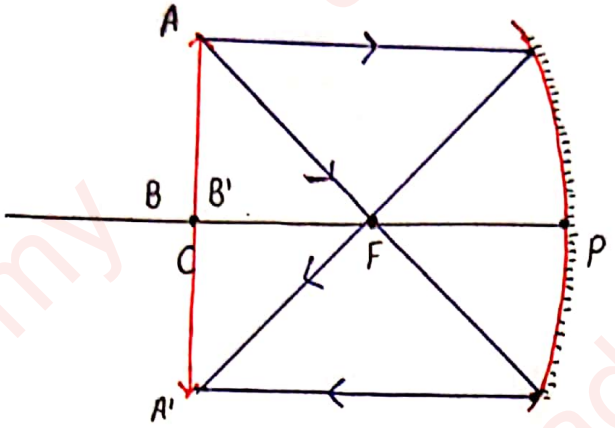
Nature & size : Real, Inverted & Diminished.



③ Object at the centre of Curvature

Position of Image - At centre of Curvature.

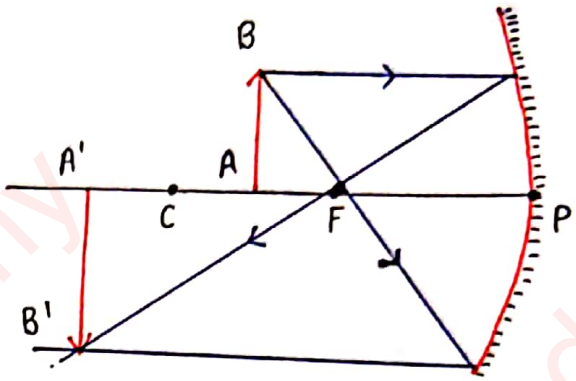
Nature & Size - Real, Inverted & equal to the same size.



④ Object between the focus & Centre of Curvature

Position of Image - Beyond the Centre of Curvature

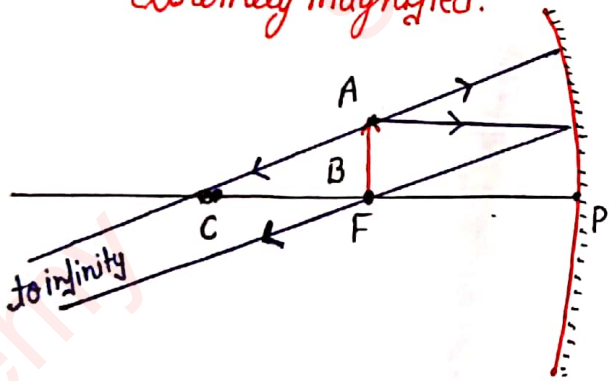
Nature & Size - Real, Inverted & bigger than object.



⑤ Object at the focus

Position of Image - Image forms at ∞.

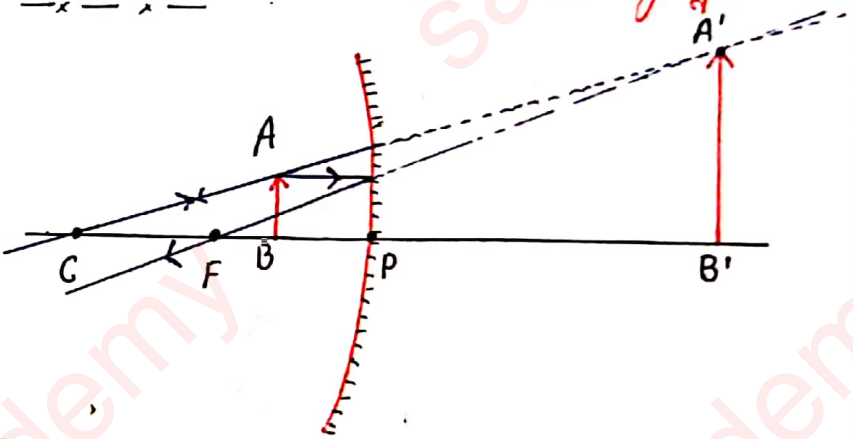
Nature & Size - Real, Inverted & extremely magnified.



⑥ Object bet. the pole & the focus

Position of Image - Behind the mirror.

Nature & Size - Virtual & erect & magnified.

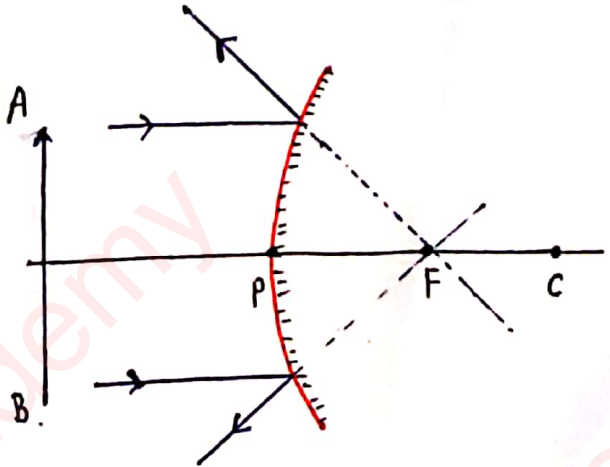


Formation of Image by a Convex Mirror

① Object at ∞.

Position of Image - At F, behind the mirror.

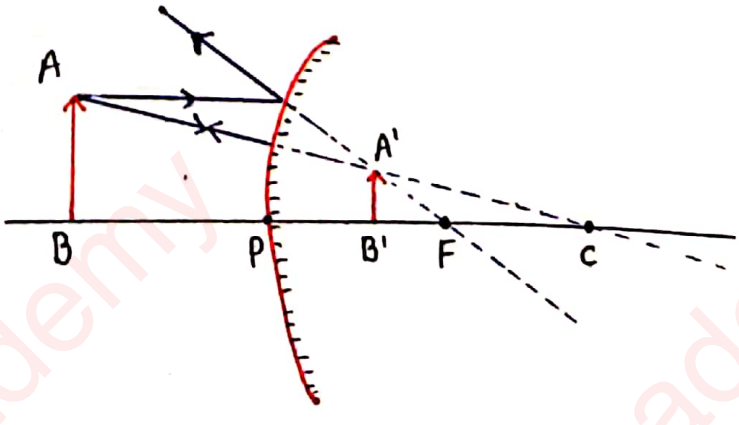
Nature & Size - Virtual, Erect, highly diminished.



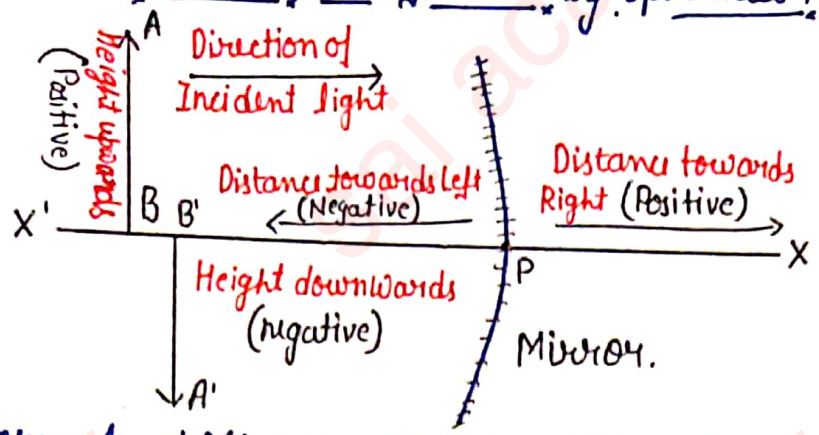
② Object btw. Infinity and Pole.

Position of Image - between focus & Pole behind the mirror.

Nature and Size - Virtual, erect & diminished.



Sign Convention for Reflection by Spherical Mirrors.



- Mirror is considered as origin.
- The object is always placed to the left of the mirror.

Formula of Mirror It is the relation between quantities. u, v and f.

It can be expressed as $\boxed{\frac{1}{v} + \frac{1}{u} = \frac{1}{f}}$

1. Object distance (u) The distance of the object from its pole in case of mirror.
2. Image distance (v) The distance of the image formed from pole of the mirror.
3. focal length (f) The distance of focus from the pole of the mirror.

◆ Values of u, v & f to be used according to Sign convention.

Linear Magnification : It gives the relative extent to which the image of object is magnified with respect to the object size. It expressed as.

$$\text{magnification}(m) = \frac{\text{Height of } \cancel{\text{Object}} \text{ Image } (h_i)}{\text{Height of } \cancel{\text{Image}} \text{ Object } (h_o)}$$

It also related to the u & v.

$$m = \frac{\text{Image distance } (v)}{\text{Object distance}} = \frac{-v}{u}$$

We can say that,

$m = 0 \rightarrow h_i = h_o$

$m < 1 \rightarrow h_i < h_o$

$m > 1 \rightarrow h_i > h_o$

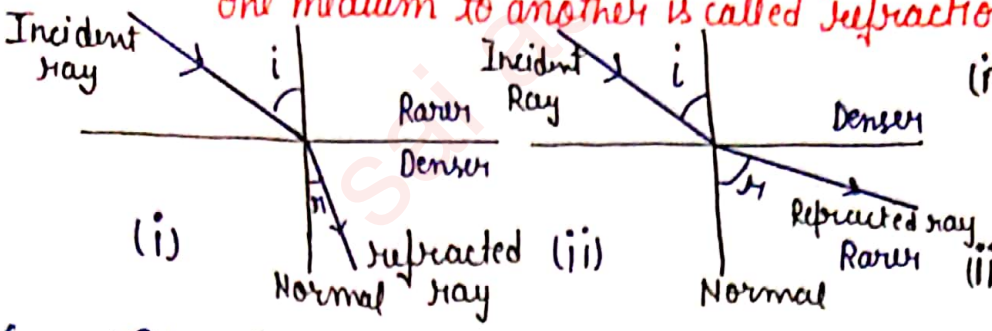
$$\boxed{m = \frac{h_i}{h_o} = \frac{-v}{u}}$$

If m is +ve → Image Virtual & erect.

If m is -ve → Image Real & Inverted.

Refraction

The phenomenon of bending of light ray when passes from one medium to another is called refraction of light.



(i) When light ray passed from Rarer to Denser it bends towards the normal.

(ii) When it passed Denser to Rarer it bends away from the normal.

Cause of Refraction In every medium, speed of light is different. It may be lesser in denser medium and higher in rarer medium. So, when light enters a denser medium, its speed reduces and it bends towards the normal and when it enters a rarer medium, its speed increases and it bends away from the normal.

Laws of Refraction

1. The incident ray, the refracted ray and the normal to the interface of two transparent media at the point of incidence, all lie in the same plane.
2. The ratio of Sine of angle of incidence to the sine of angle of refraction for light of a given colour is constant for a given pair of media. (Snell's law).

$$\frac{\sin i}{\sin r} = \mu = \text{Constant } (\mu \text{ or } n)$$

The constant is known as refractive index (μ).

Refractive Index of Medium and Absolute Refractive index.

→ For a given pair of media ${}_1\mu_2$ represents refractive index of medium 2 with respect to medium 1, when light passes from medium 1 to medium 2.

→ If the refractive index of a medium is taken with respect to vacuum, It is called absolute refractive index of the medium.

For glass/water pair $\quad {}_w\mu_g = \dfrac{{}_a\mu_g}{{}_a\mu_w}$

Min. refractive index is of Air.
Max. refractive index is of Diamond.

Refractive Index & Speed of light :

$$\mu = \frac{\text{Speed of light in vacuum/Air}}{\text{Speed of light in medium}} = \frac{c}{v}$$

For any two media, the refractive index of second medium w.r.t first medium is equal to the ratio of the velocities of light in the medium.

$${}_a\mu_g = \frac{c}{v_g} \quad -① \qquad {}_a\mu_w = \frac{c}{v_w} \quad -②$$

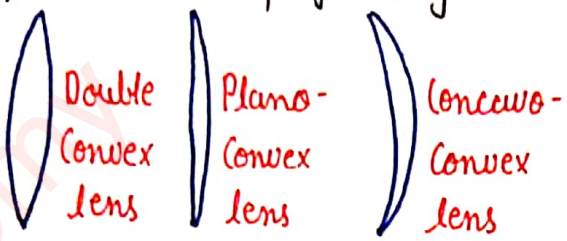
On dividing eqn ② from eqn ①.

$${}_g\mu_w = \frac{{}_a\mu_w}{{}_a\mu_g} = \frac{v_g}{v_w}$$

Lenses - It is a transparent medium bounded by two surfaces, out of which one or both surfaces are spherical. These are of two Types.

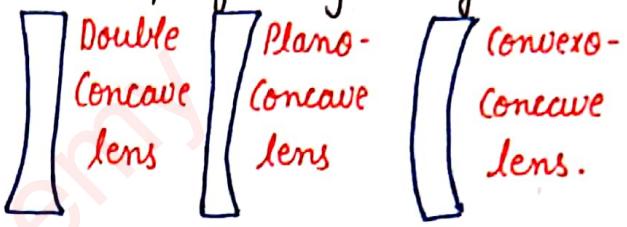
Convex or Converging Lens

A lens which is thicker at the centre & thinner at its ends is a convex lens. Converging lens because it converges a parallel beam of light ray.



Concave or Diverging Lens

A lens which is thinner at the centre and thicker at its ends is a concave lens. Diverging lens because it diverges a parallel beam of light ray through it.



Some Terms related to lenses -

1. **Optical Centre** - The geometrical centre of a lens is called as its optical centre (o).

2. **Centres of Curvature** - The centre of curvature of the two imaginary spheres of which lens is a part are referred to as centres of curvature of lens. because of two curved surfaces a lens has two centres of curvature.

3. **Radii of Curvature** - The radii of the two imaginary spheres of which, the lens is a part are known as radii of curvature of the lens. (c).
The two radii of curvature of lens may or may not be equal dipends upon spheres.

4. **Principal Axis** - The imaginary line joining the two centres of curvature is called principal axis of a lens. It also passes through optical centre.

5. **Principal Focus** - Lens has two principal focii.
   ① **First principal Focus** - A point located on principal axis of lens, where the rays where the rays turn parallel to principal axis after refraction.

   ② **Second principal Focus** - A point located on principal axis at which the rays coming parallel to the principal axis, converge on the other side of lens (Convex) or appear to meet on the same side of lens (Concave), after refraction from the lens.
   Both focii of convex lens are Real while of concave lens are Virtual.

6. Focal length of a Lens - The distance between focus & optical centre of lens.

7. Focal Plane - The plane passing through focus & perpedicular to principal axis.

8. Aperture - The effective diameter of a circular outline of a spherical lens.

9. Refractive Axis - Imaginary axis at the optical centre perpendicular to the principal axis which represents the lens.

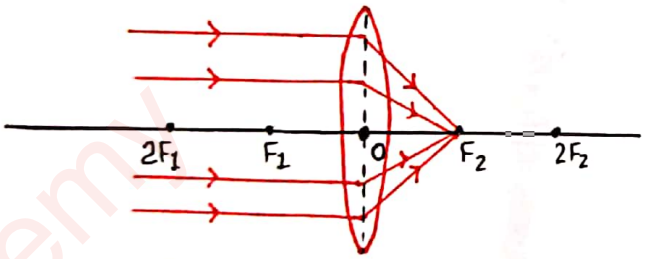
Image formation by Lenses

Rules

1. Rays parallel to the principal axis, will pass through second principal focus after refraction
2. Rays passing through the focus will emerge parallel to the principal axis after refraction.
3. Rays passing through the optical centre, will emerge without any deviation after refraction through the lens.

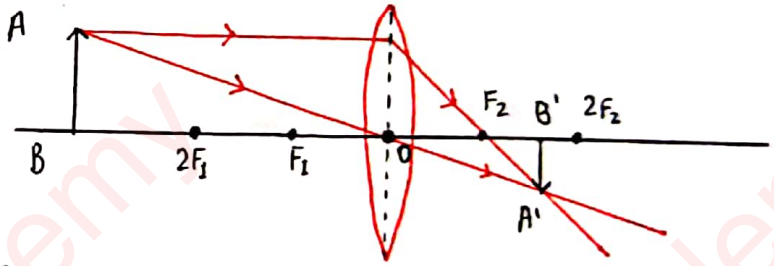
Image formation by a Convex Lens

① When object is at infinity.



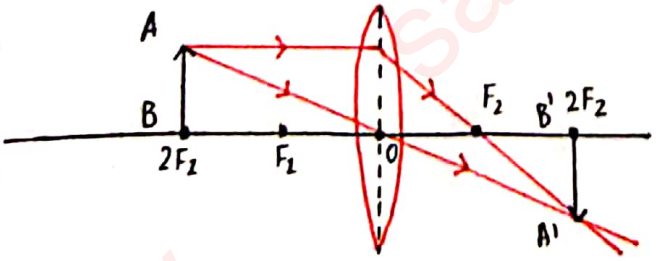
Position - Image Forms at F_2.
Size & Nature - Real & Inverted.
Extremely diminished.

② Object beyond $2F_1$ (at Finite distance)



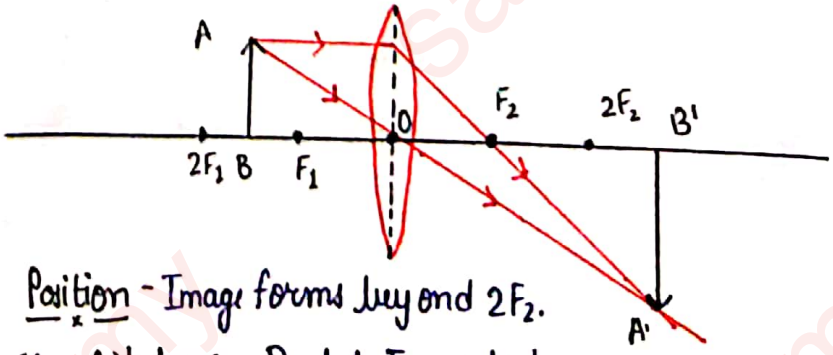
Position - Image forms btw. F_2 and $2F_2$.
Size & Nature - Real & Inverted. Diminished.

③ Object at $2F_1$.



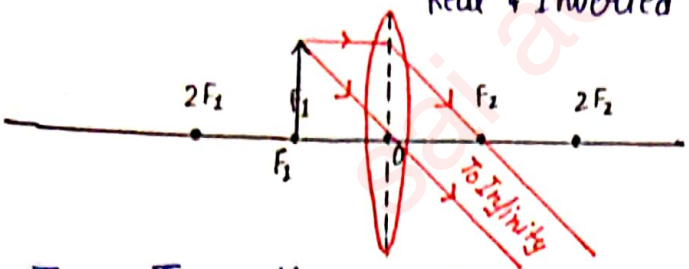
Position - Image forms at $2F_2$.
Size and Nature - Real & Inverted
Same Size

④ Object between F_1 and $2F_1$.

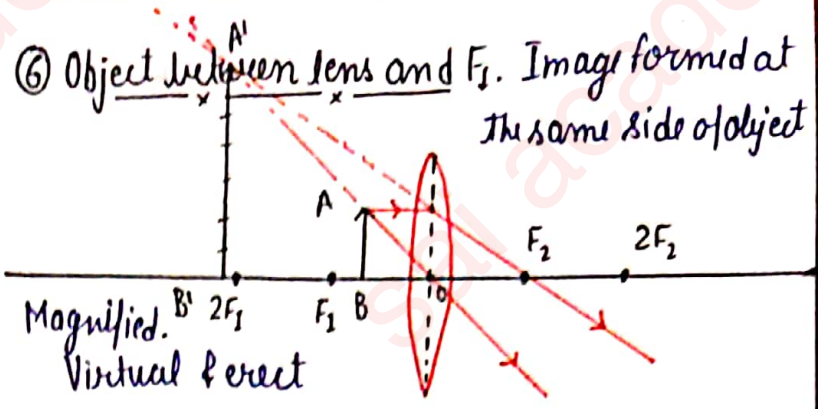


Position - Image forms beyond $2F_2$.
Size & Nature - Real & Inverted
Magnified.

⑤ Object at F_1 — Image Formed at ∞. Highly magnified. Real & Inverted



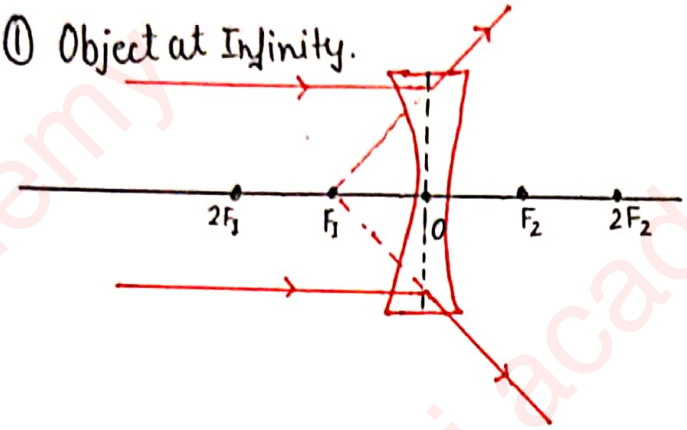
⑥ Object between lens and F_1. Image formed at the same side of object



Magnified. Virtual & erect

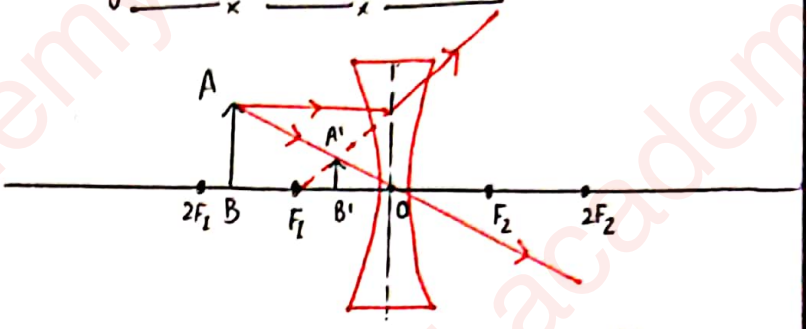
Image Formation by a Concave Lens

① Object at Infinity.



Position :- Forms at Focus same side of object
Size & Nature :- Highly diminished. Virtual & Erect.

② Object at a finite distance



Position :- Image forms between F_1 & O same side of object.
Size & Nature :- Diminished Virtual & erect

Sign Convention for Spherical Lenses.

	For Convex Lens	For Concave Lens
1. Distance of the object	Negative	Negative
2. Distance of Real Image	Positive	N.A.
3. Distance of the Virtual Image	Negative	Negative
4. Focal Length	Positive	Negative
5. Height of the Object	Positive	~~Negative~~ Positive
6. Height of Real & Inverted image	Negative	N.A.
7. Height of Virtual erect image	Positive	Positive

Lens Formula Represents relationship between u, v and f.

$$\boxed{\frac{1}{v} - \frac{1}{u} = \frac{1}{f}}$$

u = object distance v = Image distance
f = focal length.

Linear Magnification The ratio of height of image to the height of object is known as magnification (m).

$$\text{Linear Magnification } (m) = \frac{h_i}{h_o} \text{ or } m = \frac{v}{u}$$

Power of a Lens

The ability of a lens to converge or diverge light rays is known as Power (P) of the lens.

- It is always resiprocal of focal length (in metre).

$$P = \frac{1}{f} \text{ (in metre)}.$$

- It's S.I. Unit is Dioptre (D) $(1D = 1\,m^{-1})$

1 Dioptre is the power of lens whose focal length is 1m.

For Convex lens, power & focal length are positive.
For Concave Lens, power & focal length are negative.

Power of Combination of Lenses

When two or more thin lenses are combined the Equivalent focal length (f) and power of combination (P) can be calculated as:

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} + \text{----} \quad \text{and} \quad P = P_1 + P_2 + \text{---}$$

Magnification of Lens in Combination (m).

$$m = m_1 \times m_2 \text{ -- and so on.}$$

Uses :-

Concave Mirror :-
- by a dentist.
- In a shaving mirror.
- In search light.
- In head lamps.
- In Ophthalmoscope.

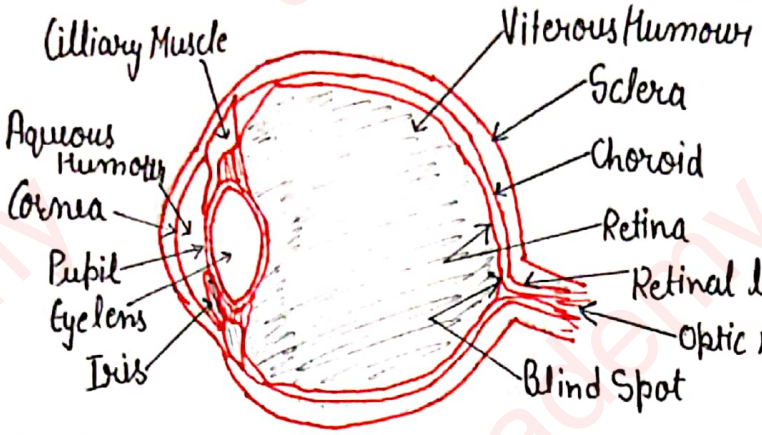
Concave Lens :-
- Wide-angle spy hole indoors.
- Myopic eye defect correction.

Convex Mirror :-
- As a rear-view mirror.
- In shops to check theft.
- At traffic junctions.
- To lighten large area.

Convex Lens :-
- Telescope
- Camera
- Microscope
- Magnifying glass.
- Hypermetropic eye defect correction.

Human Eye and the Colourful World.

The most sensitive and Valuable sense organ of the human body is the Human Eye. It is like a camera and is based on the lens system.



← Human Eye & Its parts

The Parts of Human Eye & It's functions :

1. **Cornea** →
   - A Thin membrane covering the surface of eyeball, through which light enters into the eye.
   - Acts as a primary lens.
2. **Iris** →
   - A dark muscular diaphragm located just behind the Cornea.
   - Controls the size of pupil.
3. **Pupil** →
   - A black opening between the aqueous humour and the eye lens.
   - Regulates and controls the amount of light entering the eye.
4. **Ciliary Muscles** →
   - Controls the focal length of the eye lens and hold the lens in right position.
   - due to relaxation of these muscles focal length of lens increases.
   - When these muscles contract focal length of lens decreases.
5. **Crystalline lens** →
   - The eye lens is a transparent, crystalline & double convex lens.
   - Made of transparent & flexible tissues.
   - Focuses the incoming light rays from the object on the retina to form real & Inverted images.
6. **Retina** →
   - A delicate membrane having enormous no. of light sensitive cells.
   - Acts like a screen on which image of objects are formed.
7. **Optic Nerves** →
   - It is formed by the nerve fibres attached with retina.
   - It carry nerve impulses or signals to the brain.
8. **Aqueous Humour** →
   - It is a transparent liquid filled behind the cornea.
   - It maintains intraocular pressure.
9. **Vitreous Humor** →
   - Filled between eye lens and retina.
   - keep retina in place by pressing it against the choroid.

Working of the Eye {function}

When a person looks towards any object, a reflected light from the object enters the pupil of the eye and falls on the eye lens (Convex lens), which forms a real and inverted image on the retina of the eye that consists of some special cells in the shape of rods & cones. Such special cells transform light energy in the form of signals for the brain. These signals reach to the brain by optic nerve. At last, the brain interprets these signals and the person is able to see the objects.

Power of Accommodation

- The focal length of the lens increases if its thickness decreases.
- The focal length decreases, the thickness of the lens increases.

The ability of an eye to focus the distant objects as well as nearby objects on the retina by changing the focal length of the eye lens is known as accomodation of the eye.

For normal eye:

- Far point - Infinity.
- Near point - 25 cm.

For Distant Object
↓
Ciliary muscles relax.
↓
Eye lens becomes thin.
↓
Increase in focal length

For nearby objects
↓
Ciliary muscles contract.
↓
Eye lens becomes thick.
↓
Decrease in focal length.

Defects of Vision

Myopia or Near-Sightedness

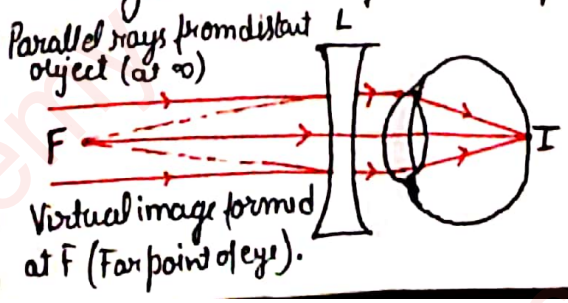
- Cannot see distant objects distinctly.
- Can see nearby objects clearly.
- Image of distant object is formed in front of the retina.

↓ **Causes**

- Excessive curvature of the eye lens or decrease in the focal length of eye lens.
- Elongation of eyeball.

↓ **Correction**

Using Concave lens of suitable power.



Hypermetropia or Far-Sightedness

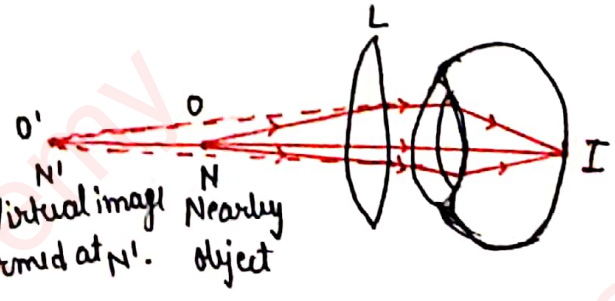
- Cannot see nearby objects distinctly.
- Can see distant objects clearly.
- Image of nearby object is formed behind the retina.

↓ **Causes**

- Focal length of the eye lens is too long.
- Eyeball becomes short.

↓ **Correction**

Using Convex lens of suitable power.



Presbyopia

- Near point of the eye gradually reduces away with aging.
- Power of accomodation of eye decreases.

↓ **Causes**

- Gradual weakening of the cilliary muscles.
- Diminishing flexibility of the eye lens.
- An eye suffers from both myopia and Hypermetropia.

↓ **Correction**

Bifocal lens.

- Upper portion is consists of concave for distant vision.
- Lower portion is consists of convex for near vision.

Contract

- Eye lens becomes milky & cloudy.
- Image cannot be seen distinctly.

↓ **Causes**

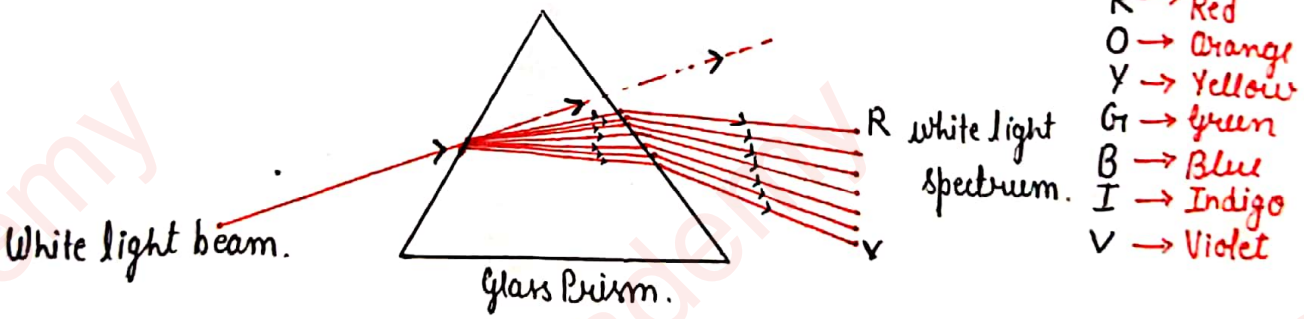
- Protein layer formation over eye lens.

↓ **Correction**

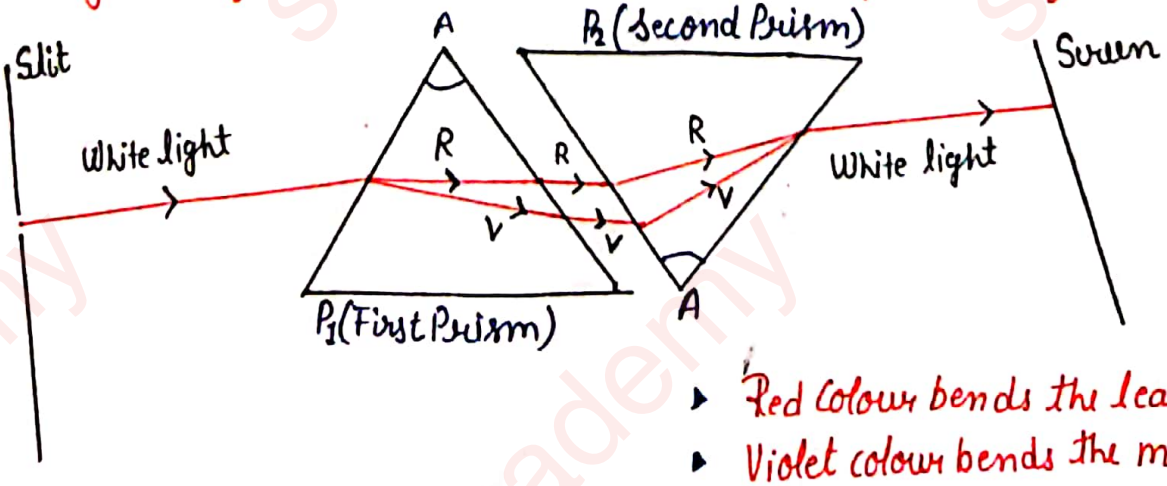
- Contract surgery for removal of extra growth on eye lens to restore the vision.

Astigmatism :- When the eye of a person cannot focus on both horizontal and vertical border simultaneously, then such type of a vision defect is suffered to Astigmatism.

Dispersion of white light by a glass Prism The splitting of white light into its components due to different bending abilities of colours when it passes through a prism, is called Dispersion.

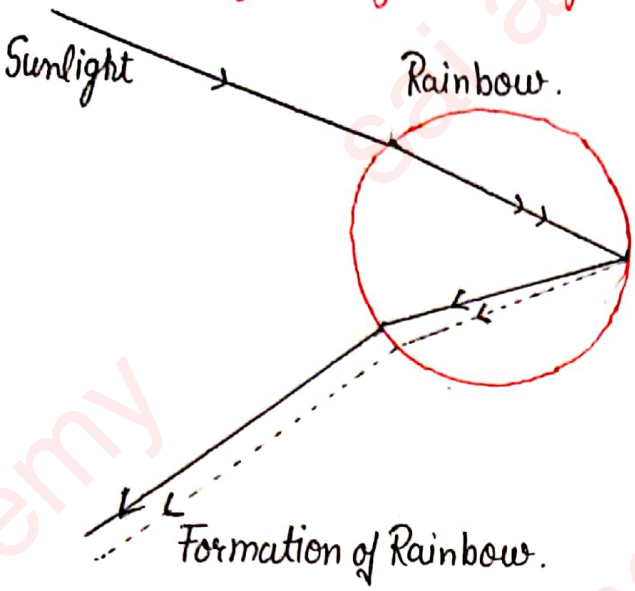


Recombination of White light. When white light is passed through a prism dispersion of light occurs and when another prism is kept inverted the dispersed light which was formed will get back to white light after passing through it known as recombination of white light.



- Red colour bends the least.
- Violet colour bends the most.

Spectrum (Rainbow) The rainbow is an arc of seven colours. (VIBGYOR), visible in the sky during the rainy season. The arc (called VIBGYOR) is Spectrum.



Formation of Rainbow.

Rainbow is caused by → Dispersion of sunlight by tiny water droplets, acts like a small prism present in atmosphere.

Conditions for its formation →
- Presence of water droplets in the atmosphere.
- The sun must be at the back of observers.

Atmospheric Refraction
- Due to the continuous variation in the density & temperature in the different layers of earth's atmosphere. This layers will acts as a different medium.
- Sunlight gets refracted through these atmospheric layers. The phenomenon is called atmospheric refraction.

Some Natural Phenomenon Based on Atmospheric Refraction

Twinkling of Stars
The light coming from a star undergoes refraction due to varying optical densities of air at various altitudes. The star appears to be very bright at one moment & at the next moment it becomes very dim.

Apparent Start Position
As higher up in the sky, the surface is rarer but near to the earth, surface is denser. The ray coming from star bends. Refraction of light of the star take place and the star appears to be at a higher position.

Planets do not twinkle
They are larger in size and are much closer to the Earth, so they can be taken as a collection of large no. of point-sized source of light. The total variation in the amount of light entering our eyes properly which reduces twinkling effect.

Advance Sunrise and Delayed Sunset The sun can be observed two minutes before the sunrise and after sunset because of atmospheric refraction.

Scattering of light

When a ray of light passes through a path of suspended particles, it splits up in various random directions. Such a phenomenon is known as Scattering of light.

- Scattering depends upon the size of particles. (In case of true and colloidal)
  - → fine particles in air scatter blue colour.
  - → Large-sized particle scatter longer wavelength of light.

Basic Events due to Scattering

Tyndall Effect

When a light ray passes through the air, the particles of dust, smoke & vapour present in air makes the path of the light ray visible. Such phenomenon is known as "Tyndall Effect."

Colour of the sky Blue.

Blue component of white light (sunlight) is scattered more by the air molecules than the other fine particles present in the atmosphere. Blue has the shorter wavelength which scatter faster in comparison to other colours present in sunlight.

Colour of the Sun at Sunrise & Suset

Sky Appears Black :- When ~~there~~ there is no atmosphere (space) or no light (night), the scattering does not take place.

Sky Appears Red :- During Sunrise / Sunset the sun is near the horizon. light passes through larger distance in the earth's atmosphere. Most of the blue light is scattered away. The red light does not get scattered and reaches our eyes.

Electricity

Charge :- A fundamental property of matter that causes it to experiences a force (attraction or repulsion) in the presence of the other matter.
It come into action when e^- are transferred from one body to other.

S.I. Unit :- Coulomb, $1C = 6.25 \times 10^{18}\ e^-$
The amount of charge due to access of or deficiency of $6.25 \times 18^{18}\ e^-$ is "1 coulomb".

Properties

Fundamental	Conservation of charge	Quantization	Additivity
Like charges repel and Unlike charges attract each other.	The net charge in an isolated system is constant.	Charge can only exist in the form of integral multiple of charge at one. ($Q = \pm ne$).	Charges are additive in nature.

There are two types of charge → Positive, Negative.

Electric Current :- The rate of flow of charge is called electric current. $I = \frac{Q}{t}$
S.I. Unit :- Ampere, $1A = 1C\,s^{-1}$
"If 1 coulomb charge is passing through a cross section per second is said to be one Ampere."
It measured by ammeter.

where I = Current, Q = electric charge, t = time.

Electric Potential :- The amount of work done in bringing a unit positive charge from infinity to a point is called as electrical potential at that point

- It is a scalar quantity.
- S.I. Unit :- Volt, $1V = 1JC^{-1}$.

$V = \frac{W}{q}$ W = Work Done, q = amount of Charge.

Electric Potential Difference (ΔV) :- The amount of work done in bringing one unit positive charge from one point to another is refered to as electric potential difference between them.

If One joule work is done to bring unit charge from one point to another, the potential difference will be one volt. $V_A = \frac{W_A}{q}$ — (i) $V_B = \frac{W_B}{q}$ — (ii)

$$V_B - V_A = \frac{W_B - W_A}{q}$$

Voltmeter :- The potential difference between any two points in an electric field is measured by an instrument called voltmeter.
It is always connected in parallel.

Electric Circuit :- A closed and continuous path through which electric current flows, is known as an electric circuit.
A pictorial representation of the electric devices connected in a circuit, is called a "Circuit diagram."

Symbols of some Commonly Used Components in Circuit Diagrams :-

- An electric cell
- A plug key or a switch (open)
- A wire joint
- An electric bulb
- A variable resistance or rheostat

or

- A battery or a combination of cells
- A plug key or a switch (closed)
- Wires crossing without joining
- A resistor of resistance R
- An ammeter
- A Voltmeter

OHM'S LAW :- Acc. to Ohm's Law, "At constant temperature, pressure and strain, the current flowing through a conductor is directly proportional to the potential difference across the conductor."
Given by German Physicist Georg Simon Ohm.

Acc. to Ohm's Law, $V \propto I$ then, $\boxed{V = RI \text{ or } V = IR}$ $\boxed{\frac{V}{I} = \text{Constant } (R)}$

where, I = electric current V = Potential difference across the conductor
R = Resistance of the Conductor

V-I Graph :- The graph between the potential difference (V) and the corresponding current (I) is found to be a straight line passing through the origin for ohmic conductors.

Resistance :- It is the property of a conductor that opposes the flow of charge (current) through it. S.I. Unit :- Ohm 'Ω'

If the potential difference across the ends of a conductor is 1 Volt and the current through the conductor is 1 Ampere, the resistance of the conductor is said to be 1 Ohm.

Factors on which the resistance of a Conductor depends :-

① Length of the Conductor : $R \propto l$

② Area of Cross-section of the Conductor : $R \propto \frac{1}{d^2}$

③ Nature of material of the Conductor : different material has different resistivity.
$R \propto$ resistivity.

④ Temperature of the conductor : For a conductor $R \propto$ temperature.

from above discussion : $R = \rho \frac{l}{A}$, where ρ is called resistivity of material.

Resistivity :- Resistivity of a material can be defined as the resistance per unit length of unit cross-section of the material.

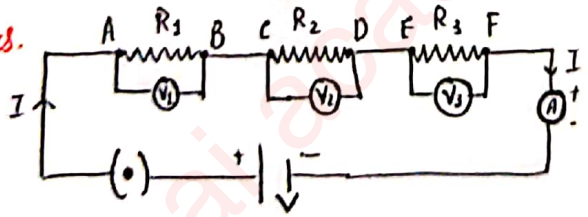
It depends on the nature of the material & temperature and is independent of the length and area of cross-section of the conductor.
It only depends on type of material and temperature.

Unit :- Ohm-metre or Ωm.

Resistance of a System of Resistors :- The resistors can be combined in two ways.

Resistors in Series

When two or more resistors are joined end-to-end so that the same current flows through each of them, it is called a series combination of resistors.



Total potential difference (V) = $V_1 + V_2 + V_3$

$V = IR_1 + IR_2 + IR_3$

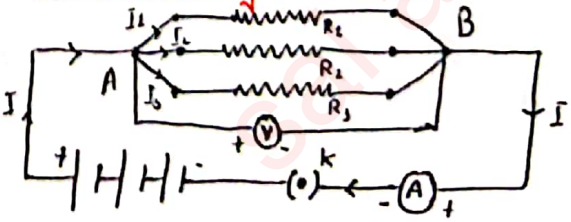
$IR_S = IR_1 + IR_2 + IR_3$

$\boxed{R_S = R_1 + R_2 + R_3}$

R_S = Equivalent resistance (series)

Resistors in Parallel.

When two or more resistors are connected between two common points such that the same potential difference is applied across each of them, it is called parallel combination of resistors.



Total Current flowing $I = I_1 + I_2 + I_3$

R_P = Equivalent resistance (Parallel)

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

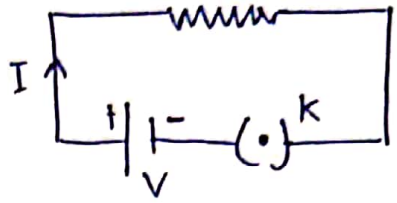
$\boxed{\frac{1}{R_P} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

Heating Effect of Electric Current : When an electric current passes through any electric component with non-zero resistance, it produces heat that heats up the corresponding component. This phenomenon is called heating effect of current.

Heat Produced in the resistance in time t, $H = QV$

We know that, $I = \frac{Q}{t}$, $\therefore Q = I \times t$

$\therefore H = I \times t \times V$ or $\boxed{H = VIt}$



We know that, $I = \frac{V}{R}$

$\therefore H = V\left(\frac{V}{R}\right)t \Rightarrow \boxed{H = \frac{V^2}{R}t}$

We know that, $V = IR$

$\therefore H = (IR)It$

$\boxed{H = I^2RT}$

This is known as Joule's law of heating and its implies that the heat produced in a resistance is:

(i) Directly proportional to the square of current for a given resistance & a given time.
(ii) Directly proportional to the resistance for a given current and a given time.
(iii) Directly proportional to the time for which a given current flows through a given resistance.

Electric Power : If W be the amount of electric energy consumed in a circuit in t seconds then electric power is given by

$$\text{Electric Power} = \frac{\text{Electric work Done}}{\text{Time taken}}$$

S.I. Unit : Watt (W)

$$\boxed{P = \frac{W}{t}}$$

It is defined as the rate of doing work. also the rate at which energy is consumed or produced.

If $W = QV$, where Q = Charge . V = Potential Difference.

$$P = \frac{VQ}{t} = VI \Rightarrow \boxed{P = VI}$$

from Ohm's law $\Rightarrow I = \frac{V}{R}$ then, $\boxed{P = \frac{V^2}{R}}$

Magnetic Effects of Electric Current

Magnetic field :- The region around a magnet in which the force of attraction or repulsion can be detected is called a magnetic field.

S.I. Unit :- Tesla.

Properties of Magnetic field lines

- Strength of magnetic field lines in a unit space, more strength with more greater no. of magnetic field lines.
- Strength of magnetic field is a quantity that has both magnitude & direction.
- As we go away from the pole of the magnet, strength decreases.

Magnetic field lines :- Curved path along which the iron filings arrange themselves due to the force acting on them in the magnetic field are known as magnetic field lines.

Properties

- It has both magnitude and direction.
- Outside the bar magnet, magnetic field lines start from north pole
- end at south pole.
- Magnetic field lines are closed and continuous curves.
- Regions where lines are closer, denote a strong magnetic field.
- Regions where lines are farther denote a weaker magnetic field.
- The two magnetic field lines never cut each other.

Magnetic field due to a Current-Carrying Conductor →

When electric current flows through a metallic conductor, then magnetic field is produced around it.

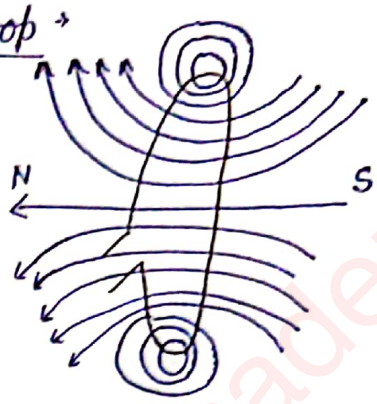
Pattern of magnetic field produced by a current-carrying conductor depends on its shape.

Magnetic field due to Current through a Straight Conductor

The magnetic lines of force around a straight current carrying conductor are concentric circles with their centres on the wire.

Right-Hand Thumb Rule → Imagine a straight current-carrying conductor in your right hand in such a way that your thumb points in the direction of electric current. Now, the direction of your right hand's fingers will give the direction of magnetic field lines.

Magnetic field due to a current through a circular loop →



- Circular and Concentric field near the coil.
- Near the centre field lines are straight & parallel.
- At the centre field is perpendicular to the plane of the coil.

Magnetic field depends upon : ⊙ Amount of current ($B \propto I$)

⊙ Number of turns in the wire ($B \propto N$).

⊙ Radius of coil.

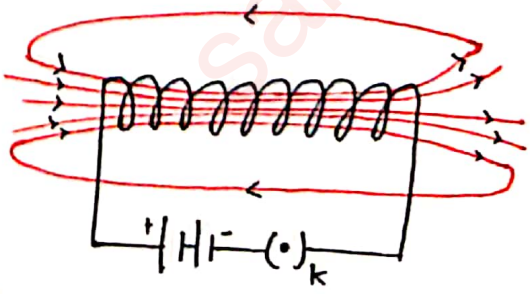
Direction of Magnetic field →

Direction of coil current	Pole created
Clockwise	South pole
Anticlockwise	North pole
at the centre	⊥ to the plane.

Magnetic Field Produced by a Current-Carrying Solenoid →

When a Coil of an insulated copper wire is wrapped closely in the shape of a Cylinder, it is called a Solenoid.

Pattern of field of Solenoid is compared with the magnetic field around a bar magnet it looks similar. The field inside the solenoid are in the form of parallel straight lines.



One end of solenoid behaves as north pole while the other end behaves as South pole.

It has uniform magnetic field inside it.

Electromagnet :- It refers to a magnetised solenoid which works on the principle of magnetic effect of current.

An electromagnet consists of a long insulated copper wire wound around a soft iron core.

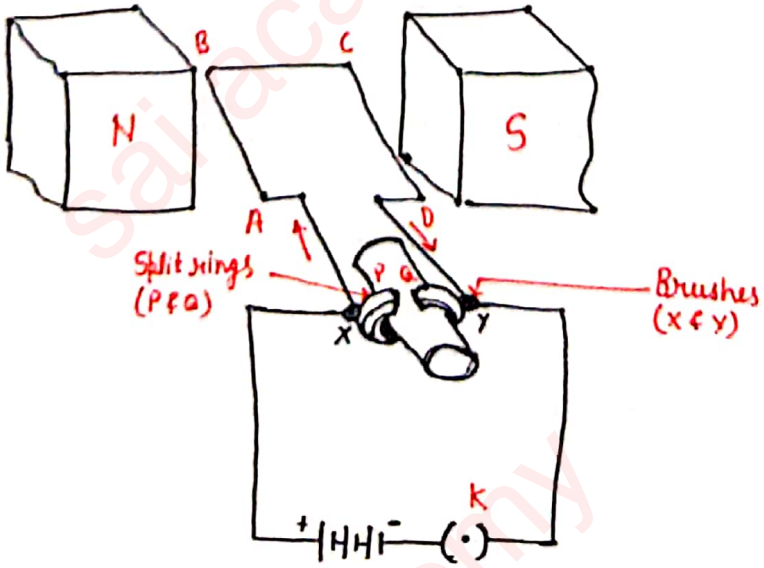
Force On A Current-Carrying Conductor in a magnetic field →

When a current-carrying wire is held near a magnetic needle (or compass) the magnetic needle gets deflected. This is because the magnetic field around the current carrying conductor (wire) exerts a mechanical force on the magnetic needle and produces a motion in it.

It depends on :-
- Current ($F \propto I$)
- Length of conductor in magnetic field ($F \propto l$)
- Magnetic field strength ($F \propto B$)
- Angle between Conductor & magnetic field ($F \propto \sin\theta$)

Fleming's Left Hand Rule → It states that, "Stretch the thumb, forefinger & middle finger of your left hand such that they are mutually perpendicular to each other. Where the first finger points in the direction of magnetic field and the second in the direction of current, then thumb will point in the direction of motion of force acting on the conductor."

Electric Motor :-



Principle – It works on the principle of magnetic effect of current. When a current carrying conductor is placed perpendicular to the magnetic field, it experiences a force.

Construction ... It consists of a rectangular coil PQRS of insulated copper wire suspended in a uniform magnetic field. The ends of rectangular coil are connected to the two copper metallic split ring 'C' and 'D' called split ring commutator. It rotates along with the coil. The external source such as battery sends the current to the coil through key and conducting stationary carbon brushes 'x' and 'Y' which slides over the split ring 'C' and 'D' respectively.

Working ... The current I flows in the coil ABCD, it will exert an equal & opposite force separated by a perpendicular distance. This causes the coil to rotate about its axis. After 180° rotation, the arms of the coil change their sides. At this position, the commutator reverses the direction of current and ensures the flow of current in the same direction. Therefore, the motor continues to rotate the coil. During this rotation, some amount of induced current is obtained which flows in the opposite direction. As a result of it, the current flowing through the coil is reduced as the speed of the motor increases.

Role of Split ring Commutator .... The two carbon brushes provide the path to the induced current to flow from the armature and the slip rings to the external circuit containing load resistance.

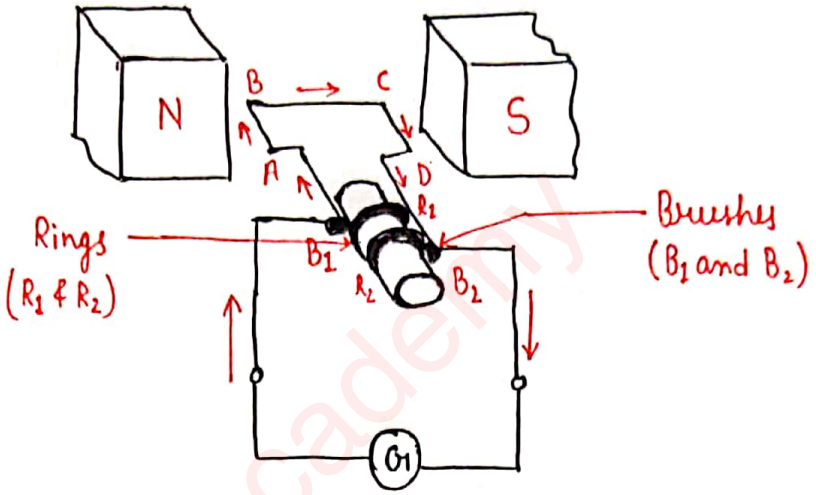
Electromagnetic Induction :- The phenomenon of producing electric current in a conductor by moving it perpendicular to a magnetic field or vice-versa is called Electromagnetic induction.

Induced Current :- The alternating current produced in a conductor or a closed coil, when magnetic lines of force rapidly change in it, is called induced current.

Fleming's Right Hand Rule [Dynamo Rule] :- It states that, "Stretch the thumb, fore finger middle finger of your right hand, so that they are perpendicular to each other

If the forefinger indicates the direction of magnetic field and the thumb shows the direction of motion of conductor, then the middle finger will show the direction of induced current."

Electric Generator :



Principle : It is based on the principle of electromagnetic induction which is the process of producing induced current in a coil by changing its orientation i.e. by rotating it in a uniform magnetic field.

Working of an AC Generator → When the armature coil ABCD rotates in the magnetic field, with the help of some mechanical work in clockwise direction. i.e. arm AB moves up and CD moves down, due to change in magnetic flux, induce current sets up in the coil. Then according to Fleming's right hand rule, the current flows in the direction ABCD. Then, the current in external circuit flows from B_2 to B_1. After half rotation, CD starts moving up & AB moves down. Hence, net induced current in the direction DCBA. Hence the current in the external circuit flows from B_1 to B_2.

Thus, after every half rotation the polarity of the induced emf thereby induced current across the load resistance changes. Therefore, in the external circuit, we get alternating current.

Function of Brushes → The two carbon brushes provide the path to the induced current to flow from the armature and the slip rings to the external circuit containing load resistance.

Direct Current — Continuously flows in the same direction

Alternating Current — Periodically change its direction.

Domestic Electric Circuits :- The electricity supplied to our houses by the electricity board is Alternating Current (AC) at 220V at 500 Hz frequency.

- Each home is fitted with two different supplies.

Domestic Light	Domestic Power.
Current rating 5A.	Current rating 15A.
Used for bulbs, fans, TVs etc.	Used for heaters, coolers, ACs, geysers etc.

- We connect all the domestic electrical circuits in parallel because :
  - → When two or more appliances are used at the same time, each appliances will be able to draw current as per the requirement.
  - → When distribution circuits are in parallel, then each circuit operates seperately. So if one, of the distribution circuits get overloaded, only the fuse in that circuit will be blown off.

- Live wire, red insulation at 220 V.
- Neutral wire, black or blue insulation at zero volt.
- Earth wire, green or yellow insulation.

The Overloading of electric wiring in any circuit, due to the flow of large current through it, is called Overloading of the electrical circuit.

Short Circuiting A sudden flow of very large current due to direct contact of a live and a neutral wire is called short Circuiting.

Electric Fuse A wire is a piece of thin wire made up of a material having a low melting point and high resistance. • It is made of alloy of lead & tin.

Earthing Connecting the metallic body of an electrical appliances to the earth by a conducting wire is called the earthing of an appliances.

- Maintain the metallic body at zero potential.
- User gets protected from electric shock.

Sources Of Energy

The capacity or ability to do work is called Energy.

Any substance or process or system which is capable of providing adequate amount of useful energy at a steady rate over a long period of time is called a Source of Energy.

The useful energy is the difference between output energy & input energy.

Useful Energy = Output Energy − Input Energy.

Characteristics of a Good Source of Energy :

1. The source should be convenient to use, use & transport.
2. It should be economical so that everybody can effort it.
3. It should be capable of producing adequate amount of useful energy.
4. The source of energy should be capable of delivering desired amount of energy at a steady rate for a long period of time.

Classification of Sources of Energy

Conventional Sources of Energy

- Non-renewable Sources of Energy.
- Sources of energy which are present in nature in a limited quantity & cannot be replenished by any natural process.
  E.g. Coal, petroleum, natural gas.
- Have been accumulated in nature over a very long period of millions of years.

Non-Conventional Sources of Energy.

- Renewable Sources of Energy.
- Sources of energy which are continuously produced in nature & can be replenished by any natural process.
  E.g. Solar Energy, wind Energy etc.
- Develop with in a relatively short period of time.

Conventional sources of Energy:

1. **Fossil Fuels** :- The fuels preserved under the earth's crust as the remains of plants and animals who had died millions of year ago.
The process of formation of fossil fuels is called fossilisation.

Main kind of fossil fuels are :-

1. **Coal** It is complex mixture of compounds containing Carbon(C), Hydrogen(H), Oxygen(O), and smaller amount of Nitrogen(N) and Sulphur(S).
Used as source of heat energy in thermal power plant & as a fuel.
manufacturing of coke, coaltar and coal gas, Synthetic petrol.

2. **Petroleum** It is a complex mixture of large number of organic compounds of different types mixed with saline water and silt.
It is a dark coloured, viscous, fluorescent liquid which occurs deep inside earth of the depth of about 1000m to 1500 m.
After refining many major fractions are obtained.
Uses in power stations, heating purposes, transportation, lubricants etc.

3. **Liquified Petroleum Gas (LPG)** LPG is petroleum gas which is liquified under pressure it consists mainly of butane (C_4H_{10}) with small amount of ethane (C_2H_6) and propane (C_3H_8). It is havier than air.
It burns without smoke and is polutionless & Convinient to use. Its calorific Value is 50 kcal/g.

4. **Natural Gas** It is an important fossil fuel which is found near an oil source.
It is mixture of methane (CH_4)(95%), ethane (C_2H_4)(, propane (C_3H_8), butane (C_4H_{10}).
Components found in natural gas includes CO_2, helium, Nitrogen, H_2S.
Used as domestic & industrial fuel. & in manufacturing of fertilizers.
CNG (Compressed Natural Gas) is used as a fuel in transport as it is pollution free.

Advantages of fossil fuels

- Very easy to find & extremely efficient.
- generates thousands of job every year.
- fossil fuels are aviaible widely.

Disadvantages of fossil fuels

- Burning these causes Air pollution.
- These are not burn completely.
- Releases acidic oxides & greenhouse gases.

2. **Bio Mass** Fire wood and waste materials produced by the living beings and the dead material of living beings are used as a fuel or as a source of fuel which is called Biomass.

Biomass can be used as fuel by many ways :-

- Dry it out and burn it.
- Anaerobic degradation of biomass.
- Fermentation of biomass produces ethanol which is known as parental substitute for petrol and diesel.

3. **Biogas** It is a mixture of combustible gases produced by anaerobic degradation of biomass in the absence of air.

Composition of Biogas :- 1. Methane (CH_4) 50-75%
2. Carbondioxide (CO_2) 25-50%
4. Hydrogen Sulphide (H_2S) 0-3% 3. Hydrogen (H_2) 0-1% 5. Nitrogen (N_2) 0-10%

Biogas Plant

1. **Outlet Chamber or Overflow tank** : It is an outlet to take out the left over slurry. It is used as a manure as it is rich in nitrogenous compounds.
2. **Mixing Tank** : the mixture of animal dung and water is prepared called as slurry. In mixing tank, it is fed into the digester.
3. **Gas Tank** : It is stored in the gas tank just above the digester tank from which it is drawn out through pipes for use.
4. **Inlet Chamber** : It connects the mixing tank and the digester tank. It is having a slope to ensure smooth flow of slurry into the digester.
5. **Digester Tank** : It is a sealed chamber in which there is no oxygen. Here complex compounds is formed. This process takes a few days.

4. **Wind Energy** Flowing or moving air is called Wind.
Speed of wind may vary from 5-10 km/h (gentle) to 700-800 km/h.
The kinetic energy of moving air (wind) is called Wind Energy.

Advantages

- It is cheap and inexhaustible & does not cause any pollution.

Principle & Working : The design of the blades of a windmill is designed in such a way that a pressure difference is created between its different regions when wind strikes them. The rotation of motion of the blades is then utilised to perform mechanical work or to generate electricity.

Thermal Power Plant :- In thermal power plants, large amount of fossil fuels are burnt everyday in power stations to heat up water to produce steam which further runs the turbine to generate electricity. Mostly, thermal power plants are set up near coal or oil fields.

Hydro Power Plant :- A Hydroelectric power plant is an arrangement in which kinetic energy of flowing water is transformed into electrical energy.

The electric energy generated by hydroelectric plant is refferd to as hydroelectric energy.

Production

- As the water flows into reservoir from the catchment area, the kinetic energy of flowing water changes into the potential energy.
- The potential energy of water changes into kinetic energy as the water is released through control valves.
- As the water flowing at a high speed strikes a blades of turbine, it converts kinetic energy into mechanical energy of turbine.
- The mechanical energy of turbine converts into mechanical energy of the armature which further changes into electric energy produced in the coils.
- This electricity is then transmitted to distant places through the overhead electric cables or wires.

Advantages of Hydel Power Plant

- It is a cheap source of electricity.
- It does not cause any kind of pollution.
- It is renewable & inexhaustible source of energy.

Disadvantages of Hydel Power Plant

- The initial investment is very high.
- It is not available at all the places.
- It damage the environment, cause population displacement.

Non-Conventional Sources of Energy

1. **Solar Energy** - The energy from the sun in the form of radiation is Solar Energy. It does not cause any pollution. & available free of cost. Available in abundance in a hot country.

The amount of energy reaching perpendicularly per square metre per second in outer-most boundary of the earth's atmosphere is refferd as **Solar Constant**. (i.e 1.4)

Harnessing Solar Energy

Solar Energy converted directly into →
- Direct Harnessing.
  - Electricity → By Using Solar Cell.
  - Heat Energy → Solar Cooker, Solar water heater
- Indirect harnessing
  - here it responsible for
    1. Photosynthesis in plants.
    2. Movement of wind.
    3. Ocian thermal energy.

Solar Cell → Devica which converts solar energy directly into electricity.

The phenomenon due to which light energy directly changes into electric energy, when light is incident on certain sensitive material is called a **Photovaltaic Effect.**

A typical solar cell consists of a 2cm·square piece of almost pure silicon. It consists of n-type and p-type silicon. It generates about 0.7W of electric power and 0.5-1V of voltage.

Solar Cooker → Solar cooker are painted black from outside and a large glass plate to trap solar radiations by green house effect.

Advantages
- Eco-friendly.
- Renewable
- Used in rural areas.
- Retains all nutrients in food due to slow cooking.

Disadvantages
- Silicon cells are expensive.
- Solar radiations are not uniform.
- Cannot be used to make all type of foods.

2. Energy from the Sea:

Tidal Energy: Up and down movement of sea water along the shore is called tide. The energy possessed by the rising and falling tidal water is known as tidal Energy.

To harness tidal energy, a huge dam (barrage) is constructed across narrow opening to the sea. During tides, the sea water moves in and out of the opening in the dam. The moving water runs the turbine fixed inside generates electricity.

→ It is clear, environmental friendly, cheap, harnessed almost throughout year.

→ The sites are very few for this & the rise & fall of water is not very large.

Wave Energy : The unequal solar heating of the earth generates wind and the wind blowing over water generates wave.
The energy possessed by the ocean and the sea waves is known as Wave Energy.

Devices used for harnessing ocean wave energy.
- Oscillating water columns.
- Focusing devices.

Ocean thermal Energy : The solar energy stored in the ocean in the form of heat is called Ocean thermal Energy. (OTE).
The process of Harnessing it is called OTEC (Ocean Thermal Energy Conservation) and devices used for the purpose are called OTEC power plants.

3. Geothermal Energy : The heat from the interior of earth can be utilized as a source of energy under certain favourable conditions that are created by natural process. It is known as geothermal energy.

Advantages
- It is non-polluting & eco-friendy.
- Can be harnessed all time.
- It is easily produce.

Disadvatages
- Available only at few places
- Requires deep drilling which is highly technical & expensive.

4. Nuclear Energy : Energy contained in the nucleus of an atom is called nuclear Energy. It is released during nuclear reactions.

A reaction in which the composition of the reacting nuclei changes to form new elements with a ~~nuclear~~ reactions & release of large amount of energy is called nuclear reaction.
Nuclear reactions occur in two ways

Nuclear fission
- The reaction in which a heavy nucleus splits into two or more smaller nuclei, with the evolution of large amount of energy, when it is bombarded with slow moving neutrons, is called nuclear fission reaction.
- These are categorised in two ways :
  1. Uncontrolled Nuclear Fission reaction
  2. Controlled Nuclear Fission reaction

Nuclear fusion
- A reaction in which two or more lighter nuclei fuse to form a heavy nucleus and a large amount of energy is released, is called nuclear fusion reaction.
- Conditions for fusion reaction
  1. High temperature
  2. High pressure.

Chapter :- Our Environment

Environment :- Everything which surrounds us. It may include living (biotic) and non-living (abiotic) components.

Biotic :- Plants and animals.

Abiotic :- Air, water etc.

Bio-Degradable :- Substance that can be decomposed by the action of micro-organism like bacteria are called bio-degradable. Eg. Organic wastes.

Non-Biodegredable :- Substances which cannot be decomposed by the action of microorganisms are called non-biodegradable. ex :- polythene bags, metals, radioactive wastes etc.

Eco System and its components.

- All the interacting living organisms in an area together with non-living components form an ecosystem. So an ecosystem consists of both biotic and non living (abiotic) components like temperature, rainfall, wind, soil etc.

Ecosystem

- **Man-made Ecosystem**
  - eg. Crop-field, Aquarium etc.
- **Natural Ecosystem.**
  - **Aquatic Ecosystem**
    - **Marine Ecosystem**
      - eg. Sea, Oceans
    - **Fresh water ecosystem.**
      - eg. River, lakes, ponds.
  - **Terrestrial Ecosystem**
    - eg. forest, desert.

All organisms are classified on the basis of nutrition.

Producers:- All green plants, blue green algae can produce their food (Sugar and starch) from inorganic substance using light energy (photosynthesis).

Consumers:- Include Organisms which depend on the producer directly or indirectly for their substance.

Consumers

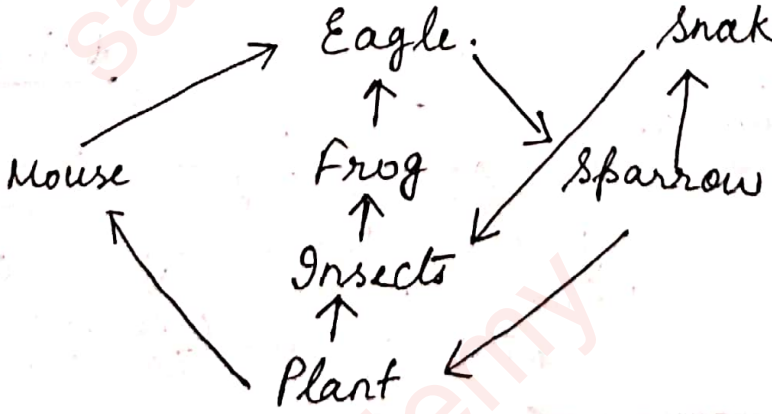
- **Herbivores** — eg. Cow, goat
- **Carnivores** — eg. Lion, Tiger
- **Parasites** — eg. Plasmodium
- **Omnivores** — eg. Crow.

Decomposers:- Fungi & Bacterias which break down the dead plant, animals complex compounds into simpler substances. Thus decomposers help in the replenishment.

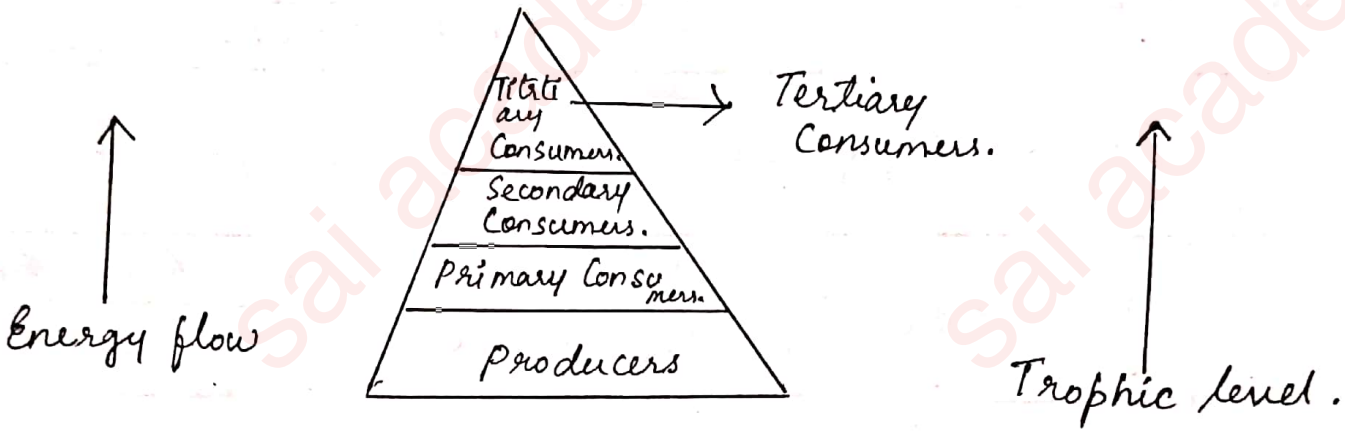
Eg:- T_1 T_2 T_3

Grass → Dear → Lion.

Food Chain:- It is the sequence of living organism in which one organism consumes other organism for energy. It is undirectional.



- In a food chain, various steps while trasfer of energy takes place called a trophic level.
- The green plants capture 1% of suns energy.
- The flow of energy is undirectional in a food chain.
- There is gradual decrease in the amount of energy from one trophic level to next trophic level in a food chain.



10 percent law:- The energy is transferred to next level while 90% energy is used by present trophic level in its life processes.

- The concentration of harmful chemicals increases with every next trophic level in a food chain. It is called Bio-magnification.
- Maximum concentration of such chemicals get accumulated in human bodies. Since, humans occupy the top of level in any food chain.

Environmental Problems:-

Changes in environment affect us and our activities change the environment around us. Environmental problems caused by humans are:-

(a) depletion of Ozone layer and waste disposal.

(b) Pollution due to mismanagement of waste disposal.

1. **Depletion of Ozone Layer:-**

- (O_3) layer is largely found in the stratosphere which is a part of our atmosphere from 12km - 50km above sea level.
- Ozone is a deadly poison at the ground level.
- Ozone is formed as a result of photochemical reaction:-

  $O_2 \xrightarrow{UV} O + O$ (splitting of molecular oxygen).

  $O_2 + O \longrightarrow O_3$
- Ozone layer is a protective blanket around earth which absorbs most of the harmful U.V (ultraviolet) radiation of the ~~sky~~ sun.
- Ozone layer emits harmful ozone gases which causes skin cancer, cataract in eyes, weaker immune system etc.
- The decline of Ozone layer thickness in Antartica was first observed in 1985 and was termed as "Ozone Hole"

Garbage Disposal:- Industrialization and rise in demand of consumer goods have created a major problem in the form of wastes and its disposal. The different ways of solid waste disposal commonly around us are:-

Methods for Garbage Disposal :-

1. **Open Dumping** :- It is a conventional method in which solid wastes dumped in selected area of a town.

2. **Land fillings** :- Wastes are dumped in low living areas and are compacted by rolling with bulldozers.

3. **Composting** :- Organic wastes are filled into a compost pit (2m x 1m x 1m). It is then covered with a thin layer of soil. After about three months the same garbage filled inside the pit changes into organic manure.

4. **Recycling** :- The solid waste is broken down into its constituent simpler materials. These materials are then used to make new items.

5. **Reuse** :- A very simple conventional technique of using an item again and again.
   For eg. paper can be reused for making envelops etc.