CHAPTER 1

Chemical Reactions and Equations

CHEMICAL REACTIONS AND EQUATIONS

- **Reaction**
  - Change in
    - Colour
    - State
    - Temperature
  - Form Equation
    - $2Mg(s) + O2(g) \rightarrow 2MgO(s)$
    - Simplest Way to Write Word Equation
      - Magnesium + Oxygen → Magnesium oxid
      - $Mg + O_2 \longrightarrow MgO$ — Unbalanced Equation
      - $2Mg + O_2 \longrightarrow 2MgO$ — Balanced
        - Energy Absorbed – Endothermic
        - Energy Released – Exothermic
        - ✓ Follows law of conservation of mass.
        - ✓ No. of atoms remain same.
        - ✓ Reactants and Products both
        - ✓ Physical states of elements, written as solid$_{(s)}$ liquid$_{(l)}$, aqueous$_{(aq)}$ and gas$_{(g)}$
- **Types of Chemical Reaction**
  - Combination Reaction – **Exothermic Reaction**
  - Decomposition Reaction – Endothermic Reaction
  - Displacement Reaction
  - Double Displacement Reaction
  - Reaction – Precipitation Rk^n
  - Oxidation – Reduction Reaction – Magnesium
  - Effects of Oxidation – Corrosion

combine to form a single product.

e.g. (i) Burning of coal

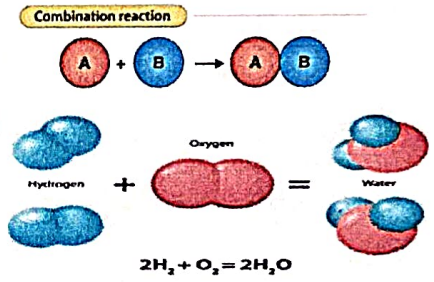
$C(s) + O_2(g) \rightarrow CO_2(g)$

(ii) Formation of water

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

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

Quick lime — Slaked lime



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

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

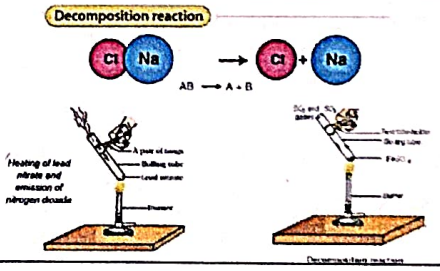
(Ferrous sulphate) Green colour — (Ferric oxide) Red-brown colour

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

(Lime stone) — (Quick lime)

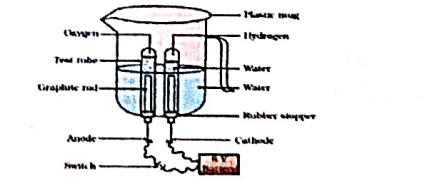
(iii) $2Pb(NO_3)_2(s) \xrightarrow{Heat} 2PbO(s) + 4NO_2(g) + O_2$

(lead nitrate) — (lead oxide) (Nitogen dioxide)



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

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



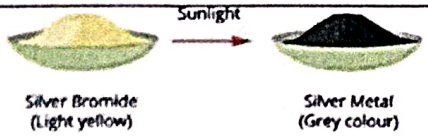
Photolytic Decomposition : When decomposition is carried out in presence of sunlight.

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

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

Silver chloride turns grey on exposure to sunlight

* Above reaction is used in black & white photography.



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

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

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

(b) $Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$

Zn is more reactive than copper.

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

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

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

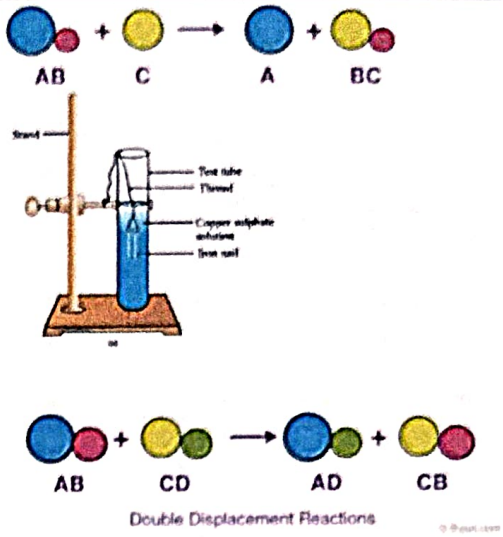
white precipitate of $BaSO_4$ is formed, so it is also called precipitation reaction.

(ii) $2KI + Pb(NO_3)_2 \rightarrow PbI_2 + 2KNO_3$

Potassium iodide, Lead nitrate, Lead iodide (Yellow ppt), Potassium nitrate

(iii) $2KBr + BaI_2 \rightarrow 2KI + BaBr_2$

Potassium bromide, Barium iodide, Potassium iodide, Barium bromide



OXIDATION AND REDUCTION :

Oxidation : (i) The addition of oxygen to reactant.

(ii) The removal of hydrogen from a reactant.

$C + O_2 \rightarrow CO_2$

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

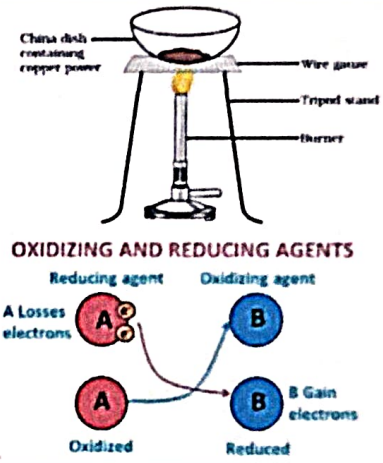
$CuO + H_2 \xrightarrow{Heat} Cu + H_2O$

Reduction : (i) The addition of hydrogen to reactant.

(ii) The removal of oxygen from a reactant.

$CuO + H_2 \xrightarrow{Heat} Cu + H_2O$ (oxidation: H_2 → H_2O; Reduction: CuO → Cu)

In this reaction CuO is reduced to Cu and H_2 is oxidized to H_2O. So, oxidation and reduction taking place together is redox reaction.



Rancidity: Oxidation of oils or fats in a flood, resulting in a bad smell and taste.

Preventions: ✓ Adding anti-oxidants. ✓ Replacing air by Nitrogen ✓ Refrigeration of foodstuff ✓ Storing the food in air-tight containers (Vacuum Packing)

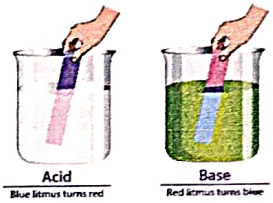
SOME IMPORTANT REACTIONS

1. $2FeSO_4$ (Green crystal) ------ HEAT-------- Fe_2O_3 (s) + SO_2 (g) + SO_3(g)
   Ferric Sulphate - Green; Ferric Oxide - Red-Brown; (Rotten Egg Smell)
2. $CaCO_3(s)$ ----------HEAT---------- $CaO(s) + CO_2(g)$
   (Limestone) (Quicklime) + (Carbon dioxide)
3. $2Pb(NO_3)_2(s)$---------- HEAT-- $2PbO(s) + 4NO_2$(brown fumes) + $O_2(g)$
   (Lead nitrate) (Lead oxide) + (Nitrogen dioxide) + (Oxygen)
4. $BaCl_2\ (aq) + Na_2SO_4\ (aq) \rightarrow BaSO_4\ (s) + 2\ NaCl(aq)$
5. $Pb(NO_3)_2 + 2\ KI\ (aq) \rightarrow PbI_2\ (\downarrow) + 2\ KNO_3\ (aq)$ **PRECIPITATION**

Acids, Bases and Salts

ACID	BASE
Properties of Acids: • Produce hydrogen ions [H+] in H_2O. • Sour taste. • Turn blue litmus red. • Neutralize solutions carrying hydroxide ions. • React with several metals releasing Hydrogen gas. • React with carbonates releasing CO2(g) • Corrode metal surface quickly.	**Properties of Base:** • Produce hydroxide ions [OH–] in H_2O. • Water soluble bases are called alkalise. • Bitter Taste • Turn Red Litmus blue. • Neutralize solutions containing H+ ions. • Have a slippery, 'soapy' feel.
a) **Strong acids:** Completely dissociate into their ions in aqueous solutions. Examples: **Nitric acid (HNO3), Sulphuric acid (H2SO4)**, and **Hydrochloric acid (HCl).** b) **Weak acids**: Weak acids are those acids which **do not completely dissociate** into their ions in aqueous solutions—for example: Carbonic acid (H2CO3) and acetic acid (CH3COOH).	a) **Strong bases**: Strong bases are those bases which completely dissociate into their ions in aqueous solutions. Example: Sodium hydroxide (NaOH) Potassium hydroxide (KOH) b) **Weak bases**: Weak bases are those bases which do not completely dissociate into their ions in aqueous solutions. Example: Ammonium hydroxide (NH4OH)

	INDICATORS	COLOUR IN ACID	COLOUR IN BASE
VISUAL INDICATORS	BLUE LITMUS		
	METHYL ORANGE		
	PHENOLPHTHALEIN		
	RED LITMUS		
OLFACTORY INDICATORS		ACID	BASE
	ONION JUICE	RETAINS SMELL	LOSES SMELL
	CLOVE OIL	PUNGENT SMELL	LOSES SMELL
	VANILLA ESSENCE	PUNGENT SMELL	LOSES SMELL



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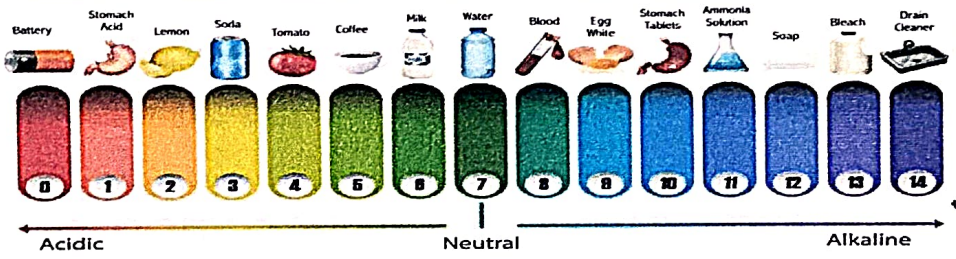
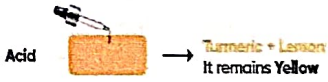
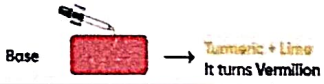






S. No.	Solution	Colour of pH paper	Approx-imate pH value	Nature of substance
1	Saliva (before meal)	Green	6.8–7.4	Slightly acidic or basic
2	Saliva (after meal)	Yellow green	5.8	Acidic
3	Lemon juice	Orange	2.2	Acidic
4	Colourless aerated drink	Yellow	4.0	Acidic
5	Carrot juice	Yellow green	6.0	Acidic

S. No.	Solution	Colour of pH paper	Approx-imate pH value	Nature of substance
6	Coffee	Yellow	4.5	Acidic
7	Tomato juice	Yellow	4.3	Acidic
8	Tap water	Green	6–8.5	Varied
9	1M NaOH	Dark blue	14	Basic
10	1M HCl	Red	0	Acidic

pH < 7 (Acidic Solution $[H_3O^+ > OH^-]$ $[H_3O^+ = OH^-]$ pH > 7 (Basic Solution $[H_3O^+ < OH^-]$

pH Sensitivity of Plants & Animals:

The human body works in a narrow range of pH 7 to 7.8. Acidity can be lethal for plants and animals.

pH of Digestive System: The stomach secretes HCl to kill bacteria in the food. The inner lining of the stomach protects vital cells from this acidic pH.

pH and tooth decay: Lower pH because sour food and sweet food can cause tooth decay. The pH of the mouth should always be more than 5.5.

pH as a self-defence mechanism in plants & animals: Certain animals like bees and plants like nettle secrete highly acidic substances for self-defence.

❖ CHEMICAL PROPERTIES OF ACIDS:

- Acids react with active metals to give hydrogen gas. $Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$
- Acids react with **metal carbonate** and **hydrogen carbonate** to give carbon dioxide.

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

- Acids react with bases to give salt and water. This reaction is called a neutralization reaction.

$NaOH + HCl \rightarrow NaCl + H_2O$

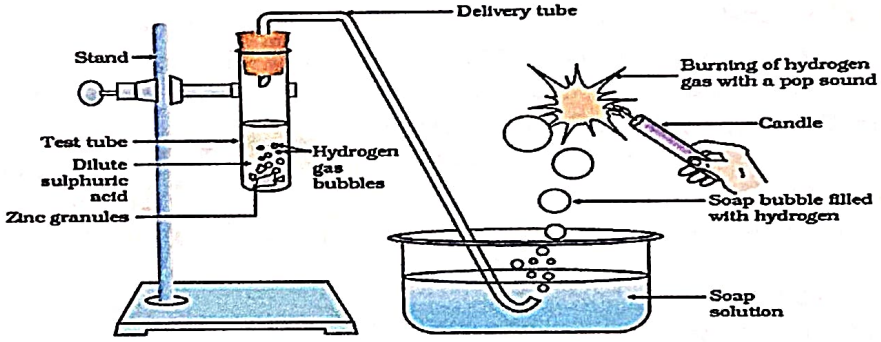
- Acids react with metal oxides to give salt and water. $CuO + H_2SO_4 \rightarrow CuSO_4 + H_2O$

❖ Addition of Acids or Bases to Water:

The process of dissolving an acid, especially nitric acid or Sulphuric acid or a base in water is a highly exothermic one.

Note: **Always add acid to water and never the other way!** The acid must be added slowly to water with constant stirring. If one mixes the other way by adding water to a concentrated acid, the heat generated causes the mixture to splash out and cause burns.

Reaction of Zinc Metal with Dilute Sulphuric Acid



CHEMICAL PROPERTIES OF BASES:

- **Reaction with Metals** - Certain reactive metals such as Zinc, Aluminium, and Tin react with alkali solutions on heating and hydrogen gas is evolved.

$2NaOH + Zn \rightarrow Na_2ZnO_2 + H_2$

- **Reaction with acids** -Bases react with acids to form salt and water. $KOH + HCl \rightarrow KCl + H_2O$
- **Reaction with Non-metallic oxides** – These oxides are generally acidic. They react with bases to form salt and water.

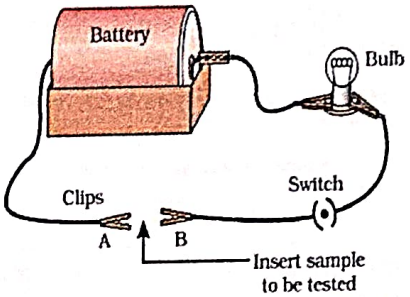
$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$

Metals and Non-metals

Properties	Metal	Non-Metal
Appearance	Shiny	Dull Except Iodine
State at room temperature	Solid (except mercury - liquid)	*About half are solids, about half are gases, and* one (bromine) is a liquid
Density	High (they feel heavy for their size)	Low (they feel light for their size)
Strength	Strong	Weak
Malleable or brittle	Malleable (they bend without breaking) Except Sodium, Potassium	Brittle (they break or shatter when hammered)
Conduction of heat	Good Except Lead	Poor (they are insulators)
Conduction of electricity	Good	Poor (EXCEPT **graphite**)
Magnetic material	Only iron, cobalt, and nickel	None
Sound when hit	They make a ringing sound (they are sonorous)	*They make a dull sound*
Melting and boiling points	Metals generally have high MP and BP except for **gallium and caesium.**	Non-metals have low MP and BP except **diamond and graphite.**
Type of oxide	Basic or alkaline	Acidic

❖ **Chemical properties of Metals and Non-metals: -**

METAL	NON-METAL
REACTION WITH OXYGEN	
Metals form **basic oxides**	Non-metals form **acidic oxides**
Metal + Oxygen → Metal Oxide	Non-metal+Oxygen →Non-metal oxide
$4Na_{(s)} + O_{2(g)} \rightarrow 2Na_2O_{(s)}$	$C + O_2 \rightarrow CO_2$
$4Al_{(s)} + 3O_{2(g)} \rightarrow 2Al_2O_{3(s)}$	$S + O_2 \rightarrow SO_2$
• Zn and Al form **amphoteric oxides** (they show the properties of both acidic and basic oxides)	• CO and H2O are neutral oxides (they are neither acidic nor basic in nature)
• Most of the metal oxides are insoluble in water.	• Non-metal oxides are soluble in water.
• Some of them dissolve to form **Alkali**	• They dissolve in water to form acids.
• $Na_2O_{(s)} + H_2O_{(l)} \rightarrow 2NaOH_{(aq)}$	• $SO_2 + H_2O \rightarrow H_2SO_3$
REACTION WITH WATER	
Metals react with water to form metal oxides or metal hydroxide and H_2 gas is released. $2Na_{(s)}+2H_2O_{(l)} \rightarrow 2NaOH_{(s)}+H_{2(g)}+Heat$	Non-metals do not react with water, steam to evolve hydrogen gas.

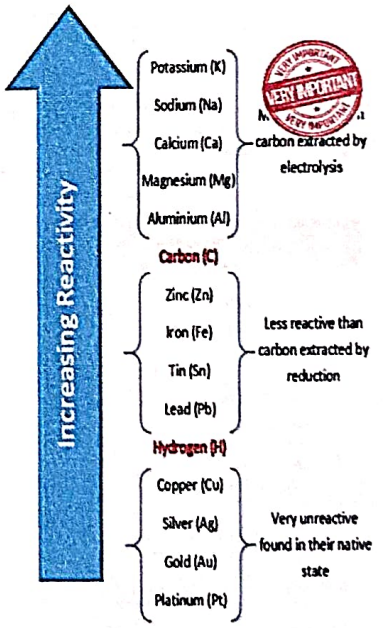


THERMITE REACTION

$Fe_2O_3(s) + 2Al(s) \xrightarrow{\Delta} 2Fe(l) + Al_2O_3(s)$

Iron (III) oxide · Aluminium · Molten iron · Aluminium oxide

REACTION WITH DILUTE ACIDS	
Metal + Acid → Metal salt + Hydrogen • With HCl $Mg(s)+2HCl(aq) \rightarrow MgCl_2(aq)+H_2(g)$ • With H_2SO_4 $2Na(s)+H_2SO_4 \rightarrow Na_2SO_4(aq)+H_2(g)$ • With HNO_3 Metal + HNO_3 → H_2 gas is not evolved. **Reason-** HNO_3 is strong oxidizing agent.	Non-metals do not react with acids to release H_2 gas
REACTION WITH SALT SOLUTIONS	
Metals react with salt solution and more reactive metal will displace a less reactive metal from its salt solution – **Single displacement reaction.** $CuSO_{4(aq)} + Zn_{(s)} \rightarrow ZnSO_{4(aq)} + Cu_{(s)}$	When non-metals react with salt solution, more reactive non-metal will displace a less reactive non-metal from its salt solution. $2NaBr_{(aq)}+Cl_{2(g)} \rightarrow 2NaCl_{(aq)}+Br_{2(aq)}$



IONIC COMPOUNDS:

1. Metals tend to lose electrons to form cations (+).
2. Non-metals gain electrons to form anions (-).
3. Ionic compounds are formed through the transfer of electrons from metals to non-metals (e.g., NaCl)

Properties of ionic Compounds:

1. **Physical nature**: solid and hard due to the strong force of attraction. (generally brittle)
2. **Melting point and boiling point**: have high M.P and B.P, as a large amount of heat energy is required to break strong ionic attraction.
3. **Solubility**: soluble in water and insoluble in kerosene and petrol.
4. Conduction of electricity: ionic compounds in a solid state do not conduct electricity. (Reason—**Ions cannot move due to rigid solid structure.**)

Note: Ionic compounds conduct electricity in a molten state. (Reason-- Ions can move freely since the electrostatic forces of attraction between the oppositely charged ions are overcome due to heat.)

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

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

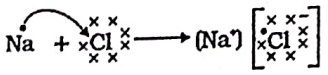


Figure 3.5 Formation of sodium chloride

$Mg \longrightarrow Mg^{2+} + 2e^-$
2,8,2 2,8
(Magnesium cation)

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

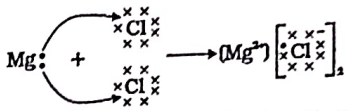


Figure 3.6 Formation of magnesium chloride

EXTRACTION OF METALS

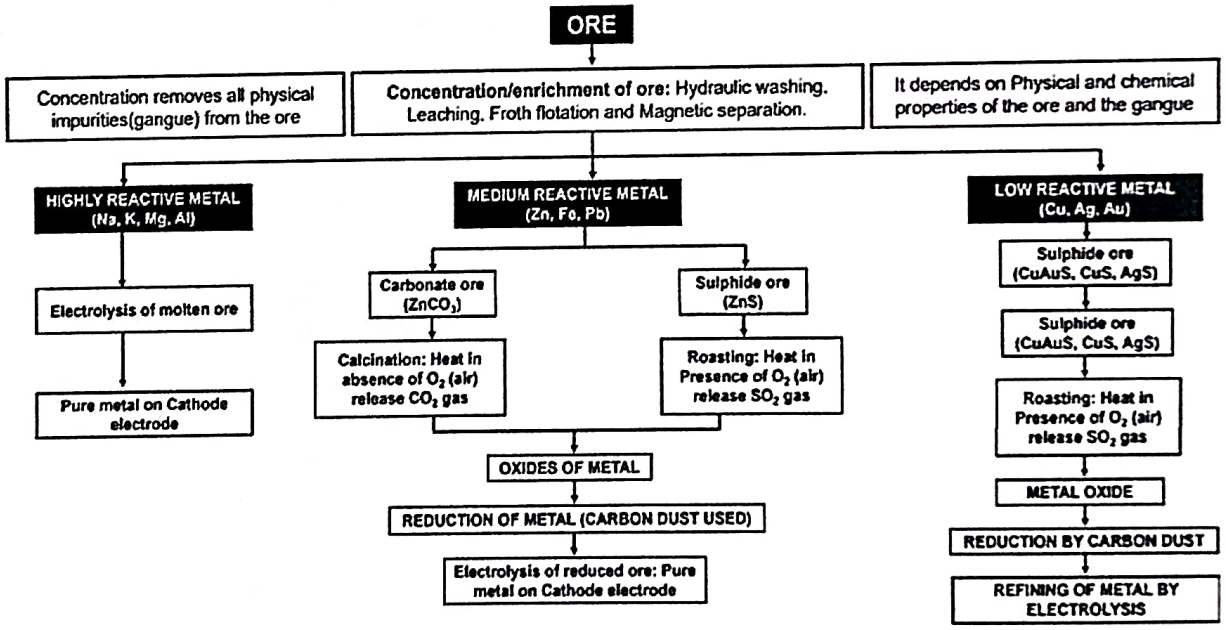
Ores: Minerals that contain a very high percentage of a particular metal and these metals can be extracted economically on a large scale.

Example:

- **Bauxite ore → Aluminium**
- **Hematite ore → Iron**
- **Magnetite ore → Iron**
- **Limestone → Calcium**
- **Gypsum → Calcium**
- **Bauxite → Aluminium**
- **Calamine → Zinc**

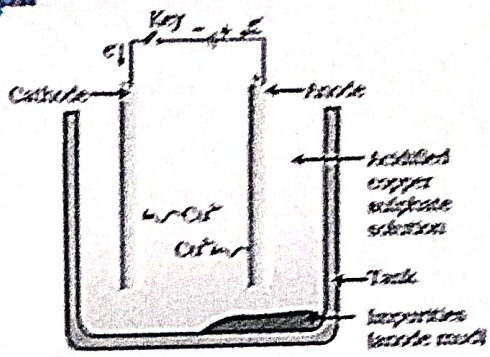
Reactivity	Metal	Method of Extraction
Most reactive	Potassium	Extracted by electrolysis of molten compounds
	Sodium	
	Lithium	
	Calcium	
	Magnesium	
	Aluminium	
	Carbon	
	Zinc	Extracted by reduction, by heating with carbon
	Iron	
	Copper	
	Silver	Found as pure elements in nature
Least reactive	Gold	

Calcination	Roasting
Calcination is carried out in absence of oxygen.	Roasting is carried out in presence of excess of oxygen.
As a result of calcination, carbonate ore is converted to the oxide. $ZnCO_3 \xrightarrow{heat} ZnO + CO_2$	As a result of roasting the sulphide ore is converted to the oxide. $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$



Electrolysis: (ELECTROLYTIC REFINING OF COPPER) [5 MARKS]

1. This is the final process to find the purest form of metal.
2. In a jar/container electrolysis is performed here impure metal(anode) and a strip of pure metal (cathode) are used as electrodes.
3. They are dipped in an electrolytic bath which contains the soluble salt of the same metal.
4. **As electricity is passed through the solution, the less basic metal moves towards the anode** mud leaving the more basic metal in the solution.
5. For example, copper is purified using this method.



Corrosion: Corrosion is the oxidation of metals.

Examples of corrosion are as follows.

- **Blacking of silver** (Silver sulphide) $4Ag + 2H2S + O2 \rightarrow 2Ag2S + 2H2O$
- **Green layer on copper** (Basic Copper carbonate) $2Cu+O_2+CO_2+H_2O \rightarrow CuCO_2Cu(OH)_2$
- **The green layer is removed using acidic solutions (Tamarind/vinegar/lemon juice)**
- **brown flaky substance on iron** $4Fe + 3O_2 + 6H_2O \rightarrow 4Fe(OH)_3\ 2Fe(OH)_2 \rightarrow Fe_2O_3.3H_2O$

Note: Corrosion of iron also known as Rusting.

PREVENTION METHODS:

✓ **Galvanization, Oiling/ greasing, Painting, Electroplating, Tinning, using alloys** (Metals are combined to form alloys to enhance properties) (e.g., brass is an alloy of copper and zinc).

Experiment to show that rusting of iron requires both air and water: [3/5 MARKS]

i) In the test tube iron nail, with un-boiled water in which about two-thirds of the nail is immersed in water and the rest is above the water, exposed to damp air.

ii) In test tube B containing iron nails, we put boiled distilled water. Boiled distilled water does not contain any dissolved air or oxygen in it.

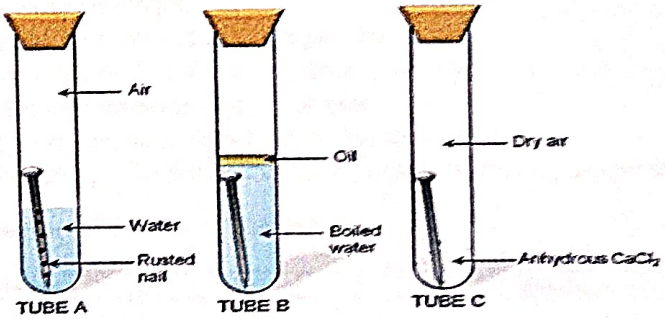
iii) A layer of oil is put over boiled water in the test tube to prevent the outside air from mixing with boiled water.

iv) In test tube C we took an iron nail, put some anhydrous calcium chloride, and closed its mouth with a tight cork.

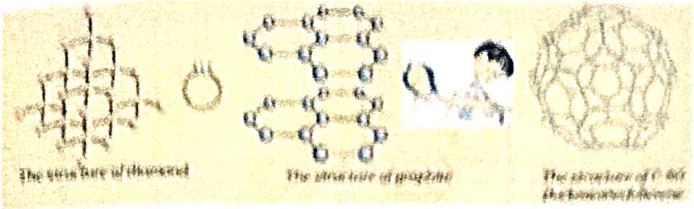
v) The anhydrous calcium chloride is added to absorb water or moisture from the damp air present in the test tube and make it dry.

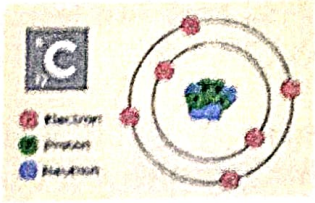
vi) The mouth of this test tube is closed with a cork and it is kept aside for about a week.

vii) This shows that rusting of iron takes place in the presence of air and water.



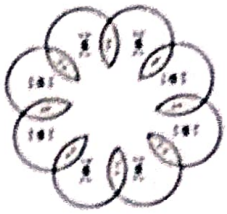
CH.4. CARBON AND ITS COMPOUNDS





4.1 BONDING IN CARBON – THE COVALENT BOND

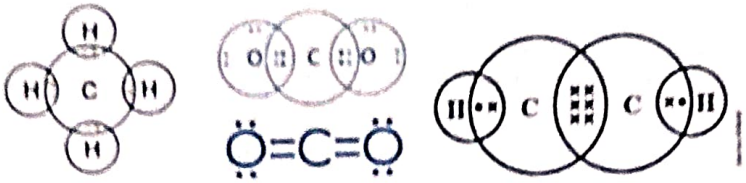
The reactivity of elements is explained as their tendency to attain a **filled outer shell**, that is, attain noble gas configuration. In elements forming **ionic compounds Stability achieved this by either gaining or losing electrons** from the outermost shell. If carbon follows this:



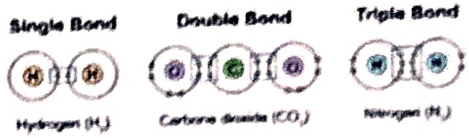
(i) To gain four electrons forming C^{4-} anion. (difficult for the nucleus with six protons to hold on to ten electrons)

(ii) To lose four electrons forming C4+ cation. (Require a large amount of energy to remove four electrons leaving behind a carbon cation with six protons in its nucleus holding on to just two electrons.)

Carbon solves the problem by SHARING ELECTRON or COVALENCY.



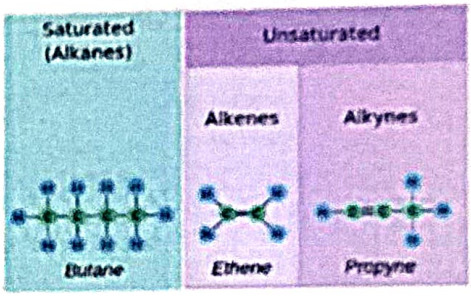
Covalent Bond Types



Properties of Covalently bonded Molecules :

a. Strong intramolecular bonding but weak intermolecular bonding. So Low Melting and Boiling point.
b. Poor conductor of electricity as electrons are shared between atoms and no charged particles are formed

4.2 VERSATILE NATURE OF CARBON



1. **Catenation**: Carbon has the unique ability to form bonds with other atoms of carbon, giving rise to large molecules. This property is called catenation.
2. **Tetravalency**: carbon has a valency of four, it is capable of bonding with four other atoms of carbon or atoms of some other mono-valent element.
3. Compounds of carbon are formed with oxygen, hydrogen, nitrogen, Sulphur, chlorine, and many other elements giving rise to compounds with specific properties
4. **Small Size**: enables the nucleus to hold on to the shared pairs of electrons strongly. The bonds formed by elements having bigger atoms are much weaker.

4.2.1 Saturated and Unsaturated Carbon Compounds

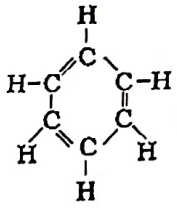
Alkane		Alkene		Alkyne	
C_nH_{2n+2}		C_nH_{2n}		C_nH_{2n-2}	
Homologous series		Homologous series		Homologous series	
Name	Formula	Name	Formula	Name	Formula
Methane	CH_4	-	-	-	-
Ethane	C_2H_6	Ethene	C_2H_4	Ethyne	C_2H_2
Propane	C_3H_8	Propene	C_3H_6	Propyne	C_3H_4
Butane	C_4H_{10}	Butene	C_4H_8	Butyne	C_4H_6
Pentane	C_5H_{12}	Pentene	C_5H_{10}	Pentyne	C_5H_8
Hexane	C_6H_{14}	Hexene	C_6H_{12}	Hexyne	C_6H_{10}

	Saturated Hydrocarbon	Unsaturated Hydrocarbon
1.	In these compounds, there is a single bond between carbon atoms.	In these compounds, there is a double or triple bond between carbon atoms.
2.	They give a clean flame on heating.	They give yellow flame with a lot of black smoke on burning.
3.	On burning, saturated hydrocarbons give a clean flame.	On burning, unsaturated hydrocarbons give yellow flame with lots of black smoke.

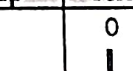
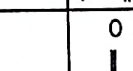
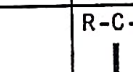
HOMOLOGOUS SERIES

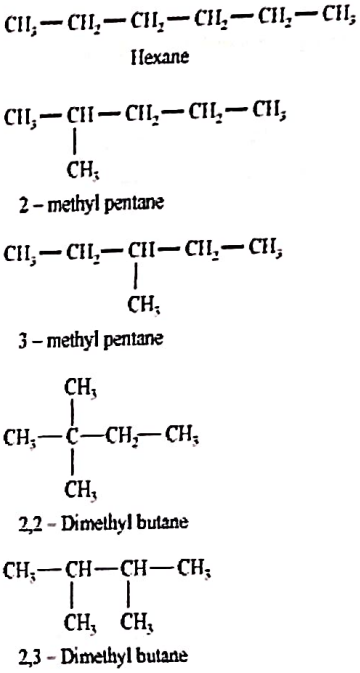
Number of Carbons	Prefix	Suffix	Structural Formula	Molecular Formula
1	Meth-	ane		CH_4
2	Eth -	ane		C_2H_6
3	Prop -	ane		C_3H_8
4	But -	ane		C_4H_{10}
5	Pent -	ane		C_5H_{12}
6	Hex -	ane		C_6H_{14}
7	Hept -	ane		C_7H_{16}
8	Oct -	ane		C_8H_{18}

1. A homologous series is a group of organic compounds that have similar structural features and chemical properties.
2. These compounds share the **same functional group** and **differ in -CH_2-**



Benzene — C_6H_6

Class	Functional Group	General Formular	Prefix	Suffix	IUPAC Name
Carboxylic acid			Carboxy	- oic acid	Alkanoic acid
Ester			Carbalkoxy	Alkyl (r,) – oate	Alkyl alkanoate
Aldehyde	- CHO	R - CHO	Formyl or oxo	- al	Alkanal
Ketone			oxo	- one	Alkanal
Alcohol	-OH	R – OH	Hydroxy	- ol	Alkanol
Alkenes	C=C	C_nH_{2n}	-	- ene	Alkene
Alkynes	C≡C	C_nH_{2n-2}	-	- yne	Alkene
Halides	-X (X = F, Cl, Br, I)	R – X	Halo	-	Haloalkane



Nomenclature of Carbon Compounds

1. Identify the Parent chain
2. Low Count to carbon-containing Functional Group.
3. Give appropriate Prefixes and Suffixes.

4.3 CHEMICAL PROPERTIES OF CARBON COMPOUNDS

COMBUSTION

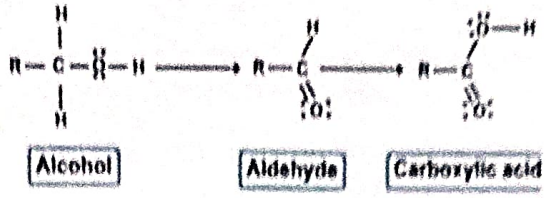
Carbon compounds can burn in the presence of oxygen to produce carbon dioxide (CO_2) and water vapour (H_2O), along with the release of energy in the form of heat and sometimes light.

(i) $C + O_2 \rightarrow CO_2$ + heat and light
(ii) $CH_4 + O_2 \rightarrow CO_2 + H_2O$ + heat and light
(iii) $CH_3CH_2OH + O_2 \rightarrow CO_2 + H_2O$ + heat and light

We see that some substances can add oxygen to others. These substances are known as oxidizing agents.

Alkaline potassium permanganate or **acidified potassium dichromate** oxidizes alcohols to acids, that is, adding oxygen to the starting material. Hence, they are known as oxidizing agents.

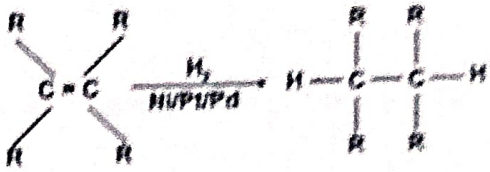
OXIDATION :



$$CH_3 - CH_2OH \xrightarrow[\text{Or acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3COOH$$

ADDITION REACTIONS

1. Unsaturated carbon compounds, such as alkenes and alkynes, can participate in addition reactions.
2. These reactions involve the addition of atoms or groups of atoms to the carbon-carbon double or triple bonds.



SUBSTITUTION REACTIONS

1. In substitution reactions, one or more hydrogen atoms in a molecule are replaced by different atoms or groups of atoms.
2. **Saturated hydrocarbons (alkanes)** are known for their **substitution reactions**. For instance, when **methane (CH_4) reacts with chlorine (Cl_2)** in the presence of sunlight, it undergoes a substitution reaction to form chloromethane (CH_3Cl) and hydrogen chloride (HCl).

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

SOME IMPORTANT COMPOUNDS

Ethanol	Ethanoic acid
(Physical properties)	**(Physical properties)**
(i) It has very low melting point (156 K) and low boiling point (351 K).	(i) It has moderate melting point (290 K) and boiling point (391 K).
(ii) It has a burning taste.	(ii) It has a sour taste.
(iii) It has a distinct smell.	(iii) It has a pungent smell.
Chemical properties	**Chemical properties**
(i) It is neutral in nature and thus, it does not turn blue litmus to red or vice-versa.	(i) It is acidic in nature and turns blue litmus to red.
(ii) Ethanol does not react with Na_2CO_3 or $NaHCO_3$. $C_2H_5OH + Na_2CO_3 \rightarrow$ No reaction	(ii) Ethanoic acid reacts with Na_2CO_3 or $NaHCO_3$ to give brisk effervescence of CO_2 gas. $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + CO_2\uparrow + H_2O$

ETHANOL :Physical State: Ethanol is a clear, colourless, and volatile liquid at room temperature, relatively low melting point and boiling point, which allows it to exist as a liquid under normal conditions.

1. **Solubility:** Ethanol is highly soluble in water, and it can mix with water in all proportions.
2. **Medical Uses:** Ethanol is used in medicines such as tincture iodine, cough syrups, and tonics.
3. **REACTIONS :**

- The evolution of hydrogen gas is a characteristic test for the presence of ethanol. $2Na + 2CH_3CH_2OH \rightarrow 2CH_3CH_2ONa + H_2$
- **Dehydration Reaction:** Heating ethanol at **around 443 K with excess concentrated sulfuric acid** (H_2SO_4) leads to the dehydration of ethanol, producing ethene ($CH_2=CH_2$) and water (H_2O). Concentrated sulfuric acid serves as a dehydrating agent, removing water from ethanol in this reaction.

$$CH_3 - CH_2OH \xrightarrow[H_2SO_4]{\text{Hot Conc.}} CH_2 = CH_2 + H_2O$$

Ethanoic Acid (Acetic Acid): Physical State: Physical State: Ethanoic acid is a colourless liquid with a strong, pungent smell and a sour taste.

Solubility: soluble in water, and it can mix with water in all proportions. Vinegar-5-7% Solution of Ethanoic acid in water.

- **Pure ethanoic acid has a freezing point of 290 K, which can lead to it freezing during cold winters, giving rise to the name "glacial acetic acid."**
- **CHEMICAL REACTIONS :**
  1. **Esterification Reaction**: Ethanoic acid can undergo esterification reactions, where it reacts with an alcohol, such as absolute ethanol, in the presence of an acid catalyst to form an ester.
  2. Esters are often sweet-smelling substances and find use in perfumes and flavouring agents.

$$CH_3COOH + CH_3CH_2OH \xrightarrow{Acid} CH_3CO\,CH_2CH_3$$

Ethanoic acid) (Ethanol) — Ester

$$CH_3CO\,CH_2CH_3 + NaOH \rightarrow CH_3COONa + CH_3CH_2OH$$

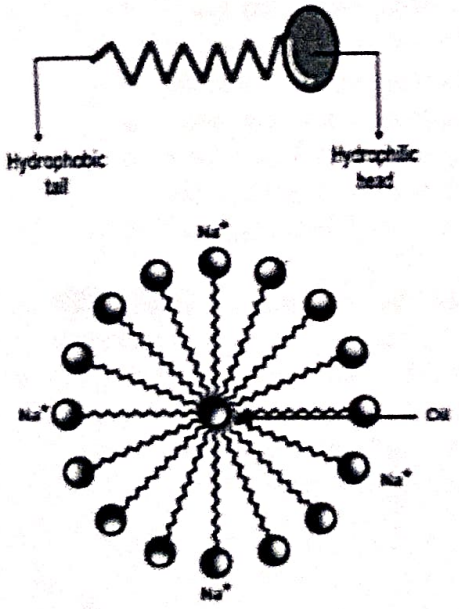
3. **SAPONIFICATION:** When treated with sodium hydroxide (NaOH), an alkali, esters can be converted back to alcohol and the sodium salt of the carboxylic acid.

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

- **For sodium carbonate:**
  $2CH_3COOH + Na_2CO_3 \rightarrow 2CH_3COONa + H_2O + CO_2$
- **For sodium hydrogen carbonate:**
  $CH_3COOH + NaHCO_3 \rightarrow CH_3COONa + H_2O + CO_2$

a. Soaps & Detergents

S. No.	Soaps	Detergents
1	These are bio-degradable	They are mostly non-bio-degradable
2	These do not work in hard water	They can be used even in hard water
3	The cleansing action of soaps is weak	The cleansing action of detergents isstrong
4	These are Na or K salts of long chain fatty acids	They are Na salts of long-chain benzene sulphonic acid



Cleansing action of SOAP

a. Soaps work by forming structures called **micelles** in water.

b. **Micelles are spherical aggregates of soap molecules** in which the hydrocarbon tails are directed inward and the ionic heads are directed outward, surrounded by water molecules.

c. When you wash something with soap, the **hydrophobic tails of soap molecules attach to oil and grease (dirt) on the surface**, while the hydrophilic heads remain in contact with water.

d. This allows the dirt to be lifted off the surface and rinsed away with water.

Differentiate between

b. Addition & Substitution Reaction

S. No.	Addition Reaction	Substitution Reaction
1	Reactions in which an unsaturated compound combines with some other substance to give a single product	Reactions in which one or more hydrogen atoms of a hydrocarbon are replaced with some other atom or group to give a single product
2	It is the property of unsaturated hydrocarbons	It is the property of saturated hydrocarbons
3	Example – Ethene on the addition of hydrogen forms Ethane	Example – Ethane on chlorination forms Chloro-ethane

c. Saturated & Unsaturated Hydrocarbons

S. No.	Saturated Hydrocarbons	Unsaturated Hydrocarbons
1	Hydrocarbons in which all the carbon atoms are linked by a single bonds only	Hydrocarbons in which all the carbon atoms are linked by double or triple bonds
2	These include alkanes	These include alkenes & alkynes
3	Example – Methane, Ethane, Propane etc.	Example – Ethene, Propene, Ethyne, Propyne etc.

Properties of covalent compounds:

1. They exist in solids, liquids, and gaseous states
2. Low melting and boiling points
3. Do not conduct electricity due to the absence of free electrons
4. Soluble in non-polar solvents

- Important **characteristics of Homologous series** are:

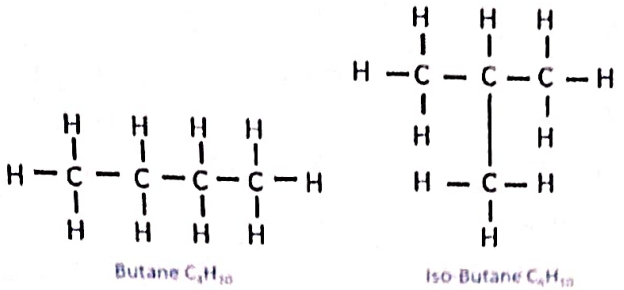
1. Have the same **general formula.**
2. Belong to the same **functional group.**
3. Have similar **general methods of separation.**
4. Have **similar chemical properties.**
5. Show similar **gradation of physical properties.** e.g. boiling pointsof alcohol increase with the increase in their molecular weights.
6. Similarly, solubility decreases with increase in molecularweights.

- **ISOMERS:** Compounds with identical molecular formulas but different structures are called structural isomers.
- With the increase in the number of carbon atoms in a molecular formula leads to an increase in the number of isomers

  n Butane, Iso Butane are Isomers of Butane

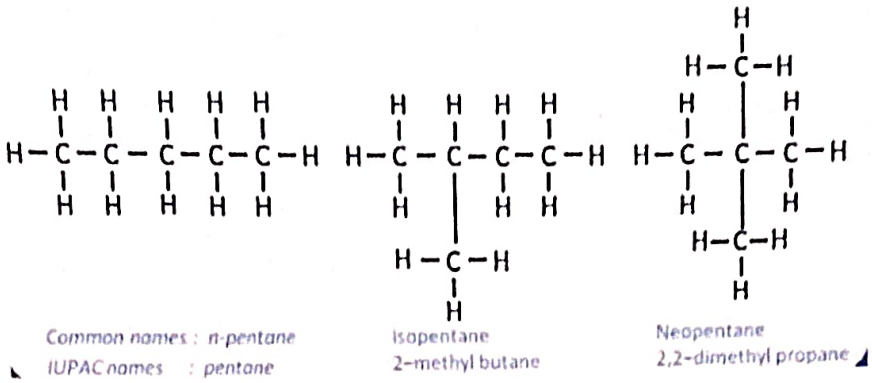
  n Pentane, Iso Pentane and neo-Pentane are Isomers of Pentane

Structural isomers of Butane (C_4H_{10})



Butane C_4H_{10} | Iso Butane C_4H_{10}

STRUCTURES OF ALL ISOMERS OF PENTANE



Common names : n-pentane
IUPAC names : pentane

Isopentane
2-methyl butane

Neopentane
2,2-dimethyl propane

Glossary:

Term	Explanation
Catenation	The ability of an atom to form bonds with itself
Isomerism	Phenomenon in which compounds have the same molecularformula but different structural formula
Homologous Series	Group of organic compounds having same functional groupand they differ by $-CH_2$ group.
Hydrogenation	Addition of Hydrogen to an unsaturated hydrocarbon to get a saturated hydrocarbon
Oxidizing Agent	The substance which gives Oxygen for oxidation
Hydrocarbon	Compounds of Carbon and Hydrogen
Functional Group	An atom or a group of atoms joined together for the characteristic chemical properties of the organic compound.
Saturated Hydrocarbon	Hydrocarbon has a single covalent bond. Example – Alkanes.
Unsaturated Hydrocarbon	Hydrocarbons have double or triple covalent bonds. Example – Alkenes, Alkynes.
Micelles	A cluster of soap molecules with a tiny droplet of oil/ fat