CHAPTER 1 : Chemical Reactions and Equations

Key Points and Concepts

- A complete chemical equation represents the reactants, products, conditions of reaction and their physical states symbolically.
- **Oxidation :** loss of electrons.
- **Reduction :** gain of electrons.
- **Rust** is mainly hydrated iron (III) oxide, $Fe_2O_3.xH_2O$.

Important Equations

- **Types of Reactions :**

S. No.	Name and Definition	Example
1.	In a **combination reaction**, two or more reactants combine to give a single product.	$\underset{\text{(Quick lime)}}{CaO(s)} + H_2O(l) \longrightarrow \underset{\text{(Slaked lime)}}{Ca(OH)_2(aq)}$
2.	In a **decomposition reaction**, a single reactant breaks down into two or more simpler products.	$\underset{\text{(Lead nitrate)}}{2Pb(NO_3)_2} \xrightarrow{\text{Heat}} \underset{\text{(Lead oxide)}}{2PbO(s)} + \underset{\text{(Nitrogen dioxide)}}{4NO_2(g)} + \underset{\text{(Oxygen)}}{O_2(g)}$
3.	When decomposition reaction is carried out by heating, it is called **thermal decomposition reaction.**	$\underset{\text{(Calcium carbonate)}}{CaCO_3(s)} \xrightarrow{\text{Heat}} \underset{\text{(Quicklime)}}{CaO(s)} + CO_2(g)$
4.	When decomposition reaction is carried out in the presence of sunlight, the process is called **photochemical decomposition.**	$\underset{\text{(Silver bromide)}}{2AgBr(s)} \xrightarrow{\text{Sunlight}} \underset{\text{(Silver)}}{2Ag(s)} + \underset{\text{(Bromine)}}{Br_2(g)}$
5.	**Electrolysis :** When decomposition reaction is carried out with the help of electric current, the process is called electrolysis.	$\underset{\text{(Water)}}{2H_2O(l)} \xrightarrow{\text{Electric current}} \underset{\text{(Hydrogen gas)}}{2H_2(g)} + \underset{\text{(Oxygen gas)}}{O_2(g)}$
6.	In a **displacement reaction**, a more reactive element displaces a less reactive element from a compound.	$\underset{\text{(Iron)}}{Fe(s)} + \underset{\text{(Copper sulphate)}}{CuSO_4(aq)} \longrightarrow \underset{\text{(Iron sulphate)}}{FeSO_4(aq)} + \underset{\text{(Copper)}}{Cu(s)}$
7.	The reactions in which two different atoms or groups of atoms are displaced by other atoms or groups of atom, *i.e.*, two compounds exchange their ions and one of the products formed is insoluble, are said to be **double displacement reactions**.	$\underset{\text{(Sodium sulphate)}}{Na_2SO_4(aq)} + \underset{\text{(Barium chloride)}}{BaCl_2(aq)} \longrightarrow \underset{\text{(Barium sulphate)}}{BaSO_4(s)} + \underset{\text{(Sodium) chloride)}}{2NaCl(aq)}$
8.	The reactions in which acid or acidic oxide reacts with the base or basic oxides to form salt and water are called **neutralization reactions**.	$\underset{\text{(Sodium hydroxide)}}{2NaOH} + \underset{\text{(Sulphuric acid)}}{H_2SO_4} \longrightarrow \underset{\text{(Sodium sulphate)}}{Na_2SO_4} + \underset{\text{(Water)}}{2H_2O}$

➢ **Some usually asked equations in exams for balancing :**

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

➢ **Redox (Oxidation and Reduction) Reaction :**

Oxidation (HCl is oxidized)

$MnO_2(s) + 4HCl\ (conc.) \longrightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O$

Reduction (MnO_2 is reduced)

●●

CHAPTER 2 : Acids, Bases and Salts

Key Points and Concepts

- Those substances which turn blue litmus solution red are called acids. Acids are sour in taste. They give H^+ ions in aqueous solution. *e.g.* :

  HCl, H_2SO_4, HNO_3, CH_3COOH

- Those acids which dissociates into ions completely are called strong acids, *e.g.* H_2SO_4, HCl.
- Those acids which do not dissociates into ions completely are called weak acids, *e.g.* citric acid, acetic acid.
- **Chemical properties of acids :**

  (a) Reaction with metal :

  $$\text{Acid} + \text{Metal} \longrightarrow \text{Salt} + \text{Hydrogen gas}$$

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

  (b) Reaction with metal carbonate and metal hydrogen carbonates :

  Metal carbonate/metal hydrogen carbonate + Acid → Salt + CO_2 + H_2O

  $$Na_2CO_3(s) + 2HCl(aq) \longrightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$$

  $$NaHCO_3(s) + HCl(aq) \longrightarrow NaCl(aq) + CO_2(g) + H_2O(l)$$

  Test for carbon dioxide (Lime water test): When carbon dioxide gas is passed through calcium hydroxide (lime water), it turns milky due to the formation of calcium carbonate.

  $$Ca(OH)_2(aq) + CO_2(g) \longrightarrow \underset{\text{(White ppt.)}}{CaCO_3(s)} + H_2O(l)$$

  $$CaCO_3(s) + H_2O(l) + CO_2(g) \longrightarrow Ca(HCO_3)_2(aq)$$

  When excess of carbon dioxide is passed through lime water, milkiness disappear due to the formation of calcium hydrogen carbonate.

  (c) Neutralization reaction : It is a reaction in which an acid react with base to give salt and water as product.

  $$\text{Acid} + \text{Base} \longrightarrow \text{Salt} + \text{Water}$$

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

  (d) Reaction with metal oxide :

  $$\text{Metal oxide} + \text{Acid} \longrightarrow \text{Salt} + \text{Water}$$

  $$CuO(s) + 2HCl(aq) \longrightarrow CuCl_2(aq) + H_2O(l)$$

  (e) Reaction with water : Acid reacts with water and produces hydrogen ions in solution.

  $$HCl(g) \xrightarrow{H_2O} H^+(g) + Cl^-(aq)$$

- **Chemical properties of base :**

  (a) Reaction with metal :

  $$\text{Base} + \text{Metal} \longrightarrow \text{Salt} + \text{Hydrogen}$$

  $$2NaOH(aq) + Zn(s) \longrightarrow Na_2ZnO_2(s) + H_2(g)$$

  (b) Reaction with non - metallic oxide :

  $$\text{Non - metallic oxide} + \text{Base} \longrightarrow \text{Salt} + \text{Water}$$

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

  (c) Reaction with water : Bases give OH^- ions in presence of water.

  $$NaOH \xrightarrow{H_2O} Na^+ + OH^-$$

- **Amphoteric oxides :** Some metallic oxides that react with both acids and bases are called amphoteric oxides.
- **Alkalies :** An alkali is a base that dissolves in water. *e.g.* NaOH, KOH, $Ca(OH)_2$, NH_4OH.
- All alkalies are bases but all bases are not alkalies.
- Strength of an acid and base can be determined with the help of universal indicator and pH scale.
- pH scale gives the measure of hydrogen ion concentration in a solution. It measures from 0 (very acidic) to 14 (very alkaline). 7 indicates neutral pH.

➢ **Examples of pH in our daily life :**

- Stomach produces HCl, which help in digestion of food.
- pH change in the mouth is the cause of tooth decay.
- Bee sting leaves an acid which causes pain and irritation.
- Plants require a specific pH range for healthy growth.
- Change in pH (less than 5.6) of rain may cause acid rain, which has a deleterious effects on aquatic life.

➢ **Hydrated salts which are white in colour :**

- **Washing soda :** $Na_2CO_3.10H_2O$
- **Gypsum :** $CaSO_4.2H_2O$
- **Plaster of Paris :** $CaSO_4.\frac{1}{2}H_2O$

➢ **Reaction of different solutions with different indicators :**

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

➢ **Important Compounds :**

- **Baking Soda :**

  The chemical formula of baking soda is $NaHCO_3$ (sodium hydrogen carbonate).
  It is prepared by using sodium chloride.

$$NaCl + H_2O + CO_2 + NH_3 \longrightarrow NH_4Cl + NaHCO_3$$

  On heating :

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

- **Green Vitriol :**

  The chemical formula of Green Vitriol is $FeSO_4.7H_2O$.
  $FeSO_4.7H_2O$ is green in colour and loses water of crystallisation when it is heated.
  It is then decomposed to Fe_2O_3 (brown coloured), SO_2 and SO_3.

- **Plaster of Paris :**

  The chemical formula of Plaster of Paris is $CaSO_4.\frac{1}{2}H_2O$ (Calcium sulphate hemihydrate)

  When Plaster of Paris reacts with water, it forms gypsum.

$$\underset{\text{(Plaster of Paris)}}{CaSO_4.\frac{1}{2}H_2O} + 1\frac{1}{2}.H_2O \longrightarrow \underset{\text{(Gypsum)}}{CaSO_4.2H_2O}$$

- **Washing Soda and its Properties :**

  The chemical formula of washing soda is $Na_2CO_3.10H_2O$ and its chemical name is sodium carbonate.

$$NaCl + H_2O + CO_2 + NH_3 \longrightarrow NH_4Cl + NaHCO_3$$

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

$$Na_2CO_3 + 10H_2O \xrightarrow[32°C]{\text{lower than}} Na_2CO_3.10H_2O$$

  It is a basic salt because when dissolved in water it gives a strong base NaOH.
  It is used as a cleansing agent for domestic purposes and also used in paper and glass industry. It is also used for manufacture of Borax.

- **Bleaching Powder and its uses :**

  The chemical formula of bleaching powder is $CaOCl_2$.

  By passing chlorine into dry slaked lime $Ca(OH)_2$, bleaching powder is obtained.

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

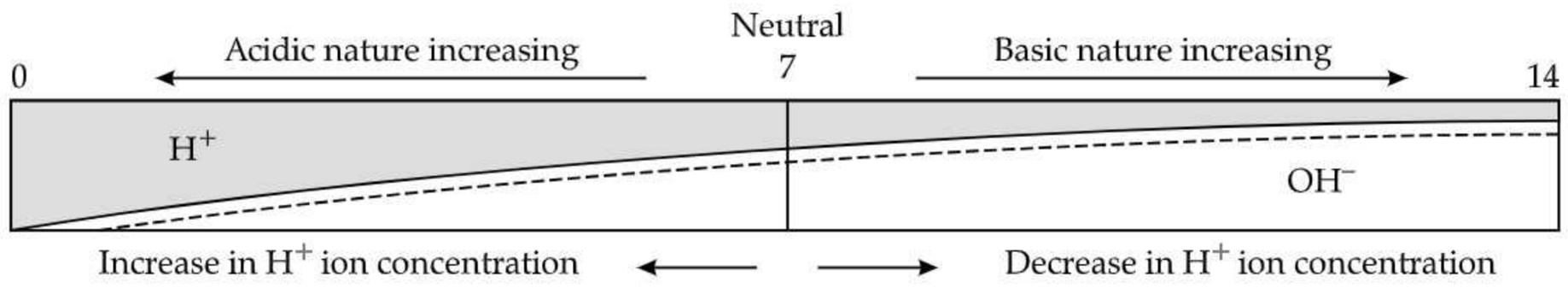
  Two uses :

  (i) Used for bleaching cotton and linen in the textile industry and wood pulp, paper industry etc.

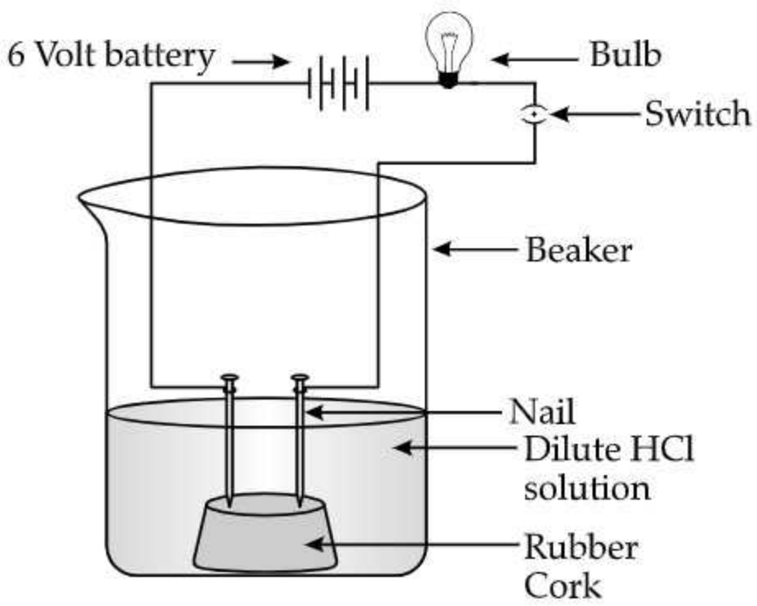
  (ii) It is used for disinfecting drinking water.

➢ **Important Diagrams :**

- **pH Indicator**



- **Setup which shows acid solution in water conducts electricity**



CHAPTER 3 : Metals and Non-Metals

Key Points and Concepts

- Elements can be classified as metals and non-metals.
- **Electronic configuration of some metals and non-metals :**

Type of element	Element	Atomic number	Number of electrons in shells			
			K	L	M	N
Noble gases	Helium (He)	2	2			
	Neon (Ne)	10	2	8		
	Argon (Ar)	18	2	8	8	
Metals	Sodium (Na)	11	2	8	1	
	Magnesium (Mg)	12	2	8	2	
	Aluminium (Al)	13	2	8	3	
	Potassium (K)	19	2	8	8	1
	Calcium (Ca)	20	2	8	8	2
Non-metals	Nitrogen (N)	7	2	5		
	Oxygen (O)	8	2	6		
	Fluorine (F)	9	2	7		
	Phosphorus (P)	15	2	8	5	
	Sulphur (S)	16	2	8	6	
	Chlorine (Cl)	17	2	8	7	

- **Properties of Ionic Compounds :**
  - Ionic compounds are solids and are somewhat hard because of the strong force of attraction between the positive and negative ions. These compounds are generally brittle and break into pieces when pressure is applied.
  - Ionic compounds have high melting and boiling points.
  - Electrovalent compounds are generally soluble in water and insoluble in organic solvents such as kerosene, petrol, etc.
  - Ionic compounds conduct electricity in the molten state.
- **Activity Series :**

K	Potassium	↓	Most reactive
Na	Sodium		
Ca	Calcium		
Mg	Magnesium		
Al	Aluminium		
Zn	Zinc		Reactivity decreases
Fe	Iron		
Pb	Lead		
[H]	Hydrogen		
Cu	Copper		
Hg	Mercury		
Ag	Silver		
Au	Gold		Least reactive

➢ **Chemical Properties of Metals :**

Condition	Chemical Equation
Metals are burnt in air	Metal + Oxygen $\longrightarrow$ Metal oxide **Example 1 :** $2Cu + O_2 \longrightarrow 2CuO$ (Copper) [Copper(II) oxide] **Example 2 :** $4Al + 3O_2 \longrightarrow 2Al_2O_3$ (Aluminium) (Aluminium oxide)
Metals react with water	Metal + Water $\longrightarrow$ Metal oxide + Hydrogen Metal oxide + Water $\longrightarrow$ Metal hydroxide **Example 1 :** $2K(s) + 2H_2O(l) \longrightarrow 2KOH(aq) + H_2(g)$ + heat energy **Example 2 :** $2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$ + heat energy **Example 3 :** $Ca(s) + 2H_2O(l) \longrightarrow Ca(OH)_2(aq) + H_2(g)$ **Example 4 :** $2Al(s) + 3H_2O(g) \longrightarrow Al_2O_3(s) + 3H_2(g)$ $3Fe(s) + 4H_2O(g) \longrightarrow Fe_3O_4(s) + 4H_2(g)$ **Example 5 :** $K_2O + H_2O \longrightarrow 2KOH$
Metals react with acids	Metal + Dilute acid $\longrightarrow$ Salt + Hydrogen $Cu(s) + 2HCl(aq) \longrightarrow CuCl_2(aq) + H_2(g)$
Metals react with solutions of other metal salts	Metal A + Salt solution of B $\longrightarrow$ Salt solution of A + Metal B $Fe(s) + CuSO_4(aq) \longrightarrow FeSO_4(aq) + Cu(s)$

➢ **Chemical Properties of Non-metals:**

(a) **Reaction with oxygen:** Non-metals form acidic oxides.
e.g. $C(s) + O_2(g) \longrightarrow CO_2(g)$

(b) **Reaction with water :** Non-metals do not react with water, because they do not release any electrons.

(c) **Reaction with dilute acids :** No reaction

(d) **Reaction with salt solutions :** A more reactive non-metal will displace less reactive non-metal from its salt solution.

(e) **Reaction with chlorine :** Non-metals react with chlorine to form chloride.
e.g. $H_2 + Cl_2 \longrightarrow 2HCl$

(f) **Reaction with hydrogen :** Non-metals reacts with hydrogen to form hydrides.
e.g. $H_2 + S \longrightarrow H_2S$

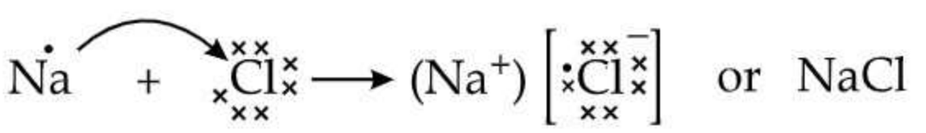
➢ **Reaction between metals and non-metals :**

- Reactivity of an element is the tendency to attain a completely filled valence shell.
- Atoms of metals can lose electrons from valence shells to form cations while atoms of non-metals can gain electrons in valence shell to form anions.
- Opposite charged ions attract each other and held by strong electrostatic forces of attraction forming ionic compounds.

➢ **Formation of Sodium Chloride**

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

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



or NaCl

➢ **Formation of Magnesium Chloride**

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

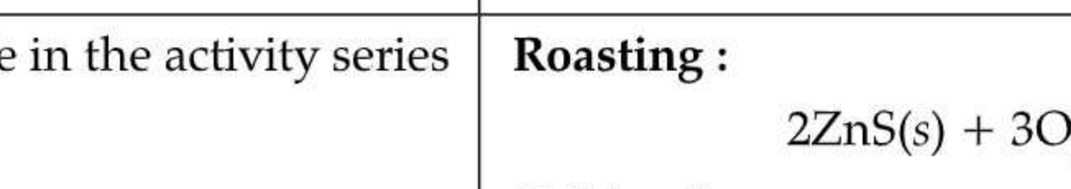
2, 8, 2 2, 8

(Magnesium cation)

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

2, 8, 7 2, 8, 8

(Chloride anion)



or $MgCl_2$

➢ **Extraction of Metals :**

Scenario	Example
Low in the activity series	$2HgS(s) + SO_2(g) \xrightarrow{Heat} 2HgO(s) + 2SO_2(g)$ $2HgS(s) \xrightarrow{Heat} 2Hg(l) + 2S(g)$ $2Cu_2S(s) + 3O_2(g) \xrightarrow{Heat} 2Cu_2O(s) + 2SO_2(g)$ $2Cu_2O(s) + Cu_2S(s) \xrightarrow{Heat} 6Cu(s) + SO_2(g)$
Middle in the activity series	**Roasting :** $2ZnS(s) + 3O_2(g) \xrightarrow{Heat} 2ZnO(s) + 2SO_2(g)$ **Calcination :** $ZnCO_3(s) \xrightarrow{Heat} ZnO(s) + CO_2(g)$
Top in the activity series	**During Electrolysis :** At cathode $Na^+ + e^- \longrightarrow Na$ At anode $2Cl^- \longrightarrow Cl_2 + 2e^-$

➢ **Corrosion :** It is the deterioration of a metal as a result of chemical reaction between it and surrounding environment. *e.g.*

(i) Silver reacts with sulphur in air to form silver sulphide and articles become black.

(ii) Copper reacts with moist carbon dioxide in air and forms green coat of copper carbonate.

(iii) Iron acquires a coating of brown flaky substance called rust. Rust is hydrated Iron (III) oxide *i.e.* $Fe_2O_3.xH_2O$.

➢ **Prevention of corrosion :** By painting, oiling, greasing, galvanizing and by making alloys.

➢ **Galvanisation :** It is the process of coating of iron articles with zinc. The oxide thus formed is impervious to air and moisture, thus protects further layers from getting corroded.

➢ **Alloys :** These are homogenous mixture of metals with metals and non - metals. *e.g.* stainless steel, brass, bronze and solder.

➢ **Amalgam :** If one of the metals in alloy is mercury, then the alloys are known as amalgam.

➢ **Some important balanced equations usually asked :**

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

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

(c) $ZnO(s) + C(s) \xrightarrow{Heat} Zn + CO$

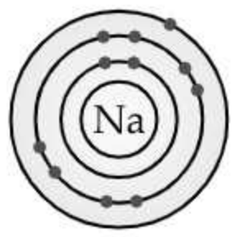
(d) $2HgS(s) + 3O_2(g) \xrightarrow{Heat} 2HgO(s) + 2SO_2(g)$

(e) $3MnO_2(s) + 4Al(s) \xrightarrow{Heat} 3Mn(s) + 2Al_2O_3(s)$

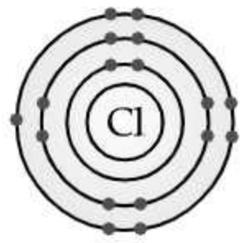
➢ Important Diagrams :

- **Electron dot structure**

Sodium (Na) – 2, 8, 1

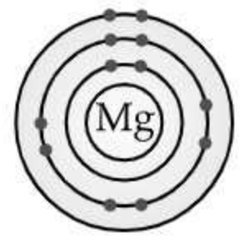


Chlorine (Cl) – 2, 8, 7



Oxygen (O) – 2, 6

Magnesium (Mg) – 2, 8, 2



- **Activity Series and related metallurgy**

K
Na
Ca
Mg
Al
} Electrolysis

Zn
Fe
Pb
Cu
} Reduction using carbon

Ag
Au
} Found in native state

- **Extraction of metals from ores**

Ore
↓
Concentration of ore
↓

Metals of high reactivity	Metals of medium reactivity		Metals of low reactivity
↓	↓	↓	↓
Electrolysis of molten ore	Carbonate ore	Sulphide ore	Sulphide ores
↓	↓	↓	↓
Pure metal	Calcination	Roasting	Roasting
	↓	↓	↓
	Oxide of metal		Metal
	↓		↓
	Reduction to metal		Refining
	↓		
	Purification of Metal		

CHAPTER 4 : Carbon Compounds

Key Points and Concepts

- Carbon is a tetravalent non-metal. It forms covalent bond. It is because :

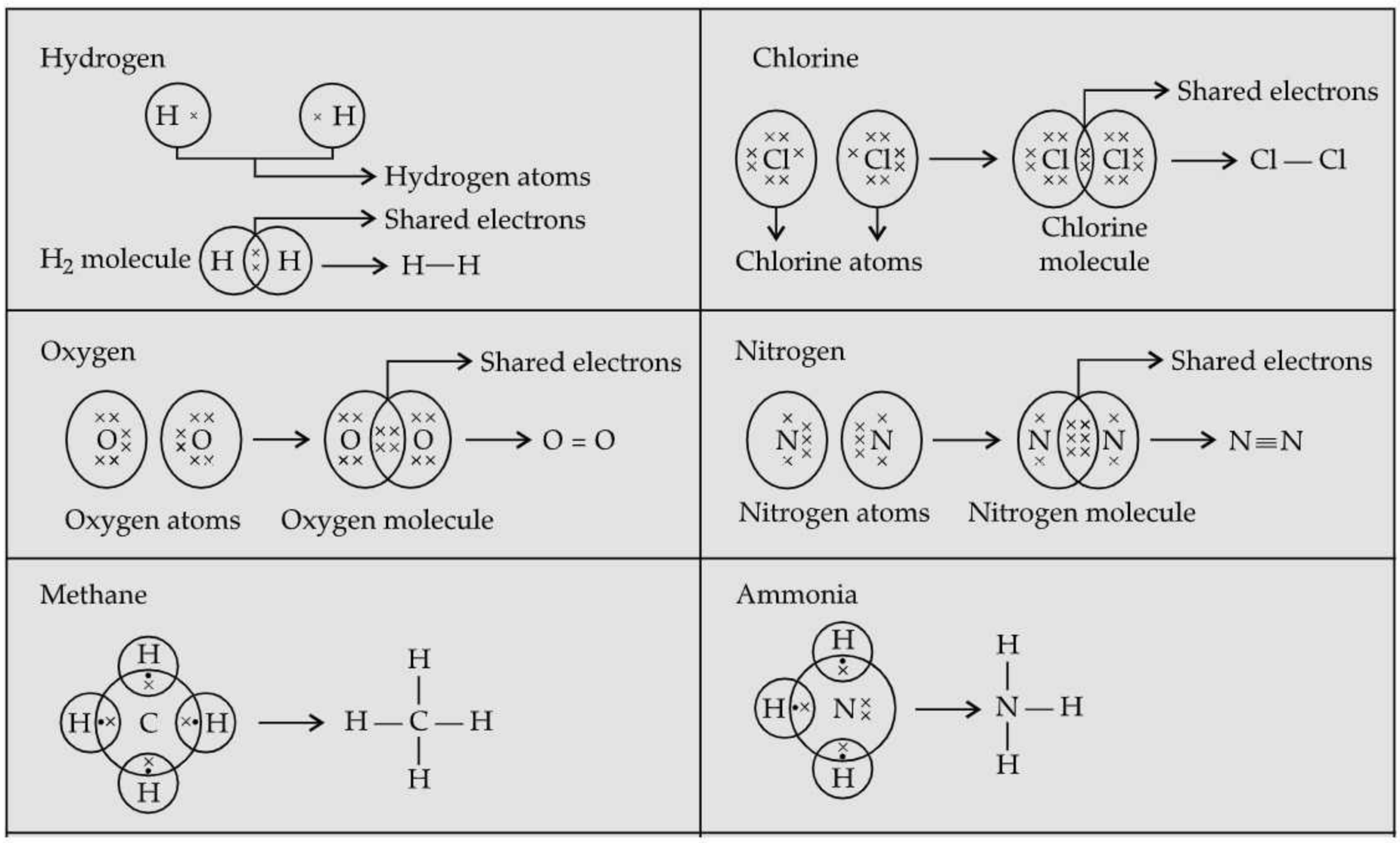
  The atomic number of carbon is 6 and its electronic configuration is 2, 4. So, to attain a noble gas configuration it requires four more electrons in its valence shell. Carbon attains the noble gas configuration by sharing its valence electrons with other atoms. Such mutual sharing of electrons between atoms to attain a stable noble gas configuration is called covalent bonding.

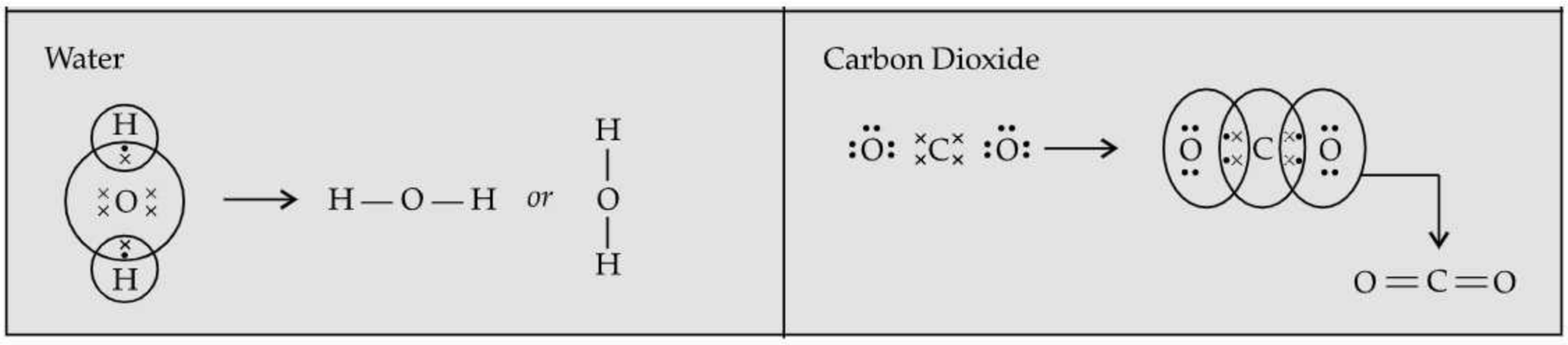
- Carbon compounds are mostly covalent compounds formed by the sharing of the outermost electrons.
- Properties of carbon which enable it to form enormously large number of compounds are catenation and tetravalency.
- **Catenation** is the property of carbon atom to form covalent bonds with other atoms of carbon.
- **Tetravalency :** Carbon requires 4 electrons to form tetravalent. It is because it has a valency of 4. As a result, carbon atom is capable of bonding with atoms of oxygen, hydrogen, nitrogen, sulphur, chlorine and other elements. The smaller size of carbon atom enables nucleus to hold the shared pair of electrons strongly, thus carbon compounds are very stable in general.

- **Covalent and Ionic Compounds :**

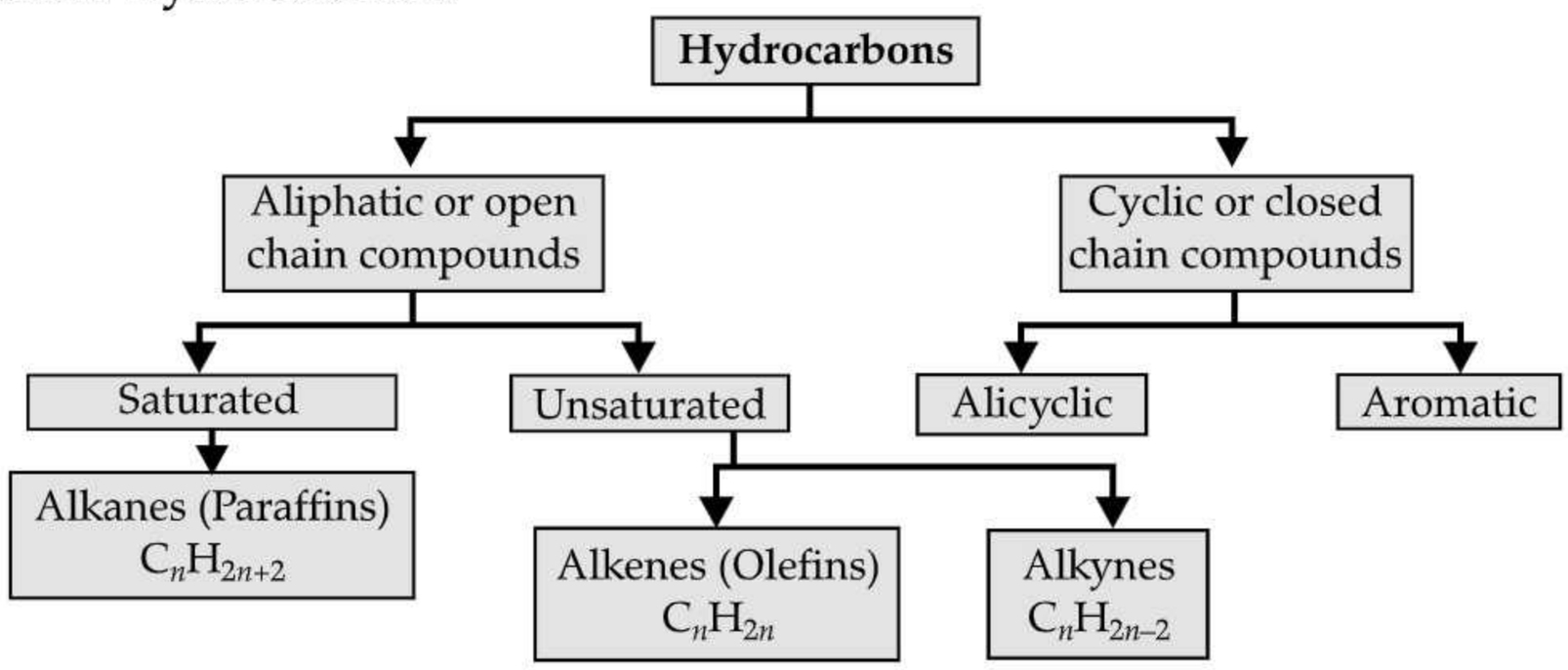
S. No.	Covalent Compounds	Ionic Compounds
1.	They are readily soluble in organic solvent.	They are not soluble in organic solvent.
2.	They do not ionise.	They ionise in organic medium.
3.	They are bad conductors of heat and electricity.	They are good conductors of heat and electricity.
4.	They have weak force of attraction between the molecules.	They have strong force of attraction between the molecules.

- **Formation of Molecules :**





➢ Classification of Hydrocarbons :



➢ IUPAC(International Union of Pure and Applied Chemistry) Nomenclature :

- **Some Common Alkanes :** Formula for Alkane : C_nH_{2n+2}

No. of carbon atoms	Name	Molecular formula	Molecular Mass (u)
1	Methane	CH_4	16
2	Ethane	C_2H_6	30
3	Propane	C_3H_8	44
4	Butane	C_4H_{10}	58
5	Pentane	C_5H_{12}	72
6	Hexane	C_6H_{14}	86
7	Heptane	C_7H_{16}	100
8	Octane	C_8H_{18}	114
9	Nonane	C_9H_{20}	128
10	Decane	$C_{10}H_{22}$	142

- **Alkyl Group :**

Alkyl group-R	Derived from Alkane	Name of Alkyl group
$— CH_3$	Methane	methyl
$—C_2H_5$	Ethane	ethyl
$—C_3H_7$	Propane	propyl
and so on		

- **Homologous Series of Alkene :** Formula for Alkene : C_nH_{2n} $(n \neq 1)$

No. of carbon atoms	Name of the Alkene	Molecular formula
2	Ethene	C_2H_4
3	Propene	C_3H_6
4	Butene	C_4H_8
5	Pentene	C_5H_{10}

- **Homologous Series of Alkyne :** Formula for Alkyne : C_nH_{2n-2} $(n \neq 1)$

No. of carbon atoms	Name of the Alkyne	Molecular formula
2	Ethyne	C_2H_2
3	Propyne	C_3H_4
4	Butyne	C_4H_6
5	Pentyne	C_5H_8

- **Common Functional Groups :**

Functional group	Class	General Formula	Example
$>C=C<$	Alkene	C_nH_{2n} $(n \neq 1)$	$H_2C=CH_2$
$-C\equiv C-$	Alkyne	C_nH_{2n-2} $(n \neq 1)$	$HC\equiv CH$
$-X$ (F, Cl, Br, I)	Haloalkane	$R-X$	CH_3-Cl
$-OH$	Alcohol	$R-OH$	CH_3-OH
$-\overset{\overset{O}{\|}}{C}-H$	Aldehyde	$R-\overset{\overset{O}{\|}}{C}-H$	$H_3C-\overset{\overset{O}{\|}}{C}-H$
$-\overset{\overset{O}{\|}}{C}-$	Ketones	$R-\overset{\overset{O}{\|}}{C}-R$	$CH_3-\overset{\overset{O}{\|}}{C}-C_2H_5$
$-\overset{\overset{O}{\|}}{C}-OH$	Carboxylic acid	$R-\overset{\overset{O}{\|}}{C}-OH$	$CH_3-\overset{\overset{O}{\|}}{C}-OH$
$-\overset{\overset{O}{\|}}{C}-O-$	Ester	$R-\overset{\overset{O}{\|}}{C}-OR$	$CH_3-\overset{\overset{O}{\|}}{C}-O-CH_3$

➢ **Chemical properties of carbon compounds :**

(a) Combustion : Carbon compounds burn in air to give carbon dioxide, water, heat and light.

$$CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O + \text{heat} + \text{light}$$

(b) Oxidation : Alcohols can be converted to carboxylic acids by oxidizing them with alkaline $KMnO_4$.

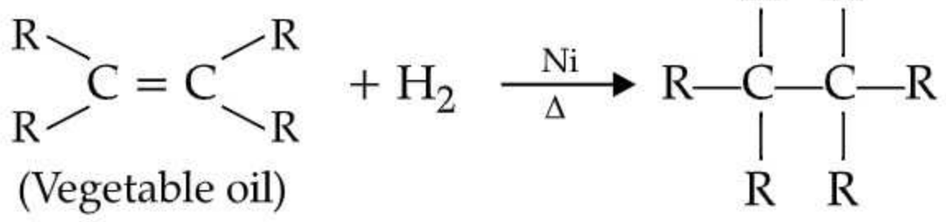
$$CH_3-CH_2OH \xrightarrow[\text{Or acidified } K_2Cr_2O_7 + \text{Heat}]{\text{Alkaline } KMnO_4 + \text{Heat}} CH_3COOH$$

Alkaline $KMnO_4$ add oxygen to the reactant thus, are called oxidizing agent.

(c) Addition reactions : Unsaturated hydrocarbons (alkene, alkyne) undergo addition reactions. They add hydrogen in the presence of catalyst Nickel and Palladium to give saturated hydrocarbons.

$$CH_2=CH_2 + H_2 \xrightarrow[\text{Heat}]{\text{Ni/Pd}} CH_3-CH_3$$

Addition reaction is commonly used in hydrogenation of vegetable oil using nickel catalyst. Addition of hydrogen at the multiple bond is known as hydrogenation process. This process is used for making vegetable ghee from oil.



(Vegetable oil) (Vegetable ghee)

(d) Substitution reaction : Saturated hydrocarbons undergo substitution reaction in the presence of sunlight.

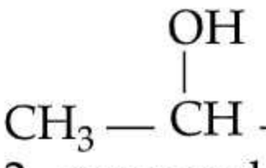
$$CH_4 + Cl_2 \xrightarrow{h\nu} CH_3Cl + HCl \text{ (in the presence of sunlight)}$$

A chain reaction is initiated in the presence of sunlight. One hydrogen atom is replaced by Cl group at each step resulting in the formation of CH_2Cl_2, $CHCl_3$, CCl_4.

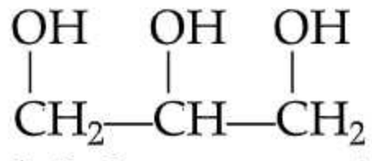
- **Some Common Alcohols :**

CH_3OH
Methanol

C_2H_5OH
Ethanol



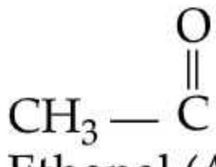
2 - propanol (Rubbing alcohol)



1, 2, 3-propanetriol (Glycerine)

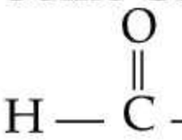
- **Some Common Aldehydes :**

Methanal (Formaldehyde)

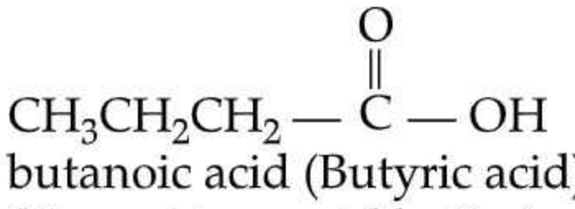


Ethanal (Acetaldehyde)

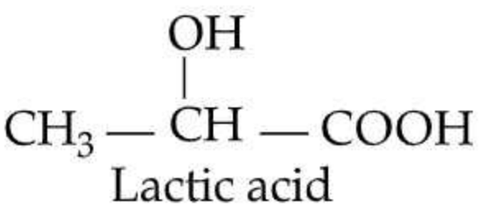
- **Some Common Carboxylic Acids :**



Formic acid (From ants)

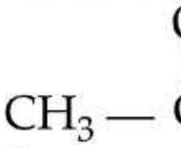


butanoic acid (Butyric acid)
(Present in rancid butter)

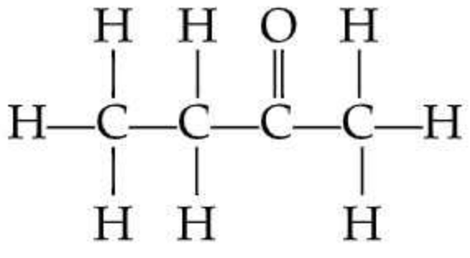


Lactic acid

- **Some Common Ketones :**



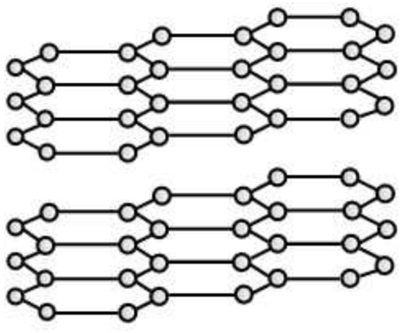
Propanone (Acetone)



Butanone

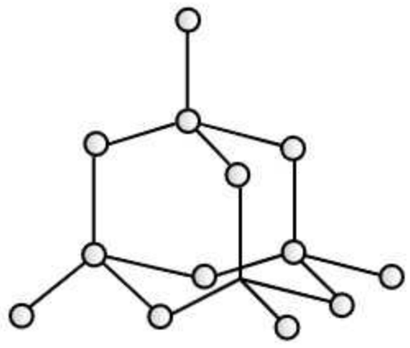
- **Graphite, Diamond and Fullerene :**

Graphite



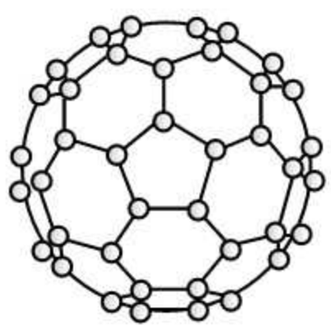
Layer structure.
Application : electrode

Diamond



Hardest material in the world.
Application : jewel, cutter

Fullerene (C60)



Soccer ball shape molecule.
Application : cosmetics
Diameter : 0.7 nm

➢ **Ethanol :**

Chemical properties :

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

e.g. $2CH_3CH_2OH + 2Na \longrightarrow 2CH_3CH_2ONa + H_2$

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

$$CH_3COOH + CH_3CH_2OH \overset{\text{conc. } H_2SO_4}{\rightleftharpoons} CH_3COOCH_2CH_3 + H_2O$$

Uses of ethanols : In preparation of soap, cosmetics, in alcoholic beverages, in medicines, and in laboratory reagent.

➢ **Ethanoic acids:**

- **Vinegar :** 5-8 % solution of acetic acid in water.
- **Glacial acetic acid :** Pure acetic acid.

➢ **Properties of ethanoic acid :**

(a) Reaction with sodium carbonate :

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

(b) Reaction with sodium hydrogen carbonate :

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

Brisk effervescence marks the presence of carboxylic acid.

(c) Reaction with NaOH :

$$CH_3COOH + NaOH \longrightarrow CH_3COONa + H_2O$$

(d) Reaction with ethanol (Esterification) :

$$CH_3COOH + CH_3CH_2OH \overset{\text{conc. } H_2SO_4}{\rightleftharpoons} CH_3COOCH_2CH_3 + H_2O$$

On hydrolysis, ester gives parent alcohol and sodium salt of carboxylic acid. Alkaline hydrolysis of ester is called **saponification**.

- **Soap and detergents :**
  - A soap is the sodium or potassium salt of long chain of fatty acids, which has the cleansing properties.
  - Soap are made by saponification process. It has two ends, one is hydrophilic and other is hydrophobic.
  - When soap is dissolved in water, micelle formation takes place. The hydrophobic end attach itself to dirt particle and remove it from the cloth.
  - A detergent is the sodium salt of long chain benzene sulphonic acid.
  - **Scum :** The magnesium and calcium salts present in hard water reacts with soap molecule to form insoluble products called scum. This obstructs the cleansing action.
  - Use of detergents overcome this problem as the detergent molecule prevents the formation of insoluble product and thus clothes get cleaned.

●●

CHAPTER 5 : Periodic Classification of Elements

Key Points and Concepts

- **Characteristics of Dobereiner's triads :**
  - **(a)** Properties of elements in each triad were similar.
  - **(b)** Dobereiner showed that when three elements in a triad were written in the order of their increasing atomic masses, the atomic mass of the middle element was roughly the average of the atomic masses of the other two elements.
- **Dobereiner's triad :**

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

- **Limitation of Dobereiner's triads :** Dobereiner could identify only three triads. He was not able to prepare triads of all the known elements.
- **Newlands' Octave :** John Newlands arranged the elements in order of their increasing atomic mass. It states that whenever the elements are arranged in increasing order of their atomic mass, the properties of the eighth element are a kind of repetition of the first, just like the notes of music.

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

- **Limitations of Newlands' law of octaves :**
  - **(a)** The law was applicable to elements upto calcium (Ca) only.
  - **(b)** It contained only 56 elements. Further it was assumed by Newlands that only 56 elements existed in nature and no more elements are going to be discovered in the future.
  - **(c)** In order to fit these elements into the table, Newlands adjusted two elements in the same slot and also put some unlike elements under the same note. For example, cobalt and nickel are in the same slot and these are placed in the same column as fluorine, chlorine and bromine which have very different properties than these elements. Iron, which resembles cobalt and nickel in properties, has been placed differently away from these elements.
- **Characteristics of Mendeleev's periodic table :**
  - **(a)** Mendeleev arranged all the 63 known elements in increasing order of their atomic masses.
  - **(b)** The table consists of vertical columns called 'groups' and horizontal rows called 'periods'.
  - **(c)** The elements with similar physical and chemical properties came under same groups.
- **Limitations of Mendeleev's periodic table :**
  - **(a)** He could not assign a correct position to hydrogen in the periodic table.
  - **(b)** Positions of isotopes of all the elements were not certain according to Mendeleev's periodic table.
  - **(c)** Atomic masses did not increase in a regular manner in going from one element to the next. So it was possible to predict how many elements could be discovered between the two elements.

- **Modern periodic law :** It states that properties of an element are the periodic function of their atomic number.
- Elements are arranged in order of increasing atomic number in the modern periodic table.
- **Trends in the modern periodic table :**
  - **Valency :** It is the number of valence electrons present in the outermost shells. Valency remains the same down a group but changes across a period.
  - **Atomic size :** It is the distance between center of the nucleus and the outermost shell of an isolated atom.
    - Atomic radius decreases from left to right along a period due to increase in nuclear charge.
    - Atomic radius increases down the group due to addition of extra shell as we go down the group.
- **Metallic and non-metallic character :** Metallic character means the tendency of an atom to lose electrons.
  - Metallic character decreases across a period as the effective nuclear charge increases.
  - Metals are electro-positive as they tend to lose electrons while forming bonds.
  - Metallic character increases as we go down a group as the effective nuclear charge decreases.
  - Non-metals are electro-negative. They tend to form bonds by gaining electrons.
  - Metals are found on the left side of the periodic table while non-metals are towards the right hand side of the periodic table.
  - In the middle we have semi-metals or metalloids because they exhibit some properties of both metals and non-metals.
  - Oxides of metals are basic in nature while oxides of non-metals are acidic in nature.
- **Nature of oxide :** Oxides of metals are basic in nature while oxides of non-metals are acidic in nature. On moving from left to right along a period, basic character of oxide decreases and acidic character increases. As we go down the group, nature of oxide remains the same.

Periodic Table of the Elements