CHEMISTRY

CHAPTER 1

PERIODIC TABLE AND ELECTRONIC CONFIGURATION

POINTS TO REMEMBER

- There are 4 sub shells.(s,p,d,f)

- Electron filling in sub shell is in accordance with increasing in energy
- 1s<2s<2<p3s<3p<4s<3d<4p<5s..... is the order
- In $1S^2$, one represents the shell number, S represents the subshell and two represents the number of electrons in that subshell

- **Period number** is equal to the highest shell number in the sub shell electronic configuration.

- **Group number**

  s-block → The no. of electrons in the outer most **s** sub shell.
  p-block → by adding 10 to the total number of electrons in the s and p sub shells of the outer most shell.
  d-block → adding the total number of electrons in the outer most s sub shell and preceding inner d sub shell.

- Most of the coloured salts are compounds of transition elements; the colour is due to the presence of transition element ion.
- In the case of transition elements the difference in energy between the outermost s sub shell and the penultimate d sub shell is very small. Hence under suitable condition the electrons in d sub shell also take part in chemical reaction. This is the reason why transition element shows variable oxidation state.
- f block contains lanthanoids and actinoids.
- Most of the actinoids are radioactive and are artificial elements.

CHAPTER 2

MOLE CONCEPT

POINTS TO REMEMBER

- **GAM**-Atomic mass expressed in Grams
- **GMM**-Molecular mass expressed in Grams
- The amount of any substance (molecule, atom...) containing 6.022×10^{23} particles is called one Mole.
- 1 GMM / GAM of any particle are equal to 1 Mole (6.022×10^{23} particles).
- The volume of 1 Mole of any gas at STP (273K,1atm pressure) is equal to 22.4 L
- Molarity is used to indicate the No. of moles of solute in one litre of solution.
- If 1L of solution contains 1 mole of solute, it is called 1molar solution (1M).

EQUATIONS

TO FIND MOLE

1. If **No .of particles** is given

$$\text{No .of moles} = \frac{\text{No .of particles}}{\text{Avogadro no.}}$$

2. If **Mass** is given

$$\text{No .of moles} = \frac{\text{Mass in grams}}{\text{GAM}} \quad \text{(Atom)}$$

$$\text{No .of moles} = \frac{\text{Mass in grams}}{\text{GMM}} \quad \text{(Molecule)}$$

3. If **Volume** is given

$$\text{No .of moles of gas at STP} = \frac{\text{Volume in STP}}{22.4}$$

- **Molarity =** $\dfrac{\text{No of moles of solute}}{\text{Volume of the solution}}$ (M = n / V)

CHAPTER 3

RATE OF CHEMICAL REACTION AND CHEMICAL EQUILIBRIUM

POINTS TO REMEMBER

- Collision theory: Reactions take place when two molecules collide together effectively.

FACTORS EFFECTING RATE OF REACTIONS

- **Concentration**

  As the concentration of reactants increases, the no of effective collisions increases, then the rate of reaction increases

- **Temperature**

  As the Temperature increases. Kinetic energy of the molecule increases, then the rate of reaction increases

- **Nature of reactants**
- **Surface area**

  As the Surface area increases then the rate of reaction increases.

- **Pressure**

  As pressure increases the molecule comes closer. The effective collisions increases, then the rate of reaction increases.

- **Light**
- **Catalyst**

  Positive catalyst: Catalyst that increase the rate of reaction.

  Negative catalyst: Catalyst that decrease the rate of reaction.

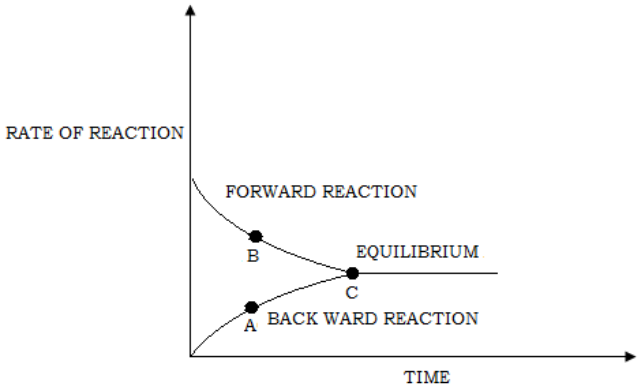
- Forward reaction

  Reactants turn into products is known as forward reaction.

- Backward reaction

  Products turn into reactants is known as backward reaction.

- Reactions taking place in both directions are called **Reversible reactions**.
- **Chemical Equilibrium** is the point at which the rate of the forward reaction becomes equal to the rate of the backward reaction in a chemical reaction.



- **LE CHATELIERS PRINCIPLE**

  When the concentration, pressure or temperature of a system at equilibrium is changed, the system will readjust itself so as to nullify the effect of that change and attain new state of equilibrium

- Concentration and Chemical equilibrium

When concentration increases, the system will increase the reaction towards the side where concentration is less.

- Temperature and Chemical equilibrium

On increasing temperature, the system tries to reduce it and as result, the rate of endothermic reaction increases.

- Pressure and Chemical equilibrium
  - If there is no change in the number of reactant or product molecules as a result of forward and backward reactions, in gaseous reactions, pressure will not have any effect on the equilibrium state.
  - When a pressure of a system at equilibrium is increased the system will try to attain chemical equilibrium by reducing pressure.
  - In gaseous reaction decrease in the molecules helps to decrease in the pressure.

- Catalyst and Chemical equilibrium
  - A catalyst cannot increase the rate of anyone of the reaction alone.
  - In reversible reaction the catalyst increases the rate of forward and backward reactions in the same extent. As a result the system reaches equilibrium at faster rate.

CHAPTER 4

REACTIVITY SERIES AND ELECTRO CHEMISTRY

POINTS TO REMEMBER

- The series obtained by arranging some of the metals in the decreasing order of their reactivity, this is known as **Reactivity series**.

  The hydrogen is also included in the series for the comparison of chemical reactivity.
- **Displacement Reaction**

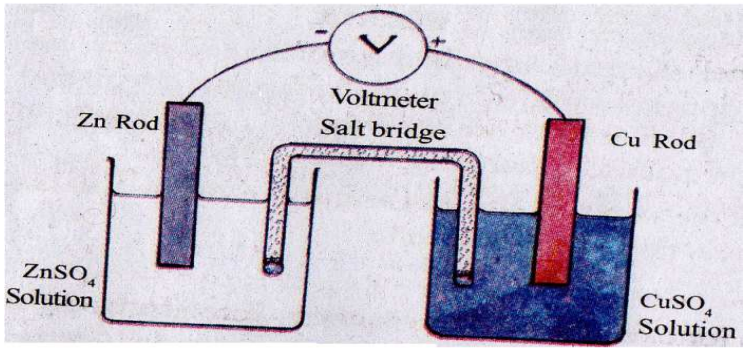
  Metal with low reactivity are displaced from their salt solutions by metals with of high reactivity.
- **Oxidation** (OIL from RIG)

  The reduction process of losing electron is known as Oxidation
- **Reduction**

  The process of gaining electrons is known as reduction.

  Oxidation and reduction takes place simultaneously, this is known as Redox reaction.
- **Galvanic cell**

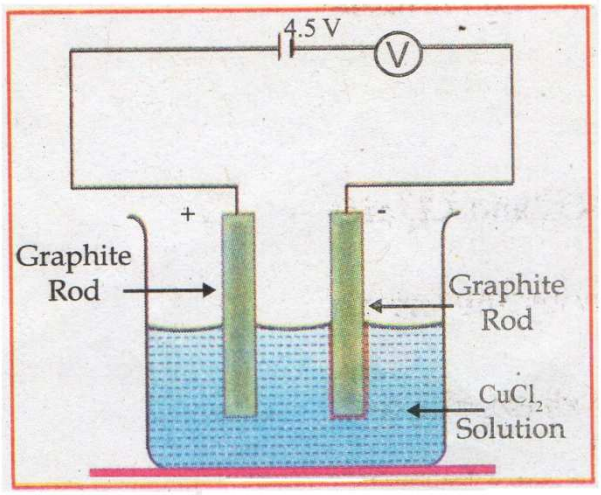
  The device used for the conversion of chemical energy to electrical energy through redox reaction is called **Galvanic cell** or **Voltaic cell**.



- The electrode at which oxidation occurs is the **Anode.**
- The electrode at which reduction occurs is **Cathode**.
- In a galvanic cell, electrons flow from the negative electrode (anode) to the positive electrode (cathode).
- **Electrolytic Cells**

  The process of chemical change taking place in an electrolyte by passing electricity is known as **Electrolysis.**

- **Electrolytes** are substances which conduct electricity in molten states or in aqueous solutions and undergo a chemical change. Acids, alkalis and salts are electrolytes in their molten state or in aqueous solution.



- During electrolysis the anions (negatively charged ions) move towards the anode and cations (positively charged ions) move towards the cathode.
- In galvanic cell, the anode is negative and cathode is positive, at the same time in electrolytic cells, the anode is positive and cathode is negative.
- In both cases oxidation occurs at the anode and reduction occurs at the cathode.

Electrolysis of Water,Molten NaCl, NaCl Solution

Substance	Anode	Cathode
Water	O_2	H_2
Molten NaCl	Cl	Na
NaCl solution	Cl	H_2

Uses of Electrolysis

- Production of metals and non metals
- Production of chemicals
- Purification of metals
- Electroplating

- **Electroplating**

The coating of metallic object with other metals by the using electrolysis is known as electro plating.

Uses of Electroplating

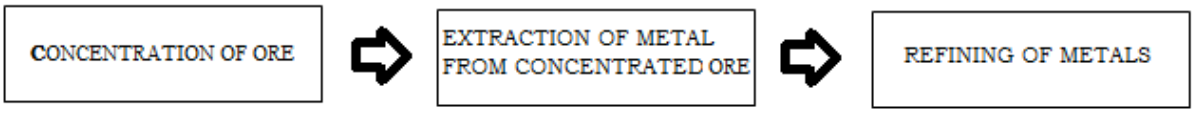
- Gold plated ornaments
- Silver plated vessels
- Chromium plated iron handles

CHAPTER 5

PRODUCTION OF METALS

POINTS TO REMEMBER

- A mineral, from which a metal is economically, easily, extracted, is called the Ore of the metal.
- **Metallurgy**



1. **Concentration of ore**

   The process of removing impurities from the ore obtained from the earth's crust. Depending on the nature of the ore and impurities, there are different methods of concentration. First the ore is powdered (Pulverisation).

   - ❖ Levigation or Hydraulic washing

     When the impurities are lighter and the ore particles are heavier, the lighter impurities are removed by washing in a current of water.

     Eg: concentration of gold.
   - ❖ Froth flotation

     This process is used when the impurities are heavier and the ore particles are lighter, a mixture of powdered ore, water and pine oil is strongly agitated by compressed air. As a result the ore particles stick to the froth of the oil formed during the mixing process and floats on the surface of water. The heavier impurities are sink to the bottom. The ore is separated from the ore.

     Eg: concentration of copper pyrites.
   - ❖ Magnetic seperation

     If either the ore or the impurity is magnetic in nature, this method is used. The powdered ore is fed to the conveyor belt moving over a magnetic wheel to separate the magnetic substance.

     Eg: concentration of the ore of iron.
   - ❖ Leaching

     On adding the ore to the suitable solution, a chemical reaction takes place and the ore dissolves in the solution. The insoluble impurities are filtered off. The pure ore is separated from the filtrate by chemical reaction.

     Eg: concentration of Bauxite

2. **Extraction of metal from concentrated ore**
   a. **Conversion of concentrated ore in to its oxide**
   b. **Reduction of the oxide**

Conversion of concentrated ore in to its oxide

- Calcination

  The process of heating the concentrated ore at a temperature below its melting point to remove the volatile impurities. Oxygen will not take Part in this reaction.

  Eg: $ZnCO_3$ is converted to ZnO by Calcination.

- Roasting

  The process of heating the concentrated ore at a temperature below its melting point in a current of air. Impurities like sulphur, phosphorous and other organic matter are oxidised and expelled.

  Eg: Cu_2S is converted to Cu_2O by roasting.

Reduction of the oxide

The process of extraction of metal from the oxide .suitable reducing agents are use for this purpose. CO is used as the reducing agent to extract iron from haematite, and C is used to extract zinc from zinc oxide.

Electricity is used to extract highly reactive metals like sodium, potassium etc from their ores.

3. Refining of Metals

The metal obtained by reduction may contain other metals, metal oxides and small quantities of non metal as impurities.

Refining is the process of removal of these impurities to get the pure metal.

There are different methods are used to for the refining of metals based on the nature of metal and impurities.

- Liquation

  Low melting metals like tin and lead may contain other high melting metals or metal oxides as impurities. On heating such on the inclined surface of the furnace, the pure metal melts and flows down leaving the impurities behind.

- Distillation

  This method is used for the refining of metals with low boiling points such as zinc, cadmium and mercury. When the impure metal is heated in a retort, the pure metal alone vapourises.the vapours are condensed to get the pure metal.

- Electrolytic refining

  It is the process of refining of a metal by the electrolysis of a solution of the salt of the metal, using a small piece of pure metal as **–ve** electrode and impure metal as **+ve** electrode. By electrolysis the pure metal from the **+v**e electrode dissolves in the electrolyte and get deposited on the –**ve** electrode. Copper and silver are refined using this method.

INDUSTRIAL PREPARATION OF IRON

- Blast furnace is the huge steel furnace with a blast of hot air in the bottom.

A mixture of roasted Haematite, coke, lime stone ($CaCO_3$) are falls into the Blast furnace.

Here the $CaCO_3$ decomposes at high temperature.

$$\mathbf{CaCO_3 \rightarrow CaO + CO_2}$$

The formed CaO is combined is here combines with silicon dioxide (SiO_2) the main impurity of ore.

$$\mathbf{CaO + SiO_2 \rightarrow CaSiO_3}$$

Flux +Gangue → Slag

- The impurities in the metal are known as **Gangue.**
- The material used to remove gangue and to convert it as separable molten material is known as **Flux.**
- The gangue and flux combines to form **Slag.** (Flux +Gangue →Slag)

  Here CaO is the flux, SiO_2 is the Gangue and $CaSiO_3$ is the slag.

- If gangue is acidic then the flux is basic and vice versa.

  Here the Gangue (SiO_2) is Acidic so the Flux is Basic (CaO)

  The coke combines with oxygen in the hot air.

$$\mathbf{C + O_2 \rightarrow CO_2 + Heat}$$

The CO in the middle of the furnace reacts with iron oxide to produce iron.

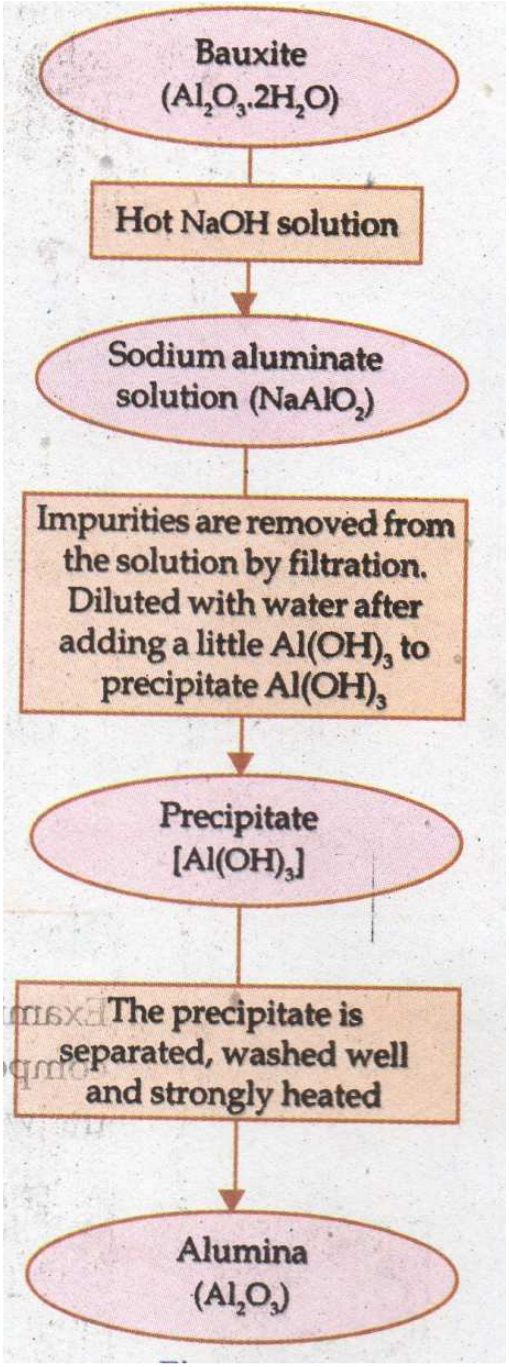
$$\mathbf{Fe_2CO_3 + 3CO \rightarrow 2Fe + 3CO_2}$$

- The iron obtained from the blast furnace contains impurities like 4% carbon silicon manganese, phosphorous this iron is called **Pig iron.**
- Pig iron+ Scrap iron +Coke→ **Cast iron.**
- By purifying the cast iron, comparatively pure raw iron is obtained this is known as **Wrought iron.**

EXTRACTION OF ALUMINIUM

- Ore of aluminium is Bauxite.
- The main impurity in aluminium is SiO_2

HALL HEROULT PROCESS



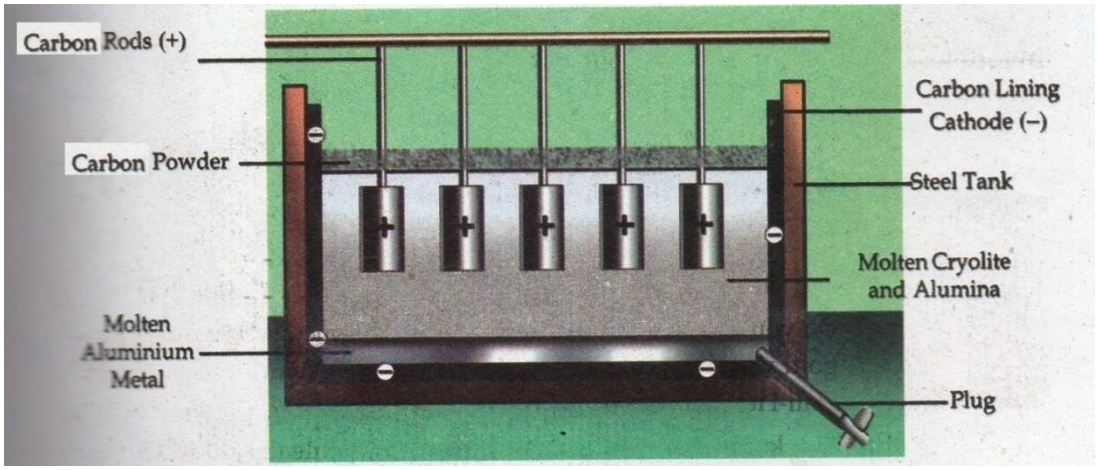
- Aluminium is extracted using electricity, because Aluminium is highly reactive
- The alumina (Al_2O_3) obtained by concentration of bauxite is mixed with cryolite (Na_3AlF_6) and subjected to electrolysis.
- Cryolite is added to alumina to reduce melting point and increase its electrical conductivity.
- When electricity is passed through this mixture, its get heated, cryolite melts and alumina dissolves in it.

CATHODE

$Al^{3+} + 3e \rightarrow Al$ (Pure aluminium is produced at cathode)

ANODE

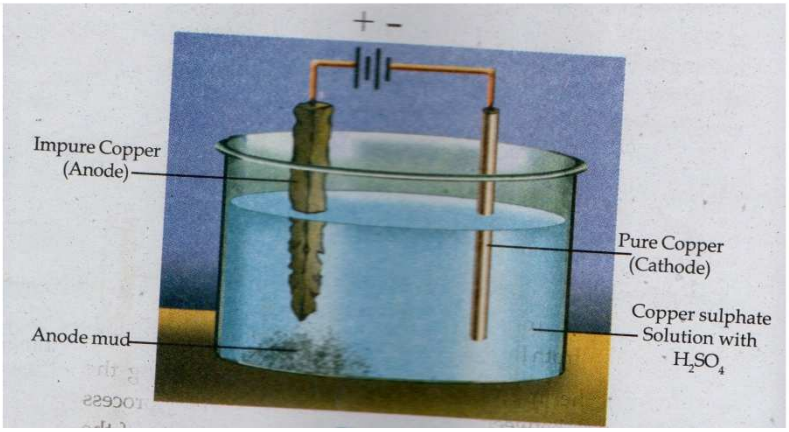
$2O^{2-} \rightarrow O_2 + 4e$



- The carbon blocks in this cell are replaced from time to time because the $\mathbf{O_2}$ liberated in the anode is oxidising the Carbon rod and produce carbon dioxide.

REFINING OF COPPER

- Copper is refined by electrolytic method.



- For refining, a thin Plate of copper is used as negative electrode and the impure metal as positive electrode, the electrolyte used is aqueous copper sulphate solution mixed with H_2SO_4.
- The impurities get deposited below the anode .this is known as **anode mud**.

CATHODE (-ve electrode)

$\mathbf{Cu^{2+} + 2e \rightarrow Cu}$

ANODE (+ve electrode)

$\mathbf{Cu \rightarrow Cu^{2+} + 2e}$

CHAPTER 6

NOMENCLATURE OF ORGANIC COMPOUNDS

POINTS TO REMEMBER

- Hydrocarbons are divided in to **Alkanes, Alkenes, and Alkynes.**
- **Alkanes** are **Single** bonded saturated hydrocarbons.
- **Alkenes** are **Double** bonded unsaturated hydrocarbons.
- **Alkynes** are **Triple** bonded unsaturated hydrocarbons.

Naming

❖ HYDROCARBONS

Word root + ane/ene/yne

$CH_3 - CH_3$

Eth+ane=Ethane

While unsaturated hydrocarbons are considered the position of double/triple bond also considered

Word root -Position of Double/Triple bond- ene/yne

$CH_3 - CH = CH - CH_2 - CH_2 - CH_3$

Hex-2-ene

❖ BRANCHED HYDROCARBONS

Select the longest chain and the branch attached to the carbon must have low number.

Position of Branch –Name of Radical + Word Root –Suffix

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

2-Methyl Hexane

- If one or more branches are present,names of the branches should be written in alphabetical order.
- If a carbon has two identical branches, the no of their position should be repeated.

$CH_2 - CH(CH_3) - CH(CH_3) - CH_2 - CH(CH_3) - CH_2 - CH_3$ 3, 6-Di Methyl Octane

- The presence of certain atoms or groups imparts certain characteristic properties to compounds. They are called **Functional groups**.

Functional group	Name of the functional compounds	Name of the compounds formed	Suffix	Example
-OH	Hydroxyl	Alcohol	OL	Methanol
-COOH	Carboxylic acid	Acid	OIC ACID	Ethanoic acid
-CO	Ketons	Keto	ONE	Propanone
-CHO	Aldehyde	Aldehydes	AL	Butanal
R-O	Alkoxy	Ethers	OXY	Methoxy propane
$-NH_2$	Amines	Amino	AMINE	Ethanamine
-X(Cl,Br,I)	Halo	-	CHLORO,BROMO,IODO	Chloro methane

ISOMERISM

Compounds having same molecular formula and different chemical and physical properties are called **Isomers**. The phenomenon is called **Isomerism**.

There are three types of Isomers

- **Chain isomer**
  Compounds with the same molecular formula but posses a difference in the chain structures are called chain isomers.

  Eg: $CH_3-CH_2-CH_2-CH_3$ C_4H_{10}

  $CH_3-CH(CH_3)-CH_3$ C_4H_{10}

- **Functional isomer**
  Compounds having same molecular formula, but having a difference in their functional groups are called functional isomers.

  Eg: CH_3-CH_2-OH C_2H_6O

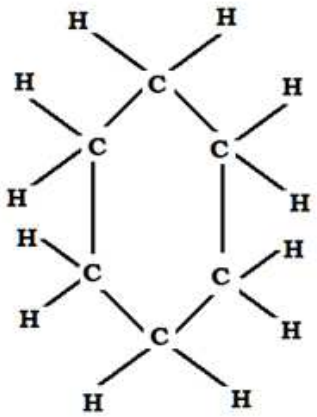
  CH_3-O-CH_3 C_2H_6O

- **Position isomer**
  If the position of the functional group is different in two compounds having the same molecular formula and the same functional group then, they are Position isomers.

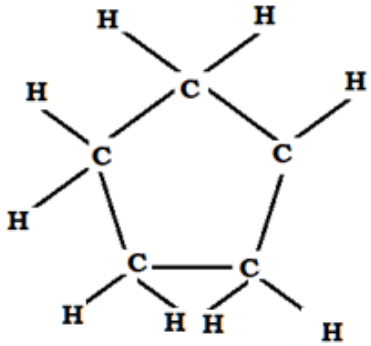
  Eg: $CH_3-CH_2-CH_2-OH$ C_3H_8O

  $CH_3-CH(OH)-CH_3$ C_3H_8O

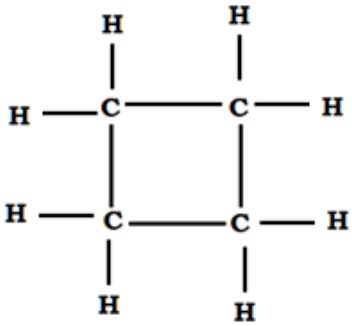
Isomerism in Alicyclic Compounds



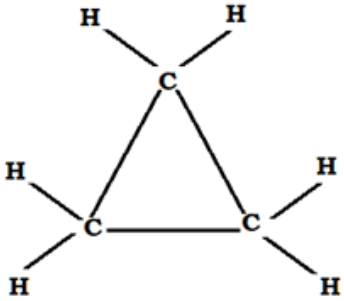
Cyclo Hexane and Hexene are isomers.



Cyclo Pentane and Pentene are isomers



Cyclo Butane and Butene are Isomers



Cyclo Propane and Propene are isomers

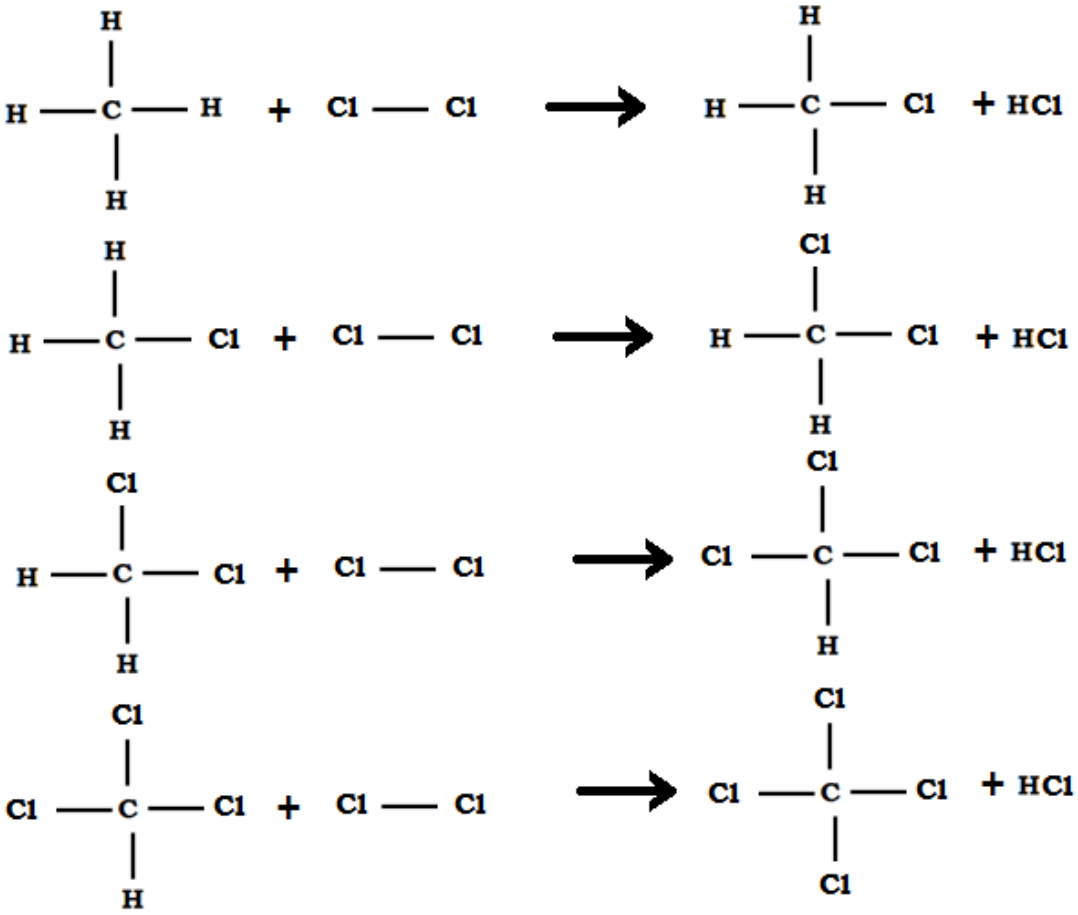
CHAPTER 7

CHEMICAL REACTIONS OF ORGANIC COMPOUNDS

POINTS TO REMEMBER

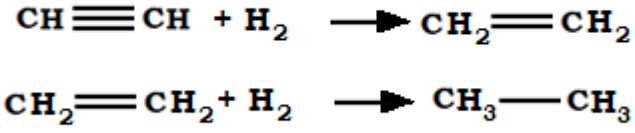
- **Substitution Reaction**

  Reactions in which an atom or group in a compound is replaced by another atom or a group are called Substitution Reaction.



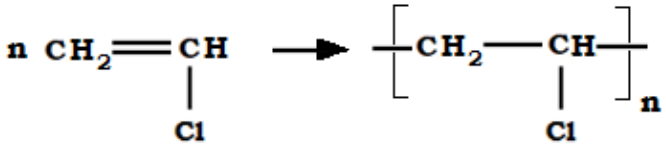
- **Addition Reaction**

  Reactions in which unsaturated organic compounds with double bond or triple bond react with other molecules to form saturated compounds are called Addition Reactions.

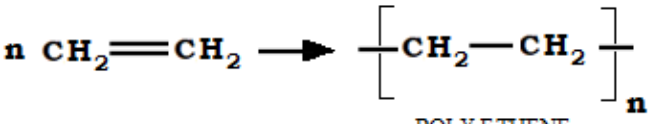


- **Polymerisation**

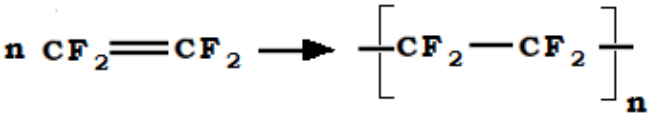
  It is the process in which large number of simple molecules combines under suitable conditions to form complex molecules. These molecules are called **Polymers**.
  The simple molecules which combine in this manner are called **Monomers**.



VINYL CHLORIDE — POLY VINYL CHLORIDE



ETHENE — POLY ETHENE



TETRA FLURO ETHANE — TEFLON

- **Combustion of Hydrocarbons**

  When hydrocarbons burn they combine with the oxygen in the air to form **CO_2** and **H_2O** along with heat and light. This process is called Combustion.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O + \text{Heat}$$

- **Thermal Cracking**

  Some hydrocarbons with high molecular masses, when heated in the absence of air undergo decomposition to form hydrocarbons with lower molecular masses. This process is called Thermal Cracking.

$$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3 \rightarrow CH_3-CH_2-CH_2-CH_2-CH_3 + CH_3-CH=CH_2$$

OCTANE → **PENTANE** + **PROPENE**

SOME IMPORTANT ORGANIC COMPOUNDS

1. **Alcohol**
   a) Methanol
      - It is also known as **Wood Spirit.**
      - It is poisonous
      - It is used in the manufacture of Varnish and Formalin

        $CO + 2H_2 \rightarrow CH_3-OH$ (In the Presence of a Catalyst, 573K, 200atm)

   b) Ethanol
      - It is also known as **Grape Spirit.**
      - Ethanol is used as an organic solvent and in the manufacture of various organic compounds and paints,beverages,fuel.

INDUSTRIAL PREPARATION OF ETHANOL

Molasses is the concentrated solution of sugar also called mother liquor is diluted. The diluted molasses by adding yeast. Here reactions occur in the presence of the Enzymes present in the Yeast.

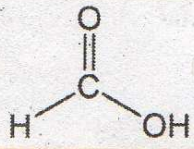
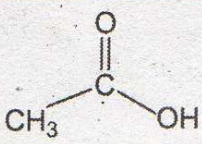
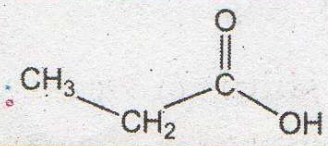
$$\underset{\text{Sucrose}}{C_{12}H_{22}O_{11} + H_2O} \xrightarrow{\text{Invertase}} \underset{\text{Glucose}}{C_6H_{12}O_6} + \underset{\text{Fructose}}{C_6H_{12}O_6}$$

$$C_6H_{12}O_6 \xrightarrow{\text{Zymase}} 2\underset{\text{Ethanol}}{C_2H_5\text{-}OH} + 2CO_2$$

- The Ethanol thus obtained will be about 8-10% strong. It is known as **Wash.**
- This subjected to fractional distillation to get 95.6% strong ethanol solution is known as **Rectified Spirit.**
- Poisonous substances are added to ethanol meant for industrial purposes to avoid its misuse as beverage. This product is known as **Denatured Spirit.**
- 99.5% ethanol is known as **Absolute Alcohol.**
- A mixture of absolute alcohol and petrol is known as **Power Alcohol** is used as fuel in automobiles.

2. Carboxylic acids

- Carboxylic acids containing twelve or more carbon atoms are called **Fatty Acids**.
- 5-8% strong acetic acid is known as **Vinegar**.

Formula	Structural formula	IUPAC name	Common name
H—COOH		Methanoic acid	Formic acid
CH_3—COOH		Ethanoic acid	Acetic acid
CH_3—CH_2—COOH		Propanoic acid	Propionic acid

INDUSTRIAL PREPARATION OF ETHANOIC ACID

$$CH_3{-}OH + CO \xrightarrow{\text{Catalyst}} CH_3{-}COOH$$

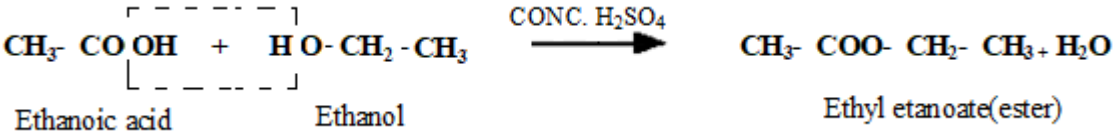
- It is also prepared by the fermentation of ethanol in the presence of air using the bacteria aceto bactor.

Uses of Ethanoic Acid

- In the manufacture of rayon
- In the rubber and silk industry
- Vinegar production

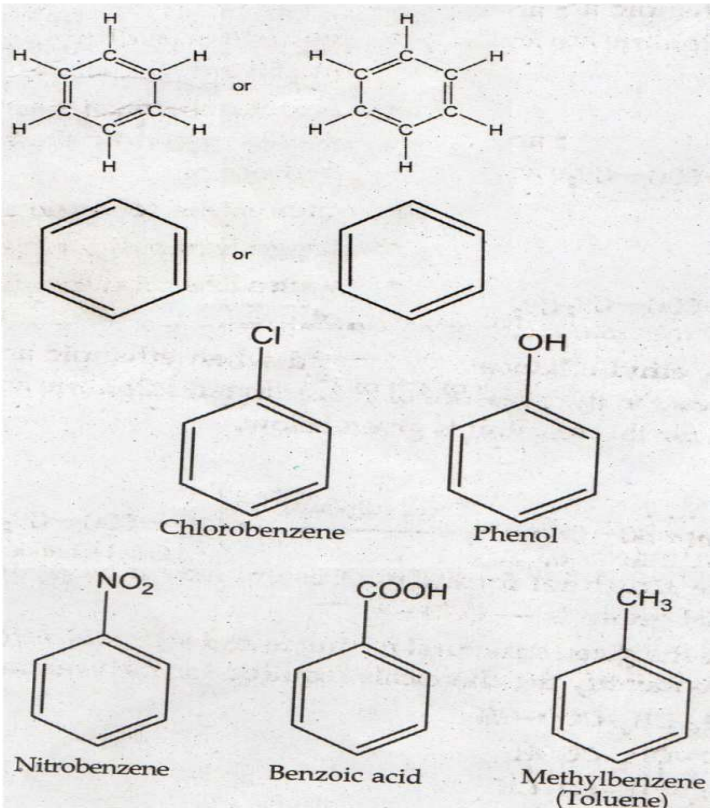
3. Ester

- Esters are obtained by the reaction between alcohols and carboxylic acids.
- Esters having the pleasant smell of fruits and flowers.
- Oils and fats are esters formed by the reaction between glycerol with fatty acids such as Palmitic acid and Stearic acid.



4. Aromatic Compounds

- All aromatic compounds have ring structure; there are double bonds between alternate carbon atoms.



CHAPTER 8

CHEMISTRY FOR HUMAN PROGRESS

PETROLEUM

- Petrol, diesel, kerosene, naphtha etc are manufactured by the Fractional distillation of petroleum.
- The main content of LPG (Liquefied Petroleum Gas) is Butane.

Components	Number of carbon atoms present in the hydrocarbons	Uses
Uncondensed gases	$C_1 - C_4$	Domestic/Industrial fuel
Petrol	$C_5 - C_9$	Motor fuel
Kerosene	$C_{10} - C_{16}$	Domestic fuel
Diesel	$C_{16} - C_{18}$	Diesel engine fuel
Petroleum jelly (Vaseline), Grease	$C_{18} - C_{22}$	Lubricant, Manufacture of cosmetics
Paraffin wax	$C_{22} - C_{30}$	Manufacture of Wax, Boot polish, Wax paper, Tarpaulin etc.
Bitumen	Above C_{30}	Road tarring

PETROCHEMICALS

The chemicals prepared from the hydrocarbons that are separated from petroleum are generally known as Petrochemicals.

- **Coal**

Coal is formed as the result of the carbonisation on the remains of plants.

The process by which the remains of plants transform into coal in the absence of air under high temperature and pressure is known as **Carbonisation**.

Different types of Coal

Coal	Percentage of carbon
Anthracite	94%
Bituminus coal	83%
Lignite	67%
Peat	57%

MEDICINES

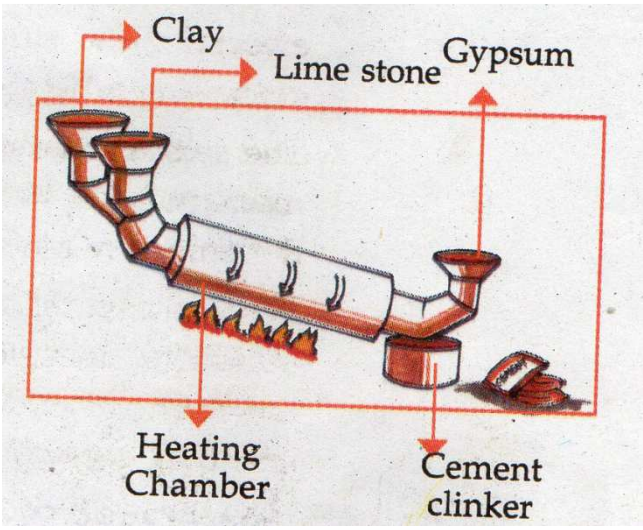
Purposes of Medicine

- Diagnosis
- Prevention of diseases
- Anaesthesia
- Treatment
- Antiseptics

Type	Function
Analgesics	To relieve pain
Antipyretics	To lower body temperature
Antacids	To reduce acidity
Antiseptics	To control micro organisms
Antibiotics	To destroy the disease causing micro organisms and prevent their growth

CEMENT

- Cement is a complex mixture of silicates and aluminates of calcium.
- Cement clinker is obtained when powdered lime stone and clay are heated in Rotary Klin. It is mixed with gypsum and then powdered and stirred to get cement.



- **Setting of Cement** is the process of cement combines with water and sets into a hardened mass is known as setting of cement. Since it is an exothermic reaction, a large quantity of heat energy liberated, so the labours must wear gloves to handle cement.

COLOURS

- Dyes and pigments are chemical substances which help to impart colour to other objects.
- Colours obtained from plants such as Alizarin Red and Indigo Blue are natural dyes.
- Organic compounds Benzene, Aniline, Phenol etc are used in the manufacture of synthetic dyes.

GLASS

- Glass is a mixture of Silicates

DIFFERENT TYPES OF GLASSES

Types of Glasses	contents	uses
SODA GLASS	SiO_2, Na_2CO_3, $CaCO_3$	Windows, bulbs
HARD GLASS	SIO_2, K_2CO_3, $CaCO_3$	Glass vessels
BOROSILICATE GLASS	SiO_2, Al_2O_3, B_2O_3	Laboratory vessels
FLINT GLASS	SiO_2, K_2CO_3, PbO	Lens, Prism

MATERIALS USED FOR COLOURING

Compound	Colour
Ferric ion	Yellow
Chromium/ Ferrous ion	Green
Cobalt Oxide	Blue
Manganese dioxide	Purple

GREEN CHEMISTRY

- A branch of chemistry has emerged which addresses the pollution caused in such situations and controls the production of poisonous chemicals and products there by reducing the adverse effects on nature and environment. This is **Green Chemistry.**

❖ Green chemistry is based on certain principle which limits the number of reactant atoms and molecules in chemical processes to the required definite proportion, thereby reducing the amount of hazardous by products to the minimum.

IMPORTANT GOALS OF GREEN CHEMISTRY

- ❖ To convert hazardous chemicals in to useful and harmless substances.
- ❖ To produce eco-friendly products.
- ❖ To reduce pollution.
- ❖ To minimise the use of poisonous products.
- ❖ Avoid the wastage of energy.