

## COLLOIDS

### What is a colloid?

Colloidal solutions are intermediate between true solutions and suspensions.



True solution  
(salt /sugar  
Solution )

Colloidal  
solution

suspension

In true solution particle size of solute is from 1A to 10A (1 angstrom to 10 angstrom)

In suspension particle size is 2000 A or more

Colloids/colloidal solution particle size is between 10 A to 2000 A

So when the diameter of the particles of a substance dispersed in a solvent ranges from 10A to 2000A, then system is called a Colloidal solution or simply a Colloid.

### A colloidal system has two phases

**Dispersed phase (solute)-** The substance distribute as colloidal particles is called dispersed phase.

1. **Dispersion medium(Solvent):-** The second phase or medium in which colloidal particles are dispersed is called dispersion medium.

Types of colloidal solution or SOL

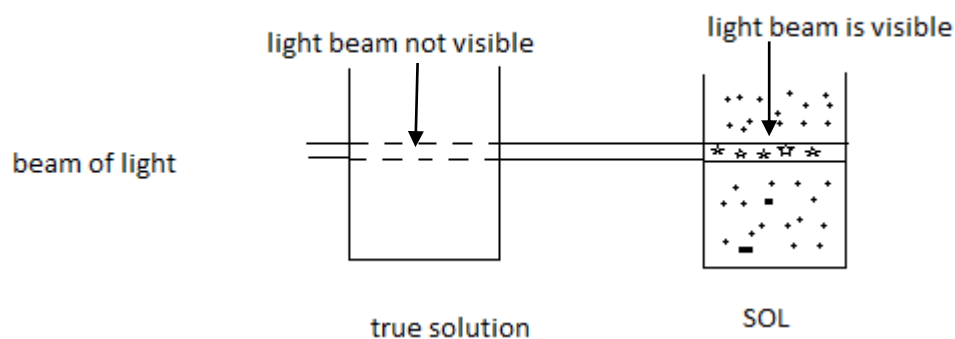
When solid is dispersed in a liquid it is called a colloidal solution or simply a sol.

### These are of two types

1. Lyophilic sols.-(Solvent loving)
2. Lyophobic sols- (solvent hating)

### OPTICAL PROPERTIES OF SOLS

Tyndall effect: Sols exhibit tindal effect. The process of scattering of light by the sol particles is called Tyndall effect. Examples of Tyndall effect are light beams from the car on a dusty road and light beams from the projector in a cinema hall.

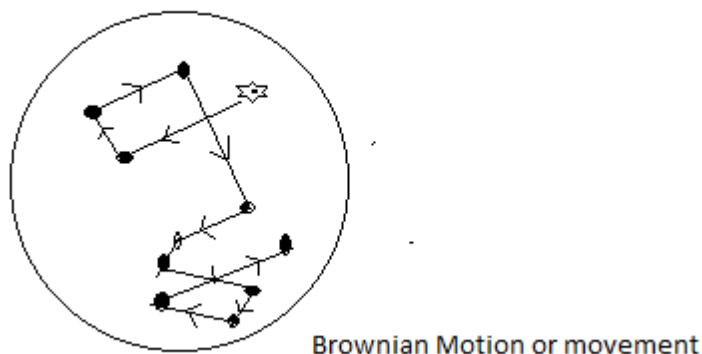


### TYNDALL EFFECT

#### MECHANICAL PROPERTIES OF SOLS

Brownian movement: The continuous rapid zig-zag movement executed by a colloidal particle in the dispersion medium is called Brownian movement

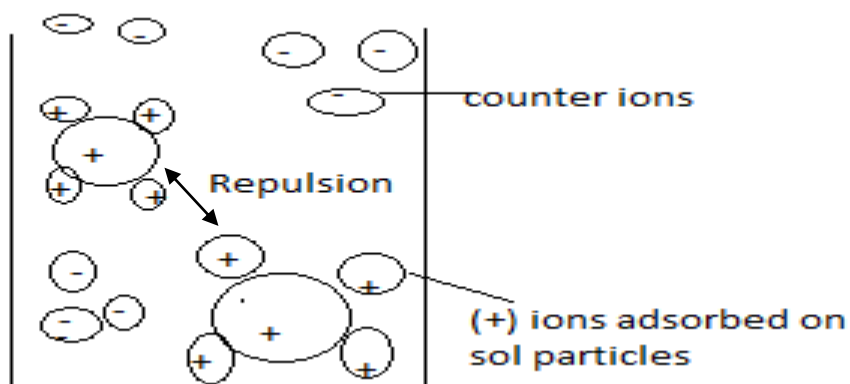
Brownian motion or movement.



When a sol is examined in an ultra microscope the suspended particles are shining light & each particle is constantly in a rapid motion called Brownian movement.

#### ELECTRICAL PROPERTIES

1. The sol particles carry an electric charge. The suspended particles in a colloidal dispersion process (+) ive or (-) charges. These particles acquire positive or negative charge by adsorption of five or –ive inos from the dispersion medium. However sol as a whole is neutral. The charge on the particle is counter balanced by oppositely charged ios called counter ions.



### COAGULATION OF SOLS

The stability of a lyophobic sol is due to the adsorption of positive or negative ions by the dispersed particles. The repulsive forces between the charged particles do not allow them to settle. If charge is removed, these particles aggregate (flocculate) and settle down under the action of gravity.

The settling down of the discharged sol particles is called coagulation or precipitation of the sol.

Coagulation can be done by

- (i) By Addition of electrolytes.
- (ii) By electrophoresis.
- (iii) By mixing two oppositely charged sols.
- (iv) By boiling.

**HARDY-SCHULZ LAW:-** This law is related to coagulation of sols by addition of electrolytes. When electrolyte (for example NaCl) is added to a sol, it furnishes both positive and negative ions in the medium. Sol particles absorb the opposite charged ions and get neutral. So these coagulate. Negative ions (anions) cause coagulation of positively charged sol and vice versa. Hardy Schulz law tells about the effectiveness of an ion for coagulation process.

According to Hardy Schulz law it states that "Precipitating effect of an ion on dispersed particle of opposite charge increases with valency of the ion".

Higher the valency of the effective ion, more is the precipitation power.

For example for precipitation (coagulation) of  $As_2S_3$  sol (negative charged), the precipitating power of  $Al^{3+} > Ba^{2+} > Na^+$

### Protective colloid

The property of lyophilic sols to prevent the precipitation of a lyophobic sol is called protection. The lyophilic sols used to protect lyophobic sol from precipitation is called Protective colloid.

**Gold number:-**

Protective action of different colloids is measured in terms of Gold Number: Gold number is defined as “the number of milligrams of a hydrophilic colloid that will just prevent the precipitation of 10 ml of a gold sol on the addition of 1 ml of 10 percent sodium chloride solution”

Gold Number of different hydrophilic colloids.

|                   |            |
|-------------------|------------|
| Lyophilic colloid | Gold No.   |
| Gelatin           | 0.005-0.01 |
| Potato starch     | 25         |
| Gum Arabic        | 0.10-0.15  |

Gelatin is added in ice cream as a protective colloid. If ice particles coagulate, the smoothness of ice cream is lost.

**EMULSIONS**

An emulsion may be defined as a dispersion of finely divided liquid droplets in another liquid. One liquid is water and other is oil.

Type of emulsions:

- A) Oil-in water – Large medium water. Ex. Milk.
- B) Water in oil- Large medium oil.

**GELS**

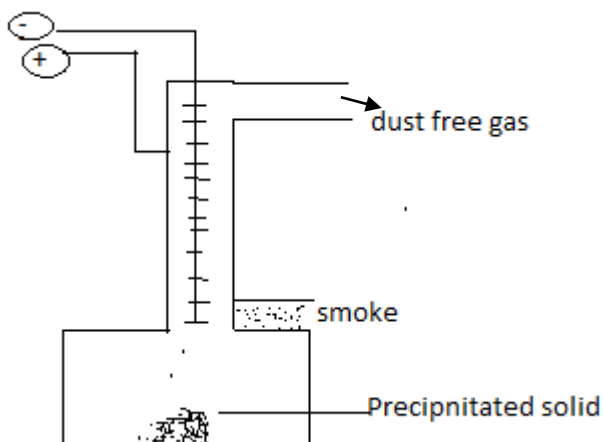
A gel is a jelly-like colloidal system in which a liquid is dispersed in solid medium. The process of formation of gels is called as Legation.

Types of Gels:

- (a) Elastic gels – These have the property of elasticity. They change their shape on applying force and return to original shape when force is removed.
- (b) Non elastic gels:- These are rigid in nature.

**APPLICATION OF COLLOIDS**

1. Foods:- Many of our foods are colloidal in nature milk is an emulsion of butter in water, Fruit jellies, Ice cream etc are examples of colloids.
2. Medicines:- Many medicines are in colloidal form. For example paracetamol syrup, Code liver oil etc.
3. Paints : all paints are colloidal dispersion of solid pigments in a liquid medium.
4. Electrical smoke precipitation: - smoke containing carbon, arsenic compounds etc is ionized and get attracted by oppositely charge electrode & gets precipitated.



5. Purification of water: Coagulation property is used to remove heavy particles from water.
6. Formation of delta: Deltas are formed due to deposition of sand (-ive charged) at the sea water bed. (tivecharge Net ng<sup>+</sup> ions).
7. Artificial kidney machine
8. Blue colour of sky-Due to Tyndale effect

**Concentration of a solution:** It is defined as quantity of solute in a unit volume of solution.

Concentration:  $\frac{\text{Quantity of solute}}{\text{Volume of solution}}$ .

Way of expressing concentration:

**Molarity (M)** No of moles of solute per liter of solution .

$$M = \frac{n}{v} \quad \text{where } n = \text{no of moles of solute} \\ v = \text{volume in liter.}$$

Where amount of solute is in grams then.

Moles = wt in grams

Molecular wt

$$\text{So } m = \frac{x}{M_w} \times \frac{1}{v}$$

**Molarity (m)** No of moles of solute per kilogram of solvent.

$$\text{Molarity (m)} = \frac{\text{moles of solute}}{\text{Mass of solvent in kg.}}$$

**Normality :- (N)** No of equivalents of solute per lile of the solution.

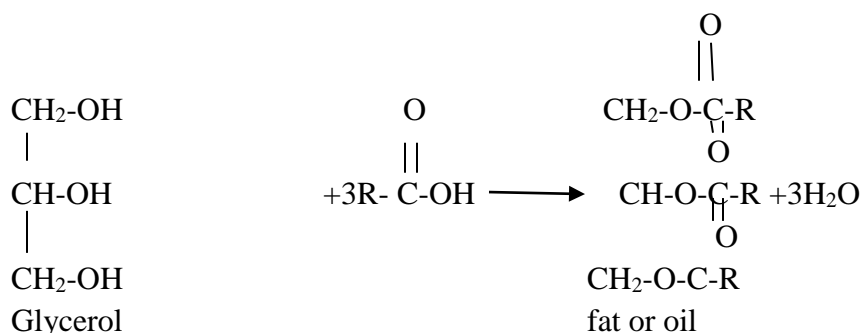
$$N = \frac{\text{equivalents of solute}}{\text{Volume of solution in liters.}}$$

Thus if 40 gm of Na OH (es.wt = 40) is dissolved in one liter of solution. Normality of the solution is one s solution is called 1 Normal.

**STRUCTURE AND COMPOSITION**

Animal and vegetable fats and oils have similar structures.

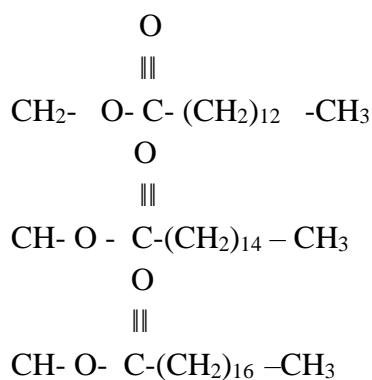
They are trimesters formed from glycerol and long chain carboxylic acids (fatty acids)



Triester of glycerol is called triglyceride or glycoside common fatty acids found in fats and oil are palmetto acid  $\text{C}_{15}\text{H}_{31}\text{COOH}$  and stearic acid  $\text{C}_{17}\text{H}_{35}\text{COOH}$

**Composition of fats and oils:-**

Fats and oil are invariably composed of no of mixed glycosides: –



Glyceryl myristo palmitostearate (mixed glycoside)

White it is difficult to know exactly as to which triglyceride are present in particular fat or oil, the over all% age comp<sup>n</sup> of fatty acids which make up the fat or oil can be determined by analysis

## CHAPTER NO-

### FAT AND OIL, SOAPS AND DETERGENTS

#### Fats and Oils-

**Introduction-** Fats and oil are the most important lipids found in nature. They are widely distributed in edible fats and oils occupy a place of pride in human diet but they also find use as raw material for manufacture of soaps and detergents, paints, varnish polish, lubricants.

**Natural sources:-** fats and oil comes from a variety of sources:-

- (1) Animal fats- located particularly in adipose tissue cells. These are present as oily droplets at body temp, but solidify after death. In the human body 12% of its total weight is fat. Butter and ghee are of animal sources oil & fats.
- (2) Vegetable oils- They are present in seeds and of plants ex. Soybeans, groundnut, coconut, mustard are ex. Of vegetable oil.
- (3) Marine oils- They are obtained from water and ex. Whales, dolphins, seals.

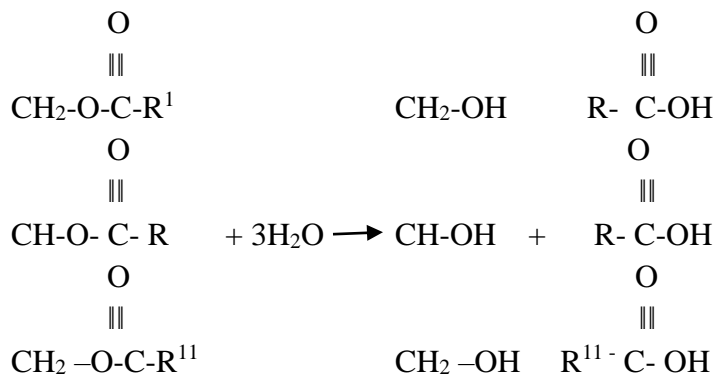
In India animal fat are not used as food ghee and butter are used as they are from animal sources and vegetable oil such as groundnut oil coconut oil, mustard oil, cotton seed oil is used.

#### PHYSICAL PROPERTIES-

1. Oil and fats may be either liquids or non crystalline solids at room temp.
2. When pure they are colorless, odorless and listless so characteristic colour, odors and flavor associated with natural all & fats are added to them by foreign substance.
3. They are lighter & insoluble in  $H_2O$ .
4. They readily form emulsions when agitated with water in presence of soap.
5. They are poor conductor of heat & electricity.

#### CHEMICAL PROPERTIES-

- (1) Hydrolysis are easily hydrolyzed by enzyme called lipases in digesting parts of human body and animals to give fatty acids and glycerol. This fatty acids so produced play imp. Role in metabolic process.

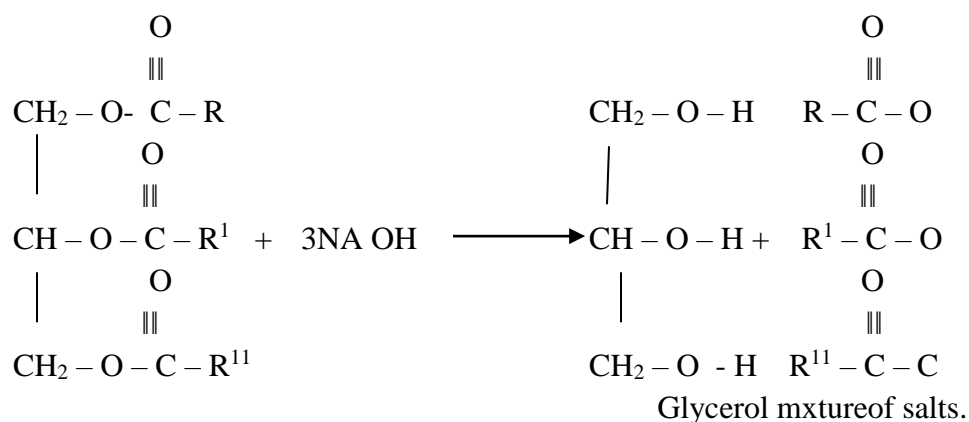


## TRI GLYCERIDE

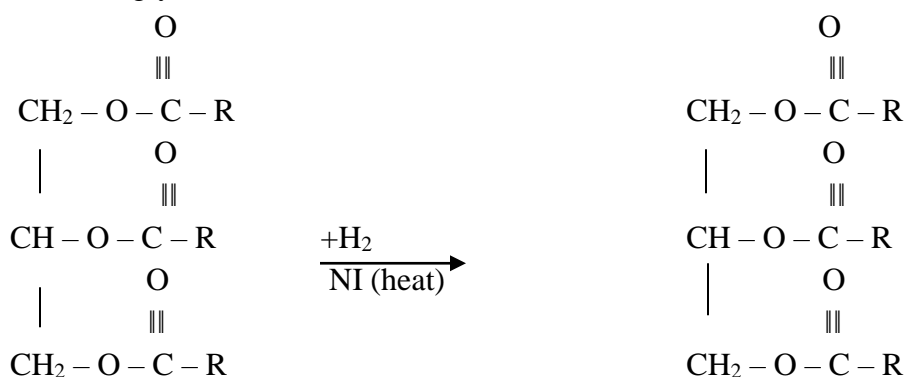
glycerol

fatty acids

Saponification – when triglycerides are saponified by alkalis, then salts of fatty acids are produced.



Hydrogenation unsaturated glycosides reacts the hydrogen in the presence of metal to give saturated glycosides



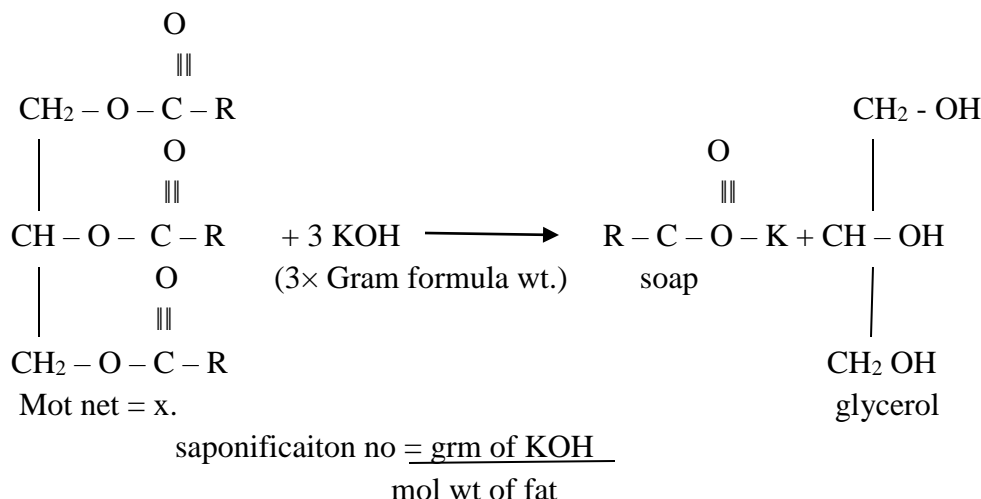
The process of hydrogenation which results hardening of oil owing to formation of fat which is called hardening of oil.

**ANAYSIS OF FATS AND OILS**

Since fats and oils are obtained from natural source, their purity & composition is variable so no of physical and chemical test have been derides to evaluate a given fat or oil some of the tests are:- 1. Saponification Number 2. Iodine 3. Acid number

Saponification Number – Saponification is applied to hydrolysis of an ester when done in alkaline medium of an ester. It is “Number of milligrams of potassium hydroxide required to saponify one grams of fats on oil.





Iodine number –

The extent of instauration in a fat or oil is expressed in trims of its Iodine no. In is “number of grams of Iodine which will add to 100 grams of fats on oil.

I ACID No – no of milligrams of potassium hydroxide required to neutralize one gram of fat.

### CLEANSING ACTION OF SOAP

Structure of a soap molecule - soap molecule is up of two parts :- a long hydrocarbon part and soap ionic part containing – coo Na<sup>+</sup>

Long hydrocarbon chain is hydro phobic (water repelling) so insoluble in HO& chain soluble in water & insoluble in oil.

Hydrocarbon parts of soap molecule is soluble in oil so it can attach to oil& grease particles on dirty clothes whereas short ionic parts is soluble in water so it can attach to the water particle.

**Cleansing Action of Soap:-** When soap is dissolved water, it form colloid, suspension in water in which soap molecule class together to form spherical micelles.

When a dirty cloth is put in water containing dissolved soap, then the hydrocarbon ends of soap molecules in the micelle attach to the oil or greasy particles present on the surface of dirty cloth. In this way the soap micelle entraps the oily or greasy particle by using hydrocarbon ends. When the dirty cloth is agitated is soap solution, the oily and greasy particles particle presentations its surface and entrapped by soap micelles get dispersed in water due to which soap water becomes dirty out cloth gets cleaned.

### LIMITATIONS OF SOAP:-

1. When soap is used for washing clothes with hard water, a large amount of soap is wasted in reacting with ca & mg. ions of hard water to form an insoluble precipitate called SCUM.

2. This SCUM formed by action of hard HO on soap sticks to the clothes being washing & Interferes with cleaning ability & makes cleaning difficult.

### DETERGENT LIMITATION :-

Detergents are not biodegradable, i.e. they cannot be decomposed by micro-organism like bacteria & causes water pollution in lakes.

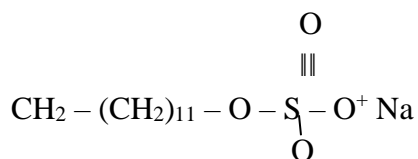
Difference between soaps & detergents

| SOAPS   | DETERGENTS   |
|---|--|
| 1. Soaps are the sodium salts of the long chain carboxylic acids. Ionia part is –<br>COO – Na + | Detergents are the sodium salt of long chain benzene euphonic acids. |
| 2. Not suitable in hard water.  | Suitable in hard water   |
| 3. Soaps are biodegradable  | Detergents are non-bio degradable                                    |
| 4. Have Relatively weak cleansing Action  | Have strong cleansing action.  |

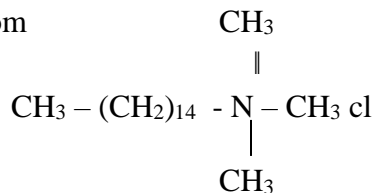
Detergents being insoluble hard and hot biodegradable in water causes water pollution whereas soap water pollution.

**TYPES OF DETERGENTS** – Anionic, Cationic, and non-Ionic detergents.

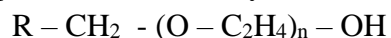
**ANIONIC** – All the alkyl sulphate as also the alkyl benzene sulphonate detergent since they bear an anion at soluble end of chain so called anionic detergent.



**CATIONIC** – are alkyl ammonium salt in which one of the four groups bonded to the nitrogen atom



**NONIONIC** – Posses effective hydrogen bonding groups at one end of the alkyl chain which helps in water solubility

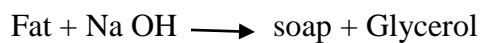
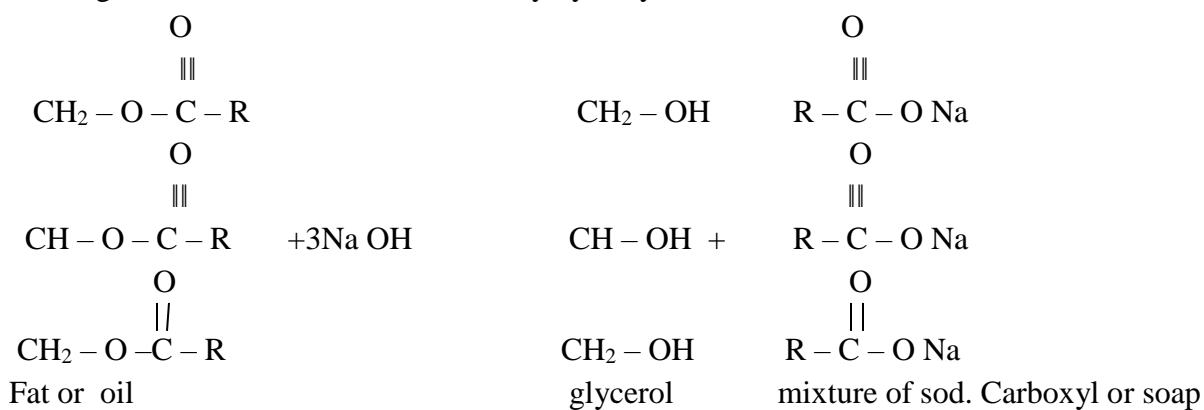


Useful in dish washing

**SOAP AND DETERGENTS**

Soaps and detergents are used as cleaning agents

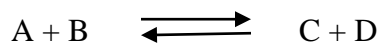
**COMPOSITION OF SOAPS** – Soap are sodium or potassium salts of higher fatty acids containing 12-18 carbon atoms. Obtained by hydrolysis of oil & fat with Na OH.



## CHEMICAL EQUILIBRIUM

### CONCEPT OF REVERSIBLE REACTIONS

A reaction which can go in forward and backward direction simultaneously is called a Reversible reaction. This is represented in the following manner.



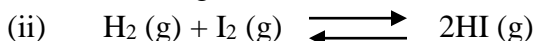
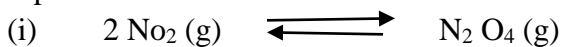
Where A, B are Reactants

C, D are Products

→ Shows forward reaction

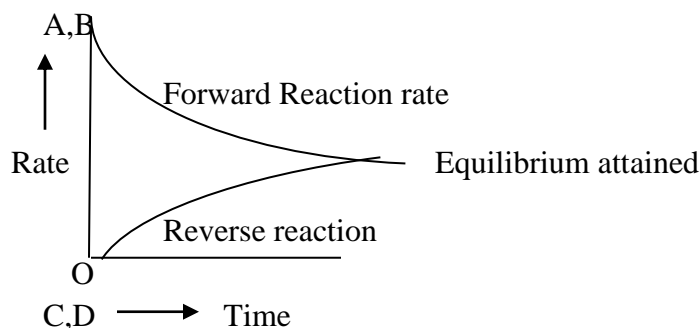
← Shows backward reaction

Example of Reversible reaction.



### CHEMICAL EQUILIBRIUM :-

The state of a reversible reaction when the two opposing reactions occur at the same rate and the concentration of reactants and products do not change with time.



### CHARACTERISTICS OF CHEMICAL EQUILIBRIUM :

1. Constancy of concentrations:

When a chemical equilibrium is established concentration of reactants and product become constant. The reaction mixture (reactants & products) is called equilibrium Mixture. Concentrations at equilibrium are called equilibrium concentrations. These are shown by [ ] brackets

2. Equilibrium can be reached from any side be forward or backward.
3. Equilibrium cannot be attained in an open vessel.

4. A catalyst cannot change the equilibrium point.
5. Value of equilibrium constant does not depend upon the initial concentration of reactants.
6. At equilibrium  $\Delta G = 0$  where G is the Gibbs free energy.

**LAW OF MASS ACTION** :- It states that "The rate of a chemical reaction is proportional to the active masses of the reactants."

Active mass means number of moles/litre. It is represented by closing the formula of substance in square brackets. For example a gas mixture containing 1 g of (H<sub>2</sub>) and 120 gm of I<sub>2</sub> per liter has concentration

$$[\text{H}_2] = 0.5 \quad [\text{I}_2] = 0.5$$

### EQUILIBRIUM CONSTANT:

Let us consider a general reaction.



Let [A], [B], [C], [D], represent the molar concentrations of A, B, C, D, at equilibrium

According to Law of mass action.

Rate of forward reaction  $\propto [\text{A}][\text{B}] = k_1 [\text{A}][\text{B}]$

Rate of Backward reaction  $\propto [\text{C}][\text{D}] = k_2 [\text{C}][\text{D}]$

Where  $k_1$  &  $k_2$  are constant of forward & backward reaction.

At Equilibrium

Rate of forward reaction = rate of backward reaction.

$$k_1 [\text{A}][\text{B}] = k_2 [\text{C}][\text{D}]$$

$$\frac{k_1}{k_2} = \frac{[\text{C}][\text{D}]}{[\text{A}][\text{B}]}$$

$$K_c = \frac{[\text{C}][\text{D}]}{[\text{A}][\text{B}]}$$

$$K_c = \text{equilibrium} = \frac{k_1}{k_2}$$

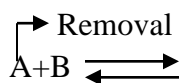
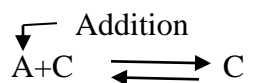
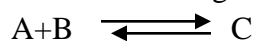
The equation (i) is called Equilibrium constant expression or Equilibrium Law.

**Le-Chatelier's principle**:- This principle is about equilibrium in chemical reactions. It states that "When a stress is applied on a system in equilibrium, the system tends to adjust itself so as to reduce the stress. Stress can be caused by change in temperature, pressure or change in concentration. By this equilibrium will shift to right or left.

**EFFECT OF A CHANGE IN CONCENTRATION:**

When change in concentration of reactants or products is done, the equilibrium shifts in a direction to reduce the change in concentration that was made.

Lets consider a general reaction.



Equilibrium shift to right      Equilibrium shift to left

For example in the reaction.

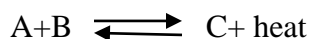


Addition of  $N_2$  or  $(H_2)$  shift the equilibrium to right and more ammonia gas is produced

**EFFECT OF A CHANGE IN TEMPERATURE:**

When temperature of a reaction is increased, the equilibrium shifts in a direction in which heat is absorbed.

Let us consider a reaction (Exothermic)



Here according to the Le-chatlier principle equilibrium shifts to the left



Equilibrium shift to left

This means concentration of reactants is increased.

or

Ir. On      Endo thermic reaction



—————> Equilibrium shifts to right & concentration of product is increased

**EFFECT OF CHANGE IN PRESSURE:**

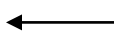
With the increase of pressure chemical equilibrium shifts in that direction in which the number of molecules decreases and vice versa for example.

**System**



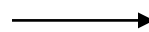
Less no of      more molecules

**Pressure Increase**

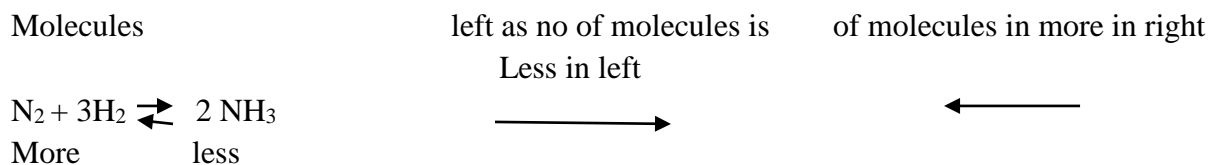


Equilibrium shift to

**Pressure decrease**



Equilibrium shift to right as no



### APPLICATIONS OF LE CHATLIER'S PRINCIPLE IN INDUSTRY

Use of le Charlie's principle is made in the following industrial processes.

1. Production of Ammonia gas by (Haber process) : Applying the principle of le chatlier  
(1) Low temp (2) high pressure (3) a catalyst (Iron with mb)

Condition favour more production of ammonia as equilibrium shifts to right



2. Production of sulphuric acid by (contact process)



Low temp, high pressure and a catalyst favours the forward reaction.

3. Manufacture of Nitric acid (birkland – eyde process)



(Nitric acid)

According to Le-chortler's principle high temp, high concentration of reactants (N<sub>2</sub>& O<sub>2</sub>) shifts the equilibrium to right & more production of Nitric Acid fumes.

## CATALYSIS

### Catalyst :

- a. catalyst is defined as a substance which change the rate of a chemical reaction, it self remaining unchanged at the end of the reaction. The process is called catalysis. Tositive catalyst increases the rate of reaction.
- b. Negative catalyst decreases the rate of reaction.

### Types of catalysis

(A) **HOMOGENIOUS CATACTYSIS:** In homogeneous catalysis, the catalyst is in the same phase as the reactants. This type of catalysis occurs in gas phase or liquid phase.

Example :-

1.  $2 \text{SO}_2 + \text{O}_2 + [\text{NO}] \longrightarrow 2 \text{SO}_3 + [\text{NO}]$   
 (gas) (gas) catalyst (gas) catalyst
2. Decomposition of  $2\text{H}_2\text{O}_2$   
 $2\text{H}_2\text{O}_2 \longrightarrow 2\text{H}_2\text{O} + \text{O}_2$   
 (e) (e) (e)

### (B) **HETROGENEOUS CATAYLSIS:-**

The catalysis in which the catalyst is in a different phase from the reactants, is called heterogeneous catalysis.

Example

- (1)  $2 \text{SO}_2 + \text{O}_2 + [\text{pt}] \longrightarrow 2\text{SO}_3 + [\text{pt}]$   
 (g) (g) (s) (g) (s)
- (2)  $2\text{H}_2\text{O}_2 + [\text{pt}] \longrightarrow 2\text{H}_2\text{O} + \text{O}_2 + [\text{pt}]$   
 (e) (s) (e) (s)
- (3)  $2\text{KClO}_3 + [\text{MnO}_2] \longrightarrow 2\text{KCl} + 3\text{O}_2 + [\text{MnO}_2]$   
 (s) (s) (s) (g) (s)

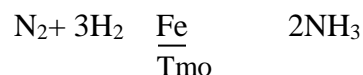
### CHARACTERISTICS OF CATALYTIC REACTIONS

- (1) A catalyst does not change its mass and chemical composition at the end of reaction.
- (2) A very small quantity of catalyst is required for an unlimited reaction.
- (3) If catalyst is finely divided it is more effective.
- (4) One catalyst may be only for me reaction & may not act as catalyst for other similar reaction.
- (5) A catalyst cannot initiate a reaction.
- (6) Catalyst does not change the final equilibrium point but it reduces the time to reach the equilibrium.
- (7) Temp. Changes the rate of catalytic reaction.



**Promoters :** A substance, which promotes the activity of a catalyst, while itself not a catalyst.

**Example:** Mole bud rum (Mo)/ Aluminum oxide  $Al_2 O_3$  promotes the activity of iron catalyst in the process of manufacture of  $NH_3$ (ammonia)



### Auto catalysis:-

When one of the products of a reaction itself acts as a catalyst for that reaction, then it is called auto catalysis.

Examples: Hydro catalysis of Ester.



$CH_3COOH$  acts as a catalyst for this reaction.

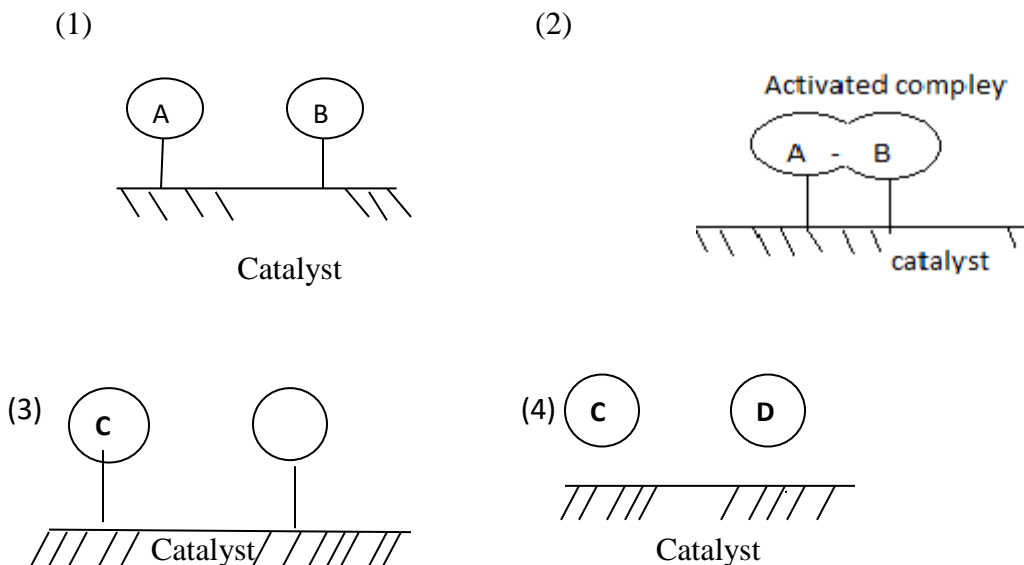
### THEORY OF CATALYSIS

Theory of catalysis means how a catalyst functions. Let us consider a reaction of heterogeneous catalysis



These are four steps of this creation of catalyst :-

1. Adsorption of reactant mole clues on the catalyst surface.
2. Formation of Activated complex: An intermediate activated complex (A-B) is formed.
3. Decomposition of Activated complex. The activated complex breaks form products C&D . Which hold to the catalyst
4. Desorption of products: Particles of products are desorbed form the surface of catalyst.



Mechanism of catalysis

## ACID- BASE CATALYSIS

There are number of homogenous catalytic reactions which are catalyzed by Acids and Bases are called Acid-Base Catalytic reaction so -

**Acid Catalysts** : All  $H^+$ , un-dissociated acids ( $CH_3COOH$ ), cations of weak bases ( $NH_4^+$ ) and  $H_2O$  act as Acid catalysts – In this  $H^+$  ion (or a proton) form the complex with Reactants.

**Base Catalysts** : Similarly all  $OH^-$  ions, undissociate bases, anions of weak acids ( $CH_3COO^-$ ). and water ( $H_2O$ ) act as Base Catalysts. In base catalysis  $OH^-$  ions (or bronsted base) form an complex with the reactants and then decompose to form products &  $OH^-$  ions

## ENZYMES CATALYSIS:

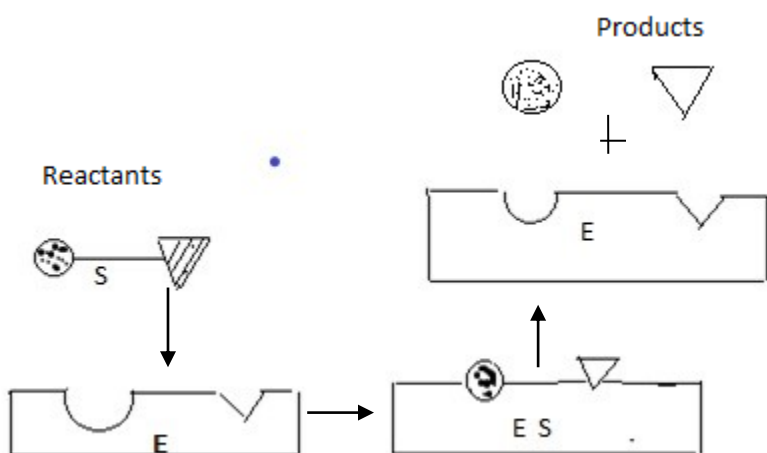
Enzymes are complex protein molecules which speed up the biological reaction. Catalysis brought about by enzyme is called **enzyme catalysis**.

Example :

(1) Conversion of Glucose into ethanol by Zymase present in yeast.



## Mechanism of Enzyme Catalysis :



## Lock & key models of Enzyme Catalysis

Properties of enzyme catalysis

- (1) Enzymes are most efficient catalysts.
- (2) Enzymes are accurate in action.
- (3) Rate of enzyme reaction is maximum at optimum temperature and PH.
- (4) Enzyme can be poisoned or stopped form working by inhibitors.

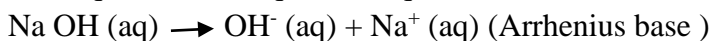
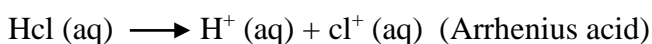
(5) Metal ions like  $\text{Na}^+$ ,  $\text{Mn}^+$ ,  $\text{Co}^{2+}$ ,  $\text{Cu}^{2+}$ , act as activators and promote the catalytic reaction.

## ACIDS AND BASES

**CONCEPTS :** There are three concepts of acids & bases

1. **ARRHENIUS CONCEPTS:** According to the scientist savant Arrhenius “An acid is a compound that releases  $\text{H}^+$  ions in water and a base is a compound that releases  $\text{OH}^-$  ion in water”

For example



Limitations of Arrhenius concept

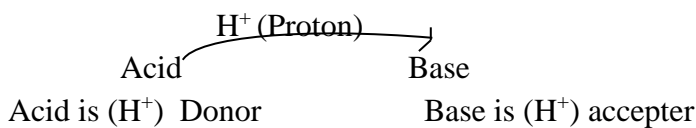
1. Free  $\text{H}^+$  and  $\text{OH}^-$  ions do not exist in waer.
2. This concept is limited to water only and not for other solvents.
3. Some bases do not contain  $\text{OH}^-$  ions. Like  $\text{NH}_3$  (Ammonia) is a base but so not contain  $\text{OH}^-$  ions.

### 2. BRONSTED – LOWRY CONCEPT:

According to this concept

“An acid is any molecule or ion that can donate a proton ( $\text{H}^+$ ) and

A base is any molecule or ion that can accept a proton”

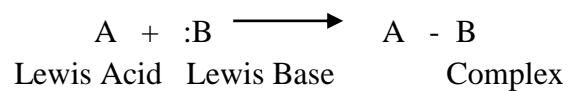


## ACID AND BASES

### LEWIS CONCEPT OF ACIDS AND BASES

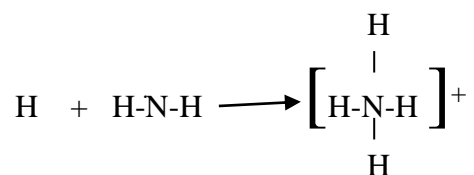
In 1930 G.N. Lewis proposed a more general model of acids and bases. According to this .

- (a) “An strong acid is an accepter of electron pair.”
- (b) “a strong base is donor of electron pair”



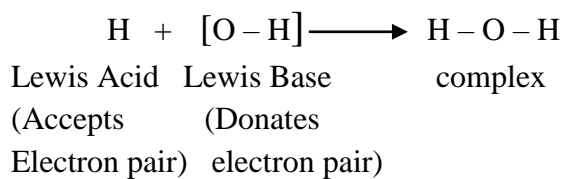
### Examples of Lewis Reactions

1. Reaction between  $H^+$  and  $NH_3$



Lewis Acid    Lewis Base    Complex

2. Reaction between  $H^+$  and  $OH^-$



## ACIDS AND BASES

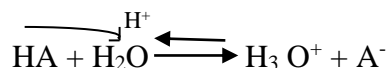
### RELATIVE STRENGTH OF ACIDS AND BASES

#### Relative strength of acids

The strength of an acid is defined as the concentration of H ions in its aqueous solution at a given temperature.

Deviation (For MULA)

Lets us take an acid HA. When it is dissolved in water.



Or Dissociation reaction can be written as



According to Law of mass Action

$$K_a = \frac{[\text{H}^+][\text{A}^-]}{[\text{HA}]}$$

( As water remain constant so [H<sub>2</sub>O] is not shown here)

So from the equation – (1) it is clear that

#### Concentration of H ion & K<sub>a</sub>

More the value of K<sub>a</sub> (Dissociation constant ) more the strength of Acid or Acidity

#### Relative strength of Bases

Let us consider a base BOH, which produce OH ions in aqueous solution. Its dissociation can be shown as



Equilibrium Expression is

$$K_b = \frac{[\text{B}^+][\text{OH}^-]}{[\text{BOH}]}$$

## ACIDS AND BASES

K<sub>b</sub> is called base dissociation constant –

From this equation it is clear that OH<sup>-</sup> ions concentration is direct by related to K<sub>b</sub> Value.

The strength of a base is defined as the concentration of OH<sup>-</sup> ions in aqueous solution at a given temperature. So

For, strong Base= Value of K<sub>b</sub> is more

For, weak base = Value of K<sub>b</sub> is less.

So value of K<sub>b</sub> given the relative strength of bases.

## PH OF SOLUTION

pH is defined as the relative of the log of  $H^+$  ion concentration. Mathematically it is expressed as

$$pH = -\log [H^+]_{10}$$

$$\text{or } pH = \log \frac{1}{[H^+]}$$

$$\text{Or } H = 10^{-pH}$$

pH is the convenient way of expressing hydrogen ion concentration.

Similarly concentration of  $OH^-$  ions in aqueous solution of a base is expressed as

$$p[OH] = -\log [OH]$$

## ACIDS BASES

### Measurement of pH

The pH of a solution can be measured with the help of an apparatus called pH meter. It contains a voltmeter connected to two electrodes

### CONSTRUCTION & WORKING OF DIGITAL pH METER:

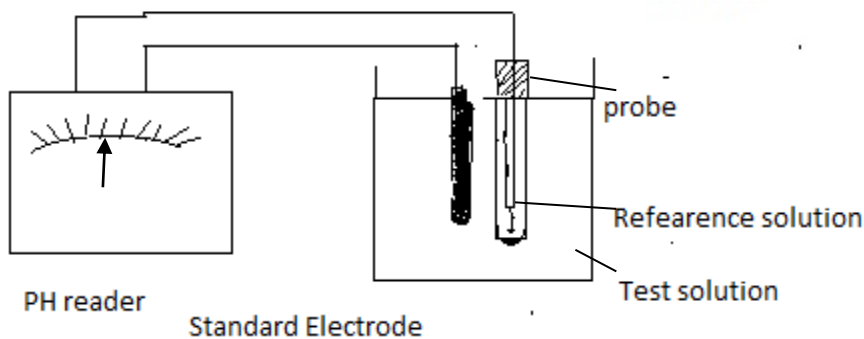


Diagram of pH meter

### It consist of two electrodes

1. Standard electrode
2. Special Electrode (probe). It is enclosed in a glass membranes that allows migration of  $H^+$  ion. The glass contains a reference solution of dilute HCl.

Working:- Two electrodes are dipped in the solution to be tested. If this solution has a different pH from the solution in the probe, an electrical potential is shown. Potential between the standard electrode & glass electrode varies with the pH of solution under test. This potential difference is noted by potential meter and reading is converted to pH scale. Knowing pH  $H^+$  ion concentration can be calculated.

## ACIDS AND BASES

### pH scale :-

The scale on which pH values are computed is called pH scale.

### What is pH:

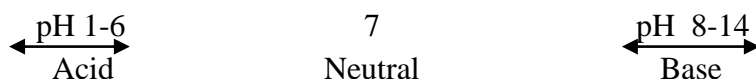
Dissociation of water can be shown here



By equilibrium expression we can write

$$K = \frac{[H^+][OH^-]}{[H_2O]} \text{ or } K_w = \frac{[H^+][OH^-]}{[H_2O]} \text{ seing constant}$$

The  $H^+$  ion and  $OH^-$  ion concentration in pure water are both  $10^{-7}$  mol liter. Water is said to be neutral. So we can say "All solutions having pH less than 7 are acidic and more than 7 are basic.



### Relation between pH and pOH.

From above we know that

$$K_w = [H^+][OH^-]$$

Applying log  $\log K_w = \log [H^+] + \log [OH^-]$

Or  $-\log K_w = -\log [H^+] - \log [OH^-]$

Or  $K_w = pH + pOH$ .

&  $K_w = 1.0 \times 10^{-14}$

&  $pK_w = -\log (1.0 \times 10^{-14}) = 14.00$

So  $pH + pOH = 14$

## ACIDS AND BASES

### BUFFER SOLUTION

A buffer solution is one which maintains the pH of the solution, even after addition of small amounts of acid or base.

#### Type of buffer solution

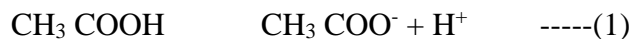
Acid buffers : a weak acid together with a salt of the same acid with a strong base for example  
 $\text{CH}_3\text{COOH} + \text{CH}_3\text{COONa}$ .

BASIC BUFFER:- A weak base together with a salt of the same base & a strong Acid.

For example  $\text{NH}_4\text{OH} + \text{NH}_4\text{Cl}$ .

### MECHANISM OF A BUFFER ACTION

Let us consider an ACID BUFFER OF  $\text{CH}_3\text{COOH}/\text{CH}_3\text{COONa}$



#### Mechanism of buffer action of an Acid buffer.

(1) Addition of HCl  $\rightarrow$  On addition of  $\text{H}^+$  ions it associates with  $\text{CH}_3\text{COO}^-$  ions to form unionized  $\text{CH}_3\text{COOH}$ .

So H ions are neutralized & pH of the buffer does not change.

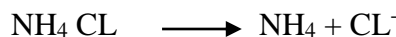
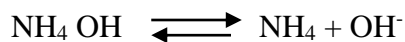
(2) Addition of Na OH

When Na OH is added to buffer. The OH ions are neutralized by H ions to form water.

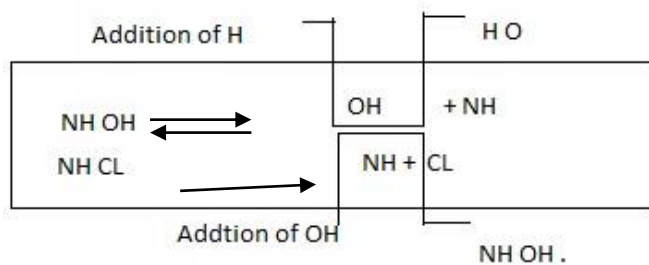
So more H ions are produced to neutralize the added OH ions & pH of the buffer solution remains unchanged.

#### BASIC BUFFER OPERATION.

Let us consider a buffer of  $\text{NH}_4\text{OH}/\text{NH}_4\text{Cl}$ .







### Adding of Hcl

On addition of HCl  $\rightarrow$   $H^+$  ions combine with  $OH^-$  ions to form water. Equilibrium shifts to right & more  $OH^-$  ions are produced to neutralise  $H^+$  ions. So pH of buffer does not change.

### Addition of Na OH

On addition of Na OH  $\rightarrow$   $OH^-$  ions combine with  $NH_4^+$  ions to produce  $NH_4 OH^-$  (unionised) & the pH of the buffer does not change.

## ALKANES

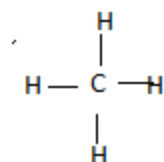
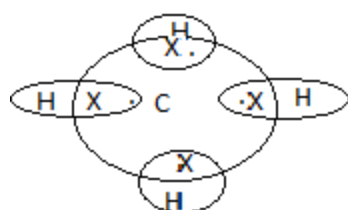
**ALKANES:** are simplest classes of organic compound. These are made of carbon and hydrogen containing.

- Types of Bonds: - carbon- Hydrogen (C-H) & carbon –carbon (C-C).

It forms homologous series with general formula  $C_n H_{2n+2}$ . Where N is no of carbon atom say n= 1, 2, 3, ---

- They are known as “SATURATED HYDROCARBONS”.

**STRUCTURE:-** The molecules of alkanes are made of carbon atoms joined each to each by single covalent bonds carbon valency - 4 & Hydrogen valency-1



Methane

$CH_4$  – Methane

$C_2 H_6$  – Ethane

$C_3 H_8$  – Propane

$C_4 H_{10}$  – Butane

$C_5 H_{12}$  – Pentane

$C_6 H_{14}$  – Hexane

$C_7 H_{16}$  – Heptanes

$C_8 H_{18}$  – Octane

$C_9 H_{20}$  – Nonane

### PHYSICAL PROPERTIES:-

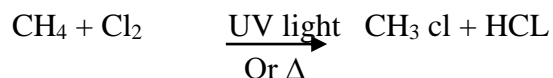
- (1) The first four alkanes ( $C_1$ -  $C_4$ ) from methane to butane are gases next ( $C_5$ - $C_{17}$ ) from pentane to heptadecane are liquids. The gaseous & liquids have characters associated with petroleum products.
- (2) Alkanes have non polar molecules & hence insoluble in water.
- (3) Density of alkanes increases with size of molecule.

### CHEMICAL PROPERTIES:-

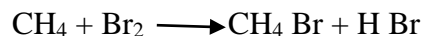
#### (A) SUBSTITUTION REACTION –

- (1) Halogenations:- It involves substitution of H-atom of alkanes by chlorine (chlorination) ; by Bromine (Bromination) ; by (Iodination) by fluorine (fluorination)

- (a) CHLORINATION – Methane reacts with chlorine in the presence of UV light or high temp to form methyl

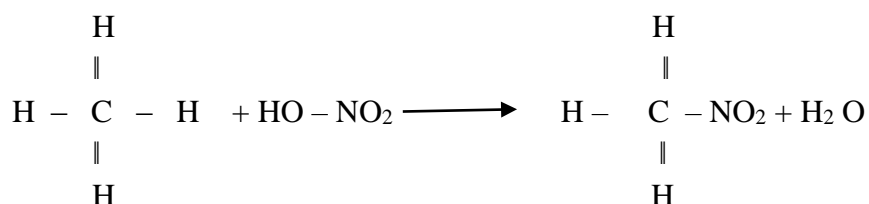


- (b) BROMINATION – Bromine reacts with methane to form ethyl Bromide



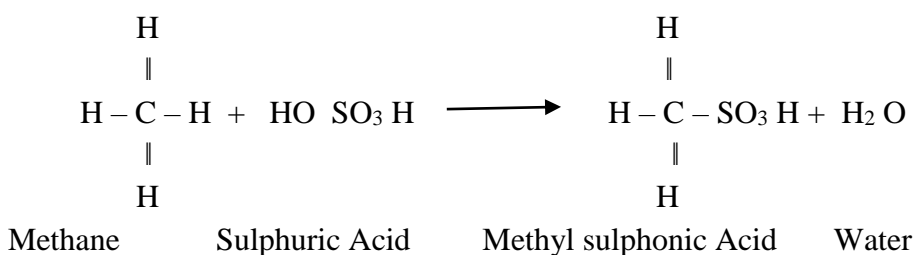
- (B) NITRATION - (Substitution of –  $NO_2$  from H)

When mixture of alkenes and nitric acid vapour is heated at 400-500<sup>0</sup>c one H atom is Substituted by –NO Group. This is called VAPOUR PHASE NITRATIO



(C) **SULPHONATION** :- (Substitution of – SO<sub>3</sub> H for H)

When alkenes is subjected to a prolonged reaction with sulphuric acid, then one H – atom is replaced by – SO<sub>3</sub> H Group.

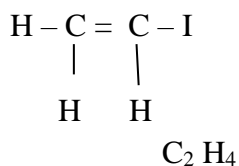
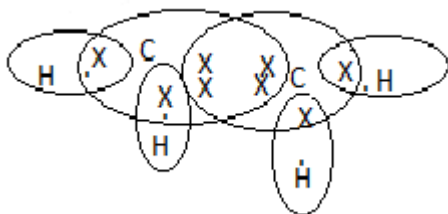


## ALKENES :

Are hydrocarbons that contains C – C double bonds (C-C ) in their molecules.

They have General formula C<sub>n</sub> H<sub>2n</sub>

They are called unsaturated compounds.



C<sub>2</sub> H<sub>4</sub> - ethane

C<sub>3</sub> H<sub>6</sub> – Propane

C<sub>4</sub> H<sub>8</sub> - Butane

C<sub>5</sub> H<sub>10</sub> – Pentene

C<sub>6</sub> H<sub>12</sub> – Hexane

C<sub>7</sub> H<sub>14</sub> – Heptanes'

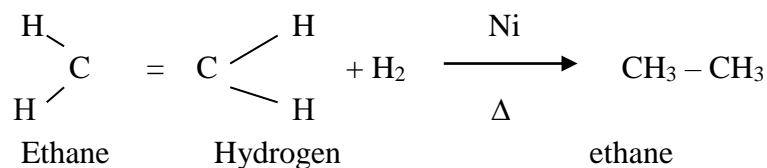
## PHYSICAL PROPERTIES:-

1. Alkenes containing 2-4 carbon atoms (ethylene, Propylene butane ) are gases, 5-18 carbon atoms are liquid and more than 18 are solids.
2. They are insoluble in H O & soluble in organ solvents like alcohol, , C cl4.
3. Lighter than H O.
4. M.P. & B.P increases with increase in chain.

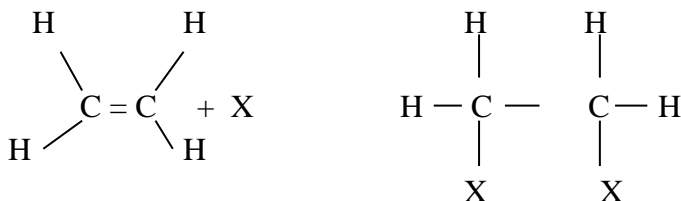
### CHEMICAL PROPERTIES :

#### 1. HYDRO GENATION- (Add<sup>4</sup> of hydrogen)

Alkenes add Hydrogen in presence of metal catalyst forming corresponding Alkane.

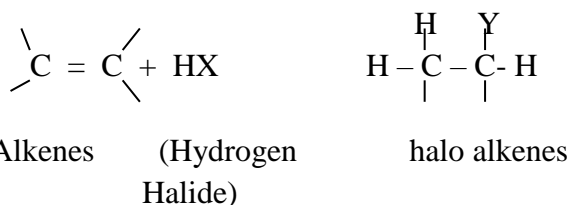


#### 2. HALOGENATION – Add<sup>4</sup> of Halogen (-cl,-Br,-I)



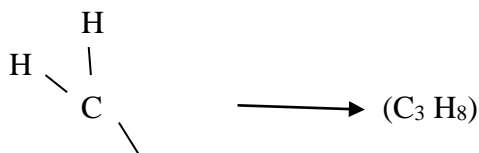
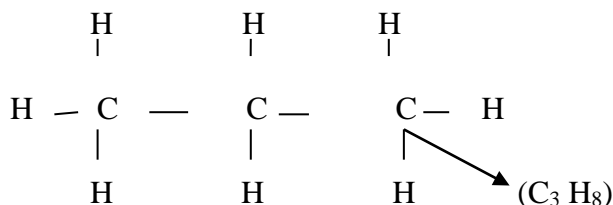
1,2 – dialog alkenes(eg. 1,2 dialog alkance)

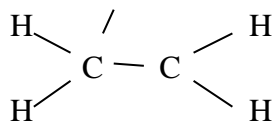
#### 3. HYDRO HALOGENATION – (Add<sup>n</sup> of – Hcl,- H Br,- HI



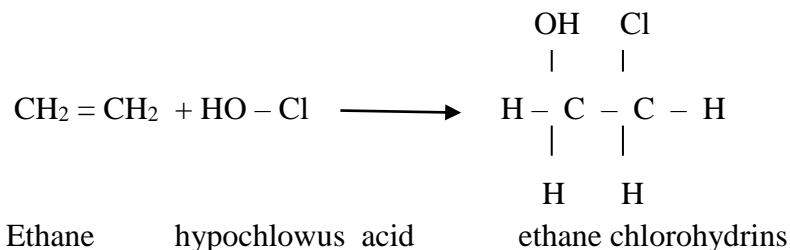
**ISOMERISM** – hydrocarbons having same molecular formula but different physical structure.

Eg- propane (C<sub>3</sub> H<sub>8</sub>)

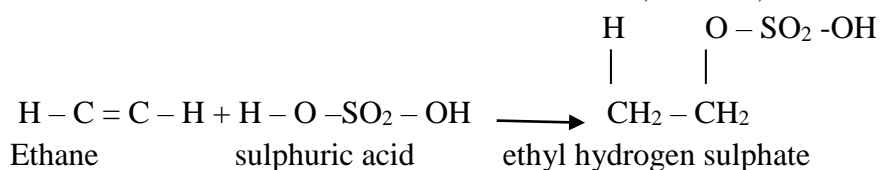




4. **ADDITIONS OF HYPOHALOUS** – Add<sup>n</sup> of HO – Cl, HO – Br

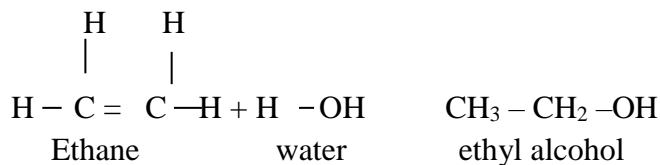


5. **ADDITIONS OF SULPHURIC ACID:-** ( - SO<sub>3</sub> H )      →



When Alkenes reacts with sulphuric acid it forms ethyl hydrogen sulphate.

6. **ADDITIONS OF WATER** (Hydration )

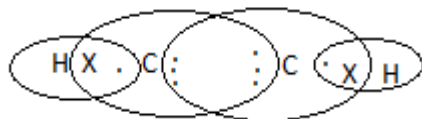
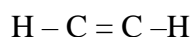


Water added to alkenes in presence of catalyst to form alcohol

**ALKYNES-**

(1) They are unsaturated hydro carbons.

(2) Their General formula is C<sub>2</sub> H<sub>2n-2</sub>



(3) They are formed p/w C & H containing triple bond

C<sub>2</sub> H<sub>2</sub> – ethylene      C<sub>5</sub> H<sub>8</sub> – Pentene

C<sub>3</sub> H<sub>4</sub> – Propane

C<sub>4</sub> H<sub>6</sub> – butane

**PHYSICAL PROPERTIES:-**

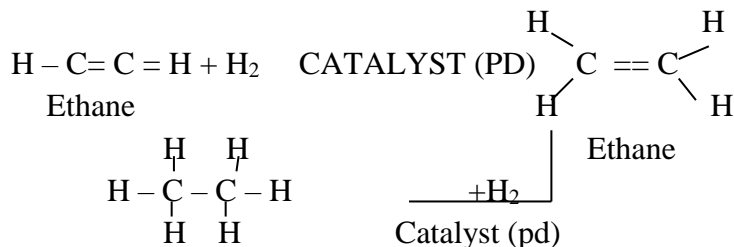
1. 1<sup>st</sup> Three members are gases, C – C is liquids & higher to C are solids.

- They are colorless & odorless.
- Alkynes are of low polarity & slightly soluble in water.
- Their melting & boiling point are higher than alkenes & alkenes.

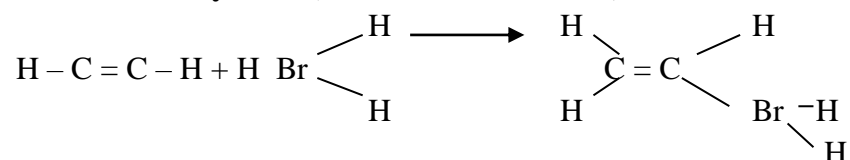
### CHEMICAL PROPERTIES:-

#### 1. ADDITIONS REACTION –

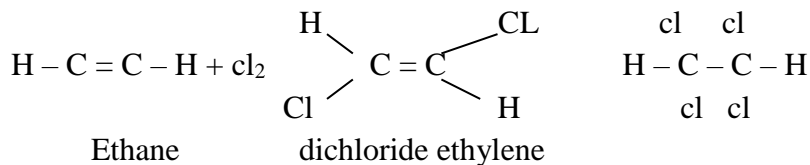
HYDROGENATION: - Add<sup>n</sup> of H



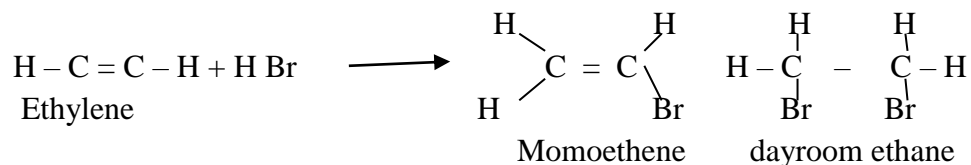
#### 2. Add<sup>n</sup> of boron Hydride (HYDROBORATION)



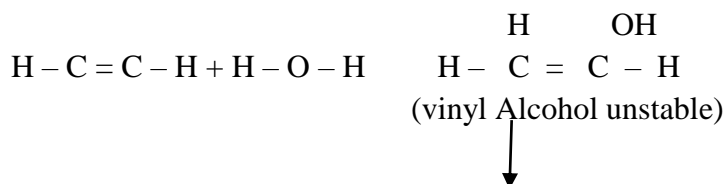
#### 3. Addition of halogen (HALOGENATION) – Alkynes adds on time molecules of halogens forming haloalkene & then tetrahalo alkenes

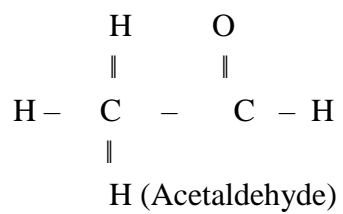


#### 4. Add of Hydrogen halides (HYDRO HALOGENATION) Addition of hydrogen halides is also done in two stages



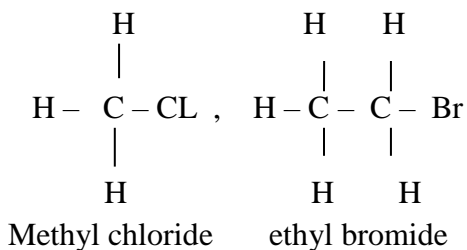
#### 5. Addition of water – (HYDRATION)





## HALOGEN DERIVATIVES:

Alkyl halides are derivatives of alkanes in which hydrogen is replaced by halogen atom (F, Cl, Br, I)



### PHYSICAL PROPERTIES

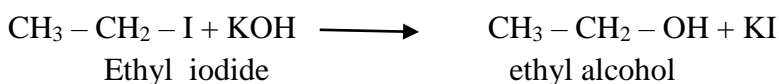
1. Are gases at Room temp?
2. Are colorless and have pleasant sweetish odor.
3. Are insoluble in Water?
4. Are generally toxic and need to be handled with care.
5. Boiling Point are higher than alkenes.

### CHEMICAL PROPERTIES:-

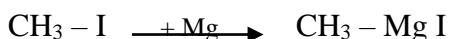
1. Reduction of Alkyl Halides – With Zn-cu couple and alcohol or with Zn and HCl acid gives alkenes.



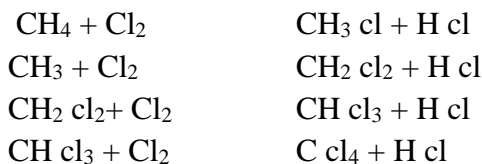
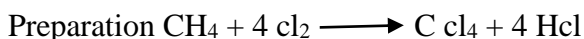
2. Substitution by hydroxyl Group:- When treated with aq. Potash in boiling water forms alcohols.



3. Reaction with Metal



### CARBON TETRA CHLORIDE $\longrightarrow$ CCl<sub>4</sub>



**Uses of Alkanes:** - Methane, Ethane etc. are member of Alkanes.

- (1) Methane is used as domestic fuel and illuminant.
- (2) For making carbon black needed for paints, printing inks.
- (3) For making Automobile tyres.



- (4) For making Anesthetic & like  $\text{CH}_3\text{Cl}$ ,  $\text{CCl}_4$ .
- (5) Ethane is used for making ethane.
- (6) Methane is used for making methyl's alcohol.

**Uses of Alkene:** (Unsaturated Hydro carbons) as these have two hydrogen atoms less than Alkenes  $\text{C}_n\text{H}_{2n}$ .

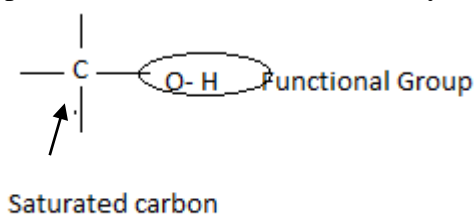
1. These are used for making oily products so these are also called olefins.
2. These are produced form cracking of petroleum.
3. Ethylene (Ist member of Alkene) is used for ox ethylene flame used for cutting and welding of metal.
4. For ripening of fruits.
5. Used as Anesthetic
6. For making Plastic (poly ethylene)

**Uses of Alkynes:** Acetylene (Ethane  $\text{CH}=\text{CH}$ ) is the simplest member of Alkynes. It is used for

1. Illumination in hawkers lamps, in light house.
2. For welding of metals.
3. For artificial ripening of fruits and vegetables.
4. For making plastic and synthetic rubber.
5. It is used for making synthetic fibre orlon.

## Alcohols

**Definition:** All organic compound whose molecule contain hydroxyl group ( $-\text{OH}$ ) attached to a



saturated carbon atom

### Types:-

Monohydric Alcohols: containing one,  $-\text{OH}$  group.

Dethydric Alcohols: Containing two  $-\text{OH}$  groups.

Trihydric Alcohol: Containing three-  $\text{OH}$  groups.

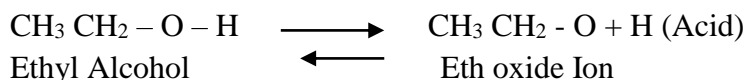
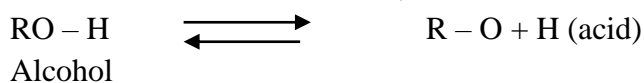
### Physical Properties:-

- (1) Odor (smell) and taste: Lower Alcohols are colourless, volatile liquids having 'alcoholic' smell and burning taste.
- (2) Solubility: - Alcohols completely mixable with water.
- (3) Narcotic Action:- Alcohols have narcotic action methyl alcohol is a nerve poison and it paralyses optic nerve and cause blindness

- (4) Boiling Point :- Boiling point of alcohols increase regularly with the addition of each – CH<sub>2</sub> groups to ch.

### Chemical Properties:-

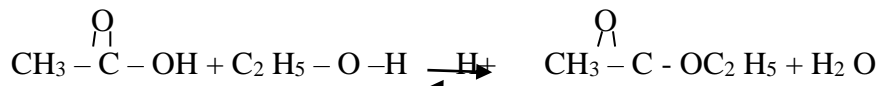
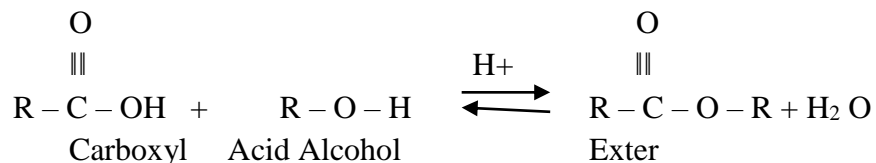
1. Alcohols be has as weak acids, like water.



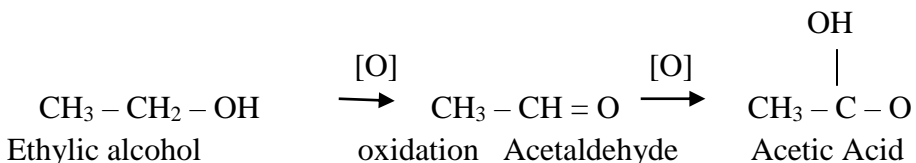
2. Alcohols react with Alkali metals to form lakesides.



3. Alcohols react with carboxylic Acids in the presence of inorganic acid, say sulphuric acid, as catalyst to form ester.



4. On oxidation of alcohols hydrogen is removed from the carbon bearing the OH groan (hydrogen) and from the oxygen atom. This makes cursorily groups.

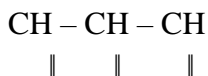


### Uses:

1. It has medical use and added in medicines.
2. Rectified spirit is used as a combustible material for flame generation in burness.
3. Uses for paint industry as solvent.
4. Residual liquor (spent wash) has nitrogen in it. It is used as fodder for cattle.
5. It is also used as fertilizer for agricultural.
6. A big beverage industry is there which a source of revenue for the gouts is.

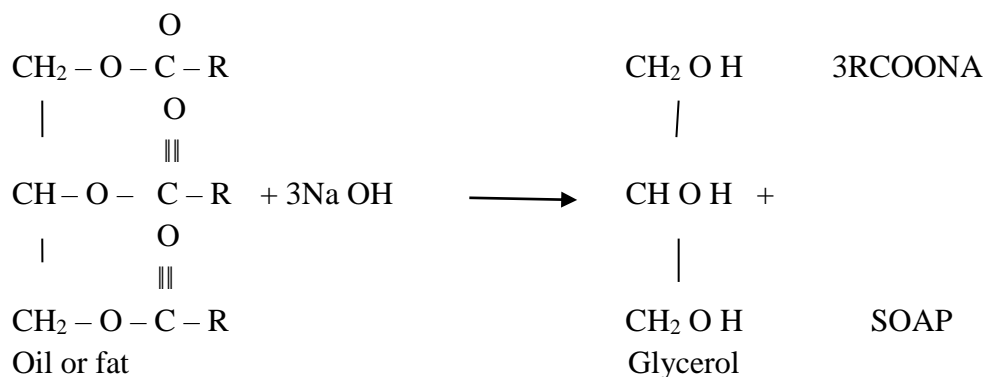
### GLYCEROL (GLYCERINE)

Definition: Glycerol is the simplest trihydric alcohol. It occurs in almost all natural animal tats and vegetable oils. General formula of Glycerol is





It is made by hydrolysis of oil and fats.



### Properties: - Physical Properties

1. It is a colourless and odorless thick syrupy liquid having sweet taste.
2. It boils at  $290^\circ \text{C}$
3. It is hygroscopic and water, soluble.
4. It is non toxic- (poisonous)

### Chemical properties

1. Reaction with organic Acids to form Di and triacetate of glycerol.
2. Reaction with HCl, OH at ---- positives are replaced to form mono or dihydro.
3. Halogens (Iodide) react with glycerin to form. Glycerol Iodide.
4. Glycerol reacts with oxalic acid to form formic acids.

### Uses:

1. It is a sweetening agent in beverages and confectionary.
2. It is used in making high class toilet soaps and cosmetics.
3. In preserving tobacco from drying out.
4. As antifreeze in automatic radiators.
5. Works as lubricants for watches, locks.
6. As a preservative for fruits and eatables.
7. For making printing inks and inks for stamp pads.
8. For preparation of nitroglycerine.

### Aromatic carboxylic Acids

When one or more carboxyl groups (-COOH) are attached to the aromatic or nucleus. It is called Aromatic carboxylic Acid.



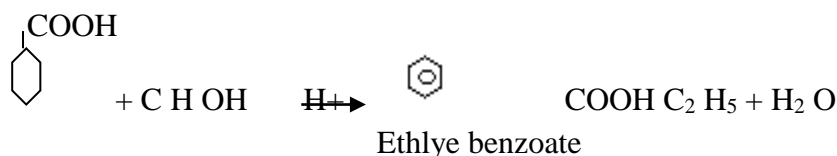
|                         |                |              |              |
|-------------------------|----------------|--------------|--------------|
| Denzoic Acrider Benzoic | ortho – methyl | meta-methyl  | Para-meter   |
| Benzene carboxylic Acid | Benzoic Acid   | Benzoic Acid | Benzoic Acid |

### Physical Properties:

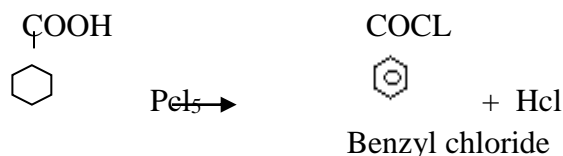
1. These aromatic acids are white crystalline solides.
2. These are slightly soluble in cold water.
3. These are fairly soluble in hot water and organic solvents.
4. Their melting point is higher than aliphatic Acids.

### Chemical Properties

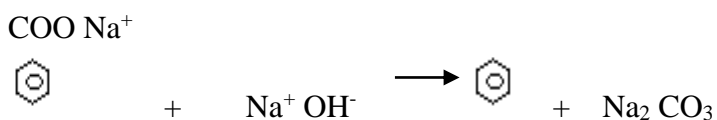
1. Acidity: The Benzoic Acid is stronger acids than Aliphatic carboxylic acids (HCOOH, CH<sub>3</sub> COOH) etc.
2. Benzoic Acid form ester (Acid + Alcohol Ester)



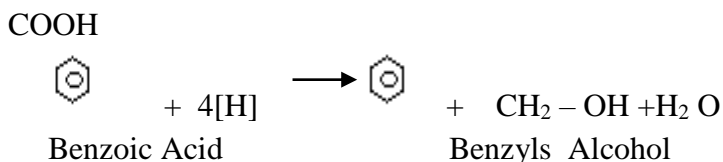
3. Benzoic acids form Acid chloride when heater with Phosphorus pinto chloride.



4. Reaction with Na OH delonboxylation



5. Reduction  $\longrightarrow$



**Uses :** Benzoic Acid is used for

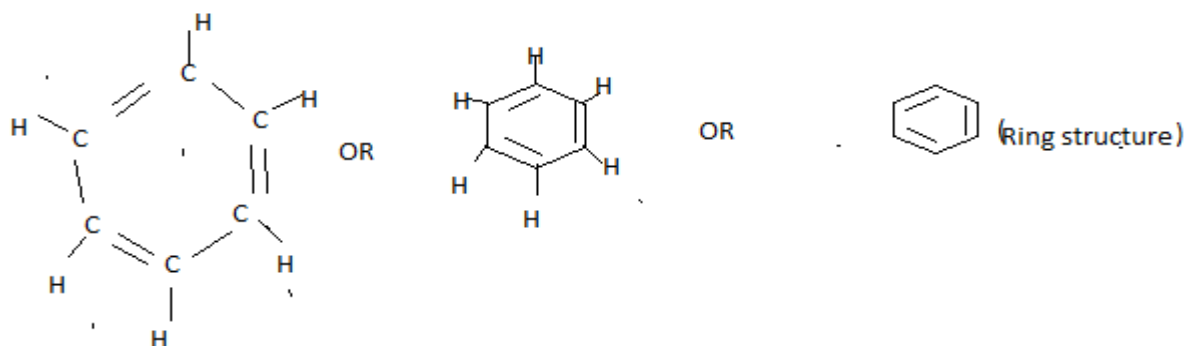
1. As medicine as antiseptic and is vapors form for lungs treatment.
2. Making Dyes Aniline Black dye.
3. As a preservative for food (sodium Benzoate) for tomato catch up and fruit juice.

**Aromatic compounds**

Aromatic compounds have a ring structure. These compounds had some pleasant smell (aroma). So these were named aromatic compounds. These are monocyclic arenas.

**BENZENE –**

Benzene is the aromatic hydro carbon. Its general structure is represented as



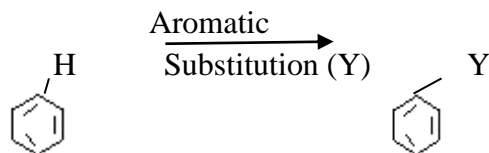
Each corner of the hexagon is understood to have one carbon and one hydrogen atom.

**Physical Properties:**

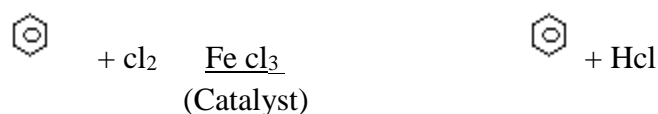
1. These are colourless liquids having good smell.
2. These are insoluble in water.
3. These are lighter than water.
4. These are mixable with organic solvents such as petrol, ether etc.
5. These dissolve fats and many other organic substances which are insoluble in water.

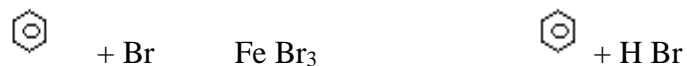
**Chemical properties:**

1. Substitution Reaction:- In this a hydrogen atom of the ring is substituted by an atom or group Y

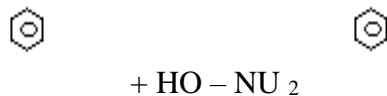


2. Benzene reacts with chlorine or bromine to give Halogenations, Bromobenzene. It is to give Halogenations Reaction.

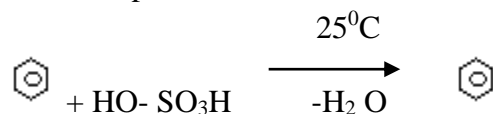




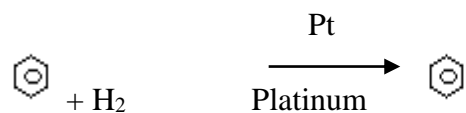
3. Benzene reacts with Nitric Acid in the presence of sulphuric Acid. It is called Nitration.



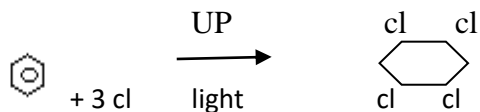
4. Sulphur nation: Benzene reacts with sulphuric Acid to form Benzene sulphuric Acids. This is called sulphonation.



5. Benzene reacts with H<sub>2</sub> to form cyclohexane.



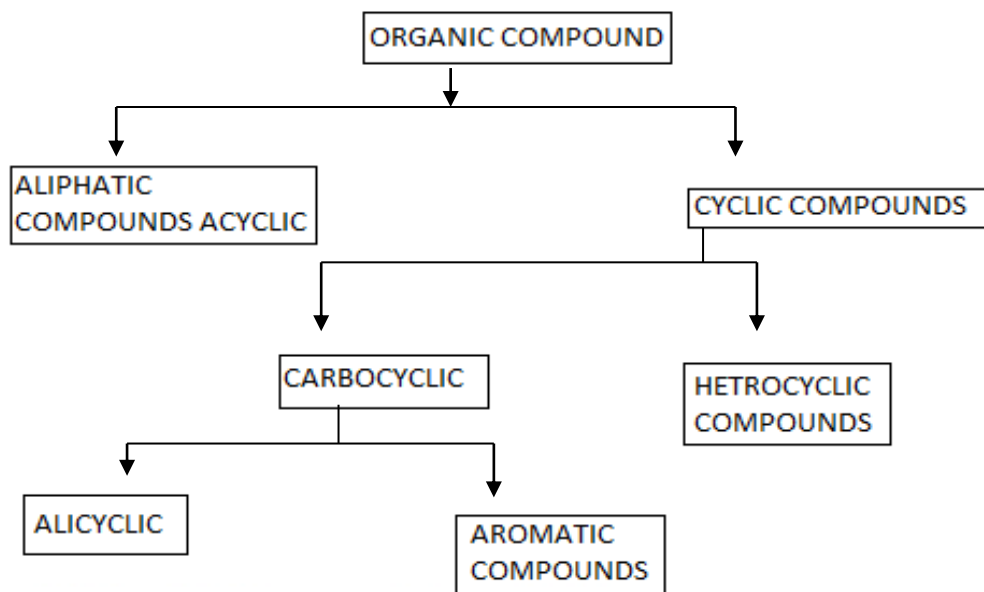
6. Benzene adds Cl atoms (Cyclohexane) under UV light



#### Uses:

1. It is used as a dry cleaning agent to remove oil and fats on woolen clothes.
2. As a motor fuel mixed with petrol.
3. For manufacture of dyes, pigments.
4. Perfumes and Explosives.
5. For making plastics and Bakelite (unbreakable plastic).
6. For making drugs.

## CLASSIFICATION OF ORGANIC COMPOUNDS



### ALIPHATIC COMPOUNDS:-

Compounds which contain open chain of carbon atoms are called aliphatic or monocyclic compounds.

Example -



Propane

### CYCLIC COMPOUNDS:-

Compounds which contain a ring made of carbon atoms.

A. **Carboxylic compound:-** which contains only carbon atoms in the ring.

Aromatic compounds – This is a carboxylic compound. It contains one or more benzene rings. These are called aromatic compounds.

B. **Heterocyclic compounds:-** Which contain one or two atoms of (O,N,S) other than atoms in the ring.