Unit - V

Surface Chemistry

Surface chemistry → It is a branch of science which deals with the study of nature of surfaces and various phenomenon occuring on the surfaces.

* Adsorption → The phenomenon of attracting and retaining the molecules of a substance at the surface of a solid resulting into the high concentration molecules on the surface than bulk is u/as adsorption

Adsorbent → The substance on the surface of which adsorption occurs is u/as adsorbent.

Adsorbate → The substance which get adsorbed on the surface of the adsorbent is u/as adsorbate.

* Absorption → The phenomenon in which the molecules of a substance is uniformly distributed through the body of other substance is u/as absorption.

Difference b/w Adsorption and Absorption

Adsorption	Absorption
1) It is the phenomenon of attracting and retaining the molecule of a substance at the	It is the phenomenon in which the molecules of a substance is uniformly distributed

	surface of solid.	through the body of other substance
2)	The concentration is more on the surface than the bulk.	The concentration is ~~more than~~ the bulk more than on the surface.
3)	It is surface phenomenon.	It is a bulk phenomenon.
4)	It is a rapid in the beginning and then slows downs	It occurs with uniform speed.

* Sorption → In some cases both adsorption and absorption occurs simontaneously. This phenomenon is ~~k~~/as sorption.

Types of adsorption →
Depending upon the nature of forces b/w the adsorbent and adsorbate there are two types of adsorption →
1) Physical adsorption / physisorption
2) Chemical adsorption / Chemisorption

Physical adsorption → when the particles of adsorbate are held on the surface of adsorbent by weak physical forces such as vanderwall forces then the adsorption is ~~k~~/as physical adsorption or physisorption.

Chemical adsorption → when the forces particles of adsorbate are held on the

surface of adsorbent by strong chemical forces such as chemical bond then adsorption is also chemical adsorption or chemisorption.

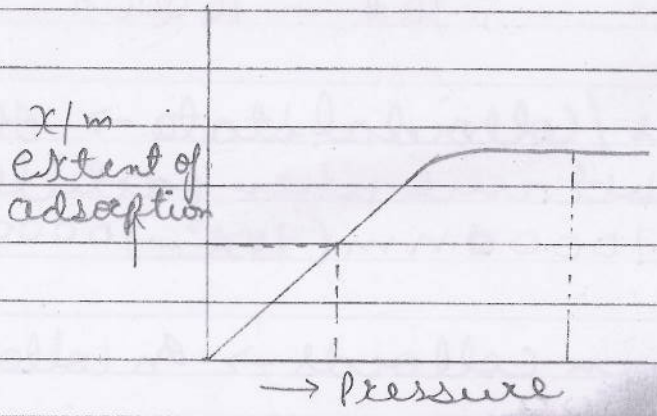
Difference b/w Physical and Chemical adsorption →

	Physical adsorption	Chemical adsorption
1)	In it the molecules of adsorbate are held on the surface of adsorbent by weak forces.	In it the molecules of adsorbate are held on the surface of adsorbent by strong forces.
2)	The enthalpy of adsorption is less	The enthalpy of adsorption is high.
3)	It is reversible in nature	It is irreversible in nature.
4)	It is not specific in nature.	It is specific in nature.
5)	It forms multilayers	It forms monolayer.
6)	It decreases with increase in temperature.	It first increase and then decrease with temperature.

Enthalpy of adsorption → It is the amount of energy released when one mole of adsorbate get adsorbed on the surface of a adsorbent.

Frendlich adsorption isotherm → The variation of extent of adsorption with

pressure at constant temperature w
given by Frendlich. This relation
is known as Frendlich adsorption isoth



The variation of extent of adsorption
pressure at constant temperature
can be represent by a plotting grap

(I) At low pressure

$$\frac{x}{m} \propto P$$

$$\frac{m}{x} = k P^{-1} \quad \text{—①}$$

(II) At high pressure

$$\frac{x}{m} \propto P^{0}$$

$$\frac{x}{m} = k P^{0} \quad \text{—②}$$

Now from equation ① & ②

(III) At intermediate pressure

$$\frac{x}{m} \propto P^{1/n}$$

$$\boxed{\frac{x}{m} = k P^{1/n}} \quad \left[\text{where } 0 < \frac{1}{n} < 1\right]$$

The relationship is known as Frendlich
adsorption isotherm.

* Colloids / Colloidal state

Types of solution

Depending upon molecular size we have three types of solution -

	1) True solution	2) Colloidal solution	3) Suspension
Size	< 1nm	1nm - 1000nm	> 1000nm
	< 10 A°	10 A° - 10000 A°	> 10000 A°

Colloids / Colloidal state → It is the state of a substance when particle size is b/w 1nm - 10000nm (10 A° - 10000 A°)

Phases in colloids → In colloids there are two phases

1) Dispersion medium
2) Dispersed phase

Dispersion medium → The phase which is present in large quantity is also dispersion medium. It is just like a solvent in normal solution.

Dispersed phase → The phase which is present in small quantity is also dispersed phase. It is just like a solute in normal solution.

Thus in colloids dispersed phase is present in dispersion medium.

* Classification of colloids →

Colloids can be classified in number of ways:

A) classification based on the physical state of dispersed phase and dispers medium we have following types of colloids →

Dispersed phase	Dispersion medium	Types of collo
solid	solid	solid sol
solid	liquid	sol
solid	Gas	Aero sol
liquid	solid	Gel
liquid	liquid	Emulsion(m
liquid	Gas	Aero sol
Gas	solid	solid sol
Gas	liquid	Foam

B) Based upon the intraction b/w dispersed phase and dispersion medium →
Depending upon the intraction b/w dispersed phase and dispersion medi we have two types of colloids :→

1) lyophillic colloids
2) lyophobic colloids

lyophillic colloids → The colloidal solu in which there is a great affinity b/w the particles of the dispersed phase an dispersion medium is K/as lyophillic colloids

lyophobic colloids → The colloidal sol in which there is a no affinity b/w the particles of dispersed phase and dispersion medium is K/as lyophobic co

Difference b/w lyophilic and lyophobic colloids →

	Lyophilic colloids	Lyophobic colloids
1)	The colloidal solution in which there is a great affinity b/w the particles of the dispersed phase and dispersion medium.	The colloidal sol in which there is no affinity b/w the particles of dispersed phase and dispersion medium.
2)	The particles of colloidal sol are tree molecules and ~~be~~ are big size.	The particles are aggregates of many molecules.
3)	They are very stable.	They are unstable
4)	They do not show tyndall effect.	They show tyndall effect.
5)	The particles are not visible under ultramicroscope.	The particles are easily visible under ultra-microscope.
6)	These colloids do not easily undergo precipitation on the addition of small Amount of electrolyte	These colloids easily undergo precipitation on the addition of small amount of electrolyte.

(C) Based on the size of particles of dispersed phase → Depending upon the size of particles of dispersed phase we have three types of colloids →

1) multimolecular colloids
2) macromolecular colloids
3) Associated colloids

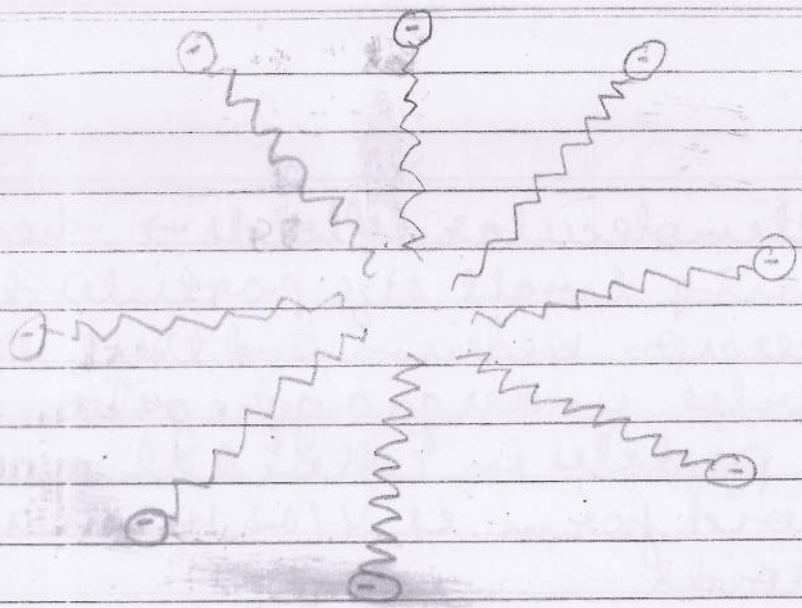
Multimolecular colloids → when substa
having small size particles dissolved i
dispersion medium and these small size
particles undergo aggregation and form
the particles in colloidal range. Thus
colloid form is called as multimolecula
colloids.

Macromolecular colloids → when su
stance having large size particles is
dissolved in dispersion medium and
these large sized particles undergo
dissociation and forms the particles
in colloidal range. Thus the colloida
form is called as macromolecular collo

Associated colloids → when a substan
dissolved in dispersion medium beha
as a normal electrolyte at low concen
tion but behaves as a colloid at high
concentration due to aggregation of
particles. This colloid is called as ass
ciated colloid.

Micelles → are the aggregation of
particles formed by ~~the~~ associatio
of molecules in colloidal solution.
eg → soap molecules formed this typ
of micelles.

$$RCOOH \rightarrow \underbrace{RCOO^-}_{\text{micelle}} \; Na^+ \; Na^+$$



Micelles

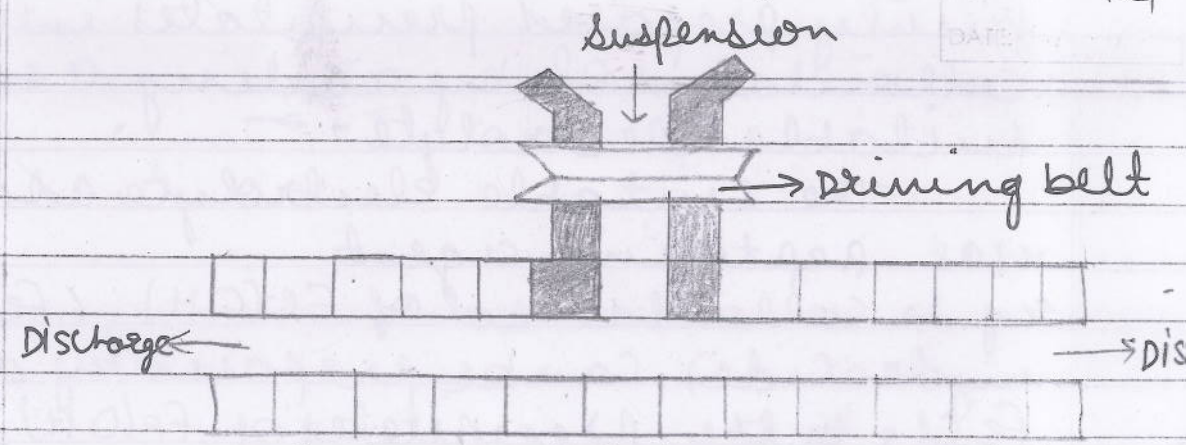
* **Methods of preparation of colloids →** Lyophillic colloids can easily be prepared by adding dispersed phase into dispersion medium.

Lyophobic colloids are prepared by following methods →

1) Dispersion method
2) Condensation method

Dispersion method → In this method large particles are dispersed to form particle in colloidal range. This can be done by following ways -

A) **Mechanical dispersion →** In this method the bigger particles are broken up into small particles which are in colloidal range with the help of a colloidal mill.

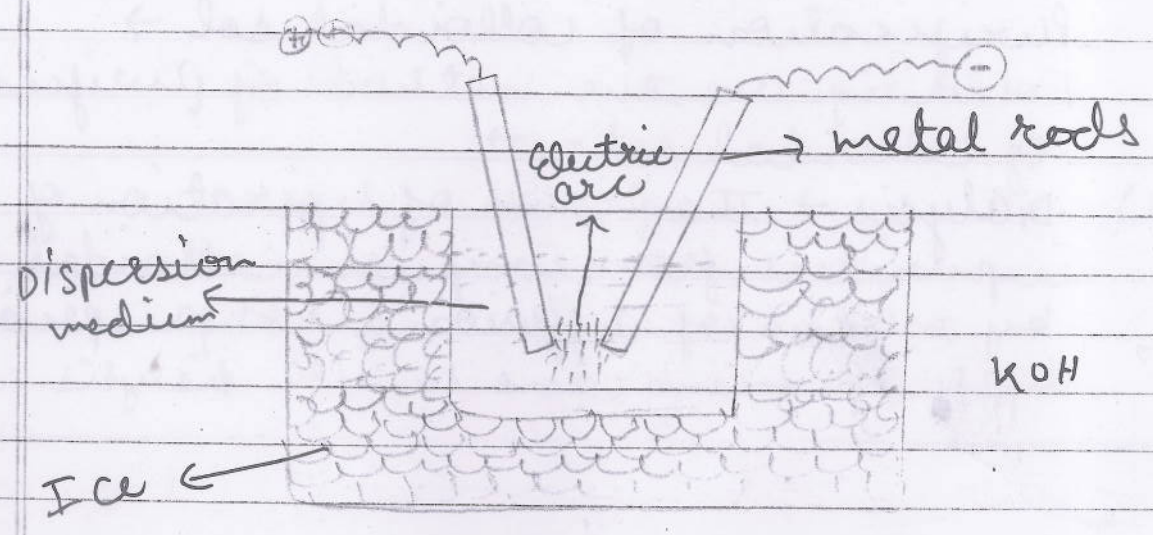


Metal disc rotating in opposite directio

B) Electrical dispersion (Bredig's arc met

→ This method is used to prepare the colloidal sol of metal such as Gold, Ag, Pt. etc. In this method two elect of metals are connected with two termi of battery. These two electrodes are dipped in the dispersion ~~phase~~ medi And an electric arc is produced bl them. During this the small particle of the metal moves to dispersion med and forms the colloidal sol.

The stability of sol can be increa by adding KOH ~~ad~~ to it.



C) Peptization → It is a process of converting freshly prepared precipitates into colloidal sol by adding a ~~set~~ suitable electrolyte. →
The suitable electrolyte added is ~~was~~ also peptising agent.
eg ⇒ colloidal sol of $Fe(OH)_3$ (Ferric hydroxide) can be prepared by adding $FeCl_3$ to the precipitates of $Fe(OH)_3$.

Condensation method → In these methods the smaller size particles are condense together to form a particle in colloidal range.
This method can be carried out in following ways →

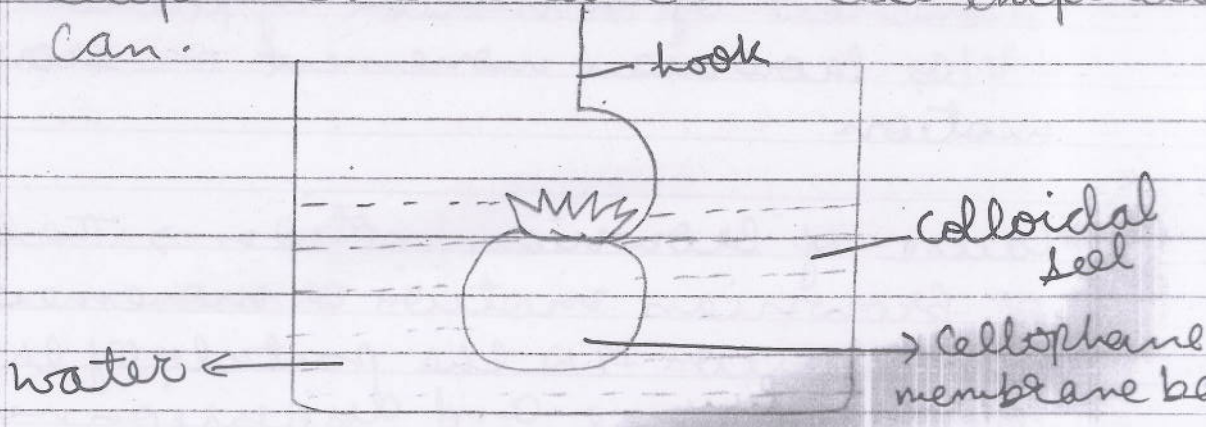
A) By excess cooling →
eg ⇒ The colloidal sol of a ice in organic solvent can be prepared by cooling the mixture of water and organic ~~sol~~ solvent

B) By exchange of solvent →
eg → The colloidal sol of phosphorus and sulphur can be prepared by pouring their alcoholic solution in excess of water.

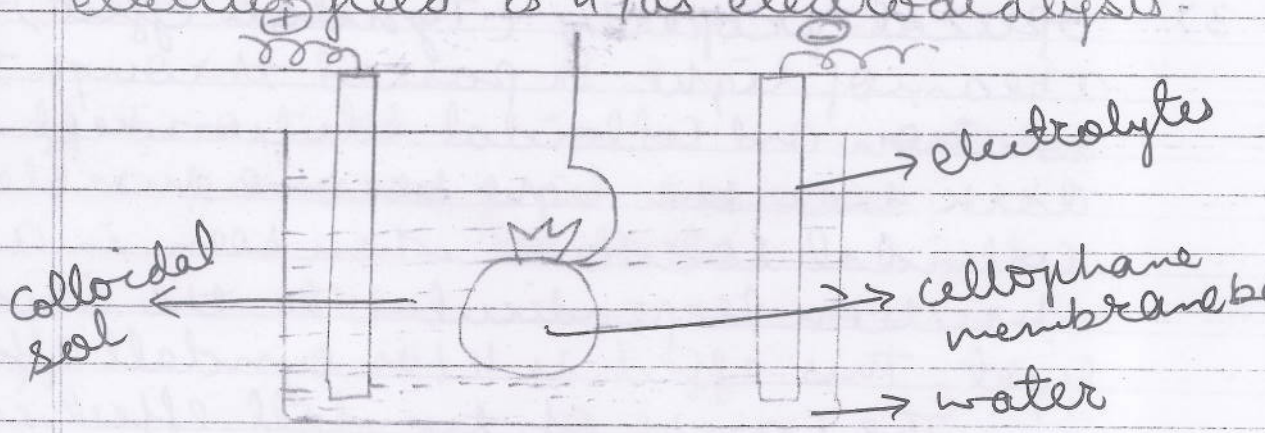
* Purification of colloidal sol →
Following are the methods of purification of colloidal sol. →

1) Dialysis → The process of seperation of impurities from impure colloidal sol by means of diffusion through special type of membrane is also dialysis.

Principle → The dialysis is based on the principle that colloidal particle cannot pass through a membrane whereas cellophane membrane whereas impurities can.



2) Electrodialysis → The normal process of dialysis is very slow. Its speed can be increased by applying the electric field. The process of dialysis in presence of a electric field is known as electrodialysis.



3) ultrafiltration → It is the filtration with help of gradded filter paper.

* Properties of colloidal solution →

1) Heterogenous nature → Heterogenous nature of colloids are heterogenous in nature. Heterogenous nature of colloids is due to

presence of two phases i.e. disperse phase and dispersion medium.

2) Mechanical property (Brownian motion/ movement) → The colloidal particles are not stationary but are moving in different directions in a zig-zag manner. This movement of or motion of particles is also known as Brownian movement or Brownian motion.

Cause of Brownian motion → The cause of Brownian motion or movement is the collision b/w the particles of the dispersed phase and dispersion medium.

Consequences of Brownian motion → Brownian motion maintains the stability of colloidal sol.

3) Optical property (Tyndall effect) → When a beam of light is passed through true solution and colloidal solution kept in a dark then the light become visible in colloidal solution when seen in a direction perpendicular to the incident light. This effect is also known as tyndall effect.

The cause of tyndall effect is scattering of light by colloidal particles.

Thus, in another words tyndall effect is the phenomenon of scattering of light by colloidal particles as a result of which light becomes visible in colloidal

Solution:

4) Electric property (Electrophoresis) → The phenomenon of movement of colloidal particles under the influence of electric field is known as electrophoresis.

* Coagulation or flocculation → The phenomenon of precipitation of colloidal sol by the addition of excess of electrolyte is known as coagulation or flocculation. It is express in mgl^{-1}

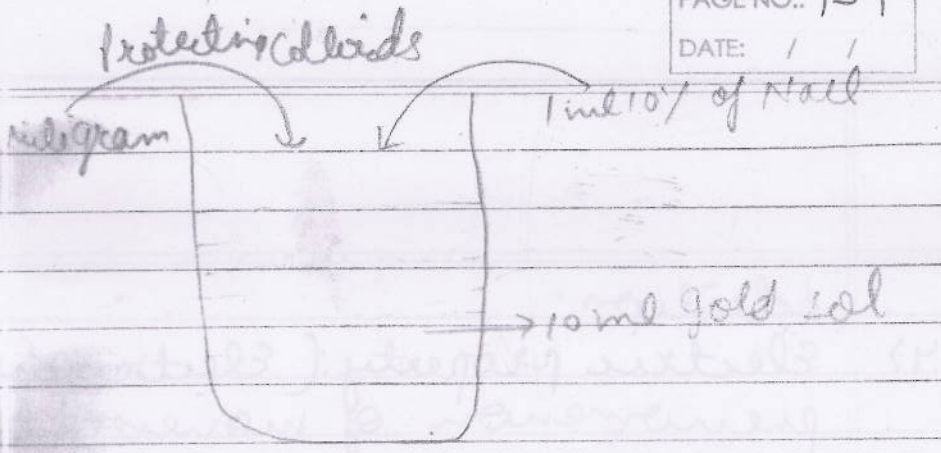
* Protection of colloids → When we add a small amount of electrolyte in lyophobic colloids it undergo coagulation. This coagulation can be prevent by the addition of lyophilic colloids.

The ~~to~~ protection of lyophobic colloid from precipitation by an electrolyte due to addition of lyophilic colloid is known as protection of colloids.

Different lyophilic colloids have different protecting power.

The protecting power of a lyophilic colloids can be express by a term known as gold number:

Gold number → It is the amount of protective colloids in milligrams which is ~~requ~~ required to prevent the coagulation of 10 ml of gold by addition of 1 ml of 10% NaCl.



Smaller be the gold number more be the protecting power of protective colloid.

* Emulsion → It is a colloidal system in which both dispersed phase and dispersion medium are in liquid state.
eg ⇒ milk
The stability of emulsion can be increased by the addition of certain substances. These substances which are added to increase the stability of emulsion are K/A emulsifying agent / emulsifier.
For eg ⇒ soap act as a emulsifier in the emulsion of oil and water.

Types of emulsion → There are two types of emulsion -
1) oil in water
2) water in oil

oil in water → In this emulsion the dispersed phase is oil and dispersion medium is water.
eg ⇒ milk.

water in oil → In this emulsion the dispersed phase is water and dispersi medium is oil.
eg :→ Cold cream.

Identification of emulsion → Emulsi can be identify by following tests →

1) Dilution test → In this test the emulsion is diluted with water if dilution occurs then it is oil in water if dilution do not occurs th it is water in oil.

2) Dye test → In this test oil soluble dye is added to the emulsion and it stained if coloured droplets are obtai then it is oil in water emulsion. I the whole background becomes colou then it is water in oil emulsion.

* Gel → It is a colloidal system in which dispersed phase and disp is liquid and dispersion me medium is solid.
eg :→ Gum, silica, gel.
There are two types of gel →
1) Elastic gel
2) Non elastic gel

* Catalysis →
Catalyst → The substance which incre the rate of a reaction and is recove unchanged after the rxn is k/as Catalys

The process involving the increase in rate of reaction using ~~electrolyte~~ Catalyst is known as catalysis.

Types of catalysis →

There are two types of catalysis →

1) Homogenous catalysis
2) Heterogenous Catalysis

Homogenous catalysis → The catalysis in which both of the Catalyst ~~have same phase~~ is known as and reactant have same phase is known as homogenous catalysis.

eg → $SO_2(g) + O_2(g) \xrightarrow{NO(g)} SO_3(g)$

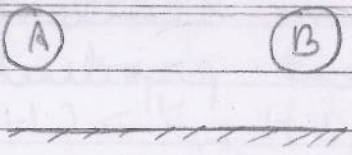
Heterogenous catalysis → The catalysis in which both of the ~~o~~ catalyst and reactant have different phase is known as heterogenous catalysis.

eg → $N_2(g) + 3H_2(g) \xrightarrow{Fe(s)} 2NH_3$

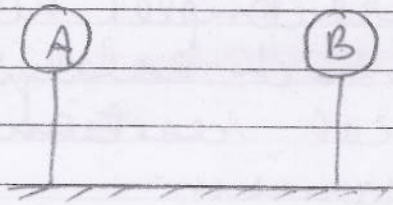
Theory of homogenous Catalysis → ~~Homogeneous~~ Homogenous catalysis can be explain by activated complex theory.

Theory of heterogenous catalysis → Heterogenous catalysis can be explain by adsorption theory which involves following steps →

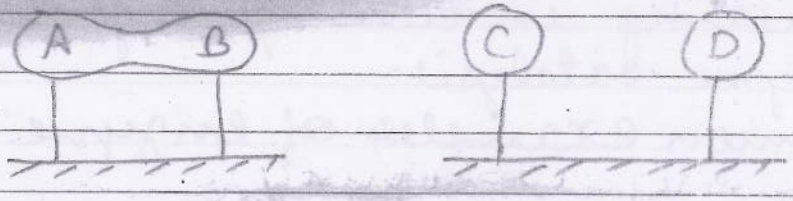
① Diffusion of the reactant on the surface of the catalyst.



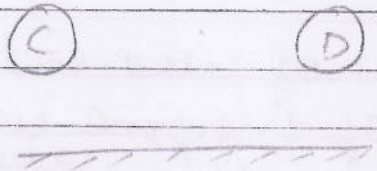
(2) Adsorption of the reactant molecules on the surface of the catalyst.



(3) Chemical reactions taking place b/w the reactants on the surface of the catalyst and formation of the products.



(4) Disorption of products molecules from the surface of the catalyst.



* Activity of a catalyst → The ability of a catalyst to increase the rate of a rxn. Different catalyst have different activity.

* Selectivity of a catalyst → The ability of a catalyst to increase the rate of a

particular rxn is also selectivity of a catalyst.
eg:- with same reactant different catalyst gives different products -

$CO + 3H_2 \xrightarrow{Ni} CH_4 + H_2O$

$CO + H_2 \xrightarrow{Ca} HCHO$ (Formeldehyde)

* Enzyme catalysis →
Enzymes are complex nitrogenous organic compound which catalysis the various biochemical reactions occuring in living organism.
Enzymes are also also biological Catalyst.
This the process in which enzymes catalysis the various biochemical rxns occuring in living organism is also enzyme catalysis.
Common examples of enzyme catalysis are

1) Conversion of a sugar into glucose and fructose using enzyme invertase

$C_{12}H_{22}O_{11} + H_2O \xrightarrow{Invertase} C_6H_{12}O_6 + C_6H_{12}O_6$
Sugar — Glucose, Fructose

2) Decomposition of urea into ammonia in presence of enzyme urase

$NH_2CONH_2 + H_2O \xrightarrow{urase} 2NH_3 + CO_2$
urea

Characteristics of enzymes catalyst →
The characteristics of enzymes are
1) High efficiency → Enzymes are very

efficient catalyst they increase the rate of a reaction upto 10^{10} to 10^{20}.

2) **Specificity** → Enzymes is highly specific in nature. Each enzymes catalysed particular reaction.

3) **Small quantity** → Small quantity of enzymes is highly effective to increase the rate of a reaction.

4) **optimum pH and temperature** → Enzyme catalysis reaction and having maximum rate at pH around 7 and temperature around 37°C.

5) **controlling the activity of enzymes** → The activity of a enzyme can be controlled.

Mechanism of enzyme catalysed rxn

→ The mechanism of enzyme catalysed rxn can be explain by following steps

① combination of enzyme with substrate or reactant to form enzyme substrate complex.

$$E + S \longrightarrow ES$$

② Conversion of enzyme substrate complex into enzyme product complex

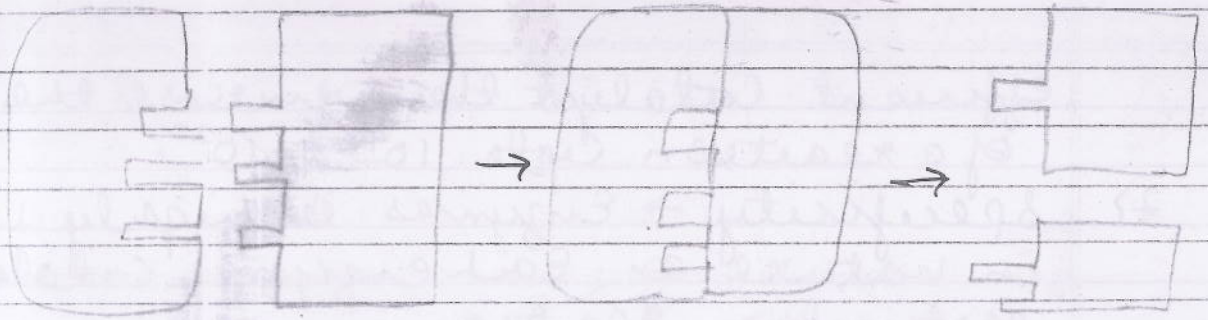
$$ES \rightarrow EP$$

③ Dissociation of enzyme product complex into enzymes and product

$$EP \rightarrow E + P$$

This mechanism can be explain with

the help of lock and key model.



* Co-enzymes → The activity of enzyme is increased in the presence of certain substances which are Co-enzymes
Co enzymes are generally metal ions such as Na^+, Mn^{2+}, Co^{2+}.

* Catalytic promotor → These are the substances which when present along with catalyst increases their activity
$N_2 + H_2 \xrightarrow{Fe/Mo} 2NH_3$
Mo is a catalytic promotor

* Catalytic poisons → These are the substances which when present along with catalyst decreases their activity.

* Difference b/w enzyme and inorganic catalyst →

	Enzymes	Inorganic catalyst
1)	They are globular proteins	They are mineral ions or small molecules.
2)	They Compromise a specific reaction of a substance.	They can promote diverse reaction.

3)	They are regulated by specific molecule	They are not regulat by any regulator molecules.
4)	They are more sensitive to temper- ature and pH.	They are less sensiti to temperature an pH -
5)	They are synthesized by ribosomes in the living cells.	They are not synthes in the living cells.