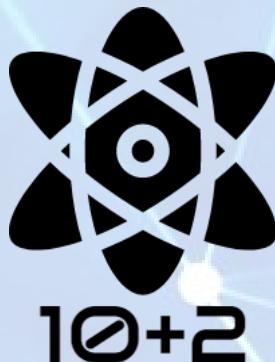


10+2 PCM NOTES

BY

JOYOSHISH SAHA

(PDF version handwritten notes of Maths, Physics and Chemistry
for 10+2 competitive exams like JEE Main, WBJEE, NEST, IISER
Entrance Exam, CUCET, AIPMT, JIPMER, EAMCET etc.)



Downloaded from <https://plustwopcm.blogspot.in/>
Visit the blog to get helpful notes for your 10+2 preparation.

With best wishes from Joyoshish Saha

Surface Chemistry

1

* Adsorption : The accumulation of molecular species at the surface rather than in the bulk of a solid or liquid. [Adsorbate & Adsorber].

* Sorption - both adsorption & absorption

* Mechanism of adsorption - residual or unbalanced forces in the surface molecules.

* Types : Physisorption

a) due to van der waals force

b) not specific

c) not depends on nature of adsorbate

d) reversible

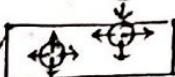
e) enthalpy low

f) decreases with temperature

g) not needed activation energy

h) multimolecular layer formed

Chemisorption



chemical bonding.

specific

depends

not reversible

enthalpy high

increases to a certain point

needed

unimolecular layer formed.

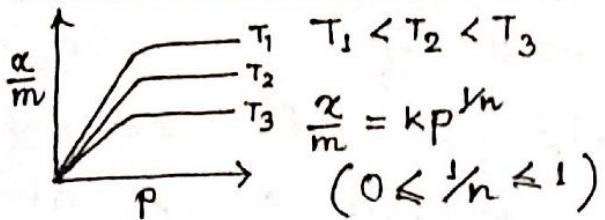
* Energetics of Adsorption: $\Delta H < 0$
 $\Delta S < 0$.

To be feasible, $\Delta H < T\Delta S$.

* See last page for characteristic features of adsorption of gases by solids.

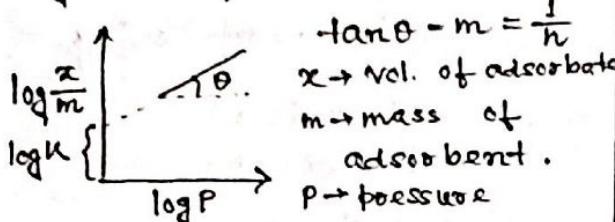
Adsorption Isotherms:

a) Freundlich Adsorption Isotherm



k & n are constants depend on T & nature of adsorbent.

$$\log \frac{\alpha}{m} = \log k + \frac{1}{n} \log P.$$



Limitsations: a) limited in a pressure range, b) doesn't tell reason of saturation at high pressure.

Adsorption from Solution Phase:

$\frac{\alpha}{m} = K C^n$ $C \rightarrow \text{concentration of}$
decreases with increasing T .
increases with increasing concentration.

* Alternate expression for Langmuir Adsorption Isotherms

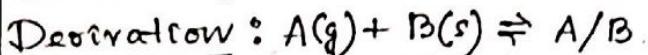
$$\theta = \frac{KP}{1+KP} \Rightarrow \frac{V}{V_{\max}} = \frac{KP}{1+KP}$$

$$\Rightarrow V = \frac{aP}{1+bP} \quad [a \rightarrow K V_{\max}, b \rightarrow K]$$

$$\Rightarrow \frac{\alpha}{m} = \frac{aP}{1+bP} \Rightarrow \boxed{\frac{P}{\alpha/m} = \frac{1}{a} + \frac{b}{a} P}$$

b) Langmuir Adsorption Isotherm (gas on solid adsorbent)

Assumptions: 1) solid surface-homogeneous, 2) no. of sites available on surface is fixed, 3) sites are same in size & shape, 4) no interaction between the gas molecules, enthalpy change for each is the same, 5) dynamic equilibrium during adsorption between free & adsorbed gas.



equilibrium constant, $K = \frac{K_a}{K_d}$ (K_a, K_d are rate constants of \rightarrow & \leftarrow reaction)

Now, θ gives the fraction of sites already occupied on the surface at equilibrium.

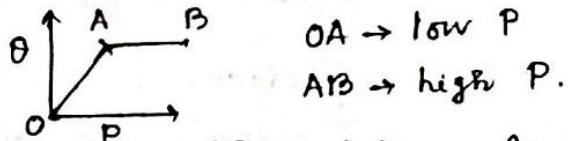
$$\text{rate}(\rightarrow) \propto P (1-\theta) \Rightarrow \text{rate}(\rightarrow) = K_a P (1-\theta)$$

$$\text{rate}(\leftarrow) \propto \theta \Rightarrow \text{rate}(\leftarrow) = K_d \theta.$$

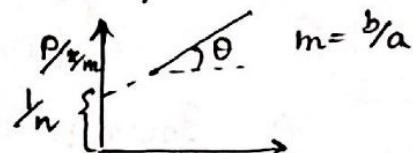
$$\text{Now, at equilibrium, } K_a P (1-\theta) = K_d \theta.$$

$$\Rightarrow \theta = \frac{K_a P}{K_d + K_a P} \Rightarrow \boxed{\theta = \frac{KP}{1+KP}}$$

Plot: at low P , $L+KP \approx L$, $\theta \propto P$
at high P , $L+KP \approx KP$, $\theta \propto P^0$



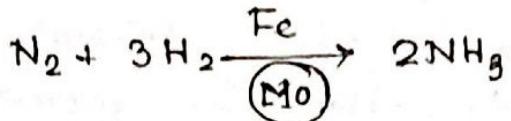
$V \rightarrow \text{amount of gas adsorbed/ unit mass of adsorbent}$
 $V_{\max} \rightarrow \text{max amount of gas that can be adsorbed/unit mass}$



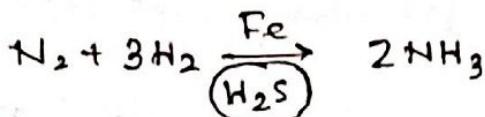
- * Application of Adsorption: a) Production of high vacuum,
- b) Gas masks, c) control of colouring material catalysts, f) separation of inert gases, g) curing diseases by adsorbent drugs, h) froth floatation i) chromatographic analysis j) adsorption indicators.

- * Catalysis: Action of Catalyst. [changes the path of reaction, without being changed during reacⁿ]

- Promoters: Enhance the catalysis.

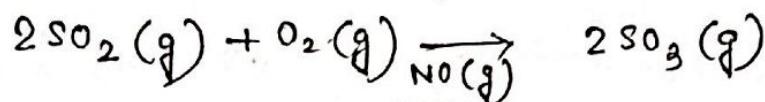


- Poisons: Decrease the catalysis.

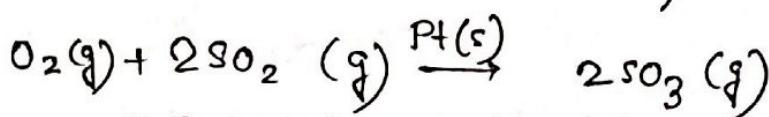


- * Types of Catalysis:

a) Homogeneous: Reactants & Catalysts \rightarrow same phase



b) Heterogeneous: Reactants & Catalysts \rightarrow different phases.



- * Mechanism of Catalysts: for heterogeneous reaction, three theories - a) Adsorption Theory, b) Intermediate formation, c) Modern Adsorption theory.

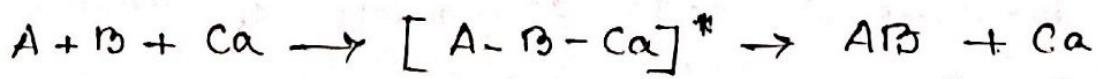
- a) Adsorption Theory: $A + B \xrightarrow{\text{catalyst}} AB$

concentration of reactants increase on catalyst's surface \rightarrow rate of

reaction increases \rightarrow heat released due to adsorption increases the rate of reaction



- b) Theory of Intermediate formation: $A + B \xrightarrow{\text{Ca}} AB$



$\text{Ca} \rightarrow \text{Catalyst}$.

Intermediate provides alternate reaction path with lower activation energy. Joyashish Saha

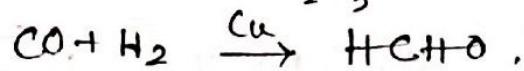
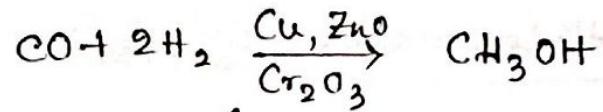
• c) Modern Adsorption Theory: Employs idea of past 2 theories.
Steps -
1. A, B diffuse & come closer to the surface of catalyst.

2. Reactants get adsorbed on surface.
3. Chemical reaction occurs on the surface of catalyst through formation of intermediate.
4. Product formed desorbs from the surface.

* Features of Solid Catalysts

a) activity - depends on strength of chemisorption.

b) selectivity - $\text{CO} + 3\text{H}_2 \xrightarrow{\text{Ni}} \text{CH}_4 + \text{H}_2\text{O}$.



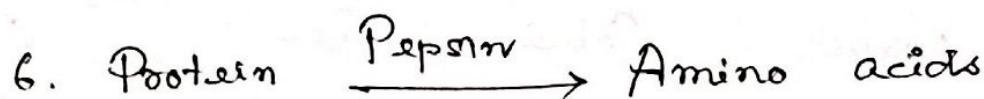
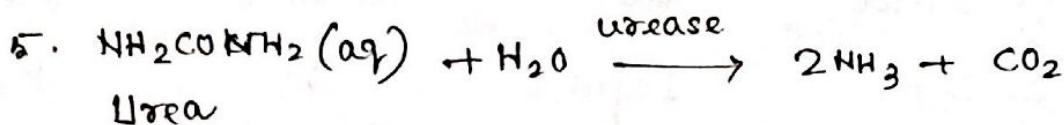
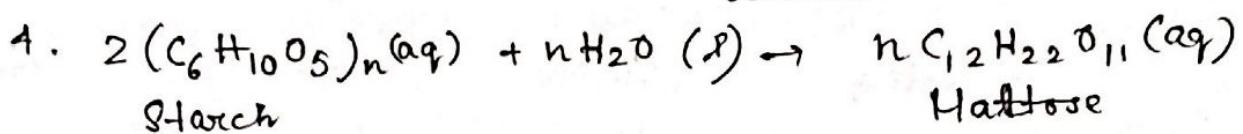
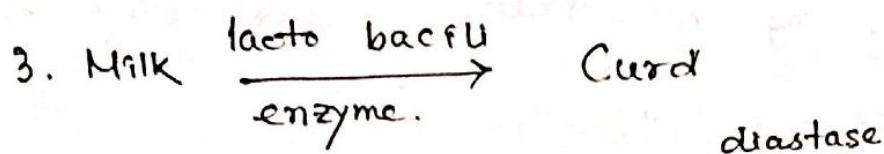
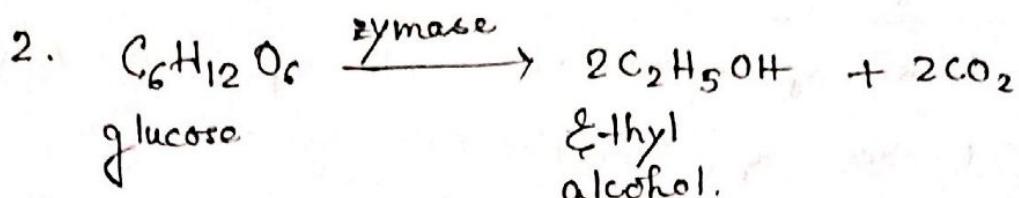
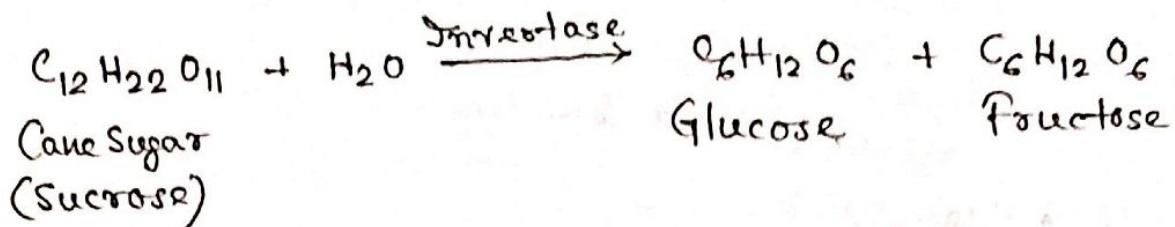
* Shape Selective Catalysis: e.g. Zeolites (honeycomb structures)

i) microporous aluminosilicates, ii) 3D network (Al-O-Si framework). ZSM-5 is a specific zeolite used for catalysis alcohol \rightarrow gasoline,

(Isomerisation, cracking of hydrocarbons also occur due to this type of catalysis).

* Enzyme Catalysis: Enzymes: Complex nitrogenous compounds (proteins), biochemical catalyst (made of amino acids).

e.g. 1. Inversion of cane sugar :



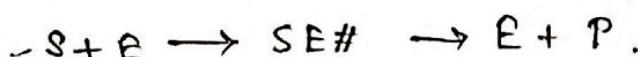
* Characteristics of Enzymes.

1. highly efficient , 2) highly specific,
 3. active under optimum temp. , 4. active
under optimum pH (5-7), 5) Increase in
activity in presence of activators (Na^+ ,
 Ca^{2+} , Co^{2+}) & Co-enzymes (vitamins) , 6) Influence
of poisons & Inhibitors.

* Mechanism of Enzyme Catalysis : lock-key.

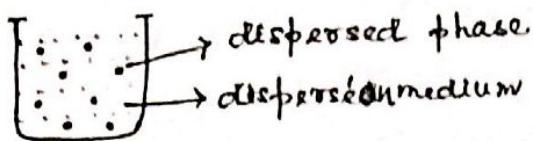
Enzyme - lock (active site)

Substrate - key



* Colloids: heterogeneous system.

1 nm < particle size < 1000 nm



• classification:

- basis of Physical state of phase & medium
- Nature of interaction
- Type of particles of dispersed phase.

+a) <u>Phase</u>	<u>Medium</u>	<u>Type</u>	<u>E.g.</u>
i) Solid	Solid	Solid sol	Gemstones
ii) Solid	Gas	Aerosol	Smoke, Dust
iii) Solid	Liquid	Sol	Paints.
iv) Liquid	Solid	Gel	Cheese, Butter
v) Liquid	Liquid	Emulsion	Milk
vi) liquid	Gas	Aerosol	Fog, Mist, Cloud
vii) Gas	Solid	Solid sol	Pumice Stone
viii) Gas	Liquid	Foam	Whipped Cream

+b) (for sols only).

Lyophilic sols.

i) liquid attracting

e.g. Gelatine

ii) reversible sol

iii) stable

Lyophobic sols.

liquid repelling.

e.g. sulphur, metal sol.

irreversible sol.

needs stabilizing agent

C.

Surface Chemistry

4

+c) i) Multimolecular Colloids: small molecules aggregate to form colloidal particles. (e.g. gold sol.)

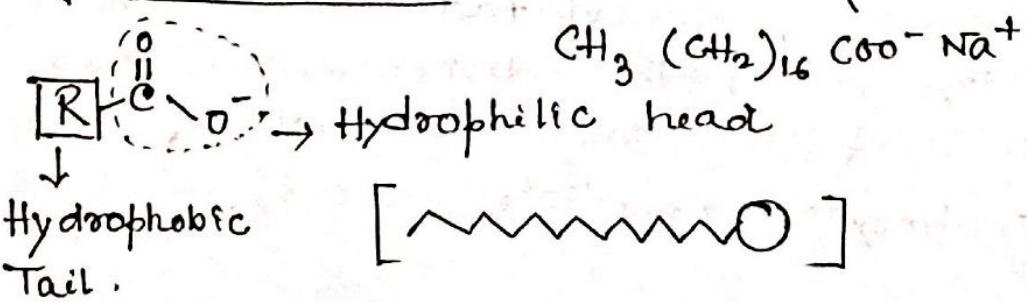
ii) Macromolecular Colloids: size of each molecule is in colloidal range. (e.g. Proteins, Starch)

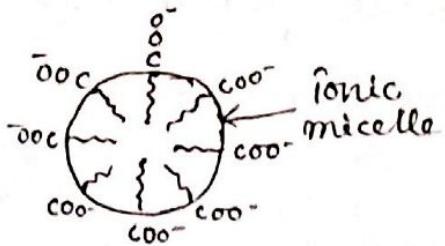
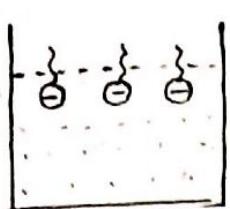
iii) Associated Colloids (Micelles): Substances which form aggregate known as micelles at high concentrations. (e.g. Soap in water).

Formation of micelle takes place only above a particular temperature, called Kraft Temperature (T_k) & above a particular concentration called Critical Micelle Concentration (CMC). Surface active agents such as soaps and synthetic detergents belong to this class. For soaps, the CMC is 10^{-1} to 10^{-3} mol/L. These colloids have both hydrophilic & hydrophobic parts.

• Mechanism of Micelle Formation:

e.g. Soap Solution: $\text{RCOO}^- \text{Na}^+$ (Sodium Stearate,



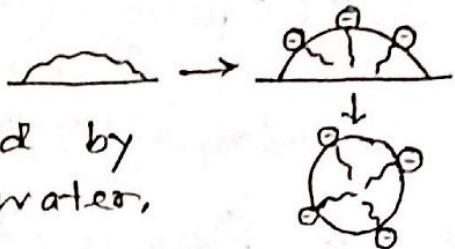


a) at low concentration

b) arrangement of separate ions inside the bulk of water at CMC

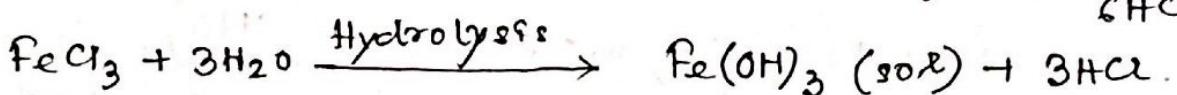
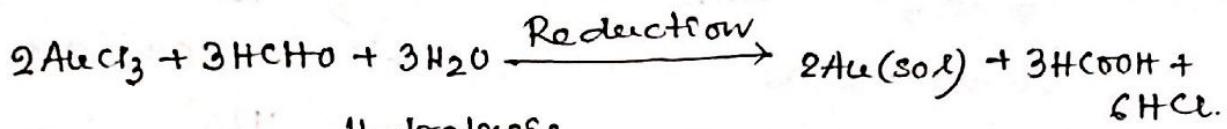
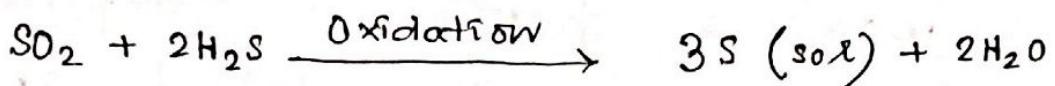
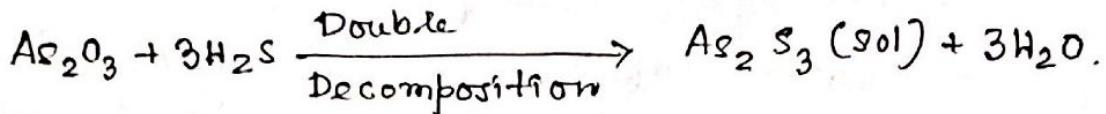
Cleansing Action of Soaps:

the oil droplet surrounded by micelles washed with water.

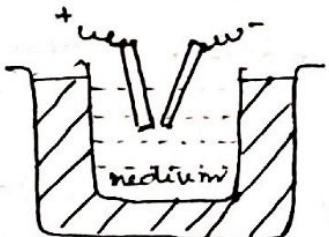


Preparation of Colloids:

a) Chemical Methods:



b) Electrical Disintegration / Bredig's Arc Method:



Process involves dispersion as well as condensation.

c) Peptization: Process of converting a precipitate into colloidal sol, by

shaking it with dispersion medium in the presence of a small amount of electrolyte.

(electrolyte \rightarrow peptizing agent).

- Purification of Colloids:

a) Dialysis: It is the process of separating a crystallloid from a colloid by diffusion or filtration through a semi-permeable membrane or dialysing membrane. The process can be quickened by applying electric field & is called electro-dialysis.

b) Ultrafiltration: Process of separating the colloidal particles by filtration through ultrafilter paper that is obtained by treating ordinary filter paper with gelatine solution.

c) Ultra-centrifugation: Based on sedimentation.

- Properties of Colloids:

1. Colligative properties: The value of colligative properties of colloidal solutions are very low due to aggregation.

2. Tyndall effect: When a strong beam of light is passed through a sol & viewed at right angles, the path of light shows up a hazy beam (due to scattering).

3. Brownian movement: Continuous zig-zag movement of colloidal particles which helps in providing stability to colloidal sols.

1. Charge on Colloidal Particles: All the dispersed particles of colloidal sol possess either a positive or negative charge. The mutual forces of repulsion between similarly charged particles prevent them from aggregating & settling under the action of gravity. This gives stability to the sol.

The surface of colloidal particle acquires a +ve charge by selective adsorption of a layer of positive ions around it. This layer attracts counterions from medium which form a 2nd layer of -ve charges. The combination of two layers of charges is called Helmholtz double layer.

5. Electrophoresis: Movement of colloidal particles towards oppositely charged electrode under the influence of electric field (cataphoresis & anaphoresis).

6. Electro-osmosis: The dispersion medium is allowed to pass through a semipermeable membrane under the influence of electric field. This happens because of the fact that the dispersion medium carries an equal opposite charge to that of dispersed particles.

7. Electrophoretic mobility of colloidal particle:

It is the distance travelled by colloidal particles in one second under a potential gradient of one volt per cm.

8. Donnan Effect: It is the reverse of electrophoresis. The sedimentation potential is set up when a particle is forced to move in a resting liquid.

9. Coagulation & flocculation: Precipitation of colloidal sol by the addition of electrolyte.

• Natural phenomena of Colloids:

1. Blue color of Sky: Dust particles along with water suspended in air scatter blue light that reaches us.

2. Fog, mist, rain: When a large mass of air is cooled below its dew point the moisture from the air condenses on the surface of these particles forming fine droplets which then forms mist or fog.

Clouds are aerosols having small droplets of water suspended in the air.

Sometimes the rainfall occurs when two oppositely charged clouds meets. It's possible to cause artificial rain by throwing electrified

sand or spraying a sol carrying charge opposite to the one on clouds from an aeroplane.

3. Food articles: Milk, butter etc are colloids.

4. Blood: Blood is a colloidal solution of an albuminoid substance. The styptic action of alum & ferric chloride solution is due to coagulation of blood forming a clot which stops further bleeding.

5. Soil: Fertile soil are colloidal in nature in which humus acts as a protective colloid.

6. Formation of Delta: River water is colloidal solution of clay. Sea water contains a number of electrolytes. When river water meets the sea water, the electrolytes present in the sea coagulate the colloidal solution of clay which get deposited with the formation of delta.

• Technical applications of Colloids:

1. Electrical precipitation of smoke,
2. Purification of drinking water,
3. Medicines, 4. Tanning 5. Photographic Plates & films.

- * Gold number: The minimum number in milligrams of the protective colloid which must be added to prevent the coagulation of 10 ml of red gold solution when 1 ml of 10% solution of NaCl is added to it.

$$\text{protective power} \propto \frac{1}{\text{Gold Number}}$$

- * Hardy-Schulze Rule: Greater the valence of coagulating ion of the electrolyte, faster is the coagulation.

- * Emulsions: Emulsions are the colloidal systems in which both the dispersed phase & dispersion medium are liquids. They are stabilised by addition of substance called emulsifiers.

- * Types of Emulsions:

i) Oil in Water Type (O/W): Oil is dispersed phase & water is dispersion medium. Milk is an O/W type emulsion.

ii) Water in Oil Type (W/O): Water is dispersed phase & oil is the dispersion medium. Butter is an W/O type emulsion.

- * Type of Emulsion

O/W

W/O

Emulsifiers

Proteins, gums, Soaps

heavy metal salts of fatty acids, long chain alcohols.

• Characteristics of Emulsions:

<u>Property</u>	<u>W/O</u>	<u>O/W.</u>
1. Viscosity	More than water.	Slightly more than water.
2. Appearance	Oily, opaque, translucent.	Watery, opaque, translucent.
3. Electrical conductivity	Very low	Nearly equal to water.
4. Dilution test	More oil added is soluble but not water.	More water added soluble but not oil.
5. Spreading Test	Spreads easily on an oily layer.	Spreads readily on watery layer.
6. Dye test	Dye dissolves giving a bright colour (cold cream, cod liver oil)	Dye remains insoluble on the form of coloured droplets. (Milk, vanishing cream.)

- * **Zeolites:** Shape selective catalysts having honey comb like structure. They are microporous aluminosilicates with $\text{Al}_2\text{Si}_x\text{O}_{5+y}$ framework & general formula $\text{M}_{x/n}[(\text{AlO})_{2z}(\text{SiO}_2)_y/m\text{H}_2\text{O}]$
- * **Collodion:** A 1% solution of nitrocellulose in a mixture of alcohol & ether is called collodion.

* Characteristic features of Adsorption of Gases by Solids:

1. Adsorption & Surface Area: Increase in the surface area of the adsorbent increases the total amount of the gas adsorbed.
2. Nature of gas: More easily liquefiable a gas is (ie higher its critical temp.), the more readily will it be adsorbed.
3. Heats of adsorption: Adsorption is an exothermic process ($\Delta H < 0$).
4. Reversible character: Physisorption is a reversible process.
5. Effect of temperature: Physisorption occurs rapidly at low temp & decreases with increasing temp. (Le Chatelier). Chemisorption increases with temp.
6. Effect of pressure: Increase of pressure leads to increase of adsorption.
7. Thickness of adsorbate layer: Above a multimolecular thick layer certain pressure is formed.