Colloids and Colloidal Solution

Lecture - 4

1. What is colloid? or colloidal dispersion or colloidal solution.

Ans: When a diameter of the particles of a substance dispersed in a solvent ranges from about 10 Å to 2000 Å, the system is termed a colloidal solution or colloidal dispersion or simply a colloid.

2. Classify colloids.
State the classification of colloids.

colloids are divided into two classes
① Lyophilic colloids
② Lyophobic colloids

① Lyophilic colloids:— Lyophilic colloids are those in which the dispersed phase exhibits a definite affinity for the dispersion medium or the solvent.

The examples of lyophilic colloids are dispersions of starch, gum and protein in water

② Lyophobic colloids:— Lyophobic colloids are those in which the dispersed phase has no attraction for the dispersion medium or the solvent.

The examples of lyophobic colloids are dispersion of gold, iron(III) hydroxide and sulphur in water.

3. Show the comparison of Lyophilic and Lyophobic sols.
or show the difference between lyophilic and lyophobic sols.

Lyophilic colloid	Lyophobic colloid
① give the defination from question ②	① give the defination from question ②
① prepared by direct mixing with dispersion medium.	① Not prepared by direct mixing with the medium.
② Little or no charge on particles.	② Particles carry positive or negative charge.
③ particles generally solvated.	③ No solvation of particles
④ viscosity higher than dispersion medium; set to a gel	④ viscosity almost the same as of medium; do not set to a gel.
⑤ precipitated by high concentration of electrolytes.	⑤ precipitated by low concentration of electrolytes.
⑥ Reversible	⑥ Irreversible.
⑦ Do not exhibit Tyndall effect.	⑦. Exhibit Tyndall effect.
⑧ particles migrate to anode or cathode or not at all	⑧ Particles migrate to either anode or cathode.

Describe the preparation of colloids by electro dispersion method or Bredig method.

Bredig was the originator of disintegrating metals into sols by means of an electric arc. Two metallic electrodes dipped in water, are connected to a D.C. source. A rheostat and an ammeter are connected in series for controlling current. On passing the current an arc is produced near the ends of the electrodes and a metal sol results.

A small quantity of sodium hydroxide is added to water. The sol thus produced consists of metal like gold, platinum, zinc, aluminium, chromium etc. It is thought that under the influence of the high temperature of arc, the metal is first vaporised and the colloidal particles formed later by condensation.

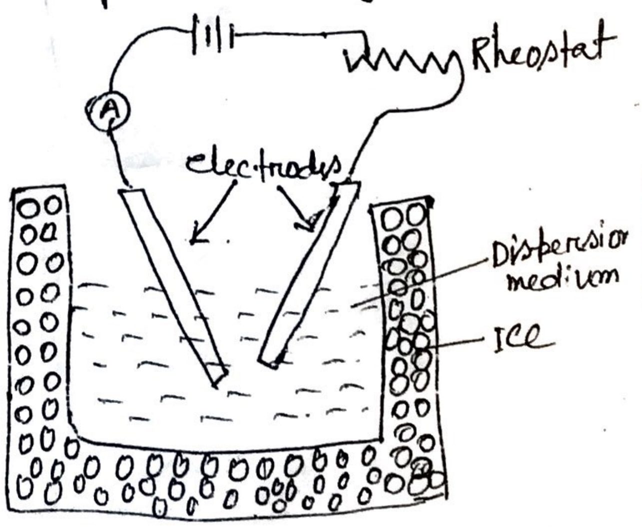

Figure: Bredig's Arc method.

5. Describe the preparation of colloids by condensation method or by chemical reaction or Association method.

In the association method the desired chemical species are formed by appropriate chemical reactions in solution. The molecules so formed undergo association or agglomeration and grows to colloidal dimension. The sol thus produced usually needs to be made from excess electrolyte which may be formed during chemical interaction. If appropriate control of the reaction rate and extent of reaction is not done, the colloid may form larger particles and seperate out as precipitate. The initial concentration of the reactant, temperature, volume, rate of addition of one of the reactants are all important steps for a successful preparation of the sol. By this method many hydrosols, alcosols etc. can be prepared.

Ferric hydroxide sol preparation by hydrolysis:
A freshly prepared nearly saturated solution of ferric chloride is first made. About 10 to 12 mL of the ferric chloride solution is then added drop wise to about 800 mL of boiling water.

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A few minutes interval is kept between successive drops. A brilliant dark red sol is produced by the hydrolysis of ferric chloride forming ferric hydroxide and hydrochloric acid. The sol needs immediate dialysis against hot water to remove the hydrochloric acid, otherwise the sol would be coagulated. Many sols of heavy metal hydroxides can be preparced in this way.

$$FeCl_3 + 3H_2O \longrightarrow \underset{\text{red sol.}}{Fe(OH)_3} + 3HCl$$

6. Describe purification of colloids.
Describe dialysis and Electrodialysis.

Dialysis: Animal membranes (bladder) or those made of parchment paper and cellophane sheet, have very fine pores. These pores permit ions (or small molecules) to pass through but not the large colloidal particles. When a sol containing dissolved ions (electrolyte) or molecules is placed in a bag of permeable membrane dipping in pure water, the ions diffuse through the membrane. By using a continuous flow of fresh water, the concentration of the electrolyte outside the membrane tends to be zero. Thus diffusion of the ions into pure water remains brisk all the time. In this way, practically all the electrolyte present in the sol can be removed easily. The process of removing ions (or molecules) from a sol by diffusion through a permeable membrane is called dialysis. The apparatus used for dialysis is called dialyser.

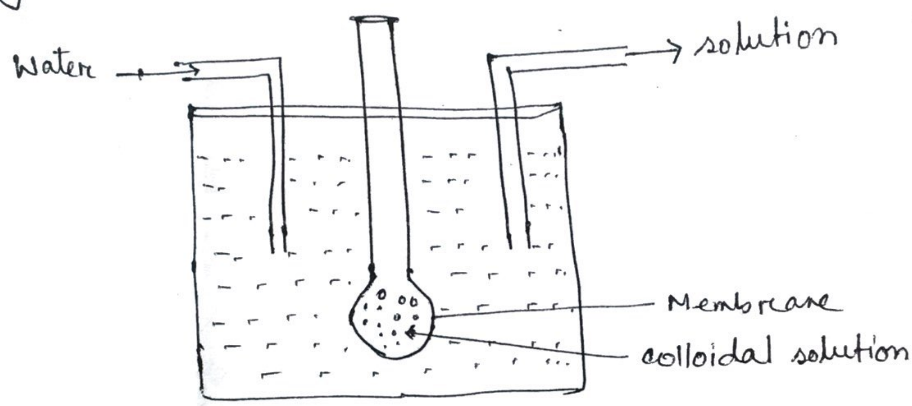

Figure: Dialysis of a sol containing ions and molecules.

Electrodialysis:— The dialysis can be frequently improved and made faster if the assembly is subjected to a suitable electric field. The migration of the ion of the electrolytes through the membrane becomes quite fast in the electric field and makes the process rapid. This is known as electrodialysis.

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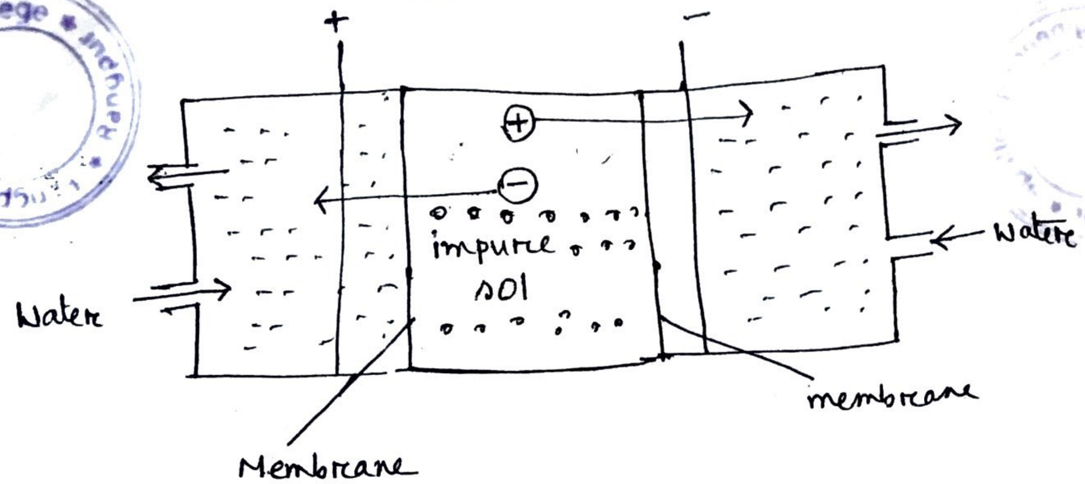

Figure: Electrodialysis.

What do you mean by dispersed phase and dispersion medium.

Dispersed phase: The substance distributed as the colloidal particles is called the dispersed phase.

Dispersion medium: The second continious phase in which the colloidal particles are dispersed is called the dispersion medium.

Example: For a colloidal solution of copper in water, copper particles are dispersed phase and water is dispersion medium.

Q. Write short notes on Tyndall phenomenon.

Colloids have some distinctive optical properties. The Tyndall phenomenon, named after Tyndall who extensively studied it, is attributed to scattering of light. If a narrow beam of sun's rays is allowed to enter into a dark or semi-dark room, the small dust particles floating in air become visible when viewed at right angle to the incident ray. One can easily see that the particles look like bright spots against the dark background of the room. This brightness of the particles is due to scattering of light by the dust and they act as secondary sources of radiation. The phenomenon is known as Tyndall effect. This property of lyophobic colloids is utilised in the ultramicroscope, first advanced by Siedentop and Zsigmondy. The principle of the ultramicroscope is illustrated in the figure.

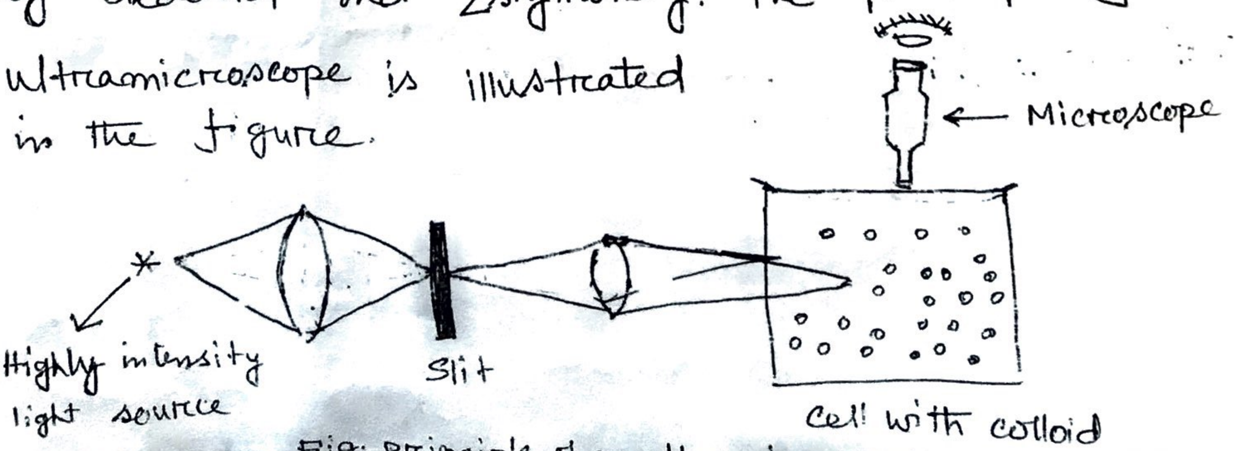

Fig: principle of an ultramicroscope

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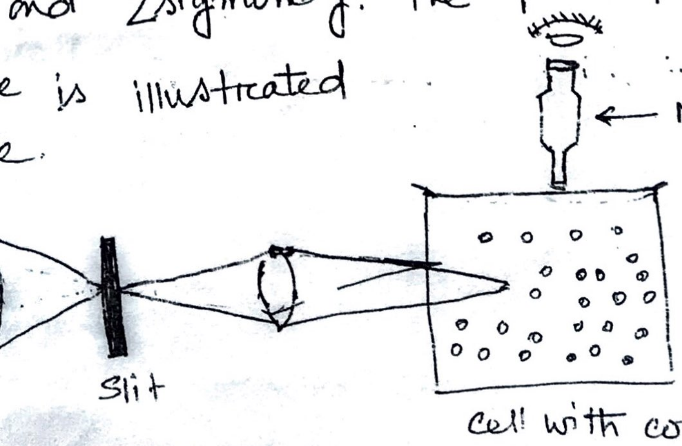

ig. principle of an ultra microscope

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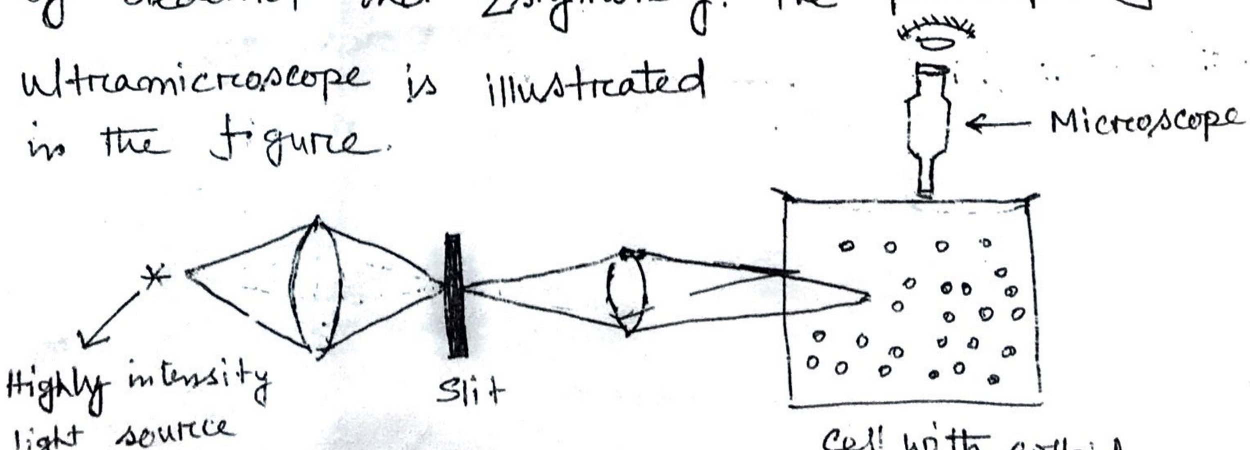

Fig. principle of an ultramicroscope

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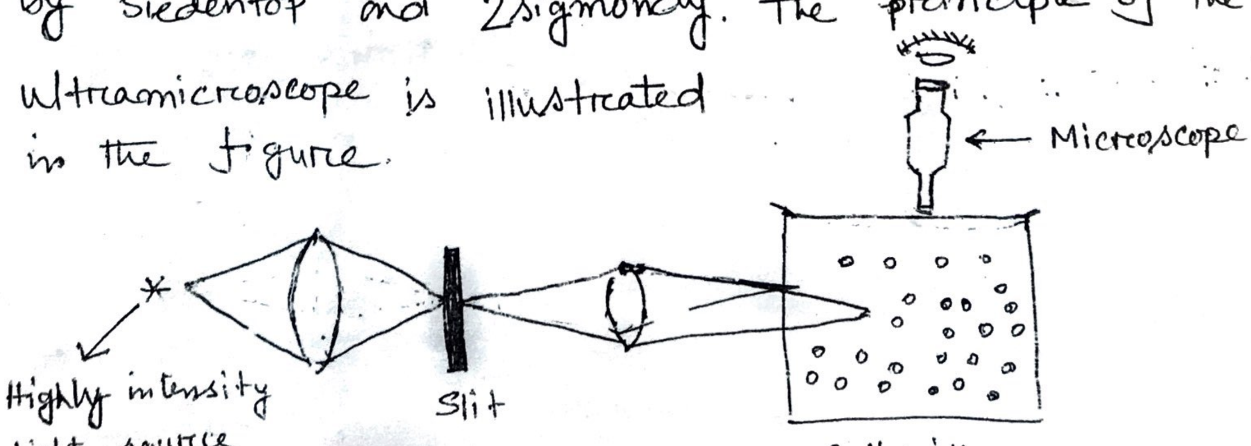

Fig: principle of an ultra microscope

From an intense light source, the rays are passed through suitable lenses and a narrow slit. By a second set of convergent lenses, the rays are converged inside the colloid which is contained in an optical cell. The microscope is focused the somewhere inside the cell in such a way that the rays scattered by the particles at right angle to the direction of incident ray, can enter the microscope and reach the eye of the observer. The particles of lyophobic colloid appear as bright spots to the observer's eye against a dark background.

8. Write short notes on Brownian movement.

When a sol is examined with an ultramicroscope the suspended particles are seen as shining specks of light. By following an individual particle, it is observed that the particle is undergoing a constant rapid motion. It moves in a series of short straight-line paths in the medium, changing directions abruptly. The continuous rapid zig-zag movement executed by a colloidal particle in the dispersion medium is called Brownian movement or motion. The explanation of

Brownian movement was advanced by Albert Einstein around 1955 by mathematical considerations based on the Kinetic moleculare theory. According to the theory, at any instant a colloidal particle was being struck by several molecules of the dispersion medium. The movement of the particle was caused by unequal number of molecules of the dispersion medium striking it from opposite directions. — When more molecules struck, the particle on one side than on another, the direction of movement changed. Figure illustrates how a colloidal-particle is knocked about in a zig-zag path by molecules of the dispersion medium.

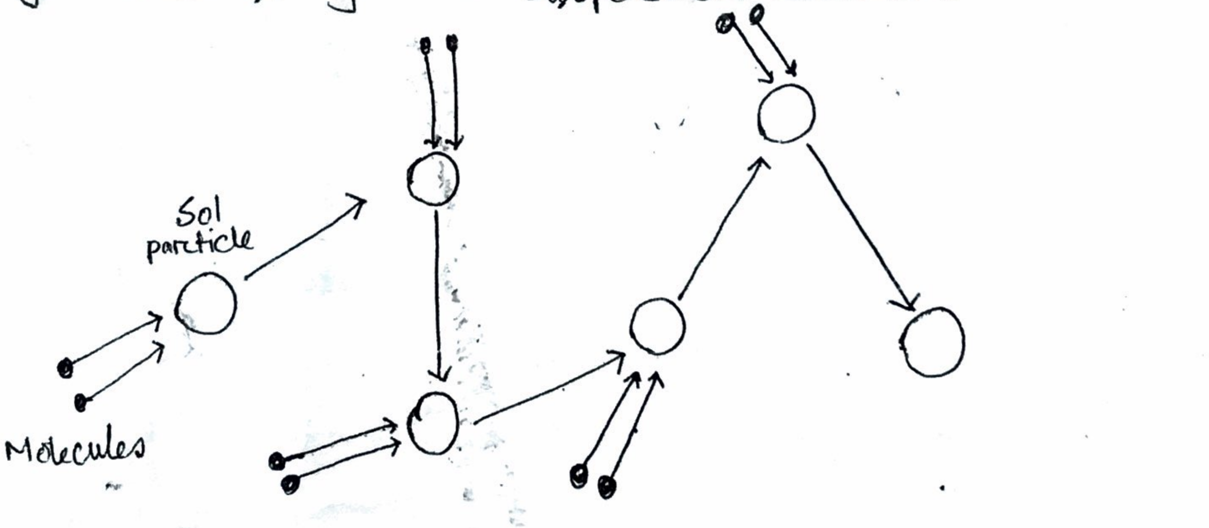

Figure: The bombardment on the sides of the colloidal particles by molecules of dispersion medium causes the random movement of the particle.

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9. Write short notes on Electrophoresis, ~~and~~ Electrosmosis.

If electric potential is applied across two platinum electrodes dipping in a hydrophilic sol, the dispersed particles move towards one or the other electrode. The movement of sol particles under an applied electric potential is called electrophoresis. If the sol particles migrate toward the positive electrode they carry a negative charge. On the other hand, if they move toward the negative electrode, they are positively charged. Thus by noting the direction of movement of the sol particles, we can determine whether they carry a positive or negative charge. The phenomenon of electrophoresis can be demonstrated by placing a layer of As_2S_3 sol under two limbs of a U-tube. When a potential difference of about 100 volts is applied across the two platinum electrodes dipping in deionised water, it is observed that the level of the sol drops on the negative electrode side and rises on the positive electrode side. This shows that As_2S_3 sol has migrated to the positive electrode, indicating that the particles are negatively charged. Similarly, a sol of ferric hydroxide will move to the negative electrode, showing that its particles carry positive charge.

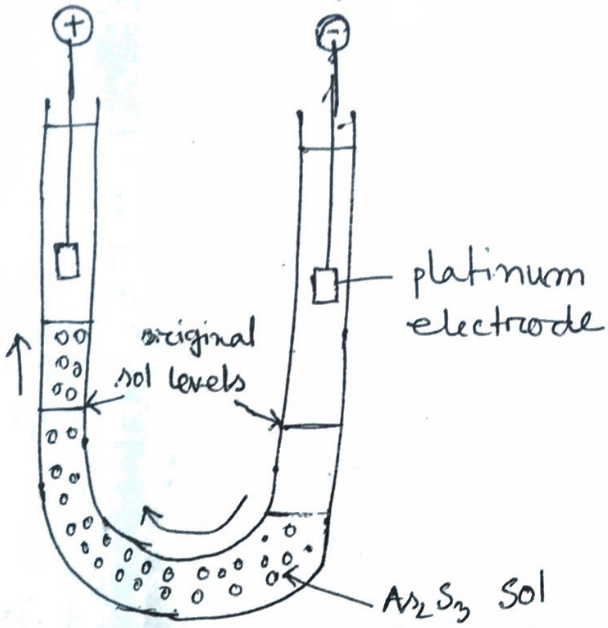

Figure : Electrophoresis of a sol.

Electro osmosis:

A sol is electrically neutral. Therefore the dispersio medium carries an equal but opposite charge to that of the dispersed particles. Thus the medium will move in opposite direction to the dispersed phase under the influence of applied electric potential. When the dispersed phase is kept stationary, the medium is actually found to move to the electrode of opposite sign that its own. Thus the movement of the — dispersion medium under the influence of applied potential is known as electro-osmosis. Electro-osmosis is a direct consequence of the existence of zeta potential between the sol particles and the medium. When the applied pressure exceeds the zeta potential, that diffuse layer moves and causes electro-osmosis

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The phenomenon of electro-osmosis can be demonstrated by using a U-tube in which a plug of wet clay is fixed. The two limbs of the tube are filled with water to the same level. The platinum electrodes are immersed in water and potential applied across them. It will be observed that water level rises on the cathode side and falls on anode side. This movement of the medium towards the negative electrode, shows that the charge on the medium is positive. Similarly, for a positively charged colloid electro-osmosis will take place in the reverse direction.

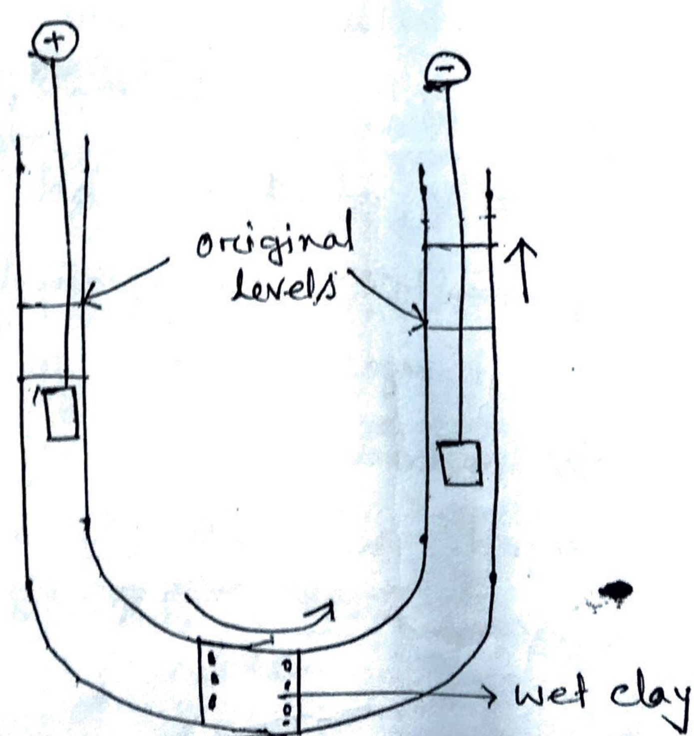

Figure: Electro-osmosis

10. Write short notes on coagulation.

Coagulation is a process of joining of colloid particles to form particles of much larger size with separation of solid phase. The coagulation results from neutralization of the charges of the colloid particles with ions of opposite charges. The stability of colloids may be explained in terms of charge carried by the colloid particles. When two particles, which are similarly charged electrically, approach each other electrostatic repulsion between the particles takes place and coagulation is prevented. When excess of an electrolyte is added to a sol, the dispersed particles are precipitated. The electrolyte furnishes both positive and negative ions in the medium. The sol— particles adsorb the oppositely charged ions and get discharged. The electrically neutral particles then aggregate and settle down as precipitate.

(11) Explain protective action of colloids.

Lyophobic colloids are readily precipitated by small amounts of electrolytes. Howevere these colloids are often stabilized by the addition of lyophilic colloids. The properety of lyophilic colloid to prevent the precipitation of a lyophobic colloid is called protection. The lyophilic colloid used to protect a lyophobic colloid from precipitation is referred to as a protective colloid.

Explanation: The particles of the hydrophobic colloid adsorb the particles of the lyophilic colloid. Thus the lyophilic colloid forms a coating around the lyophobic colloid particles. The ~~hy~~ lyophobic colloid, therefore, behaves as a ~~hydro~~ lyophilic colloid and is precipitated less easily by electrolytes.

Example: If a little gelatin (Lyophilic colloid) is added to a gold sol (Lyophobic colloid) the later is protected. The protected gold sol is no longer precipitated on the addition of sodium chloride.