Lecture notes on Physical Chemistry

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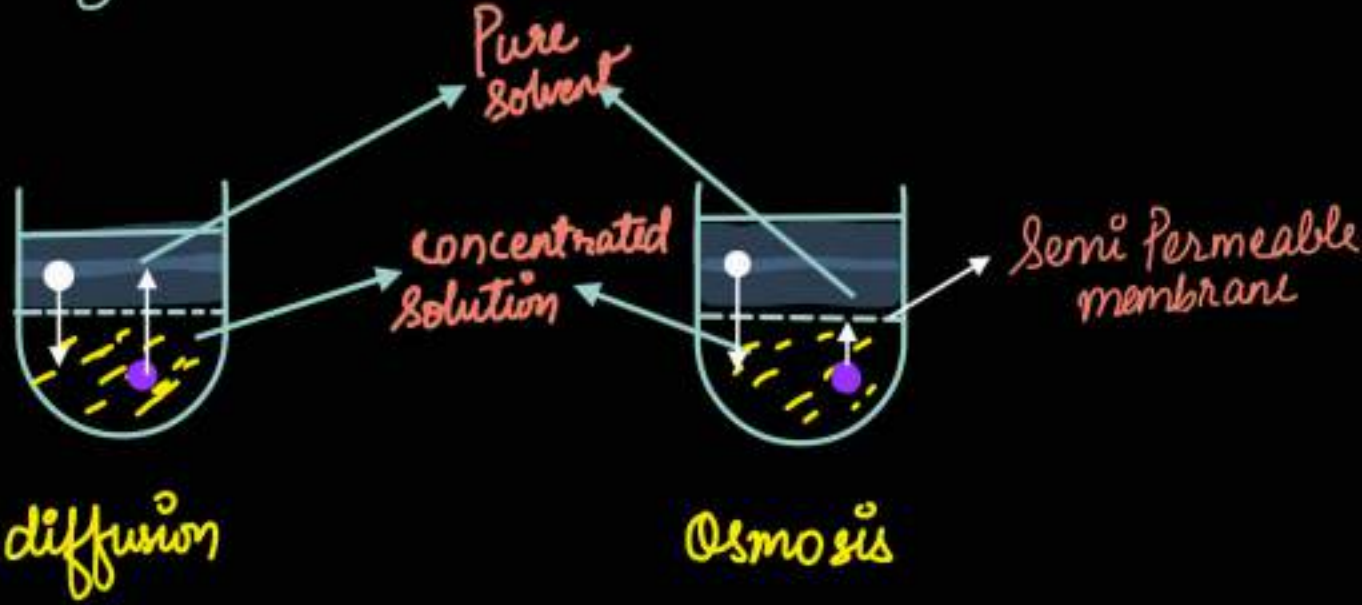
Osmosis

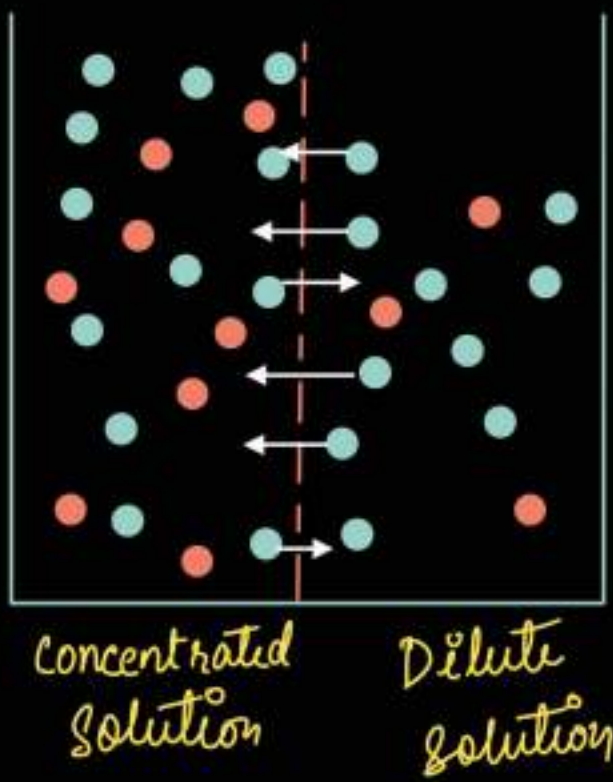
Osmosis:

It is the tendency to equalise concentration in all parts of the solution which is responsible for the diffusion of the solute.

The diffusion of solute will take place when two solutions of unequal conc^n^s are in contact. Solvent molecules will pass from the dilute to the concentrated solution and solute will pass from the concentrated to the dilute solution until equality of concentration is reached.



The solvent molecules can pass through the SPM from either side. But the net flow is from dilute to concentrated solution



★ write some examples on your own

★ Diffusion of solvent molecules takes place in both direction. The net flow of the solvent is from low to high concentration.

How. → Interesting experiments on osmosis

semi permeable membrane → A membrane which is permeable to solvent but not to the solute, is called semi-permeable membrane.

Animal and vegetable membrane are not completely semipermeable. Cupric ferrocyanide $Cu_2Fe(CN)_6$, membrane deposited on porous pot is perfectly semi-permeable. It is most generally used for accurate experimental work. All semi permeable membranes have fine holes or capillaries in their structure. These allow passage to solvent molecules but not to the larger solute molecules.

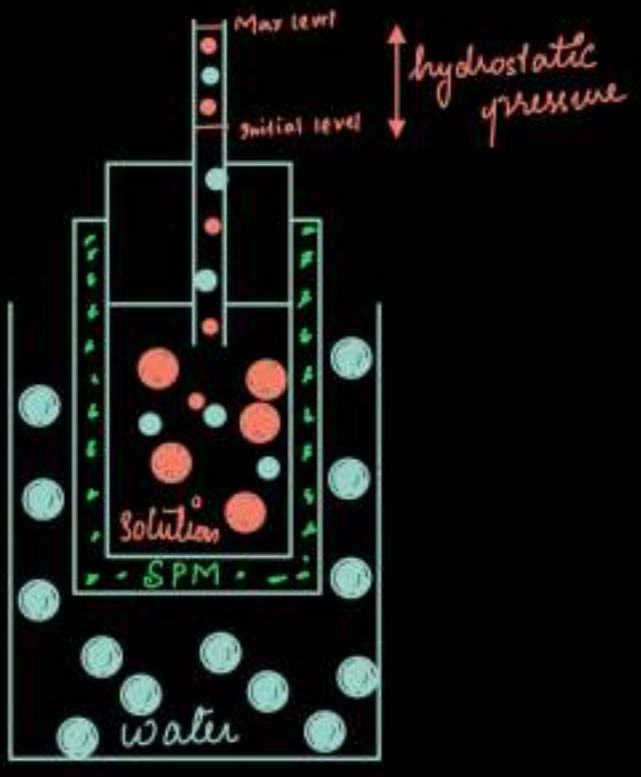
Preparation of Cupric Ferrocyanide Membrane

An unglazed porcelain battery pot filled with copper sulfate solution is placed in potassium ferrocyanide. ($K_4Fe(CN)_6$) The two solutions permeate into porous walls of the pot from opposite sides. A gelatinous precipitate of cupric ferrocyanide is formed in the middle of

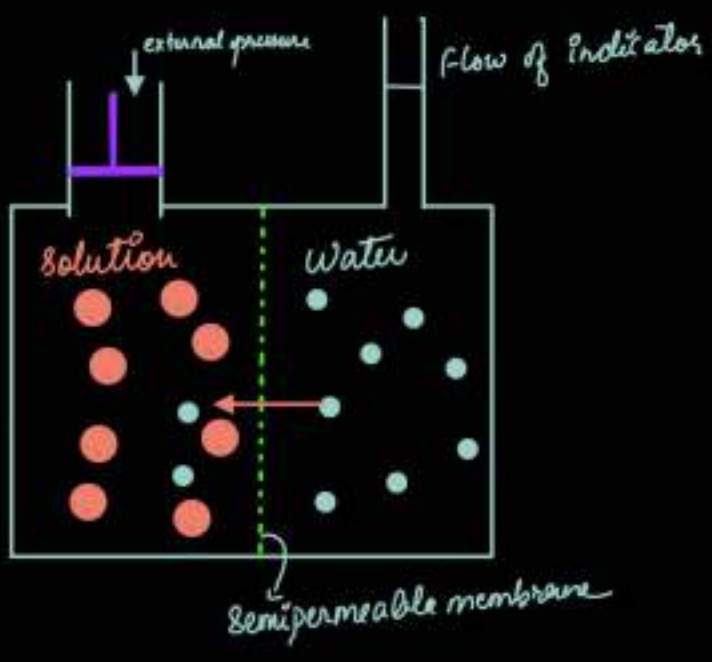
the pores of the walls.

$$2Cu^{2+} + Fe(CN)_6^{4-} \longrightarrow Cu_2Fe(CN)_6 \downarrow$$

Osmotic Pressure (π)



Hydrostatic pressure necessary to stop osmosis is equal to osmotic pressure



The external pressure applied on the solution side to stop the osmosis is equal to osmotic pressure.

Hypotonic → If the osmotic pressure of 1st sol^n is lower than the 2nd solution. $\pi_1 < \pi_2$

Hypertonic → If the osmotic pressure of 1st sol^n is greater than the 2nd solution. $\pi_1 > \pi_2$

Isotonic → If the osmotic pressure of 1st sol^n is lower than the 2nd solution. $\pi_1 = \pi_2$

Theories of Osmosis

Several theories has advanced to explain the action of SPM. The most important theories are →

(i) Molecular Sieve Theory :

According to this theory, the membrane contains lots of fine pores and acts as a sort of 'molecular sieve'. Smaller solvent molecules can pass through pores but larger solute molecules cannot. But in some instances the solute molecules are smaller than the solvent molecules, this theory remains in doubt.

(ii) Membrane soln Theory :

It says that as SPM has many proteins bearing functional groups such as $-COOH$, $-OH$, $-NH_2$, etc. dissolve water molecules by hydrogen bonding or chemical interaction. Thus it forms membrane solution. The solvent flows through the membrane solution to equalise concentrations

In this way solvent passes through the membrane while solute cannot.

(iii) Vapor pressure Theory:

It says that the vapour pressure of solution is lower than the pure solvent, the diffusion takes place

solvent vapours diffuse into solution across the gap in the capillary of the membrane.

(iv) Membrane Bombardment theory

The theory suggests that osmosis results from an unequal bombardment pressure caused by solvent molecules on the two sides of the semi permeable membrane. On one side we have only solvent molecules while on the other there are solute molecules occupying some of the surface area. Thus there are fewer bombardments on the

solution side than on the solvent side. Hence the solvent molecules will diffuse while the solute cannot.