**CONDUCTOMETRY**

* Electrolytes are the substances that form ions in solution which conduct an electric current. E.g., Sodium chloride, Copper sulphate and Potassium nitrate
* Non-electrolytes, on the other hand, are neutral molecules in solution. Their water-solutions do not conduct an electric current. E.g., Sugar, alcohol and glycerol

**Electrolysis**

The phenomenon of breakdown of an electrolyte by passing electric current through its solution is termed Electrolysis.

* The process of electrolysis is carried in an apparatus called the **Electrolytic cell.** The cell contains water-solution of an electrolyte in which two electrodes are dipped**.** These rods are connected to the two terminals of a battery (source of electricity).
* The electrode connected to the positive terminal of the battery attracts the negative ions (anions) and is called anode.
* The other electrode connected to the negative end of the battery attracts the positive ions (cations) and is called cathode.

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Fig. The mechanism of electrolysis/Conductivity cell

**Mechanism of Electrolysis**

* The cations migrate to the cathode and form a neutral atom by accepting electrons from it.
* The anions migrate to the anode and yield a neutral particle by transfer of electrons to it.

**Example:** Let us consider the electrolysis of hydrochloric acid as an example.

In solution, HCl is ionised,

HCl → H+ + Cl−

At cathode:

H+ + e– → H ......(Reduction, gain of electrons)

At anode:

Cl– → Cl + e− ......(Oxidation, loss of electrons)

The net effect of the process is the decomposition of HCl into hydrogen and chlorine gases. The overall reaction is:

2HCl → H2 + Cl2 ......(Decomposition)

**Conductometric Titrations**

* Titrations in which conductance measurements are made in determining the end-point of acid-alkali reactions, some displacement reactions or precipitation reactions are called conductometric titrations.
* **In these titrations, the conductance of a solution at a constant temperature depends upon the number of ions present in it and their mobility.**
* For this purpose, the titrant is added from a burette into a measured volume of the solution to be titrated which is taken in a conductance cell. The conductance readings corresponding to the various additions are plotted against the volume of the titrant.
* In this way two linear curves are obtained, **the point of intersection of which is the end-point.**

**(1) Titration of a Strong acid against a Strong base**

* Consider the reaction in which hydrochloric acid solution is titrated against a solution of sodium hydroxide. Take 20 ml of the acid solution in the conductance cell placed in a thermostat and determine its conductance. Now add 1 ml sodium hydroxide solution from the burette at a time. After each addition, determine the conductance of the solution after through mixing and plot the conductance of the solution against the volume of the alkali added.
* It will be observed that the points lie on two lines which are almost straight. The point of intersection of the interpolated lines will be the end point and the volume of alkali corresponding to this point is the volume of alkali required to neutralise 20 ml of the acid.
* The reason for this is that before the addition of alkali, the conductance of the solution is due to presence of H+ and Cl– ions. Since hydrogen ions possess the greatest mobility of any ion, the greater part of the conductance is due to it. As alkali solution is added, the hydrogen ions are removed by combination with the hydroxyl ions.

H+ + Cl– + Na+ + OH– → Na+ + Cl– + H2O

* As a result of this, the conductance of the solution decreases and continues to fall with every subsequent addition of alkali till the end-point is reached. After the equivalence point, further addition of sodium hydroxide solution results in an increase of conductance since the hydroxyl ions are no longer removed in the chemical reaction in the form of ionised water. **The point of minimum conductance, therefore, coincides with the end-point of the titration.**

**(2) Titration of a Weak acid against a Strong alkali**

When a weak acid like acetic acid is titrated against a strong alkali like sodium hydroxide, the initial conductance of the solution is low because of the poor dissociation of the weak acid. On adding alkali, highly ionised sodium acetate is formed. The acetate ions at first tend to suppress the ionisation of acetic acid still further due to Common Ion Effectbut after a while the conductance begins to increase because the conducting power of highly ionised salt exceeds that of the weak acid.

CH3COOH + Na+ + OH– → CH3COO– + Na+ + H2O

Immediately after the end point, further addition of sodium hydroxide introduces the fast moving hydroxyl ions. Thus, the *conductance value shows a sharp increase*. The point of intersection of the two curves, gives the end-point.

H+ + Cl– + NH4OH → NH4+ + Cl– + H2O

After the end-point has been reached, the addition of ammonium hydroxide will not cause any appreciable change in conductance value as it is a weak electrolyte and its conductance is very small compared with that of the acid or its salt.



**(3) Titration of a Strong acid against a Weak base**

* The curve obtained for the titration of a strong acid against a weak base is shown in Fig. 25.11.
* In this case, the conductance of the solution will first decrease due to the fixing up of the fast moving H+ ions and their replacement by slow moving NH4+ ions.

**(4) Titration of a Weak acid against a Weak base**

* The conductometric method is particularly suitable as such titrations do not give a sharp end-point with indicators.
* Consider the titration of acetic acid with ammonium hydroxide. The initial conductance of the solution in this case is also low due to the poor dissociation of the weak acid. But it starts increasing as the salt CH3COONH4 is formed.
* After the equivalence point, the conductivity remains almost constant because the free base NH4OH is a weak electrolyte. The end-point is quite sharp.



**Applications of conductometric titrations**

* To determine end point in case of acid-base and precipitation titrations.
* Purity of water can be checked by conductometric titrations.
* Salt content of water can be checked by this method.
* Used for tracing microorganisms in food.
* It is also used to check alkalinity of water.
* To study water pollution of rivers and lakes