ELECTROLYTIC CONDUCTIVITY, κ

Electrolytes conduct electricity because of the ions they contain.

The conductivity changes with concentration of ions in the solution.

Generally the higher the concentration of the ions the higher the conductivity.

Just like in solids, there is resistance to the flow of electric current in a solution of an electrolyte. This resistance is in accordance to ohm's law.

At a constant temperature, the electrical resistance of an electrolyte is;

i. Directly proportional to the distance between the electrodes and,
ii. Inversely proportional to the cross – sectional area of the solution between the electrode

$$R \propto \frac{l}{A}$$

$$R = \rho \frac{l}{A}$$

Where;

$R = electrical\ resistance$
$\rho = resistivity\ of\ the\ material$
$l = distance\ between\ the\ electrodes$
$A = cross - sectional\ area\ of\ the\ solution\ between\ the\ electrodes$

The resistance *R* is measured in ohms (Ω)

Conductance, *L*

This is the measure of the ease of the flow of an electric current through an electrolyte.

Conductance is obtained as the reciprocal of resistance of the solution.

$L = \frac{1}{R}$, measured in $\Omega^{-1}\ or\ Siemens\ (S)$

$L = \frac{A}{\rho l}$

$L = \frac{1}{\rho} \cdot \frac{A}{l}$

Electrolytic conductivity, κ

This is derived from the reciprocal of the resistivity, $\frac{1}{\rho}$

$Electrolytic\ conductivity, \kappa = \frac{1}{\rho}$

From, $L = \frac{1}{\rho} . \frac{A}{l}$

$\frac{1}{\rho} = L.\frac{l}{A}$

$Electrolytic\ conductivity, \kappa = L.\frac{l}{A}$

The ratio $\frac{l}{A}$ is called the cell constant measured in cm^{-1} or m^{-1}

Therefore $Electrolytic\ conductivity, \kappa = conductance\ (L)\ \mathrm{X}\ cell\ constant\ \left(\frac{l}{A}\right)$

Consider an electrolyte solution between electrodes which are 1cm^3 (or 1m^3) and 1cm (or 1m) apart;

$Electrolytic\ conductivity, \kappa = L.\frac{l}{A}$

$Electrolytic\ conductivity, \kappa = L.\frac{1}{1}$

$Electrolytic\ conductivity, \kappa = L$

Definition:

Electrolytic conductivity, κ, is the conductance of a solution between electrodes 1cm^3 in area and 1cm apart.

It is measured in $\Omega^{-1}cm^{-1}$ or $\Omega^{-1}m^{-1}$ or Scm^{-1} or Sm^{-1}

Factors which affect electrolytic conductivity of a solution

These include;

1. Temperature
2. Concentration

Effect of temperature:

Its effect depends on the type of electrolyte;

a) **Strong electrolyte**

Electrolytic conductivity of a strong electrolyte increases with increase in temperature. This is because of a decrease in the viscosity of water.

b) **Weak electrolyte**

The effect of temperature on electrolytic conductivity of a weak electrolyte will depend on the enthalpy change that accompanies the ionization process of the weak electrolyte.

If the weak electrolyte ionizes with evolution of heat (exothermic), increase in temperature will decrease the degree of ionisation and hence decrease in electrolytic conductivity due to fewer conducting ions. This is in accordance with Le – chartelier's principle.

If the weak electrolyte ionizes with absorption of heat (endothermic), increase in temperature will favour more ionisation resulting into more ions conducting hence increase in electrolytic conductivity.

Note:

At a fixed temperature, electrolytic conductivity of an electrolyte (both weak and strong) depends on;

i. The number of ions present per unit volume (concentration)
ii. The speed of movement of the ions

Effect of concentration:

Generally, the electrolytic conductivity of a solution increases with increase in its concentration, reaching a maximum value and then decreases.

(GRAPH)

For both weak and strong electrolytes, the shape of the conductivity – concentration curve is the same. However, the curve for a strong electrolyte lies above that of a weak electrolyte.

For both the weak and strong electrolytes, an increase in concentration increases the number of ions conducting per unit volume.

However, the increased conductivity is offset by the decrease in the degree of ionisation in a weak electrolyte. The more molecules there in, the lower the ability to ionise.

For a strong electrolyte, the increased conductivity is offset by an increase in ionic interference. The more ions there are per unit volume, the more they interfere with each other's movement.

The ions of opposite charge become very close to each other at higher concentration and hence exert a dragging effect on one another. This lowers the mobility of ions hence a decrease in electrolytic conductivity.

Note:

- The concentration of the solution is expressed as number of moles per dm^3
- The reciprocal of concentration is called ***Dilution, v,*** which expresses the number of m^3 of solution containing one mole of an electrolyte.

  Dilution = $\frac{1}{concentration}$, m^3mol^{-1}

$1000dm^3 = 1m^3$