CONDUCTANCE

Conductance (G) is the ease with which electricity flows through a solution.

Metallic or Electronic Conductance	Electrolytic or Ionic Conductance
- It depends on nature & structure of metal.	- It depends on nature of electrolyte.
- It depends on number of valence electrons per atom.	- It depends on size of ions produced & their solvation.
- It depends on density of metal.	- It depends on nature of solvent & its viscosity.
- Metallic conductance decreases with increase in Temperature.	- Electrolytic conductance increases with increase in Temperature.

The substance which allow the passage of electrical current through them are called conductors.

They are of 3 types:
- Metallic conductors
- Ionic conductors
- Gaseous conductors - conduct electricity under high potential difference at low pressure or when exposed to certain radiation.

Electrolytic solution has free ions. When electrical potential is applied, flow of current occurs & chemical changes occur. This leads to liberation ~~the~~ & decomposition or dissolution of electrode material of solution by electrical current. This process is called Electrolysis.

The electrolysis of molten salts produces ions which are characteristic of the salt. When certain aqueous solution are electrolysed, current carrying ions are not necessarily discharged at the electrodes. ②

Solution like metallic conductors obey Ohm's law. Thus, the resistance of electrolytic conductor to current passage can be determined by application of Ohm's law. However, while dealing with solutions, it is more convenient to speak of the conductance

$$V = IR$$

V = Potential difference
I = Current
R = Resistance.

$G = \frac{1}{R}$ = Conductance (Ω^{-1} or Siemen).

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

ρ = specific ~~con~~ resistance : It is the resistance of a specimen 1 m in length & 1 m^2 cross-section.
i.e. resistance of 1 m^3 of material.

$k = \frac{1}{\rho}$ = specific conductance ($S\,m^{-1}$).
(kappa) or Conductivity

$\frac{l}{A}$ = cell constant.

Magnitude of conductance depends on number of ions, magnitude of charge on each ion & ionic mobility

Specific conductance is conductance of 1 m^3 of solution, only if electrodes are exactly 1 m^2 in area & 1 m apart (Not usually the case).

Cell constant : value usually close to 1.0.
For dilute solution, less no. of ions & hence cell constant is less than 1.

For concentrated solution (more no. of ions), cell constant is more than 1.

$K = \frac{l}{A} \times G$

Conductance has to be multiplied by a certain factor (cell constant) in order to get specific conductance.

<u>Equivalent Conductance</u>:
Specific conductance depends on concentration of solution.
Equivalent conductance is more useful. It is the conducting power of all the ions produced by 1 gram equivalent of electrolyte in a given solution.

$\Lambda_{eq} = \frac{k}{c}$ $\quad c = \frac{\text{no. of g-equivalent}}{\text{volume of solution}}$

$(S\,m^2)$ $\quad$ no. of g-equivalent $= 1$

$c = \frac{1}{V}$

$\Lambda_{eq} = k \times V$

<u>Molar Conductance</u>
It is the conducting power of all ions produced by 1 mole of electrolyte.

$\Lambda_m = \frac{k}{c} = k \times V$ $\quad c = \frac{\text{no. of moles}}{\text{Volume of solution}}$

no. of moles $= 1$, $c = \frac{1}{V}$

<u>Electrolytic conduction</u>: When potential is applied, transfer of mass & charge from 1 part of solution to other occurs. It provides insight into structure of such solution.
Faraday assumed that flow of electricity was associated with movement of particles of matter carrying either positive or negative charges but did not give origin of ions.

Faraday's laws :

The quantitative relationship between electricity & chemical change were first described by Michael Faraday:

1.) Ist Law of Electrolysis :

The mass of a chemical substance involved at an electrode is directly proportional to amount of current passed through the cell.

$m \propto Q$, $Q = It$, $m \propto It$, $m = Z It$

2.) Second Law of Electrolysis :

The masses different substances produced by a given amount of current is directly proportional to equivalent masses of the substance. $\frac{m_1}{m_2} = \frac{E_1}{E_2}$

The quantity of electric charge carried by 1 mole of electrons is called 1 Faraday of electricity.

$1F = 96487\ C\ mol^{-1}$

These two laws hold very rigid, provided the passage of electricity takes place entirely by electrolytic conduction. It applies to molten electrolytes as well as ~~two~~ to solution of electrolytes & is independent of temperature, pressure or nature of the solvent.

Z = electrochemical equivalent of the substance.
It is defined as the amount of substance deposited or dissolved by passing one coulomb of electricity through the electrolyte melt or solution