Electrical Transport

Dr. A.K. Gupta.
chemistry

Electrolyte :- Solution which conduct electricity, is called an electrolyte.

for examples: Acids, Bases & salts (strong or weak)

Non-electrolyte :- No free ion in solution donot conduct electricity.

Conductance :-

conducting power of an electrolyte is expressed in terms of conductance. Higher is the conductance of an electrolyte, better is the electrolyte. So, conductance is defined as the reciprocal of resistance. i.e.

$$C = \frac{1}{R}$$

Unit :- ohm^{-1} or mho or Ω^{-1} or Siemen (S)

Specific Conductance —

Specific conductance is defined as the reciprocal of specific resistance.

i.e. $K = \frac{1}{S}$ —— (1)

Specific Resistance —

We know that the resistance of an electrolyte —

$$R \propto l$$

$$\& \quad R \propto \frac{1}{a}$$

where 'l' is the distance between two electrodes & 'a' is its cross-sectional area.

so, $R \propto \frac{l}{a}$

$$R = s \cdot \frac{l}{a} \quad \text{--- (2)}$$

Where, s is a constant called specific resistance. It is characteristics of the material.

If $l = 1$ cm & $a = 1$ sq. cm

$\therefore$ $\boxed{R = s}$

So, specific resistance is defined as the resistance of $1 \, cm^3$ (= 1 ml) of the electrolyte.

So, from eqn – (2)

$$s = R \times \frac{a}{l}$$

putting the value of 's' in eqn – (1) we get –

$$k = \frac{1}{s} = \frac{1}{R} \times \frac{l}{a}$$

$\therefore$ $\boxed{\text{specific conductance} = \text{Conductance} \left(\frac{1}{R}\right) \times \text{cell Constant} \left(l/a\right)}$

If $l = 1$ cm, $a = 1$ sq. cm

then, specific conductance = Conductance

so, specific conductance is defined as the conductance of $1 \, cm^3$ of an electrolyte.

<u>Unit :-</u>

$$k = \frac{1}{R} \times l/a$$

$$= ohm^{-1} \frac{cm}{cm^2} = ohm^{-1} cm^{-1}$$

Equivalent Conductance (Λ)

Equivalent conductance is defined as the total Conductance produced by 1 gm equivalent of an electrolyte.

Molar Conductance (Λ_m)

Molar Conductance is defined as the total conductance produced by 1 mole of an electrolyte.

for example-

(1) $NaCl = Na^+ + Cl^-$

1 mol = 1 mol 1 mol

1 eq. 1 eq.

$\Lambda_m = \Lambda$

(2) $Na_2SO_4 = 2Na^+ + SO_4^{--}$

= 2 mol 1 mol

= 2 eq. 2 eq.

$\Lambda_m = 2\Lambda$

(3) $CaSO_4 = Ca^{++} + SO_4^{--}$

1 mol 1 mol

2 eq. 2 eq

$\Lambda_m = 2\Lambda$

$$\Lambda = \frac{K \times 1000}{C}$$

where, C = Concentration of solution in equivalent/litre

i.e. Normality (N).

Similarly,

$$\Lambda_m = \frac{K \times 1000}{C}$$

where, C = Concentration of solution in mole/litre.

i.e. Molarity (M).

Normality (N) = Molarity (M) x acidity or Basicity

Problems :-

(1) 0.5 Normal solution of a salt placed between two pt-electrode, 20 cm apart and of a area of cross-section is 4.0 cm^2 has a resistance of 25 ohms. Calculate the equivalent conductance of the solution.

Ans :- ($\Lambda = 400\ ohm^{-1} cm^{-1}$)

Dr. A. K. Gupta.
Chemistry (L.S. College)