

①

Page No.:

1.....1

917121

Class 11 ⇒ B.Sc.(Hons.) Part-11

Subject ⇒ Chemistry

Chapter ⇒ Conductance

Topic ⇒ Conductance, cell const,

Different type of Conductance

Name ⇒ Dr. Amarendra Kumar

Dept. of chemistry,
Jain College, Arq.

Conductance

The ease with which electricity flows through a solution is called the conductance of the soln.

The reciprocal of the electrical resistance is called the conductance.

It is usually represented by C . Thus

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

units ⇒ It is expressed in the unit called reciprocal ohm (ohm^{-1} or Ω^{-1})

In SI system, the unit of conductance is Siemen (S).

$$(1 \text{ S} = 1 \Omega^{-1})$$

Specific Conductance

It is found that resistance (R) of a conductor is

(i) directly proportional to its length (l)

(ii) Inversely proportional to its area of cross-section (a)

i.e. $R \propto \frac{l}{a}$

$$\text{or } R = \rho \frac{l}{a} \quad \text{--- } ①$$

Where ρ is a constant of proportionality, called

(2)

Specific Resistance or Resistivity. Its value depends upon the material of the conductor.

The reciprocal of resistivity is known as specific conductivity or simply conductivity.

It is denoted by K . Thus, if K is the specific conductivity and C is the conductance of the solution, then

$$R = \frac{l}{C} \quad \text{and} \quad \sigma = \frac{C}{l}$$

Substituting the values of R and σ in eqn. (1)

$$\frac{1}{C} = \frac{1}{K} \times \frac{l}{a}$$

$$\text{or } K = C \times \frac{a}{l}$$

NOW if $l = 1\text{ cm}$, and $a = 1\text{ sq cm}$, then

$$K = C$$

Hence, specific conductivity of a solution is defined as the conductance of a solution of 1 cm length and having 1 sq cm as the area of cross-section.

Alternatively, the conductance of one centimeter cube of the solution of the electrolyte is called specific conductance.

If the volume of the soln. is $V \text{ cm}^3$, the specific conductivity of such a soln. at this dilution V is written as K_V

units \Rightarrow Resistivity or Specific resistance (ρ),

$$\rho = R \frac{a}{l} = \text{ohm} \frac{(\text{cm})^2}{\text{cm}} = \text{ohm cm} \text{ or ohm m}$$

SI unit

$$\text{specific conductivity } K = \frac{1}{\rho} = \frac{1}{\text{ohm cm}}$$

$$= \text{ohm}^{-1} \text{ cm}^{-1} \text{ or } \text{s}^{-1} \text{ cm}^{-1} \text{ or } \text{S}^{-1} \text{ cm}^{-1}$$

In S.I. unit.

M	T	W	T	F	S	S
Page No.:						
Date:					YOUVA	

Cell Constant

The ratio of length to the cross-sectional area is called the cell constant (G^*).

$$\text{Cell constant } (G^*) = \frac{l}{A}$$

Cell Constant is a characteristic parameter of conductivity of cell used for the experiment.

The cell constant of conductivity cell is determined by measuring the resistance of a solution of an electrolyte of known conductivity at a given temperature.

Evidently, the factor l/A is the cell constant. l is the distance in m between the electrode and A is the cross-sectional area of the electrodes in m^2 .

Obviously, the unit of cell constant is m^{-1} .

→ $\cdot 8 \text{ m}^{-1}$

Equivalent Conductance

The conductance of all the ions produced from one gm equivalent of the electrolyte dissolved in cm^3 of the solution when the distance between the electrodes is one cm and the area of the electrodes is so large that whole of the solution is contained between them is called equivalent conductance.

Equivalent conductance is represented by λ_{eq} .

Equivalent conductance is equal to the product of the specific conductance k and the volume V in cc containing one gm equivalent of the electrolyte at the dilution V .

$$\text{Equivalent Conductivity} = \text{specific conductivity} \times V$$

$$\lambda_{\text{eq}} = k \times V$$

Where V is the volume in cm^3 containing one gm equivalent of the electrolyte.

If the solution has a concentration of c gm equivalent per litre i.e. c gm equivalents are present in 1000 cm^3 of the solution, then the volume of the solution containing one gm equivalent will be $1000/c$. Thus the above

expression becomes

$$\lambda_{eq} = K \times \frac{1000}{C_{eq}}$$

$$\text{or } \lambda_{eq} = K \times \frac{1000}{\text{Normality}}$$

$$\therefore \lambda_{eq} = K \times \frac{1000}{N}$$

Units of Equivalent Conductance

$$\begin{aligned}\lambda_{eq} &= K \times V \\ &= \Omega^{-1} \text{ cm}^2 \times \frac{\text{cm}^3}{\text{gm Eq.}} \\ &= \Omega^{-1} \text{ cm}^2 (\text{gm Eq.}) \text{ or } \text{S cm}^2 \text{ eq}^{-1} \text{ or} \\ &\quad \Omega^{-1} \text{ cm}^2 \text{ eq}^{-1}\end{aligned}$$

S.I. Unit

The Unit of Equivalent Conductance are $\text{Sm}^2 \text{ eq}^{-1}$.

$$1 \text{ Sm}^2 \text{ eq}^{-1} = 104 \times \text{S cm}^2 \text{ eq}^{-1}$$

Molar Conductance

The molar Conductance of a solution at a dilution V is the conductance of all the ions produced from one mole of the electrolyte dissolved in $V \text{ cm}^3$ of the solution when the electrodes are one cm apart and the area of the electrodes is so large that the whole of the solution is contained between them.

Molar Conductance is usually represented by λ_m .

Molar conductance is related to the specific conductance as follows -

$$\text{Molar Conductance} = \text{Specific Conductance} \times \text{Volume in cm}^3$$

containing one mole of the electrolyte.

$$\lambda_m = K \times V$$

$$= K \times \frac{1000}{c}$$

$$= K \times \frac{1000}{\text{Molarity}}$$

$$\therefore \lambda_m = \frac{K \times 1000}{M}$$

where K is the specific conductivity and V is the volume of the solution containing one mole of the electrolyte and c is the molar concentration.

Units of Equivalent conductance

$\text{ohm}^{-1} \text{cm}^2 \text{mol}^{-1}$ or $\text{S cm}^2 \text{mol}^{-1}$ or $\Omega^{-1} \text{cm}^2 \text{mol}^{-1}$

S.I. Unit

$\text{S m}^2 \text{mol}^{-1}$

$$1 \text{Sm}^2 \text{mol}^{-1} = 10^4 \times 1 \text{cm}^2 \text{mol}^{-1}$$

\times
3m