Specific conductance (κ)

The reciprocal of the specific resistance is called as specific conductance. It is denoted as κ (kappa).

specific conductance → κ
specific resistance → ρ

$$\boxed{\kappa = \frac{1}{\rho}} = \frac{l}{R \times a} = \frac{1}{R} \times \frac{l}{a}$$

$$= \text{conductance} \times \frac{l}{a}$$

$$= \text{ohm}^{-1} \times \frac{\text{metre}}{\text{metre} \times \text{metre}}$$

S.I. unit of κ = $\text{ohm}^{-1}\,\text{m}^{-1}$ or $\text{S}\,\text{m}^{-1}$

$\frac{l}{a}$ → cell constant.
l → length of conductor
a → Area of cross section

So, when $l = 1\,m$, $a = 1\,m^2$
then, κ = conductance.

Specific conductance may be defined as the conductance of a material when it is 1 m long & area of cross-section is 1 m^2 of the conductor.

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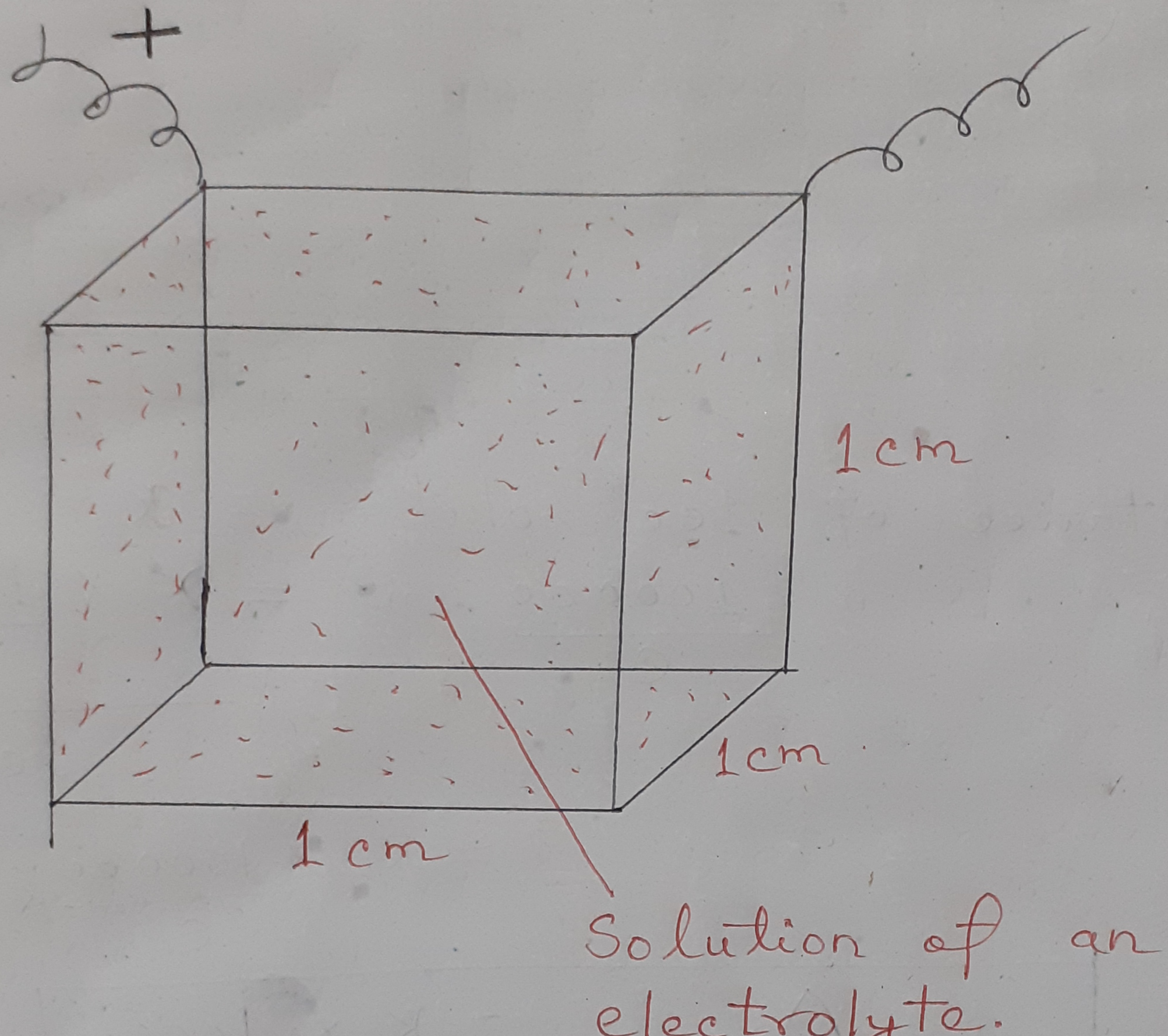
Specific conductance



In C.G.S. unit → It is the conductance of 1 cm^3 of the solution of an electrolyte.

C.G.S unit → $ohm^{-1} cm^{-1}$ / $\Omega^{-1} cm^{-1}$ / $S\ cm^{-1}$

Specific resistance (resistivity) ρ

It is the resistance offered by an unit cube of the material of a conductor to the passage of electricity.

$$R \propto l$$

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

$$R \propto \frac{l}{a} \qquad \boxed{R = \rho \times \frac{l}{a}} \qquad (\rho \to \text{proportionality constant})$$

$$\therefore \rho = R \times \frac{a}{l}$$

$$= \text{ohm} \times \frac{m^2}{m}$$

S.I. unit of ρ = ohm × m

Electrolyte

Electrolyte ⇌ Cation^+ + Anion^-

Cation → Cathode → Reduction

Anion → Anode → Oxidation

Molar conductance Λ_m

It is defined as the conducting power of all the ions produced by dissolving one gram mole of an electrolyte in solution.

It may also be defined as the conductance of the solution of an electrolyte kept between two electrodes placed at unit distance but having an cross-section large enough to contain the solution of 1 gm-mole of the electrolyte.

$$\Lambda_m = \frac{\kappa \times 1000}{c}$$

$c \rightarrow$ concentration in molarity i.e. moles/litre

(1 litre $= 1000\ cm^3 = 10^{-3}\ m^3$)

$$\Lambda_m = \frac{Sm^{-1}}{mol/m^3} = Sm^2 mol^{-1}$$

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

Equivalent conductance Λ (Capital Lambda)

It is defined as the conducting power of all the ions produced by dissolving 1 gram equivalent of an electrolyte in solution.

Specific conductance is the conductance of 1 cm^3 solu. of a given conc. i.e. length of 1 cm & cross sectional area of 1 cm^2.

If 1 cm^3 of the solu. contains 1 gm-equivalent of electrolyte, the the measured conductance will be equal to the equivalent conductance.

$\therefore$ conductance (C) = Specific conductance (K)

= Equivalent conductance (Λ)

If C is the conc. of a solu. in normality

then, C gm. equivalent present in 1000 cc solu.

$\therefore$ 1 gm " " " $\frac{1000}{C\ gm}$ cc $\times$ 1 gm

$= \frac{1000\ cc}{C}$

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conductance of 1cc solution = κ

$\therefore$ " " $\frac{1000cc}{c}$ " $= \kappa \times \frac{\frac{1000cc}{c}}{1cc}$

$= \kappa \times \frac{1000\cancel{cc}}{c} \times \frac{1}{1\cancel{cc}}$

$$\Lambda_{\text{equi. conductance}} = \kappa \times \frac{1000}{c}$$

$\Lambda = \frac{ohm^{-1} \cdot cm^{-1} \cdot cm^3}{equi}$

$\Lambda = ohm^{-1} cm^2 equi^{-1}$

$= S \cdot cm^2 equi^{-1}$

S.I unit of $\Lambda = ohm^{-1} m^2 equi^{-1}$