



CBSE

CLASS 12

CHEMISTRY

VOLUME- I



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ELECTRO CHEMISTRY

The branch of chemistry which deals with interconversion of electrical and chemical energy and all aspects related to it is called electrochemistry.

Substances are of four types:-

- | | |
|---------------|--------------------|
| ①. Conductors | ③. Semi-conductor |
| ②. Insulators | ④. Super-conductor |

CONDUCTORS:-

conductors are of 2 types:-

- | | |
|---------------------------|-----------------------------|
| ①. Conductors
Metallic | ②. Electrolytic conductors. |
|---------------------------|-----------------------------|

①. Metallic conductors:-

These are called electronic conductors as they conduct electricity due to e^- . Their conductivity depends on

- Nature of substance.
- No. of valence e^- per atom
- Temperature.

②. Electrolytic conductors:- These conduct electricity in molten and dissolved state. These are of 2 types.

→ strong Electrolyte completely dissociated in their solⁿ eg → NaOH, HCl almost in all salts.

→ Weak Electrolyte (Imcompletely dissociated) eg - CH₃COOH, NH₄OH.

ELECTRIC CONDUCTOR	ELECTROLYTE.
①. conductivity due to e ⁻ ②. High conductivity ③. Resistance ↑ es as temp ↑ es ④. Resistance is due to	due to ions low conductivity Resistance ↓ es as temp. ↑ es After passage of current their composition change.

Non-electrolyte → They don't conduct electricity in their solid, molten and dissolved state. eg. → glucose, ethyl alcohol.

⇒ SOME BASIC DEFINITION:-

① ohm's law → It states that at const, state the potential difference across the end of the conductor is directly

proportional to the current flowing through it :-

$$V \propto I$$
$$V = IR \quad (R = \text{resistance})$$

2. Resistance - It is defined as property of substance to resist the flow of current. Its unit is Ω .

FACTORS AFFECTING RESISTANCE :-

→ Nature of Substance

→ Temperature.

→ Length ($R \propto L$)

→ Area of cross section ($R \propto \frac{1}{A}$)

RESISTIVITY :-

For a conductor resistivity is defined as resistance of a conductor having unit length and unit square area of cross-section.

It is obtained as follows :-

$$(1) R \propto \frac{1}{A} \quad (2) R = \rho \frac{L}{A} \quad (3) \rho = \frac{RA}{L}$$

$$\text{unit} = \Omega \cdot \text{m}$$

CONDUCTANCE

Reciprocal of resistance is called conductance

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

unit = Ω^{-1} , Ω , seimen (S)

CONDUCTIVITY-

The reciprocal of resistivity of a conductor called conductivity.

$$K = \frac{1}{\rho}$$

unit = $\Omega^{-1} m^{-1}$, $m\Omega m^{-1}$

FACTORS AFFECTING CONDUCTANCE OF SOLUTION

- ①. Inter-ionic forces - Forces which are present ions of electrolyte \downarrow conductance.
- ②. SOLVATION - This depends upon solute - solvent interaction, larger the interaction, more be resistance and lesser will be the conductor.
- ③. Viscosity - Increase the viscosity of liquid near will be resistance and hence conductance \downarrow es.
- ④. Temperature: At temp \uparrow es all and above three factors decrease and conduct and increase.

Conductivity OF SOLUTION

It is defined as conductance of solⁿ when entire solⁿ is placed b/w two electrodes of area 1m^2 separated by 1cm

DETERMINATION OF CONDUCTIVITY

conductivity is reciprocal of resistivity

$$\rho l = \frac{l}{RA}$$

conductivity of any solⁿ can be obtained if R , l and A are known.

R is obtained from wheat

but l and A are not directly infact

$\frac{l}{A}$ is const. for a given cell and is known as cell-constant

∴, conductivity is written as -

$$k = \frac{l}{RA} \quad \left(\frac{l}{A} = \text{cell const.} \right)$$

$$k = \frac{\text{cell const.}}{R}$$

$$R = \text{conductance} \times \text{cell constant}$$

DETERMINATION OF CELL CONSTANT

For this we use standard solⁿ of KCl. It is prepared in conductivity water. Conductivity of standard solⁿ is already known. We fill standard solⁿ in conductivity cell and obtain its resistance form.

Now cell constant can be

$$k = \frac{\text{cell const.}}{R}$$

$$W_{\text{const}} = k \times R$$

Now this cell const. is name for all the cells and can be used for any solⁿ at same temp. now if same for all the cells and can be used for any solⁿ at same temp. now if conductivity of any unknown solⁿ is to be obtained, it is filled in this cell and connected to Wheatstone bridge etc to get obtained resistance cell const. obtained above and resistance is feed in full eqⁿ to get conductivity.

Ques. $\Lambda = \frac{\text{cell const.}}{R}$, what do you mean by conductivity in water?

Ans. We know water always have H^+ and OH^- and many impurities which also contribute in conductivity. But for determining conductivity of any electrolyte we want to prepare solⁿ in a solvent, which does not contribute in conductivity. This is possible if we use very pure water, although even very pure water contains H^+ OH^- but their contribution can be neglected.

This especially prepared water which has almost zero conductivity is called Normally double distilled water can be used as conductivity water.

MOLAR CONDUCTIVITY

It is conductance of water containing one mole substance that entire solⁿ placed b/w electrode having 1 cm area and separated by 1 cm

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

M

Variation in conductivity with concentration. As concentration \downarrow es i.e. dilution \uparrow es, conductivity \downarrow es. Actually more no. of ions in 1 cm^3 which results in

higher conductivity.

Variation in molar conductivity (Λ_m)

It \downarrow es on dilution \uparrow es. But this increment is diff. for weak and strong electrolyte. The study of variation in molar conductivity gives fall points -

→ Molar conductivity \uparrow es as dilution \uparrow es for both weak and strong electrolytes.

→ Relative change Λ_m of weak electrolyte is more than that of strong electrolyte for some dilution.

→ Λ_m of strong electrolyte has some limiting value for high dilution.

Ques. What is zero concentration or infinite dilution?

Ans. The dilution for solⁿ at which conductivity of strong electrolyte does not \uparrow on further of solvent is called infinite dilution or zero concⁿ.

NOTE:- Λ_m at zero concⁿ is called limiting molar conductivity (Λ_m^∞)

EXPLANATION FOR VARIATION IN Λ_m FOR Weak Electrolyte \rightarrow

Higher the dilution more will be dissociation of weak Electrolyte \uparrow , which \downarrow interionic forces.

Which further \uparrow Λ_m . At even conc. Λ_m can be given by given by Debye Huckel onwagner eqn.

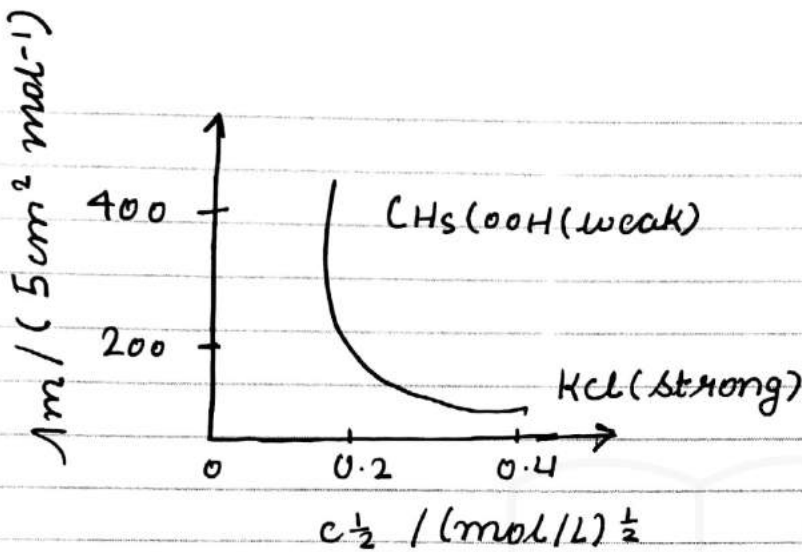
$$\Lambda_m^c = \Lambda_m^\infty - A\sqrt{c}$$

Where A is constant whose value depends on viscosity of solⁿ, dielectric constant of solution and charge on cation and anion.

on the basis of charge on cation and anion electrolytes are of fall types:-

1. 1-1 type \rightarrow $\text{CaCl}_2, \text{MgBr}_2$
2. 2-1 type \rightarrow Na_2SO_4
3. 1-2 type \rightarrow MgSO_4
4. 2-2 type \rightarrow MgSO_4

GRAPHICAL REPRESENTATION OF Λ_m ,



Λ_m vs $c^{1/2}$ for weak and strong electrolyte in aqueous solution.

It is clear from the graph that Λ_m for strong electrolyte is higher than weak electrolytes for even conc.

There is no much change in Λ_m for strong electrolyte on dilution.

then Λ_m^∞ for strong electrolyte can be obtained by extra cootation of graph line as its almost straight in nature.

Λ_m for weak electrolyte also \uparrow es but increment is comparatively higher than strong electrolyte. Moreover, Λ_m^∞ cannot be obtained by extra

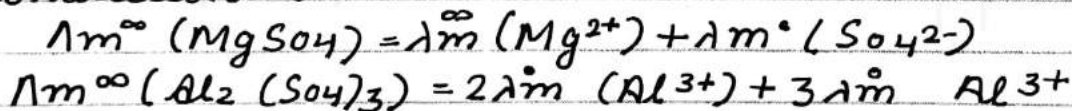
constation because at high dilution, graph turn becomes parallel to y-axis.

This problem of getting λ_m for weak electrolytes is solved by Kohlrausch law.

★ KOHLRAUSH LAW:-

It states that at ∞ dilution, when dissociation of weak electrolyte is almost complete, the contribution of each ion in molar conductivity is independent of other ions present in the solution.

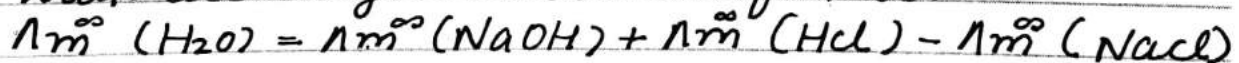
Λ_m^∞ is the sum of contribution of each ions present in the solution, If λ_m^∞ represent the contribution of ion in molar conduction then we have.



⇒ APPLICATIONS :-

→ For calculation Λ_m^∞ for weak electrolyte.

eg- we can obtain molar conductivity of weak electrolytes water as follows:-



→ To calculate degree of dissociation of weak electrolyte.

$$\alpha = \frac{\Lambda m^c}{\Lambda m^\infty}$$

→ To obtain solubility of sparingly soluble salts.

→ To obtain solubility product of salt (K_{sp})

Relation Between Equilibrium constant and Molar Conductivity:



$$K = \frac{[\text{CH}_3\text{COO}^-][\text{H}_3\text{O}^+]}{[\text{CH}_3\text{COOH}]}$$

$$K = \frac{c\alpha \cdot c\alpha}{c - c\alpha} = \frac{c^2\alpha^2}{c(1-\alpha)} = \frac{c\alpha^2}{1-\alpha}$$

since, $\alpha = \frac{\Lambda m^c}{\Lambda m^\infty}$

$$K = \frac{c\alpha^2}{1-\alpha}$$

$$K = \frac{c \left[\frac{\Lambda m^c / \Lambda m^\infty}{1 - \Lambda m^c / \Lambda m^\infty} \right]^2}{1 - \Lambda m^c / \Lambda m^\infty}$$

$$K = c \frac{[\lambda_m^{\circ} / \lambda_m^{\infty}]^2}{\frac{\lambda_m^{\infty} - \lambda_m^{\circ}}{\lambda_m^{\infty}}}$$

$$K = \frac{c (\lambda_m^{\circ})^2}{(\lambda_m^{\infty})^2 \left(\frac{\lambda_m^{\infty} - \lambda_m^{\circ}}{\lambda_m^{\infty}} \right)}$$

$$K = \frac{c (\lambda_m^{\circ})}{\lambda_m^{\infty} (\lambda_m^{\infty} - \lambda_m^{\circ})}$$

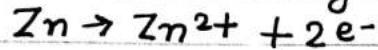
⇒ ELECTROCHEMICAL CELL

A device which converts chemical energy into electric energy is called electrochemical cell.

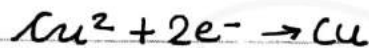
Making of cell → These cells are made up of redox reactⁿ in their mixed form. They consists of zinc rod dipped in ZnSO₄ solution and copper rod dipped in CuSO₄ solution. These rods are connected by conducting wire and two solution are connected by salt bridge.

In cell e⁻ flow from Zn to copper which are anode and cathod respectively.

Anode - It is the electrode at which oxidation takes place. It is -vely charged.



cathode - It is electrode at which reduction takes place, It is +vely charged



Overall reactⁿ



FUNCTION OF SALT BRIDGE :-

- ①. It connects anode and cathode and hence completes electric circuit.
- ②. It consists of small electrolyte in the form of paste, gelatin and agar-agar.

The ions of strong electrolyte like KCl help in maintaining electrical neutrality in anode-cathode half cells.

⇒ Representation of cell :-

- ①. Anode at LHS and cathode at RHS
- ②. Electrode and its solution is separated by vertical line and concⁿ is written in ()

3. salt bridge is shown by vertical line
 $Zn/Zn^{2+} (1M) // Cu^{2+} (1M)/Cu.$

L - left side

A → anode

O → Oxidation

N → -ve charge

A → anode

O → oxidⁿ

N → -ve charge

D → De - electrons.

⇒ EMF OF CELL

There is difference in potential of 2 electrodes of cell when cell is not in use i.e. when no current is drawn from the cell. It can be obtained by potentiometer.

Potentiometer can give difference in potential of electrodes but cannot give actual electrode potential of any electrode potential of any electrode. For this we use SHE or NHE.

SHE → It consists of containers having solution in which 1M H^+ is present i.e. 1M HCl or 0.5 M of H_2SO_4 is used. A glass tube in which platinum wire is fused, is dipped in solution. At the end of platinum wire, platinum foil is present. while its other end is free for condition. This tube is again surrounded by