Class: 2nd stage

Subject: Physical Chemistry

Ministry of Higher Education and Scientific Research
Al-Mustaqbal University College

Chemical engineering and petroleum industries
(Physical Chemistry lab)

Experiment No.5

(Variation of Molar Conductance with Concentration)

Theory:

Electrolyte is a substance that produces an electrically conducting solution when dissolved in a polar solvent, such as water. The dissolved electrolyte separates into cations and anions, which disperse uniformly through the solvent.

specific conductance or conductivity (κ): specific conductance is the ability of a substance to conduct electricity. Specific conductance is defined as the conductance of centimeter cube of the solution. Upon diluting the solution the concentration of ions per centimeter cube decrease and therefore the conductivity decrease. The standard unit of conductance is the siemens (abbreviated S) or mho.

Molar conductivity (Λ_m): the conductance (or conducting power) of all the ions of a solution produced by dissolving a mole of an electrolyte in a particular solution, in other words it is the conductance of the volume (in cm^3) of solution containing <u>one mole</u> of an electrolyte . It is denoted by Λ_m and its unit is $S\ cm^2\ mol^{-1}$

Its formula is:

$$\Lambda_m = \kappa \cdot V \quad \text{.....} (1)$$

$$M = \frac{n}{V} \quad \text{......}(2)$$

The volume in the equation of molarity is in liters so by converting it to cm^3

It becomes :

$$M = \frac{n \cdot 1000}{V}$$

n equals to 1 because in the definition the volume of a solution containing one mole

$$M = \frac{1 .\ 1000}{V}$$

So volume is

$$V = \frac{1 .\ 1000}{M} \quad \ldots\ldots (3)$$

Substitute equation 3 in 1

$$\Lambda m = \frac{\kappa .\ 1000}{M}$$

Both specific conductance (κ) & molar conductance Λ_m of a solution vary with concentration.

A **strong electrolyte** is a solution in which a large fraction of the dissolved solute exists as ions. HCl (hydrochloric acid), H_2SO_4 (sulfuric acid), NaOH (sodium hydroxide) , KCl (potassium chloride) are all strong electrolytes

A **weak electrolyte** is a solution in which only a small fraction of the dissolved solute exists as ions, such as CH_3COOH (Acetic acid).

For **strong electrolytes**, it is already completely dissociated in solution and there is only a very small increase and dissociation on dilution. At higher concentration the forces of attraction between oppositely charged ions are high and this hinders the movement of the ions. On dilution the ions move apart, the forces of attraction become negligible, and the ions are able to move about freely. This increase molar conductivity.

For **weak electrolytes**, it is partially ionised , on dilution their degree of dissociation increases causing an increase in the number of ions in the solution. This increases the molar conductivity to a great extent at higher dilution.

Apparatus:

Conductivity meter, beaker, potassium chloride, acetic acid

Procedure:

A measured volume of standard potassium chloride solution of 0.1 M concentration put in a beaker then immerse the tip of the probe of the conductivity meter in the solution to measure the conductivity, then dilute the solution to 0.05, 0.01 and 0.005 M and measure the conductivity in each.

Repeat the process using acetic acid with the same concentrations.

Fig. 1 Conductivity meter

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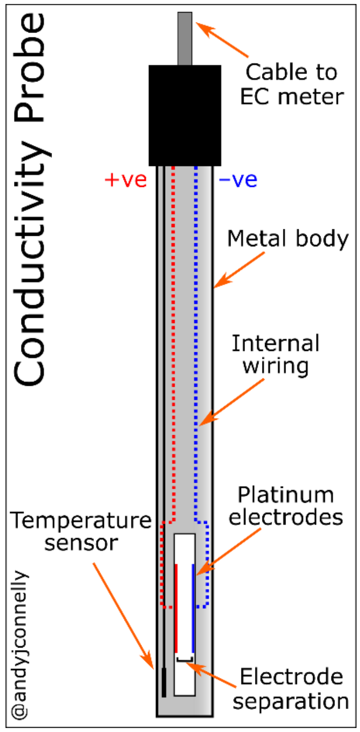

Fig. 2 conductivity probe

Calculations:

Draw a graph to illustrate the relationship between the square root of the concentration and the molar conductivity values of both a strong electrolyte and a weak electrolyte, Λ_m **vs** $\sqrt{c}$ **.**

Discussion:

1. How does specific conductivity vary with concentration?
2. Why does molar conductivity increases with decrease in concentration?
3. What is the unit of the molar conductivity?