Experiment (1)

Determination the limiting of molar conductivity for strong and weak electrolytes

Introduction:

The conductance (G) of a solution is the inverse of its resistance.

$$G = \frac{1}{R} \qquad \text{……….. (1)}$$

As resistance expressed in ohm (**Ω**)*, the conductance of a sample expressed in* (**Ω^{-1}**)*. The reciprocal **ohm** used to be the **mho**, but now called Siemens (S). The conductance of a sample decreases with its length (l) and increases with its cross-sectional area (a). We therefore write:*

$$G = k\,\frac{a}{l} \qquad \text{………..(2)}$$

Where (*l/a*) *is called cell constant, (k) is the conductivity of the solution. Can be defined conductivity is measurement of the ease with which electrical current flows through the solution. The units of (k) are ($mS.cm^{-1}$, $\mu S.cm^{-1}$, $S.cm^{-1}$). The conductivity depends upon:*

(i) The molar concentration

(ii) The charge numbers

(iii) The mobility of the ionic species present.

The molar conductivity (Λ_m) defined as:

$$\Lambda m = \frac{1000\ k}{C} \qquad \text{………..(3)}$$

Where: (C) is concentration of ionic species present. The units of (Λ_m) are ($S.cm^2.mol^{-1}$, $\mu S.cm^2.\ mol^{-1}$, $mS.cm^2.\ mol^{-1}$). For strong electrolytes (Λ_m) varies linearly with square root of the concentration, this variation called kohlrausch's law:

$$\Lambda_m = \Lambda_o - \varepsilon\sqrt{c}$$ ……..(4)

Where: (ε) kohlrausch coefficient.

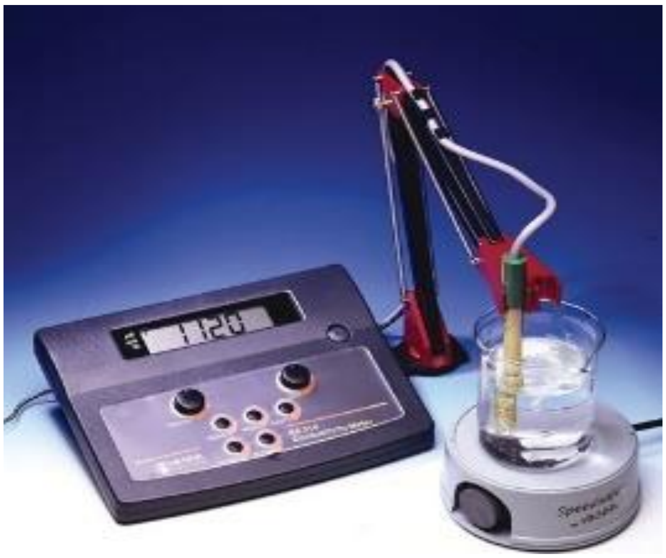
(Λ_o) is the limiting molar conductivity; it presents the molar conductivity in the limit of zero concentration (i.e. infinite dilution).

Thus, a plot of (Λ_m) against ($\sqrt{c}$) then the intercept at ($C\approx 0$) will produce (Λ_o). The kohlrausch's law is can be used only for strong electrolytes because those substances are virtually fully ionized in solution. Weak electrolytes are not fully ionized in solution, therefore cannot be used the previous equation for calculate (Λ_o), for weak electrolytes (Λ_o) must be determined using un indirect approach, which relies upon the limiting molar conductivities of several strong electrolytes at infinite dilution (the kohlrausch method).for example the (Λ_o) of CH_3COOH can be calculated from following equation:

$$\Lambda_o(CH_3COOH) = \Lambda_o(HCl) + \Lambda_o(CH_3COONa) - \Lambda_o(NaCl)$$

$$CH_3COONa + HCl \longrightarrow CH_3COOH + NaCl$$

Instrument using:



Procedure:

A- Preparation of required solutions:

1- Prepare the following dilute solutions of ***HCl*** *(2, 4, 6 and 8)×10^{-4} M in (50) mL from the stock solution (0.1)M.*

2- Prepare the following dilute solutions of ***CH_3COONa*** *(2, 4, 6 and 8)×10^{-4} M in (50) mL from the stock solution (0.1)M.*

3- Prepare the following dilute solutions of ***NaCl*** *(2, 4, 6 and 8)×10^{-4} M in (50) mL from the stock solution (0.1)M.*

B- Conductivity measurements:

1- Making sure the conductivity probe has been correctly calibrated with standard solution of KCl its conductivity is known.

2- Use the conductivity meter to measure conductivity for each solution has been prepared during dip the conductivity probe in to the solution, which you want to measure its conductivity.

3- Once the reading has stabilized (10 s), record the conductivity value on your data sheet.

4- Repeat steps (2, 3) to measure conductivities of all solutions (3 sets of 4 solutions).

5- Arrange data in the table:

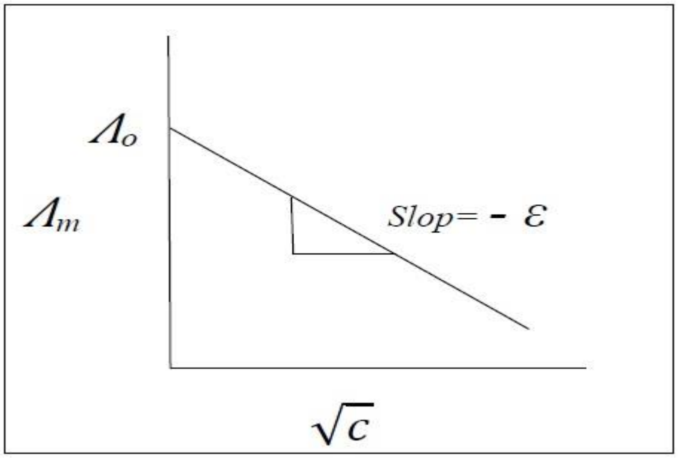
HCl				CH_3COONa				NaCl			
HCl (M) ×10^{-4}	k (μs.cm^{-1})	Λ_m (μs. mol^{-1}. cm^2)	$\sqrt{c}$	CH_3COONa (M) ×10^{-4}	k (μs.cm^{-1})	Λ_m (μs. mol^{-1}. cm^2)	$\sqrt{c}$	NaCl (M) ×10^{-4}	k (μs.cm^{-1})	Λ_m (μs. mol^{-1}. cm^2)	$\sqrt{c}$
2				2				2			
4				4				4			
6				6				6			
8				8				8			

Calculations:

1- Using equation ($\Lambda_m = 1000\ k / C$) *to determine* (Λ_m) *for all of the solutions that contain strong electrolyte.*

2- Plot (Λ_m) *versus* $\sqrt{C}$ *(eq. 4) and determine* (Λ_o) *for all the strong electrolytes*

3- Using the kohlrausch method, evaluate (Λ_o) *for acetic acid.*



Discussion:

1- Why do you can't use ($\Lambda_m = \Lambda_\circ - \varepsilon \sqrt{C}$) *to calculate* ($\Lambda_o$) *for weak electrolyte?*

2- In measurement of conductivity by using conductivity meter we must use alternating current (A. C) and must not use direct current (D. C.).

3- What is the difference between the metallic conductivity and electrolytic conductivity?