Quadrant II – Transcript and Related Materials

Programme: Bachelor of Science (Second Year)

Subject: Chemistry

Paper Code: CHC-103

Paper Title: Physical Chemistry and Organic Chemistry

Unit: Conductance

Module Name: Application of conductance measurement: solubility and solubility products of sparingly soluble salts, ionic product of water.

Module No: 20

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Notes:

Solubility and solubility product of sparingly soluble salts

Number of salts such as AgCl, $BaSO_4$, $PbSO_4$ are so sparingly soluble in water that their solubilities cannot be determined by any chemical methods.

They are generally regarded as insoluble. However it is possible to determine their solubilities by conductance measurement.

Procedure: To find solubility of AgCl

- Wash the salt repeatedly with water to remove any soluble impurities.
- Suspend the salt in conductivity water, warm and cool at 25^0C (small quantity will dissolve to form solution and rest will settle down)
- Measure conductance of solution by placing conductivity cell in solution.
- Measure the conductance of water used in preparation of solution.
- Difference between the two multiplied by cell constant gives specific conductance of solution due to dissolved salts (let it be Z Sm^{-1})

  If solubility of AgCl is ‘**C**’ $molm^{-3}$

Concentration of salt in aqueous solution =C mol m^{-3}

Molar conductance of salt is given as:

$$\lambda_m = \frac{k}{c} = \frac{z}{c}$$

As solubility of AgCl is extremely low, minute quantity that is dissolved can be regarded as present at infinite dilution and therefore the determined molar conductance can be taken as molar conductance at infinite dilution.

$$\lambda^0_m \text{ AgCl} = \lambda_{Ag+} + \lambda_{Cl-}$$

$$= (61.92 + 76.34) \times 10^{-4}$$

$$= 138.26 \times 10^{-4} \text{ Sm}^2\text{mol}^{-1}$$

$$c = \frac{z}{138.26 \times 10 -4 \text{ Sm}^2\text{mol}^{-1}}$$

Solubility of AgCl in water at 25^0C is = $\frac{z}{138.26 \times 10 -4 \text{ Sm}^2\text{mol}^{-1}}$

$$\mathbf{K_{sp} = (S)\,(S) = S^2}$$

Determination of ionic product of water (K_w)

Water is slightly dissociated as:

$$H_2O \longleftrightarrow H^+ + OH^-$$

Product of concentration of hydrogen and hydroxyl ions expressed in mol dm^{-3} is called as ionic product of water (K_w)

$$K_w = [H+]\,[OH-]$$

Kw is constant at given temperature; its numerical value can be determined experimentally by conductance measurements.

Specific conductance of purest water at 25^0C is found to be 5.54×10^{-6} Sm^{-1}

Molar conductance of 1 cubic meter of water is $\mathbf{5.54 \times 10 - 6\, Sm2}$

Molar conductance of water if it is completely ionized to give one mole of H^+ **and one mole of** OH^- **is obtained by adding up molar ionic conductance of Hydrogen and hydroxyl ion which are 349 × 10** $^{-4}$ **and 198.5 × 10**$^{-4}$ **Sm**^{2}**mol**$^{-1}$ **respectively at 25**^{0}**C**

Thus molar conductance of water should be (349 + 198.5) × 10^{-4} Sm^2 mol^{-1}

$$= 548.3 \times 10^{-4}\ Sm^2\ mol^{-1}$$

When it can give one mole of hydrogen and one mole of hydroxyl ion in aqueous solution

The no of moles of hydrogen per cubic meter will be:

$$c = \frac{5.54 \times 10 -6\ Sm^2}{548.3 \times 10\text{-}4\ Sm^2 mol-1} = 1.01 \times 10^{-4} \text{ moles}$$

The number of moles of hydroxyl ion will also be the same thus:

$$[\boldsymbol{H}+] = 1.01 \times 10^{-4} \text{ mol } m^{-3} = 1.01 \times 10^{-7} \text{ moldm}^{-3}$$

$$[\boldsymbol{OH}-] = 1.01 \times 10^{-4} \text{ mol } m^{-3} = 1.01 \times 10^{-7} \text{ moldm}^{-3}$$

$$\mathbf{K_w = [H+]}\ [\boldsymbol{OH}-] = 1.01 \times 10^{-7} \times 1.01 \times 10^{-7} \text{ moldm}^{-3}$$

$$= 10^{-14} \text{ moldm}^{-6} \text{ at } 25^0C$$