Chemistry 2201 Lab: VOLUME

Measuring the density of aqueous salt solutions to determine the partial molar volume as a function of concentration.

Partial Molar Volume ($\overline{V}$) is the change in volume when that component is added to an infinite amount of that solution.

Partial Molar Volume of Water is 18 mL/mole when added to water.

Partial Molar Volume of Water in Ethanol is 14 mL/mole.

Indication of the intermolecular interactions of the system.

Partial Molar determined from density of aqueous salt solutions.

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

Density determined by direct measurement of mass and volume of solution.

Density Bottle:

Density determined using a density bottle.

Record mass of density bottle empty.
Record mass of density bottle filled with distiled water. Using known density of distilled water. Gives volume of bottle.
Record mass of density bottle with liquid.

Given 4.00 molal NaCl and 1.00 molal $MgSO_4$. Dilute and determine density.

Calculate Φ_V and molality of each solution.

$$\Phi_V = \frac{1}{\rho_r}\left(M_2 - \frac{1}{m} \cdot \left(\frac{1000\,\mathrm{g}}{1\,\mathrm{kg}}\right) \cdot \frac{\rho_r - \rho_1}{\rho_1} \right)$$

ρ_r: solution density

ρ_1: solvent density

Plot a graph of Φ_V against $\sqrt{m}$.
Find slope and y-intercept.

Calculate partial molar volume of solvent and electrolyte($\overline{V_1}$ and $\overline{V_2}$) at various concentrations.

$$\overline{V_1} = V_1^o - \frac{1}{2} M_1 m^{\frac{3}{2}} \frac{d\Phi_V}{d\sqrt{m}} \qquad \overline{V_2} = \Phi_V^o + \frac{3}{2}\sqrt{m}\frac{d\Phi_V}{d\sqrt{m}}$$