Raoults Law

Solutions - 5. VP - Ideal Solutions

① VP of benzene (C_6H_6) at 25.0°C is 95.1 mm Hg. What is the VP of C_6H_6 above a solution that is 5.05 g of benzoic acid (C_6H_5COOH; mw = 122.1 g/mol) dissolved in 245 g benzene (C_6H_6; mw 78.1 g/mol).

$$VP_{soln} = \chi_{benzene} \cdot VP_{benzene}$$

↑ mol fraction

mol of benz acid = $5.05\text{ g BA} \times \frac{1\text{ mol}}{122.1\text{ g}} = 0.0414\text{ mol}$

mol of benz. = $245\text{ g benz} \times \frac{1\text{ mol}}{78.1\text{ g}} = 3.14\text{ mol}$

$$\chi_{benz} = \frac{3.14}{(3.14 + 0.0414)} = 0.987$$

$$VP_{soln} = 0.987 \times 95.1\text{ mm Hg} = \boxed{93.9\text{ mm Hg}}$$

② VP of pure water at 20.0°C is 17.5 mm Hg. What is the VP_{H_2O} at 20.0°C above a solution that is 0.250 mol sucrose ($C_{12}H_{22}O_{11}$) and 75.0 g urea ($CO(NH_2)_2$; mw = 60.06 g/mol) dissolved per kg of water?

$$VP_{soln} = \chi_{H_2O} \cdot VP_{H_2O}$$

mol sucrose = 0.250 mol

mol urea = $75.0\text{ g} \times \frac{1\text{ mol}}{60.06\text{ g}} = 1.25\text{ mol urea}$

mol H_2O = $1000\text{ g} \times \frac{1\text{ mol}}{18\text{ g}} = 55.5\text{ mol } H_2O$

total mols of solute = 0.25 + 1.25 = 1.50 mol

$$\chi_{H_2O} = \frac{55.5}{(55.5 + 1.50)} = 0.974$$

$$VP_{soln} = 0.974 \times 17.5\text{ mm Hg} = \boxed{17.0\text{ mm Hg}}$$