

Solutions - 7 Raoult's Law - 1 / FPT depression

1) What is the fpt of an aq. soln of sucrose that has 25.0g sucrose ($C_{12}H_{22}O_{11}$; MW = 342.3 g/mol) per 100g H₂O? ($k_{f,H_2O} = 1.86^\circ C/m$).

Ans

$$\Delta T = -k_f m \quad m = \frac{\text{mol solute}}{\text{kg solvent}}$$

$$m = \frac{\text{mol solute}}{\text{kg solvent}} = \frac{25.0 \text{g sucrose} \times \frac{1 \text{mol}}{342 \text{g}}}{100 \text{g} \times \frac{1 \text{kg}}{1000 \text{g}}} = \frac{0.0730 \text{mol}}{0.1 \text{kg}} = 0.730 \text{m}$$

$$\Delta T = -1.86^\circ C/m \times 0.730 \text{m} = -1.36^\circ C$$

$$\text{fpt}_{H_2O} = 0^\circ C \quad \text{new fpt} = \boxed{-1.36^\circ C}$$

2) What is the fpt of a soln with 10.0g naphthalene ($C_{10}H_8$; MW 128.2 g/mol) dissolved in 50.0g benzene (C_6H_6)? ($k_{f,benz} = 5.12^\circ C/m$; fpt_{benz} = 5.53°C)

$$\Delta T = -k_f m$$

$$m = \frac{\text{mol solute}}{\text{kg solvent}} = \frac{10.0 \text{g} / 128.2 \text{g}}{50.0 \text{g} / 1000} = \frac{0.078 \text{mol}}{0.05 \text{kg}} = 1.56 \text{m}$$

$$\Delta T = -5.12^\circ C/m \times 1.56 \text{m} = -7.988^\circ C$$

$$= -7.988^\circ C \quad \text{new temp}$$

original $5.53^\circ C$

$$-7.988 = T_f - 5.53$$

$$\boxed{T_f = -2.46^\circ C}$$