Problem 1

Please derive the mathematical formula for the boiling point elevation in the same manner as the development of freezing point depression in text book.

Please start with the condition for equilibrium of a solution with the vapor of the pure solvent.

$$\mu_1^l(T, P, x_1) = \mu_1^v(T, P)$$

The development will lead to the following equations.

$$\ln x_1 = \frac{\Delta_{vap} H_m}{R}\left(\frac{1}{T} - \frac{1}{T_b^*}\right)$$

$$\Delta_{vap}\mathrm{T} = K_b m_2$$

$$K_b = \frac{M_1 R {T_b^*}^2}{\Delta_{vap} H_m}$$

Problem 5.10

The normal boiling point of toluene is 100.62°C. Estimate its vapor pressure at 80.00°C assuming that toluene obeys Trouton's rule.

Problem 5.18

A solid exists in two forms, A and B, whose densities are 3.5155 gcm^{-3} and 2.2670 gcm^{-3} , respectively. If the standard Gibbs energy change for the reaction A ↔ B is 240kJ kg^{-1}, find the pressure at which the two forms of the solid are in equilibrium at 25°C. Assume that the volume change in going from A to B is independent of the pressure.

Problem 5.38

Methane dissolves in benzene with a Henry's law constant of 4.27×10^5 Torr. Calculate methane's molar solubility in benzene at 25°C if the pressure above benzene is 750 Torr. The vapor pressure of benzene is 94.6 Torr at 25°C

Problem 5.42

Pure naphthalene has a melting point of 353.35K. estimate the purity of a sample of naphthalene in mol %, if its freezing point is 351.85K ($K_f = 7.0K\ kgmol^{-1}$).

Problem 5.49

Using Henry's law, determine the difference between the freezing point of pure water and water saturated with air at 1 atm. For N_2 at 298.15K,

$$(k'')^{-1} = 2.17 \times 10^{-8}\ mol\ dm^{-3} Pa^{-1}$$

For O_2 at 298.15K,

$$(k'')^{-1} = 1.02 \times 10^{-8}\ mol\ dm^{-3} Pa^{-1}$$

Problem 5.53

If in a colligative properties experiment a solute dissociates, a term i known as van't Hoff's factor, which is the total concentrate of ions divided by the nominal concentrate, must be included as a factor. Thus, for the expression that relates to the freezing point, $\Delta_{fus}T = imK_f$. Derive an expression that relates to the degree of dissociated α and to ν, the number of particles that would be produced if the solute were completely dissociated. Then calculate van't Hoff's i factor and α for a 0.010-m solution of HCl that freezes at 273.114K