CHM 1046 - JOENS WORKSHEET #2 Due date: Wednesday, September 5th
(NOTE: Monday, September 3rd is Labor Day, and so there is no class on that day.)
WORKSHEETS ARE DUE AT THE BEGINNING OF CLASS ON THE DATE GIVEN ON THE WORKSHEET. LATE WORKSHEETS WILL NOT BE ACCEPTED.

NAME ______________________________ Panther ID ____________________________

For problems involving calculations you must show your work for credit.

1) A plot of the partial pressure of A (p_A) and the partial pressure of B (p_B) above a liquid solution of A and B is given below. The plot is for some fixed value of temperature T. Based on this plot, answer the following questions.

a) Do A and B form an ideal solution? Justify your answer.

For an ideal solution, the plot of p_A vs X_A and p_B vs X_A would both be straight lines (this follows from the fact that the partial pressures for an ideal solution of volatile liquids obey Raoult's law). Since the plots are curved lines, A and B do not form an ideal solution.

b) What is $p_A°$, the vapor pressure of pure A? _____445 torr_________

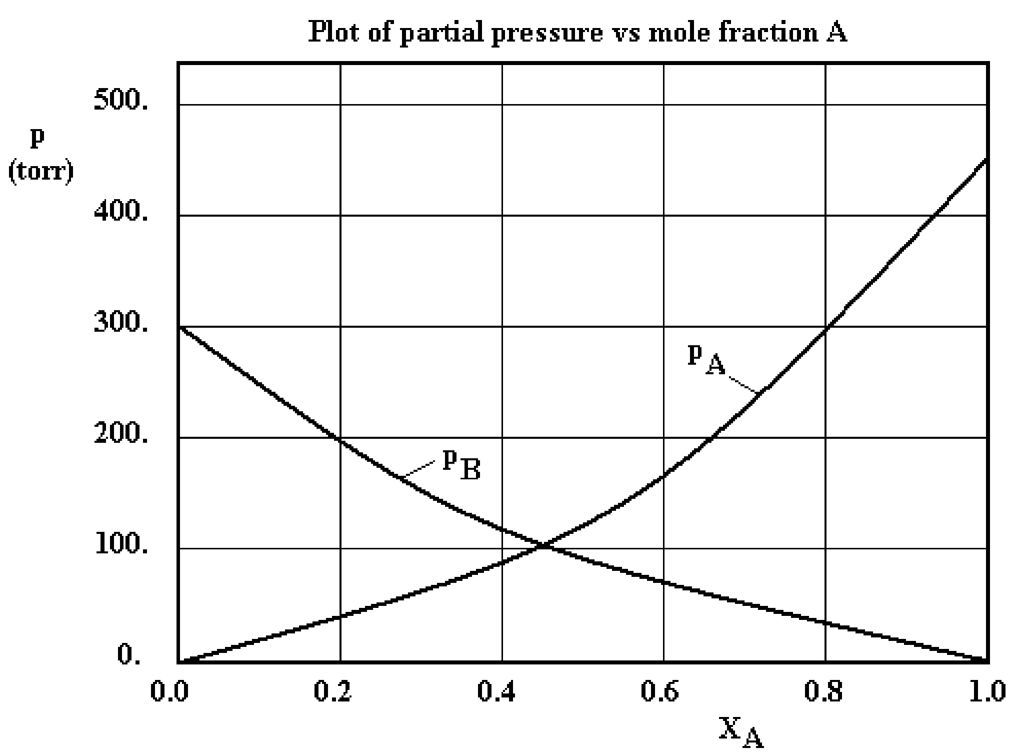
This is the point on the p_A curve corresponding to $X_A = 1$ (pure A)

c) What is $p_B°$, the vapor pressure of pure B? _____300 torr_________

This is the point on the p_B curve corresponding to $X_A = 0$ (and so $X_B = 1$, pure B).

d) What is the partial pressure of A for a solution where $X_A = 0.60$? _____170 torr_________

This is the point where the line for $X_A = 0.60$ cuts the curve representing p_A.



2) A solution is formed by dissolving 0.186 g of a nonvolatile and nonionizing solid in benzene (C_6H_6, MW = 78.11 g/mol). The final volume of the solution is V = 250.0 mL. The osmotic pressure of the solution, measured at T = 20.0 °C, is Π = 47.6 torr. What is the molecular weight of the solid?

$$\text{MW} = \frac{\text{mass solute}}{\text{moles solute}}$$ We know the mass of solute (0.186 g) so we must find the moles of solute

We are given the osmotic pressure.

Since $\Pi = [B]\,RT$ then

$$[B] = \frac{\Pi}{RT} = \frac{(47.6 \text{ torr})\,(1 \text{ atm}/760 \text{ torr})}{(0.08206 \text{ L·atm/mol·K})(293.1 \text{ K})} = 2.604 \times 10^{-3} \text{ mol/L}$$

Since we have 250.0 mL of solution, the moles of solute is

$$n = (0.2500 \text{ L})\,(2.604 \times 10^{-3} \text{ mol/L}) = 6.510 \times 10^{-4} \text{ mol solute}$$

And so $$\text{MW} = \frac{0.186 \text{ g}}{6.510 \times 10^{-4} \text{ mol}} = 286. \text{ g/mol}$$

3) Which of the following aqueous solutions is expected to have the highest value for normal boiling point?

a) A 0.100 mol/kg solution of glucose ($C_6H_{12}O_6$)
b) A 0.100 mol/kg solution of iron III nitrate ($Fe(NO_3)_3$)
c) A 0.100 mol/kg solution of calcium chloride ($CaCl_2$)
d) A 0.100 mol/kg solution of sodium bromide (NaBr)
e) Pure water

_______B________

Boiling point elevation is given by the equation $\Delta T_b = K_b\, m_B$, where m_B is the molality of solute particles. Since boiling point increases for a solution of a nonvolatile solute in a volatile solvent, and since all of the solutions (except for pure water) have the same molality of solute, we just need to find the solution with the highest concentration of particles. If we look at the values for the van't Hoff factors, we get

glucose $i = 1$ iron III nitrate $i = 4$ calcium chloride $i = 3$ sodium bromide $i = 2$

The iron III nitrate solution has the highest value for particle molality, and so the highest normal boiling point.