**Vapour pressure and Raoult´s Law**

**QUESTIONS**

**Example #1:** If 0.340 mol of a non-volatile non-electrolyte (does not break up into ions) are dissolved in 3.00 mol of water, what is the vapor pressure of the resulting solution? (The vapor pressure of pure water is 23.8 torr at 25.0 °C)

**Example #2:** 210.0 g of the non-volatile solute sucrose (C12H22O11) is added to 485.0 g of water at 25.0 °C. What will be the pressure of the water vapor over this solution? (The vapor pressure of pure water is 23.8 torr at 25.0 °C.)

**Example #3:** The vapor pressure of water above a solution of water and a non-volatile solute at 25.0 °C is 19.3 mm Hg. What is the mole fraction of the solvent? (The vapor pressure of pure water is 23.8 torr at 25.0 °C.)

**Example #4:** Calculate the vapor pressure of water above a solution at 35.0 °C that is 1.600 m fructose, C6H12O6. (The vapor pressure of pure water at 35.0 °C is 42.2 mmHg.)

**Example #5:** The vapor pressure of pure methanol, CH3OH, at 30. °C is 160. torr. How many grams of the non-volatile solute glycerol, C3H5(OH)3, must be added to 116. g of methanol to obtain a solution with a vapor pressure of 127. torr?

**ANSWERS**

**Solution 1:**

1) Calculate the mole fraction of the solvent (NOT the solute):

χsolvent = 3.00 mol / (0.340 mol + 3.00 mol)

χsolvent = 0.8982

2) Calculate the vapor pressure:

Psolution = (χsolvent) (P°solvent)

Psolution = (0.8982) (23.8)

Psolution = 21.4 torr

**Solution 2:**

1) Determine moles of water and sucrose:

water: 485.0 g / 18.0152 g/mol = 26.92171 mol   
sucrose: 210.0 g / 342.3014 g/mol = 0.61349 mol

2) Determine the mole fraction of the solvent:

χsolvent = 26.92171 mol / (26.92171 mol + 0.61349 mol) = 0.9777

3) Using Raoult's Law, determine the vapor pressure:

Psolution = (χsolvent) (P°solvent)

Psolution = (0.9777) (23.8)

Psolution = 23.3 torr

**Solution 3:**

1) Use Raoult's Law:

Psolution = (χsolvent) (P°solvent)

19.3 = (x) (23.8)

x = 0.811

**Solution 4:**

1) From the molality, we know this:

1.600 mol of fructose is dissolved in 1.000 kg of water.

2) Determine moles of water:

1000 g / 18.015 g/mol = 55.5093 mol of H2O

3) Determine mole fraction of solvent:

55.5093 / (55.5093 + 1.600) = 0.97198

4) Using Raoult's Law, the vapor pressure above the solution is:

(42.2 mmHg) (0.97198) = 41.0 mmHg

**Solution 5:**

1) Write an expression for the mole fraction of the solvent (methanol):

116. g divided by 32.0416 g/mol = 3.6203 mol

set mol of glycerol equal to x

χsolvent = 3.6203/(3.6203 + x)

2) Solve for 'x' with Raoult's Law:

127 torr = (χsolvent) (P°solvent)

127 = (3.6203/(3.6203 + x)) times 160. torr

Algebra!

x = 0.940708 mol

3) Convert moles to grams:

0.940708 mol is the amount of glycerol, so use its molar mass

0.940708 mol times 92.0932 g/mol = 86.6 g (to three sig figs)