CHM 1046 - JOENS WORKSHEET #1 Due date: Friday, May 11th

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) Which of the following liquids is expected to be miscible with water (circle all that apply)?

methanol (CH_3OH) **acetone (CH_3COCH_3)** cyclohexane (C_6H_{12})

Methanol and acetone are both polar molecules, and so expected to homogeneously mix with water, a polar liquid. Cyclohexane is nonpolar, and so is not expected to homogeneously mix with water.

2) A solution is 18.7% by mass cyclohexane (C_6H_{12}, MW = 84.2 g/mol) in carbon tetrachloride (CCl_4, MW = 153.8 g/mol). What are the molality and the mole fraction of cyclohexane in the solution?

$$\text{molality} = \frac{\text{moles solute}}{\text{kg solvent}} \qquad X_A = \frac{\text{moles A}}{\text{total moles}}$$

Assume 100.0 grams of solution. Then you have 18.7 grams cyclohexane and 81.3 grams carbon tetrachloride

$$\text{moles cyclohexane} = 18.7\ \text{g}\ \frac{1\ \text{mol}}{84.2\ \text{g}} = 0.2221\ \text{mol cyclohexane}$$

$$\text{moles } CCl_4 = 81.3\ \text{g}\ \frac{1\ \text{mol}}{153.8\ \text{g}} = 0.5286\ \text{mol } CCl_4$$

$$81.3\ \text{g } CCl_4 = 0.0813\ \text{kg } CCl_4$$

So $$\text{molality} = \frac{0.2221\ \text{mol cyclohexane}}{0.0813\ \text{kg } CCl_4} = 2.73\ \text{mol/kg}$$

$$X_{cyclo} = \frac{(0.2221\ \text{mol})}{(0.2221\ \text{mol} + 0.5286\ \text{mol})} = 0.296$$

3) Because many chemical reactions in the atmosphere occur in cloud droplets, scientists are interested in the concentration of dissolved gases in these droplets.

The Henry's law constant for hydrogen peroxide (H_2O_2, MW = 34.1 g/mol) in water is k = 8.3×10^4 mol/L•atm at T = 20. °C. What is the concentration of dissolved H_2O_2 in a cloud droplet in equilibrium with the atmosphere, and at T = 20.0°C, when the partial pressure of H_2O_2 in the atmosphere is 2.0×10^{-6} torr (a typical value for the lower atmosphere)? Give your answer both in units of mol/L and g/L.

Henry's law states $[B] = k\, p_B$

Since the Henry's law constant is in units of atmospheres, we need to convert the partial pressure of H_2O_2 from torr to atm.

$$p(H_2O_2) = 2.0 \times 10^{-6} \text{ torr} \; \frac{1 \text{ atm}}{760 \text{ torr}} = 2.63 \times 10^{-9} \text{ atm}$$

So $[H_2O_2] = (8.3 \times 10^4 \text{ mol/L•atm})(2.63 \times 10^{-9} \text{ atm}) = 2.2 \times 10^{-4}$ mol/L

In terms of mass the concentration is $(2.2 \times 10^{-4} \text{ mol/L})(34.1 \text{ g/mol}) = 7.4 \times 10^{-3}$ g/L
(or 7.4 mg/L)

4) The following question concerns ideal solutions.

a) How do we define an ideal solution of two gases?

An ideal solution of two gases is a homogeneous mixture of the gases where each partial pressure is given by the ideal gas law

$$p_A = \frac{n_A RT}{V} \qquad p_B = \frac{n_B RT}{V}$$

b) How do we define an ideal solution of two volatile liquids?

An ideal solution of two volatile liquids is a homogeneous mixture of liquids where the equilibrium partial pressure above the solution is given by Raoult's law

$$p_A = X_A\, p_A^\circ \qquad p_B = X_B\, p_B^\circ$$

where p_A° and p_B° are the vapor pressures for the pure liquids.