Chem 104 - Test 1 Practice Problems

1. Circle the best answer to each of the following.

a. If c is a constant, the equation that is the basis for Avogadro's hypothesis is

$V = c/P$ $V = cn$ $P = cT$ $KE = cT$ $V = cT$

b. A gas sample initially at 1.00 atm is expanded at constant temperature from 50.0 L to 75.0 L. the final pressure is

3.33 atm 1.50 atm 1.00 atm 0.667 atm 0.200 atm

c. At STP a 14.3-g sample of gas occupies 5.00 L. What is its molecular weight?

2.86 14.3 22.4 64.1 112

d. In a gas mixture of He, Ne, and Ar with a total pressure of 8.40 atm, the partial pressures of He and Ne are 1.50 atm and 2.00 atm, respectively. What is the mole fraction of Ar in the mixture?

0.179 0.714 0.238 0.417 0.583

e. A 0.100-mole sample of oxygen gas (m.w. = 32.0) effused through a pin hole in 5.00 seconds. Under the same conditions, how long would it take the same amount of CO_2 (m.w. = 44.0) to effuse?

1.17 s 3.64 s 4.26 s 5.86 s 6.88 s

f. Of the following gases, which would deviate most from ideal behavior?

CH_4 CF_4 CCl_4 CBr_4 CI_4

g. Which of the following is *least* soluble in methanol, CH_3OH?

SiO_2 H_2O I_2 NaF HF

h. Which of the following solutions would have the highest osmotic pressure?

0.200 M HF 0.300 M $C_6H_{12}O_6$ 0.100 M NaCl 0.100 M H_2SO_4 0.100 M Na_3PO_4

i. Which of the following has the highest boiling point?

$CH_3CH_2CH_3$ CH_3OCH_3 CH_3CHO $HOCH_2CH_2CH_2OH$ $CH_3CH_2CH_2OH$

2. Ferrocene, $Fe(C_5H_5)_2$ (m.w. = 186.0 u), is a molecular compound that is highly soluble in carbon tetrachloride (m.w. = 153.8 u). Consider a solution of 0.625 g of ferrocene dissolved in 12.0 g of CCl_4.

a. What is the molality, *m*, of the solution?

$$\left(\frac{0.625\ \text{g ferrocene}}{12.0\ \text{g } CCl_4}\right)\left(\frac{\text{mol ferrocene}}{186.0\ \text{g ferrocene}}\right)\left(\frac{10^3\ \text{g } CCl_4}{\text{kg } CCl_4}\right)$$

$$= 0.280\ m$$

b. Carbon tetrachloride freezes at -22.3 °C, and has a freezing point constant, K_f, of 28.8 °C/*m*. What is the freezing point of the solution?

$$\Delta T = K_f m = (28.8\ ^\circ C/m)(0.280\ m)$$
$$= 8.06\ ^\circ C$$
$$T_f' = T_f - \Delta T = (-22.3 - 8.06)^\circ C = -30.36^\circ C = -30.4^\circ C$$

c. What is the mole fraction of carbon tetrachloride in the solution?

$$m = 0.280\ \text{mol ferrocene/kg } CCl_4$$
$$\text{mol } CCl_4 \text{ in 1 kg} = (10^3\ \text{g})\left(\frac{\text{mol}}{153.8\ \text{g}}\right) = 6.50\ \text{mol}$$
$$\chi_{CCl_4} = \frac{6.50}{6.50 + 0.280} = 0.958_7 = 0.959$$

d. The normal boiling point of pure CCl_4 is 76.8 °C. What is the vapor pressure in torr of the solution at 76.8 °C?

$$\text{At } T_b = 76.8^\circ C,\ P^\circ = 760\ \text{torr}$$
$$\Rightarrow P = \chi P^\circ = (0.959)(760\ \text{torr}) = 728.6\ \text{torr} = 729\ \text{torr}$$

3. A 3.567-L sample of CO_2 (g) (m.w. = 44.01 u) is collected over water 35.40 °C. The pressure inside the vessel is 772.2 torr. At 35.40 °C the vapor pressure of water is 43.12 torr.

a. How many moles of $CO_2(g)$ does the sample contain?

$$P_{CO_2} = P_t - P_{H_2O} = (772.2 - 43.12)\text{torr} = 729.1\text{torr}$$

$$n = \frac{PV}{RT} = \frac{(729.1\text{torr}/760\text{torr}\cdot\text{atm}^{-1})(3.567\text{L})}{(0.08206\text{L}\cdot\text{atm/K}\cdot\text{mol})(308.55\text{K})}$$

$$= 0.1351_{51}\text{ mol} = 0.1352\text{ mol}$$

b. What are the mole fractions of $CO_2(g)$ and $H_2O(g)$ in the sample?

$$\chi_{CO_2} = \frac{729.1\text{ torr}}{772.2\text{ torr}} = 0.9441_{85} = 0.9442$$

$$\chi_{H_2O} = \frac{43.12\text{ torr}}{772.2\text{ torr}} = 0.05584 = 1 - 0.9442$$

4. A solution prepared by dissolving 0.525 g of an unknown non-electrolyte in enough water to make 125 mL of solution has an osmotic pressure of 1.10 atm at 27 °C. What is the molar mass of the solute?

$$\Pi = MRT \Rightarrow M = \Pi/RT$$

$$M = \frac{1.10\text{ atm}}{(0.08206\text{ L}\cdot\text{atm/K}\cdot\text{mol})(300\text{K})} = 0.0446_{83}\text{ mol/L}$$

$$\text{m.w.} = \left(\frac{0.525\text{ g X}}{0.125\text{ L soln}}\right)\left(\frac{\text{L soln}}{0.0446_{83}\text{ mol}}\right)$$

$$= 93.9_{96}\text{ g/mol} = 94.0\text{ g/mol}$$