NAME: SECTION:

CHEM 112 – Practice Exam I pg. 2/8

1.) A 10.0 mg sample of protein is dissolved in 2.00 ml of water. Calculate the molar mass of the protein if the solution has an osmotic pressure of 8.58×10^{-4} atm at 25 °C. (15 pts)

$$\Pi = \frac{nRT}{V}$$

$\Pi = 8.58 \times 10^{-4}$ atm

$R = 0.08206 \frac{L \cdot atm}{K \cdot mol}$

$T = 25°C = 298.15\ K$

$V = 2ml = 0.002L$

$$8.58 \times 10^{-4}\ atm = \frac{n\left(8.206 \times 10^{-2} \frac{L \cdot atm}{K \cdot mol}\right)(298.15\ K)}{0.002L}$$

$$24.46 \frac{L \cdot atm}{mol} n = 1.716 \times 10^{-6}\ L \cdot atm$$

$$n = 7.01 \times 10^{-8}\ mol$$

$$M.W. = \frac{g}{mol} \qquad mg = 10.0 = 0.01g$$

$$M.W. = \frac{0.01g}{7.01 \times 10^{-8} mol}$$

$$M.W. = 1.42 \times 10^{5}\ g/mol$$

NAME: SECTION:

CHEM 112 – Practice Exam I pg. 3/8

2.) Determine the best solvent to dissolve the given solute. Explain your answer by discussion intermolecular forces.

Should be LiCl

A.) Which solvent is best to dissolve LiCl and why? (5 points)

H_2O or hexane (C_6H_{14})

H_2O - hydrogen bonding / polar - strong bonds

Li^+Cl^- - ionic / polar - strong bonds

Likes dissolve likes

B.) Which solvent is best to dissolve methanol CH_3OH and why? (5 points)

Ammonia (NH_3) or Carbon tetrachloride (CCl_4)

CH_3OH - hydrogen bonding / polar - strong

NH_3 - hydrogen bonding / polar - strong

Likes dissolve likes

C.) Which solvent is best to dissolve benzene, C_6H_6, and why? (5 points)

Water or Carbon tetrachloride (CCl_4)

C_6H_6 - dispersion / non-polar weak

CCl_4 - dispersion / non-polar weak

Likes dissolve likes

NAME: SECTION:

CHEM 112 – Practice Exam I pg. 4/8

3.) A 500 ml sealed reaction cell is kept at a temperature of 293 K. Inside the cell is a mixture of 1.2 mols of hexane (C_6H_{14}) and 0.70 mols of chloroform ($CHCl_3$). The vapor pressure of hexane is 147 torr and the vapor pressure of chloroform is 298 torr.

a. Calculate the mole fraction of hexane. (3 points)

$$\chi = \frac{1.2 \text{ mols}}{1.2 \text{ mols} + 0.7 \text{ mols}} = 0.63$$

b. Calculate the mole fraction of chloroform. (3 points)

$$\chi = \frac{0.7 \text{ mols}}{1.2 \text{ mols} + 0.7 \text{ mols}} = 0.37$$

c. What is the partial pressure of hexane? (3 points)

$$P_{hex} = \chi P^\circ \qquad P_{hex} = 0.63(147)$$

$$P_{hex} = 93 \text{ torr}$$

d. What is the partial pressure of chloroform? (3 points)

$$P_{CHCl_3} = 0.37(298)$$

$$= 110 \text{ torr}$$

e. What is the total pressure in the reaction cell? (3 points)

$$P_{tot} = P_{hex} + P_{CHCl_3}$$

$$= 93 + 110$$

$$= 203 \text{ torr}$$

NAME: SECTION:

CHEM 112 – Practice Exam I pg. 5/8

4.) Phosphorus trichloride and chlorine react to form phosphorus pentachloride. At 140 °C, K_{eq} for this reaction is 1.60.

$$PCl_3 + Cl_2 \rightleftharpoons PCl_5$$

Calculate the concentration of all the chemicals at equilibrium if 0.6 mols of PCl_3 were initially mixed with 2.00 mols of Cl_2 in a 2.00 L flask at 140 °C. (15 points)

$[PCl_3]_i = \frac{0.6\,mol}{2\,L}$ $[Cl_2]_i = \frac{2\,mol}{2\,L}$

	PCl_3	+ Cl_2	$\rightleftharpoons$ PCl_5
i	0.3	1.0	0
C	−x	−x	+x
	0.3−x	1.0−x	x

$K_{eq} = \frac{[PCl_5]}{[PCl_3][Cl_2]}$

$$K_{eq} = 1.60 = \frac{x}{(0.3-x)(1.0-x)}$$

$$1.60 = \frac{x}{0.3 - 1.3x + x^2}$$

$$1.60x^2 - 2.08x + 0.48 = x$$

$$1.60x^2 - 3.08x + 0.48 = 0$$

use quadratic formula

$x = 1.75$ ~~too large~~ or $x = 0.17$

$[PCl_5]_{eq} = 0.17$

$[PCl_3]_{eq} = 0.3 - 0.17 = 0.13$ $[Cl_2]_{eq} = 1.0 - 0.17 = 0.83$

NAME: SECTION:

5.) Consider the following reaction and conditions:

$$N_2O_{4(g)} \rightleftharpoons 2NO_{2(g)} \quad \Delta H = 7.7 \text{ kJ/mol}$$

In a 1 L container at a temperature of 300 K you let the above reaction come to equilibrium. Does the reaction move towards products, reactants or remain unchanged (circle one) if you:

a.) remove some NO_2 (3 points)

(products) reactants unchanged

b.) add some N_2O_4 (3 points)

(products) reactants unchanged

c.) increase the temperature to 400 K (3 points)

(products) reactants unchanged

d.) increase the size of the container to 2 L (3 points)

(products) reactants unchanged

e.) add Argon, an inert gas (3 points)

products reactants (unchanged)

NAME: SECTION:

CHEM 112 – Practice Exam I pg. 7/8

6.) a.) Calculate the solubility of calcium hydroxide in an aqueous solution given $K_{sp} = 5.0 \times 10^{-6}$. (10 points)

$$Ca(OH)_{2(s)} \rightleftharpoons Ca^{2+}_{(aq)} + 2OH^-_{(aq)}$$

		$Ca^{2+}_{(aq)}$	$2OH^-_{(aq)}$
i		0	0
C		$+x$	$+2x$
e		$+x$	$+2x$

$$K_{sp} = [Ca^{2+}][OH^-]^2$$

$$5.0 \times 10^{-6} = (x)(2x)^2$$

$$5.0 \times 10^{-6} = 4x^3$$

$$1.25 \times 10^{-6} = x^3$$

~~$4.17 \times 10^{-7} = x$~~ $0.011 = x$

b.) Will the solubility of calcium hydroxide increase or decrease when NaOH is added to the solution. Why? (5 points)

Decrease, common ion (OH^-) effect

NAME: SECTION:

CHEM 112 – Practice Exam I 8/8

7.) The following equation has a $K_{eq} = 4.5 \times 10^{-1}$ at room temperature.

$$2HI(g) \rightleftharpoons H_2(g) + I_2(g)$$

You walk into a lab and see an unknown 1.5 L reaction flask sitting at room temperature and you determine the flask contains 0.785 mols of HI, 0.40 mols of H_2 and 0.38 mols of I_2. Is the reaction moving towards products, towards reactants, or at equilibrium? Support your answer mathematically. (10 points)

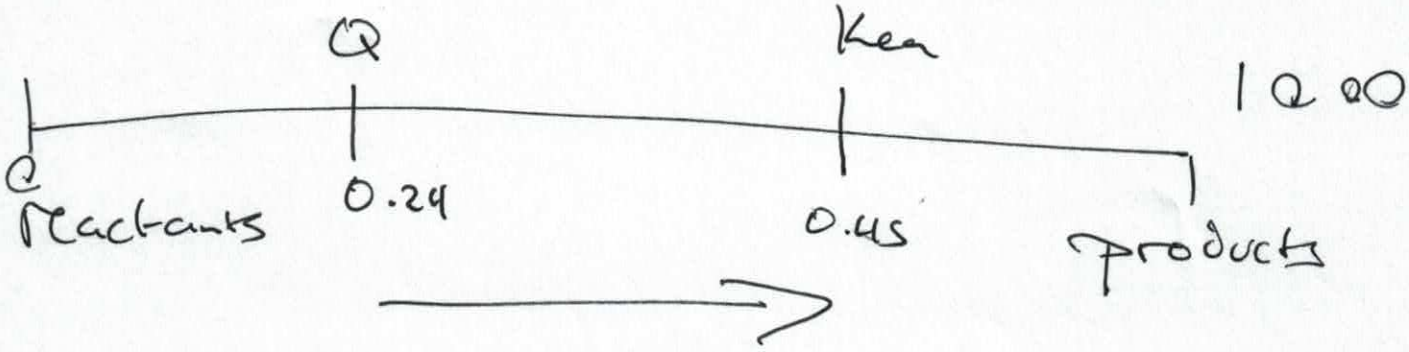
$[I_2] = \frac{0.38\text{ mol}}{1.5\text{ L}}$ $[HI] = \frac{0.785\text{ mol}}{1.5\text{ L}}$ $[H_2] = \frac{0.40\text{ mol}}{1.5\text{ L}}$

$$Q = \frac{[H_2][I_2]}{[HI]^2}$$

$$Q = \frac{(0.27)(0.25)}{(0.52)^2}$$

$$Q = 0.24$$

$$K_{eq} = 0.45$$



Reaction moving towards products