CHEM 130 **Name** ____

Quiz 9 – November 17, 2017

Complete the following problems. Write your final answers in the blanks provided.

1. At 25°C, 0.760 mol SO_3 is placed in an otherwise empty 5.00 L container. When equilibrium is reached, 0.160 mol of O_2 is present. What is K_c at this temperature? (8 pts)

$$2SO_3(g) \rightleftarrows 2SO_2(g) + O_2(g)$$

There are several ways to approach this. In the end, we need equilibrium concentrations of all species.

	$2SO_3$	$\rightleftarrows$	$2SO_2$	+	O_2
I	0.760 mol/5 L = 0.152 M		0		0
C	-2x		+2x		+x
E	0.152-2(0.032) =0.088 M		0+2(0.032) =0.064 M		0.160 mol/5L = **0.0320 M =x**

$$K_c = \frac{[SO_2]^2[O_2]}{[SO_3]^2} = \frac{(0.0640)^2(0.0320)}{(0.088)^2} = 0.0169$$

Answer_______0.0169________________

2. Determine K_c for the reaction: $2NOCl(g) \rightleftarrows N_2(g) + O_2(g) + Cl_2(g)$ from the following data at 298K: (8 points)

$\frac{1}{2} N_2(g) + O_2(g) \rightleftarrows NO_2(g)$ $K_c = 1.0 \times 10^{-9}$

$NOCl(g) + \frac{1}{2} O_2(g) \rightleftarrows NO_2Cl(g)$ $K_c = 1.1 \times 10^{2}$

$NO_2(g) + \frac{1}{2} Cl_2(g) \rightleftarrows NO_2Cl(g)$ $K_c = 0.3$

We need to rearrange reactions to make our target reaction:

$2(NO_2(g) \rightleftarrows \frac{1}{2} N_2(g) + O_2(g))$ $K_c = 1/(1.0 \times 10^{-9})^2$

$2(NOCl(g) + \frac{1}{2} O_2(g) \rightleftarrows NO_2Cl(g))$ $K_c = (1.1 \times 10^{2})^2$

$2(NO_2Cl(g) \rightleftarrows NO_2(g) + \frac{1}{2} Cl_2(g))$ $K_c = 1/(0.3)^2$

So, the sum of the reactions is:

$$\cancel{2NO_2} + \cancel{2NOCl} + \cancel{O_2} + 2NO_2Cl \rightleftarrows N_2 + \cancel{2}O_2 + \cancel{2NO_2Cl} + \cancel{2NO_2} + Cl_2$$

$$2NO_2Cl \rightleftarrows N_2 + O_2 + Cl_2$$

$$K_c = \frac{(1.1 \times 10^{2})^2}{(1.0 \times 10^{-9})^2(0.3)^2} = 1.3 \times 10^{23}$$

Answer______1.3×10^{23}________________

3. Phosphorus pentachloride decomposes according to the chemical equation below. A 0.280 mol sample of $PCl_5(g)$ is injected into an empty 4.00 L reaction vessel held at 250°C. Calculate the concentrations of $PCl_5(g)$ and $PCl_3(g)$ at equilibrium.

$$PCl_5(g) \rightleftharpoons PCl_3(g) + Cl_2(g) \qquad K_c = 1.80 \text{ at } 250°C$$

	PCl_5	$\rightleftharpoons$	PCl_3	+	Cl_2
I	0.280 mol/4 L = 0.0700 M		0		0
C	-x		+x		+x
E	0.0700-x		x		x

$$K_c = \frac{[PCl_3][Cl_2]}{[PCl_5]} = \frac{(x)(x)}{0.0700-x}$$

$$K_c = \frac{x^2}{0.0700-x}$$

$$(0.0700-x)K_c = x^2$$
$$0.0700K_c - xK_c = x^2$$
$$x^2 + K_cx - 0.0700K_c = 0$$

Inserting 1.80 for K_c

$$x^2 + 1.80x - 0.126 = 0$$

Using the quadratic equation with a = 1, b = 1.80 and c = -0.126 gives:

$$x = 0.067 \text{ or } -1.87$$

Since we've defined x as a concentration, a negative value makes no chemical sense, therefore the appropriate value for x is 0.067 or $[PCl_3] = [Cl_2] = 0.0675$ M and $[PCl_5] = 0.0700-0.0675 = 0.0025$ M

Answer_$[PCl_3]$ 0.0675 M and $[PCl_5]$ = 0.0025 M_

Possibly Useful Information

$\text{slope} = m = \frac{\Delta y}{\Delta x} = \frac{y_2 - y_1}{x_2 - x_1}$	$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$	R = 0.08206 L atm mol^{-1} K^{-1} R = 8.314 J mol^{-1} K^{-1}
pV = nRT	$\Delta G = -RT\ln K$	$K_p = K_c(RT)^{\Delta n}$