Equilibrium Worksheet II Name_____

1. Write the equilibrium expression for K_c for the following rxn:

$$Zn(s) + 2\ HCl(g) \Leftrightarrow ZnCl_2(s) + H_2(g)$$

$$K = \frac{[H_2]}{[HCl]^2}$$

2. For the rxn $2\ A(g) + B(g) \Leftrightarrow AB_2(g)$, the concentrations at equilibrium are: $[A] = 0.10$ M; $[B] = 0.20$ M; $[AB_2] = 0.050$ M. Calculate the value of K_c.

$$K = \frac{[AB_2]}{[A]^2[B]} = \frac{.65}{(.1)^2(.2)} = 25$$

3. 0.020 mol of Cl_2, 0.020 mol of H_2O, 0.060 mol of HCl, and 0.040 mol of O_2 are added to a 1.0 L container and are allowed to reach the following equilibrium:
$2\ Cl_2(g) + 2\ H_2O(g) \Leftrightarrow 4\ HCl(g) + O_2(g)$ At equilibrium, $[O_2] = 0.030$ M.
a) calculate $[Cl_2]$,$[H_2O]$, and [HCl] at equilibrium; b) calculate the value of K_c. .0018

	$2\ Cl_2$	+	$2\ H_2O$	$\rightleftharpoons$	$4\ HCl$	+	O_2
I	.02		.02		.06		.04
C	+.02		+.02		−.04		−.01
[ ]eq	.04		.04		.02		.03

$$K = \frac{[HCl]^4[O_2]}{[Cl_2]^2[H_2O]^2} = \frac{(.02)^4(.03)}{(.04)^2(.04)^2} = .001$$

4. For the rxn: $PCl_5(g) \Leftrightarrow PCl_3(g) + Cl_2(g)$, $K_c = .497$
1.66 mol of PCl_5 is put into an empty 1.0 L container. What are the concentrations of PCl_5, PCl_3, and Cl_2 at equilibrium?

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5. Answer the following questions using the equilibrium rxn:

$$2\ SO_3(g) \Leftrightarrow 2\ SO_2(g) + O_2(g) \quad \Delta H = +157\ kJ$$

a) If you increase $[SO_2]$, what happens to $[SO_3]$? ↑

b) If you decrease $[O_2]$, what happens to $[SO_2]$? ↑

c) If you increase the pressure, what happens to $[SO_3]$? ↑

d) If you increase the temperature, what happens to $[SO_3]$? ↓

e) In which of the above situations will the value of K_c change? temp (d)

Equilibrium Practice

1. Write the equilibrium expression for:
   $4\ NH_3(g) + 3\ O_2(g) \leftrightarrow 2\ N_2(g) + 6\ H_2O(l)$

$$K = \frac{[N_2]^2}{[NH_3]^4[O_2]^3}$$

2. Write the equilibrium expression for the reaction:
   $CH_4(g) + 3\ Cl_2(g) \leftrightarrow CHCl_3(g) + 3\ HCl(g)$

$$K = \frac{[CHCl_3][HCl]^3}{[CH_4][Cl_2]^3}$$

3. Using the equation in #2, the following were the concentrations at equilibrium. Calculate the value of K. $[CH_4] = 3.0$ M; $[Cl_2] = 1.0$ M; $[CHCl_3] = 5.0$ M; $[HCl] = 2.0$ M

$$K = \frac{(5)(2)^3}{(3)(1)^3} = 13.3$$

4. Use the following reaction: $A(g) + 2\ B(g) \leftrightarrow AB_2(g)$; 1.0 moles of A, 1.0 moles of B, and 2.0 moles of AB_2 are placed in a 1.0 L container and allowed to reach equilibrium. At equilibrium, $[A]_{eq} = 0.70$ M. Set up an ICE table and calculate the value of K.

	A	$+\ 2B$	$\rightleftharpoons AB_2$
	1.0	1.0	2.0
	−.3	−.6	+.3
	.7	.4	1.7

$$K = \frac{[AB_2]}{[A][B]^2} = \frac{1.7}{(.7)(.4)^2} = 15.2$$

5. In a ~~10.0L~~ vessel at 1000K, 0.250 mol $SO_2(g)$ and 0.200 mol $O_2(g)$ react to form 0.162 mol $SO_3(g)$ at equilibrium. What is the K_c at 1000K for this reaction?

Balanced equation: $\underline{2}\ SO_2(g) + \underline{\quad}\ O_2(g) \leftrightarrow \underline{2}\ SO_3(g)$

	SO_2	O_2	SO_3
I	.25	.2	0
C	−.162	−.081	+.162
E	.088	1.92	.162

$$K = \frac{[SO_3]^2}{[SO_2]^2[O_2]} = \frac{(.162)^2}{(.088)^2(1.92)} = 1.77$$

6. At a certain temperature, 2.0 mole NH3 is introduced into a ~~2.0~~ L container, and the NH3 partially dissociates into by the following reaction:

$2NH_3(g) \leftrightarrow N_2(g) + 3H_2(g)$

At equilibrium, 1.0 mol NH3 remains, what is the value of K for this reaction?

$2NH_3 \rightleftharpoons N_2 + 3H_2$

	NH_3	N_2	H_2
	2.0	0	0
	−1.0	+1.0	+1.0
	1.0	1.0	1.0

$$K = \frac{[N_2][H_2]^3}{[NH_3]^2} = \frac{(1)(1)^3}{(1)^2} = 1$$