NAME:_____

Lab Section: __1(TuTh@1) __2(TuTh@9)

CHM 102 | Winter 2009
20 points, 30 mins. | **Basic Competency Quiz #3** | week 6
Chemistry, 7th ed., Zumdahl & Zumdahl, sections 13.1-13.6
Wallace | *revised 2/10/2009*

Unless otherwise specified, each question is worth 4 points.

1. Carbonyl chloride ($COCl_2$), also called phosgene, is a highly poisonous gas that was used on the battlefield in World War I. It is produced by the reaction of carbon monoxide with chlorine gas:

$$CO(g) + Cl_2(g) \rightleftharpoons COCl_2(g)$$

In an experiment conducted at 74°C, the equilibrium concentrations of the species involved in the reaction were as follows: $[CO] = 1.2 \times 10^{-2} M$, $[Cl_2] = 0.054\ M$, and $[COCl_2] = 0.14\ M$.

a. Write the equilibrium expression for K_c.

$$K = \frac{[COCl_2]^2}{[CO][Cl_2]}$$

b. Determine the value of the equilibrium constant.

$$K = \frac{(0.14)}{(1.2\times10^{-2})(0.054)} = 216 \quad \boxed{220}$$

2. Write equilibrium expressions for each of the following reactions: (*2 points each*)

a. $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$

$$K_c = [CO_2]$$

b. $O_2(g) + 2H_2(g) \rightleftharpoons 2H_2O(liq)$

$$K_c = \frac{1}{[O_2][H_2]^2}$$

Unless otherwise specified, each question is worth 4 points.

3. The following reaction has an equilibrium constant, K_c, equal to 0.014 at 100°C.

$$2NOBr(g) \rightleftharpoons 2NO(g) + Br_2(g)$$

Determine the value of K_c for each of the following reactions at 100°C:

a. $2NO(g) + Br_2(g) \rightleftharpoons 2NOBr(g)$ (REVERSED)

$$K = \frac{1}{0.014} = \boxed{71}$$

b. $4NOBr(g) \rightleftharpoons 4NO(g) + 2Br_2(g)$

(x2) $K = (0.014)^2 = \boxed{2.0 \times 10^{-4}}$

4. At 375°C, the equilibrium constant for the following reaction is 1.2

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

At the start of the reaction, the concentrations of N_2, H_2 and NH_3 are 0.071 *M*, 0.0092 *M*, and 1.83×10^{-4} *M*, respectively.

a. Calculate *Q* for this system at the start of the reaction.

$$Q = \frac{[NH_3]^2}{[N_2][H_2]^3} = \frac{(1.83 \times 10^{-4})^2}{(0.071)(0.0092)^3} = \frac{3.35 \times 10^{-8}}{(0.071)(7.79 \times 10^{-7})} = \boxed{0.61}$$

b. Is this system at equilibrium? If this system is not at equilibrium, which direction will it proceed (or "shift") to establish equilibrium.

$\boxed{NO. \longrightarrow}$

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5. K_c for the reaction of hydrogen and iodine to produce hydrogen iodide,

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

is 54.3 at 430°C. What will the concentrations be at equilibrium if we start with 0.240 *M* concentrations of both H_2 and I_2?

	H_2	I_2	HI	
INITAL:	0.240M	0.240M	$\emptyset$	$(Q=\emptyset)$
REACT	$-x$	$-x$	$(\rightarrow)$ $+2x$	
EQUIL	$0.240-x$	$0.240-x$	$2x$	

$$K = 54.3 = \frac{[HI]^2}{[H_2][I^2]} = \frac{(2x)^2}{(0.240-x)(0.240-x)}$$

$$54.3 = \frac{4x^2}{(0.240-x)^2}$$

$$\sqrt{54.3} = \frac{2x}{0.240-x}$$

$$7.37 = \frac{2x}{0.240-x}$$

$$1.77 - 7.37x = 2x \qquad x = 0.189$$

$$[H_2] = [I_2] = 0.240 - 0.189 = \boxed{0.051\ M}$$

$$[HI] = 2x = \boxed{0.378\ M}$$