CHM152 Quiz 3 25 PTS FALL 2006 NAME: Key

1. (4 Pts) Consider the gaseous equilibrium: 2 A → 2 B + C
Determine the value of the missing B concentration at equilibrium.

Exp#	[A] at equilibrium	[B] at equilibrium	[C] at equilibrium
1	0.10 *M*	0.10 *M*	0.20 *M*
2	0.20	0.50	0.032
3	0.35	?	0.15

Since $K = \frac{[B]^2[C]}{[A]^2} = \frac{[0.10]^2[0.20]}{[0.10]^2} = 0.20$ ← constant (same value for each Rxn)

for Exp 3: $[B] = \sqrt{\frac{K[A]^2}{[C]}} = \sqrt{\frac{0.20(0.35)^2}{0.15}} = 0.40\ M$

2. (4 Pts) Write an expression for the equilibrium constant for the reaction below?

$Al_2(SO_3)_3(s) + 6HCl(g) \rightleftharpoons 2AlCl_3(s) + 3H_2O(l) + 3SO_2(g)$

$$K_c = \frac{[SO_2]^3}{[HCl]^6}$$ (but I will accept H_2O in formula)

3. (4 Pts) In a 1.0-liter container there are, at equilibrium, 0.20 mole of I_2, 0.30 mole of H_2, and 0.20 mole of HI in the system.

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

Determine the value of K_C for the reaction.

$$K_c = \frac{[HI]^2}{[H_2][I_2]} = \frac{[0.20]^2}{[0.30][0.20]} = 0.67$$

4. (5 Pts) The reversible reaction, $2SO_2(g) + O_2(g) \rightleftharpoons 2SO_3(g)$ has come to equilibrium in a vessel of specific volume at a given temperature. **Before** the reaction began, the concentrations of the reactants were 0.060 mol/L of SO_2 and 0.050 mol/L of O_2. After equilibrium is reached, the concentration of SO_3 is 0.040 mol/L. What is the value of K_C?

	$2SO_2(g)$	+ $O_2(g)$	$\rightleftharpoons 2SO_3(g)$
I	0.060	0.050	0
C	−2x	−x	+2x
E	0.060−2x = 0.020	0.050−x = 0.030	0.040

Since $2x = 0.040$

$x = 0.020$

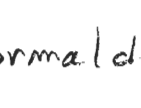
$$K_c = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$$

$$K_c = \frac{[0.040]^2}{[0.020]^2[0.030]} = 133$$

— See Back for more —

Q-3 Key

formaldehyde



5. (4 Pts) The equilibrium constant for the following gas phase reaction is 0.50 at 600°C. A mixture of HCHO, H_2, and CO is introduced into a flask at 600°C. After a short time, analysis of a small amount of the reaction mixture shows the concentrations to be [HCHO] = 1.5 *M*, [H_2] = 0.5 *M*, and [CO] = 1.0 *M*. Determine if the reaction has reached equilibrium, and if not, state which direction the reaction is shifting to reach equilibrium.

$HCHO \rightleftharpoons H_2 + CO$

1.5M 0.5M 1.0

$$Q_c = \frac{[H_2][CO]}{[HCHO]} = \frac{[0.5][1.0]}{[1.5]} = 0.33$$

Since $Q_c < K_c$ (and $\frac{\text{prod}^s}{\text{react}^s}$)

The Reaction is <u>NOT</u> at equilibrium and will be shifting toward the right (more products being formed).

6. (4 Pts) Carbon tetrachloride reacts with oxygen at high temperatures to produce chlorine and carbonyl chloride.

$2CCl_4(g) + O_2(g) \rightleftharpoons 2COCl_2(g) + 2Cl_2(g)$ $\quad K_{c_1} = 1.9 \times 10^{19}$ $\quad K_{c_1} = \frac{[COCl_2]^2[Cl_2]^2}{[CCl_4]^2[O_2]}$

What is K_c for the following:

$COCl_2(g) + Cl_2(g) \rightleftharpoons CCl_4(g) + 1/2O_2(g)$ $\quad K_{c_2} = \frac{[CCl_4][O_2]^{1/2}}{[COCl_2][Cl_2]}$

Note K_{c_2} is the square root of $\frac{1}{K_{c_1}}$

or $K_{c_2} = \sqrt{\frac{1}{K_{c_1}}} = \sqrt{\frac{1}{1.9 \times 10^{19}}} = \underline{2.3 \times 10^{-10}}$