Extra Problems for Chapter 16

1. The equilibrium constant for a particular reaction is given by:

$$K = \frac{[H_2S]_{eq}^2[CH_4]_{eq}}{[CS_2]_{eq}[H_2]_{eq}^4}$$

What is the balanced chemical equation for this equilibrium?

2. The equilibrium constant for the following reaction is 4.18 $1/M^2$:

$$CO\ (g)\ +\ 3H_2\ (g)\ \rightleftarrows\ CH_4\ (g)\ +\ H_2O\ (g)$$

The equilibrium concentrations are found to be as follows: [CO] = 0.212 M, [H_2] = 0.633 M, and [CH_4] = 0.210 M. What is the concentration of water vapor?

3. Given the information below, write each reaction as a one-way reaction if possible. If not, indicate which side the equilibrium is weighted toward:

a. $AgBr\ (s)\ \rightleftarrows\ Ag^+\ (aq)\ +\ Br^-\ (aq)\ \ K = 5.71\times10^{-7}\ M^2$
b. $CS_2\ (g)\ +\ 4H_2\ (g)\ \rightleftarrows\ CH_4\ (g)\ +\ 2H_2S\ (g)\ \ K = 27.8\ 1/M^2$
c. $CO\ (g)\ +\ Cl_2\ (g)\ \rightleftarrows\ COCl_2\ (g)\ \ K = 4.5\times10^9\ 1/M$
d. $CO_2\ (g)\ +\ H_2\ (g)\ \rightleftarrows\ CO\ (g)\ +\ H_2O\ (g)\ \ \ K = 0.0049$

4. Write the equation for the equilibrium constants of the following reactions:

a. $AgBr\ (s)\ \rightleftarrows\ Ag^+\ (aq)\ +\ Br^-\ (aq)$
b. $2Fe(OH)_3\ (s)\ +\ 3H_2SO_4\ (aq)\ \rightleftarrows\ Fe_2(SO_4)_3\ (aq)\ +\ 6H_2O\ (l)$

5. A chemist is studying the following chemical reaction at 25 °C:

$$CS_2\ (g)\ +\ 4H_2\ (g)\ \rightleftarrows\ CH_4\ (g)\ +\ 2H_2S\ (g),\ \ K = 27.8\ 1/M^2$$

For each of the following situations, determine if the reaction is at equilibrium. If it isn't, indicate which way it must shift to reach equilibrium.

a. [CS_2] = 0.100 M, [H_2] = 0.100 M, [CH_4] = 0.050 M, [H_2S] = 0.050 M
b. [CS_2] = 1.1 M, [H_2] = 1.1 M, [CH_4] = 2.2 M, [H_2S] = 4.5 M
c. [CS_2] = 0.90 M, [H_2] = 0.90 M, [CH_4] = 7.1 M, [H_2S] = 7.1 M

6. The following reaction reaches equilibrium:

$$2Fe(OH)_3\ (s)\ +\ 3H_2SO_4\ (aq)\ \rightleftarrows\ Fe_2(SO_4)_3\ (aq)\ +\ 6H_2O\ (l)\ \ \Delta H = -115\ kJ$$

a. What will happen to the concentration of $Fe_2(SO_4)_3$ if the temperature is increased?
b. What will happen to the concentration of H_2SO_4 if $Fe_2(SO_4)_3$ is added?

c. What will happen to the concentration of $Fe_2(SO_4)_3$ if $Fe(OH)_3$ is removed?
d. What will happen to the concentration of $Fe_2(SO_4)_3$ if H_2SO_4 is removed?

7. The following reaction reaches equilibrium:

$$CS_2\,(g) + 4H_2\,(g) \rightleftarrows CH_4\,(g) + 2H_2S\,(g)$$

a. What will happen to the concentration of H_2 if the pressure is increased?
b. What will happen to the concentration of H_2S if the pressure is decreased?

8. What is the equation for the acid ionization constant of $HCHO_2$?

9. What is the equation for the base ionization constant of C_2H_7N?

10. The K_a for oxalic acid is 5.9×10^{-2} M. The K_a for nitrous acid is 4.6×10^{-4} M. At the same concentration, which produces a solution with the higher pH?