Equilibrium Constant Practice Problems

1. Write equilibrium expressions for the following reactions.

a. $NH_4HS(g) \leftrightarrow NH_3(g) + H_2S(g)$

b. $4HCl(g) + O_2(g) \leftrightarrow 2Cl_2(g) + 2H_2O(g)$

c. $PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$

d. $CuSO_4 \bullet 3H_2O(s) + 2H_2O(g) \leftrightarrow CuSO_4 \bullet 5H_2O(s)$

2. At 793 K, the equilibrium constant for the reaction $NCl_3(g) + Cl_2(g) \leftrightarrow NCl_5(g)$ is 39.3.

a. Do products or reactants dominate in this equilibrium?

b. If the equilibrium constant for this reaction were less than 1, would the reactants or products be dominant?

3. **At 773 K, the reaction $2NO(g) + O_2(g) \leftrightarrow 2NO_2(g)$ produces the following concentrations: $[NO] = 3.49\times10^{-4}M$; $[O_2] = 0.80M$; $[NO_2] = 0.25M$.**

   a. What is the equilibrium constant expression for the reaction?

   b. What is the equilibrium constant for the reaction?

4. **If you wished to maximize the products of the following reactions, which concentrations would you lower or raise?**

   a. $H_2(g) + Br_2(g) \leftrightarrow 2HBr(g)$

   b. $CO_2(g) + H_2(g) \leftrightarrow CO(g) + H_2O(g)$

   c. $SO_2(g) + NO_2(g) \leftrightarrow SO_3(g) + NO(g)$

   d. $C(s) + CO_2(g) \leftrightarrow 2CO(g)$

5. For each reaction, state whether increasing or decreasing the volume of the reaction vessel would yield more product at equilibrium. Give the reason for your choice.

a. $N_2O_4(g) \leftrightarrow 2NO_2(g)$

b. $2SO_3(g) \leftrightarrow 2SO_2(g) + O_2(g)$

c. $CH_4(g) + 2O_2(g) \leftrightarrow CO_2(g) + 2H_2O(g)$

d. $2CO(g) + O_2(g) \leftrightarrow 2CO_2(g)$

6. What effect would an increase in temperature have on these reactions at equilibrium? Why?

a. $\text{Heat} + H_2(g) + I_2(g) \leftrightarrow 2HI(g)$

b. $CH_4(g) + 2O_2(g) \leftrightarrow CO(g) + 2H_2O + \text{heat}$

c. $N_2(g) + 3H_2(g) \leftrightarrow 2NH_3(g) + \text{heat}$

d. $\text{Heat} + CH_4(g) \leftrightarrow C(s) + 2H_2(g)$

7. Phosphorous pentachloride decomposes to phosphorous trichloride according to this equation: $PCl_5(g) \leftrightarrow PCl_3(g) + Cl_2(g)$. At equilibrium, $[PCl_5] = 1.00M$ and $[Cl_2] = 3.16\times10^{-2}M$.

a. Write the expression for determining the concentration of PCl_3.

b. What is the equilibrium concentration of PCl_3? Use: $K_{eq} = 1.00\times10^{-3}$.

8. The solubility product constant (K_{sp}) of Ag_2SO_4 is 1.2×10^{-5}.

a. How would you estimate the molar solubility of SO_4^{2-} without actually calculating it?

b. What is the calculated molar solubility of SO_4^{2-}?