AP WORKSHEET 13a: Kc and Le Chatelier's Principle

1. The equilibrium constant for the reaction below, at a given temperature is 45.6. If the equilibrium concentrations of F_2 and BrF_3 are 1.24×10^{-1} M and 1.99×10^{-1} M respectively, calculate the equilibrium concentration of Br_2. (4)

$$Br_{2(g)} + 3F_{2(g)} \leftrightarrow 2BrF_{3(g)}$$

2. An equilibrium is established in the reaction below and the concentrations of each component are determined. Calculate the value of Kc at this temperature. (2)

$$2N_2O_{(g)} + 3O_{2(g)} \leftrightarrow 2N_2O_{4(g)}$$

Equilibrium concentrations, $N_2O = 1.55 \times 10^{-2}$ M, $O_2 = 1.69 \times 10^{-2}$ M, $N_2O_4 = 1.71 \times 10^{-2}$ M

3. Assume that each of the reactions below are at equilibrium. Using your knowledge of Le Chatelier's principle, explain carefully how the system will respond to the change. (2)

   (a) $PCl_{5(g)} \leftrightarrow PCl_{3(g)} + Cl_{2(g)}$ Change: The volume is increased

   (b) $2NO_{2(g)} \leftrightarrow NO_{3(g)} + NO_{(g)}$ Change: More NO is added

4. Calculate the equilibrium amounts of each substance in the reaction below if an initial amount of 0.1 moles of H_2 are brought together with an initial amount of 0.2 moles of I_2 and then equilibrium is established at 300 K. Kc at this temperature = 70. (4)

$$H_2 + I_2 \leftrightarrow 2HI$$

5. Calculate the equilibrium amounts of each substance in the reaction below if an initial amount of 0.4 moles of CO are brought together with an initial amount of 2.2 moles of Cl_2 and then equilibrium is established at 900 K in a 1.0 L container. Kc at this temperature = 0.80. (4)

$$COCl_{2(g)} \leftrightarrow CO_{(g)} + Cl_{2(g)}$$

6. The Haber process is used to produce ammonia commercially.

   (a) 1.00 mol of N_2 and 3.00 mols of H_2 are mixed together to produce ammonia according to the equation below. At equilibrium, only 50.0% of the N_2 that was present originally, remains. Calculate Kc for this reaction at this temperature if the reaction is carried out in a 1.0 L container. (6)

$$N_2 + 3H_2 \leftrightarrow 2NH_3 \qquad \Delta H = -92 \text{ kJ}$$

   (b) Predict how each of the following changes would affect the percentage of ammonia in the equilibrium mixture. (3)

      (i) Adding a catalyst

      (ii) Increasing the total pressure

      (iii) Using a high temperature