Worksheet 9

1. Consider the following equilibrium, for which $K_p = 0.0752$ at 480 °C.

$$2\ Cl_2\ (g)\ +\ 2\ H_2O\ (g) \rightleftharpoons 4\ HCl\ (g)\ +\ O_2\ (g)$$

a)What is the value of K_p for the reaction $4\ HCl\ (g)\ +\ O_2\ (g) \rightleftharpoons 2\ Cl_2\ (g)\ +\ 2\ H_2O\ (g)$?

b) What is the value of K_p for the reaction $Cl_2\ (g)\ +\ H_2O\ (g) \rightleftharpoons 2\ HCl\ (g)\ +\ ½\ O_2\ (g)$

c) What is the value of K_c for the reaction in part (b)

2. Write the equilibrium constant expression, K_c, for the following reactions. In each case indicate whether the reaction is homogeneous or heterogeneous

a) $3\ NO\ (g) \rightleftharpoons N_2O\ (g)\ +\ NO_2\ (g)$

b) $C\ (s) +\ 2\ H_2\ (g) \rightleftharpoons CH_4\ (g)$

c) $Ti\ (s) + 2\ Cl_2\ (g) \rightleftharpoons TiCl_4\ (l)$

3. Phosphorous trichloride gas and chlorine gas react to form phosphorous pentachloride gas:

$$PCl_3\,(g) + Cl_2\,(g) \rightleftharpoons PCl_5\,(g)$$

A gas vessel is charged with a mixture of PCl_3 (g)and Cl_2 (g), which is allowed to equilibrate at 450 K. At equilibrium the partial pressures of the three gases are $P_{PCl3} = 0.124$ atm, $P_{Cl2} = 0.157$ atm, and $P_{PCl5} = 1.30$ atm. a) What is the value of the K_p at this temperature? b) Does the equilibrium favor reactants or products?

4. At 218 °C, $K_c = 1.2 \times 10^{-4}$ for the equilibrium

$$NH_4HS\,(s) \rightleftharpoons NH_3\,(g) + H_2S\,(g)$$

Calculate the equilibrium concentrations of NH_3 and H_2S if a sample of solid NH_4HS is placed in a closed vessel and decomposes until equilibrium is reached.