Equilibrium Problems Set III

1. Nitric oxide, an important pollutant in air, is formed from the elements at high temperatures, such as those obtained when gasoline burns in an automobile engine. At 2000°C, K for the reaction $N_{2(g)} + O_{2(g)} \Leftrightarrow 2\ NO_{(g)}$ is 0.10. Predict the direction in which the system will move to reach equilibrium at 2000°C if one starts with:

   (a) 1.62 moles of N_2 and 1.62 moles of O_2 in a 2.0-liter container (answer: towards products)

   (b) 4.0 moles of N_2, 1.0 mole of O_2 and 0.80 mole of NO in a 20-L container. (answer: reverse reaction)

2. Consider the system describe in question one, where we started with concentrations of N_2 and O_2 of 0.81 M and decided that some NO must be formed by the reaction:

$$N_{2(g)} + O_{2(g)} \Leftrightarrow 2\ NO_{(g)} \qquad K = 0.10 \text{ at } 2000^oC$$

   Under these conditions what will be the equilibrium concentrations of NO, N_2 and O_2?
   (answers: 0.22 M, 0.70 M, 0.70 M respectively)

3. For the reaction $SO_{2(g)} + NO_{2(g)} \Leftrightarrow SO_{3(g)} + NO_{(g)}$ K = 9.0 at 700°C. Calculate the equilibrium concentrations of all species if one starts with:
   (a) $[SO_2] = [NO_2] = 0.003$ M (answers: 0.0022M , 0.0022M; 0.0008M)

   (b) $[SO_2] = [NO_2] = [SO_3] = [NO] = 0.003$ M (answers: $[SO_3] = [NO] = 0.045$M; $[SO_2] = [NO_2] = 0.0015$ M)

4. At 21.0 °C , the equilibrium constant, K, is 1.2×10^{-4} for the following reaction:

$$NH_4HS_{(s)} \Leftrightarrow NH_{3(g)} + H_2S_{(g)}$$

   Calculate the equilibrium concentrations of NH_3 and H_2S if a sample of solid NH_4HS is placed in a closed vessel and allowed to decompose until equilibrium is reached at 21.0°C.
   (answer: $[H_2S] = [NH_3] = 0.011$ M)