REVIEW QUESTIONS
Chapter 15

1. A mixture of 0.10 mol of NO, 0.050 mol of H₂ and 0.10 mol of H₂O is placed in a 1.0-L flask and allowed to reach equilibrium as shown below:

\[2 \text{NO (g)} + 2 \text{H₂ (g)} \rightleftharpoons \text{N₂ (g)} + 2 \text{H₂O (g)}\]

At equilibrium \([\text{NO}] = 0.062 \text{ M}\). Calculate the equilibrium constant, \(K_c\), for this reaction.

2. At 700°C, \(K_c = 20.4\) for the reaction shown below:

\[\text{SO}_2 (g) + \frac{1}{2} \text{O}_2 (g) \rightleftharpoons \text{SO}_3 (g)\]

Calculate \(K_c\) and \(K_p\) for the reaction shown below:

\[2 \text{SO}_2 (g) + \text{O}_2 (g) \rightleftharpoons 2 \text{SO}_3 (g)\]

3. At 100°C, \(K_c = 0.078\) for the following reaction:

\[\text{SO}_2\text{Cl}_2 (g) \rightleftharpoons \text{SO}_2 (g) + \text{Cl}_2 (g)\]

In an equilibrium mixture, \([\text{SO}_2\text{Cl}_2] = 0.136 \text{ M}\) and \([\text{SO}_2] = 0.072 \text{ M}\). What is the concentration of \(\text{Cl}_2\) in the equilibrium mixture?
4. At 373 K, $K_p = 0.416$ for the equilibrium:

$$2 \text{NOBr} (g) \rightleftharpoons 2 \text{NO} (g) + \text{Br}_2 (g)$$

If the partial pressures of NOBr and NO are equal at equilibrium, what is the partial pressure of Br$_2$?

5. A mixture of 0.100 mol CO$_2$, 0.0500 mol H$_2$ and 0.100 mol H$_2$O are place in a 1.00-L flask and allowed to come to equilibrium as shown below. At equilibrium $[\text{CO}_2] = 0.0954$ M.

$$\text{CO}_2 (g) + \text{H}_2 (g) \rightleftharpoons \text{CO} (g) + \text{H}_2\text{O} (g)$$

a) What are the equilibrium concentrations of H$_2$, CO and H$_2$O?

b) Calculate $K_c$ and $K_p$ for this reaction at 25.0°C.
6. When 2.00 mol each of hydrogen and iodine are mixed in a 1.00-L flask, 3.50 mol of HI is produced at equilibrium:

\[
\text{H}_2 \ (g) \ + \ \text{I}_2 \ (g) \ \rightleftharpoons \ 2 \ \text{HI} \ (g)
\]

Calculate the equilibrium constant \( K_c \) for this reaction.

7. The equilibrium constant for the reaction

\[
\text{SO}_2 \ (g) \ + \ \text{NO}_2 \ (g) \ \rightleftharpoons \ \text{SO}_3 \ (g) \ + \ \text{NO} \ (g)
\]

has a numerical value of 3.00 at a given temperature. 1.50 mol each of SO\(_2\) and NO\(_2\) are mixed in a 1.00-L flask and allowed to reach equilibrium. What percent of SO\(_2\) is converted to product?
8. The following equilibrium exists at 1000 °C with $K_c = 2.00$.

$$2 \text{COF}_2 (g) \rightleftharpoons \text{CO}_2 (g) + \text{CF}_4 (g)$$

If a 5.00-L mixture contains 0.145 mol COF$_2$, 0.262 mol of CO$_2$ and 0.074 mol of CF$_4$ at 1000 °C, in which direction will the mixture proceed to reach equilibrium?

9. A 0.831-g sample of SO$_3$ is placed in a 1.00-L flask and heated to 1100 K. The SO$_3$ decomposes to SO$_2$ and O$_2$, as shown below. At equilibrium, the total pressure in the container is 1.300 atm. Find the values of $K_p$ and $K_c$ for this reaction at 1100 K.

$$2 \text{SO}_3 (g) \rightleftharpoons 2 \text{SO}_2 (g) + \text{O}_2 (g)$$
10. Predict how each of the following changes affect the amount of H\textsubscript{2} present in an equilibrium mixture in the reaction

\[ 3 \text{Fe (s)} + 4 \text{H}_2\text{O (g)} \rightleftharpoons \text{Fe}_3\text{O}_4 (s) + 4 \text{H}_2 (g) \quad \Delta H = -150 \text{ kJ} \]

a) Raising the temperature of the mixture.

b) Adding more H\textsubscript{2}O (g).

c) Doubling the volume of the container holding the mixture.

d) Adding a catalyst.

11. At 2000 °C the equilibrium constant for the reaction below is \(K_c = 2.4 \times 10^3\). If the initial concentration of NO is 0.500 M, what are the equilibrium concentrations of each substance?

\[ 2 \text{NO (g)} \rightleftharpoons \text{N}_2 (g) + \text{O}_2 (g) \]
12. The reaction below has an equilibrium constant $K_c = 6.90$. If 0.100 mol of BrCl is placed in a 500-mL flask and allowed to come to equilibrium, what are the equilibrium concentrations of each substance?

$$\text{Br}_2 \text{ (g)} + \text{Cl}_2 \text{ (g)} \rightleftharpoons 2 \text{BrCl (g)}$$

13. An equilibrium mixture of H$_2$, I$_2$, and HI at 458°C contains $2.24 \times 10^{-2}$ M H$_2$, $2.24 \times 10^{-2}$ M I$_2$ and 0.155 M HI in a 5.00-L flask. What are the equilibrium concentrations when equilibrium is reestablished following the addition of 0.100 mol of HI?