IMSA
Illinois Mathematics and Science Academy

The Equilibrium Constant and LeChatlier's Principle

The Equilibrium Constant

1. For the following system at equilibrium: $H_{2\,(g)} + I_{2\,(g)} \leftrightarrow 2\ HI_{\,(g)}$

   a. Predict the shift in equilibrium when more $HI_{(g)}$ is added to the system.

   b. How will the concentration of I_2 change?

2. For the reaction below, predict the direction the equilibrium will shift given the following changes. Temperature and volume are held constant.

   $2\ NO_{2\,(g)} + 7\ H_{2\,(g)} \leftrightarrow 2\ NH_{3\,(g)} + 4\ H_2O_{(g)}$

   a. addition of ammonia

   b. removal of nitrogen dioxide

   c. removal of water vapor

   d. addition of hydrogen

3. At a particular temperature, the following reaction has an equilibrium constant, K_{eq} of 0.18

   $PCl_{3\,(g)} + Cl_{2\,(g)} \leftrightarrow PCl_{5\,(g)}$

   More PCl_3 is added to the system. Will the value of K_{eq} increase, decrease, or remain the same?

4. For each of the following equilibria, predict whether the system will shift in the forward or reverse directions. Note the energy changes involved and assume that the volume remains constant.

   a. heat is removed from: $A \leftrightarrow B$ $\Delta H° = +40.0$ kJ

   b. heat is removed from: $A + B \leftrightarrow 2\ C$ $\Delta H° = -25.5$ kJ

   c. heat is added to: $A + 2B \leftrightarrow 3\ C$ $\Delta H° = -32.0$ kJ

5. In each of the following equilibria, would you increase or decrease the temperature to force the reaction in the forward direction?

   a. $H_{2\,(g)} + CO_{2\,(g)} \leftrightarrow H_2O_{(g)} + CO_{(g)}$ $\Delta H° = +41.0$ kJ

   b. $2\ SO_{2\,(g)} + O_{2\,(g)} \leftrightarrow 2\ SO_{3\,(g)}$ $\Delta H° = -198$ kJ

6. For each of the equilibria in Question 5 will the value for K_{eq} increase or decrease if the temperature is raised?

   a. $H_{2\,(g)} + CO_{2\,(g)} \leftrightarrow H_2O_{(g)} + CO_{(g)}$ $\Delta H° = +41.0$ kJ

   b. $2\ SO_{2\,(g)} + O_{2\,(g)} \leftrightarrow 2\ SO_{3\,(g)}$ $\Delta H° = -198$ kJ

7. Explain the effect of using a platinum catalyst in the equilibrium reaction of ammonia with oxygen:

   $4\ NH_{3\,(g)} + 5\ O_{2\,(g)} \leftrightarrow 4\ NO_{(g)} + 6\ H_2O_{(g)} + \text{heat}$

8. The pressure on each of the following systems is increased by decreasing the volume of the container. Explain whether each system would shift in the forward direction, the reverse direction, or stay the same.

   a. $2\ SO_{2\ (g)} + O_{2\ (g)} \leftrightarrow 2\ SO_{3\ (g)}$

   b. $H_{2\ (g)} + I_{2\ (g)} \leftrightarrow 2\ HI_{(g)}$

   c. $CaCO_{3\ (s)} \leftrightarrow CaO_{(s)} + CO_{2\ (g)}$

   d. $AgCl_{(s)} \leftrightarrow Ag^{+}_{(aq)} + Cl^{-}_{(aq)}$

9. List three ways that the following equilibrium reaction could be forced to shift to the right:

   $2\ NO_{2\ (g)} \leftrightarrow 2\ NO_{(g)} + O_{2\ (g)}$

10. Given the following equilibrium reaction:

    $2\ C_{(s)} + O_{2\ (g)} \leftrightarrow 2\ CO_{(g)}$

    What will be the effect of the following disturbances to the system:

    a. adding CO (at constant volume and temperature)

    b. addition of O_2 (at constant volume and temperature)

    c. addition of solid carbon (at constant temperature)

    d. decreasing the volume of the container