Practice Questions Section 3.5

Le Châtelier's Principle - Temperature & Catalysts

1. 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

2. 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

3. For each of the equilibria in Question 2 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

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

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

Practice Questions Section 3.5

Le Châtelier's Principle - Temperature & Catalysts Answers

1. 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

   Answer: Removing heat favors the exothermic direction to replace the lost heat. Thus the reverse direction will be favored.

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

   Answer: In this case the forward direction is the exothermic direction, so the forward reaction is favored.

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

   Answer: The reverse reaction is endothermic, so it will be favored to remove the excess heat.

2. 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

   Answer: Increase temperature, because the forward direction is endothermic and will use up the additional heat.

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

   Answer: Decrease, because the forward reaction will produce heat removed by making the system cooler.

3. For each of the equilibria in Question 2 will the value for K_{eq} increase or decrease if the temperature is raised?

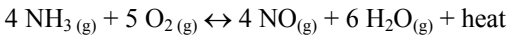
   a. $H_{2\,(g)} + CO_{2\,(g)} \leftrightarrow H_2O_{(g)} + CO_{(g)}$ $\Delta H° = +41.0$ kJ

   Answer: K_{eq} will increase. Increasing the temperature will favor the products.

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

   Answer: K_{eq} will decrease. Increasing the temperature will favor the reactants.

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



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

Answer:

The addition of a catalyst will cause the system to reach equilibrium sooner, but it will have no effect on equilibrium once it has been reached.