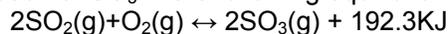


15 • Chemical Equilibrium

15.6 LeChatelier's Principle and Catalyst Worksheet

1. List four ways to increase the concentration of SO_3 in the following equilibrium reaction.



- 1.
- 2.
- 3.
- 4.

2. $\text{N}_2 + \text{O}_2 \leftrightarrow 2\text{NO} \quad \Delta H = +181 \text{ kJ}$

What will happen to the concentration of NO at equilibrium if:

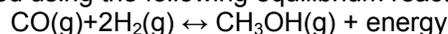
- a) more O_2 is added?
- b) N_2 is removed?
- c) the pressure on the system is increased?
- d) the temperature of the system is increased?

3. How will an increase in temperature or pressure affect each of the following equilibrium?



- a) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \leftrightarrow 2\text{NH}_3(\text{g}) \quad \Delta H = -92.2 \text{ kJ}$
- b) $\text{H}_2\text{O}(\text{l}) \leftrightarrow \text{H}_2\text{O}(\text{g}) \quad \Delta H = 41 \text{ kJ}$
- c) $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \leftrightarrow 2\text{NO}(\text{g}) \quad \Delta H = 181 \text{ kJ}$
- d) $3\text{O}_2(\text{g}) \leftrightarrow 2\text{O}_3(\text{g}) \quad \Delta H = 285 \text{ kJ}$

4. Methanol, CH_3OH , can be manufactured using the following equilibrium reaction.



Predict the effect of the following changes on the equilibrium concentration of $\text{CH}_3\text{OH}(\text{g})$.

- a) a decrease in temperature
- b) an increase in pressure
- c) addition of $\text{H}_2(\text{g})$
- d) addition of a catalyst

5. What will be the change in the equilibrium concentration of NO_2 under each of the following conditions for the following equilibrium reaction?



- a) O_2 is added
- b) NO is removed
- c) energy is added
- d) a catalyst is added

6. In the equilibrium reaction: $4\text{HCl}(\text{g}) + \text{O}_2(\text{g}) \leftrightarrow 2\text{H}_2\text{O}(\text{g}) + 2\text{Cl}_2(\text{g}) + 114.4\text{KJ}$

Predict the direction of equilibrium shift if the following changes occur

- a) the pressure is increased
- b) energy is added
- c) oxygen is added
- d) HCl is removed
- e) catalyst is added

7. For each of the following reactions between gases at equilibrium determine the effect on the equilibrium concentrations of the products when the temperature is decreased and when the external pressure on the system is decreased.

- a) $2\text{H}_2\text{O}(\text{g}) \leftrightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2$ $\Delta\text{H} = 484 \text{ kJ}$
- b) $\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \leftrightarrow 2\text{NO}(\text{g})$ $\Delta\text{H} = 181 \text{ kJ}$
- c) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \leftrightarrow 2\text{NH}_3(\text{g})$ $\Delta\text{H} = -92.2 \text{ kJ}$
- d) $2\text{O}_3(\text{g}) \leftrightarrow 3\text{O}_2(\text{g})$ $\Delta\text{H} = -285 \text{ kJ}$
- e) $\text{H}_2(\text{g}) + \text{F}_2(\text{g}) \leftrightarrow 2\text{HF}(\text{g})$ $\Delta\text{H} = 541 \text{ kJ}$