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Chemistry 30

Unit 3: Chemical Equilibrium

Assignment 3: 3-1 to 3-5 Le Châtelier's Principle

1. State Le Chatelier's Principle.

2. What are three stresses that can affect the position of an equilibrium?

   Identify the one stress that will cause the value of K_{eq} to change.

3. State the effect of a catalyst on equilibrium.

4. Methanol (methyl alcohol; CH_3OH) can be manufactured using the following equilibrium reaction:

$$CO(g) + 2\ H_2(g) \rightleftharpoons CH_3OH(g) + \text{energy}$$

   Predict the effect of the following changes on the equilibrium concentration of $CH_3OH(g)$. Will it's concentration increase, decrease, or remain the same?

   a) The temperature of the system is decreased.

   b) The pressure of the system is increased.

   c) More $H_2(g)$ is added.

   d) A catalyst is added to the system.

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5. Use Le Chatelier's Principle to predict how the changes listed will affect the following equilibrium reaction:

$$2\ HI\ (g) + 9.4\ kJ \rightleftharpoons H_2\ (g) + I_2\ (g)$$

a) Will the concentration of HI increase, decrease, or remain the same if more H_2 is added?

b) What is the effect on the concentration of HI if the pressure of the system is increased?

c) What is the effect on the concentration of HI if the temperature of the system is increased?

d) What is the effect on the concentration of HI if a catalyst is added to the system?

e) Write the equilibrium constant expression for this reaction.

f) At 435°C the equilibrium constant for this reaction is 1.88×10^{-2}. Does equilibrium favor the reactants or products?

6. Suggest four ways to increase the concentration of SO_3 in the following equilibrium reaction:

$$2\ SO_2(g) + O_2(g) \rightleftharpoons 2\ SO_3(g) + 192.3\ kJ$$

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7. In the equilibrium reaction:

$$4\ HCl(g) + O_2(g) \rightleftharpoons 2\ H_2O(g) + 2\ Cl_2(g) + 114.4\ kJ$$

Predict the direction of equilibrium shift (forward, reverse, no change) if the following changes occur:

a) the pressure is increased

b) heat is added

c) oxygen is added

d) HCl is removed

e) a catalyst is added

8. Nitric oxide, NO, releases 57.3 kJ/mol when it reacts with oxygen to give nitrogen dioxide.

a) Write a balanced equation for this reaction.

b) Write the equilibrium constant expression for this reaction.

c) Predict the effect that increasing the temperature will have on:

1) the equilibrium concentration of all reaction participants (NO, O_2, and NO_2)

2) the numerical value of the equilibrium constant, K_{eq}