

Chemistry 30

Unit 3: Chemical Equilibrium

Assignment 3: 3-1 to 3-5

Le Châtelier's Principle

1. State Le Chatelier's Principle.

When a reaction at equilibrium is subjected to a stress, equilibrium will shift to minimize the effect of that stress.

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.

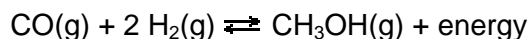
**Change in concentration
Change in pressure and/or volume
Change in temperature**

Temperature is the only one that will change the value of K_{eq}

3. State the effect of a catalyst on equilibrium.

Since a catalyst affects the rate of both the forward and reverse directions, it has no net effect on equilibrium.

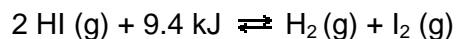
4. Methanol (methyl alcohol; CH_3OH) can be manufactured using the following equilibrium reaction:



Predict the effect of the following changes on the equilibrium concentration of $\text{CH}_3\text{OH(g)}$. Will its concentration increase, decrease, or remain the same?

- a) The temperature of the system is decreased. **$[\text{CH}_3\text{OH}]$ will increase**
- b) The pressure of the system is increased. **$[\text{CH}_3\text{OH}]$ will increase**
- c) More $\text{H}_2\text{(g)}$ is added. **$[\text{CH}_3\text{OH}]$ will increase**
- d) A catalyst is added to the system. **no change**

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



- a) Will the concentration of HI increase, decrease, or remain the same if more H₂ is added?

[HI] will increase

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

no change

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

[HI] will decrease

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

no change

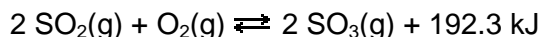
- e) Write the equilibrium constant expression for this reaction.

$$K_{\text{eq}} = \frac{[\text{H}_2][\text{I}_2]}{[\text{HI}]^2}$$

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

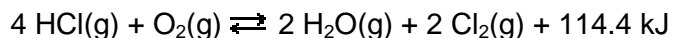
reactants are favored ($K_{\text{eq}} < 1$)

6. Suggest four ways to increase the concentration of SO₃ in the following equilibrium reaction:



- **decrease temperature**
- **increase concentration of SO₂ and/or O₂ by adding more**
- **remove SO₃ (decrease its concentration) as it forms**
- **increase pressure / decrease volume**

7. In the equilibrium reaction:



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

- a) the pressure is increased **forward**
- b) heat is added **reverse**
- c) oxygen is added **forward**
- d) HCl is removed **reverse**
- e) a catalyst is added **no change**

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.



(note: the question indicates a release of 57.3 kJ PER ONE MOLE of NO)

b) Write the equilibrium constant expression for this reaction.

$$K_{\text{eq}} = \frac{[\text{NO}_2]^2}{[\text{NO}]^2[\text{O}_2]}$$

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

1) the equilibrium concentration of all reaction participants (NO, O₂, and NO₂)

Increase concentration of NO and O₂
Decrease concentration of NO₂

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

the value of K_{eq} will decrease