

Le Chatelier's Principle

Name: _____

Date: _____

Hour: _____

Information: The Principle

Equilibrium is a delicate balance. Many different kinds of changes can upset the equilibrium in a chemical reaction. For example, if an extra amount of a reactant is added to a reaction container then the equilibrium adjusts, or *shifts*.

Le Chatelier's Principle explains that a reaction will adjust to relieve any "stress" that happens to it. Consider the following equilibrium reaction:



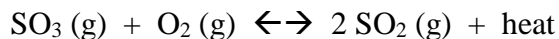
If more water is added to the reaction container, then the reaction will adjust, or shift toward the left, to get rid of the water that was added. The reaction uses up the water to make more H_2CO_3 .

Critical Thinking Questions

1. Consider the above reaction. If some CO_2 were removed from the container, what would the reaction do in an attempt to replace the CO_2 ? (Which direction would the reaction shift—left or right?)
2. Consider the reaction: $2 \text{HI} \leftrightarrow \text{H}_2 + \text{I}_2$
 - a) In which direction would the reaction shift if more HI were added to the reaction container?
 - b) Would taking away some H_2 cause the reaction to form more HI?
 - c) Why would removing some I_2 cause the reaction to produce more H_2 ?
 - d) True or False: Adding more H_2 would cause the amount of I_2 to decrease.
3. Let's review a bit... Which of the following has the heat written correctly for an endothermic reaction?
 - A) $\text{A} + \text{B} \leftrightarrow \text{C} + \text{D} + \text{heat}$
 - B) $\text{A} + \text{B} + \text{heat} \leftrightarrow \text{C} + \text{D}$

Information: Changing Temperature

As you may recall, an exothermic reaction includes the heat term as a product in a chemical reaction. An exothermic reaction is written below:

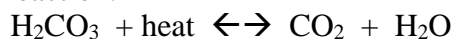


As you consider how a temperature change will impact a reaction it will be helpful to consider the heat as a reactant or a product in a chemical equation. Increasing the temperature will do the same thing as increasing the concentration of a reactant or product.

Critical Thinking Questions

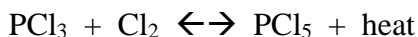
4. Consider the equation given in the above information section. Increasing the amount of SO_2 in the container will have the same shifting effect as increasing the temperature. Explain what that effect is and explain why.

5. Consider the following reaction:



- a) What would happen if some H_2O were added to the container? (Which direction would the equilibrium shift?)
- b) To increase the amount of H_2CO_3 in the equilibrium, should you raise or lower the temperature? Explain.

6. Consider the following reaction:



Would increasing the temperature also increase the amount of product formed? Explain.

Information: Changing Pressure

The pressure during a reaction has a large effect on a reaction only for the gaseous reactants or products. If a reaction doesn't have any gaseous substances, then changing the pressure wouldn't produce a significant shift in the equilibrium.

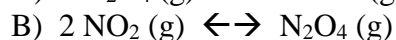
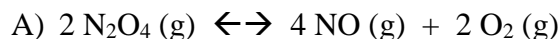
One way to increase the pressure of a reaction is to decrease the volume of the container in which the reaction takes place. When the pressure increases, the reaction tries to shift in order to make more room and relieve the pressure.

Critical Thinking Questions

7. Consider the two containers of gas. They are equal in size and have the same temperature:



- a) Which container has the greatest pressure?
- b) The more moles of gas, the _____ the pressure
greater OR lower
8. Consider the following reaction: $\text{N}_2(\text{g}) + 3 \text{H}_2(\text{g}) \leftrightarrow 2 \text{NH}_3(\text{g})$
The left side (reactant side) of the reaction has a total of 4 moles of gas. How many moles are on the product side?
9. Consider the following reaction:
 $\text{PCl}_3(\text{g}) + \text{Cl}_2(\text{g}) \leftrightarrow \text{PCl}_5(\text{g})$
- a) Which side—the reactant side or the product side—contains the greatest number of moles of gas?
- b) If the pressure increased, the reaction will shift to reduce the pressure. Which direction do you think the reaction will shift—to the right or to the left? (Hint: the reaction will try to reduce the pressure.)
10. Consider the following two reactions. Which reaction would produce more products if you increased the pressure? Explain.



11. Explain why a change in pressure doesn't affect the following reaction very much:

