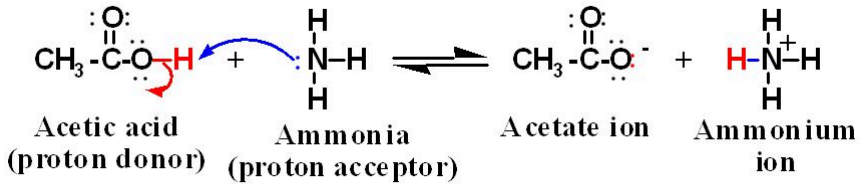
Exploring Creation with Chemistry

Module 15 Chemical Equilibrium

In a chemical equation, there are **products** and **reactants**. But, often, reactions can go in either direction. Notice the "reacts to form" arrow is now two arrows. The Forward and Reverse reactions will keep taking place FOREVER as molecules collide. The rate at which they happen will eventually reach a state of equilibrium.



THIS DOES NOT MEAN HAVING THE SAME AMOUNT OF PRODUCTS AND REACTANTS. IT MEANS THE TWO REACTIONS ARE OCCURRING AT THE SAME RATES.

Experiment 15.1 – Demonstrating Equilibrium – Go outside, it's messy!

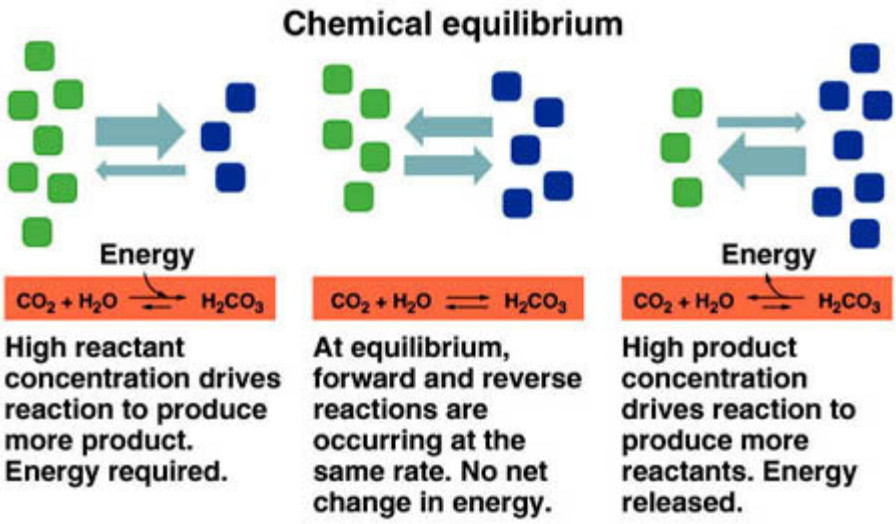
LE CHATELIER'S PRINCIPLE:

IF A STRESS IS PLACED ON A SYSTEM AT EQUILIBRIUM, THE SYSTEM WILL PROCEED IN A DIRECTION THAT MINIMIZES THE STRESS.

FACTORS THAT ADD STRESS TO A SYSTEM:

- Increasing or decreasing the **Amount of reactants**.
- Increasing or decreasing **Pressure** on Gases.
- Increasing or decreasing the surrounding **Temperature**.
  - When temperature is raised, the equilibrium shifts AWAY from the side of the equation that contains energy. (In other words, adding heat to an exothermic reaction will slow it down and cause the reverse process to happen more quickly.

$$H_2(g) + Cl_2(g) \rightleftharpoons 2HCl(g) + \text{heat}$$



Carbon Dioxide and water react to form Carbonic Acid (the fizzy in your soda). Carbonic acid decomposes back into Carbon dioxide and water. In a closed system (your soda can) this reaction will continue back and forth. ***WHAT HAPPENS IF YOU ADD ENERGY TO THE SYSTEM?***

Experiment 15.1 Demonstrating Equilibrium

Question: Can a system of two containers emptying into each other reach a state of equilibrium?

Hypothesis: _____

Procedure:

1. Cut the tops off of 2 two liter soda bottles.
2. Carefully punch a hole in the side about 2 inches from the bottom on **Bottle #1**
3. Punch a hole in the side of **Bottle #2** about an inch from the bottom.
4. Each partner should be ready in front of their bottle with cups to catch water coming out of the hole.
5. Have someone fill **Bottle #1** with water.
6. **Partner #1**, use a cup to catch the water as it begins to pour out of the hole. When the cup catching water from **Bottle #1** is full, pour the cupfull of water into **Bottle #2**. Continue doing this, using cups to catch water pouring from **Bottle #1** and pouring it into **Bottle #2**.
7. **Partner #2** should be ready to catch the water that will begin to pour out of **Bottle #2**, and each cupful from **Bottle #2** should be poured back into **Bottle #1**.
8. Once you are both filling cups and pouring them into the opposite bottle, start counting to 20. Each time you reach 20, empty the cup in your hand into your partner's bottle and begin to fill a new cup.
9. Observe what happens to the water level of each bottle as you continue to exchange water on the count of 20.

Observations:

In the beginning of the experiment, the water level in Bottle #1 ...

_____

_____

As we reached a rhythm and were emptying water into each container regularly, the water level in both bottles….

_____

_____

Conclusions:

Did the water level in the containers reach a state of equilibrium?

_____

_____

Does equilibrium mean the bottles have the same amount of water as each other?

_____

_____

If not, what does equilibrium mean?

_____

_____

Experiment 15.2 Effects of Temperature on Le Chatelier's Principle

Question: How does varying the temperature affect the equilibrium of an acid-base reaction?

Hypothesis: _____

Procedure:

1. Each person should have 1 test tube, which can be set in a beaker to hold it upright.
2. Using a pipette, place 20 drops of cabbage water in your test tube.
3. ***Rinse the pipette well*** and use it to add 15 drops of vinegar to the test tube.
4. Use a separate dropper to add ammonia to your test tube, ***slowly, one drop at a time,*** swirling between drops, just until the color changes to any shade of green.
5. Place your test tube into a beaker of ice water for at least one minute. Observe the color.
6. Place your test tube into a beaker of boiling water for about 30 seconds, pull it out, swirling, and observe the color. If the color hasn't changed significantly, you can leave it in the hot water longer.
7. Repeat steps 5 & 6 as often as you like to confirm what color change occurs with varying temperature.

$$NH_3(aq) + C_2H_4O_2(aq) \leftrightharpoons NH_4^+(aq) + C_2H_3O_2^-(aq)$$

Ammonia (base) + Vinegar (acid) ⇋ Ammonium Acetate (a base) + heat (this reaction is exothermic)

Observations:

Color of Cabbage Water (slightly basic/neutral)	
Color of Vinegar solution (acid)	
Color of solution after addition of Ammonia (base)	
Color of solution when heat is added	
Color of solution when heat is removed	

Conclusions:

Did adding heat to the reaction cause it to shift to the right (toward the products) or to the left (toward the reactants)?

What about removing heat?

Why does adding or removing heat make a difference in this reaction?

Please be sure to clean up your work stations before you go!

Thank you!