Chemistry Lecture #83: Demonstration of Chemical Reaction Rates.

In this lecture I'm going to show you a chemical reaction to demonstrate what we mean by reaction rate - how long it takes a chemical reaction to occur.

We're going to take two solutions. One solution has iodate, the other solution has sulfite, hydrogen ion, and starch.

Solution A   Solution B
IO_3 (iodate) SO_3^{2-} (sulfite)
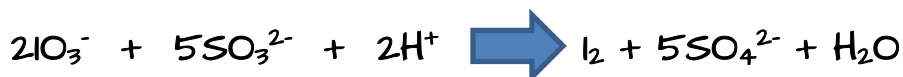 H^+ (hydrogen ion)
                                              Starch

We'll mix the two solutions together. What happens is that when iodate, sulfite, and hydrogen ion are mixed, the elemental form of iodine is made.

Net Reaction:

$2IO_3^- + 5SO_3^{2-} + 2H^+$ ⟹ $I_2 + 5SO_4^{2-} + H_2O$

Bonds with starch and looks dark.

We'll start by mixing a reference solution. We'll be doing several reactions, and we'll compare all the reactions to the reference solution.

Reference solution:

2 teaspoons Solution A (IO_3^-)
2 teaspoons Solution B (SO_3^{2-}, H^+, and starch)

Reaction time: 23 seconds

Appearance of Solution A before mixing with Solution B.

Appearance of Solution A after mixing with Solution B.

Now we'll do things to change the rate of the reaction. We're going to slow it down and speed it up.

The next reaction will use a concentrated solution mixture. The concentrated solution mixture will have additional $NaIO_3$ added to it. It will have a richer concentration of IO_3^-. Concentrated solution mixture means there is more reactant per volume. Solution A has more iodate in it than normal.

Concentrated Solution Mixture:

2 teaspoons of Solution A plus additional $NaIO_3$ added,

2 teaspoons of Solution B.

Reaction time: 11 seconds.

The reaction is faster when Solution A is more concentrated.

The next reaction will occur at lower concentration. To make a lower concentration, we took solution A and added extra water to it. We diluted it so the amount of iodate per volume is less.

Lower Concentration Solution Mixtures

2 teaspoons of Solution A plus 2 teaspoons of water.

2 teaspoons of Solution B.

Reaction time: 66 seconds.

The reaction is slower when Solution A is less concentrated.

The next reaction uses a cold solution. We just chilled the liquids before we mixed them. The liquids will be at a lower temperature.

Cold Solutions

2 teaspoons of Solution A, chilled.
2teaspoons of Solution B, chillded.

Reaction time: 18 seconds. Usually when you chill things, it takes longer for the reaction to occur. I probably mixed the wrong concentration for the solutions, or the solutions were not properly chilled.

The next reactions will use warmed solutions.

Warm Solutions

2 teaspoons of Solution A, warmed.
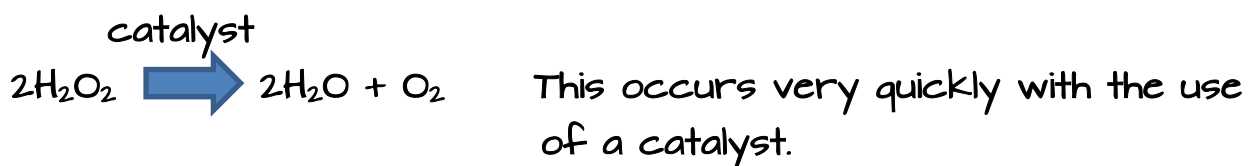2 teaspoons of Solution B, warmed.

Reaction time: 14 seconds.

The reaction is faster when the solutions are warmed up.

There's one more type of reaction we'll do involving hydrogen peroxide. Hydrogen peroxide decomposes into water and oxygen very, very slowly. We can make the reaction go faster if we use a catalyst.

A catalyst is a substance that makes a reaction go faster. The catalyst itself does not get consumed in the reaction. It interacts with the reactants and then leaves intact. The catalyst can be used over and over again; it is not destroyed in the chemical reaction or turned into anything else.

Yeast has a catalyst makes the reaction go faster.

$2H_2O_2$ ⟶ $2H_2O + O_2$ This is a very slow reaction.

catalyst
$2H_2O_2$ ⟶ $2H_2O + O_2$ This occurs very quickly with the use of a catalyst.

The bowl contains yeast, which has a catalyst that causes hydrogen peroxide to decompose.

When hydrogen peroxide is poured in, the mixture swells and foams with oxygen bubbles.

If a smoldering wood splint is inserted into the oxygen bubbles, the wood splint will catch on fire. You can see this demonstrated in Chemistry Video #83.

What should have occurred:

Higher Concentration → Faster reaction

Lower Concentration → Slower reaction

Cold Solutions → Slower reaction

Warm Solutions → Faster reaction

Use of a catalyst → Faster reaction