Iodine Clock Reaction

Recommended Grade Level(s):

Appropriate for: Middle school and High school

Time Requirements:

Activity Time: 10 minutes

Teaching Topics & Concepts:

To illustrate a time-delayed reaction, which leads to the exploration of several factors which affect reaction rate.

- Kinetics, Analyzing and interpreting data, Clock reactions, Indicators, Structure and properties of matter, Chemical reactions.

Background:

A chemical clock is a mixture of chemicals that show an observable change after a short time. When one of the reagents has a visible color, crossing a concentration threshold can lead to an abrupt color change. Teachers can use this demonstration to introduce concepts about kinetics. For example, students can learn about the effect of concentration, temperature, and a catalyst on the rate of reaction. Chemical kinetics has applications across many disciplines, including cosmology, geology, biology, engineering, and even psychology.

Materials:

- Soluble starch
- Potassium iodate, KIO_3
- Sodium hydrogen sulfite (sodium bisulfite), NaH_5O_3
- Sulfuric acid, H_2SO_4 (1.0 M)
- (2) 1 L Erlenmeyer flasks
- (2) 400 mL beakers
- 1 each 25 mL and 100 mL graduated cylinders
- Distilled water
- Stirring rod
- Electronic balance
- Timer (optional)

Safety

- Read the SDS sheets for all chemicals before using them.
- Wear safety glasses, gloves, and a lab coat.

Procedure:

1. Prepare Solution A in a 1 L Erlenmeyer flask (Flask A) containing 0.9 L of water.
2. Add 2 g of potassium iodate to Flask A. Stir.
3. Add distilled water to Flask A to make a total volume of 1 L.
4. Prepare Solution B in a 1 L Erlenmeyer flask (Flask B) containing 0.9 L of boiling water.
5. While stirring, slowly add 4.0 g of soluble starch to Flask B.
6. Add 0.8 g of sodium bisulfite to Flask B. Stir.
7. Add 10.0 mL of 1.0 M sulfuric acid to Flask B. Stir.

8. Add distilled water to Flask B to make a total volume of 1 L.
9. Allow Flask B to return to room temperature.
10. Pour 100 mL of Solution A in a 400 mL beaker (Beaker A).
11. Pour 100 mL of Solution B in a second 400 mL beaker (Beaker B).
12. Pour the solution in Beaker B into Beaker A, and mix.
13. Start the timer (optional). The ability to record the time at which the blue complex appears allows the rate of reaction to be determined accurately with a timer.

Expected Results:

Upon mixing the two reactants, the colorless solution turns dark blue after a set amount of time.

Teaching Notes:

- Time the reaction just before the demonstration to say a "magic word" to activate the reaction.
- Prepare the solution no earlier than the day before you plan to do the demonstration.
- A white background will heighten the impact of the sudden and spectacular color change. There is no warning when the blue color is about to appear.
- This demonstration is a captivating way to show the classic characteristics of a clock reaction. The reaction is also an excellent way for students to learn about kinetics—the effects of concentration, temperature, and the presence of a catalyst on the rate of reaction.

Follow up/Extension:

Student Questions:

1. What is the role of the starch in this reaction?
2. What conclusions would you make from this activity regarding the effect of temperature or the effect of concentration of a reagent on the rate of a chemical reaction?

- Allow students to investigate the effect of concentration on the rate of reaction by diluting a known amount of Solution B with a known amount of water.
- Allow students to investigate the effect of temperature on the rate of reaction by heating and cooling the contents of Beaker A and Beaker B.
- Replace starch with cellulose paper. This provides the reaction with a white solid surface in which color change can be clearly observed and reduces reagent amounts required to 540 µL per group. Ask students to calculate reaction orders and the reaction constant k to determine the rate equation for this reaction.

Disposal/Clean-Up:

The solutions can be disposed of down the drain. Consult local regulations before any disposal activity.