Iodine Clock Reaction

A Study of the Effects of Concentration, Temperature, and a Catalyst on Reaction Rate

Introduction

Mix two colorless solutions and watch as, after a few seconds, they suddenly change from colorless to a dramatic deep-blue color! Captivate your students' attention with this popular starch–iodine clock reaction while studying the effects of concentration, temperature, and a catalyst on the rate of reaction.

Concepts

- Clock Reactions
- Kinetics/Rates of Reaction
- Catalysts
- Indicators

Materials

Potassium iodate solution, KIO_3, 0.20 M, 325 mL
Starch solution, 2%, 180 mL
Sodium metabisulfite, $Na_2S_2O_5$, 3.8 g
Sulfuric acid solution, H_2SO_4, 0.1 M, 10 mL
Water, distilled or deionized
Balance
Beakers, 250-mL, 6
Beakers, 400-mL, 6
Graduated cylinder, 10-mL
Graduated cylinder, 50-mL
Graduated cylinder, 100-mL
Hot plate
Ice bath
Thermometer
Timer or stopwatch
Stirring rod

Safety Precautions

Potassium iodate is an oxidizer. It is moderately toxic by ingestion and a body tissue irritant. Sodium metabisulfite is a skin and tissue irritant. Sulfuric acid solution is corrosive to eyes, skin, and other tissues. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Safety Data Sheets for additional safety, handling, and disposal information. Wash hands thoroughly with soap and water before leaving the laboratory.

Preparation

1. Prepare 100 mL of a 0.20 M sodium metabisulfite solution by dissolving 3.8 g of sodium metabisulfite in enough distilled or deionized water to make 100 mL of solution. This solution has a poor shelf life (about 1–2 months) and should be prepared fresh for the demonstration.
2. Prepare a 2% starch solution by first making a smooth paste with 20 g of soluble (potato) starch and 100 mL of distilled or deionized water. Pour the starch paste into 1 L of boiling water while stirring. Stir until dissolved and the solution is clear. Allow the solution to cool to room temperature before use. Starch solutions have a poor shelf life and will form mold if kept too long. Fresh solutions work best. Use within one or two months.
3. Prepare a series of solutions called Solution A according to the following chart. Use 400-mL beakers.

	Beaker 1A	Beaker 2A	Beaker 3A	Beaker 4A	Beaker 5A	Beaker 6A
Potassium Iodate Solution, 0.20 M	50 mL	100 mL	25 mL	50 mL	50 mL	50 mL
Distilled or Deionized Water	150 mL	100 mL	175 mL	150 mL	150 mL	140 mL
Sulfuric Acid Solution, 0.1 M	0 mL	0 mL	0 mL	0 mL	0 mL	10 mL
Temperature of Solution A	Room Temp	Room Temp	Room Temp	45 °C	10 °C	Room Temp

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4. Prepare a series of six identical solutions called Solution B (1B–6B) by mixing 10 mL of 0.20 M sodium metabisulfite solution, 30 mL of starch solution, and 40 mL of distilled or deionized water in 250-mL beakers. Keep each of the solutions at room temperature.

Procedure

1. *Control Reaction.* Pour Solution 1B into Solution 1A. Stir. Carefully time the reaction with a stopwatch or timer. Record the time from when the two solutions are mixed until the appearance of the blue color.
2. *The Effect of Concentration upon Reaction Rate.* Pour Solution 2B into Solution 2A. Record the time from when the two solutions are mixed until the appearance of the blue color. Repeat with Solutions 3B and 3A.
3. *The Effect of Temperature upon Reaction Rate.* Pour Solution 4B into Solution 4A. Record the time from when the two solutions are mixed until the appearance of the blue color. Repeat with Solutions 5B and 5A.
4. *The Effect of a Catalyst on the Reaction Rate.* Pour Solution 6B into Solution 6A. Record the time from when the two solutions are mixed until the appearance of the blue color. *Note:* Sulfuric acid is a catalyst for this reaction.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures, and review all federal, state and local regulations that may apply, before proceeding. The final solutions may be reduced with sodium thiosulfate solution according to Flinn Suggested Disposal Method #12a. Add just enough reducing agent to decolorize the blue color of the starch–iodine complex.

Results and Discussion

	1	2	3	4	5	6
[KIO_3]	0.04 M	0.07 M	0.02 M	0.04 M	0.04 M	0.04 M
Temperature	Room Temp	Room Temp	Room Temp	Warm	Cool	Room Temp
Catalyst Added?	No	No	No	No	No	Yes
Time Until the Blue Color	6 sec	3 sec	12 sec	4 sec	8 sec	2 sec

In this reaction, potassium iodate and sodium metabisulfite react to form iodine. The starch solution serves as an indicator of the end of the reaction by forming a deep-blue colored starch–iodine complex. The reaction time can thus be measured by noting the time until the appearance of the blue color for each trial. Three general statements can be made by looking at the results from this experiment. (1) The reaction rate increases as concentration increases and decreases as the concentration decreases. (2) The reaction rate increases with increasing temperature and decreases with decreasing temperature. (3) The reaction rate increases in the presence of a catalyst.

NGSS Alignment

This laboratory activity relates to the following Next Generation Science Standards (2013):

Disciplinary Core Ideas: Middle School
MS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions

Disciplinary Core Ideas: High School
HS-PS1 Matter and Its Interactions
PS1.A: Structure and Properties of Matter
PS1.B: Chemical Reactions

Science and Engineering Practices
Asking questions and defining problems
Planning and carrying out investigations
Constructing explanations and designing solutions

Crosscutting Concepts
Patterns
Cause and effect
Structure and function
Stability and change

Materials for the *Iodine Clock Reaction* are available from Flinn Scientific, Inc.

Catalog No.	Description
P0168	Potassium Iodate Solution, 0.2 M, 500 mL
S0151	Starch Solution, 500 mL
S0317	Sodium Metabisulfite, 100 g

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.