A Flash of Blue

A Classic Clock Reaction

Introduction

In a flash, a colorless solution turns a dramatic deep-blue color! Amaze your students with this popular starch–iodine clock reaction.

Concepts

- Clock Reactions
- Indicators

Materials

Potassium iodate solution, 0.01 M, KIO_3, 100 mL
Sodium meta-bisulfite, $Na_2S_2O_5$, 0.02 g
Starch solution, 0.5%, aqueous, 100 mL
Sulfuric acid solution, 1 M, H_2SO_4, 3 mL
Water, distilled or deionized
Balance
Beaker, 250-mL
Graduated cylinder, 10-mL
Graduated cylinder, 100-mL
Stirring rod

Safety Precautions

Potassium iodate solution is an oxidizer. It is moderately toxic by ingestion and a body tissue irritant. Sodium meta-bisulfite is a skin and tissue irritant. Sulfuric acid solution is corrosive to eyes, skin, and other tissues and moderately toxic by ingestion. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Procedure

1. Pour 100 mL of the starch solution in a 250-mL beaker. Add 0.02 g of sodium meta-bisulfite to the starch solution. Stir to dissolve.
2. Add 3 mL of 1 M sulfuric acid solution to the beaker and stir.
3. Quickly, but carefully, add 100 mL of 0.01 M potassium iodate solution to the beaker. Stir to mix. Observe the appearance of the deep-blue color which suddenly appears (after about 10–15 seconds).

Extension

Performing the procedure above as indicated is an attention-getting demonstration that shows the classic characteristics of a clock reaction. However, this reaction is also ideal for studying kinetics—the effects of concentration, temperature, and the presence of a catalyst on the rate of reaction. For more information, please request Flinn ChemFax #10245, Iodine Clock Reaction.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Dispose of the resulting solution according to Flinn Suggested Disposal Method #12a.

Discussion

This reaction is a classic example of a clock reaction. A *clock reaction* is a reaction characterized by an initial period with no noticeable change, followed by a sudden change, commonly in the color of the solution. The time period during which no noticeable change occurs is called the *clock period*, and the sudden change is called the *alarm*. What actually triggers the

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alarm varies from clock reaction to clock reaction.

In this reaction, potassium iodate and sodium meta-bisulfite react to form iodine. The starch solution serves as an indicator of the end of the reaction, forming a deep-blue colored starch–iodine complex in the presence of iodine. The chemical pathway for the formation of iodine is complicated and not completely understood, but the following mechanism serves as an outline.

Step 1: Sodium meta-bisulfite contributes hydrogen sulfite ions, HSO_3^-, while potassium iodate contributes iodate ions, IO_3^-, to the solution.

$$H_2O(l) + Na_2S_2O_5(s) \rightarrow 2HSO_3^-(aq) + 2Na^+(aq)$$

$$KIO_3(aq) \rightarrow IO_3^-(aq) + K^+(aq)$$

Step 2: The iodate ions react with the hydrogen sulfite ions to produce iodide ions, I^-.

$$IO_3^-(aq) + 3HSO_3^-(aq) \rightarrow I^-(aq) + 3H^+(aq) + 3SO_4^{2-}(aq)$$

Step 3: In the presence of hydrogen ions, H^+, the iodide ions react with excess iodate ions to produce iodine, I_2.

$$6H^+(aq) + 5I^-(aq) + IO_3^-(aq) \rightarrow 3I_2(aq) + 3H_2O(l)$$

Step 4: Before the iodine can react with the starch to produce a dark-blue colored complex, it immediately reacts with any hydrogen sulfite ions still present to form iodide ions.

$$I_2(aq) + HSO_3^-(aq) + H_2O(l) \rightarrow 2I^-(aq) + SO_4^{2-}(aq) + 3H^+(aq)$$

Step 5: Once all of the hydrogen sulfite ions have reacted, the iodine is then free to react with the starch to form the familiar dark-blue colored complex.

$$I_2(aq) + \text{starch} \rightarrow \text{dark-blue colored complex}$$

The deep-blue color of the complex is due to the presence of the pentaiodide anion, I_5^-. By itself, the pentaiodide anion is unstable; however, it is stabilized by forming a complex with the starch. The appearance of the deep-blue color in solution indicates that all of the reactants have been consumed and the reaction has gone to completion.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement
Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter
Content Standards: Grades 9–12
Content Standard B: Physical Science, structure of atoms, structure and properties of matter, chemical reactions

Materials for *A Flash of Blue* are available from Flinn Scientific, Inc.

Catalog No.	Description
P0064	Potassium Iodate, 100 g
S0151	Starch Solution, 500 mL
S0317	Sodium meta-Bisulfite, 100 g
AP8657	A Flash of Blue—Chemical Demonstration Kit

Consult the Flinn Scientific website for current prices.