Indigo Carmine

Stop-'N-Go Light

Introduction

A flask of solution is shaken, turning the color of the solution from yellow to red to green and then back to yellow again.

Concepts

- Oxidation–reduction
- Indicators

Materials

Dextrose solution, 0.13 M, $C_6H_{12}O_6$, 100 mL
Indigo carmine solution, 1%, 10 mL
Sodium hydroxide solution, 1.0 M, NaOH, 100 mL
Cylinder, graduated, 10-mL
Cylinder, graduated, 100-mL
Erlenmeyer flask, 500-mL
Stopper, to fit flask

Safety Precautions

Indigo carmine indicator solution is moderately toxic by ingestion and is a body tissue irritant. Sodium hydroxide solution is a corrosive liquid and skin burns are possible. It is very dangerous to eyes. 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.

Preparation

1. Prepare the indigo carmine solution by dissolving 1 g of indigo carmine in 100 mL of distilled or deionized water.
2. Prepare the dextrose solution by dissolving 24 g of dextrose in enough distilled or deionized water to make 1 L of solution.
3. Prepare the sodium hydroxide solution by dissolving 40 g of sodium hydroxide pellets in enough distilled or deionized water to make 1 L of solution.

Procedure

1. Place 100 mL of the dextrose solution and 100 mL of the sodium hydroxide solution into a 500-mL Erlenmeyer flask.
2. Add 10 mL of the indigo carmine indicator solution to the flask. Firmly insert the stopper.
3. Allow the solution to sit and become fully reduced (yellow).
4. Once reduced, shake to obtain all of the colors.

Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. The Stop-'N-Go Light solution may be rinsed down the drain according to Flinn Suggested Disposal Method #26b.

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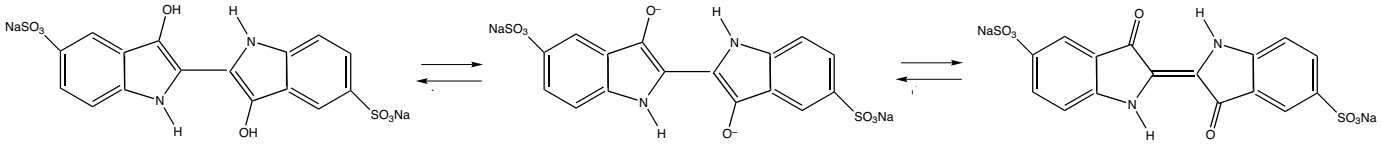
Tips

• The solution will be green initially. Allow the solution to sit undisturbed until it becomes a bright amber (yellow). This may take as long as 10 minutes. If the solution is not bright amber, you may need to add more indigo carmine. Show the amber solution to the class and then place it behind your back and shake it *gently.* Show the students that it is now red. Let it change back to the amber color and again place it behind your back, shake it *vigorously*, and show the students the green color. A little practice will quickly determine how many shakes are needed for the red color and how many additional shakes for the green color. The Stop-'N-Go Light solution will repeat this yellow to red to green cycle for 20 minutes or so depending on how often it is shaken and how much oxygen is reintroduced by opening the bottle. The colors will become less vivid with time. The indigo carmine solution has a limited shelf life (6 to 12 months) and should be royal blue in color. If it is not blue, the solution needs to be prepared fresh in order for the demonstration to work.

Discussion

An alkaline dextrose solution is shaken in the presence of oxygen and indigo carmine. Indigo carmine can be reduced by the alkaline sugar and oxidized by the oxygen in the bottle. When the reduced form of indigo carmine (amber color) is agitated, it becomes oxidized to the green color. Shakashiri proposes the middle structure below as the red intermediate. As the solution containing the oxidized forms is allowed to sit, most of the available dissolved oxygen is used up and the indigo carmine is slowly reduced back to the reduced form (amber color). After about 10 or 15 cycles, when all of the oxygen in the flask has been used up, the redox reaction will cease. Remove the stopper to introduce more air and repeat the process. An outline of the reaction mechanism is as follows



reduced form (amber) | intermediate (red) | indigo carmine (green)

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
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

Acknowledgment

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References

Ferguson, H. W.; Schmuckler, J., *et al. Laboratory Investigations in Chemistry*, Silver Burdett: Parsippany, NJ, 1970.

Shakhashiri, B. Z. *Chemical Demonstrations: A Handbook for Teachers in Chemistry;* Univ. of WI, Madison; Vol. 2, pp 145–146.

Soifer, M. and Garber, M., (Students of Joseph Schmuckler, Haverford High School, Haverford, MA), 1969.

Materials for the *Indigo Carmine—Stop-'N-Go Light* are available from Flinn Scientific, Inc.

Catalog No.	Description
D0002	Dextrose, 500 g
S0074	Sodium Hydroxide, 100 g
I0047	Indigo Carmine, 5 g
AP2083	Stop-'N-Go Light—Chemical Demonstration Kit

Consult the Flinn Scientific website for current prices.