Lightstick Kinetics

Effect of Temperature on Reaction Rates

Introduction

A good way to show the effect of temperature on reaction rates is to use two lightsticks, one in cold water and one in hot water.

Concepts

- Kinetics
- Reaction Energy
- Temperature

Materials

Beakers, 400-mL, 2
Commercial lightsticks, 2
Hot plate or Bunsen burner
Ice

Safety Precautions

Be careful not to puncture the outer plastic of the lightstick. According to the manufacturer, the materials in the lightsticks are relatively non hazardous, but common sense dictates that the solutions be kept contained. Wear chemical splash goggles and always follow laboratory safety rules while performing demonstrations.

Procedure

1. Fill one of the beakers with hot water and the other with ice water.
2. Place a lightstick in each beaker and allow about 3 minutes for temperature equilibration.
3. Following the directions for the lightstick, break the inner ampule of each. The one that was in the hot water will be significantly brighter than the one that was in the ice water.

Disposal

Used lightsticks may be discarded in the trash.

Tips

- Lightsticks do have a shelf life! Older materials do not work as well. It seems that they start to lose power after about a year, and after about four years, they will not react at all. Use fresh lightsticks! The light green/yellow lightsticks seem to work better.
- The warm water should not be above 50 °C as extreme heat affects the plastic casing of the lightsticks.

Discussion

The reaction is a chemiluminescence reaction and, like most reactions, its rate is temperature dependent. The lightstick contains dilute hydrogen peroxide in a phthalic ester solvent that is held in a thin glass ampule. This ampule is surrounded by a solution containing phenyl oxalate and a fluorescent dye (9,10-bis(phenylethynyl) anthracene or 9,10-diphenyl anthracene). When the ampule is broken, the peroxide and the phenyl oxalate ester react. During the course of the reaction, an intermediate is produced that transfers energy to the dye molecule. Visible light is emitted when the excited dye returns to the ground state.

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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 9–12
Content Standard B: Physical Science, chemical reactions, interactions of energy and matter

Flinn Scientific—Teaching Chemistry™ eLearning Video Series

A video of the *Lightstick Kinetics* activity, presented by George Gross, is available in *Effect of Temperature on Reaction Rates*, part of the Flinn Scientific—Teaching Chemistry eLearning Video Series.

Materials for *Lightstick Kinetics* are available from Flinn Scientific, Inc.

Catalog No.	Description
AP1443	Light Stick, Green
AP2066	Light Stick, Red
AP2067	Light Stick, Blue
AP2068	Light Stick, Yellow
AP2069	Light Stick, Orange
GP1025	Beaker, Borosilicate Glass, 400-mL

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