Observing Reactions in Lightsticks

Summary

Students will use lightsticks to understand the chemical reaction that takes place when it is snapped.

Time Frame

1 class periods of 45 minutes each

Group Size

Small Groups

Materials

- student page
  (attached)
  three lightsticks (a party store will have them),
  two glass containers such as beakers or coffee cups
  hot water (no hotter than 70 C--about the temperature of hot coffee)
  ice; cold water
  a darkened room

Background for Teachers

Lightsticks contain dilute hydrogen peroxide in a phthalic ester solvent enclosed in a glass vial, which is surrounded by a solution containing a phenyl oxalate ester and a fluorescent dye. When the lightstick is "snapped" and the vial is broken, the two solutions react to produce an intermediate that transfers energy to a dye molecule. Visible light is emitted when the excited dye molecule returns to the ground state.

Instructional Procedures

Hook activity: N/A

The activity was written for groups of three students because of the number of lightsticks needed and the cost of the lightsticks. Each student or group should have three lightsticks for direct comparison at the three different temperatures. (Working in groups allows all three lightsticks to be activated simultaneously so students may assume that the difference in light intensity is not due to the length of time the lightstick has been reacting.)

When the activity is finished, the lightsticks can be given to students or kept for longer testing. It is safe to dispose of used lightsticks in a regular trash container.

Students should observe the following:

The temperature of the lightstick does not change when it reacts. Chemiluminescence produces light without heat.

The hot-water lightstick will glow more brightly than the room-temperature and ice-water lightsticks. The room temperature lightstick will glow more brightly than the ice-water lightstick. CAUTION: students should not use water that is hotter than 70 C or heat lightsticks directly. The lightstick's plastic casing will melt at higher temperatures.

Carbon dioxide is a product in the reaction (1, 2). Bubbles of CO_2 can be observed forming in the lightstick. Bubbles form vigorously inside the hot-water lightstick and more slowly inside the room-temperature lightstick. No noticeable bubbles form in the ice-water lightstick.

When the three lightsticks return to room temperature, they should have roughly the same

light intensity. The light intensity of the hot-water lightstick may have diminished because more of its reactants were converted to products.

Assessment Plan

Answer key:

1. *The lightsticks are activated at the same time to insure that the differences in light intensity and bubble formation in steps 2 and 3 cannot be attributed to the length of time each lightstick had been activated.*
2. *The lightstick at the highest temperature is brightest because the rate of reaction is fastest at the highest temperature.*
3. *The lightstick at the highest temperature produces the highest rate of bubbling because the rate of reaction is fastest at the highest temperature.*
4. *The bubbles will stop forming when all the reactants have been converted to products.*
5. *A lightstick stops glowing when all the reactants are converted to products and no longer produce the intermediate that excites the dye molecules.*
6. *The lightstick that was at the highest temperature would have the lowest light intensity at room temperature because of the smaller concentration of reactant remaining--the reaction rate was fastest at the highest temperature so more of the reactants would have been used up. The lightstick that was at the lowest temperature would have the highest light intensity, because the low temperature slowed the rate of the reaction leaving a greater concentration of reactants.*

Bibliography

Adapted from The Effects of Temperature on Lightsticks . J. Chem. Educ. 1999 76 40A.
Lesson Design by Jordan School District Teachers and Staff.

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