Student Page

Title: Observing Reactions in Lightsticks

Introduction: "*Chemiluminescence* is the emission of visible light as the result of a chemical reaction without a noticeable change in temperature. Some familiar items that use chemiluminescence are lightsticks and glow necklaces and bracelets. They are often sold at amusement parks, hardware stores, and in some discount and toy stores, especially around Halloween. Very small lightsticks are used for night fishing and are sold in sporting goods stores. In nature, fireflies use Chemiluminescence for signaling.

When you "snap" a lightstick to activate it, you are setting a chemical reaction in motion. The lightstick contains a solution of a chemical (phenyl oxalate ester) and a fluorescent dye. There is also a small glass vial inside the lightstick containing a hydrogen peroxide solution. When you break the glass vial, the solution in the lightstick and the hydrogen peroxide from the vial react. This causes a transfer of energy to the fluorescent dye molecules, which excites electrons in the dye molecules to a higher energy level. When these excited electrons return to the ground state, light is given off. In this activity, you will investigate the effect of temperature on lightsticks." (*J. Chem. Educ.* **1999** *76* 40A.)

Materials

- Three lightsticks
- 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

Procedures:

1. In a darkened room, each person should take one lightstick out of its package. Feel the outside of the lightstick to determine its approximate temperature. Each person in the group should then "snap" a lightstick at the same time and shake it. Feel the outside of the lightstick again. Has the temperature changed?
2. Fill one of the glass containers with hot water. (**CAUTION: do not use water that is hotter than 70 C. If the water is hotter, the plastic of the lightstick may melt. The lightsticks should not be placed in water that is being heated. Heat the water, remove it from the heat source, and then add a lightstick.**) Fill the other container with a mixture of ice and cold water. At the same time place one lightstick in the hot water and place one lightstick in the ice water.
3. Leave the third lightstick at room temperature. How long does it takes for a change to occur in the hot-water lightstick and in the ice-water lightstick? What happens to the light intensity of each lightstick?
4. Look closely at the hot-water lightstick without removing it from its container. Notice the bubbles rising to the top of the lightstick. Compare the rate of bubble formation between the three lightsticks. If you have difficulty seeing the bubbles forming, you may have to remove the lightsticks from their containers and hold them up to a light source such as a window. What causes the bubbles to form?
5. Remove the lightsticks from the hot water and the ice water. Allow them to come to room temperature. What happens? How long do you observe changes?
6. Clean-up: After completing the experiments and answering the questions, ask your instructor what to do with the used lightsticks. It is safe to dispose of used lightsticks in a regular trash container.

Adapted from The Effects of Temperature on Lightsticks . *J. Chem. Educ.* **1999** *76* 40A.

Prediction/Hypothesis

If _____,
[state hypothesis]
Then by changing _____ and measuring
[INDEPENDENT VARIABLE]
_____, I predict that
[DEPENDENT VARIABLE]
_____.
[Prediction of results. Be specific. Do not simply state that there will be an effect]
Because _____
_____
_____.
[Scientific phenomenon to support your prediction. Cite evidence from your textbook.]

Data/Observations:

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Analysis

1. In step 1 all three lightsticks were activated at the same time. Why was it necessary to do this?

2. Is the light intensity of the three lightsticks different at different temperatures? Explain.

3. Do bubbles form in the lightsticks at different rates at different temperatures? Explain.

4. When do bubbles stop forming in a lightstick? Why?

5. When does a lightstick stop glowing? Why?

6. If you keep three lightsticks for several hours at different temperatures (hot, cold, room temperature) and then allow them to come to room temperature, how would the light intensities compare? Explain the reasoning behind your answer. (To check your answer, try the experiment. You may need to add more hot water or ice during the test to maintain constant temperature.)

7. Describe the evidence that you have observed that a chemical reaction has occurred.

Conclusion:

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