Kinetics of Light Sticks

Materials

- Lightstick
- Two tall 1000 mL beakers
- Hotplate
- Thermometer
- Ice (from the second floor)

Procedure

1. To start the lightstick glowing, bend it to break glass ampule end the lightstick in order to break the thin ampule inside. The lightstick should glow.
2. To each beaker add water.
3. Heat one of these beakers on a hotplate to 70ºC. Do not allow the temperature of the water to exceed 70ºC or the lightstick will melt.
4. To the other beaker add ice.
5. Place one end of the lightstick in the ice water and place the other end in the hot water. The lightstick will glow more brightly at a higher temperature. The lightstick will glow less brightly in cold water.

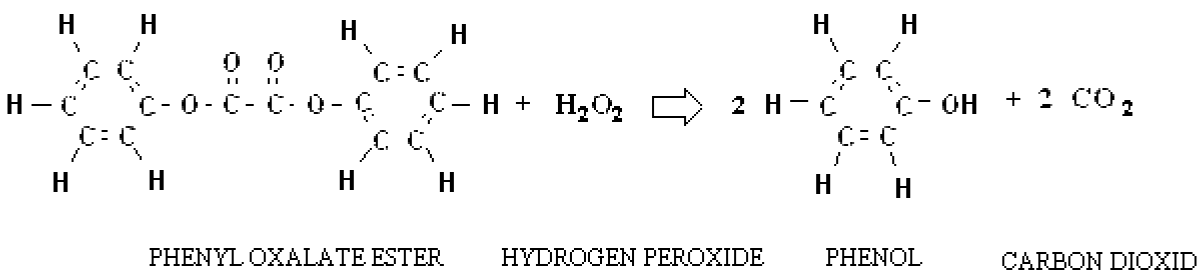
Hint: Three small "Cylume" lightsticks can be used instead of one flexible "necklace".

Discussion

This demonstration shows the effect of temperature on reaction rate. The rate of almost all chemical reactions increases with increasing temperature. At higher temperatures the number of collisions between reactant molecules increases. Also and more importantly, at higher temperatures these collisions are more likely to have enough energy to form products. In this demonstration the lightstick glows more brightly at a higher temperature because in a given time period, more reactant molecules are colliding with sufficient energy to form the products, with the accompanying release of light. The more molecules that react in a given time period the brighter the light.

Reaction rates are slow at low temperatures because most of the collisions between reactants don't result in products. In this demonstration the lightstick glows less brightly in ice water because in a given time period, fewer reactant molecules are colliding with sufficient energy to form the products.

The thin glass ampule in the lightstick contains dilute hydrogen peroxide. The ampule is surrounded by a solution containing a phenyl oxalate ester and a fluorescent dye. When the ampule is broken, the hydrogen peroxide and the oxalate ester react. A chemiluminescent reaction (a reaction that produces light) occurs.



$$C_2O_4Ph_2 + H_2O_2 \longrightarrow 2\,C_6H_5OH + 2\,CO_2$$

During the course of the reaction, an intermediate is produced which transfers energy to the fluorescent dye molecule. When the dye molecule absorbs energy, the energy is used to raise electrons to an excited state. When the dye molecule returns to the ground state light is emitted.

Department of Chemistry
University of Washington
109 Bagley Hall
Box 351700
Seattle, WA 98195-1700

Main Office: 206.543.1610
chemdesk@uw.edu

Advising: 206.616.9880
advisers@chem.washington.edu