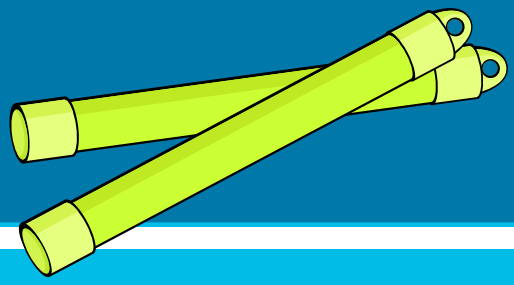
Chemical Kinetics (Glow Sticks)

Experiment Instructions

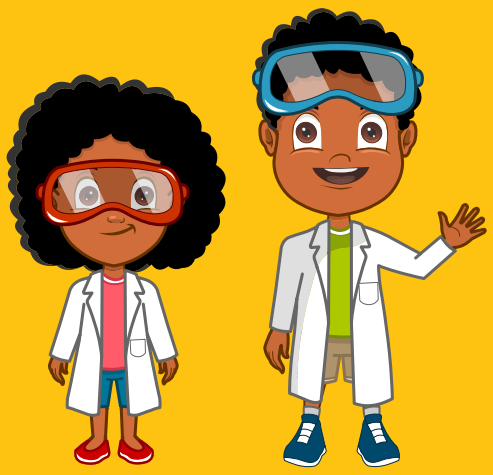


Description:

Glow sticks vary in brightness when placed in hot and cold water.

Safety:

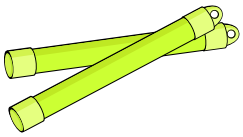
Always wear a lab coat and safety glasses



Do not handle the contents of a glow stick

Materials:

2 identical glow sticks



1 beaker of cold water

1 beaker of hot *tap* water

Directions:

1. Remove the glow sticks from their wrappers and show the audience that they are the same type.
2. Darken the room lights, if possible.
3. Activate the glow sticks by bending them until a crack is heard and the glow sticks begin to emit light. Explain the chemical process that is occurring and what happens when the glass ampoule is broken.
4. Place one glow stick into hot water and the other into cold water. Wait until the luminosity begins to change. Explain what is happening and why (chemical kinetics).
5. Remove the glow sticks from the various beakers. You can switch beakers, place the hot into the cold and vice versa and watch the luminosity change again.

Chemical Kinetics (Glow Sticks)

Experiment Instructions (Continued)

Simple Explanation

The chemical reaction occurring in the glow stick (chemiluminescence) requires that two materials come in contact with one another to make the glow. Adding heat to the system (hot water) increases the rate that these molecules come in contact with one another and also that more molecules have enough energy for the reaction to proceed. Removing heat from the system (cold water) has the opposite effect. Glow sticks can be preserved by being placed in freezers.

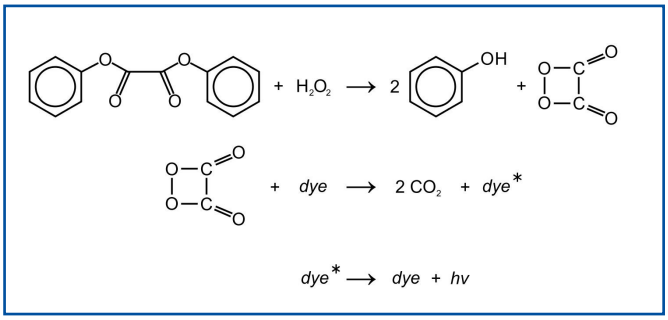
Detailed Explanation

The glow stick contains two chemicals and a suitable fluorescent dye. The chemicals in the plastic tube are a mixture of the dye and Cyalume (phenyl oxalate ester). The chemical inside the glass vial is hydrogen peroxide. By mixing the peroxide with the Cyalume, a chemical reaction takes place. The ester is oxidized, yielding two molecules of phenol and one molecule of peroxyacid ester. The peroxyacid decomposes spontaneously to carbon dioxide, releasing energy that excites the dye, which then de-excites by releasing a photon. The wavelength of the photon—the color of the emitted light—depends on the structure of the dye.

Chemical reactions proceed at various rates due to the temperature of the system. This can be represented by the Arrhenius equation:

$k = Ae^{-Ea\,RT}$

where k is the rate constant of the chemical reaction, A is the prefactor, E_a is the activation energy, *R* is the gas constant, and T is the temperature (in Kelvin).



This can be more simply stated as: "for many chemical reactions at room temperature, the reaction rate doubles for every 50°F (10°C) increase in temperature." This can clearly be seen as the light stick that is placed in the hot water begins to grow brighter and the one placed in the cold water darkens. It can also be mentioned that the glow stick in which is placed in the hot water longer will also have a shorter life span.

This demo is related to the Chemiluminescence demo and may be performed back to back.

Waste Disposal

The water can be disposed of in a sink and the glow sticks can be handed out to the audience or placed in the trash.

Reference: http://www.stevespanglerscience.com/experiment/light-sticks-the-science-of-liquid-light

http://en.wikipedia.org/wiki/Glow_stick