STEM gems

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GLOW ON TRY THIS

big IDEAS

THE NIGHTS ARE DARK AND ALL THE HALLOWEEN GLOW GOODIES ARE ON CLEARANCE. NOW IS THE PERFECT TIME TO EXPLORE THE SCIENCE OF GLOW STICKS. The cold ghostly fluorescent light of a glow stick easily captures the imagination of young people everywhere, but like all good things the glow fades. It is of no surprise that after Halloween I am bombarded with questions that revolve around whether it is possible to make the "magic" of a glow stick last longer. Instead of providing a quick answer, there is an easy experiment that you can do with young people that allows them to discover the answer for themselves.

WHAT IS A CHEMICAL REACTION?

Everything around us is made of chemicals. Chemicals are made from atoms that have joined together to form molecules. A chemical reaction is what happens when two or more chemicals are mixed together and react with each other to form a new chemical that was not present when the reaction started. In a chemical reaction, molecular bonds are broken and formed to create new molecules.

HOW DO GLOW STICKS WORK?

Glow sticks produce light through a chemical reaction. Glow sticks contain three different chemicals. Two of the chemicals react together to create energy. The third chemical, a fluorescent dye, is excited by this energy and releases light. Different colored fluorescent dyes are used to make different colored glow sticks. In the main body of the glow stick, the first chemical, a phenyl oxalate ester, is mixed together with the fluorescent dye. The third chemical, hydrogen peroxide, is sealed in a glass vial, so the reaction does not start until needed. When you want to activate the glow stick, you snap the tube to break the glass vial inside. This releases the hydrogen peroxide, which reacts with the phenyl oxalate ester, causing energy to be released. The energy given off excites the atoms in the fluorescent dye causing their electrons to jump to a higher energy state. These electrons instantly fall back, releasing the extra energy as visible light.

The chemical reaction taking place in a glow stick produces light instead of heat, but it is influenced by heat. The hotter the reaction, the faster it will occur and the brighter the glow stick will be. Each glow stick is a sealed system and the amount of light it can give off is fixed by the amount of chemical that it contains. Heating the reaction makes a glow stick glow brighter, but the reaction occurs faster, using up the chemicals faster. A hot glow stick glows brighter, but can only glow for a short amount of time. On the other hand, cooling the reaction causes the stick to glow less. The reaction slows down and the chemicals are used at a slower rate, so the glow will last a lot longer.

SCIENCE talk

ATOM: The smallest part of an element that can exist. Atoms are made up of protons and neutrons in a nucleus with orbiting electrons. | **CHEMICAL REACTION:** When two or more chemicals combine to form something new. | **CHEMICAL LUMINESCENCE:** The emission of light as the result of a chemical reaction. | **MOLECULE:** A unit of matter; two or more atoms chemically bound together to form a substance. | **NEUTRON:** A neutral particle in the nucleus of an atom. | **NUCLEUS:** The central part of an atom made up of protons and neutrons. | **PROTON:** A positively charged particle that orbits the nucleus of an atom.

engage

What kinds of light can help us find our way in a dark night? *Young people's choice: The moon, stars, electric light, firelight, candles, flashlights, glow sticks, etc.*

What is a glow stick? *A plastic tube filled with chemicals that, when broken, produces a bright cold light. Glow sticks have a long shelf life waiting to be activated. They are durable and produce a strong light without a lot of heat. They were originally used by the US Navy in survival kits.*

How long does a glow stick last? *Several hours.*

Is it possible to make a glow stick glow longer or glow brighter? *Young people's choice.*

what YOU WILL NEED & before YOU BEGIN

- **4 Glow sticks of the same color**
- **3 Clear glasses or cups**
- **Hot water**
- **Room temperature water**
- **Ice**
- **Cardboard box**
- **Black paper or paint**
- **Paintbrush** *(optional)*
- **Scissors**
- **Tape or glue**
- **Timer**

Find a large cardboard box and cover the inside with black paper or paint to make a dark area in which to showcase the experiment.

Fill one glass with water and ice, another with room temperature water, and the third with hot water. The hotter the better.

EXPLORE & EXPERIMENT

1. **Show the group a glow stick.** Have the group gently pass it around and examine it. Ask the group to describe what they observe. The stick is made from colored plastic and filled with a liquid. If shaken gently you can feel that there is a small container inside the tube floating in the liquid.

2. **Collect the glow stick and ask the group how to activate it.** Explain that the small container floating inside the plastic tube is made from glass and contains a chemical. When the glow stick is snapped, the glass breaks and the chemicals inside mix together. This starts a chemical reaction that gives off light. Snap the glow stick, pass it around the group, and have them examine it.

3. **Explain that you have set up an experiment with three glasses of water.** One has cold water, one has hot water and one has room temperature water. Ask the group to hypothesize what they think will happen when three glow sticks are activated and one is placed into each of the glasses of water. Will the glow stick glow brighter or dimmer? Will the glow fade faster or slower?

4. **Snap three glow sticks and drop one into each glass of water.** Place the glasses in the dark box and compare the glow from each. Ask the group which stick glows the brightest and which one is the dimmest.

5. **Have the group check the glasses every 30 minutes to note any changes.** If possible, store the glasses overnight for the next class. Place the hot water glass somewhere warm and the cold water glass in a refrigerator. Have the children note any differences when they return. In my experiments, the hot water glow stick will glow brightly, but only for about one to two hours. The glow stick in cold water will glow weakly for about 24 hours, especially if left in a refrigerator.

6. **Explain that the chemical reaction that makes the glow sticks glow is influenced by heat.** The hotter the environment, the faster the reaction happens. This makes the glow sticks glow brightly, but the chemicals are used up quickly, so the sticks only glow for a short time. If a glow stick is chilled, the reaction takes place more slowly. The chemicals will last for a long time, but will only produce a dim glow.

make THE CONNECTION

Explain that our lives are filled with different chemical reactions. Remember a chemical reaction takes place when two or more chemicals are mixed together and something new is created. Ask the group if they can think of other examples of a chemical reaction.

BAKING: Flour, eggs and sugar are turned to cookies. A cookie is very different from the starting ingredients.

DIGESTION: When we eat food, a chemical reaction in our stomachs break down the food into energy for our bodies.

PHOTOSYNTHESIS: Plants turn sunlight, water and carbon dioxide into sugar.

RUST: Metals left in damp air oxidize to form rust.

BURNING: When a fire is lit, a chemical reaction occurs that breaks down the wood into carbon, while releasing heat.

BATTERIES: Chemicals in a battery mix together to make electricity.

BAKING SODA AND VINEGAR: The classic volcano model. When mixed together, these two chemicals make water and carbon dioxide gas. The fizzing gas causes the mixture to bubble.

EXTEND & EVALUATE

If you wanted a glow stick to last until morning, is it better to store it on a heater or in the freezer?

Ask young people to draw a diagram of the experiment. The diagrams should illustrate how the glow stick in each glass of water produced a different amount of glow. Challenge young people to use their imaginations to include in their illustrations a visual representation of the different temperatures of the glasses of water and the different speeds of the reactions taking place in each glow stick.