

Instant Light in the Bag Inquiry Demonstration

Kit # 94002-19

Materials

Provided in this kit:

- Instant light crystals, 100 g
- Plastic bags, 10
- Instructions, including answer key (pp.6-7) and student worksheet (pp.8-9)

Required but not provided:

- Water, 400 mL
- Spatula
- Hot plate (optional)
- Thermometer
- Beaker, 200-mL, 3

Number of uses:

This demonstration can be performed about 10 times with the materials provided in this kit.

Class time required:

This activity will require about 5 minutes to set up and less than 5 minutes to perform each demonstration.

Overview

In this demonstration, students will observe an example of a chemiluminescence reaction. Instant light crystals and water are placed in a plastic bag, producing a blue light similar to a common glow stick. This “In the Bag” demonstration is designed to be inquiry-based for students to further understand the topics of chemiluminescence and kinetics.

Concepts

- Chemiluminescence
- Oxidation-reduction reactions
- Electron states
- Kinetics

National Science Education Standards

Grades 5–8

Content Standard B: Physical Science

- Properties and Changes of Properties in Matter
- Transfer of Energy

Content Standard E: Science and Technology

- Abilities of Technology Design
- Understanding about Science and Technology

Content Standard F: Science in Personal and Social Perspectives

- Science and Technology in Society

Content Standard G: Nature of Science

- Science as a Human Endeavor
- Nature of Science

Grades 9–12

Content Standard B: Physical Science

- Structure and Properties of Matter
- Chemical Reactions
- Interactions of Energy and Matter

Content Standard G: History and Nature of Science

- Science as a Human Endeavor

Teaching Tips



- Luminol's application as a forensics investigative tool may be interesting to students and shows a practical application. Search for more information on this subject on the Internet or in the library.

Safety

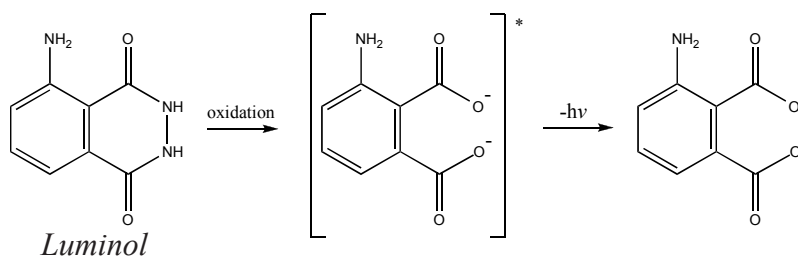


- Read all instructions thoroughly before starting the demonstration.
- Wear gloves, lab apron or lab coat, and safety goggles throughout this demonstration.
- Review the material safety data sheets (MSDS) for additional safety precautions, handling procedures, storage, and information. Visit www.scholarchemistry.com for the latest and most up-to-date MSDS.
- Instant light crystals are slightly toxic by ingestion and may be a body tissue irritant.

Background

Chemiluminescence is the release of energy in the form of light from a chemical reaction. Luminol is the organic compound responsible for the blue light produced in the reaction. In this chemical process, luminol is oxidized, and the luminescence appears as the electrons return from an excited state back to the ground state. Energy is released as excited electrons fall from a higher energy state back to a lower energy state and the energy is released in the form of visible light.

Instant light crystals are made up of luminol ($C_8H_7N_3O_2$), potassium ferricyanide ($K_3Fe(CN)_6$), and Clorox 2. The reaction is initiated by the presence of the ferricyanide ion $[Fe_3(CN)_6]^{3-}$ and Clorox 2. Clorox 2 contains the compounds sodium percarbonate ($Na_2CO_3 \cdot 1.5H_2O_2$) and sodium carbonate (Na_2CO_3). When Clorox 2 is dissolved in water, the sodium percarbonate undergoes hydrolysis to form hydrogen peroxide and sodium carbonate. The hydrogen peroxide then acts as an oxidizing agent in the chemical reaction. The luminol is oxidized and gains two electrons. The hydrogen peroxide is reduced to oxygen gas and protons. The oxidized luminol then exists in its activated state where the electrons occupy higher energy levels than the ground state. The electrons then move from the higher energy state to the ground state and a photon of blue light is released. This process is outlined below.



Luminol has many practical applications. For example, it is used at crime scene investigations to locate traces of blood. Investigators prepare a solution of luminol and spray it throughout the crime scene. The iron present in blood catalyzes the chemical reaction that leads to the luminescence of luminol, revealing the presence of the blood.

The process of chemiluminescence is also used in glow sticks, emergency lighting, and numerous analysis techniques involving organic and inorganic species. Bioluminescence, a subset of chemiluminescence, takes place in numerous living organisms. For example, the firefly produces light when ATP (adenosine triphosphate) reacts with luciferin with the aid of a catalyst luciferase. This forms an intermediate complex which then combines with oxygen to produce a highly chemiluminescent compound that is seen when the firefly lights up.

Teacher Tips



- Chemiluminescence is a very faint light. This demonstration must be performed in a dark room.
- Sprinkling a few instant light crystals on a wet paper towel will produce a chemiluminescence effect. The crystals will light up like stars.
- Light is a product and students should realize the connection between the brightness of the light and the length of time the chemiluminescence lasts.

Pre-Demonstration Preparation

- Make copies of the student data table (page 8) and pass it out to students before the demonstration begins.
- Add about 4 grams of instant light crystals to a weighing dish.
- If performing the inquiry demonstration, obtain 300 mL of water. Separate the water into three equal portions in three 200-mL beakers. Heat one beaker with the water to 60 °C, leave one beaker at room temperature, and put ice in the other beaker.

Procedure

Noninquiry Demonstration

1. Direct students to fill in the data table as the demonstration takes place.
2. Add 100 mL of water to a plastic bag.
3. Turn off the lights to make the room as dark as possible. The shades on the windows should also be drawn.
4. Add about 4 grams of the dry powder mixture to the plastic bag and knead the bag to dissolve the powders.
5. A blue light will be produced in the bag.

See the next page for the Inquiry Demonstration procedure.

Teacher Tips



- Inquiry Demonstration:
If students are struggling to suggest further experiments to perform, ask them how to make the chemiluminescence brighter or dimmer. Then try and get them to suggest how to make that happen.
- Inquiry Demonstration:
This section can be performed without asking questions of the students; however, it is designed for students to supply the experiments, as this is an inquiry-based demonstration.

Inquiry Demonstration

1. Direct students to fill in the data table (page 8) as the demonstration takes place. Do not hand out the questions and analysis worksheet (page 9) yet.
2. Demonstrate the reaction in steps 1-5 in the noninquiry demonstration.
3. Challenge students to develop suggestions or hypotheses to:
 - a) make the light brighter
or
 - b) make the light last longer.
4. Ask students to identify some possible variables and hypothesize what will happen if these variables are increased or decreased. Have students record these variables in the data table.

If the students are unable to come up with ideas for variables, offer a few suggestions, such as:

- Increasing or decreasing the temperature of the water.
 - Increasing or decreasing the amount of water added.
 - Increasing or decreasing the amount of instant light crystals added.
5. Perform the experiments described by the students, and have them record their results in the data table.
 6. Have students complete the questions and analysis worksheet.

The steps below describe a typical procedure that could be used if the temperature of the water was changed.

1. Label three plastic bags, one “hot”, one “room temperature”, and one “cold”.
2. Add 100 mL of the hot water to the plastic bag labeled “hot,” 100 mL of room temperature water to the “room temperature” bag, and 100 mL of the cold water to the “cold” bag.
3. Ask for two volunteers to help with the addition of the dry powder to the plastic bags. Make sure these students are wearing the necessary safety equipment.
4. Turn off the lights to make the room as dark as possible. The shades on the windows should also be drawn.
5. Add about 4 grams of the dry powder mixture to each plastic bag simultaneously and knead the bags to dissolve the powders.
6. A blue light will be produced in each bag. The length of time that the blue light lasts, based on the temperature of water, should be noted.

Disposal

Review local regulations or consult with local authorities before disposing of any chemicals in the trash or down the drain. The following are suggested disposal procedures:

- Wash the solutions down the drain with running water.
- Keep all leftover reagents in a locked chemical storeroom.

Addressing Misconceptions and Misunderstandings

- The terms chemiluminescence, fluorescence, and phosphorescence are all easily confused by students. In all of these processes, light is produced from chemicals; however this is the only common trait that these processes share. In fluorescence, the energy from an external source of light is absorbed and almost immediately re-emitted. Fluorescence cannot be seen in the dark though, due to the fact that the emitted light is only visible when the stimulating light is turned on. In phosphorescence, the excited product is more stable than the ground state product, so the time until the energy is released is much longer. The “glow” in phosphorescence is seen after the light is removed.

Extension Ideas

- Have students design experiments to try and produce other colors besides blue. They will need to use the Internet or a textbook to find other compounds that luminesce, or they will need to design a different procedure to produce the same effect.
- Have students research the practical applications of luminol in forensics. They should find that luminol is the most common chemical used to locate traces of blood at a crime scene.

Instant Light in the Bag Inquiry Student Worksheet– ANSWER KEY

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Data Table

Experiment	Variables			Description of the Luminescence occurring	Length of the Luminescence	Any other Observations
	<i>Amount of Instant Light Crystals Used (g)</i>	<i>Amount of Water Added (mL)</i>	<i>Approximate Temperature of the Water (°C)</i>			
1	4	100	0	<i>Faint Blue</i>	<i>Longest</i>	
2	4	100	25	<i>Medium Blue</i>	<i>Medium</i>	
3	4	100	60	<i>Bright Blue</i>	<i>Shortest</i>	
4						
5						
6						
7						
8						

Instant Light in the Bag Inquiry Student Worksheet– ANSWER KEY

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Questions and Analysis

1. Describe this demonstration in your own words. What was occurring?

In this demonstration, crystals were added to a solution of water, and a blue, glowing light was formed. In the inquiry part of the demonstration, the amount of crystals that were added was increased and the light was brighter.

2. Name three variables that can be changed in this demonstration.

- *Amount of water added*
- *Amount of crystals added*
- *Temperature of water used*

3. Why might the temperature of water have an effect on the length of the luminescence?

Students' answers may vary. However, one possible explanation is that if cold water is used, the water molecules are moving more slowly than in the hot water and this in turn causes the chemiluminescence to last longer with cold water than with hot water. Almost all reactions occur faster at high temperatures. The rate of reaction in this demonstration is greatly increased with heat.

4. Is light a product or a reactant in this chemical process? How is this known?

Light is a product in this reaction because it is produced by the reaction. Light is not necessary for the reaction to occur.

5. If light is formed in a reaction, what must be occurring? Circle True or False.

- | | | |
|---------------------------------|---------------------------------------|--|
| • Electrons are being excited | <input checked="" type="radio"/> True | <input type="radio"/> False |
| • The nucleus is breaking apart | <input type="radio"/> True | <input checked="" type="radio"/> False |
| • Energy is being produced | <input checked="" type="radio"/> True | <input type="radio"/> False |

6. What is chemiluminescence? Give an example of another chemiluminescence process.

Chemiluminescence is the release of energy in the form of light from a chemical reaction. Other examples of chemiluminescent processes are glowsticks and fireflies. The lighting of fireflies is in actuality considered bioluminescence, but bioluminescence is a subset of chemiluminescence.

Instant Light in the Bag Inquiry Student Worksheet**Data Table**

Experiment	Variables			Description of the Luminescence occurring	Length of the Luminescence	Any other Observations
	1	2	3			
1						
2						
3						
4						
5						
6						
7						
8						

