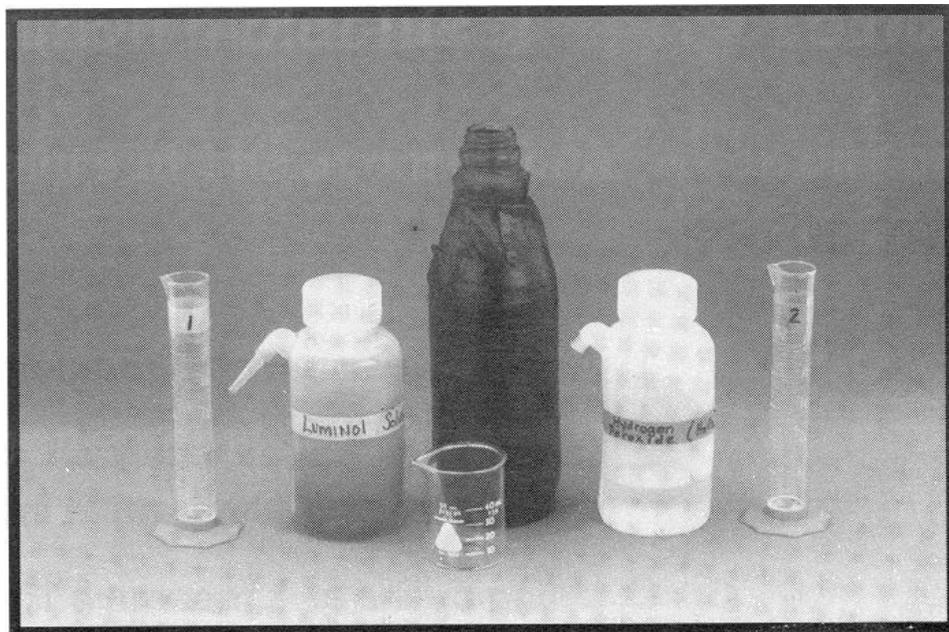




EXPERIMENT See the Light

Visitors mix a solution of luminol with hydrogen peroxide to produce a reaction that gives off blue light.



OBJECTIVES:

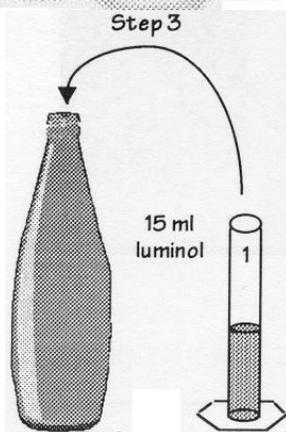
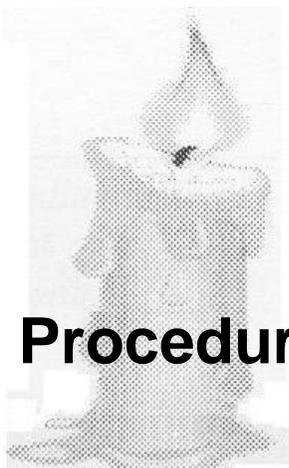
Visitors learn that some chemical reactions release energy in the form of light, and that this process is called chemiluminescence.

SCIENCE TOPICS	PROCESS SKILLS	VOCABULARY
Chemical Reactions	Observing	Chemical Bond
Chemical Bonds	Measuring	Chemical Reaction
Properties of Electrons	Investigating	Electron
Light	Controlling Variables	Energy
Chemiluminescence		Solution



See the Light

Procedure:



1. Always wear safety goggles.
2. Rinse the beaker, the two graduated cylinders, and the bottle in the sink.
3. Using cylinder 1, measure 15 ml luminol solution. Carefully pour it into the dark bottle. Look into the bottle:

Does the luminol glow in the bottle?

4. Using cylinder 2, measure 10 ml hydrogen peroxide (H_2O_2) solution. Carefully pour it into the dark bottle. Look into the bottle:

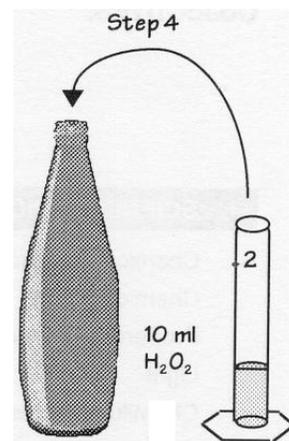
Is there light in the bottle?

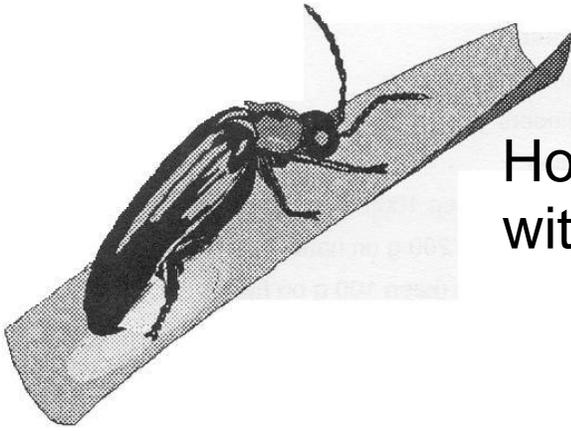
What color is the light'?

5. Carefully pour the contents of the bottle into the beaker.

Is the solution the same color as the glow in the bottle?

6. Empty the beaker into the sink. Rinse the beaker, the two cylinders, and the bottle in the sink.





How do you make light without electricity or fire?

A Closer Look:

Energy may be stored (for example, in food) in the chemical bonds that hold molecules together. When bonds break, energy may be released as heat or light.

When energy is added to a chemical, electrons (tiny charged particles) can become “excited” (move to a higher energy level). Light is given off when the electrons return to their natural “unexcited” level.

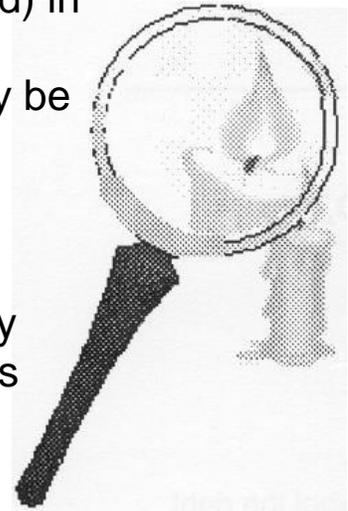
This light is called chemical light, or

(kəm' ə lōō' mə nes' əns)

chemiluminescence .

The reaction of luminol with hydrogen peroxide (H_2O_2) releases energy in the form of chemiluminescence.

Examples in nature include the night glow of sea animals or the yellow-green glow of a firefly. You also see chemiluminescence in commercial “light” sticks. All are “cool” (heatless) sources of light.



MATERIALS

See *Materials Prep*
for more details

(with amounts to have on hand)

- One small dark opaque bottle
- Two 10-ml graduated cylinders
- Two 250-ml squeeze bottles
- NaHCO_3 (sodium bicarbonate) (keep 1000 g on hand)
- Na_2CO_3 (sodium carbonate) (keep 200 g on hand)
- $(\text{NH}_4)_2\text{CO}_3$ (ammonium carbonate) (keep 100 g on hand)
- $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (copper sulfate) (keep 100 g on hand)
- $\text{C}_8\text{H}_7\text{N}_3\text{O}_2$ (luminol (3-aminophthalhydrazide)) (keep 25 g on hand)
- 6 500-ml brown plastic bottles
- One 1000-ml brown plastic bottle
- One 1 liter plastic bottle
- 3% H_2O_2 (hydrogen peroxide) (1 liter)
— OR — 30% H_2O_2 (100 ml)
- Black tape
- One 50-ml glass beaker

Setup/Takedown Procedures**ORIGINAL SETUP**

- Label the small bottle with “bottle” in white.
- Label the 10-ml graduated cylinders “1” in green and “2” in orange.
- Label the 250-ml squeeze bottles “ H_2O_2 (Hydrogen Peroxide)” in orange and “ $\text{C}_8\text{H}_7\text{N}_3\text{O}_2$ (Luminol)” in green.
- Label the 1000-ml brown bottle “Luminol.” in green
- Label the 1 liter plastic bottle “0.15% H_2O_2 hydrogen peroxide” in orange.

WEEKLY SETUP

- Prepare fresh luminol solution; STORE IN REFRIGERATOR (see Materials Prep).
- Prepare fresh 0.15% H_2O_2 (hydrogen peroxide) solution; STORE IN REFRIGERATOR (see Materials Prep).

DAILY SETUP

- Set out the visitor instructions in a Plexiglas stand.
- On a tray, set out the following:

- small bottle wrapped in black tape
 - Two labeled graduated cylinders
 - Labeled $C_8H_7N_3O_2$ (luminol) squirt bottle (from refrigerator)
 -
 - Labeled 0.15% H_2O_2 (hydrogen peroxide) squirt bottle (from refrigerator)
 - One 50-ml glass beaker
- Test the chemicals by following the experiment instructions once. If the light reaction is absent, is too brief, or takes too long to occur, the hydrogen peroxide probably needs to be replenished from stock. If it still does not work, prepare fresh 0.15% H_2O_2 (hydrogen peroxide) (see Materials Prep).
- Refill the luminol and hydrogen peroxide squirt bottles with solutions from stock bottles.

DAILY TAKEDOWN

- Rinse graduated cylinders, beaker, and bottle.
- Return all equipment to tub.
- RETURN LUMINOL AND HYDROGEN PEROXIDE TO REFRIGERATOR.



RUNNING SUGGESTIONS

- ◇ $C_8H_7N_3O_2$ (luminol) and H_2O_2 (hydrogen peroxide) solutions react with daylight and air; therefore:
- Store them in opaque bottles,
 - REFRIGERATE them, and
 - Set out small amounts at a time.
- ◇ Luminol solution should be a medium blue color; if not, discard it and refill with fresher stock.
- ◇ When H_2O_2 (Hydrogen peroxide) is added to luminol, it should produce a bright blue glow lasting several seconds; if not, discard it and refill with fresher stock.
- ◇ Visitors should look in the bottle right after the second chemical is added.
- ◇ The chemicals may react too quickly if the opaque bottle is not clean.



EXTENSIONS

Examples of similar chemiluminescent reactions:

- Glow sticks
- Fireflies

SAFETY & DISPOSAL



Copper sulfate, ammonium carbonate, luminol, and hydrogen peroxide are hazardous substances; follow handling and disposal instructions in Materials Prep.

Consult Material Safety Data Sheets (MSDS) for additional information.

MATERIALS PREP

To prepare luminol solution:

- Dilute 500 ml stock solution to 1 liter with H₂O (water)

To prepare luminol **stock** solution:

- CAUTION: Avoid breathing copper sulfate, ammonium carbonate, or luminol dust.**
- To an appropriately sized beaker, add about 80% of the desired final volume of water.
- Add ingredients according to the chart below:

	500 mL	1 liter	2 liters	2 liters*	3 liters
NaHCO ₃ (sodium bicarbonate)	24g	48g	96g	108.7g	144g
Na ₂ CO ₃ (sodium carbonate)	4g	8g	18.7g	6.0g NaOH	28g
(NH ₄) ₂ CO ₃ (ammonium carbonate)	0.5g	1g	2g	2g	3g
CuSO ₄ • 5H ₂ O (copper sulfate)	0.4g	0.8g	1.6g	1.6g	2.4g
C ₈ H ₇ N ₃ O ₂ (luminol (3-aminophthalhydrazide))	0.2g	0.4g	0.8g	0.8g	1.2g

- Use a stir bar and stir plate to mix the items well. The luminol may take a while to dissolve. Low heating can help the luminol dissolve more quickly. Add water to the beaker to the desired final volume.
- Fill 500-ml brown bottle(s); label the bottle "Stock Luminol Solution" in green with your initials and date.
- Note: you will need to dilute 500 ml stock solution with 500 ml dH₂O (deionized water) to make 1000 ml luminol solution for the experiment.

To prepare 0.15% H₂O₂ (hydrogen peroxide):

- Add 50 ml of 3% H₂O₂ to 950 ml H₂O (water) (to prepare 3% H₂O₂ see instructions below).

To prepare 3% H₂O₂ (hydrogen peroxide):



CAUTION: 30% hydrogen peroxide is a strong oxidizer. Handle with care. Wear protective eyewear, gloves, and apron. Use only in the fume hood. Avoid contact with skin and clothing. If contact occurs, wash affected area with copious amounts of water.

-
- Wear protective eyewear, chemical safety gloves, and apron or lab jacket.
- In the fume hood, measure 25 ml 30% H₂O₂.
- Add H₂O (water) to a final volume of 250mL.
- Store in a labeled/dated, 250-ml plastic squeeze bottle
IN REFRIGERATOR.

