Cool Light

An Enlightening Demonstration

Introduction

One of the most well-known examples of chemiluminescence is that of luminol. This demonstration features chemiluminescence of luminol through oxidation by hydrogen peroxide.

Concepts

- Chemiluminescence
- Oxidation–reduction
- Catalyst

Materials

Luminol, $C_8H_7N_3O_2$, 0.1 g
Sodium hydroxide solution, 5%, NaOH, 50 mL
Potassium ferricyanide, $K_3Fe(CN)_6$, 0.7 g
Hydrogen peroxide, 3%, H_2O_2, 15 mL
Water, distilled or deionized, 2000 mL
Beakers, 1-L, 2
Erlenmeyer flask, 2-L
Funnel, large
Graduated cylinder, 50-mL
Ring stand and ring

Safety Precautions

Hydrogen peroxide is an oxidizer and skin and eye irritant. Sodium hydroxide solution is corrosive, very dangerous to eyes, and skin burns are possible. Much heat is evolved when sodium hydroxide is added to water. If heated to decomposition or in contact with concentrated acids, potassium ferricyanide may evolve poisonous hydrogen cyanide fumes. Wear chemical splash goggles, chemical-resistant gloves, and a chemical-resistant apron. Please review current Material Safety Data Sheets for additional safety, handling, and disposal information.

Preparation

1. Prepare a 5% solution of sodium hydroxide solution by dissolving 5 g of sodium hydroxide pellets in approximately 90 mL of distilled or deionized (DI) water. Once dissolved, dilute the solution to a final volume of 100 mL with DI water.
2. Prepare Solution A by adding 0.1 g of luminol and 50 mL of 5% sodium hydroxide solution to approximately 800 mL of DI water. Stir to dissolve the luminol. Once dissolved, dilute this solution to a final volume of 1000 mL with DI water.
3. Prepare Solution B by adding 0.7 g of potassium ferricyanide and 15 mL of 3% hydrogen peroxide to approximately 800 mL of DI water. Stir to dissolve the potassium ferricyanide. Once dissolved, dilute this solution to a final volume of 1000 mL with DI water.
4. Set up the demonstration equipment as shown in Figure 1.

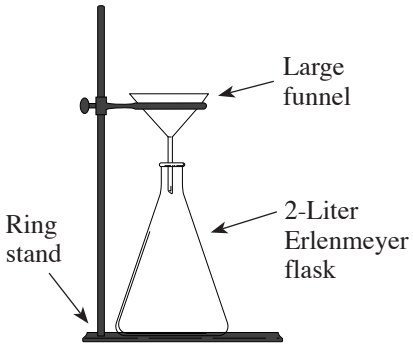

Figure 1.

Procedure

1. Completely darken the classroom.
2. Pour Solution A and Solution B into the large funnel simultaneously. As soon as the two solutions are mixed, light from the chemiluminescence is emitted.
3. Enhance the reaction as it progresses by adding small amounts of potassium ferricyanide and 5–10 mL of 5% sodium hydroxide solution to the flask.

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Disposal

Please consult your current *Flinn Scientific Catalog/Reference Manual* for general guidelines and specific procedures governing the disposal of laboratory waste. Flush the resulting solution down the drain according to Flinn Suggested Disposal Method #26b.

Connecting to the National Standards

This laboratory activity relates to the following National Science Education Standards (1996):

Unifying Concepts and Processes: Grades K–12
Evidence, models, and explanation
Constancy, change, and measurement

Content Standards: Grades 5–8
Content Standard B: Physical Science, properties and changes of properties in matter, motions and forces, transfer of energy

Content Standards: Grades 9–12
Content Standard B: Physical Science, structure and properties of matter, chemical reactions, interactions of energy and matter

Tips

- Pour the two solutions into a "Cool Light Spiral Apparatus" to increase the surface area over which light is emitted and increase the visual impact! To make your own "Cool Light Spiral Apparatus", attach a small piece of plastic tubing, a glass elbow, and a long piece of plastic tubing to the funnel stem (see Figure 2). Insert this setup into a long, Plexiglas® tube. Drill a hole in the Plexiglas tube just below the height of the glass elbow connected to the funnel stem. Thread the long plastic tubing through this hole from the inside out. Wind the tubing around the Plexiglas tube. Drill a hole in the Plexiglas tube about 1″ above the height of the collecting vessel. Feed the coiled tubing through the hole and attach it to another glass elbow and a small piece of plastic tubing. If the tubing does not stay tightly coiled, a small amount of quick-drying glue can be used to keep it in place. Insert the plastic tubing into the collecting vessel. If the spiral you build is tall, we recommend that some sort of support stand is used or that it is attached to a ring stand for stability and safety.
- Place Solution A and Solution B into separate spray bottles and spray the two solutions at each other. A luminescent cloud is the result. The key to this procedure is to get the solutions into as fine a mist as possible. *Caution:* Do not spray the solutions toward anyone, or in a manner in which they can be easily inhaled.

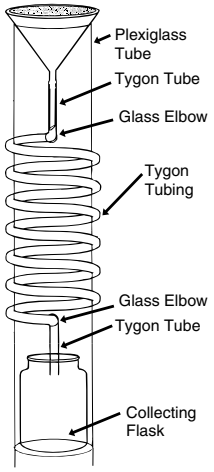
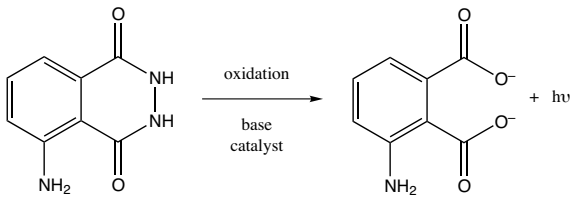


Figure 2.

- Use only distilled or deionized water when preparing the solutions. Hard water and softened water contain high con centrations of ions (such as chloride ions) that may interfere with the excited state of the luminol and prevent chemiluminescence.

Discussion



I **II**

Chemiluminescence is the emission of light as a result of chemical reaction. Out of a wide variety of "cool" light demonstrations—demonstrations where little or no heat is produced—the use of luminol (3-amino-phthalhydrazide) is one of the most popular. Numerous procedures have been developed that produce light using luminol. For luminol to chemilunesce, an oxidizing agent, an alkaline pH, and some type of catalyst (such as copper or iron compounds) are required. In this demonstration, sodium hydroxide provides the basic environment, hydrogen peroxide is the oxidizing agent, and potassium ferricyanide serves as the catalyst. In the reaction, luminol (I) is converted to an aminophthalate ion (II). The aminophthalate ion is first produced in an excited state. The excited state then relaxes back down to its ground state through chemiluminesence, emitting a photon in the visible region of the spectrum (λ = 425 nm) in the process. We see the emitted photons as the glowing blue light that is produced-when the two solutions are mixed.

References

Harvey, E. N., *A History of Luminescence.* The American Philosophical Society: Philadelphia, PA, 1957; p 5.

Huntress, E. H.; Stanley, L. N.; Parker, A. S., *J. Chem. Educ.*, 1934, 11, 145.

Shakhashiri, B. Z. *Chemical Demonstrations: A Handbook for Teachers of Chemistry, Vol. 1;* **University of Wisconsin: Madison, 1985; pp 156–167.**

Materials for *Cool Light* are available from Flinn Scientific, Inc.

Catalog No.	Description
L0078	Luminol, 5 g
S0074	Sodium hydroxide, 100 g
P0050	Potassium ferricyanide, 100 g
H0009	Hydrogen peroxide, 3%, 500 mL

Consult your *Flinn Scientific Catalog/Reference Manual* for current prices.