

## Chemiluminescence with Luminol

**Description:** Several reactions are given which demonstrate chemiluminescent reactions with luminol.

### Demonstration A

#### Materials:

Luminol	3% H <sub>2</sub> O <sub>2</sub>
Na <sub>2</sub> CO <sub>3</sub>	Deionized water
NaHCO <sub>3</sub>	Spiral glass tube (Dab 125)
(NH <sub>4</sub> ) <sub>2</sub> CO <sub>3</sub> or (NH <sub>4</sub> )HCO <sub>3</sub>	Erlenmeyer flask
CuSO <sub>4</sub> •5H <sub>2</sub> O	Large funnel

#### Procedure:

Perform this demonstration in a dark lecture hall. Typically, this reaction is performed on a large scale.

1. Make fresh solutions to guarantee longer periods of luminescence. Solution A: Dissolve 0.2 g luminol, 4.0 g Na<sub>2</sub>CO<sub>3</sub>, 24.0 g NaHCO<sub>3</sub>, 0.5 g (NH<sub>4</sub>)<sub>2</sub>CO<sub>3</sub>, and 0.4 g CuSO<sub>4</sub>•5H<sub>2</sub>O in a final volume of 1 L; Solution B: dilute 50 mL of 3% H<sub>2</sub>O<sub>2</sub> in 950 mL water (1 L total).
2. Setup spiral glass tubing and flask as shown in the diagram below. Pour both solutions slowly *and* simultaneously down the spiral tube. Once the solutions are contained in the flask, the solution should continue to glow for approximately two minutes.

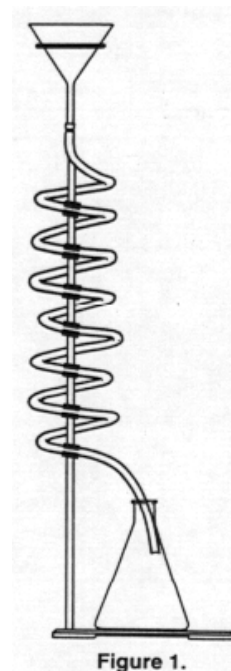


Figure 1.

**Demonstration B**

**Materials:**

Luminol	Beaker or RB flask
Bleach	Deionized water
1 M NaOH	

**Procedure:**

Perform this demonstration in a dark lecture hall.

1. Make fresh solutions to guarantee longer periods of luminescence. Solution A: Dissolve 0.05 g luminol in 100 mL of 1 M NaOH; Solution B: 0.5% NaClO (9 mL of commercial bleach in 91 mL water).
2. Chill both solutions in an ice bath. Darken the room and slowly pour the two solutions together. When mixed, the solutions will produce a blue glow. When the lights are turned back on, the solution is observed to be a yellow/green color.

**Demonstration C**

**Materials:**

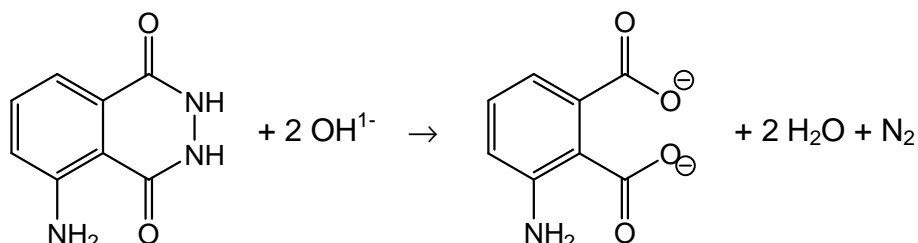
Luminol	2L flask or grad. cylinder
$K_3Fe(CN)_6$	Stir plate/stir bar
1 M NaOH	Deionized water
3% $H_2O_2$	

**Procedure:**

Perform this demonstration in a dark lecture hall.

1. Make fresh solutions to guarantee longer periods of luminescence. Solution A: Dissolve 0.1 g luminol in 5 mL of 1 M NaOH and dilute to 1 L; Solution B: Dissolve 0.25 g  $K_3Fe(CN)_6$  and 10 mL of 3%  $H_2O_2$  in water and dilute to 1 L.
2. Turn the lights in the lecture hall out. Mix solutions A and B together in a 2 L flask or 2 L grad. cylinder with vigorous stirring. Alternatively, prepare solution A, add 10 mL of 3%  $H_2O_2$  to solution A and place this mixture on a stir plate with vigorous stirring. Sprinkle solid  $K_3Fe(CN)_6$  on the surface.

**Discussion:** The blue emission of luminol (3-aminophthalhydrazide) is easily observed in chemiluminescent reactions. In the listed demonstrations, the chemiluminescent reactions of luminol are oxidations occurring under basic conditions as shown in the general equation below:



In these reactions, the blue emitting species has been identified as the aminophthalate ion shown in the above equation. Transition metal complexes, such as the hexacyanoferrate ion (Demo C), are used to catalyze the decomposition of  $\text{H}_2\text{O}_2$ . Decomposition generates the superoxide radical anion ( $\text{O}_2^-$ ) which is responsible for the oxidation of luminol. Sensitizers can also be added to emit different colors of light (fluorescein – yellow; rhodamine B – purple).

**Safety:** Wear proper protective equipment including gloves and safety glasses when preparing and performing this demonstration.

**Disposal:** Rinse any containers thoroughly with water and place used solutions in an appropriate waste container.

#### References:

Shakhashiri, B. Z. In *Chemical Demonstrations: A Handbook for Teachers of Chemistry*, The University of Wisconsin Press: 1985; Vol. 2, p 156-167.

O'Hara, P. B.; St. Peter, W.; Engelson, C. *J. Chem. Educ.* **2005**, *82*, 49.

Prypsztejn, H. E.; Stratton, D. *J. Chem. Educ.* **2005**, *82*, 53.

Tokumar, K.; Coyle, J. D. *Pure & Appl. Chem.* **1992**, *64*, 1343.

#### Video:

<http://www.youtube.com/watch?v=yZOvbho4Hil>

<http://www.youtube.com/watch?v=i3Pd-iK1Rk8>

<http://www.youtube.com/watch?v=oTJ9bJlfjEs>