

D5: Blue Glow

A colourless liquid and a blue liquid when mixed together emit a blue chemiluminescent glow. Light sticks are devices that produce a 'coolight' by means of a similar chemical reaction.

- Preparation time 30 minutes
- Demonstration time less than five minutes



HARMFUL
copper sulphate

Requirements

4 g sodium carbonate (anhydrous), Na_2CO_3
 3 litres of distilled water
 0.2 g luminol (3-aminophthalhydrazide), $\text{C}_8\text{H}_7\text{O}_2\text{N}_3$
 24 g sodium hydrogencarbonate NaHCO_3
 0.5 g ammonium carbonate monohydrate, $(\text{NH}_4)_2\text{CO}_3 \cdot \text{H}_2\text{O}$
 0.4 g copper(II) sulphate pentahydrate, $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ (**harmful**)
 50 cm³ 10 vol. hydrogen peroxide, H_2O_2
 2 x 1 litre flasks
 3 litre conical flasks or round bottomed flask with rubber stoppers
 glass funnel (15-20 cm in diameter)
 ring stand and glass spiral or transparent tubing (see diagram)

Method

Solution A

Dissolve 4.0 g of sodium carbonate in 500 cm³ of distilled water. Add 0.2 g of luminol and stir to dissolve. Add 24 g of sodium hydrogencarbonate, 0.5 g of ammonium carbonate and 0.4 g of copper sulphate. Stir until all the solid dissolves. Dilute to a final volume of 1 litre with distilled water. The pH of this solution will be around 9.

Note: this solution must not be made more than 10 minutes in advance of the demonstration.

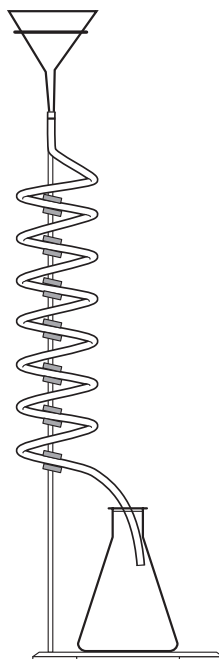
Solution B

Dilute 50 cm³ of 10 vol. hydrogen peroxide to 1 litre with distilled water.

Set up a funnel and spiral apparatus either using a glass spiral or transparent tubing coiled around a set of clamps. See diagram on page 92.

Demonstration

- 1 Dim the lights but allow sufficient light to see what you are doing! Slowly pour solution A and B simultaneously into the funnel. A strong blue glow will be observed.
- 2 Continue pouring until both flasks are empty. The glowing liquid runs through the spiral and collects in the 3 litre conical flask. The solution will continue to glow for approximately 2 minutes after it first exits the spiral.
- 3 Flush out the coil with water as soon as possible, before disconnecting the apparatus.

D5: Blue Glow (contd)**Alternative procedure**

Wear gloves and soak a piece of cotton fabric in about 100 cm³ of solution A. In the dark, immerse the piece of cotton in about 100 cm³ of solution B and wring out the cotton. The cotton will glow and 'drip fire'.

Extension

Using light sticks to demonstrate how the rate of chemical reaction varies with temperature.

A lightstick consists of dilute hydrogen peroxide solution in a phthalic ester solvent contained in a thin glass ampoule which is surrounded by a solution containing a phenyl oxalate ester and the fluorescent dye 9, 10-bis(phenylethynyl) anthracene all contained in a plastic tubular container.

When the glass ampoule is broken, by bending the light stick, the hydrogen peroxide and the phenyl oxalate ester react to form phenol and some intermediate (short lived) compounds. During the reaction, the energy given off is transferred to the dye molecules. The excited dye molecules give off the excess energy in the form of light without any noticeable heat. Thus the name 'coolight'.

- 1 Prepare three beakers with water at different temperatures: ice water, hot tap water (not boiling) and room temperature.
- 2 Initiate three light sticks. Place one light stick in ice water, one in hot tap water and leave one at room temperature as a control.
- 3 How quickly does the reaction take place?
For how long does the light stick emit light?
What are the best conditions for extending the time the light stick emits light?