Chemiluminescence (cool light)

Introduction

Many chemical reactions, such as a candle burning, produce both light and heat.

It is rare for a chemical reaction to produce light without heat. A 'cool light' such as this can come from chemiluminescent reactions. A special, and perhaps familiar type of chemiluminescent reaction, which occurs in living organisms such as fireflies, is called bioluminescence.

The following chemiluminescent reaction uses luminol (3-amino-phthalhydrazide) solution and gives a blue glow that will last for several minutes. Luminol can be purchased from various suppliers (see below). Although it may appear expensive, only tiny quantities are required for each demonstration.

Chemicals

luminol
sodium hydroxide solution, 1.25M
hydrogen peroxide solution, 10 vol.
potassium hexacyanoferrate(III)
deionised or distilled water

Equipment

beakers, 2 x 250 cm^3
measuring cylinder, 250 cm^3
conical flask, 250 cm^3
filter funnel, glass
tubing, clear plastic (2 metres of silicon tubing of int. diameter 5 mm)
- The use of odd shaped vessels and curly tubes adds to the fun and interest. Ensure the plastic tube will drain any solution into the large flask without airlocks.

bottle, 2 litre plastic drinks
retort stand, bosshead & clamp

Preparation

To be carried out in the light

Dissolve 0.02 g of luminol in a little 1.25M aqueous sodium hydroxide CORROSIVE) solution and then dilute to 200 cm^3 with deionised or distilled water. This solution should be freshly prepared each time.

Prepare 3 x 0.45 g portions of potassium hexacyanoferrate(III) pre-weighed in small containers. This will give you enough for three tries.

Measure 180 cm^3 of the luminol solution into a 250 cm^3 beaker and 18 cm^3 of the 10 volume hydrogen peroxide solution into a second beaker. Add the potassium hexacyanoferrate(III) to the hydrogen peroxide in the second beaker and stir until dissolved.

Figure 1 *The expensive hi-tech (not!) apparatus. Blue dye illustrates the path the chemicals take*

To be carried out in the dark

Allow some minutes for the eyes to become adjusted and the pupils widened.

Slowly pour the luminol and the hydrogen peroxide/potassium hexacyanoferrate(III) mixture into the filter funnel simultaneously. They will react to give a blue glow that spirals down the tubing into the collecting flask.

Suppliers of luminol - Scientific & Chemical Supplies (1 g, LU005, £6.33), Griffin (1 g, A/3150/43, £9.53), (5 g, A/3150/44, £30.66) and Philip Harris (5 g, B6A68925, £33.43)

Disposal - Dilute the products of the reaction with copious amounts of water and flush to waste.

Chemicals, Hazards & Control Measures
Luminol powder **Hazards** May be harmful by inhalation, ingestion or skin absorption. May cause irritation. Avoid contact with eyes. **Control Measures** Avoid raising dust. Wear gloves and indirect vent goggles.
Hydrogen peroxide **Hazards** At 10 volume the solution still has the potential to irritate the skin, eyes & respiratory system. If preparing from higher concentrations of solution (e.g. 100 volume), the solution and vapour is corrosive, causing burns to eyes, lungs, mouth and skin. 20 to 50 volume is classed as irritant. **Control Measures** When using 100 volume hydrogen peroxide wear nitrile gloves and indirect vent goggles.
Sodium hydroxide **Hazards** Concentrated sodium hydroxide solution and solid are strongly corrosive. Very harmful if swallowed. Extremely dangerous to eyes. **Control Measures** For solutions of 0.5M and above wear indirect vent goggles and gloves.
Potassium hexacyanoferrate(III)-3-water **Hazards** Dangerous if heated or in contact with concentrated acids since it emits very toxic fumes of hydrogen cyanide and even with dilute acids if heated. Low oral toxicity since the cyano groupings are firmly bound. Irritating to eyes and skin. Dangerous if heated to decomposition. **Control Measures** Use eye protection and wear rubber or plastic gloves.

Table 1 *Chemicals, Hazards and Control Measures*