

D1: Zinc Christmas Tree

● Preparation and demonstration time 30 minutes

Requirements

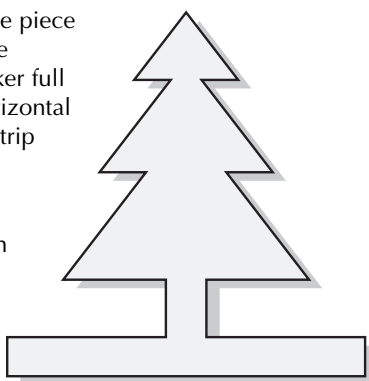
sheet of zinc foil (7 cm x 7 cm)
 shears or metal cutters suitable for cutting foil
 100 cm³ glass beaker
 150 cm³ lead nitrate solution (0.5 mol dm⁻³) (**toxic solid and solution**)



TOXIC
lead nitrate

Method

- 1 Cut out the shape of a Christmas tree from the piece of foil. The tree should be small enough to be submerged when standing in a 100 cm³ beaker full of solution. At the base of the trunk cut a horizontal strip (perpendicular to the trunk). Curve the strip so that the tree stands up in the beaker.
- 2 Stand the tree in the empty beaker.
- 3 Carefully pour in enough lead nitrate solution to cover the tree. Leave undisturbed.
- 4 Within a few minutes the tree becomes covered with sparkling crystals of lead. For the best results leave for about 20 minutes.



Safety advice

This activity is for younger pupils, but should be carried out by the teacher because lead nitrate is toxic at this concentration.

Beware of the sharp edges of the cut foil.

Chemical background

Zinc displaces lead from the solution because it is higher than lead in the reactivity series. The lead forms beautiful crystals.

D2: Electrolysis of Red Cabbage Water

- Preparation time 30 minutes
- Demonstration time 30 minutes



TOXIC
chlorine

Requirements

Universal indicator	filter funnel
shredded red cabbage (about 30 g)	filter paper
salt (sodium chloride)	ring clamp for filter funnel
250 cm ³ glass beaker	U-tube (calcium chloride absorption tube 130mm high and 15mm bore or similar)
150 cm ³ glass beaker	2 carbon electrodes
large spatula	variable dc power pack capable of supplying a current of at least 1 A at 12V
Bunsen burner	connecting leads and crocodile clips
tripod	clamp
gauze	clamp stand
heat proof mat	

Method

- 1 Put about 30 g shredded red cabbage into the 250 cm³ beaker, so that it is about one third full. Add tap water so that the cabbage is covered.
- 2 Boil the mixture to extract the juice from the red cabbage.
- 3 Allow to cool to room temperature.
- 4 Filter, collecting the filtrate in the small beaker.
- 5 Pour some of the filtered juice into the U-tube and add two large spatulas of salt.
- 6 Clip a crocodile clip onto one end of a carbon electrode and put the other end into the red cabbage juice in the U-tube. Use the crocodile clip to support the carbon rod by balancing it across the opening in the U-tube.
- 7 Repeat with the other electrode.
- 8 Connect the power pack, using about 10 volts.
- 9 After about 10 minutes the juice should start to change colour, giving three separate bands of red, blue and green.

Safety advice

Chlorine (**toxic**) will be produced. Take care not to breathe this. Do not run the electrolysis for longer than necessary to achieve the result. Be particularly aware of the sensitivity of asthmatic pupils.

Extension

Add Universal indicator to 100 cm³ potassium iodide solution (0.1 mol dm⁻³). Using the same apparatus try the experiment with this solution instead of the red cabbage juice.

D3: The Non-burning £5 Note

- Preparation time 10 minutes
- Demonstration time 5 minutes

Requirements

Bunsen burner	eye protection
pair of tongs	fire extinguisher
heat proof mat	
3 x 250 cm ³ beakers	
paper	
bowl of water	
£5 note (optional)	
75 cm ³ ethanol (highly flammable)	
a few grams of sodium chloride	

Method

- 1 Prepare some pieces of paper about the size of a £5 note.
- 2 Prepare three beakers: one containing about 50 cm³ water, the second containing 50 cm³ ethanol and the third containing a mixture of 25 cm³ of water mixed with 25 cm³ ethanol with a little sodium chloride dissolved in it.
N.B. For the demonstration, have a bowl of water ready to put burning paper into if necessary.
- 3 Soak a piece of paper in water and try to ignite it by holding it with tongs in a yellow Bunsen flame. It will not ignite.
- 4 Soak a second piece of paper in ethanol and repeat. This will ignite easily - you will only need to hold the paper in the flame very briefly. The alcohol will burn and ignite the paper, which will burn away.
- 5 Soak a third piece of paper in the alcohol-water mixture and hold it briefly in the Bunsen flame. This time the alcohol will ignite and burn away, but the paper will not. Optional: repeat with a £5 note.

Safety advice

Eye protection for teacher **and** pupils must be worn. A fire extinguisher should be readily available, but a heat proof mat or damp cloth is likely to be effective.

Chemical background

The water in the alcohol-water mixture evaporates, which keeps the temperature below the ignition temperature of the paper (approximately 230°C). The paper will still be wet with water after the alcohol has burned away. The alcohol-water flame is almost invisible, but by adding sodium chloride it looks like a normal yellow flame.

Reference

Adapted from a demonstration in *Classic Chemistry Demonstrations*, RSC, 1995.



eye protection
must be worn



**HIGHLY
FLAMMABLE**
ethanol

D4: Gas Explosion

The gas used in laboratory Bunsen burners (methane) normally burns with a blue or yellow flame. However, mixtures with air explode when the concentration of the methane is between 5 and 15%. The following is a way of demonstrating the explosive route.



eye protection
must be worn

● Preparation and demonstration time 5 minutes

Requirements

Bunsen burner
Pringles tube (tall type) or similar
tripod
taper

Method

- 1 Take a cardboard tube with a plastic lid (a tall Pringles tube, or similar). Cut holes in the metal bottom and the plastic lid with diameter 1 cm or less.
- 2 Put Bunsen burner tubing just into one hole and turn on the gas to fill the tube. Turn the gas off and put your fingers over the holes in the tube.
- 3 Place the tube on top of a tripod, with the metal base uppermost.
- 4 At arm's length light the top of the tube with a burning taper.

Initially the gas burns with a bright yellow flame. This flame reduces in size until it is barely visible. It is at this point that the combustion becomes explosive. The Pringles tube will leap about 30 cm in the air with a pop.

It is important to be patient when waiting for the pop - it can take up to one minute for the flame to die down and the explosion to happen. Sometimes the flame seems to disappear some time before the explosion occurs. A good flow of air into the bottom of the tube will speed up the demonstration.

Safety advice

Note the delay before the explosion - be patient!

Eye protection must be worn by all.

Do not attempt to light any other types of gas.

Discussion

Combustion, explosions, gas/air mixtures, gas safety.

The hole at the bottom of the tube is required to allow air to replace the burning methane. This effectively dilutes the methane until the air/gas mixture is explosive.

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

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.

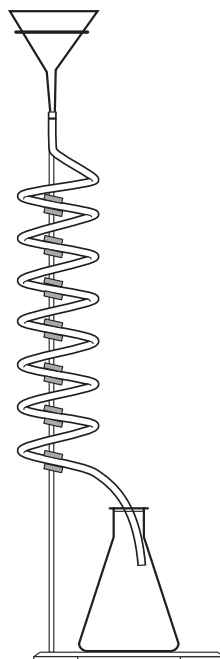
Set up a funnel and spiral apparatus either using a glass spiral or transparent tubing coiled around a set of clamps. See diagram on page 92.

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.



HARMFUL
copper sulphate

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?

D6: Bubble Bath Tower

- Preparation time 5 minutes
- Demonstration time 5 minutes

Requirements

500 cm³ measuring cylinder
 20 vol. hydrogen peroxide (**irritant**)
 bubble bath
 food dye
 potassium iodide
 large bowl
 spatula

Method

- 1 Put the measuring cylinder in the bowl.
- 2 Add 50 cm³ of 20 vol. hydrogen peroxide, 15-20 cm³ bubble bath and a few drops of food dye.
- 3 Add 6 g of potassium iodide, swirl and stand back.
- 4 To clear up, stand the bowl in a large sink and hose away the bubbles with rubber tubing attached to a tap.

Alternative

100 vol. hydrogen peroxide (**corrosive**) can be used for a more vigorous reaction, but this is VERY messy!

Safety advice

Make sure pupils are at a safe distance.

Wear goggles (safety specs are not adequate if using 100 vol. hydrogen peroxide).
 Wear gloves.

Chemical background

The bubble bath is added to make the liquid froth more by reducing surface tension. The food dye is added to increase the visual effects. When the potassium iodide is added to the peroxide, it bubbles vigorously as oxygen gas is given off. (You might like to place a glowing splint in the neck of the measuring cylinder to demonstrate this.) The iodine goes into solution and, if food colouring is not used, a brown solution would be seen. Using more concentrated peroxide will produce bubbles even faster.



eye protection
must be worn



IRRITANT
hydrogen
peroxide (20 vol.)



CORROSIVE
hydrogen
peroxide (100 vol.)