eye protection must be worn

IRRITANT hydrochloric acid

19: Eggsperiment

- **Basic/Intermediate level**
- **30 minutes + 30 minutes + 30 minutes + leave for a few hours**

Requirements

A
2 egg shells
pestle and mortar
2 cm^3 2 mol dm^{-3} hydrochloric acid
2 cm^3 limewater
spatula
2 boiling tubes
10 cm^3 measuring cylinder
dropper pipette

eye protection

B
2 clean, dry egg shells
pestle and mortar
50 cm^3 measuring cylinder
50 cm^3 2 mol dm^{-3} hydrochloric acid
side-arm flask
thistle funnel
rubber tubing
gas jar
beehive shelf
trough
beakers
measuring cylinders
gas syringe
clampstand
top pan balance

eye protection

C
dry crushed egg shell
requirements for flame tests
(see 12: Mystery Metal p68)

eye protection

D
whole egg
250 cm^3 glass beaker
150 cm^3 2 mol dm^{-3} hydrochloric acid

eye protection

Advance preparation

Wash and dry 2 egg shells, removing the membrane.

Method

See pupils' sheet.

A What are egg shells made of?

When the pupils wash the egg shells they will notice the membrane attached to the inside. They should remove this as far as possible.

They may test the membrane with acid when they will find that it does not react. It is composed of a highly insoluble protein, ovokeratin.

B How much gas?

After trying to collect the gas in the boiling tube experiment (**A**) the pupils could be introduced to further possibilities. These include:

A side-arm flask with a thistle funnel may be used to add the acid with no loss of gas. The gas can be collected over water.

Since CO_2 is soluble some gas will be lost if it is collected over water (unless the water is pre-saturated). The pupils may try using a gas syringe.

It is also possible to measure the mass loss using a balance. I.00 g of calcium carbonate produces 0.44 g of carbon dioxide.

Safety advice

Take care with the acid.

Chemical background

When the naked egg is produced there is a lot of froth, which is probably due to the protein that binds the calcium carbonate together in the shell.

The hard shell of the egg is permeable. The membrane is semi-permeable, it keeps moisture inside the egg.

Extension

The project could be extended to dyeing eggs, as described in *Salters' Chemistry Club Handbook* volume 1.

20: Paper-making

● **Intermediate level** ● **60 minutes**

Requirements

wooden mold and deckle (see below - one for each group of pupils to share)
3 double sheets newspaper
a magazine picture or a leaf (optional)
powdered laundry starch
a tea towel
a balloon whisk
an electric iron
a large bowl
absorbent paper

Advance preparation

Each group of pupils will need a mold and deckle, as in the diagram on page 39. (You might be able to get your Technology department to help with this.)

To make the mold

1 Cut two pieces of pine (2 cm x 2 cm) to 20 cm lengths.
2 Cut two similar pieces of pine to 12 cm lengths.
3 Fix the frame together with glue and screws and fix with a clamp until the glue is dry.
4 Sand any rough edges.
5 Seal the wood with varnish and leave to dry.

To make the deckle

1 Repeat steps 1-5 above.
2 Cut a screen which is slightly smaller than the outer edges of the frame, place over the frame and staple into place.

Method

See pupils' sheet.

Avoid using too much starch, because this makes the iron messy.

Safety advice

If possible, borrow an electric iron from the Technology department. Any electrical appliances brought in from home must undergo a portable appliance test before being used in school.

Chemical background

Paper is made of cellulose fibres. Laundry starch acts as a filler or sizer. It enables the paper to take ink and be erased. Paper deteriorates with age because it slowly oxidises in the air. Making paper harms the environment by destroying forests and polluting water.

Extension

Try making paper with other fibrous materials (e.g. broccoli spears, cotton rags or grass). You can also make 'papyrus' using the separated layers of a leek, cooked gently in a light starch solution.

eye protection must be worn

IRRITANT sodium hydroxide

hot glass

EXPLOSIVE Tollen's reagent is safe in solution, but must not be stored

CORROSIVE silver nitrate

21: Silvered Glass Balls

● Intermediate level ● 30 minutes

Requirements

Glass blowing

25 cm length of clean soda glass tubing
(5 or 6 mm internal diameter)
One end of each length should be heat-smoothed (see Advance preparation).
Bunsen burner

eye protection

Formation of 'silver mirror'

5 cm^3 of 0.1 mol dm^{-3} silver nitrate
5 drops of 0.4 mol dm^{-3} sodium hydroxide (**irritant**)
a few drops of 1 mol dm^{-3} ammonia
test tube
test tube rack
glucose
small spatula
teat pipette
100 cm^3 deionised water
hot water from a kettle
250 cm^3 glass beaker

Advance preparation

Heat smooth one end of each length of glass tube.

Dissolve 1.7 g of silver nitrate $AgNO_3$ (**corrosive**) in 100 cm^3 of deionised water. This makes a solution of concentration 0.1 mol dm^{-3}.

TOLLEN'S REAGENT SHOULD BE PREPARED IN **SMALL QUANTITIES ONLY.**

TOLLEN'S REAGENT SHOULD **NEVER BE MADE UP IN ADVANCE.**
IT SHOULD **NEVER** BE STORED.

It is suggested that pupils may prepare their own Tollen's reagent, just before forming the silver mirror.

Method for preparing Tollen's reagent

Place 5 cm^3 of 0.1 mol dm^{-3} silver nitrate solution in a test tube. Add 5 drops of 0.4 mol dm^{-3} sodium hydroxide. Shake. Add 1 mol dm^{-3} ammonia drop by drop until the precipitate just redissolves.

DO **NOT** SAVE THE USED SILVER SOLUTION IN A SILVER RESIDUE CONTAINER.
(See safety advice below.)

Method

See pupils' sheet.

The pupils will find the 6 mm tubing easier to blow than the 5 mm tubing.

There is no sensible alternative to using teat pipettes, but the solutions are hazardous so the pupils should be extremely careful.

Safety advice

Wear eye protection for glass blowing and for making the silver mirror.

Tie hair back for glass-blowing.

Siver nitrate will stain hands and clothing. Avoid skin contact.

There are rare reports of incidents where alkaline silver nitrate solution has exploded after standing for some time. To avoid this risk the ammoniacal silver nitrate solution should not be made up in advance of the practical.

Any Tollen's reagent left over should be washed down the sink with plenty of water. The silvered glass balls should be rinsed thoroughly with water and the washings washed down the sink as soon as the silvering is finished.

If pupils want to take their silvered glass balls home, make sure they are transported safely.

Chemical background

Tollen's reagent contains silver ions complexed with ammonia ($Ag(NH_3)^{2+}(aq)$). These ions are reduced to silver in the presence of aldehydes such as glucose. The silver is produced as a thin layer on the inside surface of the glass ball. This is the traditional method by which mirrors are silvered.

Extension

Small glass objects may be plated by hanging them on threads and then suspending them in the silver-plating solution. They must be very clean.

22: Electroplating a Design

● Intermediate level ● 30 minutes

HIGHLY FLAMMABLE propanone

IRRITANT sulphuric acid

CORROSIVE nitric acid

eye protection must be worn

HARMFUL copper(II) sulphate

Requirements

Per pupil
Brass key ring fob/dog tag (cost approx 20p each)
6 cm (approx) brass wire
tissue

eye protection

Teacher
dilute nitric acid (**corrosive**)
Brasso (check the label for hazard warning)
soft cloth

Per group of pupils
low voltage dc supply, 6V
2 connecting wires: 4 mm plug at one end and a crocodile clip at the other
0.9 mm thick scrap copper, minimum size 10 cm x 5 cm (you might be able to get this from the Technology department)
250 cm^3 beaker (for plating bath)
electrolyte of sulphuric acid and copper sulphate (125 g of copper(II) sulphate (**harmful**) dissolved in 500 cm^3 of 1 mol/litre sulphuric acid (**irritant**) - about 250 cm^3 per group)
propanone residue bottle, labelled 'propanone residue' and 'highly flammable'
pieces of cloth or cotton wool for drying and buffing
permanent ink felt-tip pens
propanone (**highly flammable**) (about 100 cm^3 per group)
paint brush

Advance preparation

Clean the brass discs beforehand: dip in dilute nitric acid (**corrosive**), wash under a tap and dry with a cloth, clean with Brasso and buff with a soft cloth.

Electroplating bath
Set up the current for electroplating using a piece of scrap copper (it need not be clean) as the anode (positive electrode). **Do not switch on the power pack**. Make sure it is set for 4 volts. The plastic coated wire plugged into the black (negative) terminal of the power pack should have a crocodile clip on the other end of the wire. This will hold the brass discs on the wire.

Method

See pupils' sheet.

Safety advice

Propanone is highly flammable and an irritant to the eyes. Ensure that the stock and residue bottles are kept closed and that students do not expose themselves to the vapours when rinsing the electroplated brass.

Chemical background

The propanone is used to help make sure the surface being coated or plated with copper is scrupulously clean, as it will not plate properly if the surface is dirty. The copper is used as an anode and is purified during the electrolysis process and plated onto the object at the cathode as pure copper metal.

Reference

This practical is based on a Nuffield experiment sheet.

HIGHLY FLAMMABLE propanone

eye protection must be worn

23: What Colour are Leaves *Really*?

● Intermediate/High level ● 40-50 minutes

Requirements

Extraction of pigments

1g freshly collected copper beech or other coloured leaves (in winter you can use red leaves from plants such as *Heuchera* 'Raspberry Regal', or indoor red-leaved begonias)
2 g washed sand
5 cm^3 propanone (**highly flammable**)
scissors
pestle and mortar

Paper chromatography

chromatography tank or coffee jar with lid
10 cm^3 propanone for chromatography
capillary melting point tubes
chromatography paper (Whatman No.1, 40 x 150 mm)
pencil

eye protection

Method

See pupils' sheet.

Safety advice

The solvents used in this experiment are highly flammable. All Bunsen burners and other flames must be extinguished.

Chemical background

The red colour of the copper beech leaves comes from an anthocyanin pigment. The anthocyanins are members of a class of compounds called flavonoids. They are not responsible for all reds in plants; the red of beetroot and bouganvillea is due to other compounds (betacyanins).

Like the anthocyanin extracted from red cabbage water (cyanidin) these pigments are often pH sensitive.

Extensions

The purple/red pigment in copper beech leaves is similar to that in red cabbage. Does it act as an indicator? Test the spots with acidic and alkaline solutions.

You could do a comparison with green leaves on the same chromatography paper.

Autumn leaves could be analysed at various stages to see how their colours change. Here the yellow pigments are carotenoids while the reds are anthocyanins.

References

P. Borrows, *Education in Chemistry*, **33** (5), 119, 1996.
Molecules, P. W. Atkins, Scientific American Library, W.H. Freeman and Company, 1987.