
eye protection must be worn


HARMFUL copper sulphate crystals and solution (>1.0mol dm^{-3})


wear gloves when using nickel or cobalt compounds

nickel sulphate crystals and solution (>0.5mol dm^{-3})

cobalt chloride crystals and solution (>1.0mol dm^{-3})

18: A Magic Box

● Intermediate level
● 30 minutes to prepare; 30 minutes to carry out

Requirements

weighing balance
spatulas
cardboard box - shoe box or similar
pestle and mortar
fine paint brush
pen with steel nib
crystallising dish
2 sheets of absorbent paper
100 cm^3 measuring cylinder
150 cm^3 beaker
copper sulphate crystals, $CuSO_4$
ammonia solution, NH_3, 3%
OPTIONAL:
cobalt chloride, $CoCl_2$
nickel sulphate, $NiSO_4$

disposable gloves (for use with nickel and cobalt compounds)
eye protection

Method

See pupils' sheet.

Safety advice

Ensure that pupils wear eye protection.

Nickel compounds can cause sensitisation, avoid exposure to dust. Pupils younger than 13 years old should not use nickel sulphate solution. Wear gloves if the concentration exceeds 1.0mol dm^{-3}. Take similar precautions with cobalt salts.

Chemical Background

The parts of the picture painted with blue $CuSO_4$ 'ink' turn deep blue. This is because Cu^{2+} ions from the $CuSO_4$ react with the ammonia gas to form a complex of $[Cu(NH_3)_4]^{2+}$ ions which are dark blue.

The writing turns a shiny copper colour. Metallic copper is deposited on the paper as well as the nib itself when the steel pen is used. This is because the Cu^{2+} ions oxidise the iron to Fe^{2+} (aq) ions and are reduced to Cu(s).

You may suggest using other transition metal salt solutions to develop different coloured inks. Cobalt chloride (which is the safer of the two) and nickel sulphate will work too (but see Safety advice above).


eye protection must be worn


IRRITANT calcium chloride


fine dust


OXIDISING do not use nitrates


HARMFUL copper oxide

19: Burning Food

● Intermediate level ● 30 minutes total

Requirements

glass funnel
long piece of rubber tubing (borrow from a Bunsen)
disinfectant
2 Bunsen burners
2 clamp stands
heat proof mats
spatula
newspapers
a variety of powdered food substances (e.g. custard powder, hot chocolate, flour, etc.)

safety screens
eye protection

OPTIONAL - FOR TEACHER ONLY DEMONSTRATION OF METAL FLAME TESTS
strontium chloride, $SrCl_2$, potassium chloride, KCl, sodium chloride, NaCl,
calcium chloride, $CaCl_2$, copper oxide, CuO

Method

See pupils' sheet.

Safety advice

Ensure that sufficient safety screens are used to protect experimenter and observers.
Restrict the quantity of food burned to one spatula measure.
Fine dust may irritate asthma sufferers.
This activity must be supervised very closely as pupils can become over-enthusiastic.

Chemical background

When food is burned in this way the stored energy is released very dramatically.

The finely powdered state of most of the foods and their large surface area will increase the rate of the reaction. The vigour of the reaction will also be affected by the calorific value of the food (compare fats and sugars).

After observing a teacher demonstration of metal flame tests the pupils could use this knowledge when

examining the listed contents on the food packets and interpreting the flame colours of burning foods.

Most foods burn with a yellow/orange flame which is linked to their sodium content.

20: Chemistry in the 23rd Century

● Intermediate level ● 60 minutes

eye protection must be worn

ensure that the pupils' plans are safe before you allow them to proceed

A. Battery Enterprise

Requirements

voltmeters, crocodile clips and leads

carbon electrodes in pencils, metals available in the kitchen, cutlery etc,
copper pipe off-cuts, aluminum foil
sodium chloride, NaCl
washing powder
vinegar, lemonade, lemons

The purpose of the activity is to produce the most appropriate combination of metals and electrolyte to produce a good voltage.

Safety advice

Do not allow your pupils to use bleach. You must check their plans before they proceed.

B. Chemical Power

Requirements

sodium hydrogencarbonate, NaHCO3, 5 g per pupil or working group
citric acid, 15 g per pupil or working group
100 g mass which will represent the 'dilithium crystal'

In addition to general lab equipment pupils should have access to assorted 'junk' e.g. plastic lemonade bottles, plastic bags, metal drink cans etc.

You may need to point out that they will need to add water to make the substances react to produce CO2.

An alternative procedure can be performed with half the quantities stated in the Pupil Worksheet.


eye protection must be worn

C. Dr Who's Sherbet Mixture

● Intermediate level ● 30-60 minutes total

Method

Each student should be given 20 g citric acid and 30 g sodium hydrogencarbonate and have access to a thermometer. You may need to tell them to add a few drops of water.

Chemical Background

With the right mixture the endothermic reaction which takes place can lower the temperature to -10°C.


eye protection must be worn


exothermic reactions
hydrochloric acid and magnesium can spit


EXPLOSIVE
hydrogen gas


FLAMMABLE
magnesium filings


IRRITANT
hydrochloric acid

21: Hydrogen Balloons

● Intermediate level ● 30 minutes total

Requirements

small plastic food bags or a bag of round balloons
boiling tubes and rack
pipette or similar to dispense 5 cm^3 - 10 cm^3 of acid
spatulas
sellotape
cotton
newspaper
elastic bands

magnesium filings, Mg
hydrochloric acid, HCl, (1 mol dm^{-3})

eye protection

Method

See pupils' sheet. Five boiling tubes of gas are generally sufficient to fill a bag or balloon.

Safety advice

Do not use magnesium powder. The reaction between magnesium and hydrochloric acid is very exothermic. Pupils will need strict supervision to prevent them sprinkling magnesium dangerously in a Bunsen flame.


eye protection must be worn


IRRITANT
ammonia solution
hydrochloric acid


wear gloves when you remove the silver fractals immediately after the experiment using a piece of filter paper


see cautionary note

22: Silver Fractals

● Intermediate level
● Under 30 minutes to prepare; 30 minutes to carry out

Requirements

overhead projector
petri dish, 15 cm diameter, 2 cm depth
power pack (range up to 22 V)
stands/clamps/boss head
2 paper clips
filter paper
250 cm^3 measuring cylinder

silver nitrate solution, $AgNO_3$, (0.1 mol dm^{-3})
ammonia solution, NH_3 (aq), (3.0 mol dm^{-3})
dilute hydrochloric acid, HCl, (2.0 mol dm^{-3})

eye protection

Method

See pupils' sheet.

Safety advice

Ensure that pupils use eye protection at all times.

Wear gloves while you remove the silver fractals immediately after the experiment using a piece of filter paper. You can re-use the silver.

CAUTION!
Explosive silver fulminate, Ag_3N, may form after a few hours. To dispose of the silver nitrate add 10 cm^3 5mol dm^{-3} hydrochloric acid and reduce to metallic silver by means of zinc rods or granules.

Chemical background

The silver ions are reduced to metallic silver during electrolysis.

$$Ag^+(aq) + e^- \longrightarrow Ag(s)$$

23: Slime with a Twist

● Intermediate level ● 30 minutes to prepare
● 30-60 minutes to carry out

eye protection must be worn

UV source

Requirements

weighing balance
100 cm^3 measuring cylinder
250 cm^3 beaker
disposable pipettes
hot plate
stirring rod
source of ultraviolet light

eye protection

40 g poly(ethenol) (polyvinyl alcohol, PVA) $M_r = 65 \times 10^3$ or 115×10^3
4.0 g sodium tetraborate (borax) $Na_2B_4O_7.10\ H_2O$
0.40 g sodium fluorescein
0.10 g bromophenol blue

Method

SLIME
Advance preparation. These solutions will be sufficient to prepare ten 100 cm^3 portions of slime.

1. Add 4.0 g of sodium tetraborate to 100 cm^3 of water and warm slightly. Place in a labelled container.
2. Add 0.4 g of sodium fluorescein and 0.10 g of bromophenol blue to 1 dm^3 of distilled water. Label and set aside until you are ready to use it.

See pupils' sheet for further details of making the slime.

PUTTY
PVA glue from a chemical supplier produces a better result than cheaper `craft' glue.

Safety advice

Eye protection must be worn.

Pupils must not use the UV source themselves. If short wavelength UV (less than 315 nm) is used do not view directly.

It is best to mount the UV lamp in a box with a hole, so that the lamp cannot be viewed directly - only by reflected light.

Chemical background

The poly(ethenol) chains are linked by the borate groups through hydrogen bonding. The cross linking can break and reform easily. Most of the space within the gel is taken up by water molecules.

The sodium fluorescein fluoresces in the green region of the spectrum. The electrons in the fluorescein absorb light from the blue - ultraviolet end of the spectrum and emit this energy as they relax in the green region. Green light is seen on the incident side. The bromophenol blue absorbs the remaining regions of visible light except for the red end. This allows the red light to pass through the slime and be visible on the side the light exits from.