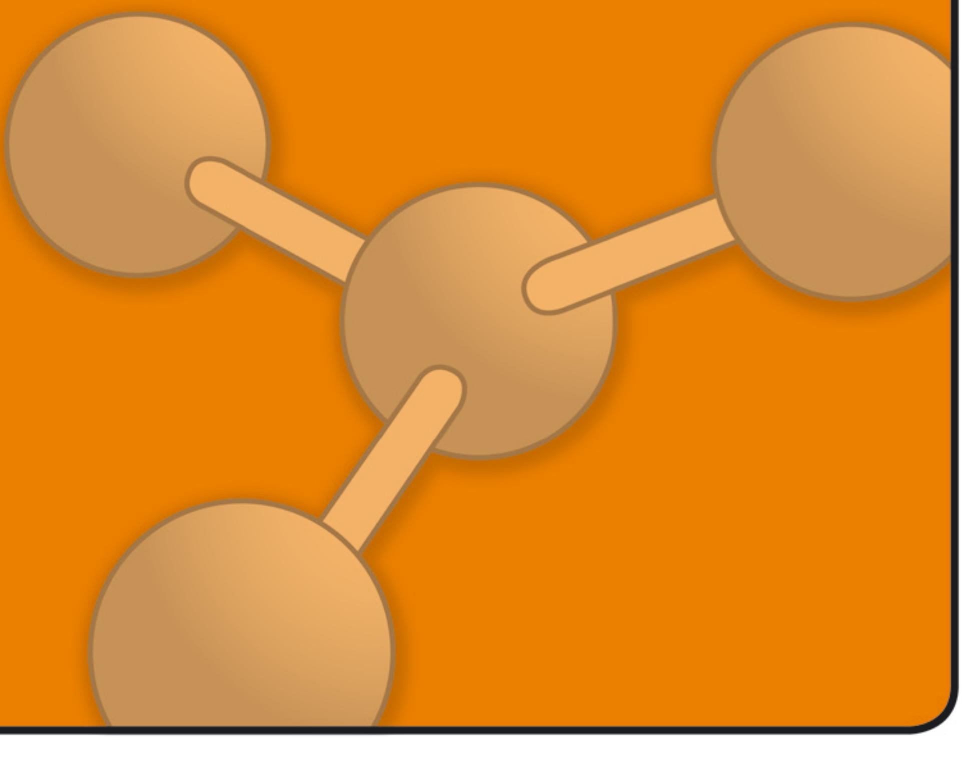
200 Super Science Investigations

Book A
The Material World



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User Friendly Resources Ltd., 167 Victoria Street, Christchurch, New Zealand.
Tel: +64 3 377 2886; Fax: +64 3 377 2086; email: info@userfr.com

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Editor: Darrell Kilian
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DEDICATION

Winifred, Felicity and Marjory

PUBLISHERS

User Friendly Resources

New Zealand Office
PO Box 1820
Christchurch
Phone: 0508-500-393
Fax: 0508-500-399

Australian Office
PO Box 914
Mascot, NSW 2020
Phone: 1800-553-890
Fax: 1800-553-891

WEBSITE

www.userfr.com

E-MAIL

info@userfr.com

SAFETY TIPS

Safety in the Science classroom is a priority for teachers and students alike. Prior to commencing any scientific experiment, teachers should discuss safety issues relevant to that experiment. This is best achieved in a 'brainstorming context, where the teacher and the students share responsibility for identifying any potential safety issues, and developing strategies to address these.
Taking this student-centred approach, as opposed to a 'teacher imposition' of safety rules, will likely achieve a greater awareness and appreciation of safety considerations on the part of the students.

Here is a list of generic safety considerations. This can be used (and added to!) as part of a general discussion on safety in the Science classroom.

- Always follow teacher instructions.
- Keep surfaces as uncluttered as possible.
- Return equipment/chemicals etc. to their storage places immediately after use.
- Tie long hair back.
- Never leave a Bunsen burner or other naked flames unattended.
- Wear safety goggles when handling chemicals or dealing with naked flames or hot fluids.
- Angle test tubes/containers away from you when heating.
- Take special care when dealing with boiling water.
- Never look directly down a test tube, or any other container being heated.
- Take special care when mixing and stirring hot liquids.
- Take special care when handling sharp instruments.
- Chemicals can be hazardous – avoid skin contact and inhaling vapours, and handle with care.
- Many products carry hazard signs and other warnings – follow these.
- Promptly ask your teacher how to deal with any spillages.
- **If in any doubt on anything!... ask your teacher.**

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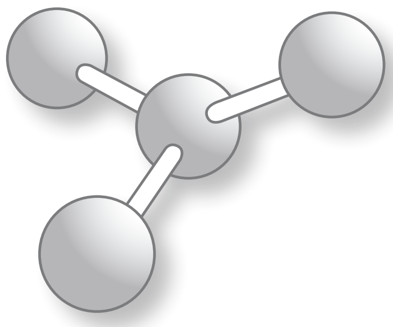


Introduction

200 Super Science Investigations is a series of four books that provides 200 ready-to-go investigative activities, covering a wide range of content areas within science. With this tremendous variety to choose from, there will nearly always be a suitable activity to support and enhance your current area of focus in science.

The investigative activities are presented in the form of photocopiable worksheets for students. They are all simple to set up, usually requiring little in the way of formal scientific equipment. Most students should be able to complete them independently, usually in 30 minutes or less. They can be used flexibly for individual work, group work or class demonstrations, and are suitable for a range of ability groups.

The four books in the series focus on:

- Material World (this book)
- Physical World
- Living World
- Earth and Beyond

How can this book help?

The experiments in **200 Super Science Investigations** are designed to:

- Support the modern science curriculum.
- Allow students to discover scientific concepts themselves.
- Take scientific understanding to a deeper level.
- Help students recognise science in everyday life.
- Build student confidence with experimental work.
- Give teachers ideas for demonstrating scientific concepts.
- Motivate students, encourage curiosity and make science fun.

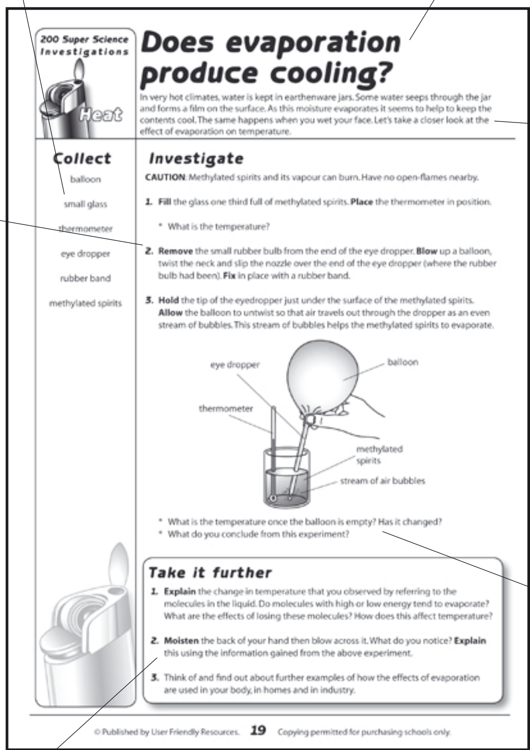
While intended primarily for experimentation in the classroom, many of the activities can be given to students to complete at home – if they are safe, easy to follow and require equipment and materials available in the home.

How does each activity work?

Each activity has the following parts:

List of equipment and materials – often suggesting more than one alternative. An asterisk (*) shows items that are only required for the extension activities

Title – posed as a question to encourage curiosity



200 Super Science Investigations

Heat

Does evaporation produce cooling?

In very hot climates, water is kept in earthenware jars. Some water seeps through the jar and forms a film on the surface. As this moisture evaporates it seems to help to keep the contents cool. The same happens when you wet your face. Let's take a closer look at the effect of evaporation on temperature.

Collect

balloon
small glass
thermometer
eye dropper
rubber band
methylated spirits

Investigate

CAUTION: Methylated spirits and its vapour can burn. Have no open-flames nearby.

1. **Fill** the glass one third full of methylated spirits. **Place** the thermometer in position.
   * What is the temperature?
2. **Remove** the small rubber bulb from the end of the eye dropper. **Blow** up a balloon, twist the neck and slip the nozzle over the end of the eye dropper (where the rubber bulb had been). **Fix** in place with a rubber band.
3. **Hold** the tip of the eyedropper just under the surface of the methylated spirits. **Allow** the balloon to untwist so that air travels out through the dropper as an even stream of bubbles. This stream of bubbles helps the methylated spirits to evaporate.

eye dropper
balloon
thermometer
methylated spirits
stream of air bubbles

* What is the temperature once the balloon is empty? Has it changed?
* What do you conclude from this experiment?

Take it further

1. **Explain** the change in temperature that you observed by referring to the molecules in the liquid. Do molecules with high or low energy tend to evaporate? What are the effects of losing these molecules? How does this affect temperature?
2. **Moisten** the back of your hand then blow across it. What do you notice? **Explain** this using the information gained from the above experiment.
3. Think of and find out about further examples of how the effects of evaporation are used in your body, in homes and in industry.

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Introduction – briefly sets the scene and points the way conceptually in straightforward language

Instructions – step by step points which are easy to follow with key verbs highlighted in bold, along with supporting illustrations

Questions – start with asterisks. They are suitable for students to answer in their notebooks. The questions help and encourage students to:
• focus their observations
• record results
• discover and explain specific concepts
• engage in open-ended discussion

Extension activities – can be used as the teacher decides to:
• go a step further conceptually or experimentally
• extend more advanced students
• encourage open–ended discussion
• set short research tasks
• provide homework

Take care to read the safety instructions listed previously and to use good sense in guiding students to work safely.

200 Super Science Investigations

Matter

What is matter?

The properties of a substance are the things we notice when we observe and experiment with that substance. In this activity, we look at some of the properties of matter, including a comparison between the three different phases of matter – solids, liquids and gases.

Collect

block of wood

piece of metal

stone

beaker or glass

water

balloon

scale or balance

Investigate

1. **Draw a table** like the one below.

	Solids	Liquids (water)	Gases (air)
Can you touch it?			
Does it take up space?			
Does it have mass?			
Can its shape change easily?			
If you put it in a container will it spread out in all directions to fill the container?			

* **Complete** the table as you work through the following points.

2. **Examine** the solid objects – the block of wood, the piece of metal and the stone. **Squeeze** them and lightly **hammer** one item with another. **Place** them on the scale or balance and **measure** their mass.

3. **Place** a beaker or glass on the scale or balance. **Measure** the mass then fill it with water and note the new mass. Then **get** a drop of water on your finger and **squeeze** it.

4. **Wave** your hand in the air. Can you **feel** or touch the air? Now **blow up** the balloon and tie off the nozzle. **Squeeze** and prod the balloon without bursting it. If you have a very sensitive scale that can measure milligrams you can try to **measure** the mass of the balloon before and after filling it with air (air will have mass, but only very little).

5. **Analyse** your results.

* What are the properties of all matter (solids, liquids and gases)?
* What are the differences between solids, liquids and gases?

Take it further

Research what 'antimatter' is. How does it differ from matter? What are 'positrons'? What happens when matter and antimatter meet?

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200 Super Science Investigations

Matter

Can you change the state of matter?

Matter means everything that takes up space and has mass. Matter can be in the form of a solid, liquid or gas. We can change many substances from a solid to a liquid to a gas by heating them. We can also reverse these changes by cooling them.

Collect

heat-resistant dish or tin lid

tripod and gauze or wooden block supports

burner or candle

ice

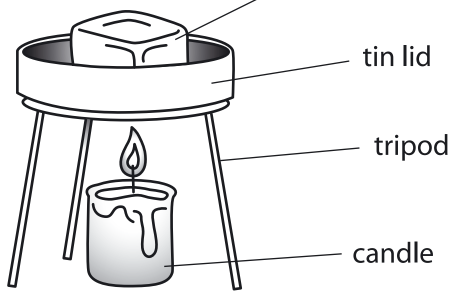
glass

cold water

Investigate

1. Place a piece of ice in a shallow dish or tin lid over the burner or candle.

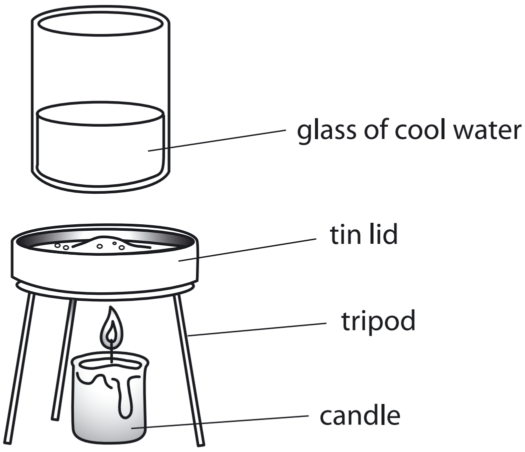
* Is ice a solid, liquid or gas?
* How does the ice change?



2. Continue heating until the ice is all melted and the water starts to boil.

* The amount of water gets less and less. What is happening to the water that is disappearing? Where has it gone?
* What is water vapour?

3. Before the water boils away completely, **hold** a glass of cool water a little way above the boiling water.



* What substance forms on the underside of the cool glass? Where has this come from?

Take it further

1. **Discuss** the changes of state that occur in the water cycle.
2. Scientists sometimes talk about a fourth phase of matter called plasma. Research what it is. Give examples of substances in the plasma state.

200 Super Science Investigations

Matter

Can you compress matter?

A solid keeps a constant shape, provided that force is not used to change the shape. A liquid does not have a definite shape, but spreads out below the surface level to take the shape of the container it is in. A gas spreads out in all directions to fill the space it is in. In this experiment we investigate how the volume of solids, liquids and gases changes if we push inwards on them. If we can compress them, the volume or space they take up will get smaller.

Collect

jar with piece of wood to fit inside

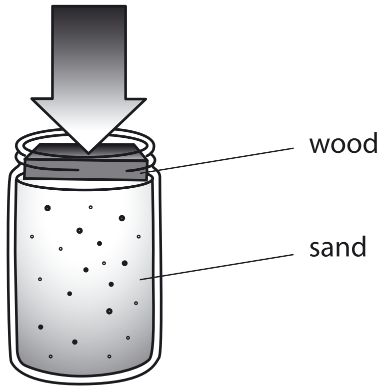
sand

bicycle pump

container of water

Investigate

1. **Fill** the jar with sand or other small pieces of solid. **Shake** a little to settle the sand. **Cover** the surface with a piece of wood and **press** down firmly.



   * Can you compress this solid?

2. **Suck up** water into a bicycle pump, partly **filling** it with water. **Hold** the pump vertically with handle down and **push** the handle in until only water and no air comes out of the hole. **Hold** a finger tightly over the hole in the end and **push** firmly on the handle.

   * Can you easily compress water?

3. **Empty** the bicycle pump. **Pull** the handle fully out, filling the pump with air only. Again **hold** a finger over the end and **push** firmly on the handle. **Release** the handle suddenly.

   * Can you easily compress air?
   * **Compare** how easily you can compress solids, liquids and gases.

Take it further

1. Matter is made up of small particles (called atoms, molecules or ions). There are spaces between these particles. Use your findings about how easily solids, liquids and gases are compressed to **suggest** whether the spaces between the particles are biggest in solids, liquids or gases. For each phase of matter, **explain** how big you think the spaces are when compared to the size of the particles themselves.

2. **Research** how the massive gravity of stars can compress even solids under unusual conditions. Find out about how matter is compressed in neutron stars and black holes. What happens to the matter that is compressed?

Are there spaces between liquid particles?

Matter is made up of separate particles with spaces between them. In a solid the particles are held together closely and strongly. In liquids, the particles are held less strongly and can slide past one another. In gases, the spaces between particles are bigger and the particles move randomly in all directions.

Collect

two 100 ml measuring cylinders

water

methylated spirits or rubbing alcohol

sand*

salt*

small jar with lid*

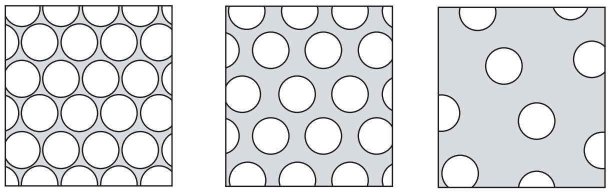
Investigate

1. **Measure** out exactly 50 ml of water into one measuring cylinder and exactly 50 ml of methylated spirits into the other.

2. **Add** the water to the methylated spirits. Then **place** your hand over the top of the cylinder and **shake** well to mix the liquids.

3. **Measure** the combined volume.

   * What do you find – when can you say one plus one is not two?
   * Can you explain this? Refer to the drawings below.



SOLID LIQUID GAS

"All things around us are made of building blocks, so small their size cannot be diminished. I call them atoms."

The words of Democritus who lived in Greece 2000 years ago.

Take it further

Half **fill** a small jar with sand then **top it up** with salt. **Replace** the cap and **shake** well. What do you notice? Are there spaces between the grains? **Explain** how this helps you to understand the above experiment.

Do particles of matter move?

Matter is made up of very small particles – either separate atoms or molecules, which are groups of atoms joined together. The particles are moving all the time. The particles of a solid vibrate, but stay in the same overall position. In this activity we will investigate the movement of particles in gases and liquids.

Collect

strong scent

saucer

small tray with edge

ten marbles or more – one of a different colour

glass of water

colourful powdered jelly or Condy's crystals

glass or plastic tube

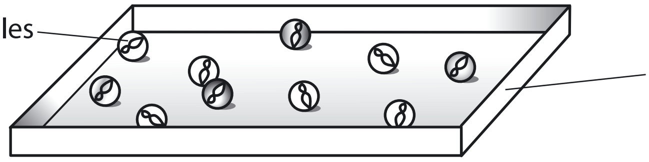
glass of water

Investigate

1. **Close** the doors and windows so there are no draughts. **Pour** a few drops of strong scent onto a saucer. **Note** how the smell travels to all parts of the room.

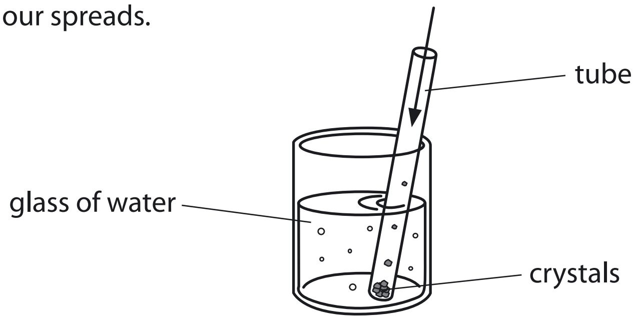
   * How do you think the scent spreads to all parts of the room so that we can smell it?

2. **Place** the marbles in the small tray. **Move** the tray about with a rapid, round-about motion, so that the marbles move around rapidly while keeping on the tray.



   * Imagine that the different coloured marble is a scent molecule and the other marbles are air molecules. Does it move across from one part of the container to another? Does it bounce off other marbles? Using this information, **draw a sketch** of the path of a scent molecule through the air.

3. Carefully **slide** the colourful crystals down the tube so that they reach the bottom of the glass of water without disturbing the water. **Remove** the tube. The crystals will start to dissolve in the water. **Leave** the glass on a shelf for several days. **Observe** how the colour spreads.



   * How do you think the dissolved colour moves through the liquid?
   * Do gas molecules move faster than liquid molecules? **Explain.**

Take it further

1. Use the tray with marbles to **demonstrate** what happens to molecules of matter when a solid melts to form a liquid and then boils to form a gas.

2. The spreading out of molecules through liquids and gases because of their own natural movement is called diffusion. Do you think that the spreading of scent smells and colour that you have just observed is due only to diffusion? What else may have helped?

200 Super Science Investigations

Matter

Do molecules attract each other?

Water behaves as if there were a thin skin stretched all over it. This is the result of water molecules pulling strongly towards each other. Because of this, small objects such as leaves and twigs can float on the surface of water. In this experiment you will observe the effect of soap and detergent, which weaken the pulling power between the water molecules that they touch.

Collect

two 4 cm lengths of drinking straw

soup bowl

water

soap

detergent

toothpick

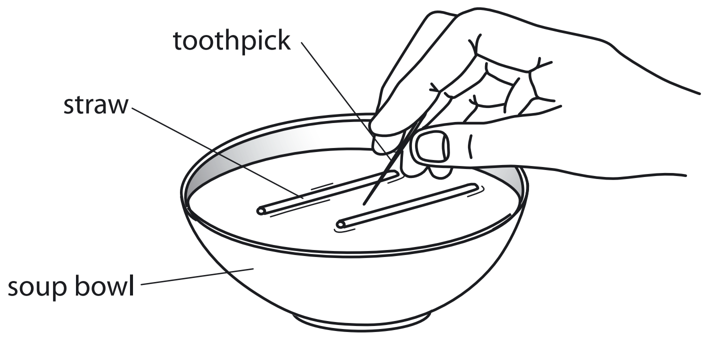
silk thread

balloon*

fur or woollen sock*

Investigate

1. **Fill** the soup bowl three-quarters full of water. **Float** the two pieces of drinking straw at the centre of the bowl about 3 cm apart. **Dip** the tip only of the toothpick into detergent then touch it between the floating straws.

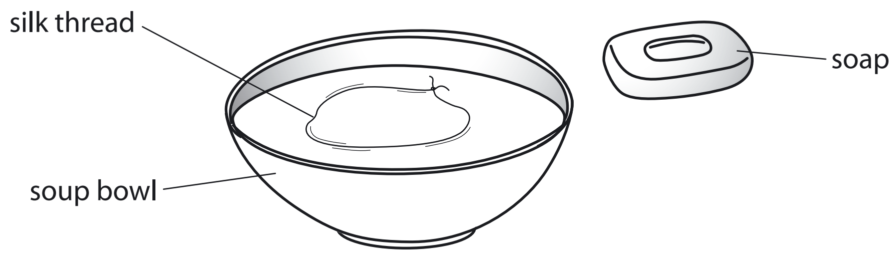


   * **Describe** what happens.
   * How does this show the pulling power of water molecules?

2. **Wash** the bowl and straws with cold running water. **Refill** the plate with water. Then **repeat** the experiment using soap in place of detergent.

   * What works best to weaken the attraction between water molecules – soap or detergent?

3. **Wash** the bowl again and **refill** it with fresh water. **Make** a loop of fine silk thread and float it on the water. **Touch** a piece of wet soap to the water surface inside the loop.



   * **Describe** what happens.
   * Can you **explain** what you observe?

Take it further

Blow up a balloon and tie off the neck. **Rub** one side of the balloon with a woollen sock or piece of fur. This creates an electrical charge on the balloon. **Bring** your hand near the balloon. Is the balloon attracted to your hand? Do you think that electrical charge may have something to do with the attractive powers of molecules? **Research** this further.

Contents

Can you make floating water beetles?

Water molecules attract each other. Molecules at the surface are pulled together by the attractive force of nearby water molecules beneath them. This acts as a barrier and creates a thin film which on which light objects can float. The force of this resistance is called surface tension.

Collect

thin wire

wooden matches

candle

basin or dinner plate

fresh clean water

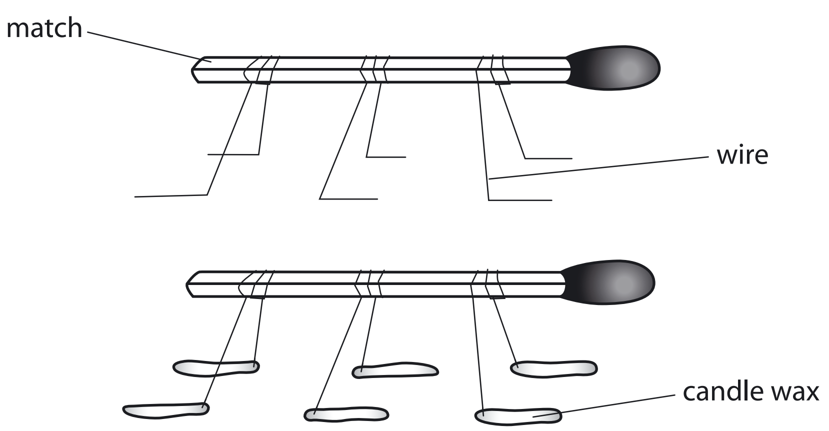
spoon

magnifier

Investigate

1. **Cut** the thin wire into 20 cm lengths and use them to **make** six legs on a wooden match as shown in the picture below. **Make** each foot 3 cm long and turn up each toe about a ½ cm. When completed, your 'beetle' should stand level on the bench.

2. **Cut** some candle-wax and **melt** it in the spoon. As it cools, **dip** each foot in it a number of times and so build up a good deposit of candle-wax on each foot.



3. **Run** some cold, fresh water into a large basin or tray. **Wait** for the surface to become still then carefully **float** your water beetle on it. **Blow** on the water beetle so that it moves.

   * **Explain** in your own words why it floats.

4. **Look** carefully at the water surface where the beetle's feet touch it.

   * Is the surface indented? If necessary, use a hand magnifier to find out.
   * Would you say that water molecules attract each other more strongly than they attract wax molecules? **Explain** your answer.

Take it further

Animals and plants make use of surface films. **Look** for animals and plants floating on water, such as pond skaters, mosquito wrigglers, water ferns and duckweed. Try to **draw** some of them.

Can you siphon a gas?

You have probably seen water or other liquids being siphoned from a higher to a lower container using a piece of plastic tubing. Can we do the same with a gas?

Collect

- 1 litre glass jar or bottle
- glass or beaker
- plastic tubing
- baking soda
- vinegar
- taper or wood splint
- matches
- cardboard box
- sink or large basin

Investigate

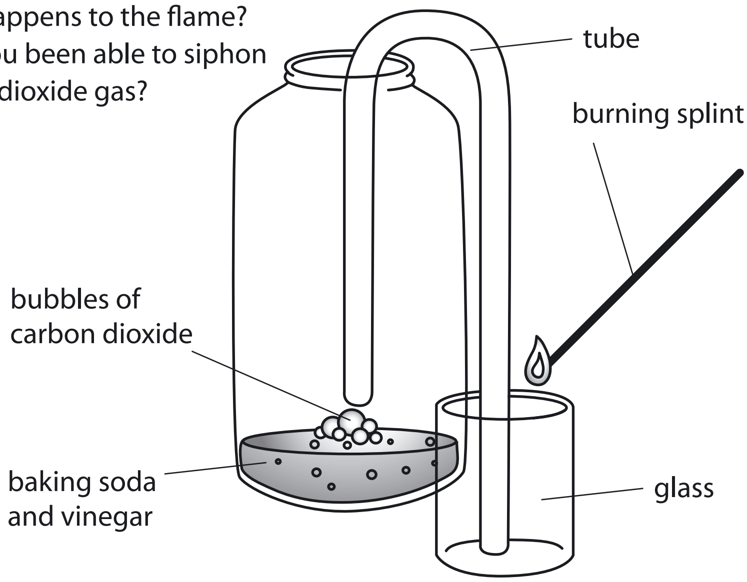
1. First remind yourself about siphoning by siphoning water. **Fill** the bottle with water. Place the tube into it and curve the tube down so its end is below the bottle, over a sink or basin. **Suck** until water comes out. Then **stop** sucking and **observe** the water emptying from the bottle.

2. Now try with a gas. **Empty** any water that remains in the bottle. **Put** two teaspoons of baking soda in the bottle. **Add** about 40 ml (a quarter of a cup) of vinegar a little at a time. You will see a vigorous fizzing up of heavy carbon dioxide gas which will fill the bottle. **Test** the gas by quickly dipping a burning taper or wood splint into the bottle.

   * Does the carbon dioxide stop the burning?

3. Now **connect** bottle and glass with the plastic tubing as shown. Have the end just above the frothing mass in the bottle and lower the other end of the tubing below the bottom of the bottle. Give it a strong **suck** and place in the glass. **Wait** for one or two minutes then **test** the gas in the glass with the burning splint.

   * What happens to the flame?
   * Have you been able to siphon carbon dioxide gas?



Take it further

1. Try to **explain** why the heavier carbon dioxide gas has siphoned over.
2. See how many reasons you can think of why carbon dioxide is useful for putting out fires.
3. Can you find out about a better test for carbon dioxide? Why is this better than using a burning splint?

Can you show radioactivity?

Some substances such as the uranium give out invisible rays that pass through paper and even metal. This is called radioactivity and these substances are called radioactive substances. The luminous dials of older types of watches contain a small quantity of a radioactive substance called radium. We can use photographic film to detect the rays given off by this radium.

Collect

black and white photographic film

older-type wrist watch with luminous dial (radiation source)

small metal key such as a car key

adhesive tape

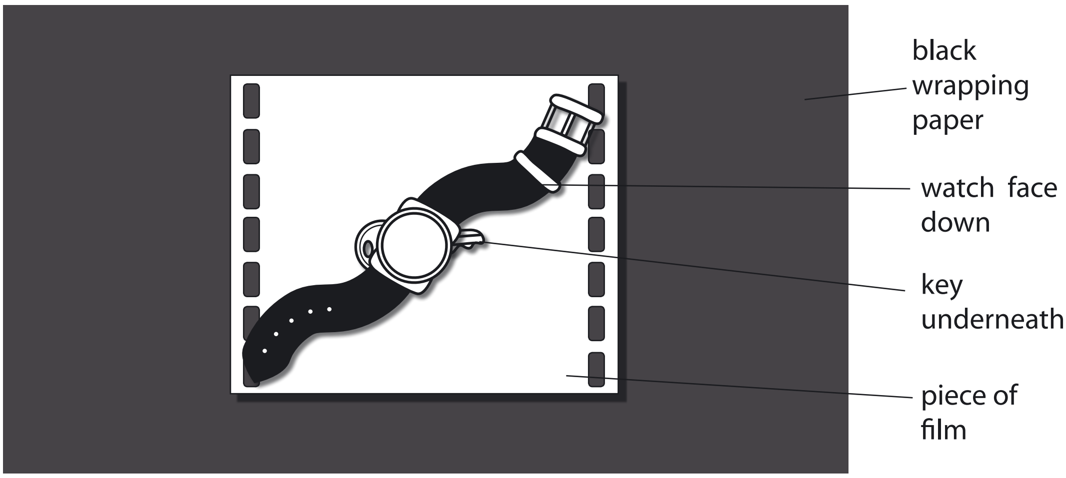
black wrapping paper

access to film development facilities

Investigate

1. Go into a dark room. **Cut** off a piece of film just big enough for the key to lie on. **Place** the key on the film and the watch over it. Use adhesive tape to **fix** the watch in place over the film.

2. **Wrap** layers of black paper around the watch, key and film so that no light can enter. **Tape** the end of the paper down. **Place** it in a completely dark cupboard or drawer. **Leave** for 4 to 5 days.



3. **Develop** the film, being sure to take the film from the package in a dark room. **Look** carefully at the developed film.

   * What do you see on it? **Draw** a sketch.
   * You have made an autoradiograph – what does this mean?

Take it further

Radioactivity was discovered by accident over 100 years ago when the French scientist Antoine Henri Becquerel placed a piece of radioactive uranium ore in a drawer on top of some photographic plates. Later, when he examined the plates, they were fogged up, even though no light could have reached them in the drawer. He concluded that some sort of invisible rays from the uranium must have done it. **Research** the story of the discovery of radiation, including the role played by Marie Curie.

What conducts heat best?

Heat moves through solids mostly by a process that scientists call conduction. Some materials conduct heat better than others. In this activity you will compare how well different metals conduct heat.

Collect

candle

2 lengths of wire made from different metals (for example, copper and nichrome)

drawing pins

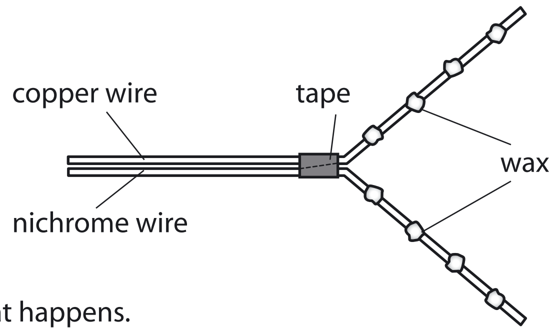
tin can

equal size strips of different types of metal

matches

Investigate

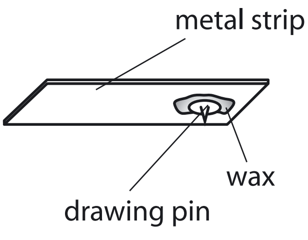
1. **Connect** the two wires together as shown below. **Light** the candle and **drop** blobs of wax at intervals along the wires. Let the wax harden. **Place** the joined ends in a candle flame. **Wait** and **observe** the wax blobs.

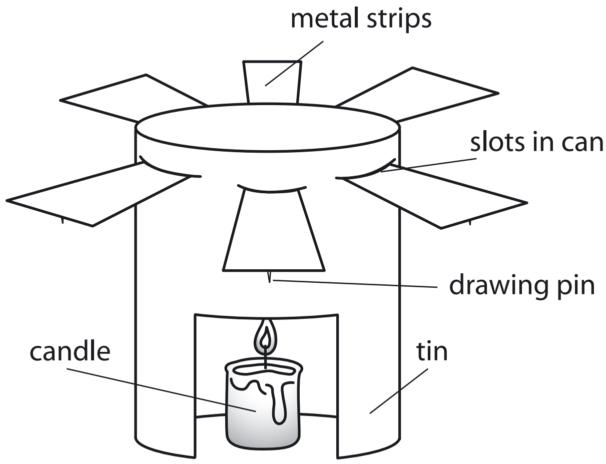


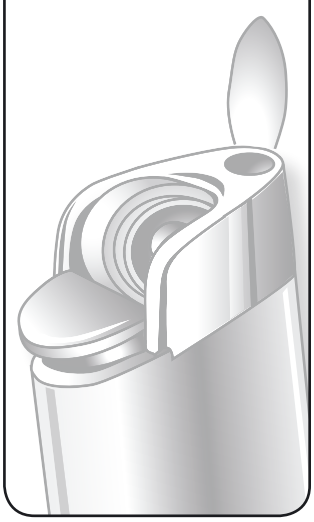
   * **Describe** what happens.
   * Which wire conducts heat best?
   * Are the wires the same thickness? Is the comparison fair?

2. Use candle wax to **fix** drawing pins to the end of a number of strips of different metals. **Attach** the strips to a tin can as shown below. **Put** the can over a lighted candle. **Measure** the time taken for the drawing pin to fall off each metal strip.

   * **Draw a table** to record your results and compare how well the different metals conduct heat.







Take it further

1. **Find out** and **describe** how vibrating molecules allow heat to move by conduction.

2. **Research** how heat moves through liquids and gases by convection.

Can matter expand and shrink?

In this activity you will investigate how heating and cooling changes the size of things. You will look at solids, liquids and gases.

Collect

tin or jar with a lid

coin

candle

matches

clothes-peg or tweezers

bottle with narrow neck

pot of hot water

soft-drink bottle

balloon

rubber band

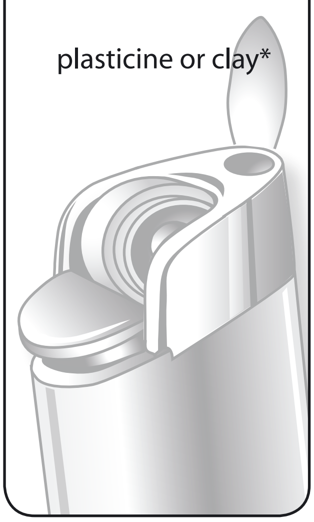
straw or glass tube*

glass of water*

food colouring*

thermometer*

plasticine or clay*



Investigate

1. **Cut** a slot in the tin lid just big enough for a coin to pass through. Holding the coin with the tweezers or clothes-peg, **heat** it over the candle. Now try to **push** the coin through the slot.

   * Does it still pass through? If not, why not?

2. **Fill** the narrow-neck bottle with hot water right up to the brim. Now **leave** the water to cool.

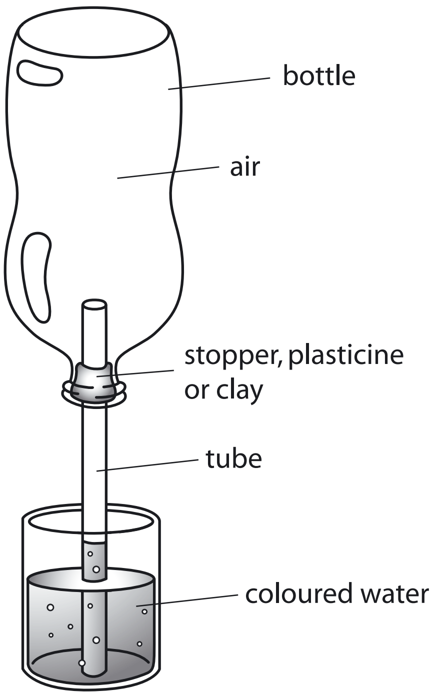
   * What happens to the level of the water in the neck of the bottle?
   * How does cooling affect liquids?

3. **Slip** the neck of the balloon over the mouth of the soft-drink bottle. **Fix** it there securely with a rubber band. **Stand** the bottle in a pot of hot water.

   * **Describe** and **explain** what happens after a minute or two.

Take it further

Can you make an air thermometer like one made by Galileo, the famous Italian scientist? Use the equipment shown alongside. First **warm** the bottle with the candle to drive a little air out of it. Then **put** the tube into coloured water. As the air in the bottle cools, some water rises up the tube. **Clamp** the bottle tube in place. **Note** what happens to the water level over a period of time as the air temperature rises and falls. Can you work out a way to **draw** a reliable temperature scale on the tube (or on card attached behind the tube)?



Can you make a bimetal?

Different types of metals expand differently when heated. Some expand more than others. So, when two strips made of different metals (such as brass and iron) are fixed together and heated, the metal that expands more bends the other metal away. By bending towards or away from a metal contact, bimetals can make or break electric circuits, thus acting as thermostats in appliances designed to work at specific temperatures.

Collect

brass and iron strips about 9 x 1.5 cm

small nuts and bolts

drill

pliers

baseboard

battery

bulb and holder

hook-up wire

copper strip

metal bracket

screws

candle

cellotape or soldering iron

workshop tools

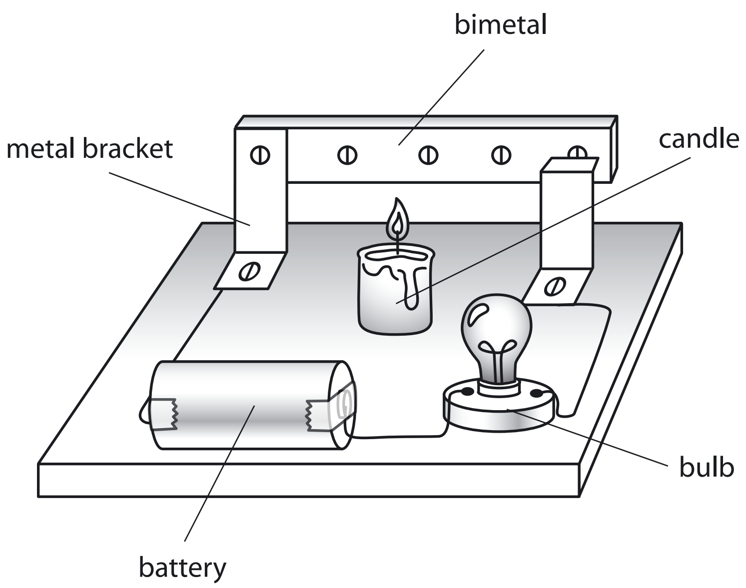
Investigate

1. **Place** the brass and iron strips together in a vice or using pliers. **Drill** holes through both metals just big enough for the small bolts. **Fit** the nuts and bolts and screw the metal strips together tightly.

2. **Heat** your bimetal by holding one end over a candle flame. **Hold** the other end with a pair of pliers.

   * Which way does it bend?
   * Which metal expands more than the other?

3. **Build** an electric warning device using your bimetal. **Use** the design shown here or design one yourself. Such a circuit could, for example turn on a lamp or electric buzzer, or operate a relay.



Take it further

Place your bimetal in the refrigerator. What happens – which side does it bend towards?

200 Super Science Investigations

What happens when you warm and cool air?

The first true flight by humans was in a balloon filled with heated air that was built by the Montgolfier brothers in France. In this activity we will take a closer look at what happens to air when it is heated in a balloon.

Collect

round balloon

matches

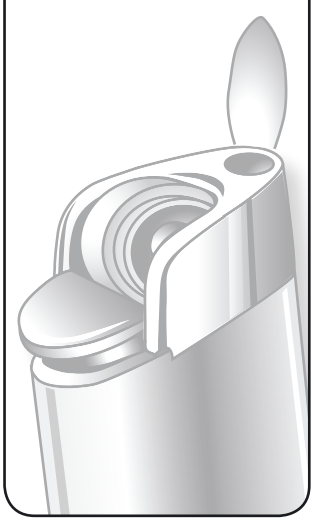
candle or heater

wire

tissue paper or light plastic bag

glue

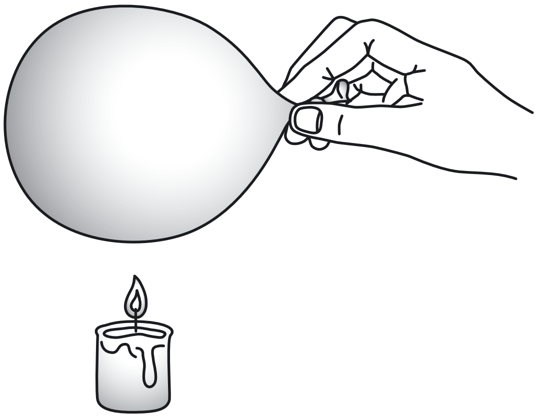
hand-held hairdryer



Investigate

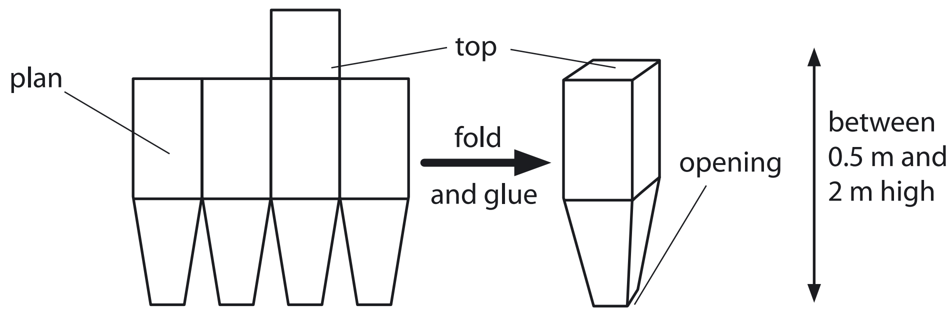
1. **Blow** up the balloon until it is well inflated and tie off the neck. **Make** a circle with the wire so that the balloon can only just pass through it.

2. **Heat** the air in the balloon by holding it a little distance above a lighted candle or heater for 3 to 4 minutes. Now try to **pass** the balloon through the wire loop.



* Can it still pass through the wire loop easily?
* What has happened to the air in the balloon?

3. **Glue** tissue paper together to form a hot air balloon with a structure as shown below (using a light plastic bag is an alternative). **Use** the hairdryer to blow hot air into the opening at the bottom of your hot air balloon.



* Does the tissue paper or plastic bag rise into the air?
* Try to **explain** why this happens.

Take it further

1. What happens to the molecules of air as the gas in the balloon gets warmer and cooler?

2. Think of or find out three ways in which air high above the Earth differs from air at ground level.

Does evaporation produce cooling?

In very hot climates, water is kept in earthenware jars. Some water seeps through the jar and forms a film on the surface. As this moisture evaporates it seems to help to keep the contents cool. The same happens when you wet your face. Let's take a closer look at the effect of evaporation on temperature.

Collect

balloon

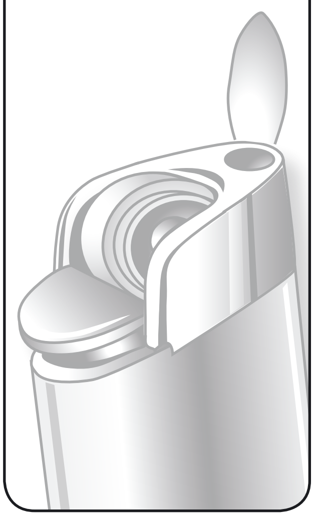
small glass

thermometer

eye dropper

rubber band

methylated spirits



Investigate

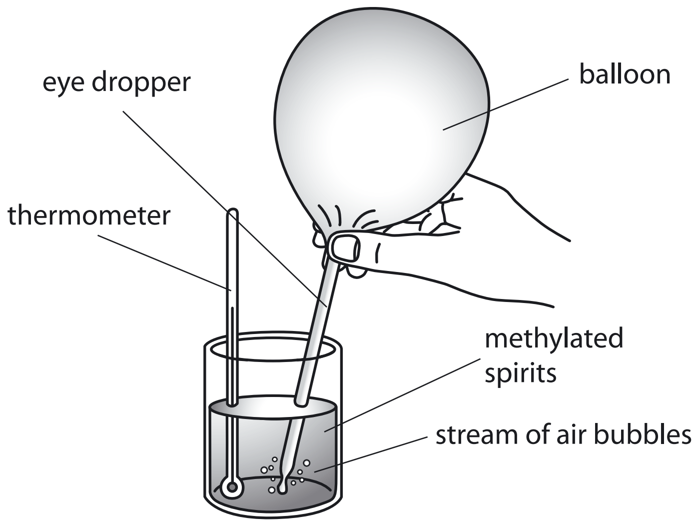
CAUTION: Methylated spirits and its vapour can burn. Have no open flames nearby.

1. **Fill** the glass one-third full of methylated spirits. **Place** the thermometer in position.

   * What is the temperature?

2. **Remove** the small rubber bulb from the end of the eye dropper. **Blow** up a balloon, twist the neck and slip the nozzle over the end of the eye dropper (where the rubber bulb had been). **Fix** in place with a rubber band.

3. **Hold** the tip of the eyedropper just under the surface of the methylated spirits. **Allow** the balloon to untwist so that air travels out through the dropper as an even stream of bubbles. This stream of bubbles helps the methylated spirits to evaporate.



* What is the temperature once the balloon is empty? Has it changed?
* What do you conclude from this experiment?

Take it further

1. **Explain** the change in temperature that you observed by referring to the molecules in the liquid. Do molecules with high or low energy tend to evaporate? What are the effects of losing these molecules? How does this affect temperature?

2. **Moisten** the back of your hand then blow across it. What do you notice? **Explain** this using the information gained from the above experiment.

3. **Think** of and **find out** about further examples of how the effects of evaporation are used in your body, in homes and in industry.

Contents

200 Super Science Investigations

What cools a jet engine?

No metals can withstand the extremely high temperatures in the combustion chambers of liquid fuelled rockets. So, to cool the metal around the combustion chamber, cold fuel from the storage tank flows around the chamber before entering it. In this way the fuel cools the metal around the chamber. Also, the cold fuel is forced through tiny holes in the wall of the chamber so that it evaporates before burning. Evaporation causes further cooling.

Collect

piece of thin cardboard

paper clips

water

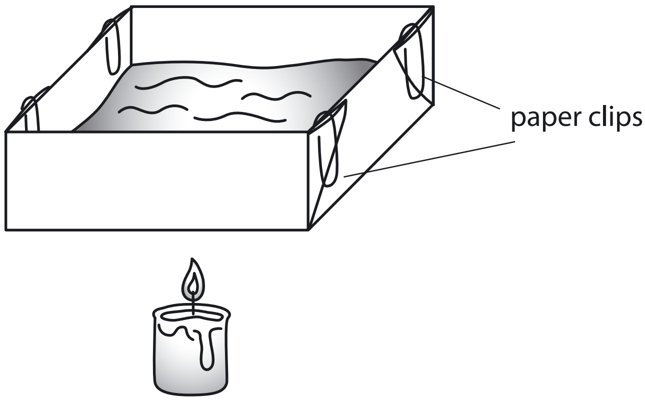
candle or burner

thermometer

methylated spirits

Investigate

1. **Cut** a piece of thin cardboard 12 x 8 cm. **Make** it into a small box by folding up the edges 3 cm from each side (do not cut). **Fold** the corners in and **fix** together with paper clips. Half **fill** the box with water. **Hold** it over a small flame (candle or burner) until the water boils.



* Does the cardboard char or catch alight?
* **Explain** your observation. Where is the heat of the flame going?

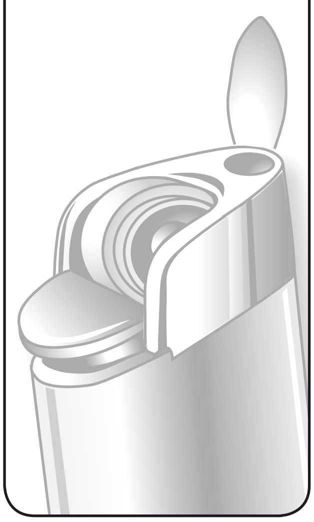
2. **Dip** the bulb of a thermometer in methylated spirits then remove it.

   CAUTION: Methylated spirits and its vapour can burn. Have no open flames nearby.

   * What happens to the level of mercury? Why?

3. **Rub** a little methylated spirits on the back of your hand and blow across it.

   * As the methylated spirits evaporates, what effect does it have?
   * Why did you use methylated spirits instead of water in this experiment?



Take it further

1. Now, in your own words, **explain** how a rocket engine is cooled.
2. **Explain** how our bodies use evaporation to keep cool.

How is temperature controlled in spacecraft?

A spacecraft must be able to insulate the astronauts and equipment inside against the temperature extremes of space. One method of controlling temperature is by using insulating materials such as polystyrene, which is also used in making ceiling tiles and in packaging. In this experiment you will investigate how good polystyrene is at shielding materials from outside heat.

Collect

polystyrene scrap from the packaging of an appliance

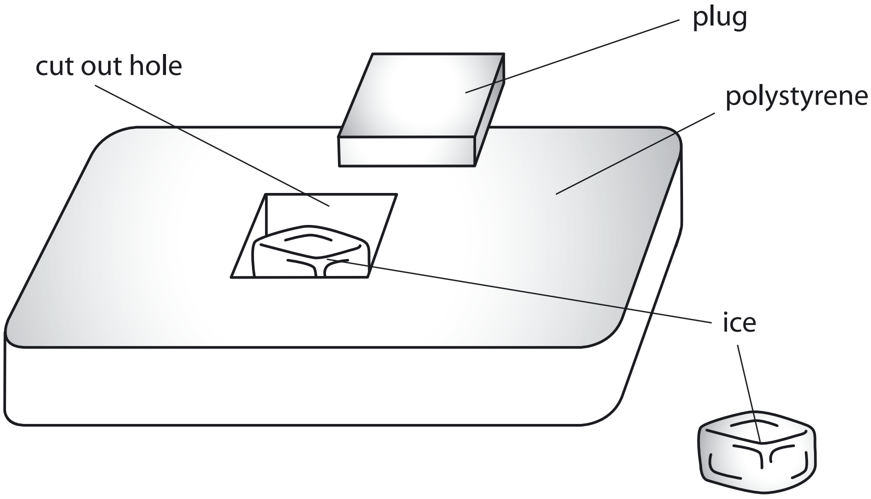
sharp knife

two ice cubes

watch

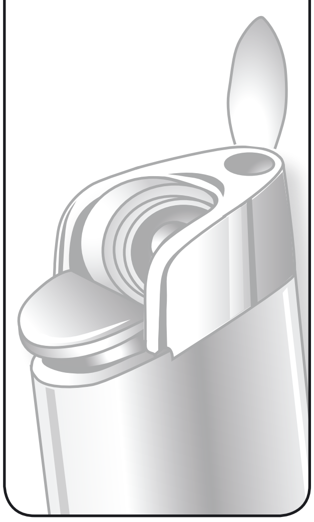
Investigate

1. **Select** a large piece of polystyrene. Use the sharp knife to **cut** a hole in this big enough to take an ice-cube. Also **cut** a piece to close the top of the hole.



2. **Place** one ice-cube in the hole. **Close** the hole with the plug. **Place** the other ice-cube nearby in the open. **Note** the time as you do this.

   * How long does the ice-cube in the open take to melt?
   * How long does the ice-cube in the polystyrene take to melt?
   * What does this tell you about the heat-insulating power of polystyrene?



Take it further

Research how polystyrene is made. What are its properties? Why is it a good insulator? Give some examples of things it is used to make.

Can you test materials at low temperatures?

Cryogenics is the study of materials and how they behave at very low temperatures – much lower than experienced in everyday life. The behaviour of substances at low temperatures is often different from their behaviour at normal temperatures.

Collect

acetone

dry ice

measuring cylinder

stirrer

newspaper

test tube

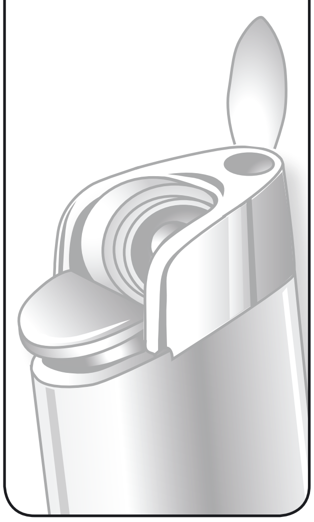
flower

rubber tubing

hammer

nichrome wire (from an old electric toaster or heater)

circuit with bulb and battery



Investigate

CAUTION: Have no flames nearby as acetone is inflammable. Wear thick gloves when handling dry ice or anything frozen with it. Dry ice can cause burns. Do not leave dry ice or the freezing mixture in a closed container.

1. **Powder** the dry ice by wrapping it in several layers of newspaper and pounding with a hammer. **Pour** about 200 ml of acetone into a beaker. **Add** the powdered dry ice while stirring. After the bubbling stops, **add** more dry ice to get a mushy mixture. You can get temperatures of around -75°C with this mixture.

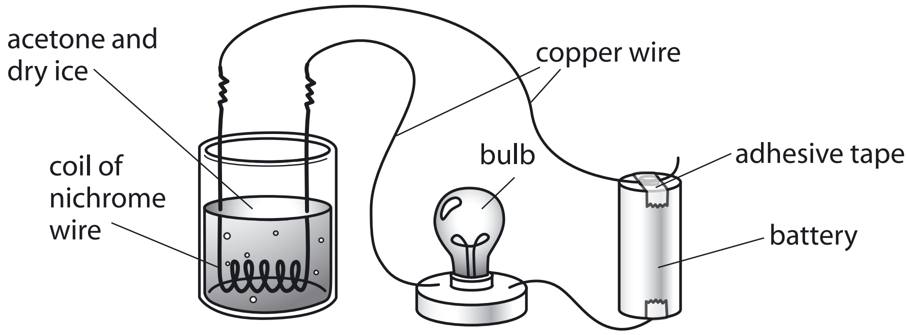
2. **Lower** a flower into the very cold mixture. **Leave** it for a minute or two then **remove** it.

   * How does it change? **Describe** the petals.

3. **Lower** a piece of rubber tubing into the cold mixture for 1 to 2 minutes. **Take it out** and **hit** it with a hammer.

   * **Describe** what happens.

4. **Connect** up an electric circuit with a coil of nichrome wire as shown below. **See** how bright the bulb is. Then **lower** the nichrome coil into the cold mixture.



   * What changes do you observe in the bulb?
   * Has the low temperature helped the current to flow?

Take it further

Research what the lowest temperature possible is. What is it called? What happens to the movement of molecules at this temperature?

Can you make anti-freeze?

We add anti-freeze to car radiators to stop water freezing in the engine which would cause damage. Antifreeze also provides protection against overheating in the hot months of summer. In this activity we will see that dissolving table salt in water also affects the temperature at which the water freezes.

Collect

two plastic drinking cups

water

table salt

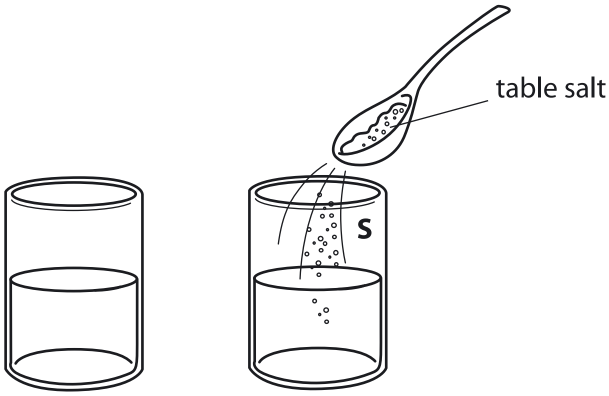
tablespoon

freezer

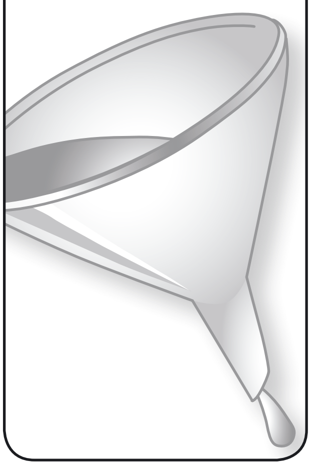
marker pen

Investigate

1. **Fill** both cups half full of water. **Add** a tablespoon of table salt to one of the cups. **Stir** to dissolve. **Write** an 'S' for 'salt' on this cup.



2. **Place** both cups in the freezer of your refrigerator. **Look** at them every 30 minutes.
   * **Record** any changes.
3. **Leave** the cups in the freezer over night.
   * What do you find when you look at them in the morning?
   * Does one cup freeze more easily than the other?
   * Has the salt made the water freeze more easily or less easily?



Take it further

Find out about how dissolved substances interfere with the forces of attraction between molecules in a liquid. **Explain** how this in turn affects the freezing and boiling points of solutions.

Can you grow crystals?

Alum is one of the easiest crystals to grow. It usually crystallises as eight-sided octahedra. Let's experiment!

Collect

alum (potassium aluminium sulphate)

2 small glass dishes

beakers or glasses

teaspoon

pencil

thread

magnifier

hot water

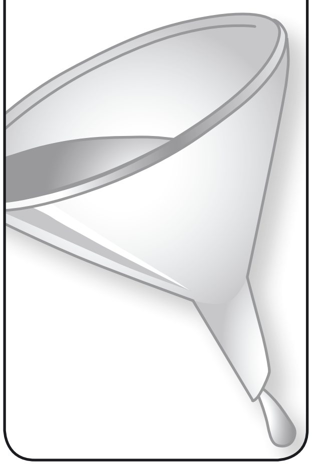
filter paper

pocket knife

fine sandpaper

Epsom salts (magnesium sulphate)*

saltpetre (potassium nitrate)*



Investigate

1. **Place** a teaspoon of alum in a small glass dish or beaker. **Add** three teaspoons of water (about 15 ml), then stir to dissolve. Then **add** more alum, a quarter teaspoon at a time with stirring until no more will dissolve. The solution is now saturated.

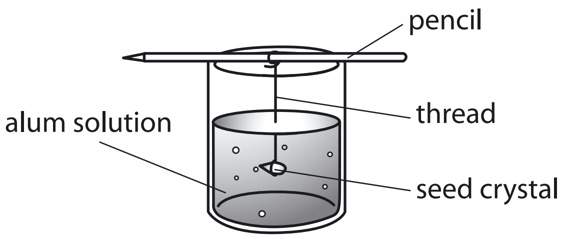
2. **Place** the beaker in a basin of hot water. **Stir** to dissolve any alum still in the beaker. Then **add** another quarter teaspoon of alum. **Stir** to dissolve. This gives you a super-saturated solution.

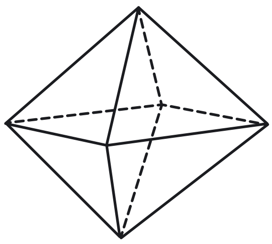
3. **Wrap** the dish in a cloth. **Store** in a quiet place where the temperature stays fairly constant. **Leave** overnight or longer.

   * **Describe** the shape and size of the crystals that form.

4. **Pour** off the liquid from the crystals into another beaker. Use a pocket knife to **transfer** 3 or 4 of the best diamond-shaped crystals to a filter paper to dry them.

5. **Add** a thin layer of alum powder to the beaker of saturated alum solution. **Warm** very gently to dissolve. **Leave** it to cool. Then **suspend** your crystal as shown below. **Leave** overnight.





   * What two things have you done in step 5 that will help you grow a larger crystal?

6. **Repeat** this process and within a week or so your crystal may have grown too big for the beaker.

If you find small irregular growths on your crystal, **dry** the crystal as described in step 4 and gently **rub** these away with fine sandpaper. Then **wipe** the crystal face over with a damp cloth. Also, **remove** small alum crystals on the thread by crushing them with the flat blade of the pocket knife.

Take it further

Try the above experiment with Epsom salts (magnesium sulphate) and then with saltpetre (potassium nitrate). **Look** at the different crystals through a magnifier. What shapes can you recognise?

Can you make oil and water mix?

A mixture of oil and water tends to separate into two layers. This can be delayed or prevented by adding a substance called an emulsifier. Emulsifiers allow oil and water to mix to form a milky liquid known as an emulsion.

Collect

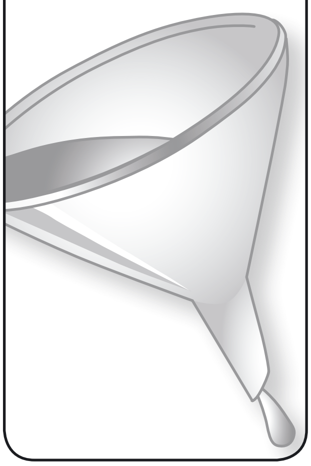
4 small jars (preferably with screw lids) or 4 test tubes

cooking oil

detergent

egg-yolk

gum arabic

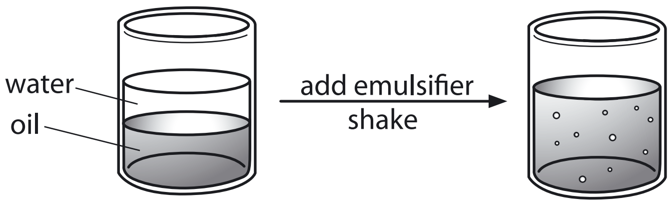


Investigate

1. **Fill** each jar one third full of olive oil and one third full of water. **Put** on the screw-top and **shake** well.

   * **Describe** what happens.
   * Do oil and water mix?

2. **Add** a little detergent into the second jar. **Shake** well.



   * What can you say about the mixture now – how would you describe the appearance?

3. To the next jar, **add** an egg yolk. **Shake** well.

   * **Describe** the emulsion.

4. To the fourth jar, **add** some gum arabic. **Shake** well.

   * Do you get a good emulsion – is gum arabic helping to mix the oil and water?

Take it further

1. Use your knowledge of emulsions to **explain** how soap helps to clean things.
2. Mayonnaise is an emulsion. **Find out** how it is made.
3. Emulsions are important in many industries today, including cosmetics, foods, dyeing, tanning, plastics and medicines. **Find out** more about one of these.

Can you create perfumes?

Many substances used as perfumes are made from pleasant smelling essential oils found in plants. Solvents such as alcohol are used to dissolve and extract the oil from the plants. In this activity, alcohol dissolves the oil of lavender in the lavender plant. The alcohol evaporates quickly leaving a tiny amount of the aromatic oil behind.

Collect

pieces of lavender (with flower heads if possible)

2 small bottles with screw-tops or 2 test tubes with stoppers

rubbing alcohol (or methylated spirits)

20 cloves

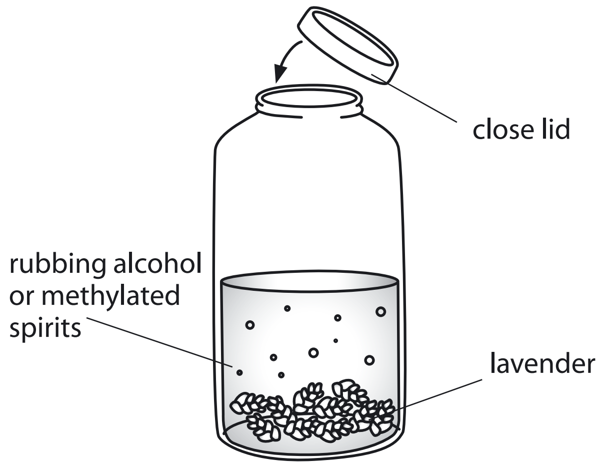
samples of perfume or essential oils*

filter paper strips*

glass rod*

Investigate

1. **Cut** the lavender into very small pieces. **Place** the pieces in the bottle or test tube. Half **fill** the bottle with alcohol or methylated spirits. **Close** it and leave overnight.



2. Using your finger, **dab** a few drops of the alcohol from the lavender mixture onto a card or onto your wrist. **Leave** the alcohol to evaporate. Then **smell**.

   * How would you **describe** the smell?
   * Can you **explain** where the smell comes from?

3. **Place** the cloves in the small bottle or test tube. Half **fill** with alcohol or methylated spirits. **Close** it and **set it aside** for a week. Now **repeat** the test as described in step 2 above.

   * Have you managed to extract an essential oil from cloves?

Take it further

Write the name of each sample perfume or essential oil on a strip of filter paper. Use the glass rod to **place** a drop of the correct perfume or essential oil on each strip of filter paper. Now **hold** the strips together in various combinations and sniff each combination. Which combinations do you like best? How successful are you at producing an attractive and pleasing perfume?

Can chemicals protect us against disease?

Disease-causing bacteria, protozoa and viruses can spread in contaminated water. For this reason, most drinking water is treated to kill germs – usually by adding small amounts of chemicals that kill germs. Chlorine is commonly used, while iodine is also very effective.

Collect

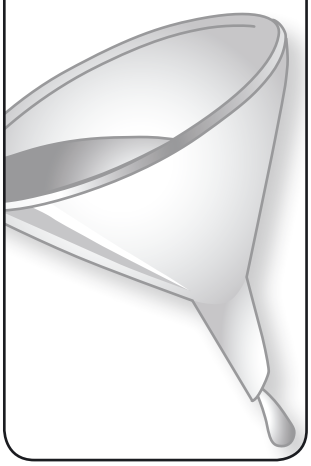
water

egg white

beaker or glass

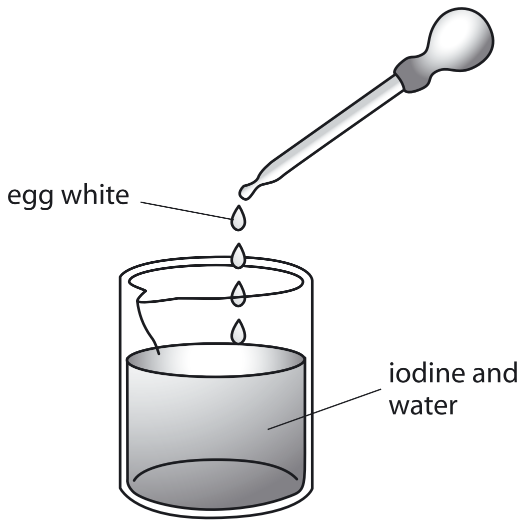
iodine solution (use bench reagent of iodine in potassium iodide solution)

eye-dropper or straw



Investigate

1. **Half fill** a small beaker with water. **Add** six drops of iodine reagent with a dropper.



* What colour is the water and iodine?

2. **Clean** the dropper. **Add** ten drops of egg white. **Leave** it for 30 minutes.

3. **Examine** the egg white.

* How has it changed?
* As egg white and bacteria are both protein, what effect would you expect iodine to have on bacteria?

Take it further

Research how large cities treat drinking water. Share your information by **drawing** a diagram of a typical water treatment facility, with labels that briefly describe the steps in water treatment.

Can you separate solid particles from water?

Filtering can separate a mixture of a liquid and a solid that cannot dissolve. A filter allows the liquid through (called the filtrate), but not the solid. If a solid settles quickly when the liquid is allowed to stand, we can also decant (pour off) the liquid while the solid remains behind.

Collect

2 beakers or glasses

stand with ring (or willing helper)

filter funnel

clay

filter paper

sand

stirring rod

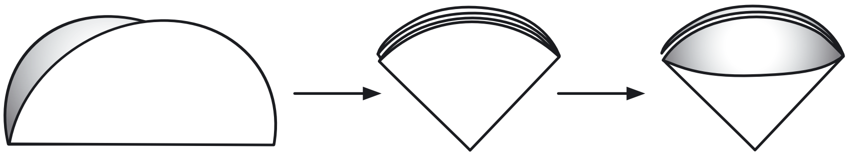
water

cooking oil*

Investigate

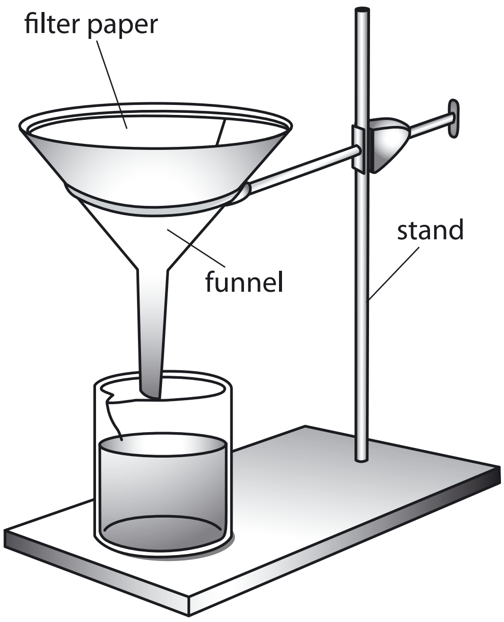
1. **Stir** up a little clay with water in a glass or beaker.

2. **Fold** a circular filter paper as shown below – first into a semicircle, then again **fold** it into a quarter circle. Now **open** it so as to form a cone with three thicknesses of paper on one side and one thickness on the other.



3. **Place** the paper cone in the funnel. **Moisten** it with a little water. **Support** the funnel with a stand. **Pour** the muddy water down a stirring rod onto the filter paper.

   * Is the filtrate that comes out the bottom clear?
   * What has happened to the mud?

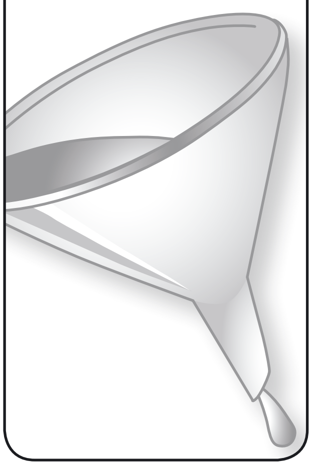


4. **Put** a little sand in a beaker containing water.

   * Does the sand float or settle quickly?

5. **Decant** the water down a stirring rod into another beaker, leaving the sand in the first beaker.

   * How successful is your decanting at separating the mixture?



Take it further

Separate cooking oil and water using the method of decantation. How successful are you?

200 Super Science Investigations

Can you clean dirty water?

When people treat water to provide drinking water for cities, they often need to remove solid particles such as soil. One way to remove solid particles is to add aluminium sulphate to the water. This chemical is a flocculating agent. This means it causes any particles in the water to 'flock' together to form clumps or flakes. These clumps of materials quickly settle to the bottom or may be easily filtered out to leave clean water.

Collect

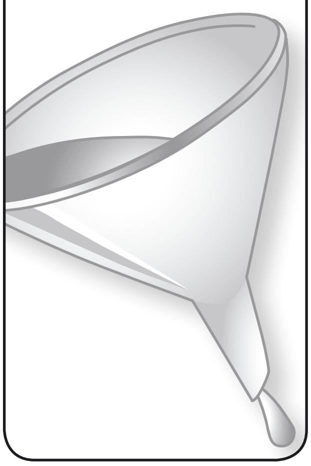
garden soil

3 test tubes

2 jam jars

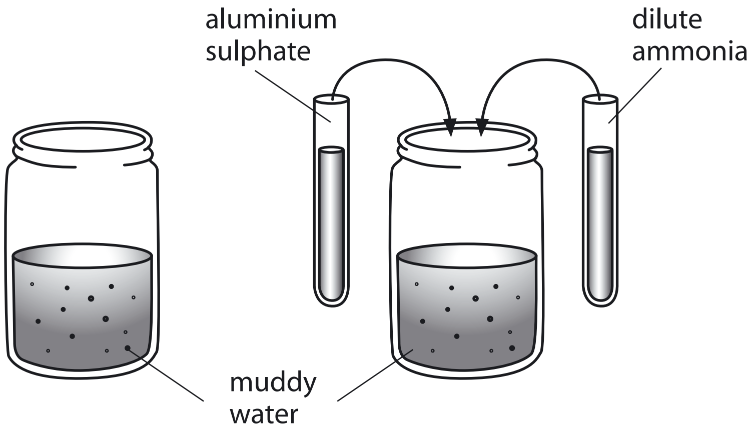
aluminium sulphate solution

ammonia or sodium carbonate solution



Investigate

1. **Put** soil in a test tube to a depth of 3 cm. **Fill** the tube with water and shake well. **Pour** half the muddy liquid into one jar and the other half into the other jar.



2. Now **add** water to each jar to make them close to half full.

3. To one jar **add** half a test tube of the aluminium sulphate solution. Then slowly **add** half a test tube of dilute ammonia or sodium carbonate solution.

4. **Leave** undisturbed for 10 to 15 minutes. **Place** the jars alongside each other.

   * **Compare** the water in the two jars.

   * Has chemical treatment helped to clean the water?

Take it further

Water for our homes comes from reservoirs and passes through filters. **Find out** what these filters are made from and how they remove sediments. What are 'zeolites'?

Can spinning separate mixtures?

When you mix tiny solid particles with water, they will slowly settle to the bottom of the mixture because of gravity. In this activity you will speed up this separation using a simple centrifuge. A centrifuge is a machine that spins containers of liquid around very fast in order to separate substances in the liquid.

Collect

clear plastic jar

bradawl or other sharp pointed tool

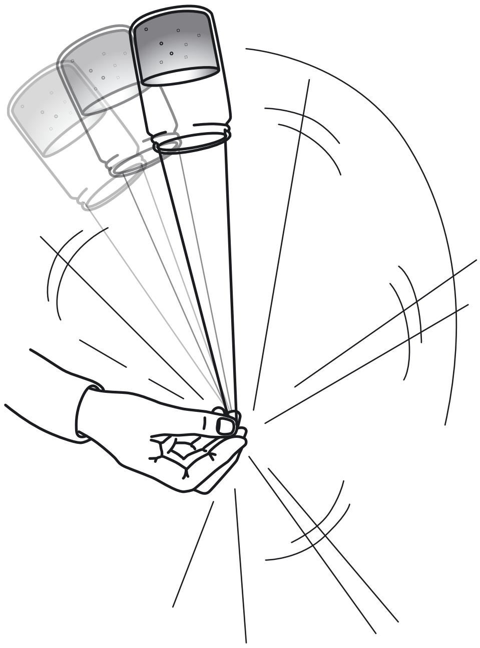
string

water flour

2 glasses

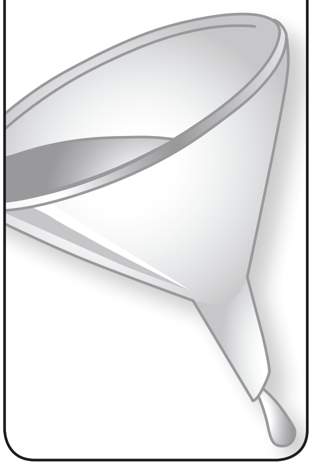
Investigate

1. Using the sharp-pointed tool, **make** two holes opposite one another near the top of the plastic jar. **Tie** the ends of a 60 cm piece of string in these holes.
2. Three quarters **fill** the jar with water. **Add** four dessert spoons of flour. **Mix** in well. **Pour** half a glass of this mixture into a glass. **Leave** the glass on the bench.
3. Now **go** outside. **Swing** the jar in a circle about 20 times as fast as you can.



4. **Return** inside. **Pour** half a glass off from the top of the mixture into a second glass.

   * How does the appearance of the second glass **compare** with that of the first?
   * What happened to the solid particles in the jar when you swung them around?
   * **Explain** how the spinning has helped the settling process.



Take it further

1. **Find out** more about centrifuges. **List** some examples of the uses of centrifuges, for example, in food processing and medicine.
2. How is a centrifuge used in training astronauts?

200 Super Science Investigations

Mixtures

Can magnets separate mixtures?

Magnets can separate magnetic materials from non-magnetic materials. This is important for separating mixtures of some minerals and for separating metals for recycling from other scrap.

Collect

iron filings

sand

strong magnet

paper or plastic

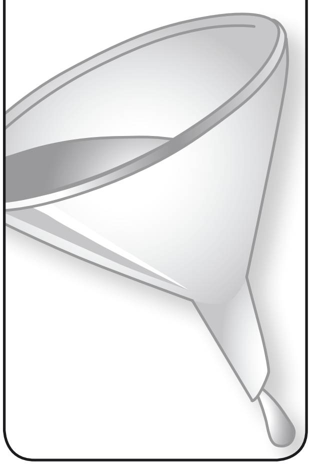
rubber band

sulphur*

crucible or small tin*

burner*

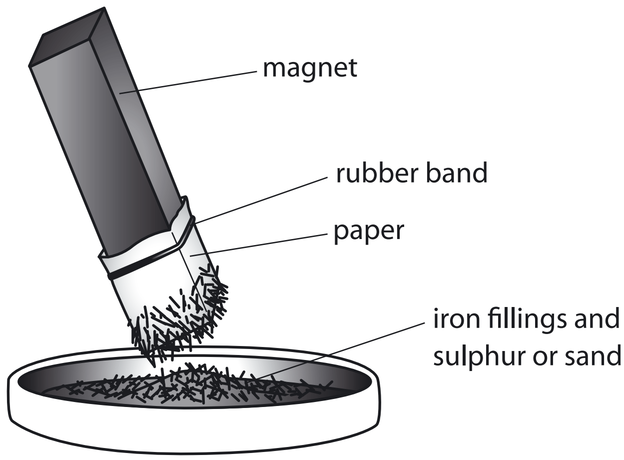
heating stand*



Investigate

1. **Make** a mixture of iron filings and either sand or sulphur powder.

2. **Wrap** the magnet with paper or plastic film and **fix** it in place with a rubber band. Now **stir** the covered magnet around in the mixture. **Withdraw** it and **hold** it over another container. **Remove** the magnet from the paper.



* What happens to the iron filings?
* Was any sand or sulphur removed by the magnet?

3. **Repeat** step 2 until there are no more iron filings left.

Take it further

1. **Draw a design** for a machine that separates recycled (magnetic) tin cans from recycled plastic bottles.

2. Working safely, **put** 3 teaspoons of sulphur powder into a crucible or small tin. **Heat** on a heating stand until the sulphur boils and turns a dark colour. **Remove** the heat and **add** half a teaspoon of iron filings. A chemical reaction forms a new substance – a compound of iron and sulphur. What is this compound called? **Let** the new substance cool and **compare** it to a mixture of iron filings and sulphur. **Test** the new substance with a magnet. (Note: it should not be magnetic, but you may find that it still is as some iron may be left unchanged.)

Contents

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Mixtures

Can you separate colours?

In this activity you will use a method called chromatography to test the ink in a water-soluble black felt-tip pen. You will see if the ink is made of a mixture of more than one coloured dye. A dye is a substance used to give colour to something.

Collect

strip of filter paper 10 x 1cm

black water soluble felt-tip pen

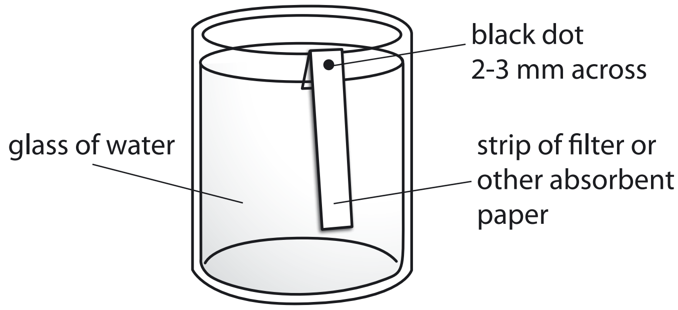
glass

water

other dyes*

Investigate

1. About 4 cm from one end and in the centre of the strip of filter paper, **make** a dot 2 to 3 mm across with the black felt-tip pen.
2. **Fill** a glass with water nearly to the top. **Make** a fold in the strip of filter paper just above the dot. **Place** this on the edge of the glass of water, with the folded part in the water.



3. **Observe** for a short time.

   * Do you see one colour only or different colours separating out?
   * If more than one colour, **list** the colours.

Take it further

Find a second black felt-tip pen of a different make and **repeat** your experiment. You can also try clothing dyes, coloured inks, food colourings, beetroot juice concentrate, etc.

Can you separate ink in circles?

Chromatography is a method of separating dissolved dyes using a liquid (called the solvent) seeping though paper. Different dyes move at different speeds through the paper so they separate from each other as they move.

Collect

2 shallow clear glass or plastic dishes e.g. Petri dishes about 9-10 cm in diameter

2 pieces of filter or blotting paper about 11-12 cm square

scissors

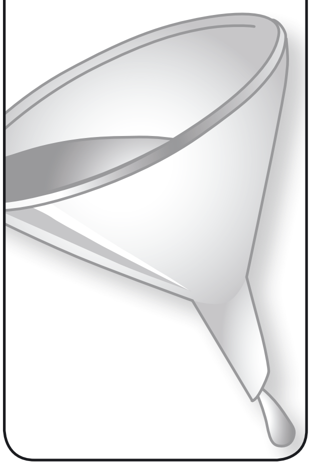
red dye or red felt-tip pen

vinegar

water*

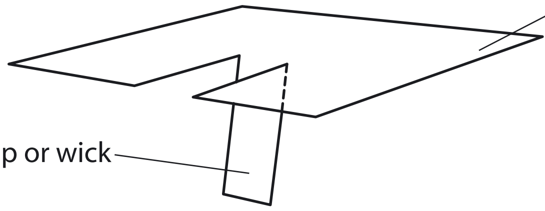
alcohol*

coarse string or cotton wool

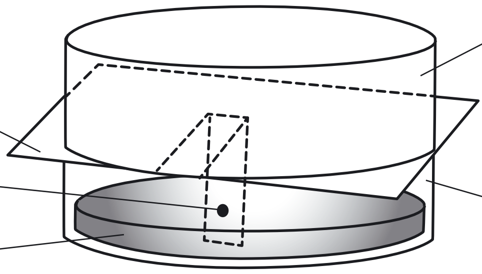


Investigate

1. **Cut** a strip ½ cm wide to the centre of a piece of filter paper. **Bend** it to a right angle. **Trim** the strip so that when the paper is placed flat on the dish, the strip or wick just touches the base of the dish. **Place** a dot of red dye in the centre of the strip, about 2 cm from the end.



2. **Pour** vinegar into the dish just enough to cover about a ½ cm of the end of the strip. Now **place** the second dish upside down over the first so that the paper is covered and evaporation prevented.



3. **Observe** the solvent move up over the dot of dye, to the top of the strip and then horizontally out almost to the edge of the dish.

   * Do you see circles of colour?
   * How many separate colours can you identify?

Take it further

Try to **improve** your method of chromatography: **Cut** a ½ cm hole at the centre of the second piece of filter paper. Use the same dye that you used before. **Make** a wick by rolling some cotton wool into a shape that neatly fits the hole (or use coarse string). Make sure the bottom of the wick touches the base of the dish. Use a water and alcohol mix as developer. Do you get better separation of the dyes than when using the previous method?

Can you purify citric acid from lemons?

The sour taste of lemons, oranges and many other fruits is due to a substance called citric acid. Pure citric acid is a white crystalline solid. It dissolves in water to form a weak acid which is only slightly corrosive. In this activity you will use evaporation to try to separate citric acid from the mixture of many substances found in lemons.

Collect

lemon

lemon squeezer

beaker

filter funnel

filter paper

burner

evaporating dish

powdered charcoal

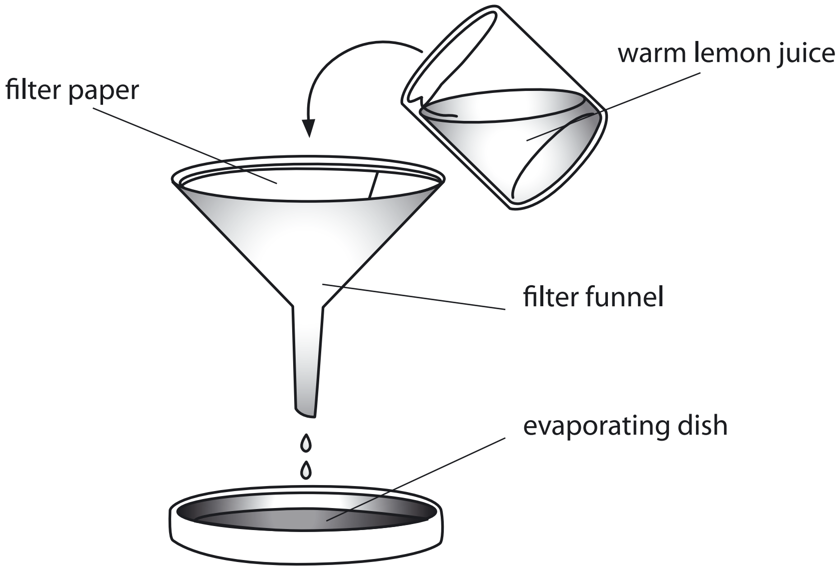
old teaspoon*

pliers*

Investigate

1. **Squeeze** a lemon using a lemon squeezer. **Put** the juice into a beaker. **Add** an equal volume of water and boil over a low flame for 10 to 15 minutes.

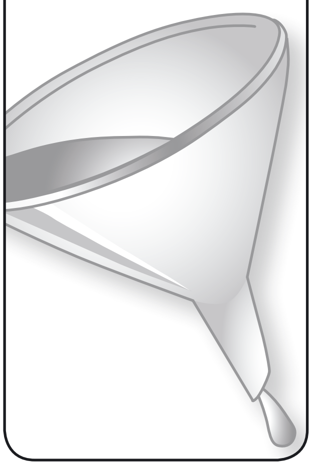
2. While still warm, **filter** the liquid into an evaporating dish. **Leave** for a while so that evaporation reduces the volume until about one third is left.



   * What do you see forming in the dish as cooling takes place?

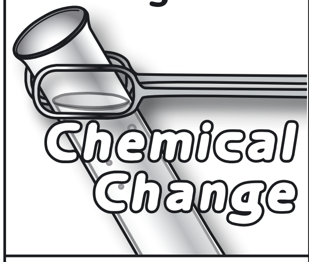
3. If the crystals are brown, follow these steps to purify them further. **Add** a little water to dissolve the crystals. Then **boil** for about 10 minutes with a little powdered charcoal using a low flame. Finally **filter** the liquid and **leave** it to evaporate and form crystals.

   * How does the charcoal help?
   * What is the shape of the crystals?



Take it further

Find out the effect of heat on citric acid. **Half fill** an old teaspoon with the acid and with the help of pliers, **hold** it over a small flame. **Describe** what happens. Is a deposit left on the spoon? Does the vapour from the crystals catch fire? What is the flame colour?



Can you release energy from chemicals?

When chemicals react, they change to form new substances. This often releases energy stored in them. We can observe the heat, light or even electrical energy released.

Collect

quicklime

tin lid

Condy's crystals

glycerol

small piece of wood

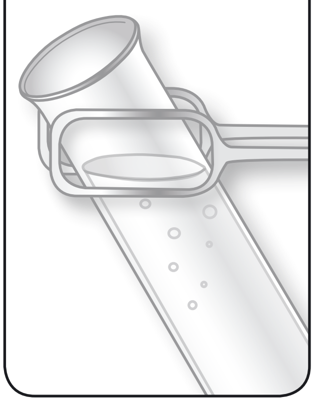
dropper

candle

matches

lemon*

strips of zinc (from an old torch battery) and copper, or use a copper nail and a galvanised nail (coated with zinc)*

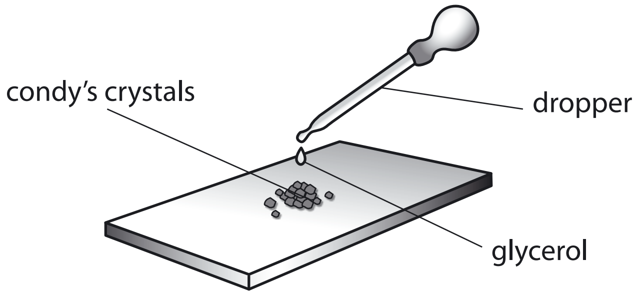


Investigate

1. **Put** a small quantity of quicklime (burnt lime) in a tin lid. Then **add** water to it drop by drop.

   * Does the lid become warm? Is energy set free?

2. **Grind** up some Condy's Crystals and **place** a small heap 1 to 2 cm across on a small piece of wood. **Make** a small hole at top of the heap. Use the eye-dropper to **drop** one drop of glycerol into this hole.



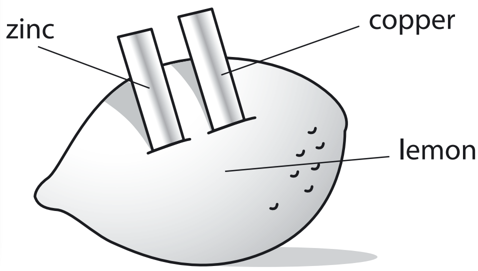
   * What happens? Is chemical energy released?

3. **Light** the candle. Then **cover** it with a glass and see what happens.

   * What forms of energy does the burning wax release?
   * What happened when you covered the candle? What other substance is needed to react with the wax when it burns?
   * Do you know what products are formed when the candle burns?

Take it further

Make an electric cell with a lemon. Start by **rolling** the lemon on the desk to soften it. **Push** the zinc and copper strips well down into the lemon about 2 cm apart. **Press** your tongue across them. Can you feel an electric current produced when citric acid in the lemon juice reacts with the two metals? How does this cell resemble a car battery?



What makes dough rise?

In this activity you will investigate the chemical change that happens between tartaric acid and sodium bicarbonate – the two ingredients of baking powder. You will also see what happens to heated sodium bicarbonate. In order to understand these experiments you must know that the gas carbon dioxide is the only gas that turns clear lime water a milky colour.

Collect

small bottle fitted with cork (or modelling clay) and a tube

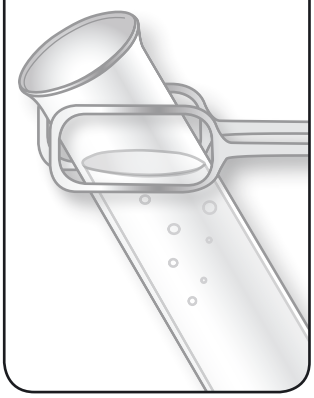
clear lime water

small glass or beaker

test tube fitted with cork (or modelling clay) and tube

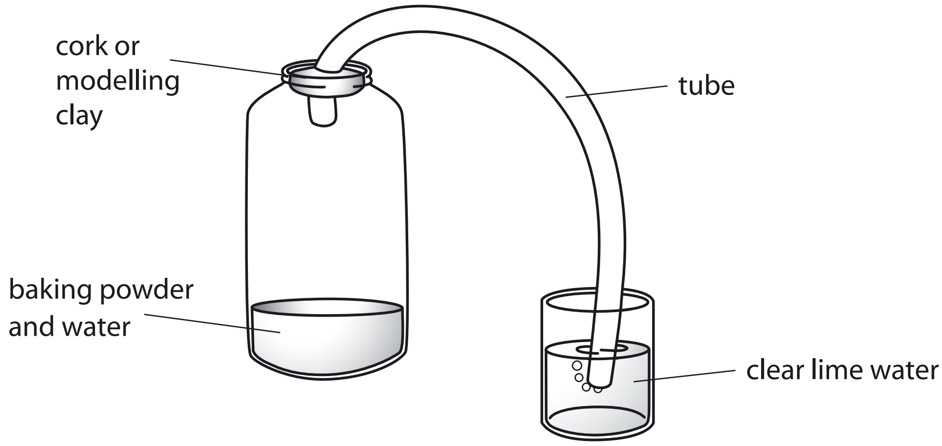
sodium bicarbonate (bicarbonate of soda; baking soda)

candle or burner



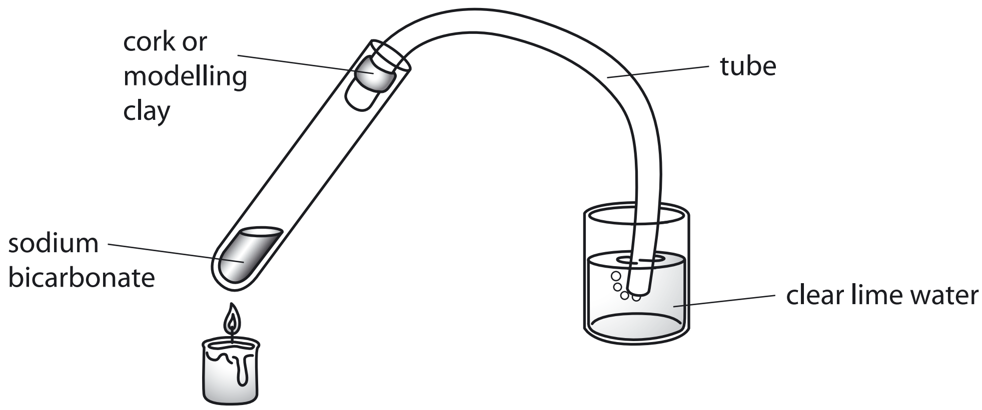
Investigate

1. **Put** 4 teaspoons of baking powder into the small bottle. **Pour** a little water to cover the baking powder. **Fit** the tube and cork or clay so that the bubbles of gas produced can pass through the tube and bubble through the clear lime water in the glass, as shown below.



* **Describe** what happens to the clear lime-water.
* **Identify** the gas produced.
* Use the results of this experiment to **explain** how baking powder makes dough rise.

2. **Heat** a little bicarbonate of soda in a test tube using the set up below, with the gas produced passing through clear lime water in a glass.



* **Describe** what happens.
* How is heating bicarbonate of soda similar to mixing baking powder and water?

Take it further

Make two small cakes of dough, adding a pinch of baking soda to the flour for one cake only. Bake in the same oven. How does the dough without the soda cook? What about the other one – how does it differ? Explain the difference.

200 Super Science Investigations

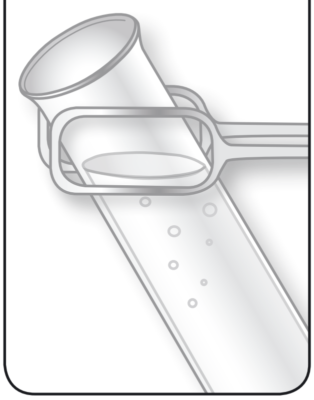
Chemical Change

Can you make sherbet?

Sherbet is a sweet and tangy mix of citric acid, baking soda and sugar. The citric acid and baking soda react together when mixed with water to form bubbles of carbon dioxide gas. The sugar makes it taste sweet. Adding this mixture to fruit juice produces a tasty drink. Let's experiment!

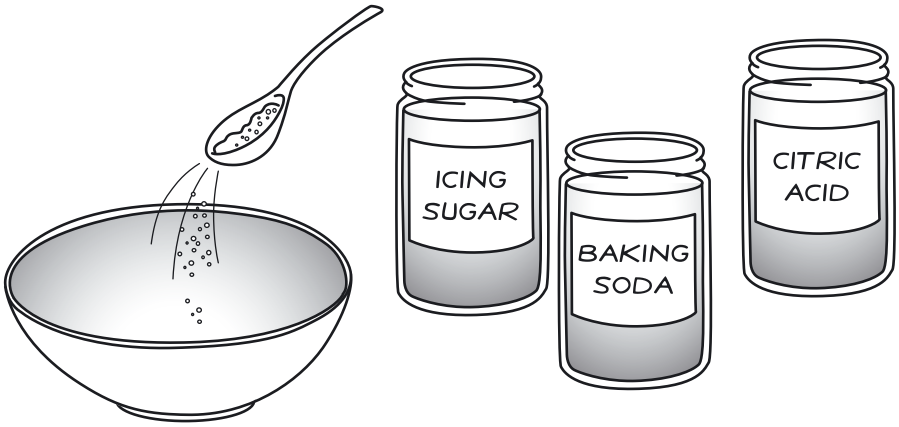
Collect

- citric acid
- baking soda
- icing sugar
- small kitchen basin
- glass suitable for drinking out of
- water
- ice cubes
- tablespoon
- clean dry screw-top jar
- orange
- juice squeezer or extractor



Investigate

1. In a small basin, **mix** together 50 g (7 tablespoons) of icing sugar, 25 g (1 ¼ tablespoons) of baking soda, and 25 g (3 tablespoons) of citric acid. The finished mixture should be a fine powder with no lumps. **Store** this in a dry screw-top jar.



2. **Test** your sherbet by adding a teaspoon of the powder to a glass of water.

   * What happens? Why do you think this happens?

3. **Squeeze** an orange. **Add** the juice to a glass half filled with ice-cooled water. Now **add** a teaspoon of the sherbet powder and you have orange-flavoured sherbet drink.

   * Does it fizz up? Does it taste good? What can you do to make it taste even better?

Take it further

All the parts of our body produce carbon dioxide as a waste. The carbon dioxide must travel in our blood to our lungs where it passes out of the blood and is breathed out. **Find out** how carbon dioxide is transported in blood. What things in the blood help to transport carbon dioxide?

200 Super Science Investigations

Chemical Change

Can washing soda change into baking soda?

Baking soda (also called sodium bicarbonate - $NaHCO_3$) is commonly used in cooking, while washing soda (sodium carbonate - $NaCO_3$) is used for washing. In this activity you will use carbon dioxide to turn washing soda into baking soda, producing a new substance, with new properties.

Collect

small bottle fitted with cork (or modelling clay) and a tube

vinegar or citric acid

marble chips

sodium carbonate

test tubes

burner

teaspoon

washing soda (sodium carbonate)

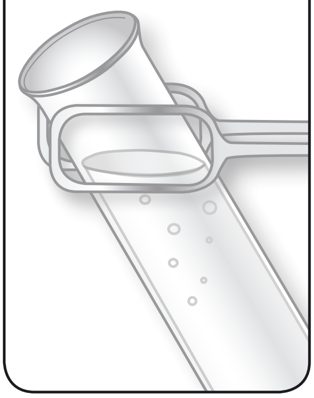
water

glass or beaker

filter paper and funnel

clear lime water

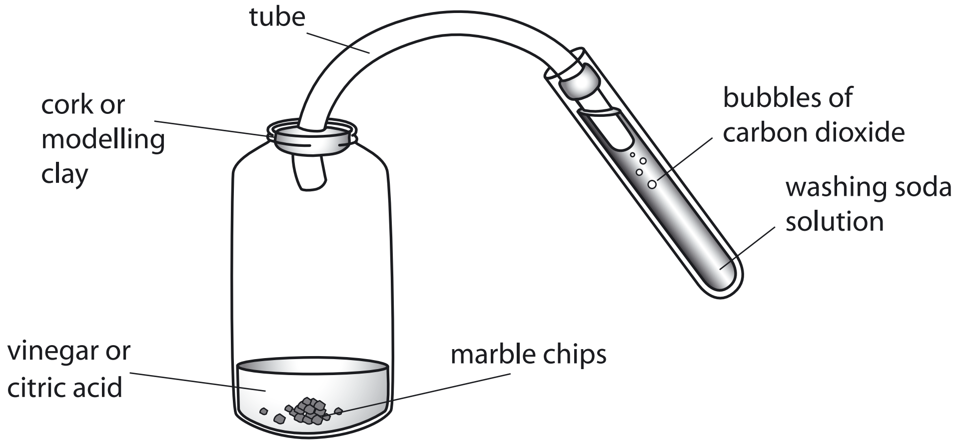
phenolphthalein*



Investigate

1. **Add** one teaspoon of washing soda to half a test tube of water. **Warm** and **mix** until dissolved. Then **cool** by placing the test tube in a glass or beaker of cold water.

2. **Set up** the apparatus shown below for supplying carbon dioxide to a solution of washing soda. **Place** the free end of the tube in the test tube of washing soda solution made in the previous step.



3. **Allow** a slow stream of the gas to bubble through the test tube containing the washing soda solution for 10 to15 minutes.

4. **Filter** the white precipitate that forms. **Allow** it to dry out by placing the opened out filter paper in a warm place.

   * What is the name of this precipitate?
   * Can you write a chemical equation for the reaction?

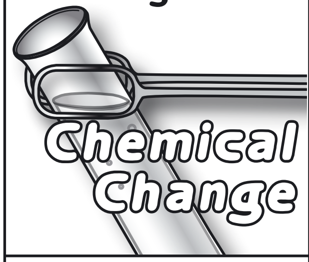
5. **Heat** a little of the precipitate in a test tube and test for carbon dioxide by 'pouring' the gas produced into a test tube containing clear lime water. Carbon dioxide is a heavy gas and will flow down into the lime water tube. After a minute or two of heating, **put** your thumb over the end of the lime water tube and **shake** well. Carbon dioxide is the only gas that turns clear lime water milky.

   * What is the effect of heat on baking soda?

Take it further

Repeat the experiment, but now follow the course of the reaction by adding a drop of phenolphthalein to the washing soda solution in the test tube. How does the colour change as the reaction proceeds? Can you **explain** why?

200 Super Science Investigations



Chemical Change

How do catalysts help chemical reactions?

Molecules of hydrogen peroxide readily break down to produce oxygen and water. This reaction normally happens too slowly to notice, but we can add a catalyst to speed up this chemical change. A catalyst speeds up a chemical change, but does not change itself.

Collect

hydrogen peroxide

glass

manganese dioxide

square of cardboard

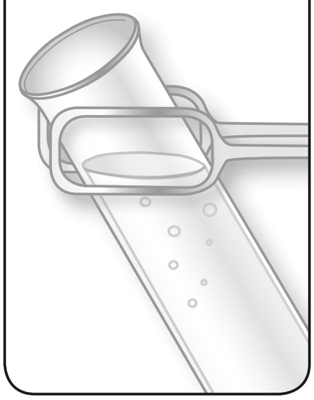
matches

wood splint

test tube

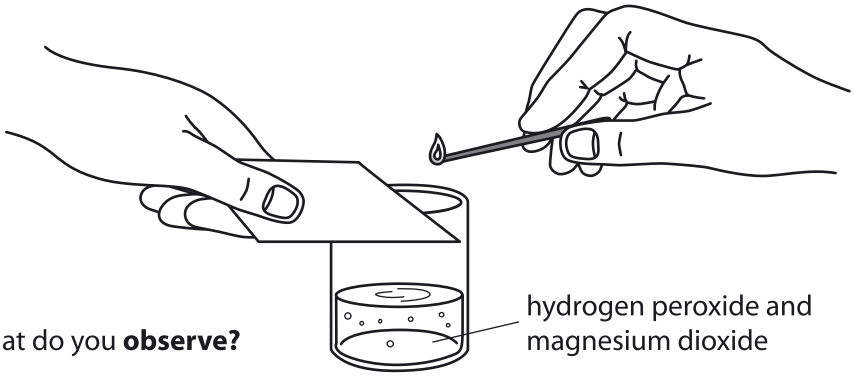
ammonia solution

cup or beaker of hot water



Investigate

1. **Pour** hydrogen peroxide into a glass – about 3 cm deep. **Add** half a teaspoon of manganese dioxide (the catalyst). **Cover** the glass with a square of cardboard.

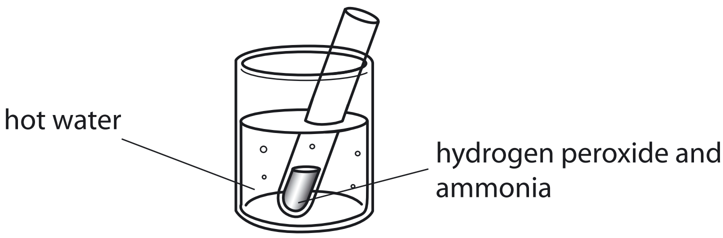


   * What do you **observe?**

2. **Hold** a glowing wood splint in the glass just above the surface of the liquid.

   * What happens to the glowing splint? What gas causes this – where has it come from?
   * What is the liquid left in the glass?

3. **Pour** hydrogen peroxide into a test tube – about 3 cm deep. **Add** a few drops of ammonia. **Stand** the test tube in a cup or beaker of hot water. **Leave** for a minute.



   * What do you **observe** in the test tube?

4. Again, **test** the gas with a glowing splint.

   * What is the gas formed in the test tube?
   * Do manganese dioxide and ammonia have similar effects on hydrogen peroxide?

Take it further

1. **Write** a chemical equation for the breakdown of hydrogen peroxide.

2. **Find out** how catalysts are used in making household ammonia.

200 Super Science Investigations

Chemical Change

Do chemicals change in your mouth?

Food is made up of many different complex molecules. When these molecules move through our mouth, stomach and intestines they change chemically and break up into separate smaller molecules.

Collect

white bread

iodine reagent (iodine in potassium iodide)

medicine dropper or syringe

saucers

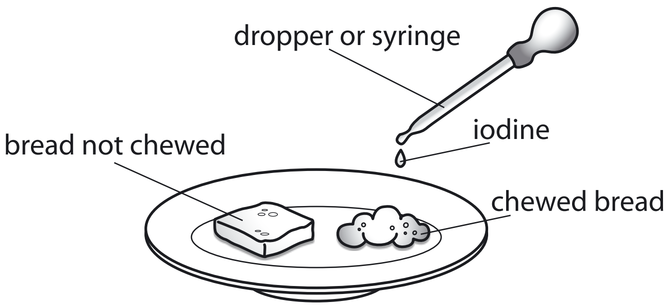
Investigate

1. **Cut** two small pieces, 2 cm by 2 cm, from a slice of white bread. Bread contains a lot of starch.

2. **Place** one piece of bread in your mouth. **Chew** it 30 to 40 times or until it becomes like a slurry. Be sure it is well-mixed with saliva.

3. **Spit** the slurry into an empty saucer. **Place** the piece of dry bread into the second saucer.

4. Use a medicine dropper or syringe to **add** two drops of iodine solution to each bread sample (same amount to both). **Note** that starch changes to a blue-black colour in the presence of iodine. The darker the colour, the more starch.



* Is the colour produced equal in both samples? If not, which is darker?
* Which piece has more starch remaining? **Explain** why you think this is so.

Take it further

Research what enzymes are and how they bring about changes in the body. **Find out** the names of some enzymes that digest food in the mouth, stomach and intestine, including the names of enzymes that digest starch. **List** the enzymes. For each enzyme, **name** the substance it breaks down, the name of the smaller molecules that are formed and the place in the body where the enzyme causes digestion.

200 Super Science Investigations

Chemical Change

Can you make colour disappear?

Bleach (sodium hypochlorite) is a chemical that contains chlorine. People often use it to remove stains from white clothes. In this activity you will investigate the effects of bleach reacting chemically with dyes. Dyes are colourful substances.

Collect

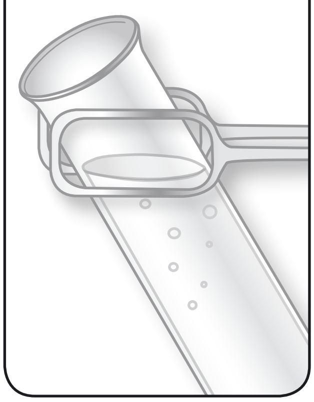
blue, green and red felt-tip pens (water soluble)

saucers

bleach

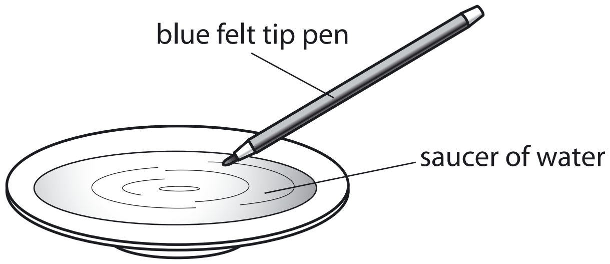
paint brush

small cup of bleach

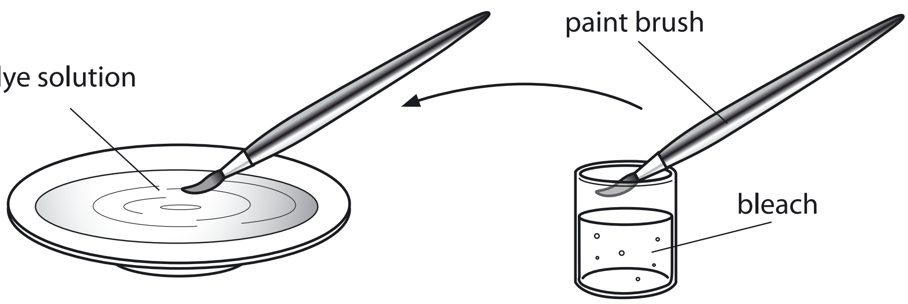


Investigate

1. **Add** water to one of the saucers to a depth of 4 to 5 mm. **Press** the tip of the blue felt-tip pen into the saucer 2 to 3 times so that the water turns a blue colour.



2. **Dip** the paint brush in the bleach then stir it into the saucer of blue solution. **Repeat** two or three times, as necessary.



   * What do you **observe**?
   * When bleach reacts with dyes, does the reaction form more or less colourful substances?

3. **Repeat** for the other two felt-tip pens.

   * How successful are you at making the colours disappear?

Take it further

1. **Write** a word equation for the reaction of calcium hypochlorite and sodium carbonate to form bleach (sodium hypochlorite).

2. Bleach molecules contain the element chlorine. **Find out** more about other substances used in homes and industry that contain chlorine. Would you say that chlorine reacts easily with other substances?

200 Super Science Investigations

Chemical Change

What happens when fuels burn?

Fuels are substances that burn. Burning is a chemical change that releases energy in the form of light and heat. In this activity you will investigate what happens when candle wax burns.

Collect

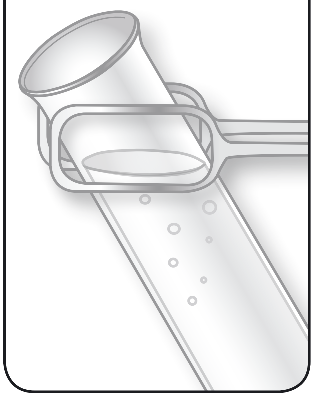
4 small candles (each the same size)

matches

4 glass jars or glasses of various sizes

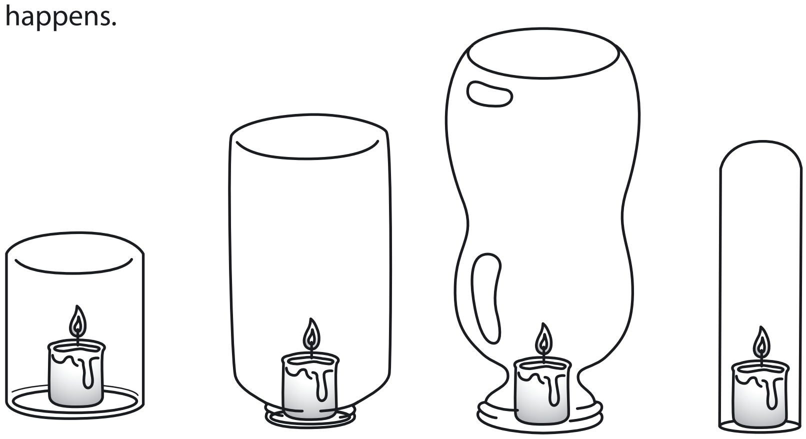
2 identical clean large glass jars with lids

clear lime water



Investigate

1. **Stand** the 4 candles on the desk and light them. With the aid of a helper, **place** the four different size glasses or jars over the candles at exactly the same time. **Observe** what happens.



   * Why do you think the candles go out?
   * In what order did the candles go out?
   * Explain why you think they went out at different times.
   * What gas in air is needed for burning?

2. **Place** a candle on the desk and light it. **Place** one of the large jars over the candle and **wait** until the candle goes out. **Turn** the jar over, immediately **pour** clear lime water into the jar and **close** the lid.

3. Also **place** clear lime water into the second identical jar, which contains ordinary air unaffected by burning. **Close** the lid. **Shake** both jars and observe the colour of the lime water. (**Note** that carbon dioxide is the only gas that turns clear lime water milky.)

   * Is there more carbon dioxide in the jar after burning, or in the jar with ordinary air?
   * Is carbon dioxide used up or produced during burning?

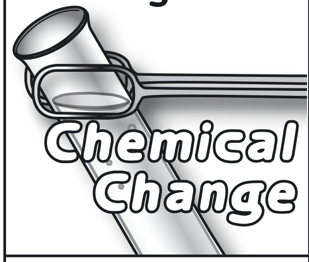
Take it further

1. Burning produces two main substances. **Name** these substances. Why don't we see these substances?

2. **Write** the chemical equation for burning.

3. What forms the soot, smoke and ash that are also produced by burning?

200 Super Science Investigations



Can you make sparks?

Iron reacts with the oxygen to form iron oxide (also called rust). At room temperature this reaction is slow, but heat can speed it up. For example, we can heat tiny grains of iron called iron filings so that they react with oxygen so quickly that they burn. Large lumps of iron will not burn readily. This is because a lot of the metal surface must be open to the air for burning to occur (compare this to lighting a fire with small pieces of wood).

Collect

iron filings

burner

fine steel wool

tweezers or pliers

small bowl

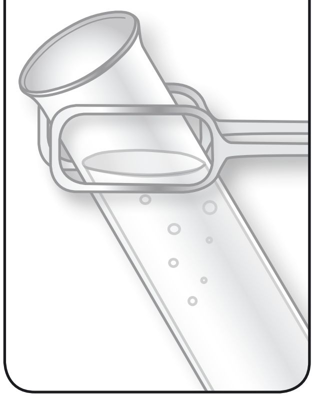
water

rosin (as used by violinists)*

hammer*

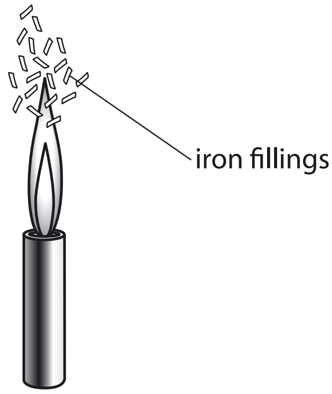
plastic bag*

newspaper*



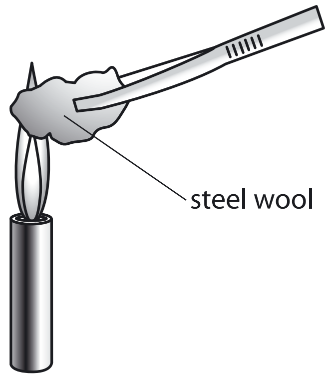
Investigate

1. **Take** some iron filings between your fingers and **sprinkle** these into the flame of a burner.



   * **Describe** what happens. Does the iron burn?
   * What is the rusty-red ash or deposit?

2. **Try** some fine steel wool, holding it in the flame with tweezers or pliers. (If the steel wool contains detergent, wash it first.)



   * Is there a reaction? **Describe** what you see.

3. **Leave** a piece of steel wool in a bowl of water for a few days.

   * How has it changed when you look at it again? **Explain** what has happened to it. Is the substance formed the same as that formed when iron burns?

Take it further

Put a piece of rosin into a plastic bag. **Wrap** in newspaper and **hammer** it to a powder. **Sprinkle** some of the powder into the flame – what do you see? What kind of chemical reaction is this? How does the fineness of the powder help?

Contents

200 Super Science Investigations

Chemical Change

Can you detect energy changes?

Some chemical reactions give off energy in the form of heat, light or electrical energy. Other chemical reactions will only occur if a source of energy such as heat, light or electricity continuously provides energy to drive the reaction. Some reactions, such as burning, need some energy to start the reaction, but once the reaction starts it gives out energy.

Collect

thermometer

bicarbonate of soda (baking soda)

tartaric acid

test tubes or other small glass containers

2 small beakers

oxygen weed (plant living in water with leaves submerged)

funnel

large basin of water

matches

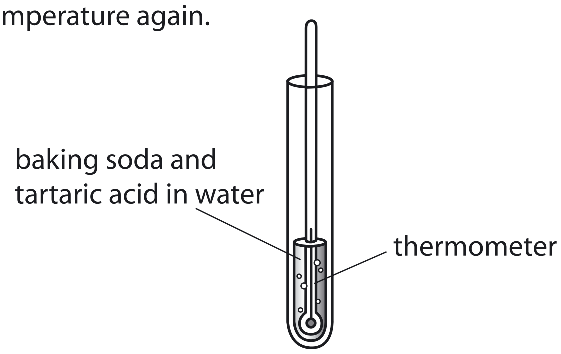
funnel

wood splint

matches*

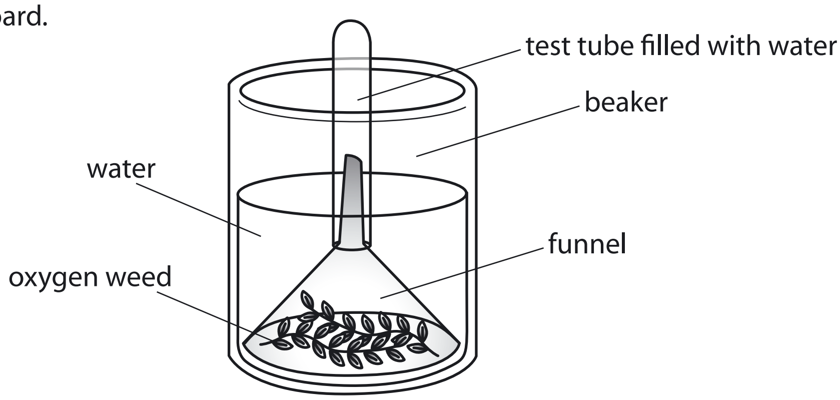
Investigate

1. **Add** a teaspoon of baking soda to a little water in a test tube. **Put** the thermometer into the mixture and **measure** the temperature. **Add** half a teaspoon of tartaric acid. **Measure** the temperature again.



* Does the reaction take in or give out energy?

2. **Set up** two identical experiments as shown below. You will have to set up the upside-down water-filled test tube by putting the test tube, beaker and funnel underwater in a large basin. **Leave** one experiment in the sun and **put** the other in a dark cupboard.



3. **Look** at the two experiments later in the day. If a gas has collected in the test tube, test it by **pouring** the water out and immediately **inserting** a glowing splint of wood.

* Has one collected a gas? Which one? What gas is this?
* Does the reaction which produces this gas in plants take in or give out energy? **Explain**.

Take it further

Rub the head of a match on the side of the matchbox. What is the name of the main chemical that burns in the head of the match (and gives off a strong smell)? What provides the heat needed to start these chemicals burning? Why do matches work better to start a fire than rubbing two sticks together, as people used to do many years ago? **Describe** how energy changes to different forms when you light a match.

Contents

200 Super Science Investigations

Chemical Change

How much energy is there in foods?

Carbohydrates and fats in foods are our main source of energy, while proteins also provide some energy. When one pound of sugar is burned, it changes to carbon dioxide and water and gives up 1800 calories of energy. Food energies are usually measured in calories, a calorie being the amount of energy to raise the temperature of one gram of water by 1°C.

Collect

cork

peanut

needle

test tube

measuring cylinder, pipette or syringe to measure 10 ml

candle

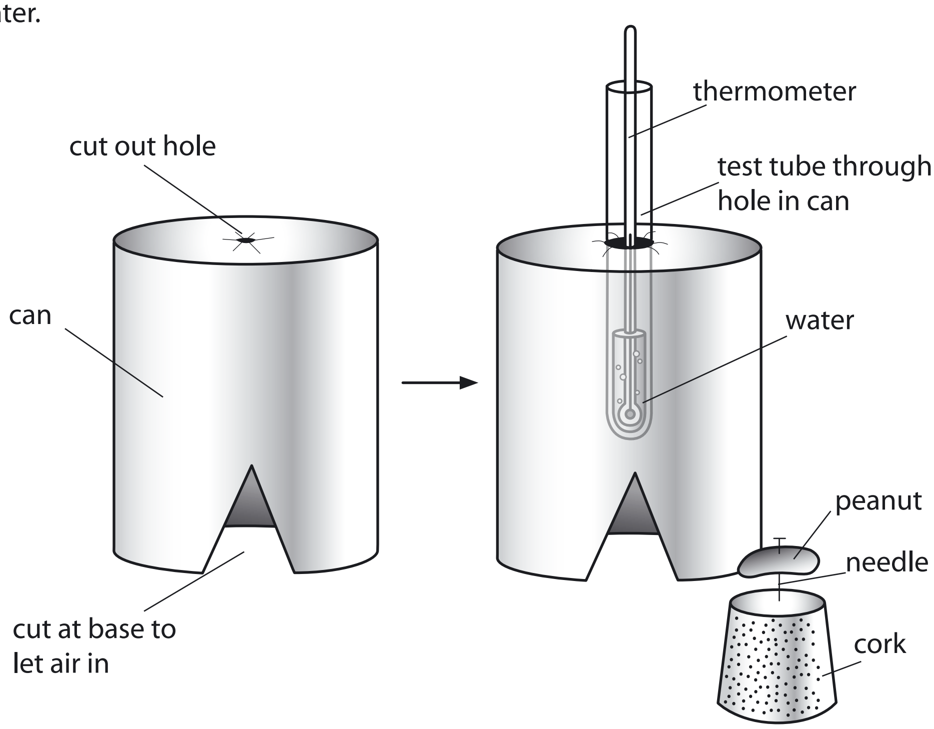
matches

tin can cut as shown

thermometer

Investigate

1. **Set up** the apparatus as shown below. **Measure** exactly 10 ml of water and pour it into the test tube. **Fix** the peanut to the needle and **place** it under the test tube so that the test tube is about 2 cm above the peanut. **Measure** the temperature of the water.



2. **Light** the candle, then **remove** the cork with peanut and **place** the peanut in the flame. As soon as the peanut is alight, **place** it in the can under the test tube. **Allow** it to burn completely. **Measure** the final temperature of the water.

   * What is the increase in temperature of the water in °C?

3. It takes one calorie to raise the temperature of 1 ml of water by 1°C, so heat energy gained by the water = 10 ml X temperature rise in °C

   * **Calculate** how much energy was supplied by the burning of one peanut.
   * Do you think this is a good measurement of how much energy the peanut contains? **Explain**.

Take it further

List five uses of energy in our bodies.

200 Super Science Investigations

Chemical Change

Can chemical energy make things move?

The famous scientist Isaac Newton discovered that for every force (or action) in one direction, there is an equal and opposite force (or reaction) produced in the opposite direction. For example, try pushing against a wall and you will feel a push back against yourself.

Collect

baking soda

vinegar

water

soft drink bottle

cork that fits tightly into the bottle

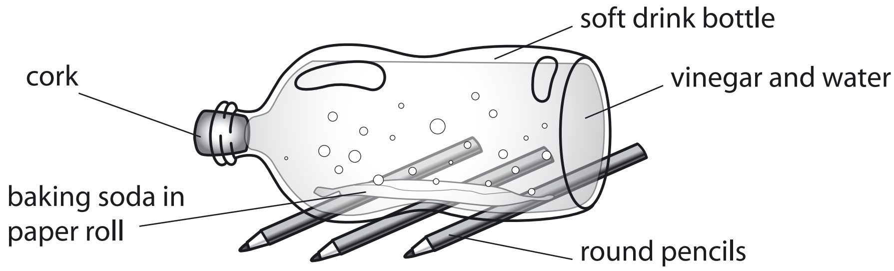
3 round pencils

paper 12 x 10 cm

Investigate

1. **Go** outside. **Fill** the soft drink bottle to the bottom of the neck, half with vinegar and half with water. **Put** two teaspoons of baking soda onto the paper and roll it into a thin shape that will fit into the bottle.

2. **Arrange** the 3 round pencils on a smooth surface. Quickly **put** the rolled-up paper with baking soda into the bottle. **Replace** the cork firmly. **Put** the bottle on the pencils so that a small force will move it forward.



* **Describe** what happens and **explain** why it happens. Did a chemical reaction create a force?
* Does the bottle move? In the same or opposite direction to the foam? **Draw** a diagram to show the directions of movement of foam and bottle?

Take it further

1. **Find out** more about how jet and rocket engines work. **Compare** a rocket engine to the experiment above.

2. **Find out** more about Isaac Newton. When did he live? What are his most famous discoveries? Do you think this knowledge changed the world?

200 Super Science Investigations

Chemical Change

Can you protect steel from rusting?

Most metals will corrode as they react with oxygen in the air. Water speeds up corrosion. Some types of metal can protect another type of metal from corrosion if they are joined together. The metal that corrodes more easily will corrode, while the other one will be protected. This is known as cathodic or galvanic protection.

Collect

10 cm strip of magnesium ribbon

3 plain steel nails (not galvanised)

glass or beaker

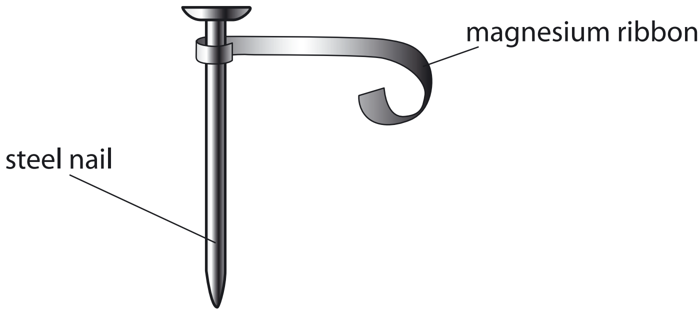
aluminium strip 10 cm

water

Investigate

1. **Wrap** one end of the 10 cm strip of magnesium ribbon around the first steel nail just below the top. **Wrap** one end of the strip of aluminium around the second steel nail. **Leave** the third steel nail free of other metals.

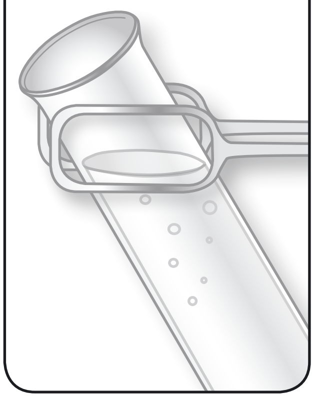
2. **Place** all the nails in tap water. **Leave** overnight. **Examine** the next day.



* What metal is steel mostly made of?
* **Compare** the amount of rusting in the three nails.

3. **Leave** the nails in water for a few more days before examining again.

* Has the steel nail wrapped with magnesium corroded?
* What do you see at the point of contact between the nail and the magnesium? Can you suggest a name for the white powder?
* Does the magnesium protect the nail?
* Has the steel nail wrapped with aluminium corroded?
* Does the aluminium protect the nail? **Explain**.



Take it further

1. **Find out** about the order of the three metals iron, magnesium and aluminium in the Activity Series. According to this series, aluminium should corrode more easily than iron, so it should protect steel from corrosion. What forms on the surface of the aluminium that makes aluminium appear to be less corrosive than iron?

2. What would happen in a roof if you fixed aluminium sheets with iron nails?

3. What is the objection to using aluminium screws to fix flat iron as a cover for a shed?

Can a chemical change freeze water?

When some chemicals dissolve in water they give out heat and cause an increase of temperature. Others absorb heat when they dissolve, so causing the temperature to drop. Some of these chemicals can make the temperature drop well below 0°C, which can freeze water.

Collect

beaker or cup

small tin

cotton wool

test tube

watch that can measure seconds

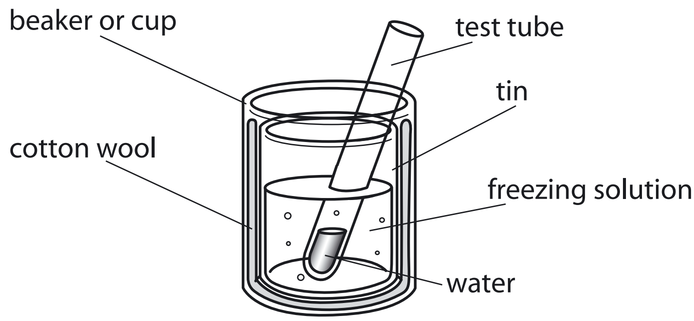
ammonium chloride

sodium carbonate crystals

tablespoon

Investigate

1. **Pack** some cottonwool at the base of the beaker or cup. Then **put** the small tin inside and **pack** cotton-wool around it firmly as shown below.

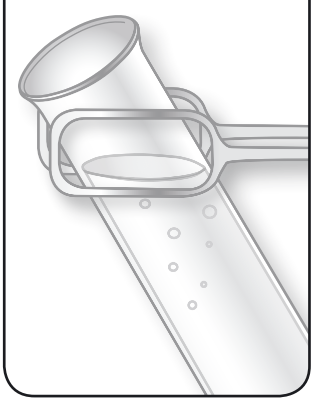


2. Have a test tube ready with not more than 1 ml of water in it.

3. **Measure** out one tablespoon of powdered ammonium chloride and an equal amount of powdered washing soda crystals. **Mix** the two together and put the mixture into the tin.

4. **Pour** 1¼ tablespoons of cold water into the tin. **Put** the test tube containing water into the tin and use it to **stir** the mixture. **Note** the time on your watch minute hand.

   * What happens to the water in the test tube?
   * How long did the freezing into ice take?



Take it further

Try out some of the following mixtures. See which freezes 1 ml of water the quickest. Think of how to make this comparison fair.

a) ammonium chloride (5 parts) + potassium nitrate (5 parts) + water (10 parts)
b) ammonium chloride (5 parts) + potassium nitrate (5 parts) + sodium sulphate (8 parts) + water (16 parts)
c) ammonium nitrate (1 part) + sodium carbonate (1 part) + water (1 part)
d) sodium sulphate (6 parts) + ammonium nitrate (5 parts) + dilute nitric acid (4 parts)

Can you use invisible inks?

People have used invisible inks throughout history to write secret messages of love, friendship and war. Invisible inks are made of invisible chemicals that can be made to react so that they become visible. For example, you can use rice water to write invisibly, but when you apply iodine, a chemical reaction produces a visible substance allowing you to read the message.

Collect

salt

fine-tipped paint brush

lead pencil

egg cup

sugar

electric heater or candle

alum or copper sulphate

paper

ammonia*

cooking oil*

Investigate

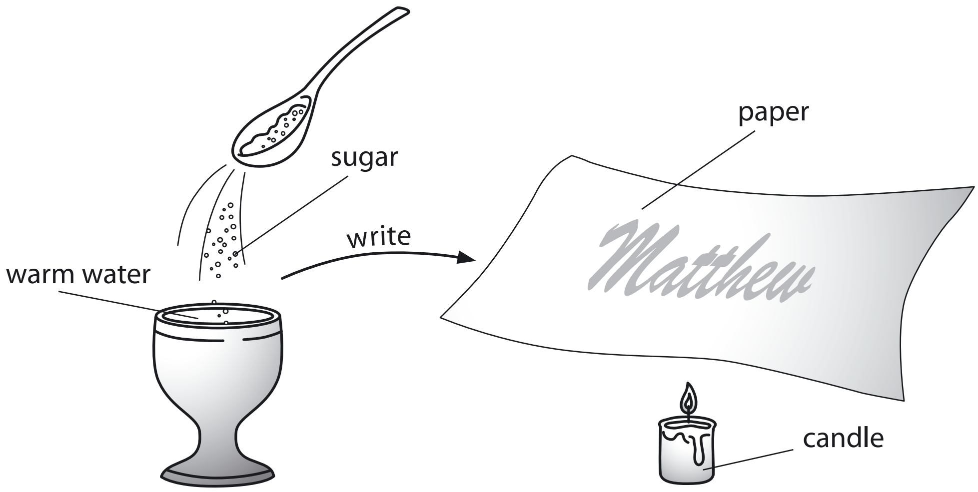
1. **Make** a strong solution of table salt in hot water and let it cool. Then use a fine-tipped brush to **write** your name and **let** the writing dry.

   * Is the writing invisible or nearly so?

2. **Rub** across it with a lead pencil.

   * Is it now visible? Why?

3. **Dissolve** a teaspoon of sugar in an egg cup of warm water. **Wash** the fine-tipped brush and dip it into the sugar solution. **Write** your name on paper. When it is dry, **warm** the paper by holding it in front of an electric heater or 10 to 15 cm above a candle flame.



   * Is the writing visible now? What colour is it? How has heat helped?

4. **Dissolve** a teaspoon of alum or copper sulphate in an egg cup of water. **Write** on paper and then **heat** as in step 3 above.

   * **Compare** the colour of the writing before and after heating.

Take it further

Put a drop of cooking oil in a test tube and **add** 1 cm of strong ammonia. **Add** water to nearly fill the tube and shake. **Dip** a fine-tipped paint-brush in the liquid and write a message on paper. **Allow** to dry. Is the writing invisible? Now dip the paper into water. What happens to the writing? **Allow** the paper to dry again. What happens?

Can you make fire extinguisher foam?

Aluminium sulphate reacts with sodium bicarbonate forming bubbles of carbon dioxide gas. In this activity you will investigate this reaction and its use in fighting fires.

Collect

warm soapy water

jam jar

test tubes

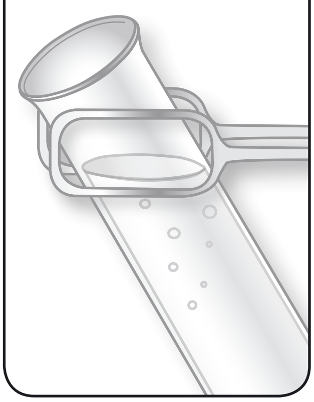
teaspoon

sodium bicarbonate (baking soda)

strong aluminium sulphate solution

large metal bucket or other metal container

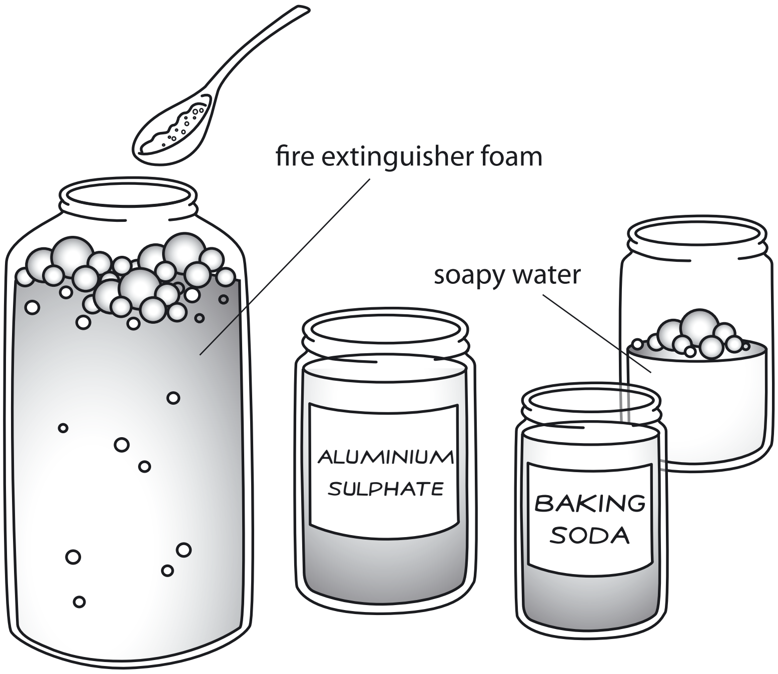
newspaper



Investigate

1. **Add** warm soapy water to a jam jar until it is about 3 cm deep. Half **fill** a test tube with water, **add** three teaspoons of sodium bicarbonate and **shake**. **Pour** the contents of the test tube into the soapy water in the jar.

2. Now **add** half a test tube of strong aluminium sulphate solution to the jar.



* **Describe** what happens.
* What gas is produced?

3. **Crumple** half a sheet of newspaper in a large bucket. **Light** it at its lower end. When it is burning well, **pour** your fire-extinguisher foam over it.

* What happens to the fire?
* **Explain** why the foam is good at putting out a fire.

Take it further

Water by itself is not very successful at putting out oil fires, but fire extinguisher foam can put them out. **Explain** why.

Contents

Can you tell acids from bases?

Scientists put chemicals into groups to help understand them and how they react. Acids and bases are two important groups of chemicals. Bases dissolved in water are called alkalis.
In this activity you will make an indicator. An indicator is a chemical that tells us whether a substance is an acid or a base. We say that substances are neutral if they are not acids or bases.

Collect

cupful of chopped red cabbage leaves

boiling water

cup or beaker

filter paper or coffee filters

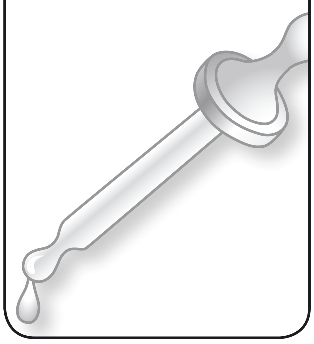
scissors

screw-top jar

glasses

vinegar

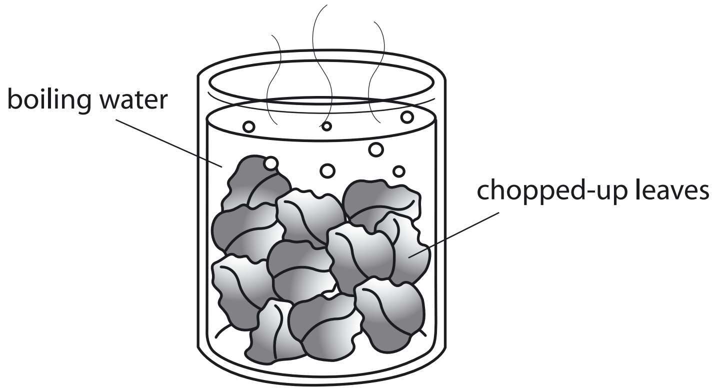
baking soda (bicarbonate of soda)



Investigate

1. **Fill** the cup of chopped cabbage leaves with boiling water. **Allow** the cup to stand until it has cooled to room temperature.

2. **Pour** off the purple liquid you have extracted from the red cabbage into a glass or jar. **Cut** strips from the filter paper about 2 x 8 cm. **Dip** these in the cabbage solution then **place** aside to dry.



   * What colour is the paper when wet? And when dry?

3. **Dip** a piece of red cabbage paper into a glass of vinegar (acid). Also **dip** a piece of red cabbage paper into a glass with a solution of baking soda (base).

   * What colour is red cabbage in an acid?
   * What colour is red cabbage in a base (alkali)?

Take it further

Try making and testing other indicators:

a) Juice of red cherries turns green with bases and red with acids.
b) Common blue iris extract is green in bases, red in acids and blue when neutral.
c) Red rose petal extract turns bright green with bases and pink with acids.
d) Purple violets, cut into tiny pieces and extracted with boiling water, on cooling give a deep green-blue solution. This turns green with bases and red with acids.
e) Many other flower extracts can act as indicators too.

Can you test for acids and bases?

Scientists put chemicals into groups to help understand them and how they react. Acids and bases are two important groups of chemicals. In this activity you will use an indicator to test different substances to see if they are acids or bases. An indicator is a chemical that tells us whether a substance is an acid or a base.

Collect

cabbage testing paper (from previous experiment) or litmus paper

sheet of paper

cotton tips

lemon

ammonia

shampoo

vinegar

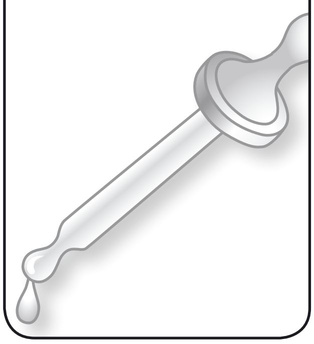
orange

baking soda (bicarbonate of soda)

washing soda (sodium carbonate)

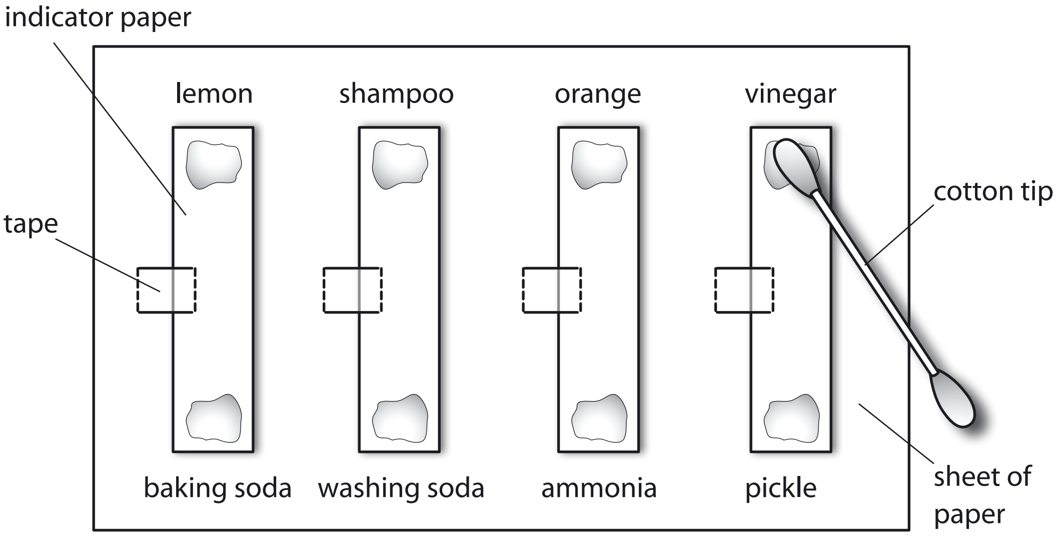
pickle

pH paper*



Investigate

1. **Place** 4 strips of the cabbage test strips (or litmus paper) on the sheet of paper and **tape** in place. **Write** the names of the substances you are testing on the paper sheet.



2. Cut the lemon. **Squeeze** 2 drops of the juice onto the test paper labelled 'lemon'. **Repeat** for all the other substances that you are testing. **Complete the table** below.

Substance Tested	Colour of Indicator	Acid or Base
lemon juice		
ammonia		
vinegar		
orange juice		
solution of baking soda		
solution of washing soda		
pickle juice		
shampoo		

Take it further

Research how we can measure the strength of different acids and bases using the pH scale. Use pH paper to **measure** the pH of the above substances.

200 Super Science Investigations

Acids & Bases

Are some acids stronger than others?

Some acids are stronger than others. This means they react more quickly and so are more corrosive. Mineral acids such as hydrochloric acid and sulphuric acid are made in factories from mined minerals. They are stronger than organic acids, such as acetic acid (in vinegar), tartaric acid and citric acid, which come from plants, animals or bacteria.

Collect

cabbage indicator strips (from second-last experiment)

cabbage indicator juice (from second-last experiment)

sheet of paper or card

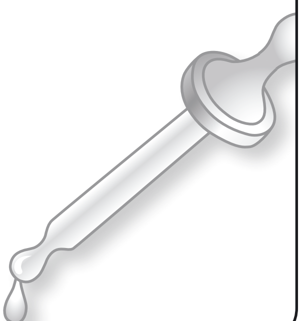
alum

cream of tartar

lemonade

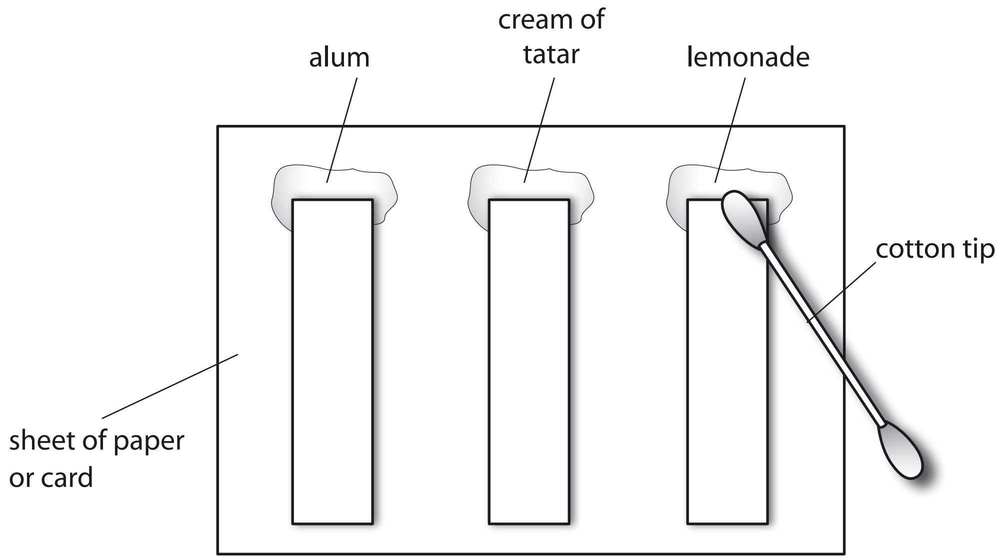
cotton tips

teaspoon



Investigate

1. **Place** a half teaspoon of alum and cream of tartar on a sheet of card 7 to 8 cm apart.
2. **Take** three strips of the cabbage indicator paper. **Dip** one end of each strip in the cabbage indicator solution.
3. **Lay** the damp end of the first strip over the heap of alum. **Lay** the damp end of the second strip over the heap of cream of tartar. **Lay** the damp end of the third strip on the card as shown in the drawing below and **touch** a cotton tip, wet with lemonade, to the damp end. **Leave** for 3 to 4 minutes.



* What colour does alum turn the cabbage paper?
* What colour does cream of tartar turn the cabbage paper?
* What colour does lemonade turn the cabbage paper?
* Which of the three is the strongest acid?

Take it further

Research why some acids are stronger than others. What ions do acids release? Are these ions very reactive? Do some acids release more of these ions than others?

200 Super Science Investigations

Can you test with litmus paper?

Litmus is the oldest and most commonly used indicator for acids and bases. It is a mixture of dyes obtained from a species of lichen which grows along Mediterranean coasts. Litmus has the property of turning red with acids and blue in the presence of a base.

Collect

litmus papers (red and blue)

beakers or glasses

tap water

soda water

milk

cooking oil

vinegar

alum

cream of tartar

soil sample

rubbing alcohol or methylated spirits

yoghurt

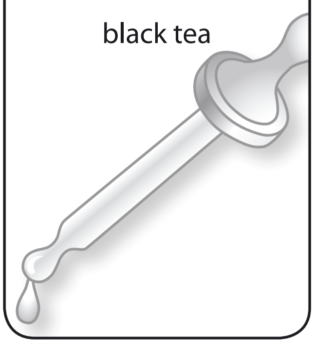
almond essence

liquid soap

shampoo

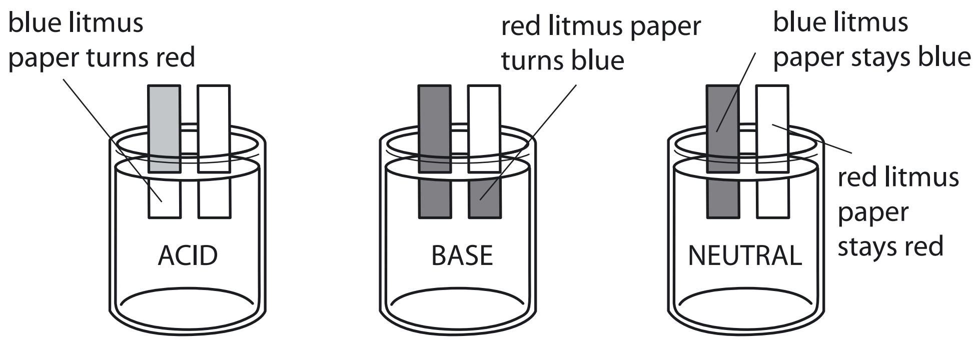
aspirin solution

black tea



Investigate

1. Use red and blue litmus paper to **test** the substances in the table below. **Record** your results in the table. The first substance has been done for you.



Substance	Colour of Red Litmus	Colour Of Blue Litmus	Acid, Base or Neutral
vinegar	red	red	acid
tap water			
soda water			
milk			
cooking oil			
alum solution			
cream of tatrtar			
soil sample			
alcohol/methylated spirits			
yoghurt			
almond essence			
liquid soap			
shampoo			
aspirin solution			
black tea			

Take it further

Find out the names of acids or bases found in lemons, apples, aspirin, tea, soap, cream of tartar, milk and vinegar.

200 Super Science Investigations

Acids & Bases

What can you do with tartaric acid?

Tartaric acid is a white crystalline solid that people purify from grape juice. Mixtures of the acid (or its acid salt called cream of tartar) with baking soda (sodium bicarbonate), are used to make baking powder and effervescent health salts.

Collect

tartaric acid

sodium carbonate (washing soda) solution

small narrow necked bottle

test tube

modelling clay

plastic tube

clear lime water

granulated zinc or zinc filings

beakers or glasses

tablespoon

Rochelle salt (potassium sodium tartrate)

dish of hot water

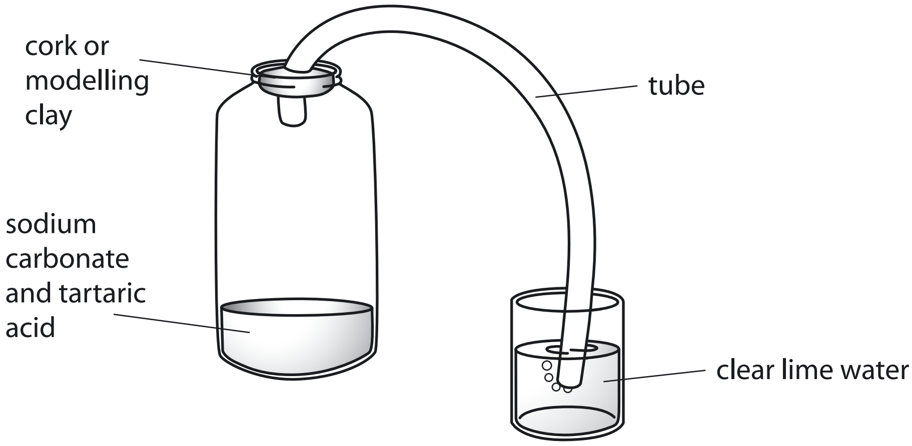
thread

pencil or glass rod

hand magnifier

Investigate

1. **Get** the equipment shown below in position. **Add** 5 to 10 ml of sodium carbonate solution to the bottle. Then **add** a teaspoon of tartaric acid. Quickly **fit** the tube and modelling clay on the top of the bottle. Ensure that gas can only escape from the bottle through the tube and that one end of the tube is below the surface of the lime water.



   * Do you see bubbles? What do the gas bubbles do to the clear lime water? What gas is this?

2. **Dissolve** a heaped teaspoon of tartaric acid in a little water in a test tube to make a strong solution. **Add** zinc. **Warm** by placing the test tube in the dish of hot water.

   * What do you **observe**?

3. **Dissolve** a tablespoon of Rochelle salt in a tablespoon of water in a beaker or glass. **Stand** the beaker in a dish of hot water and **add** more of the salt, half a teaspoon at a time with continuous stirring until no more will dissolve. The solution should be clear. **Cover** the beaker or glass with a cloth and store in a safe place. **Watch** for crystals to form. **Allow** your crystals to grow for several days. **Examine** them through a hand magnifier.

   * **Describe** and **draw** the shape of the crystals.

Take it further

Find out what gas is produced when an acid is mixed with zinc. How would you test for this gas? Try out this test with care.

Can you make an acid neutral?

Ammonia is a base and vinegar contains an acid called acetic acid. When you add an acid to a base a chemical change occurs to form a salt and water. In this experiment you will see what happens to an acid as you slowly add a base to it drop by drop.

Collect

vinegar

ammonia

cup

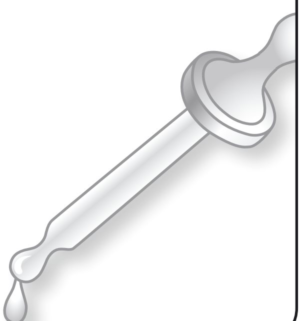
medicine dropper or syringe

teaspoons

blue litmus paper

egg cup

felt-tip pen



Investigate

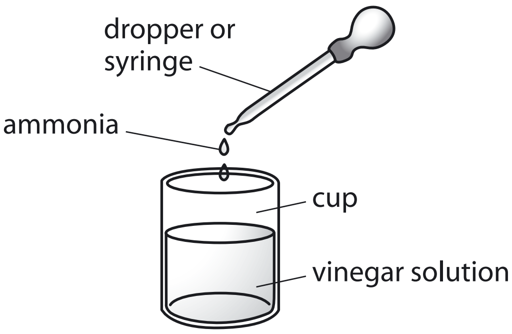
1. **Add** a teaspoon of vinegar to a ¼ cup of water and stir well to mix. With the felt-tip pen **write** "A" (for acid) on the cup.

2. Using a clean teaspoon, **add** a teaspoon of ammonia to an egg cup and mix well with one teaspoon of water. With the felt-tip pen **write** "B" (for base) on the container.

3. **Dip** a piece of blue litmus paper into the acid.

   * What colour change do you observe?

4. **Cut** off the wet piece of litmus and set aside. Using the medicine dropper or syringe, **add** about ten drops of the ammonia to the vinegar and **stir** well. **Test** the vinegar with litmus again. As before **cut** off the wet tip and place next to the first piece you cut off. **Add** about ten more drops, stir, and test the vinegar again. **Cut** off the wet tip and place next to the second piece.



5. **Repeat** this process, keeping a record of the number of drops added and watching for the gradual colour change in the litmus.

6. As you continue with the experiment, **add** fewer drops of ammonia. When the colour change from blue to red is very slight in the litmus, **add** only one drop of ammonia at a time.

   * **Describe** how the colour of the dipped litmus changes.
   * Do you reach a point when there is no colour change in the blue litmus at all?
   * Has the base 'cancelled out' the acid?
   * What has happened to the acetic acid?

Take it further

Try reversing the process. **Make** a weak solution of ammonia by adding one teaspoon of ammonia to a ½ cup of water. To this **add** drops of an acetic acid solution made by adding 1 teaspoon of vinegar to 1 teaspoon of water. **Use** red litmus as indicator.