Activity Pack:
Science for all ages

About this pack

This activity pack is filled with fun activities for use in informal places of learning (for example: at home, science clubs, community groups) that could be expanded in formal places of learning. The pack provides out-of-the box activities that are engaging, inexpensive, easy to do and generate a “wow factor” amongst children and adults alike.

There are 15 short activities, and each includes a brief introduction linking the activity to Britain, in celebration of our re-brand as British Science Week.

There are three sections of activities:

- **Activities 1-6 are appropriate for 11-year-olds and under**
- **Activities 7-12 are appropriate for 11 to 16-year-olds**
- **Activities 13-15 are appropriate for 16-year-olds and over**

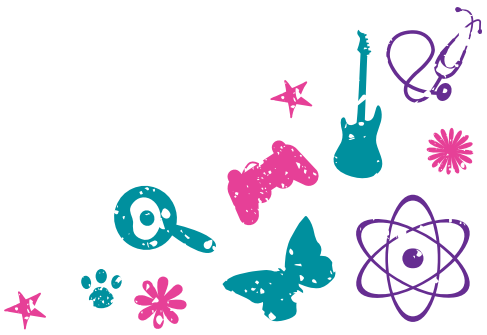
Of course, these are just guidelines. Families and schools are encouraged to try a number of the activities. For activities 1-12, there are broad curriculum links at the end of the resources as well.

A note about safety ...

These activities should be undertaken with adult supervision and guidance. Assess all risks and hazards before starting, and take precautions to limit them. Always take care when handling chemicals - even if they are commonly-found in the home - and take care when using tools for cutting or piercing holes.

British Science Association
Registered charity 212479 and SCO39236

Contents



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Cloud generator

We Brits do like to talk about the weather, don't we? So it's no surprise that the first person to name clouds was British. Luke Howard, an amateur meteorologist, described different cloud formations in a presentation in 1802. His "nomenclature system" (in other words, his set of names for clouds) is still used today.

Your challenge

Build a cloud generator to make clouds in a bottle.

You will need

For the simple version: A two litre plastic bottle, matches and some water.
For the harder version: A two litre plastic bottle, a bike pump, scissors, glue, metal skewer and an old bike inner tube valve.

What you do

For the simple version: Place about five caps of water in the bottom of an empty two litre plastic bottle. Screw the top on and give it a quick shake.

Strike a match and blow it out. Open the bottle and put the smoking match to the neck of the bottle. Squeeze the bottle and release to force the smoke in.

Screw the cap back onto the bottle. To generate a cloud, squeeze and release the bottle.

For the harder version: Use the skewer to pierce a hole in the lid of the bottle – you will need to widen it to the size of the valve on the bike inner tube. Cut out the valve from the old bike inner tube. Glue the valve into the cap and let it dry – this is so that the bike pump can be attached when it is screwed onto the bottle, so be careful to glue it to the correct side.

Once the glue is dry, pour five caps of water into the bottom of the bottle. Screw the cap on and attach the bike pump. Pump two or three times on the bike pump – but don't do it too much.

To generate a cloud, carefully unscrew the cap. Watch the cloud form instantly as the air rushes out.

What is happening?

The clouds that form in the bottle are made because squeezing the bottle and releasing it increases and decreases the pressure of the water vapour in the air, which helps the water reach its dew point. The smoke provides a site for the water to form into a droplet, which we can see, and not remain as a gas. The formation of a real cloud is caused by a combination of the atmospheric pressure changing (mainly due to temperatures dropping) and the saturation of water in the air.

You could try

You could try making clouds in a terrarium. This is an ecosystem set up with plants and soil in an enclosed glass bottle. If you get the balance of soil, water and plants right, then you should see a self-sustaining system.

Organiser's notes

Be careful when trying to make the hole; you may need to use a drill bit or metal skewer.

Cooking in the Sun

It seems to rain all the time in Britain but actually, in the last 30 years, there were only about 150 rainy days a year. And there was an average of more than 1,300 hours of sunshine.

Energy from the Sun (also known as solar energy) is renewable, so scientists are always thinking of ways to use it. One way is to use light from the Sun for cooking.

Your challenge

Build a solar oven to melt chocolate and marshmallows into a biscuit sandwich.

You will need

A shoebox with lid, aluminium foil, a stick (about 30 cm long), scissors, black paint, oven-safe cling film, glue, sticky tape, a small baking tin, and some biscuits, chocolate and marshmallows.

What you do

Glue or tape aluminium foil on the inside of the lid and the side walls of the box. This will reflect the light into the bottom of the box.

Paint the bottom of the box black – this will help to absorb heat.

Allow the glue and paint to dry. You now have a simple solar oven.

Place the baking tin into your "oven" with your biscuit, chocolate and marshmallow sandwiches. Cover the top opening with cling film. This allows the light to pass into the box but traps the heat inside.

Place the "oven" in a sunny place. Use the stick to prop open the lid of the box so light reflects onto the baking tin through the cling film.

Let your biscuit sandwich cook until the chocolate and marshmallows are a bit melted. This should take about 60 minutes, depending on how sunny it is.

What is happening?

The aluminium foil reflects and focuses the sunlight onto a small area. The cling film traps the heat – like in a greenhouse. This makes the temperature rise.

You could try

You could try designing and building a better solar oven which will melt the chocolate and marshmallow faster. Experiment with different sizes of boxes, different reflection angles, different reflective materials and different foods.

Organiser's notes

Using foil to focus sunlight can cause extreme temperatures and even fire. Test your solar oven away from material that could catch fire easily and be careful not to burn yourself.

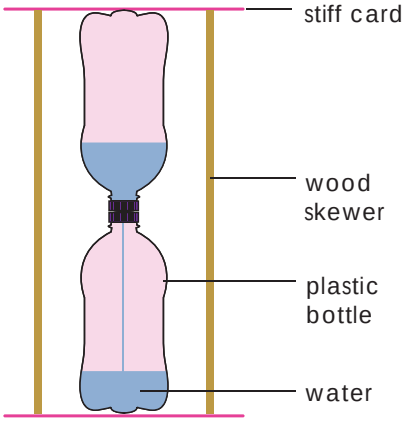
Giant egg timer

The average Brit eats two to three eggs every week. So, how do you get the perfect soft boiled egg? Depending on the size of the egg, it takes about seven minutes. But even in this age of technology, a lot of families still use egg timers containing sand to make sure they cook their egg perfectly. You can even get an egg timer app for your phone which uses a graphical sand clock!

Your challenge

Build an egg timer with sand or water to cook the perfect soft boiled egg.

under 11s



You will need

Two 500 ml (or bigger) plastic bottles, some tape and/or glue, two 10 cm x 10 cm pieces of stiff cardboard, a measuring jug, a funnel, four long wooden skewers, some old plastic cards or transparency film, and a stopwatch or clock.

You will also need some fine sand or water.

What you do

The first step is to work out what volume of water or sand you'll need, and what size the hole should be in order for your clock to work for about seven minutes. To do this, fill one of the plastic bottles to the top using a funnel. Pierce a small hole into a square of plastic card.

Tape the plastic card to the opening of the bottle. Turn the bottle upside down over the measuring jug.

Use the stopwatch or clock to measure how much water or sand passes in seven minutes. If you run out of water before the seven minutes is up, try again with a smaller hole. If there's still a lot of sand or water left in the bottle after seven minutes, then you can try making the hole a little bigger. You may need to do this a few times.

Once you know the size of the hole and the amount of water or sand needed, you can build the final version. Glue or tape the two bottle caps together top-to-top. Pierce the hole through both caps, to the same size you worked out before. Fill your bottle with your measured amount of sand or water. Screw the caps on.

To help stabilise your timer, glue the stiff card to the ends of the bottles, like a sandwich. The four skewers can be cut to size and each end fitted to the four corners of both pieces of card.

What is happening?

You are matching the volume of water or sand to how much can flow through the hole for a set amount of time. As the hole is a fixed size, it takes a certain time for all the sand or water to pass. This method has been used for centuries as a judgement of time.

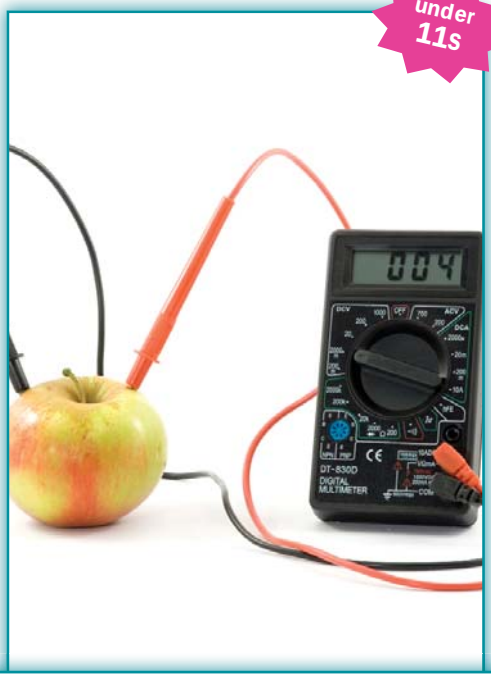
You could try

You could try making an adjustable timer by calculating markings on the side of the bottle or, even better, try making an adjustable hole system for altering the amount of sand that can pass.

Organiser's notes

Be careful when trying to make the hole; you may need to use a drill bit or metal skewer.

Battery building



In the early 2000s, British people bought more than 680 million batteries (and we're using even more nowadays due to our love of mobile technology).

In 2013, about 5% of our energy came from renewable sources, but most of our energy still comes from fossil fuels. In the future, it will be important to use more renewable energy if we are to combat global problems of climate change and dwindling resources.

Your challenge

Build a battery and compare the amount of electricity generated from different fruits or vegetables (which are renewable energy resources).

You will need

For the battery, you'll need a selection of fruits and vegetables of your choice and either the copper from a small piece of electrical wire or a 1p or 2p coin (most are copper plated, but not all of them).

You'll also need a piece of zinc – we suggest a galvanised nail.

Finally, you'll need one of the following: a digital multimeter, a small light bulb, an LED or an old battery powered device (such as a small digital clock or a string of Christmas lights). A pound store is a great place to find cheap battery-powered clocks.

What you do

Stick the nail in one side of the fruit or vegetable. Stick a piece of copper in the other side. Make sure the copper and nail don't touch. Attach the red wires from your multimeter (or other device) to the nail, and attach the black wire to the copper. You should see a reading on the display, or the light will light up, or the clock will tick (depending on what you're using!)

Don't worry if the wires aren't coloured or you don't get a reading – just switch them around.

Make a record of the current (in amps), or brightness of the light, etc. and try as many other fruits or vegetables as you want to see which gives you the most electricity.

What is happening?

The juice of the fruit helps dissolve small particles of the metal known as ions. This allows electrons (negative particles) to flow. The flow of electrons is known as electricity.

You could try

You could try using cola or other fizzy drinks or even different types of vinegar to make a battery. The idea is the same. Which type of drink do you think will work the best? You could also try powering bigger devices by adding more pieces of fruit in a row.

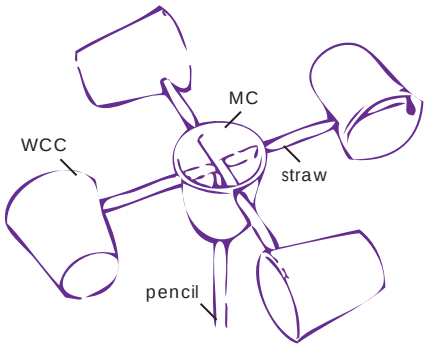
Organiser's notes

Take care if you decide to strip wires or take apart an old battery clock. Help may be needed to set up an electrical meter.

Measuring wind speed

under 11s

In Britain we have a 'moderate climate'. We don't have many extremes of weather and there's not a great deal of variation between the seasons. But, of course, we still have the occasional bit of extreme weather – the fastest recorded gust of wind in Britain was 142 miles per hour! The wind speed was measured using an **anemometer**.



Your challenge

Build your own anemometer.

You will need

Two straws, five plastic cups, a skewer, a long pin, a pencil with a rubber on top, and a stopwatch.

What you do

Use the skewer to pierce a hole in the side of a cup, about 1 cm from the top rim. Do the same to three more cups. These are the "wind catcher cups". We'll call them WCCs. In the fifth cup, make four evenly-spaced holes around the sides, each about 1 cm from the top rim. Make one more hole in the centre at the bottom of the cup. This cup is the "middle cup" – or MC.

Push one end of a straw into one WCC. Push the other end through two opposite holes of the MC and into a hole in another WCC, facing the opposite direction as the first WCC. Tape both ends of the straw into place. Do the same thing for the second pair of WCCs.

Note: Make sure the open ends of all the WCCs are facing the right way so they catch the wind in the same direction!

Push a pencil (rubber end first) through the bottom hole of the MC and let the rubber meet the crossed straws.

Pushing the pin through the middle of both straws and into the pencil's rubber.

Finally, mark one of the WCCs so that, when it spins, you can easily see it to count the number of times it spins.

To measure the wind speed, hold your anemometer up by the pencil into the wind and count the number of times the cups rotate in one minute.

What is happening?

The cups capture the wind and cause the device to spin, allowing you to count the number of 'revolutions per minute'. This is a measure of wind speed. The more times the cups spin in a minute, the faster the wind speed.

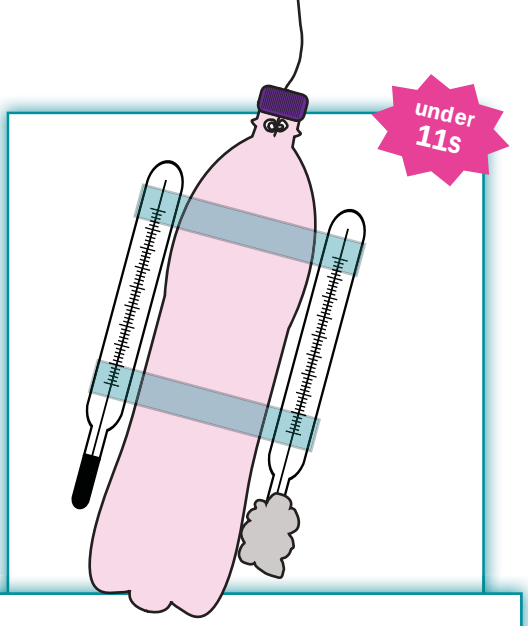
You could try

Try measuring wind speeds at different times of year and times of day. What do you find? You could try converting your spins per minute into metres per second, and compare this to weather and climate data on the Met Office website (**www.metoffice.gov.uk**). Finally, why not try building and flying your own kite? Did the spot with the fastest wind speed provide the best place to fly the kite?

Organiser's notes

Take care piercing the holes.

Humidity meter



If you've ever been out on a foggy day – which is very likely in Britain – you may have noticed that the air feels wet.

Fog happens when the air has a high water vapour content and it is 'humid'.

Your challenge

Build a whirling hygrometer to estimate the amount of water in the air in different places.

You will need

Two cheap bulb thermometers (the longer the better), some cotton wool, strong string, some duct tape, water, a 500 ml plastic bottle and a metal skewer.

What you do

Use the 500 ml bottle as a handle for your whirling hygrometer: make a small hole in the bottle cap with the metal skewer and push about 30 cm of strong string through it (you can double the string for extra strength). Once through, tie a knot on the end of the string – making sure it is on the underside of the cap – and tape the knot to the cap to secure it. Screw the cap back onto the bottle.

A whirling hygrometer must have one dry thermometer bulb and one wet thermometer bulb. Tape some cotton wool over the bulb – this will be your wet bulb; you just pour about 5 ml of water onto it before use.

Tape the two thermometers opposite each other along the length of the 500 ml bottle. Make sure you tape the thermometers at the top and the bottom.

Now choose a place where you would like to test the humidity of the air. Gently and slowly swing the whirling hydrometer in front of you for about a minute. Then take the readings from both thermometers. Calculate the difference by subtracting the dry bulb thermometer temperature from the wet bulb temperature. The bigger the difference, the greater the humidity.

What is happening?

When the amount of water in the air (humidity) is very low, the difference in temperature between the dry and wet thermometer bulbs will be very high because the wet bulb loses heat faster (by evaporation). The higher the humidity, the less temperature difference there is.

You could try

Try working out the relative humidity of the different places you have investigated by looking at a relative humidity table. You can find these with a Google images search for 'relative humidity table'. Using your dry bulb temperature and the difference of temperatures, you can use the table to look up the percentage of water in the air. You could compare it with the metrological office readings in your area, enter your location at **www.metoffice.gov.uk/public/weather/forecast** and look for the hour-by-hour humidity values in the forecast.

Organiser's notes

Take care piercing the holes. Do not swing your device over your head.

Wireless signal blockade

11-16

Brits love the Internet, and we're never far from a wireless signal to get connected. In 2013, the average Brit spent about 37 hours a month surfing the 'net. That's a five-hour increase from the year before.

It can be really annoying when the wireless signal is a bit dodgy, or gets blocked.

Your challenge

Investigate which materials block a wireless signal from your home wireless router.

You will need

A wireless router and a device that can detect wireless signal and display signal strength (for example, a computer, smart phone or tablet with the ability to connect to a wireless network will work).

You'll also need some materials to test – this could be anything from a sheet of paper or a plate, to small sheets of metal or wood.

What you do

Place your wireless router and your computer, smart phone or tablet on two different tables, about three metres apart. Make sure they're at the same height.

Put your first material very close to the front of the router. Note: Don't stand between the two tables as you may interfere with the signal.

On your computer there will be a network centre which displays your connections. There's usually a set of bars lit up to show signal strength for your home network.

A few seconds after placing your test material in front of the router, make a note of how many bars are lit up. Repeat this for each of the different test materials.

When you have tested all your materials once, repeat the tests again to see if you get the same reading as the first time.

What is happening?

Wireless routers use radio waves to 'talk' to devices and a network adapter to connect to the Internet. Blocking the signal means there is no communication between the device and the router. Different materials affect signal strength differently. Metals in particular tend to reduce signal strength as they interact strongly with the energy in the radio waves.

You could try

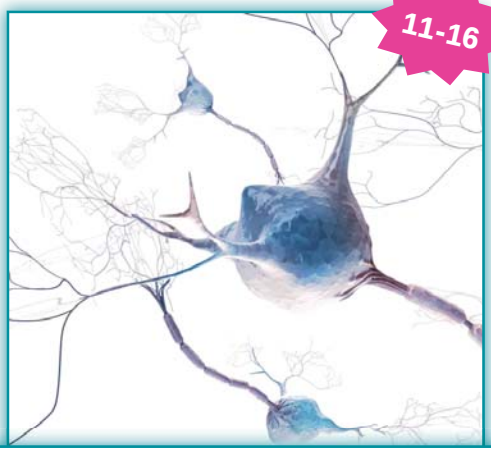
Try getting more accurate information about how much signal is blocked by downloading software which measures signal quality from your router. You can then investigate the same materials again to see if they give you the same results. You could also try seeing what happens if you cover the whole router.

Organiser's notes

Some knowledge of computers and routers is needed! You may need help finding the signal strength bars on your device.

Have you got the nerve?

11-16



There are more than 100 billion nerve cells in the human brain. Each connection between cells holds an important function. This could be memory, breathing or movement, to mention but a few.

Your challenge

Perform tests on yourself and an older family member, and compare who has the best nerves.

You will need

A 30 cm ruler, ice cubes, some water, a large bowl, a stopwatch and a paperclip.

What you do

You're the tester; your family member is the subject. Once you've done the tests, swap roles and repeat. Compare your results.

Test one: Reactions

Hold a 30 cm ruler at the 30 cm mark between your thumb and index finger.

Ask the subject to hold their thumb and index finger by the 0 cm mark close to – but not touching – the ruler.

When you drop the ruler, the subject should try to catch it as quickly as possible by closing their fingers.

Record the distance that the ruler dropped by noting the mark on the ruler where the subject's fingers pinched it. Repeat five times and take an average.

Test two: Pain receptors

Place ice cubes and water into a large bowl big enough to fit both hands. Ask your subject to place their hands into the ice water, and to take them out when they feel a sensation of pain (in other words, as soon as it feels uncomfortable).

Use the stopwatch to time how long they keep their hands in the ice water.

Test three: Touch receptors

Bend a paperclip into a U-shape. Make the two points about 4 cm apart.

Ask the subject to close their eyes.

Touch the subject on their thumb with both points of the paperclip. Ask if they can feel one or two points. If they can feel two points, repeat the process but move the points closer together by further bending the paperclip. Continue to decrease the distance between the two points until the subject only feels one point. Record the distance between the points.

Do the same thing on different areas of the body, for example, the hand, forearm, upper arm and back.

What is happening?

As you get older, your reaction time slows down and the sensitivity of your nerves is reduced. Do you have quicker reactions and more sensitive hands compared with the adults you tested?

In test three, if the points are close together when the subject feels both points, it means there are a greater number of receptors in that area of the body. Which area of the body has most touch receptors?

You could try

Test other family members. Try doing it at different times of the day to see if this makes a difference.

Organiser's notes

Do not keep your hands in the bowl if you start to lose sensation – take them out as soon as it's uncomfortable. It can be dangerous to leave them in for too long, and this is not the purpose of the test.

Carbon footprints

11-16

You've probably heard of the term 'carbon footprint', but what is it? A carbon footprint is a measure of how much carbon dioxide (and methane) we give off during a period of time or during a certain activity.

The carbon footprint of the average Brit over a year is nearly 10 tonnes of carbon dioxide. In India, it's only just over one tonne.

Your challenge

Work out your carbon footprint for a particular activity or for a given time period. Note: this challenge requires good data keeping skills!

You will need

A pen, paper and a computer.

What you do

For this activity, you are going to measure the carbon footprint of your journey to school using a free online calculator at:

www.travelfootprint.org/journey_emissions

You can then try to think how you might reduce your carbon footprint.

You will need to research and collect some data. You'll need to make note of the type of transport you use, what fuel it takes, the start and end points of your journey and how many people are travelling in the car.

Put this information into the online calculator and see the results.

Work out what your weekly, monthly and yearly footprint is for this journey.

What is happening?

Carbon dioxide is a greenhouse gas. The more of it that is in our atmosphere, the more global temperatures are likely to rise. The change in global climate and its causes are hotly debated but the evidence that humans have contributed to the onset and speed of climate change above what is "natural" is very strong.

You could try

Try calculating your carbon footprint for other activities. Research what would happen if you chose a different way to travel to school. You can then try lowering your personal carbon emissions.

Organiser's notes

You can use this carbon footprint calculator: http://carboncalculator.direct.gov.uk/index.html to calculate your household's footprint.

Bugs and biodiversity

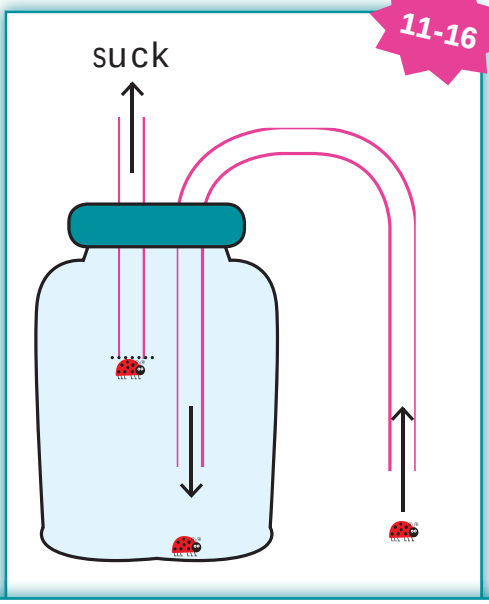
11-16

Picnics in the British countryside can be lovely. But then the wasps start buzzing around, or you realise you've sat on an ants nest! There are loads of insects in Britain, aren't there?

There are even more across the world – in fact, there are thought to be about 1.5 billion insects for every person on Earth!

Your challenge

Build a device to catch small insects and see which part of your garden or local park is the most diverse.



You will need

A jam jar with lid, two flexible plastic tubes (15 cm and 30 cm long), small piece of cloth, glue or tape, a hammer, a nail, measuring tape, pen and paper.

What you do

Take the lid off the jar. Use the hammer and nail to make two holes through the lid, opposite each other, each about 1 cm from the edge.

Glue some cloth over one end of the 15 cm tube. Push the cloth-covered-end through one of the holes in the jar lid, about a third of the way into the jar. Glue or tape the tube in place. Push the 30 cm tube through the other hole, about three-quarters of the way into the jar. Glue or tape it in place.

Point the end of the long tube so it's just over an insect and suck on the short tube. The insect should whizz up the tube into the jar. The cloth will stop it from shooting up the other tube and into your mouth!

Biodiversity test

Measure a small area with your tape measure (about 1 m x 1 m). Suck up all the insects you can see. Record how many different kinds of insects you captured and how many of each type there were. If you don't know what they're called, draw a picture and write the numbers next to it.

NOTE: Do not collect flying insects, or other animals such as slugs and snails. Always work ethically – insects are living things. Always put your insects back where you found them as soon as possible and minimise damage to any other plants and wildlife.

What is happening?

You performed a survey which provides an idea of the level of biodiversity of the insect population (the variety of insects in a particular habitat). These surveys are very important: they tell us what kinds of insects live in a particular area, and let us see if anything is changing.

The greater the biodiversity of an environment, the more chance every species will have to survive change and recover from problems.

You could try

Use your data to estimate the population size of the different insects you saw.

Organiser's notes

Ensure that no harmful insects are collected – the UK is a very safe place to conduct this kind of study, but bees and wasps should be avoided.

Peripheral vision

11-16

In Britain, nearly three-quarters of the population use glasses, contact lenses or have laser eye surgery to correct sight problems.

Peripheral vision is the sight which is not at the centre of our vision and, therefore, is not usually in focus.

Your challenge

Test your friends and family's peripheral vision by building a large cardboard protractor.

You will need

A semi-circular plastic protractor, a large piece of cardboard (about A3-sized; you can cut out the side of a box), scissors, a ruler, a pen and a pin. You might want to use a toilet roll tube as a handle.

What you do

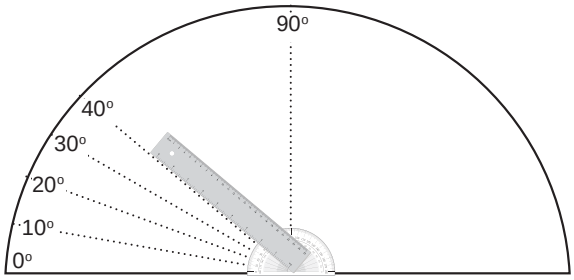
Measure the long edge of your cardboard. Draw a vertical line across the middle. Mark the top of the line 90º.

Draw a semi-circle from corner to corner, passing through the 90º mark. Cut it out.

Place your plastic protractor on the long edge of the card, lined up with the centre line. Place the ruler so it passes through the 10º mark of the plastic protractor, and draw a line all the way to the edge of the cardboard. Label the edge of the cardboard with 10º. Repeat at 10º intervals until you get to 90º, and then repeat for the other half. Put the pin in the 90º mark.

While sitting or standing, ask your subject to look straight ahead. Hold the cardboard protractor so it is parallel to the floor and the subject can look along the centre and focus on the pin.

Hold a pen at the 0º mark. Slide it around the cardboard protractor very slowly. Ask your subject to shout when they can see the pen. Repeat on both sides several times to find an average for each eye. Record your results for each friend or family member. Do you see any patterns?



What is happening?

When we look straight ahead and focus on something, we still can see what's on our left and right, even if it's out of focus. The further to the left and right we can see, the better our peripheral vision is. As we get older we generally see a loss of our peripheral vision. A minority of people will end up suffering from tunnel vision, where they can't see anything that's not in the centre of their vision.

You could try

Try using different coloured and shaped objects to see if these factors have an effect on our ability to see the objects in our periphery. Also, is there a difference between still and moving objects?

Organiser's notes

Take care with the pin and when using scissors.

Metallic food

11-16

Did you know that iron is essential to help carry oxygen around your body? Yet 30% of the world's population has an iron deficiency (they are anaemic). In Britain, however, only 5-10% of people are anaemic.

One possible reason it is lower in Britain than the world average is because we add iron and vitamins to our breakfast cereals. We also have a good standard of healthcare.

Your challenge

Assess how much iron is present in breakfast cereals.

You will need

A two-litre plastic bottle, a magnet, some tape, a blender, a large bowl, scissors, a measuring jug, a supply of tap water and a selection of different breakfast cereals.

What you do

Cut the bottom from the two-litre bottle. Tape the magnet to the outside of the bottle.

To prepare the cereal, add 200g into the blender with 200 ml of water and blend it to the finest consistency possible. If it is too thick, add more water.

Now you are ready to extract the iron from the food. Rest the bottle's neck on the side of the large bowl. Slowly pour the cereal sludge into the open bottom of the bottle. Use more water if you need to wash out the blender jug. Make sure the magnet is on the outside bottom of the bottle so the cereal sludge passes over it.

You should repeat this several times by re-pouring the collected sludge from the large bowl back through your iron collector.

You will start to notice that a pellet of iron is forming where the magnet is. This is your iron pellet.

Repeat for different foods and cereals and compare the size of the pellets.

What is happening?

By blending up the cereal you are breaking up all the cells, releasing their contents. The magnet attracts the iron and holds it in the bottom of the bottle. Scientists often have to separate mixtures, so many laboratories use separation techniques that work on similar ideas.

You could try

Try looking at different foods that are meant to be high in iron, such as spinach. You may also like to test food supplement tablets.

british science week

Organiser's notes

Be careful when using the blender. Always put the lid on and never put your hands inside the jug.

Soap boats

16+

Britain has approximately 11,000 miles of coast, is surrounded by water and is known for being a maritime nation. Water plays an incredibly important role in all our lives. It is a simple and ubiquitous molecule which, when collected together, has some very unusual properties essential for life.

By understanding these properties we can do things that might be considered unusual – like using soap as a fuel to propel boats.

Your challenge

Build a soap-powered boat and design it to travel the greatest distance on the least amount of detergent.

You will need

You can build your boat using all sorts of materials – you could use a two-litre plastic bottle or build an origami boat out of paper. The choice is yours!

You'll also need a bath or large tub of water (the smaller the boat, the smaller the tub) and some washing up liquid.

What you do

For a simple plastic bottle boat, cut a slot in the top (so you can gain access), and pierce a small hole in the rear of the bottle for detergent to exit. Tape some stabilising fins on the side of the bottle.

To make it move, take a measured amount of washing up liquid and pour it into the slot on top of the bottle. When the detergent comes out of the hole in the rear of the bottle it will touch water, and the boat will move forward.

Be creative with your designs. You can use most things that float and that can hold a small amount of washing up liquid. It doesn't have to be huge either; a small tag from a bread bag can work brilliantly.

However, if you choose to build a more elaborate boat, play with the design to see if you can improve it and reduce the amount of fuel (detergent) you need. Try to make it move as far as possible.

What is happening?

Water is an incredible molecule with some very unusual properties. The hydrogen bonding causes the water to have surface tension. The detergent breaks the surface tension creating a gradient between the back and the front of the boat. The surface tension at the front is greater, so effectively pulls the boat forward. This is one of the properties your lungs contend with every day. They produce surfactant to stop the alveoli membranes sticking together, meaning they can open.

You could try

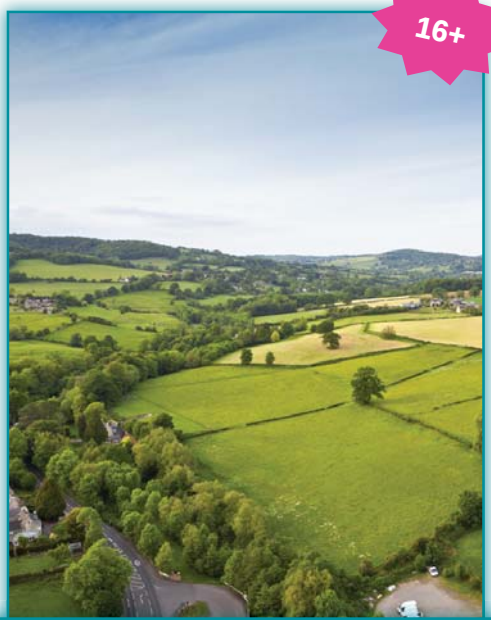
Try investigating differences between brands or types of detergent.

Organiser's notes

Be careful not to slip over or get detergent in your eyes.

Colourful plants

16+



In 1804, William Blake wrote a poem in which he described England as a "green and pleasant land."

This green colour comes from the plants reflecting more green wavelengths of light compared with other wavelengths. This is due to the amazing pigment chlorophyll, without which there would possibly be no life on Earth. But chlorophyll is not just a single pigment...

Your challenge

Separate the different types of chlorophyll from a plant's leaf.

You will need

A solvent (acetone, e.g., nail polish remover, or iopropyl alcohol is easy to find in chemists), coffee filter paper, a glass ramekin, a pencil, a ruler, a blender or pestle and mortar and a few leaves (spinach works well).

What you do

Prepare the filter paper by cutting it into a rectangle about 3 cm wide by 7 cm long.

Prepare the leaves by cutting them into small pieces and blending (with a blender or pestle and mortar) until you get a pulp. You can add a very small amount of water to help it blend, but don't add too much.

To run the chromatography separation, put the pulp from your leaves into the ramekin and cover with the solvent. Put one end of the filter paper into the mixture, about 5 mm deep. Hold or clip it vertically and watch the solvent move up the paper, carrying the pigments. The different pigments will settle at different places.

Chlorophyll B will stop closer to where it started than chlorophyll A. They will be green in colour. You will probably get several other pigments. Do some research to try to find out what they are.

What is happening?

Chlorophyll is made up of chlorophyll A and B. Some plants and fungi also contain other photosynthetic pigments called xanthophylls, which have a yellow colour, and orange pigments, called carotenoids. These pigments are drawn up the filter paper with the solvent and separate depending on their ability to dissolve, or their solubility, in the isopropyl alcohol. The least soluble stops closest to the origin.

You could try

Try repeating on different coloured leaves, different plant leaves and leaves in the autumn when they are yellow and orange. You could also research how to calculate the retention factor (Rf) values of your pigments, and work out which pigments you have found. This value is a ratio between how far the pigments travel compared with the rest of the solvent. Each pigment has a set Rf value when using the same solvent and chromatography paper.

Organiser's notes

You should always use these chemicals in a well ventilated space, keeping them away from naked flames, and adhere to the warnings on the product labels.

Calorie counter

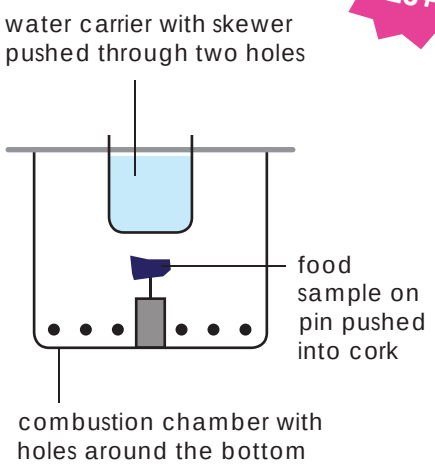
16+

In Britain, most of our food has a label saying what it contains and how much energy is in it. The energy in food is usually given in kilo joules and kilo calories.

How do we know that the values they give us are correct? We can check them using a calorie counting device.

Your challenge

Build a calorie counter with a burning chamber and measure the calories stored in food.



You will need

A large empty can (e.g. a paint tin), a smaller can that fits inside, a metal skewer, a large and small nail, a small hammer, a cork, a can opener, some water, a baking tray to put everything on, a thermometer, a selection of foods to burn (foods high in fat work well), kitchen scales, matches or a lighter, and a pen and paper.

What you do

To make the combustion chamber, remove the lid from the large can. Make a number of holes using your hammer and large nail around the side of the can, about 1 cm up from the bottom edge. This will allow air – which contains oxygen – to flow into the chamber, feeding the combustion.

To make the water holder, remove the lid from the small can. Make two holes in the wall of the can opposite each other, about 1 cm down from the top. Put the metal skewer through the two holes.

To make a stand for your food, push the small nail into the cork. Place the cork in the bottom of the combustion chamber. Hang the water chamber over it.

Place the apparatus on a baking tray.

Weigh a piece of food, record the weight and put it onto the nail on your cork base.

Put the thermometer in the water and record the starting temperature.

Carefully set the food on fire and place the water holder over the top. Wait until the food is completely burnt and record the new temperature. Don't touch anything until it has cooled down!

Subtract the end temperature from the start temperature. Divide this by the weight of food. This will give you a ratio of the temperature rise to weight of food, so you can compare it with other types of food.

Repeat the experiment for each food at least three times, and take an average.

What is happening?

Combustion transfers the chemical energy in the food to heat. Measuring the temperature rise of the water allows us to make an assessment of the amount of stored energy in a piece of food. Commercial calorie counters work in a similar way but minimise any loss of heat to give a more accurate reading.

You could try

Research how to calculate the number of calories from the temperature rise. Try to improve the design of your calorie counter: where might heat be escaping?

Organiser's notes

Always use the baking tray when using the calorie counter. Fire can be dangerous, so be especially careful with this experiment.

Curriculum links

This activity pack provides lots of opportunity to use a range of investigative, practical and communication skills. Many areas of the curricula for 5-16 year olds in England, Wales, Scotland and Northern Ireland are covered:

1 Cloud generator

England, KS1 and KS2: Seasonal changes

Scotland, Curriculum for Excellence: Processes of the planet

Wales, KS2: The sustainable Earth

Northern Ireland, KS2: The world around us

2 Soak up the Sun

England, KS1 and KS2: Renewable energy

Scotland, Scottish Curriculum for Excellence: Energy sources and sustainability

Wales, KS2: The sustainable Earth

Northern Ireland, KS2: The world around us

3 Giant egg timer

England, KS2: Forces

Scotland, Curriculum for Excellence: Forces

Wales, KS2: How things work

Northern Ireland, KS2: The world around us

4 Battery building

England, KS2: Electricity

Scotland, Curriculum for Excellence: SCN 1-09a Forces, electricity and waves

Wales, KS2: How things work, section 1

Northern Ireland, KS2: The world around us

5 Measuring wind speed

England, KS1 and KS2: Seasonal changes

Scotland, Curriculum for Excellence: Processes of the planet

Wales, KS2: The sustainable Earth

Northern Ireland, KS2: The world around us

6 Humidity meter

England, KS1 and KS2: Seasonal changes

Scotland, Curriculum for Excellence: Processes of the planet

Wales, KS2: The sustainable Earth

Northern Ireland, KS2: The world around us

7 Wireless signal blockade

England, KS3 and KS4: Waves and Electromagnet waves

Scotland, Curriculum for Excellence: Vibrations and waves

Wales, KS4: Energy, electricity and radiations

Northern Ireland, KS3 and KS4: Science and technology, and Forces and energy

8 Have you got the nerve?

England, KS3 and KS4: Structure and function of living organisms, and Coordination using the nervous system

Scotland, Curriculum for Excellence: SCN 3-12a Biodiversity, body systems and cells

Wales, KS3 and KS4: Interdependence of organisms, and Organisms and health

Northern Ireland, KS3 and KS4: Organisms and health

9 Carbon footprints

England, KS3 and KS4: Earth and atmosphere, and Activities of humans

Scotland, Curriculum for Excellence: SCN 3-05b Processes of the planet

Wales, KS3 and KS4: Interdependence of organisms, and Organisms and health

Northern Ireland, KS3 and KS4: Earth and Universe (human influences on their environment)

10 Building, bugging and biodiversity

England. KS3 and KS4: Interactions and interdependencies, and Ecology.

Scotland, Curriculum for Excellence: SCN 2-01a and SCN 3-01a Biodiversity and interdependence

Wales, KS3 and KS4: Interdependence of organisms, and Organisms and health

Northern Ireland, KS3 and KS4: Organisms and health

11 Out of the corner of your eye

England, KS3 and KS4: Structure and function of living organisms, and coordination using the nervous system.

Scotland, Curriculum for Excellence: SCN 3-12a Biodiversity, body systems and cells

Wales, KS3 and KS4: Interdependence of organisms, and Organisms and health

Northern Ireland, KS3 and KS4: Organisms and health

12 Metallic food

England, KS3 and KS4: Structure and function of living organisms: Nutrition and digestion, and Health and diet

Scotland, Curriculum for Excellence: Body systems and cells, and Materials

Wales, KS3: Interdependence of organisms

Northern Ireland, KS3 and KS4: Organisms and health, and Chemical and material behaviour

