NATIONAL SCIENCE & ENGINEERING WEEK
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Accidental discoveries

Part of the British Science Association's National Science & Engineering Week activity pack series. **www.nsew.org.uk**

BIS Department for Business Innovation & Skills

BRITISH SCIENCE ASSOCIATION

Accidental discoveries: Activity pack

INTRODUCTION

This activity pack contains a range of different activities on the theme of 'Accidental discoveries' for National Science & Engineering Week.

Activities are aimed at 5-11 year olds but may be suitable for a range of age-groups. The Microwave oven activity on page 5 is most suitable for older KS2 pupils (10 to 11 years) as it introduces more advanced concepts and skills. All activities are intended to act as a stimulus for your own National Science & Engineering Week activities and can be tailored to the ability of the group.

The 'Accidental discoveries' activities have all been designed for use in discrete 20–60 minute class or science club sessions. Activities 1-12 are short, fun experiments that can be done as filler activities or a range of round-robin sessions. They use resources that can be sourced cheaply and easily. Successful completion of each of activities 14 and 15 can count towards a **CREST ★ Investigators** award. There is one Star and one SuperStar activity in the pack.

In Star activities (usually for 5–7 year olds) children discuss, solve problems and share experiences. In SuperStar activities (usually for 7–11 year olds) children work independently, discuss ideas and how to test them, solve simple problems and decide how to share results. Extra suggestions are also given for each activity for older or more advanced children.

More information about **CREST ★ Investigators** can be found at **www.britishscienceassociation.org**

Download more activity packs for National Science & Engineering Week at **www.nsew.org.uk**

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VIDEOS

There are three videos to accompany this pack – one each for **01 Bakelite plastic**, **03 Play-Doh®** and **05 Microwave oven.**

Click the 'stream video' tab underneath the instructions to connect to the Internet and view the video online.

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Accidental discoveries: Bakelite plastic

Making silly putty

More than one hundred years ago, electric wires were covered with 'shellac'. It stopped people getting an electric shock if they touched the wire. It was very expensive because it was made from beetles that came from Asia. So, a man called Leo Baekeland decided to make a new type of covering. However, instead he discovered how to make the first plastic, called Bakelite. Plastics can be moulded into all kinds of shapes. They are used to make all sorts of things. You can have a go at making a bouncy plastic, called silly putty.

This 1950s telephone is made from Bakelite

You will need: 2 containers (such as plastic cups), a wooden stick (for stirring), some food colouring, PVA glue, borax solution (about 1 tablespoon of borax to a cup of water)

What you do

Put about one tablespoon of borax into one cup of water. Stir until it dissolves. Stir in two or three drops of food colouring.

Put some PVA glue into the other container – just enough to cover the bottom.

Pour some of the borax solution into the PVA glue. Stir the mixture until it makes a soft lump.

By now the mixture should be joining together like putty. Take it out of the container and mould it into a ball in your hands. If it is still sticky, wash your hands with water and rinse the ball. You have made silly putty!

Try squishing it into different shapes. Does it bounce?

Accidental discoveries: Artificial sweeteners

Light sweeteners

One day in 1879 a man called Constantin Fahlberg was trying to discover new uses for coal tar (a sticky black substance used for making paints and other useful things). At lunchtime he sat down to eat a sandwich – without washing his hands. His bread tasted very sweet.

At first he couldn't understand why.

So, when he went back to work he tasted some of the chemicals he'd been working with. One of them was very sweet. It was called 'saccharin'. It can be used instead of sugar to make things sweet.

You will need: a large container of water, a 330ml can of fizzy drink, a 330ml can of diet fizzy drink (make sure they're the same brand, so there are less 'variables' – other things stay the same).

What you do

Place the can of regular fizzy drink into the container of water. What happens?

Now put the can of diet fizzy drink into the water. What happens?

Artifical sweeteners are used in 'diet' fizzy drinks

Accidental discoveries: Play-Doh®

Play-doh® circuits

In the 1930s a company called Krogers Grocery made a product to clean coal from wallpaper. Then, one of the workers saw some school children using it to make Christmas decorations. So, he added some colour and sold the product as a toy for children. It was called Play-Doh® and is still popular today. You're going to make your own Play-Doh® and use it to make an electric circuit.

Play-Doh®

You will need: a mixing bowl, 200ml water, 100ml salt, food colouring and plastic gloves, 100ml cream of tartar, a tablespoon, vegetable oil, 400ml plain flour (plus a bit extra for sprinkling on the tray), a wooden spoon, a board or tray, a battery pack, leads, an LED or light bulb in a holder.

What you do

Put on your plastic gloves. Pour 200ml water into a mixing bowl. Add the salt and a few drops of the food colouring. Stir. Add 100ml cream of tartar, a tablespoon of vegetable oil and 400ml flour. Stir until it is mushy (not watery or floury). Sprinkle the board or tray with flour. Scrape the mixture out of the bowl onto the board or tray. Knead it with your hands until it turns into a ball. If it still feels sticky add a bit more flour. If it is too stiff, add a few drops of water and knead again. Add flour or water until you have a nice soft but not sticky ball. Now use your play-doh to connect leads to make a simple electric circuit to light your LED – like in the picture.

A simple play-doh circuit

Accidental discoveries: Chocolate chip cookies

Melting chocolate

Nearly one hundred years ago, a lady called Ruth Wakefield was making cookies when she ran out of cooking chocolate. Cooking chocolate melts and makes the cookies all brown and chocolatey.

She didn't give up and used a different type of chocolate instead, called 'semi-sweet' chocolate. But it didn't melt. Mrs Wakefield had accidentally invented the chocolate chip cookie!

She sold the recipe to Nestlé in exchange for a lifetime supply of chocolate chips.

Mmm, chocolate chip cookies!

You will need: different types of chocolate samples (such as milk chocolate, chocolate chips, cooking chocolate, dark chocolate), a cup and saucer, hot water at about 45 °C (water from the hot tap should be OK), a timer.

What you do

Carefully pour the hot water into a cup so it's nearly full. Place the saucer on top.

Wait for a few minutes until the saucer gets hot.

Break the different types of chocolate into same-sized pieces.

Place a piece of each type of chocolate on the saucer. Start the timer.

How long does it take for each kind of chocolate to melt?

Which chocolate would you put into a cookie?

Accidental discoveries: Microwave oven

The speed of light

Percy Spencer was an engineer. One day at work he was stood next to a bit of machinery called a magnetron. It made microwave radio signals. He noticed that a bar of chocolate in his pocket melted. Percy had accidentally discovered that these signals could make things hot. He used his ideas to make the first ever microwave oven. You're going to use chocolate buttons and a microwave oven to measure the speed of light.

A microwave oven

You will need: a microwave oven, a microwavable plate, some chocolate buttons (enough to cover the plate), a ruler and a calculator.

What you do

Sprinkle the chocolate buttons so they cover the plate. Take the turntable out of the microwave oven. Put the plate and chocolate in. Set the microwave oven to full power and start cooking the chocolate. Watch it very carefully. As soon as it starts to melt (usually about 20 seconds) stop the oven. Let the plate cool for a few minutes, then take it out.

There should be melted spots in the chocolate. This is where the microwave energy has been highest.

Now you have to do some tricky maths – so make sure you have a calculator. You might need to ask your teacher for some help. Measure the distance, in centimetres, between the melted spots. Add all your measurements and then divide the answer by the number of measurements you took – that is the average distance.

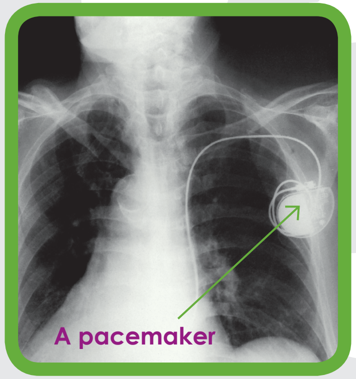
Times the average distance by two. Divide this number by 100 (to get the distance in metres). Then multiply by 2450 000 000. The answer is the speed of light in metres per second.

Accidental discoveries: Pacemaker

Rhythm of the heart

Sometimes, if somebody's heart doesn't beat quite right, they have a 'pacemaker' fitted. It helps to keep their heart beating at just the right rhythm.

The pacemaker was an accidental invention. An engineer called Wilson Greatbatch was building something to record the rhythm of people's heart beats. He reached into his tool box and accidentally pulled out the wrong bit of kit. He fixed it to his circuit. The circuit 'pulsed' for 1.8 milliseconds and then stopped for one second. As luck would have it, that was just the right rhythm needed to make a pacemaker.



You will need: a partner, a wrist heart monitor or timer, a calculator.

What you do

Sit down and keep calm while you read these instructions.

When your partner is feeling relaxed, follow the instructions which come with a wrist heart monitor to find their resting heart rate.

If you don't have a heart monitor, you need to find the pulse at their wrist: ask them to rest their arm on a table or desk with the palm up. Use the tips of your first two fingers to find their pulse about 2 cm below the base of their thumb. Have a look at the picture to help.

Count the number of beats in 15 seconds. Multiply by four to get the number of beats per minute.

How many beats is this per second?

How does this compare with Wilson's circuit?

you could try ...
what's happening?
hide controls

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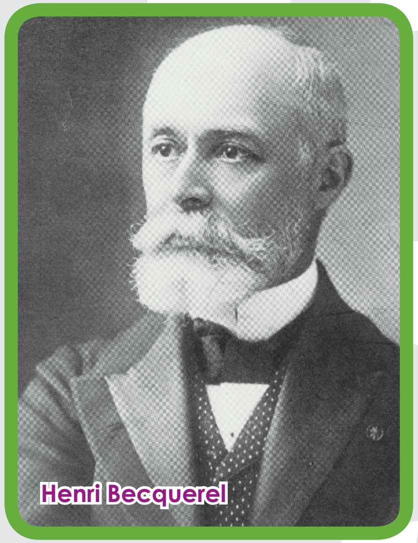
Accidental discoveries: Radioactivity

Detecting radiation

More than a hundred years ago, a man called Henri Becquerel decided to do some experiments. He wanted to see if things that glow in the dark could produce X-rays if they were left in the sun. (There was probably a very clever reason for this!)

But when he decided to do his work, it was winter. There wasn't much sun. So, he put his materials in a drawer and waited for a sunny day. When he took them our he noticed that a rock had made an image on a piece of paper. The rock was radioactive.

You can't investigate radioactivity (it's really dangerous!). But you can make cool pictures with objects using something called sunprint paper – a bit like when Henri left his rock in a drawer!



Henri Becquerel

You will need: a sunny day, a piece of sunprint paper in an envelope, a sink with cold water tap, a stopwatch, some objects for your picture (you can choose pretty much anything as long as they will stay on the paper – leaves, feathers, pens, scissors, cut-out shapes).

What you do

Choose your objects. Decide how you want to arrange them to make a picture or pattern.

Take the sunprint paper out of the envelope.

Quickly place the objects on it and put it in a sunny place for two minutes.

Quickly take off the objects.

Put the sunprint paper back in the envelope and take it to a sink.

Take out the sunprint paper and rinse it. Hang it up to dry.

you could try ...
what's happening?
hide controls

Accidental discoveries: Penicillin

Growing mould

In 1928, Alexander Fleming was growing bacteria in Petri dishes. Bacteria are tiny living things – some of them make people poorly. One of the dishes accidentally got some mould in it. He noticed that the bacteria didn't grow close to the mould. The mould is now used as a medicine, called 'penicillin'. It can kill bacteria. You may have taken some, if you've ever been poorly with an infection.

You can't actually make penicillin yourself, but you can investigate the growth of bacteria and moulds in Petri dishes.

Mould growing on a Petri dish

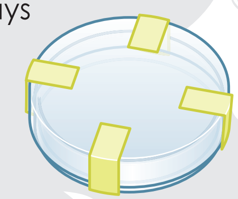
You will need: a fine (thin) permanent marker pen, a sterile Petri dish with clear jelly containing nutrients (food), a clock or timer, some clear sticky tape.

What you do

Handle the Petri dish carefully – it has a loose lid that must stay on until you start your experiment.

Use the marker pen to write your name on the base. Place the dish where you want to test the air for bacteria and mould spores (tiny structures that can grow into new moulds).

Remove the lid completely. Do not lean over the dish or breathe on it. Replace the lid after fifteen minutes. Stick the lid on with four pieces of clear tape placed crossways – do not seal all round the edge (look at the picture).



Leave it in a warm place until you can see some changes. Look for hairy structures growing on the jelly.

Can you see any clear areas around the hairy structures?

you could try ... what's happening?

hide controls

Accidental discoveries: Vulcanised rubber

Treating rubber bands

Have you ever heard of 'vulcanised rubber'? Probably not! But it's used in all sorts of things such as car tyres and shoes. It was discovered accidentally, when Charles Goodyear spilt a mixture of rubber, lead and sulfur (a chemical) on to a hot stove. The mixture burnt a bit. It then went hard but was still usable.

Tyres made from vulcanised rubber

You will need: untreated rubber bands, rubber bands that have been treated in different ways (stored in water, oil or alcohol, or left in sunlight, heated or frozen), some weights and hangers, a ruler, a pencil.

What you do

You will need to work with at least one other person.

Loop one of the rubber bands around a pencil. Hang a weight hanger from the rubber band.

Measure its 'original length' to the nearest millimetre – record the result in a table, a bit like the one below. Add weights until the rubber band has stretched to three times its original length. Compare the rubber bands treated in different ways.

		treated				
	untreated	water	oil	sunlight	heated	frozen
original length (mm)						
number of weights needed to stretch rubber band to three-times its original length						

you could try ... what's happening?

hide controls

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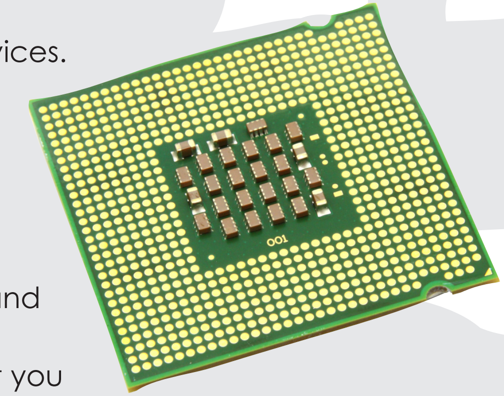
Accidental discoveries: Smart dust

Making a mote



Silicon chips are used in computers and other electronic devices. A student, called Jamie Link, was working with silicon chips when one burst into pieces. She then discovered that the tiny pieces could still work as 'sensors' to detect changes in all kinds of things. It is now possible to put tiny devices called motes in different places to warn about changes. One of the things they are used for is detecting how much salt is in concrete. It's helpful because salt can weaken concrete – and no-one wants bridges to start falling down!

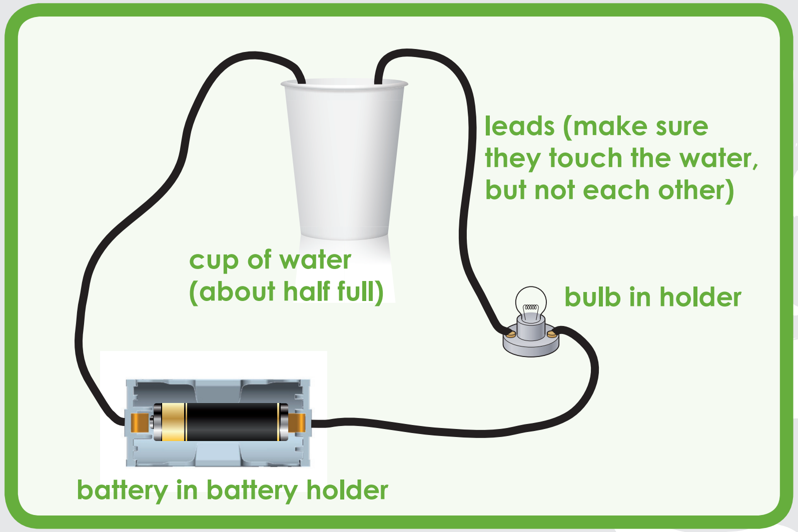
You can't use motes in the classroom (they're too small!) but you can have a go at making a sensor for detecting salt.

You will need: a plastic cup, water, some salt solution, a battery pack, leads, an LED or light bulb in a holder.

What you do

Set up an electric circuit like the one in the picture.

Carefully pour salt solution into the water until the bulb lights up.



you could try ...
what's happening?
hide controls

Accidental discoveries: Coca-Cola®

Adding the fizz

John Pemberton was trying to make a cure for headaches when he invented Coca-Cola®.

For eight years it was only sold in chemist shops. But it became so popular that it was put in bottles and made available everywhere. It eventually became the best selling fizzy drink in the world.

The recipe is still a closely guarded secret, but you can make your own fizzy drink.

You will need: a place where food can be prepared, a lemon, a clean knife, a clean plastic cup, drinking water, a teaspoon, sodium bicarbonate, sugar.

What you do

Cut the lemon in half and squeeze as much of the juice as you can into the cup.

Add an equal amount of water to the lemon juice.

Add a teaspoon of sodium bicarbonate.

Taste your drink and add some sugar if you think it needs to be sweeter.

Squeeeeeeze!

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Accidental discoveries: Teflon®

Introduction

In 1938, a man called Roy Plunkett was doing some work in his laboratory. He was using gases to try to make a 'coolant' (a liquid that helps make refrigerators cold). One of his attempts went wrong and he accidentally discovered a slippery powder, called Teflon®.

Teflon® is so slippery that pretty much nothing sticks to it. It's used to coat non-stick frying pans. It's also used to make tape, which plumbers use to make water-tight seals on pipes.

A frying pan coated with Teflon

You will need: a permanent fine marker pen, some Teflon® tape.

What you do

Write your name on a piece of Teflon® tape using a marker pen.

Carefully stretch it sideways in a few places to mess up your writing.

Now take the ends of the tape and pull it lengthways.

What happens to the tape and the writing?

Plumbers' tape

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Accidental discoveries: Mauve

Extracting dyes

Way back in 1856, an 18-year old chemist was trying to find a cure for malaria (a really deadly disease which kills millions of people). But his experiment went a bit wrong. He looked at what he'd made and, even though it wasn't what he'd hoped for, he thought it looked rather nice. He had accidentally made the first ever synthetic dye – he called it Mauve. It was nice and bright and didn't fade. Dyes are used to make clothes and other fabrics colourful.

It's a bit tricky to make synthetic dyes in your school (the chemicals you need must be used very carefully). But you can make natural dyes from foods and plants.

Group activity

This activity is great for group work – you could all make a different dye.

You will need: a kettle and water, glass jars, various plants and foods to extract dyes from (such as beetroot, coffee beans, carrots, mint leaves, dandelions, red onion, tea leaves), a knife, a pestle and mortar, a sieve, some pieces of white fabric to dye (an old cotton t-shirt or sheet, for example).

What you do

Decide which foods and plants you want to make natural dyes from. Then, for each one:

Chop it up (or crush it in a pestle and mortar if you can't cut it). You might even be able to use an electric food chopper if your teacher has one. Put a small handful of it to a glass jar. Nearly fill the jar with boiling water from the kettle [be careful!]. Leave it for about 10 minutes to cool down. Pour it through a sieve into a clean jar, to get rid of the bits. You now have a natural dye.

Use it to dye some pieces of fabric. Cut your fabrics into same-sized squares (about 5 cm x 5 cm should be OK). Add a bit of fabric to the jar of dye and leave it for a few minutes. Take it out of the jar and hang it up to dry.

you could try ... what's happening?
hide controls

Accidental discoveries: Tea and tea bags

All the tea in China

According to ancient Chinese legend, tea was invented accidentally nearly 5000 years ago! A Chinese Emperor called Shen Nong liked to boil water before drinking it (he thought it was more hygienic). Then, one day when his servants were boiling up some water, the leaves from a camellia bush fell in. The emperor thought it smelt lovely. He took a sip and it tasted lovely too!

These days we make our brew using a tea bag.

- ★ **Have you ever helped to make a cup of tea?**
- ★ **Do you know how tea bags work?**

Your challenge

Find the best material to make a tea bag. Do you think it will be kitchen roll? Maybe newspaper could work. What about a thin fabric?

Here's one way to find out

Cut out a square of kitchen roll. Put a teaspoonful of tea leaves in the middle. Gather up the corners with a clothes peg to make a bag.

Half fill a clear beaker with water from the hot tap. Holding the peg, dunk the tea bag up and down in the water for one minute.

Try other papers and fabrics to see which type makes the best tea bag (lets the flavour and colour out, and keeps the tea leaves in).

Take care with the hot water and don't drink the tea!

- ★ **Can you think of other ways to test tea bags?**

Talk about

Talk to your friends about your ideas.

Plan how you can test different tea bags with a buddy. How will you know which is the best tea bag?

some extra things to do
share your ideas
hide controls

Accidental discoveries: Velcro® (learning from plants)

Learning from plants

In the 1940s a Swiss engineer was out walking his dog. When he got home he realised that he and his dog were both covered in 'burrs' (a type of seed sack from plants). He looked at one under a microscope and saw it had lots of little hooks – that's why it hooked onto his jumper. He used this principle to make a new fastening device, which he called Velcro®. These days it's really common. It just goes to show that looking at plants is really useful!

Your challenge involves making and testing models that fall to the ground like seeds from a sycamore tree.

★ **Have you ever seen a sycamore seed fall to the ground?**
★ **Do you know how to make a model sycamore seed?**

Your challenge

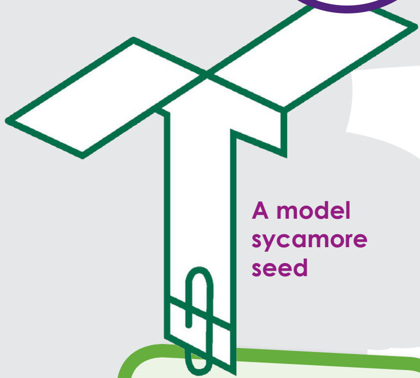
Find out whether the size of the 'blades' make a difference to the speed at which your sycamore seed falls to the ground.

Here are some ideas to get you started

Make sycamore seed models like the diagram. Put a paper clip on the bottom to help them fall properly. What sizes will you make them? How big will you make the blades? How many clips will you add?

Now put them to the test

Watch the seeds carefully as they fall. Can you make them go faster and slower? You could try landing them on a target and score points for where they land. Remember to change only one thing at a time.



A model sycamore seed

Talk about

What happens if you drop flat and scrunched up paper? What do you notice about the way that they fall? What might be making a difference to the way that they fall?

A real sycamore seed

A 'burr' from a burdock (a type of thistle)

some extra things to do

share your ideas

hide controls

Accidental discoveries: Organiser's notes

ACCIDENTAL DISCOVERIES

For each activity, read through the pupil instructions to familiarise yourself with the method. Make sure the pupils understand what they are going to do.

Check the 'what you need' list and make sure that everything that pupils need is available. Extra materials may be needed for trial runs or repeats.

Give pupils all the equipment they need and make them aware of any health and safety issues; a risk assessment should always be carried out before starting any practical work.

Read through the notes below for some additional information for each activity.

Bakelite Plastic

Equipment and advice: You can buy borax in some supermarkets and hardware stores (don't get the stuff called Natural Borax Substitute!). Plenty of places sell it online, too: search on Amazon (Fizzy Cosmetics is good).

A saturated solution of borax is needed. It can take a while to dissolve, so you might want to do this for the pupils.

Background science: Borax solution causes the polymer chains of polyvinyl acetate (PVA) to cross-link. PVA chains normally move easily and form a liquid. When the chains become cross-linked they can no longer slide easily and form a solid but flexible plastic material.

Additional health and safety note: Borax can be harmful if swallowed and is an irritant. Wash your hands after touching the putty. Do not taste or ingest putty. Wear eye protection and an apron or laboratory coat for this preparation.

Artificial sweetener

Equipment and advice: You'll need quite a large container of water for this – a fish tank is good because pupils can look through the sides.

Background science: Although the two cans of fizzy drink have the same volume, they have different densities – it's because of what's dissolved in the drink. Diet drinks use artificial sweeteners. Regular drinks use sugar. Artificial sweeteners are sweeter than sugar. So, you need about 40 grams of sugar but only a few grams of artificial sweetener. The difference in the amount of dissolved sweeteners is what causes a difference in density.

Play-Doh®

Equipment and advice: Plastic cups can be used. If the facilities are available, the mixture can be gently heated on a very low heat in a saucepan before kneading (a risk assessment should be completed and appropriate safety measures taken). The mixture should be stirred until it forms a ball. Make sure an adult checks that the ball is not too hot before kneading. Do not allow the mixture to be eaten.

The instructions provided make a pretty big ball of play-doh! ... it might be best if pupils work in small groups, or you could reduce the quantities.

Components for the circuits can be bought online or from shops such as Maplins. Don't connect the batteries directly to the LEDs – it can cause them to get hot and burn out; the play-doh should provide enough resistance to prevent this.

Background science: The salt water in the play-doh is a conductor, so it will allow an electric current to flow.

Chocolate chip cookies

Equipment and advice: If pupils have access to a food preparation area, they could experiment by making cookies themselves, using different types of chocolate.

Background science: This useful website, www.food-info.net, says *"The type of chocolate and its ingredients will have an effect on the heat resistance and melting of the finished product. Melting is important for the mouthfeel and taste of the chocolate."*

Microwave oven

Equipment and advice: Pupils should not be allowed to use the microwave oven unsupervised – an adult should take the plate out of the oven as some plates get very hot. Microwave frequency varies slightly between ovens, the exact figure may be found on the oven.

Note: sometimes, even with the microwave plate removed, the plate of choclate touches the rotating mechanism and turns; try placing an upside-down plate into the microwave to cover up the mechanism to stop your plate of chocolate moving.

This activity is best suited for older (at least KS2) pupils; it requires some maths that may be too difficult for younger pupils. However, with help from a teacher they may enjoy working with such 'big numbers' and will be amazed at how close their answer is to the real thing!

Background science: The distance between the melted spots is the distance between a peak and a trough (= half a wavelength). Double the distance is the length of one wave. How often the waves go by is their frequency. In a typical microwave oven, 2450 million waves go by every second. So, the length of the wave in metres multiplied by the number of waves per second gives us the distance in metres that light and microwaves travel in one second.

The speed of light is exactly 299,792,458 metres per second (the metre is defined from the speed of light), or about 300 000 kilometres per second (186 000 miles per second).

Pacemaker

Equipment and advice: You can buy heart monitors for about £20 from school science suppliers, or online shops (such as the Kinetik Monitor Watch from Argos).

Background science: The human heart must keep a constant flow of blood to the body's tissues to supply food and oxygen and remove waste, especially in the brain.

The natural pacemaker of the heart generates electrical signals to stimulate the heart muscle to contract. In a heart attack, the muscles of the heart are deprived of oxygen and some may die. Cells in the pacemaker may also be killed so it no longer produces the necessary electrical signals. When this happens, an artificial pacemaker can be used to deliver regular electrical signals to the heart.

If you don't have a heart monitor, pupils can simply take each other's pulse – they may need some help with this.

Additional health and safety note: If pupils decide to measure heart rate after exercise, check for pupils who suffer from any conditions which might affect their ability to undertake the exercise safely. Do not allow pupils to carry out this activity unsupervised. Advise pupils to stop, sit down and report if they feel dizzy or unwell.

Radioactivity

Equipment and advice: You can buy sunprint paper in craft shops or online (such as Amazon); a pack of ten A5 sheets costs about £5.

Sunprint paper is soaked in light sensitive Berlin green, which washes away when the paper is rinsed with water. The action of sunlight on Berlin green causes a light activated reaction producing Prussian blue. This is not washed away by water. The darker the blue colour, the more complete the reaction that has taken place.

Penicillin

Equipment and advice: You can buy pre-poured Petri dishes from suppliers such as Blades Biological. Malt agar is an appropriate agar medium.

Background science: Bacteria form solid colonies containing millions of cells. Moulds grow hairy structures. If a mould produces a chemical that inhibits bacterial growth, bacteria will not grow near them.

Additional health and safety notes: Wash hands before and after any microbiology experiment. Cover any exposed cuts to the skin with waterproof dressings. Do not put fingers in mouth and do not eat or drink in the lab. Avoid touching face or eyes with hands until after they have been washed. Open Petri dishes only for as long as is necessary (15 minutes should be sufficient). Avoid breathing or coughing over an open Petri dish. Don't touch the exposed agar medium. Close an inoculated plate with small strips of clear adhesive tape (see diagram in pupil instructions). Incubate the plate upside down. Ensure plate is carefully labelled on its base. Keep the plates' temperatures at or below 30 °C. Keep incubated plates closed during examination. Ensure that all used Petri dishes are autoclaved before being disposed of – you may need to find a co-operative secondary school or university to help.

For further notes on the handling and disposal of microbe material, refer to CLEAPSS guide G190 for microbiology activities, and the 'Be Safe' booklet from the ASE.

Vulcanised rubber

Equipment and advice: The rubber bands should be the same for comparison. They need to be treated in different ways – it's probably best if you do this beforehand, although with time and guidance the pupils may help with the process.

Treatments include: *Boiling in water* (makes the rubber stretch more easily), *Soaking in mineral oil for three days or more* (makes rubber stretch more easily, but not as much as boiling in water), *Freezing* (no effect – water molecules are unable to penetrate the rubber to form ice crystals), and *Exposing to sunlight* (become brittle and snap easily).

Background science: Vulcanisation is a curing process of rubber involving high heat and the addition of sulfur or other curatives. Polymer molecules are linked to other polymer molecules by bridges composed of sulfur to sulfur or carbon to carbon bonds. Springy rubber molecules become cross-linked to a greater or lesser extent, making rubber material harder, much more durable and more resistant to chemical attack. It also makes the surface of the material smoother and helps to prevent it from sticking to metal or plastic.

Smart dust

Equipment and advice: Components for the circuits can be bought online or from shops such as Maplins. The water in the cup needs to be distilled/deionised – you can buy it from school science suppliers or from shops such as Halfords (it's the same stuff you put in car radiators). Alternatively, previously-boiled water should be OK. To make the salt solution, just dissolve a few spoons of salt in a cup of water.

Background science: Here the objective is simply to show that electrical devices can be used as sensors to detect chemical changes. Motes, also known as 'smart dust', use a small, low cost computer to monitor one or more sensors for such things as light, temperature, position, sound, vibration, pressure, humidity, acceleration and so on. They may be switched on and off remotely and connect by a radio link to transmit information. At present they are typically the size of a couple of matchboxes. Power consumption is the main problem, so the battery is usually the largest component. In the future motes are expected to be a few millimetres in size and may be used inside the body.

See: http://computer.howstuffworks.com/mote.htm

Coca-Cola®

Equipment and advice: The preparation must be done in a suitable food preparation area. To avoid the use of knives, lemons can be cut in half and stored in plastic bags beforehand. Sodium bicarbonate (sodium hydrogencarbonate) may be bought cheaply in chemists or supermarkets and should not be confused with baking powder (which also contains acid such as tartaric acid).

Background science: Sodium bicarbonate reacts with the citric acid in the lemon juice to give carbon dioxide.

Teflon®

Equipment and advice: You can buy Teflon tape (or PTFE tape) from DIY shops. You may be able to obtain wider rolls than the usual standard size.

Background science: Teflon's scientific name is Polytetrafluoroethylene (PTFE). The polymer molecules in plastic shopping bags line up from top to bottom to resist the weight of the shopping.

Super non-stick surfaces are being developed that are self-cleaning. See, for example, http://www.technologyreview.com/news/409169/no-more-thumbprints/

Mauve

Equipment and advice: How much can be achieved depends, of course, on the time available. Here are two approaches. If time allows, both could be used.

★ Different plants or plant products and just one sort of fabric, e.g. cotton.

★ Different sorts of fabrics and just one plant or plant product. If this approach is taken pupils could be asked to make a note of the types of fabric by looking at labels on the clothing, etc.

Pupils might work in pairs. Make sure their work stations are set out neatly and keep a close eye on pupils using boiling water. It's a good idea to dye the fabrics while the dye solution is still warm, say about 40 °C.

Pupils can put their dried pieces of dyed fabric in cold water to see how easily the dye comes out. Another test sometimes used is the 'rub test'. Simply rub the dried fabric with a clean dry piece of white fabric. Does it rub off?

CREST STAR INVESTIGATORS

The following two activities count towards a Crest Award at either Star or SuperStar level. If you enjoyed these activities and would like to do more then why not register for CREST ★ Investigators and receive a pack of further activities and investigations? CREST ★ Investigators is a UK-wide award scheme that enables children to solve scientific problems through practical investigation.

For more information on how to register and receive your CREST ★ Investigator packs, visit our website at http://www.britishscienceassociation.org/creststar or call 020 7019 4943.

Tea and teabags

What do I do?

Get the pupils to talk to a friend about the questions and the ideas.

Look at some tea bags together. Talk about making tea.

If possible, let them choose their own materials.

Check that they understand how to make tea bags using the pegs. Let them talk about what makes a good tea bag.

Discuss safety issues when using hot water.

If drawing cups of tea, encourage the pupils to use lighter or darker browns to show the tea colour and to draw in tea leaves.

Accidental discoveries: Organiser's notes

Things to look out for

They need to fix the peg so that the tea leaves cannot escape through the top. Pupils may need to practice. Thin or soft materials are easier to use.

Some materials will absorb a lot of water and some will tear easily. Encourage pupils to notice this.

Encourage pupils to use the same amount of tea in each bag, the same sized piece of material, the same volume and temperature of water, and to dunk for the same amount of time.

Encourage pupils to observe differences in tea colour and the number of escaping tea leaves.

How can pupils share their ideas?

Pupils can draw pictures of cups of tea. They can stick a piece of the appropriate tea bag material next to each picture.

Resources

Loose tea leaves and tea bags, water from the hot tap (see Safety), clothes pegs, a selection of different materials (e.g. tissues, newspaper, kitchen roll, silk, cotton, tissue paper, crepe paper, material from a pair of tights), teaspoons, clear containers, measuring jug, minute timer, scissors and thermometers, coloured pencils (including brown).

Safety

Water from the hot tap will work. Check its temperature before use to make sure it is not too hot for pupils to use.

Try to prevent over vigorous dunking and splashing.

Pupils should not drink the tea.

Velcro® (learning from plants)

What do I do?

Check the resources list, including preparing a spinner and **templates** if you think that they might be needed.

Give pupils time to explore flat and screwed up paper and to think about what might be making a difference to the way that they fall.

Encourage the pupils to make their own large and small spinners. It is important to let them explore their ideas on their own. Have templates available if pupils need them.

Some may need help to work out how to cut and fold the spinners.

Now let pupils try the spinners to see what happens.

Remind them about safety, particularly about not climbing to drop the spinners.

Give pupils some time to talk about their observations and ideas. You could show pupils other spinners with different blade lengths and ask them to predict how they will fall.

Pupils can share their 'best' spinner or they can create a display.

Things to look out for

Encourage pupils to drop their spinners from the same height. This should be as high as possible so that the spinners can twirl before they hit the ground.

Very large spinners require a long drop to see any effect. If they are too flimsy they will not spin.

Very tiny spinners can spin extremely quickly.

It is difficult timing the spinners if they fall quickly. However, if pupils want to try timing, you should let them have a go to see if works.

Adding paperclips or Blu-Tack® can increase spin speed.

Resources

A4 Paper, 30 cm ruler, metre ruler, paperclips or Blu–Tack®, scissors, one ready–made spinner to show the pupils how they work, large and small templates for spinners (if you think pupils will need them, **click here**), stopwatches, other types of paper and card.

Safety

It can be useful to drop the spinners from a height greater than a child. However, pupils should not stand on chairs or tables to launch their spinners unless very closely supervised. A library stool or kitchen steps are better.

Pupils need to handle and carry scissors in a safe manner.

CURRICULUM LINKS

Working through the activity pack provides lots of opportunity to engage in practical work and scientific enquiry. Many areas of the 5-11 curriculum across England, Northern Ireland, Scotland and Wales are touched on, as indicated below:

ENGLAND

Science

★ Scientific enquiry

★ Life processes and living things – Humans and other animals (Circulation); Green plants (Growth and nutrition; Micro-organisms)

★ Materials and their properties – Grouping (and classifying) materials; Changing materials

★ Physical processes – Electricity (Simple circuits); Light and sound

NORTHERN IRELAND

The World Around Us

★ Interdependence

★ Movement and Energy

Accidental discoveries: Organiser's notes

★ Place

★ Change over Time

SCOTLAND

Sciences

★ Planet Earth – Biodiversity and interdependence

★ Forces, electricity and waves – Electricity; Vibrations and waves

★ Biological systems – Body systems and cells

★ Materials – Properties and uses of substances; Chemical changes

WALES

Knowledge and Understanding of the World (3-7 year olds)

★ Myself and other living things

★ Myself and non-living things

Science (7-19 year olds)

★ Communication; Enquiry

★ Interdependence of organisms

★ The sustainable Earth

★ How things work