Just add water…!

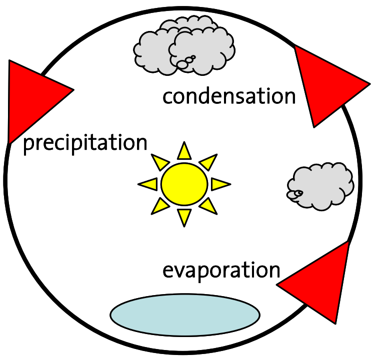
A BA challenge pack for National Science and Engineering Week

This challenge pack is full of activities on the theme of water. Find out how to make a hovercraft, how to build a solar still, how to filter your own water or even make your own water turbine.

For further challenge packs, please visit **www.the-ba.net/nsew**

National Science & Engineering Week is funded by the Department of Trade and Industry and supported by the Engineering and Technology Board

Water, water, everywhere...



Soil
Water
Small margarine tub
Large, clear plastic container
Cling film
Tape or large elastic band
Bag of ice (optional)
Heat lamp (optional)

What you do

Put the soil in the large container and mould it to make hills, mountains, plateaus and a lake basin as if it were a real landscape. Put the margarine bowl in the lake basin and fill it with water. Next, tightly cover the large container with cling film and secure it with the tape or elastic band.

You can either leave the container in a sunny place for a few days or, to speed up the process, place a bag of ice on top of the cling film at one end of the container and aim a heat lamp at the other.

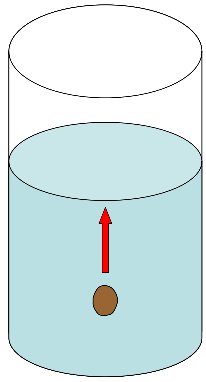
What's happening?

Keep your eyes peeled and, after a day or two, you should see condensation form on the cling film (or "sky"). When enough condensation has collected on the cling film it will fall, or "rain", onto the soil "landscape".

The earth, like the experiment, only has a limited amount of water. This water keeps going around and around in what we call the "Water Cycle".

When the sun heats the earth's surface, the water turns into steam or vapour and **evaporates** into the air. When this water vapour rises in the air, it then cools and **condenses** into clouds. When those clouds become too heavy with moisture they release it as precipitation or rain. This precipitation then collects in lakes or oceans after filtering through the earth or along streams and rivers. Then it evaporates in the sun and the cycle is repeated again and again.

Floating fruit



A tall, clear glass
Some raisins
Some clear, fizzy drink that has a lot of bubbles (this won't work if it's not very fizzy)

What to do

First, pour the fizzy drink into the glass. Now drop in a raisin and wait for 20 to 30 seconds to see what happens.

What's happening?

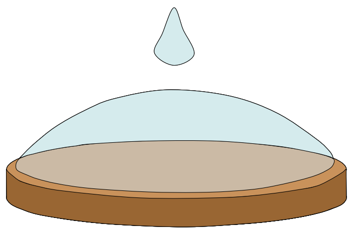
You should have seen the raisin float to the top of the glass after 20 to 30 seconds. This is because the bubbles of carbon dioxide that are being released by the fizzy drink stick to the sides of the raisin to make it more buoyant – just like a mini life jacket.

What happens if you wait a bit longer? You should find that the raisin will start to sink after a while. This is because the gas in the bubbles escapes once they reach the surface of the glass. Once the raisin has sunk, the process can start again.

Now that you've tried a raisin how about experimenting with other things. You could try anything....how about some of these to get you started: a brazil nut; a dried pasta shape; a dried chickpea or a safety pin.

Think about how you can get more of the carbon dioxide gas bubbles to stick to the objects and make them float more easily.

Drops on pennies



Water
Different types of liquid
Pennies
Pipettes/droppers
Pencil and paper
Washing up liquid

What you do

Very carefully, use the pipette to drop one drop of water onto your penny at a time. How many drops do you think the penny will be able to hold before they fall off the edge? Make a little chart for how many drops you **predict** the penny will hold and how many drops it **actually** holds. It's important to try to make sure that each drop is the same size.

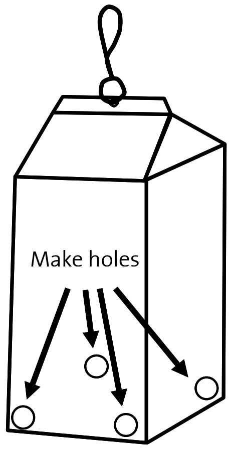
Next, try the same experiment but add a small amount of washing up liquid to the water. How many drops does the penny hold this time?

What's happening?

Because of the way hydrogen and oxygen atoms are joined within a water molecule, water molecules are attracted to one another enabling them to stick together and pile up on a surface. The sticking together of these molecules is called cohesion and is what enables so many drops of water to stay on top of the penny at once. A water molecule at the surface is held in place by the molecules beneath it and forms a kind of "skin" on the surface of the water. This results in what is called "surface tension". It is this surface tension that also lets some insects walk around on the surface of the water.

When you add washing up liquid to the water, the cohesion between the molecules is reduced and you should find that the penny holds less drops of water than before.

Twisting turbines



A large square fruit juice carton
String
A pen
Water in another larger container
A funnel
Masking tape

What you do

Using the pen make a hole in the bottom right corner of each side of the fruit juice carton and then cover each one with a piece of masking tape. Now make another hole in the middle of the top of the carton so that you can thread some string through to hang the carton up. Make sure you hang the carton up in a place that you don't mind getting wet e.g. from a tree outside. Next, use the funnel to fill the carton with water from the top.

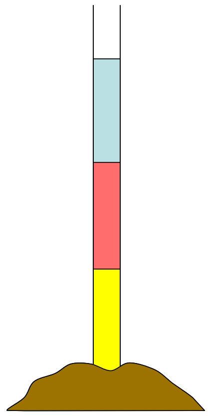
You can now pull off the masking tape from one corner and watch what happens. Do the same with the masking tape on the opposite hole and then the other two holes, pausing each time to watch what effect this has on your turbine.

What's happening?

As the water is forced out of the hole it makes the carton move in the opposite direction. This is called **Newton's Third Law**, the theory that for every action, there is an equal and opposite reaction. In this case, the water being forced out of the hole in one direction was causing the carton to turn in the opposite direction. You should have seen that the more holes that were uncovered the faster the carton spun.

This simple experiment demonstrates how some industrial turbines work. Turbines use the pressure of water, or even steam, to turn a shaft connected to a generator. When turned, the generator then produces electricity.

Luminous layers



Salt
Water
Clear straws
Clay
Food colouring - blue, red and yellow
3 plastic cups
Pipettes/droppers

What you do

Firstly, fill the three plastic cups with water and add a few drops of a different food colouring to each of them – one blue, one red and one yellow. Secondly, add lots of salt to the blue cup, a medium amount to the red and none at all to the yellow and stir until dissolved.

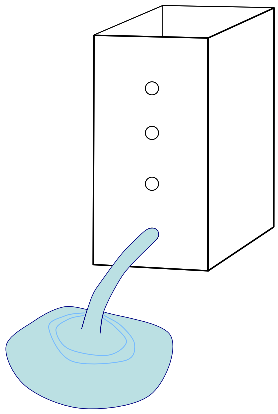
Mould the clay so that it forms a base for the straw and stick the straw into it so that it stands up straight and there are no gaps in the clay around the bottom. Use the pipette to drop the different coloured waters into the straw and watch what happens.

What's happening?

The coloured waters float on top of one another in the straw because the more salt there is in the water, the denser (or heavier by volume) it is. You should therefore see the blue water at the bottom, the red in the middle and the yellow at the top.

Try adding different amounts of salt to the different coloured waters and see what happens.

The pressure's on!



A large square fruit juice carton
5 litres of water
A nail
Masking tape
Ruler
Marker pen
Pair of scissors
Pad of paper and pencil to make notes

What you do

Using the scissors cut off the top of the fruit juice carton. Next, measure 1.25 cm from the bottom of the carton and make a small hole with the nail. Make another 3 holes (taking care that they are all the same size) directly above the first hole by measuring up from the bottom at 2.5cm, 6cm and 12 cm.

Cover up all four of the holes with the masking tape and stand the carton with the holes pointing towards the sink. Fill the carton with water and mark the water level - you will need to fill the carton to the same place every time.

Next, quickly remove the tape from all four holes and measure how far away each of the streams of water hits the sink. As the water empties watch what happens to the streams.

Now tape up all holes again, fill the carton to the same level and remove the tape from the bottom hole only. How far does the stream reach this time? Repeat this process with each of the holes in turn and measure how far each of the streams reach.

What's happening?

The streams from each hole reached a different distance because water has weight. The closer the hole is to the bottom of the carton, the more water is above it and therefore more weight is pressing down. This weight of water is called water pressure. The more pressure there is the further away the stream will reach and the faster it will go.

Hydroelectric power plants are built at the bottom of large dams so that they can use the high pressure water at the bottom of the reservoir to generate electricity. This water is directed through a series of pipes and tunnels and pointed onto the blades of a turbine. The water then turns the turbine and generator to make the electricity.

Watching water

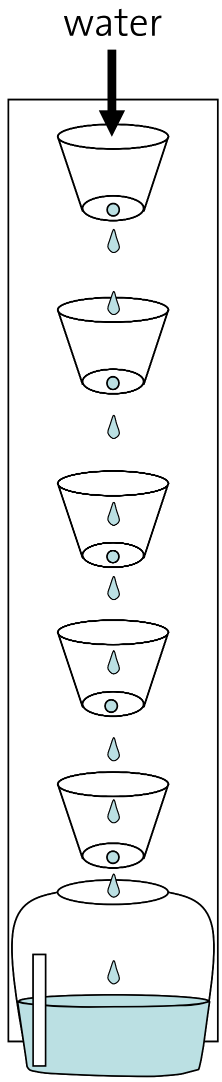
Why not take a look at how much water you use at either home or at school?

Count how many litres of water your house or school uses and then think of ways in which you can help save this water For example, count how many times you wash your hands, flush the toilet, wash the dishes or how long you spend in the shower (see Shower Power). Are there any leaks or dripping taps? Do you have a power shower? How many loads of washing do you do in a week?

Check the following for more information on how to do your very own water audit.

www.waterintheschool.co.uk
www.southernwater.co.uk/educationandenvironment/educationalresources
www.eco-schools.org.uk/

The dripping clock



5 paper cups (all the same size)
5 drawing pins
Some sticky tape
A pencil
A large clear glass jar
A timer or stopwatch
A strip of heavy card
A small thin strip of paper

What you do

Use a drawing pin to make a hole in the bottom of each cup and then stick the 5 paper cups, in a vertical line, to the strip of heavy card

Next, stick the small thin piece of paper vertically on the large jar (as shown in the diagram) and place the jar directly underneath the bottom cup.

Fill the top cup with a small amount of water and check that it flows smoothly through all of the cups into the jar. If it doesn't work properly carefully make the holes in the paper cups a little bigger.

You should now empty the water that you used to check everything was working properly and fill the top cup once more. This time you will need to use the stop watch and at the end of every five minutes mark how much water is in the bottom jar on the thin strip of paper stuck to it.

Once all the water has flowed into the glass jar you will have enough information to use the water clock to keep track of time.

What's happening?

Because you now know how long it takes for the water to reach certain levels you will be able to use the water clock to estimate all sorts of things just by checking the level. Try it by filling the top cup at the beginning of your favourite TV programme or when you start your homework and then checking the level in the glass jar when the programme ends or you finish your homework.

Shower power

A shower
Stopwatch (or water clock!)
Measuring jug

What you do

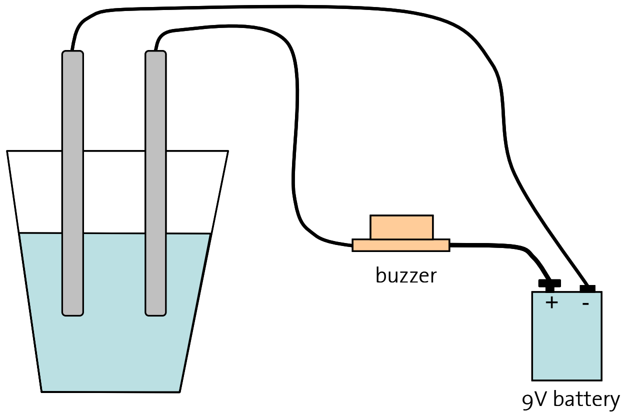
First, you will need to time how long you take in the shower– either using the stop watch or by checking your water clock. Once you've timed yourself, you can calculate how much water you use.

Hold a bucket of water under the shower for 1 minute while you run the water. Now measure how much water you used during this period.

You now have enough information to calculate how much water you use when you shower. All you have to do is multiply the amount of water used in a minute by the time you spend in the shower.

Do you think a power shower, or bath, uses more or less water?

Salty science



Masking tape
9-volt battery
Electrical wire (optional)
Buzzer
2 lollipop sticks
Aluminium foil
Water
Salt
A bowl or beaker

What you do

Put some water into a bowl, add a few tablespoons of salt and then stir until it has dissolved. Now take the two lollipop sticks and cover them with aluminium foil.

Take the buzzer and stick the red wire of the buzzer to the positive end (the end with a plus sign on it) of the battery with some tape, and tape the black wire of the buzzer to one of the foil-covered lollipop sticks. Now stick the other lollipop stick to the negative end (the end with a minus sign on it) of the battery with some tape (or using the optional electrical wire).

To make sure your tester is working touch the lollipop sticks together. This should complete the electric circuit and make the buzzer buzz. If you don't hear a buzz, make sure that your connections are taped securely to the right places and try again.

Now to use the circuit as a salt water tester all you have to do is dip the tips of the foil covered lollipop sticks, about 2.5cm apart, into the salt water.

What's happening?

If you've done everything correctly the buzzer should buzz when you dip the lollipop sticks into the salt water. The salt water acts as a conductor of electricity - like an invisible wire - completing the circuit.

When salt dissolves in water, it splits apart into smaller parts called "ions" with positive and negative electrical charges. Ordinary table salt splits into Na^+ (Sodium) and Cl^-. (Chlorine). These charged particles are dragged opposite ways by the electrical field, created by the battery, which enables them to carry the electricity through the water. As fresh water does not have these ions, it cannot conduct electricity, and will not make the buzzer buzz.

Water magnifier

Cling film
A washer
Newspaper
Water
Pipette/dropper

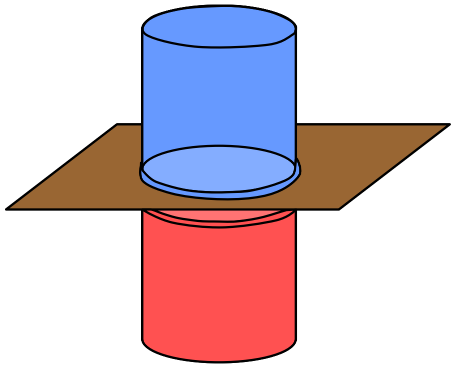
What you do

Cover your newspaper with cling film and place the washer over the top of a word. Use the pipette or dropper to put a couple of drops of water into the centre of the washer and look at the letters through the washer. How do they look?

What's happening?

The water in the centre of the washer acts like a lens. The water drop's rounded shape bends the light outwards making the letters appear larger or magnified.

Mix it up



Two identical small, wide-mouthed jam jars
Hot water
Cold water
Food colouring (blue and red)
A postcard or square of waxed paper big enough to cover the top of the jam jars
Scissors
A large, shallow bowl or baking dish or a sink

What you do

Fill one of the jam jars with very hot tap water, add a few drops red food colouring and place the jar in the bowl.

Fill the other jar with cold water and add a few drops of the blue food colouring. Carefully add more cold water to the blue jar until you can see a bulge of water over the rim of the jar. Rest the postcard over the top of the jar and give it a gentle tap. Now quickly flip the blue jar upside down and the water should hold the postcard in place.

Next, place the upside-down blue jar squarely on top of the red jar and, while someone holds both jars steady, carefully pull out the post card and see what happens to the coloured waters. Make sure that you do not disturb or move either jar.

Try the experiment again but this time put the card on the hot water and balance the red jar on top of the blue jar and watch what happens.

What's happening?

Density is a measure of the amount of the mass of a substance compared to the amount of space that it takes up. Substances with lower density will float on top of substances with a higher density.

The hot water is less dense than the cold water because the molecules have more energy, and move faster, than the cold water molecules, causing them to spread further apart. Since the hot water is less dense than the cold water, it will float on top.

When the hot water is in the bottom jar, the red water will rise and the blue, cold water will sink, causing the two substances to mix together, or diffuse, to make purple water.

When the cold blue water is on the bottom, the hot water doesn't have to rise as it is already on the top and so no mixing occurs.

Eventually the two sets of beakers will look the same because both the hot and cold water will reach room temperature, will become equally dense and will mix thoroughly.

Succulent science

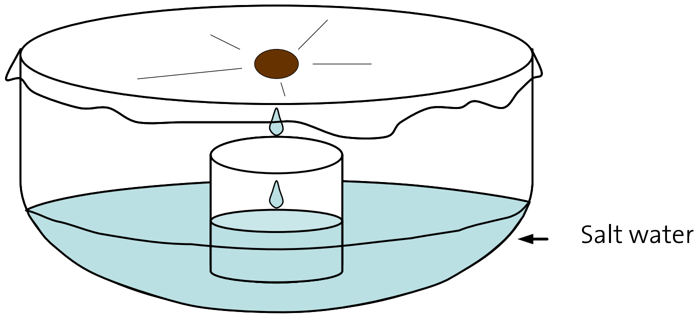
Project Idea

Try researching some plants that can survive on little water – what mechanisms do they use?

Why not create a rain garden – a garden that needs little watering and holds water in the soil – and collect rain water in a barrel in order to water the plants?

Think about other ways of saving water in your garden...can you come up with ten top tips?

Still crazy



A large bowl
A short glass or beaker
Tape
Cling film
A small pebble or stone
Jug of water
Salt

What you do

Stir a generous sprinkling of salt into some water and pour it into a large bowl until about 5cm deep.

Next, stand the beaker in the middle of the bowl so that the top is higher than the salt water but lower than the rim of the bowl. Stretch some cling film over the top of the bowl and seal around the edge with tape.

Place the pebble in the centre of the cling film making sure that it is weighed down over the middle of the beaker; this will help to collect the water.

Leave your solar still outside in the sunshine for about a day and see what happens. This will work better on a sunny day!

What's happening?

As the sun heats up the salt water in the bowl, the water evaporates, leaving the salt behind. As the water vapour rises, it hits the cling film, cools and turns back into water droplets. The pebble on the cling film then helps these droplets to make their way to the centre of the cling film and fall into the beaker.

This water has now been distilled and will not taste of salt.

You can also try distilling fresh water from other liquids – try lemonade or cola for example and see what happens.

Hovercraft hustle

A plastic plate
A film canister
A nail or sharp object
Blu-tack
Balloon

What you do

Firstly, very carefully punch a hole through the centre of your plate with your nail (or sharp object) and another through the bottom of your film canister.

Secondly, using the Blu-tack, stick the film canister (bottom up) over the hole in your plate ensuring there are no gaps and that the holes are not blocked.

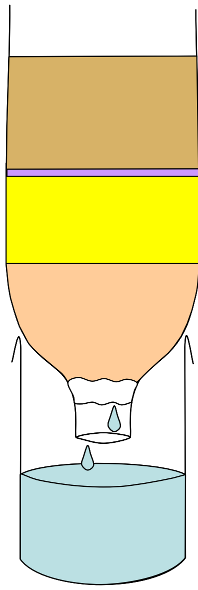
Now inflate your balloon and twist the end so that the air cannot escape. Stretch the opening of the balloon over the film canister making sure that it lines up with the hole in the bottom of the canister.

To test your hovercraft, place it on a smooth, flat surface, let go of the balloon and give it a gentle push. What happens?

What's happening?

As the air flows through the holes it forms a layer between the hovercraft and the table. This air layer reduces the friction enabling the hovercraft to slide across the table!

Filtering fun



A large clear plastic bottle
Two clear jars or beakers
Cotton wool
Clean, washed sand
Clean, washed gravel
Paper/kitchen towels
Garden soil
An old spoon
Scissors

What to do

Carefully cut the bottom off the bottle, turn it upside down and plug the neck with the cotton wool. Next put a good thick layer of gravel in on top of the cotton wool. Now spoon in a deep layer of sand. Finally cut out a disc of kitchen/paper towel big enough to cover the sand and place it on top.

You have now constructed your filter and are nearly ready to test it. All you need to do is stand the filter (with the cotton wool at the bottom!) on top of the beaker.

Next take three spoonfuls of the garden soil and mix it in with some water so that you have a beaker containing a runny muddy water solution.

Carefully pour the muddy water solution into your filter, on top of the paper towel disc and wait to see what comes out at the other end.

What's happening?

Rivers and lakes supply us with most of the water we need for drinking, cooking, washing and cleaning. Before we use river or lake water it has to be cleaned – you have just made a water filter that will clean dirty water.

The filter process allows the water to flow slowly through a granular bed (or filter) of varying grades – in this case the paper towel followed by the sand, gravel and finally the cotton wool. These filters hold onto most of the solid matter (the mud, small stones etc) and allow the water to pass through.

In large scale commercial factories this process is repeated a number of times to ensure that enough of the unwanted particles are removed to make the water safe to drink. The process, generally referred to as slow sand filtration, is one of the oldest methods and is still used today in many water treatment plants.

Cold as ice

A cup of water
An ice cube
A piece of cotton
Salt

What you do

Put the ice cube into the glass of water and place one end of your cotton on top of the ice. Sprinkle a bit of salt onto the top of the ice cube and leave it for a minute or two and then gently lift the thread up out of the water.

What's happening?

Salt lowers the freezing point of the water so melts the ice. The water then quickly refreezes trapping the cotton within the ice so that you can lift it.

Crafty rafts (group activity)

Plastic tanks, bowls or buckets of water – 1 per group
Sheets of squared paper (20cm x 20cm or A4) – 6 per group plus spare sheets
A set of marbles, or plastic or wooden cubes, all the same size – 30 per group plus some spares
Sellotape, masking tape, staplers, or other fasteners. Provide the same for each group
Waterproof coverings if you are working on wooden desks
Other materials for raft making eg different types of paper, lolly sticks, food trays, fasteners etc if you want the children to do the extra challenges

Your challenge is to build a raft which will hold the largest number of objects before it sinks

What to do

Give each group a number of sheets of squared paper. Challenge groups to make several rafts of different shapes and sizes. They can do this by folding the paper and securing the corners with sellotape. Give children time to discuss which shapes might work and to practise ways of folding the paper to make different rafts. Remind children of the challenge – to build a raft able to hold the largest number of objects before it sinks. They can do this by floating their rafts in a container of water and adding cubes or marbles until the rafts sink. The raft that carries the greatest number of objects will be the winner. Give children time to share ideas about what they have found out.

Key questions for the children to think about:
What happens if you make the shape of the raft broader, shallower, deeper or narrower?
What is the best way to load the raft?
What happens if you put all the objects on one side of the raft?
Are some shapes more stable (less wobbly) than others?

Background information

An object that is normally unable to float can be made to float by changing its shape. Different shapes will float in different ways. You will find a wide flat raft is very stable when it floats but can tip if it is loaded on one side. If the children are investigating carefully, the best raft is likely to be one with a large base and with sides approximately 1.5 cms deep.

For further information on National Science and Engineering Week and for other challenge packs visit www.the-ba.net/nsew

Educational Links

The activities and challenges within this pack can be used to complement, or contribute to, the Science and Art & Design sections of the National Curricula in England, Wales and Northern Ireland, and the Scottish 5-14 Guidelines in Environmental Studies and Expressive Arts. We recommend that you consult the National Curriculum on the website (www.nc.uk.net/), and the 5-14 Guidelines (www.ltscotland.org.uk/5to14).

Thank you for using Just Add Water!

We hope you enjoyed the activities within this pack. To help us to continue to provide new challenge packs we'd like to ask you to tell us a little about what you did for National Science & Engineering Week.

Please take a few minutes to fill in this form and return it to the National Science & Engineering Week office.

Name: ______________________________

Organisation: ______________________________

Address: ______________________________

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______________________________ Postcode: ______________________________

Tel: ______________________________ Fax: ______________________________

Email: ______________________________

Which dates did you do National Science Week activities on?

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What did you do?

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Please make any comments about this challenge pack, National Science & Engineering Week and/or other possible topics for future packs.

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Please return to:

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Post:	National Science & Engineering Week FREEPOST LON 14913 London SW7 5BR