Questacon Science Circus

Hands On Science Activities to Inspire Students & Teachers

Australian Government

Questacon The National Science and Technology Centre

FOUNDING PARTNER

Australian National University

Introduction

This is a series of some of our favourite science experiments. Each experiment can be used to demonstrate one or more scientific concept. Some experiments link with others, while others are stand-alone activities.

For each of the activities we have tried to use readily available materials that are found around the home or can be bought cheaply at a nearby store. You don't need expensive equipment to try science in the classroom.

We hope you enjoy these experiments and have hours of fun in your classroom.

The Questacon Science Circus Team

Safety

These activities have been designed using every-day materials which pose minimal safety risks. However, potential risks (and ways of mitigating them) should always be considered before conducting activities in a classroom environment. Some safety issues to consider in the experiments described in this document include:

- **Risks associated with allergic reactions.** Check for allergies before conducting any science activities described in this resource. A number of these activities involve materials that are known to cause allergic reactions in some people, including detergent, latex (used to make most rubber gloves, and balloons), and eggs. Look for alternatives to allergy-causing materials, or use personal protective equipment (such as gloves) to avoid skin contact with the allergen. Rubber gloves can be worn by students with sensitivities to detergent. Non-latex gloves are available from most supermarkets and pharmacies. Small water balloons can be substituted for eggs in 'Can you push an egg into a bottle?' and 'Now, can you get the egg out of the bottle?'.
- **Risks associated with fire.** Some activities in this resource involve the use of matches and flames. Always supervise students closely when conducting experiments involving fire. Keep a bucket of water and a fire blanket or extinguisher nearby.
- Risks associated with chemicals. Although all chemicals used in these science activities can commonly be found in kitchen cupboards, they should still be treated with caution. For example, vinegar and lemon juice are acidic and will sting if they splash into eyes, and Alka-Seltzer tablets can cause an overdose if taken in excess. Encouraging 'safe laboratory practices' by never eating science experiments, wearing safety glasses, and washing hands after science activities is strongly encouraged.
- **Risks associated with high air pressure.** Some activities in this resource involve building up high air pressure within a vessel (including 'Can you make a cloud in a bottle?' and 'Can you make a film canister fly?'). There is a risk that the vessel could explode if the pressure becomes too high. Always check that containers do not have visible cracks or weaknesses before using them for pressure experiments. Ensure that container lids face away from people in case the top pops off unexpectedly. When launching rockets, ensure that they sit on a flat launching surface and that they are not pointed towards people or breakable objects.
- **Slip hazards.** Oil and detergent spills can be very slippery, so ensure you clean up all spills as soon as they occur. A small amount of vinegar can be mixed with oil spills to assist in their clean up.
- **Communicable diseases.** To limit the spread of communicable diseases like the flu, when breath is needed, ensure students do not blow in each other's faces. When making kazoos for 'Can you make a kazoo?', ensure enough materials are provided so each student can construct their own instrument.

Can you make a film canister fly?

Science concepts:

Pressure, chemical reactions

You'll need:

- Alka-Seltzer or other effervescent tablet
- Photographic film canister with tight-fitting lid (the clear ones work the best, as the seal on black film canisters often isn't tight enough for this activity)
- Water
- A hard surface (preferably outdoors)

Time required:

10 minutes

What to do:

In an outdoor area, partly fill the film canister with water. The next step should be one swift action: Place 1/4 of an Alka-Seltzer tablet into the water and quickly put the canister lid on, shaking it once or twice and turning it upside down so that it sits on its lid.

Step back quickly and watch. If it starts to leak, carefully lift the canister up and flick off the lid, ensuring it is aimed away from people or delicate objects.

You can try changing a number of variables in this activity, including the quantities of water and Alka-Seltzer, the temperature of the water, or breaking the tablet into small pieces before adding it to the water.

What's happening?

Alka-Seltzer tablets contain sodium bicarbonate and citric acid, both in dry powder form. When they dissolve in water, they react together. This reaction produces carbon dioxide gas. Once the canister is closed the gas can't escape and it begins to build up inside the container, increasing the air pressure in the canister (more air pushing = more pressure). Eventually the air pressure is high enough to blow the canister off the lid. Using smaller pieces of Alka-Seltzer or grinding it up increases the surface area over which the reaction can occur, usually leading to a faster rocket launch.

Can you use a straw to make a hole in a potato?

Science concepts:

Air pressure

You'll need:

- A raw, unpeeled potato
- Straight plastic drinking straws

Time required:

5 minutes

What to do:

Place the potato on a table and hold it steady with one hand.

Grasp the middle of a straw firmly without bending or crushing it. Leave the top end of the straw uncovered.

Hold the straw 10cm above the potato and then stab the straw into the potato. Will the straw pierce the potato? Is the straw bent or crushed?

Using a new straw, place your thumb over the top end of the straw to make an air tight seal.

Hold the straw 10cm above the potato. Once again, stab the end of the straw into the potato. Will the straw pierce the potato this time? Is the straw bent or crushed?

What's happening?

This activity demonstrates the idea that air has 'push', or pressure. In the same way that air which has been pumped into a bicycle tyre pushes out on the wall of the tyre, air which is trapped in the straw when one end is covered by a thumb and the other is in contact with the potato pushes on the straw, increasing its structural integrity.

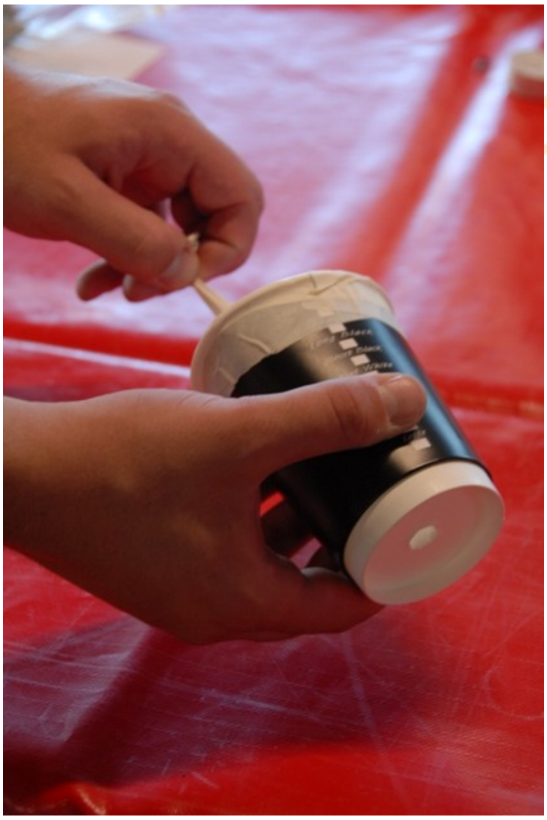
Can you make an air cannon?

Science concepts:

Air movement (fluid dynamics)

You'll need:

- A paper coffee cup (corrugated or reinforced cups work best)
- A balloon
- Scissors
- Masking tape
- Candle & matches (optional)
- Torn up paper or confetti (optional)



Time required:

10 minutes

What to do:

Cut off the top of the round part of the balloon and keep the section with the neck. Tie off the neck of the balloon.

Stretch the open end of the balloon over the top of the cup, being careful not to squish the cup. Try and align the neck of the balloon with the middle of the cup. You may need to fasten with masking tape.

With your pen, poke a hole about 1cm in diameter in the middle of the bottom of the cup. You have now built your air cannon.

Pull the balloon neck backwards then let it go suddenly so air shoots out of the hole at the bottom of the cup. Test that the air is coming out by having a friend place their hand in front of your air cannon.

You can see the effects of the air cannon by shooting it at some torn up paper or the flame of a lit candle.

What's happening?

Gases move from high pressure to low pressure. Drawing the balloon back lowers the pressure inside the cylinder, so air rushes in. Releasing the balloon increases the pressure inside the cylinder, so air rushes out, through the small exit hole. That's where things get a bit more complicated.

The air starts spinning, rather than travelling in a straight line, for a number of reasons. These include friction between the air and the hole in the cup, as well the air outside the cup that resists moving away. The spinning air makes a toroidal vortex, which is a donut-shape of spinning air.

Science in the real world

Vortices form when fluids flow. You usually only notice them when you can see particles moving in the fluid, or have different coloured fluids mixing. Famous examples of these are smoke rings, which can be blown by volcanos and pirate's cannons. Toroidal vortices can also be created underwater and are created by dolphins, who "play" with these underwater rings.

Scientists have recently used toroidal vortices to help explain how some waves behave strangely, as well as how they could help develop more efficient underwater travel.

Can you make a marshmallow catapult?

Science concepts:

Potential energy, elasticity

You'll need:

- 9 paddle pop sticks
- 5 rubber bands
- A plastic teaspoon
- Marshmallows or other objects to launch (optional)

Time required:

10 minutes

What to do:

Take 7 of the paddle pop sticks and bind them together by winding a rubber band tightly around one end. Repeat this on the other end of the paddle pop sticks

Take the remaining 2 sticks and tie a rubber band on one of the ends. Try to tie the band close to the edge of the sticks.

Gently slide the 7 paddle pop sticks between the 2 paddle pop sticks, splitting the 2 sticks apart.

Loop the rubber band in a cross fashion to join the two pieces together.

Attach the spoon to one of the single sticks using a rubber band to fasten it in place.

Now, place a marshmallow on the spoon, pull back on the spoon and watch your catapult fling!

What's happening?

The paddle pop stick and plastic spoon have an elastic property, which means they return to their original shape after being bent or deformed. Rubber bands also have this property.

When you bend the paddle pop stick back, you are creating elastic potential energy as the stick and spoon want to return to their original shape. When you release, that potential energy becomes kinetic energy as the catapult and marshmallow start to move.

While the spoon and stick of the catapult stop moving, there is no force to stop your marshmallow and it keeps flying through the air thanks to its momentum.

You can try investigating how far the marshmallow will fly, depending on how far you pull your catapult back. But be careful you don't pull it back too far!

Science in the real world

The catapult is just one type of medieval weapon used to fling objects great distances. Others include the ballista and the trebuchet. Catapults and ballistae store tension in ropes, flexed pieces of wood, or rubber (modern versions only) to launch objects. The trebuchet is different with a pivoting beam and counterweight to help fling objects into the air. All of these were popular during the medieval period in Europe and used in attacks to lay siege on castles and other fortresses. Large catapults can launch projectiles up to 300 metres, enabling the attacker to remain at a safe distance.

Can you make a Mexican jumping bean?

Science concepts:

Momentum, inertia, moving toys

You'll need:

- A whiteboard marker, or similar, with a diameter slightly larger than the marble
- Rectangular lunchbox with lid
- Scissors
- Aluminium foil
- Small marble

Time required:

10 minutes

What to do:

Cut a piece of aluminium foil about 10cm x 6cm (see photo dimensions, below).

Roll the foil around the whiteboard marker from the short side to make a 6cm long tube.

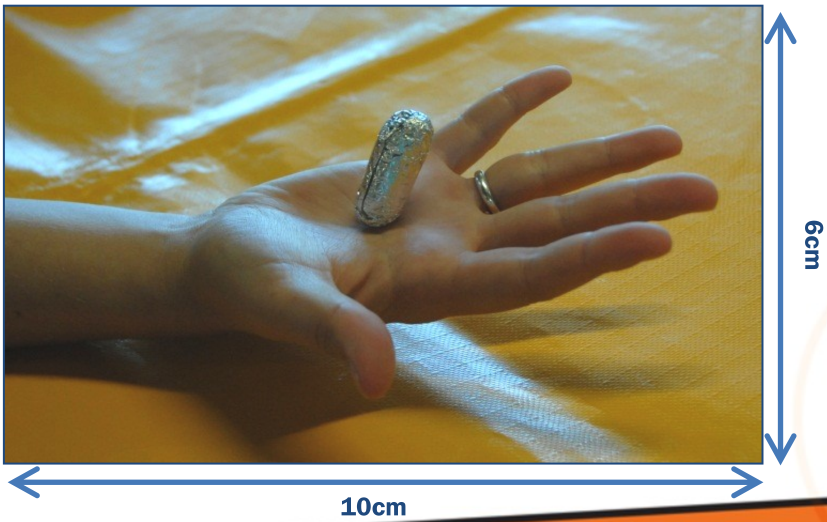
Slide the tube slightly off the whiteboard marker, and close over one of the open alfoil ends.

Slide the tube completely off the whiteboard marker and place the marble inside the hollow aluminium foil tube.

Carefully close the open end of the alfoil tube to seal it. It's ok if it looks a bit rough at this point, but the marble should be able to roll within the tube.

Put the bean in the rectangular lunchbox and shake it side to side. As the bean hits the wall, it will push on the aluminium foil and create round ends.

Remove the lid of the container and gently roll the bean around to see it come alive!



What's happening?

While the bean may look like it's moving in a crazy way, it's really just the rolling marble pushing the aluminium foil tube along. When you tip the bean, the marble rolls along the tube. When it reaches the end of the tube, the marble will try and keep rolling, but to do this it has to push the tube so that it flips over. Once the tube flips over, the marble can roll down the tube again and this pattern continues. The tube part of the bean may appear to flip magically, but it's just the marble rolling along smoothly that causes it all.

On a high school level, the movement of the 'bean' illustrates Newton's first law of motion- that an object at rest will stay at rest unless a force acts on it, and that a moving object will keep moving in the same direction, and at the same speed, unless a force acts on it. In other words, all objects resist changes to their state of motion. This idea is often referred to as inertia.

Science in the real world

Mexican jumping beans are real. The jumping bean moth lays eggs inside developing flowers of the plants. The eggs hatch and the larvae grow inside the hardened beans. The beans jump around because the larvae move inside the bean, somewhat like the marble inside the foil capsule.

Further information

While you can order Mexican Jumping Beans online, they are not allowed to be imported or brought into Australia due to our strict biosecurity laws.

Can you make cardboard climb?

Science concepts:

Friction

You'll need:

- Thick cardboard (cardboard from moving boxes works well)
- A plastic drinking straw
- 2m length of string
- Scissors
- Tape
- Pen or pin and pinboard
- Coloured pencils and decorations

Time required:

30 minutes

What to do:

Draw and cut out an animal on cardboard.

On the back attach two short lengths (5cm) of straw angled slightly inwards at the top (like a capital letter A, but with a gap between the straws at the top).

Thread a long length of string through one straw from the bottom to the top, and back down the other straw from the top to the bottom. Both ends of the string should be hanging downwards, with a loop of string at the top of the animal.

Place the loop in the string around the pen or pin in a board and slide your animal to the bottom of the string (away from the loop). If using a pen, ask a friend to hold it in the air.

Gently pull down alternatively on either string to make your cut-out move upwards.

Does nylon string work as well as other types of string? Is the length of the straw or the angle of the straws important? Try adding other moving parts. Will it still work if the climber has jointed limbs? Will it work along the floor? Or only moving upwards?

What’s happening?

When the string is pulled on one side, it moves freely through the straw, allowing the climber to move up. However, angle of the second straw creates friction and stops the character from moving on that side. Alternating between pulling the string on each side enables the cardboard to creep forward along the string.

Can you use air and water to do work?

Science concepts:

Pneumatics, hydraulics

You'll need:

- 2 plastic syringes
- Flexible plastic tubing
- Cardboard
- Scissors
- Tape

Time required:

30 minutes

What to do:

Pull the plunger of a syringe back so it is full of air.

Attach this syringe to some plastic tubing.

Attach another syringe to the other end of the tubing, but this time leave the plunger in the syringe.

Push on the extended plunger. What happens to the plunger at the other end of the tubing?

Repeat the experiment, but this time fill the plastic tubing and the first syringe with water. Is it easier or harder to move the second syringe?

Design a small object out of cardboard so that part of the object can be moved using the movement of air through the tubing to the other syringe. For example, you could put the body of a turtle on the syringe, and its head and neck on the plunger.

What’s happening?

As the air is forced out of one syringe, it is pushed along the tubing and into the other one. There will be a delay between pushing the plunger on one end and the plunger at the other end moving, because air can be compressed (or squashed). When you push the plunger in, the air is compressed, increasing the pressure of the air in the tubing. After a while the pressure gets high enough that it can push the plunger out at the other end of the tubing.

When you have the plunger and the tube filled with water there is no delay in the movement. This is because water cannot be compressed. As soon as you push the plunger, the water pushes out the other plunger. There will only be a delay if you still have air in your system. Try pushing down both plungers at once. You can move them both a little way when you have air in the tube but not at all when the tube is full of water.

Science in the real world

The term ‘hydraulic’ refers to something that is moved, operated or affected by water. Car brakes, wing flaps on aeroplanes and heavy machinery (such as dump trucks and excavators) all use hydraulic systems to move, like the water-powered syringes used in this activity, but on a much larger scale.

The term ‘pneumatic’ can be used to refer to a machine which moves using compressed air. Air brakes on busses and jackhammers are examples of pneumatic machines.

Can you make a lava lamp?

Science concepts:

Change in states of matter, density

You'll need:

- 2 clear plastic cups
- Vinegar
- Cooking oil
- Bicarbonate of soda
- Food colouring

Time required:

10 minutes

What to do:

Cover the base of one cup with about 5mm of bicarbonate of soda.

Slowly half fill this cup with oil.

Fill the second cup about 1/3 full with vinegar and add 1-3 drops of food colouring.

Gently pour the vinegar into the cup with the oil. Watch what happens.

What's happening?

The coloured vinegar doesn't mix with the oil - they are immiscible, so the vinegar forms globules or small balls in the vinegar. Because it is more dense than the oil, the vinegar globules sink to the bottom of the cup, where they come into contact with the bicarbonate of soda.

The vinegar undergoes a chemical reaction with the bicarbonate of soda to produce bubbles of carbon dioxide gas. This makes the vinegar and carbon dioxide globules less dense than oil, so they rise upwards through it (a little like giving a small child floaties or water wings in a swimming pool). As the vinegar globule reaches the surface the carbon dioxide is released into the air leaving the vinegar and food colouring globule behind, where it will start to sink again. This process will continue for several minutes until the chemical reaction is complete.

Can you make popcorn dance?

Science concepts:

Chemical reactions, floating and sinking

You'll need:

- Clear plastic cup
- Bicarbonate of Soda
- Popcorn kernels
- Vinegar
- Water
- Spoon

Time required:

10 minutes

What to do:

Half fill the cup with water and add roughly 1/4 cup of vinegar.

Drop about a dozen popcorn kernels into the water and vinegar mixture.

Add 1-2 teaspoons of bicarbonate of soda and stir briefly.

Watch what happens!

What's happening?

The popcorn kernels seem to dance, sinking to the bottom of the cup and then rising to the surface again before falling back down. This happens because bicarbonate of soda and vinegar undergo a chemical reaction, producing carbon dioxide gas. Small bubbles of carbon dioxide stick to the uneven surfaces of the popcorn kernels. These carbon dioxide bubbles are less dense than the liquid that surrounds them, so they rise to the surface of the cup (less dense liquids and gases float above more dense liquids and gases). Eventually, enough bubbles will form on a popcorn kernel to pull the popcorn to the surface. When the popcorn reaches the surface the carbon dioxide is released into the air and the popcorn sinks back down to the bottom of the cup again.

Can you make one can float and another can sink?

Science concepts:

Density

You'll need:

- One large clear container of water (a small fish tank works well)
- One can of diet soft drink
- One can of non-diet soft drink

Time required:

5 minutes

What to do:

Fill the container three quarters full of water.

Lower the can of non-diet soft drink gently into the container of water and let it go. Does it float or sink?

Now lower the can of diet soft drink into the container. Does it float or sink?

What's happening?

The two cans of soft drink have different densities due to the different amounts of dissolved sugar in the liquids they contain. The more dissolved sugar, the more dense the liquid.

The can of non-diet soft drink has a high concentration of dissolved sugar, so it sinks lower as it is more dense. A single can of Coke contains around 40g of sugar (or 10 teaspoons)!

The can of diet soft drink doesn't contain any sugar - it contains a small amount of concentrated artificial sweetener instead. So the density of the diet soft drink is much closer to that of pure water, making it float higher in the jug.

Science in the real world

Dissolved salts in sea water make it denser than freshwater. This means that fresh water floats on top of salt water.

Differences in salt levels and water temperatures of different bodies of ocean water can be responsible for large-scale ocean currents due to the different densities. You can learn more about these currents by researching the term ‘thermohaline circulation’, in which ‘thermo’ refers to temperature, and ‘haline’ refers to salt.

Can you make a Newton's Cradle?

Science concepts:

Conservation of energy

You'll need:

- At least seven marbles, all the same size
- A length plastic tube approx. 20cm cut in half to form an open pipe

Time required:

10 minutes

What to do:

Place five of the marbles in a row in the middle of the tube, with the tube sitting flat on to of a level surface.

Make sure they are all touching each other.

Roll another marble down the groove into the lined-up marbles – what happens?

Repeat the experiment, and this time roll two marbles into the row of five. Now try with three and then four marbles.

What's happening?

The moving marble has moving, or kinetic energy. The marble you roll collides with the stationary marbles and transfers, or passes on, the energy. This energy is then transferred along the row of marbles with the last marble shooting off.

The number of marbles that you roll towards the stationary ones is the same as the number of marbles that shoot off. When all the collisions occur with objects that are the same size, what goes in should be the same as what comes out.

This is an example of the concept of 'conservation of energy'- energy can be transferred from one marble to another, but it does not disappear. Newton's cradles in which the balls are suspended from string and swing back and forth will eventually stop moving, but this is because during each collision a small amount of kinetic energy is transformed into other types of energy (heat energy, sound energy etc), reducing the amount of kinetic energy in each collision until the balls eventually stop moving.

Now can you get the egg out of the bottle?

Science concepts:

Pressure

You'll need:

- A hard-boiled egg or water balloon inside a bottle (see 'Can you push an egg into a bottle?')
- Petroleum jelly

Time required:

15 minutes

What to do:

Take the bottle outside.

Grease the opening of the bottle with petroleum jelly. Make sure there is petroleum jelly well inside the opening.

Tip the bottle upside down above your head. Shake the bottle gently until the egg is sitting in the mouth of the bottle, sealing the opening.

Blow sharply at the egg through the mouth of the bottle and be prepared to have egg on your face! This can take some practice...!

What's happening?

When you blow inside the bottle, this increases the amount of air inside the bottle, creating higher pressure. This means the air outside the bottle is at lower pressure. The higher air pressure inside the bottle then tries to move to the area of lower pressure outside and forces the egg out of the bottle, sometimes with messy results.

How many drops of water can you fit on a 20 cent coin?

Science concepts:

High surface tension of water, low surface tension of soapy water

You'll need:

- 20 cent or other small coin
- Eye dropper or pipette
- Cup of water
- Detergent

Time required:

15 minutes

What to do:

Estimate (make a guess) how many drops of water you can fit on a twenty cent coin.

Place the coin on a flat surface. Hold the eye dropper close to the coin and drop water on it, one drop at a time. Count the drops.

Keep adding drops until the water overflows. How many drops fit on the coin before the water overflows? Look carefully at the shape of the water just before it overflows.

Dry the coin and mix two drops of detergent in the cup of water.

Estimate how many drops of the water and detergent mixture will fit on the coin. Use the eye dropper to test your guess. How many drops fit on the coin before the water and detergent overflows?

Try the experiment using another liquid, such as milk. How does the surface tension of milk compare with plain water and water and detergent?

What's happening?

Water has a high surface tension, which means that each molecule (or tiny piece) of water is very attracted to the water around it, and wants to 'hold on' tightly to the surrounding water. This high surface tension means that the water sitting on the coin takes on a curved shape and behaves as if a skin is holding it together. Adding detergent to water lowers the surface tension, because part of the detergent molecule is very attracted to the water, and this interferes with the water's ability to hold tightly to itself. This reduced surface tension means fewer drops will fit on the coin before it overflows.

Science in the real world

The high surface tension of water also explains why water droplets are spherical. The great attraction of the molecules to each other makes the surface contract to the smallest area possible. Spheres are the shape which has the smallest surface area for a given volume. So raindrops, drops of oil, and falling drops of molten metal are all spherical.

Can you make pepper pounce?

Science concepts:

High surface tension of water, low surface tension of soapy water

You'll need:

- Bowl of water
- Ground pepper (not cracked)
- Toothpick or skewer
- Detergent

Time required:

15 minutes

What to do:

Sprinkle pepper over the surface of the water.

Stick the toothpick into the detergent, then touch it to the surface of the water. What happens?

To repeat the experiment, the detergent will need to be thoroughly rinsed from the container.

What's happening?

Water has a high surface tension, which means that each molecule (or tiny piece) of water is very attracted to the water around it, and wants to 'hold on' tightly to the surrounding water.

The surface tension of water is strong enough to hold the pepper on top of the water.

Adding detergent to water lowers the surface tension, because part of the detergent molecule is very attracted to the water, and this interferes with the water's ability to hold tightly to itself.

When detergent is placed near the pepper, the surrounding water pulls the water (and pepper with it) away from the detergent and the pepper disperses to the edges of the bowl. This is a little bit like a line of people holding hands and pulling tightly out on each other. If two people in the middle of the line let go of each other's hands, the rest of the lines falls away from the point at which the chain was broken.

Can you make a paperclip float?

Science concepts:

High surface tension of water, low surface tension of soapy water

You'll need:

- 2 paperclips
- Bowl of water
- Detergent

Time required:

15 minutes

What to do:

Rest a paperclip on the surface of the water.

Make sure the paperclip is lying flat and straight.

Look closely at the surface of the water. Is the surface bent from the weight of the paperclip?

Add a drop of detergent to the water. What happens to the paperclip?

What happens to the surface of the water?

Note: To repeat the experiment, the detergent will need to be thoroughly rinsed from the container.

What's happening?

An unravelled paperclip can be used as a handle to slowly and gently lower another paperclip onto the water.

Water has a high surface tension, which means that each molecule (or tiny piece) of water is very attracted to the water around it, and wants to 'hold on' tightly to the surrounding water. This means that the outside of the water acts a little like a skin.

The surface tension of water is strong enough to hold the paperclip on top of the water. Some small insects such as mosquitoes are able to walk on water because of high surface tension.

Adding detergent to water lowers the surface tension, because it interferes with the water's ability to hold tightly to itself.

When detergent is placed in the water, the surrounding water pulls away from the detergent. This is a little bit like a line of people holding hands and pulling tightly out on each other. If two people in the middle of the line let go of each other's hands, the rest of the lines falls away from the point at which the chain was broken. As the water's 'skin' breaks, the paperclip sinks.

Can you make a ‘submarine’ that floats and sinks?

Science concepts:

Pressure, floating and sinking

You’ll need:

- PET bottle of any size with a lid, filled with water
- Pen lid
- Plasticine or blu-tac

Time required:

20 minutes

What to do:

If the pen lid has a hole at the top, cover it with plasticine so that air can be trapped in the lid.

Fill the bottle with water and put the lid to one side.

Place some plasticine on the arm of the pen lid to act as a weight.

Place the lid with the arm facing downwards in the water in the bottle. Adjust the amount of plasticine on the arm until the lid floats upright with its top sitting level with the surface of the water.

Screw the lid on the bottle and squeeze the sides. Does the pen lid sink to the bottom?

Does the pen lid sink to the bottom?

Release the pressure from the sides of the bottle. What happens to the pen lid now?

Experiment to determine how much pressure you need to put on the bottle to make the ‘submarine’ sit half way down the bottle.

What's happening?

Whether the pen lid floats or sinks depends on the size of the air bubble trapped inside the pen lid- the larger the air bubble, the more water it displaces, and the easier the pen lid can float. If an object displaces (or pushes out of the way) a volume of water which is larger than the mass of the object, it will float. This is why a steel ship can float, but a lump of steel which has the same mass will sink (the ship displaces a much larger volume of water due to its shape).

Squeezing the bottle causes the pen lid to sink because the increased water pressure forces water into the lid. This compresses an air bubble in the lid and reduces the amount of water displaced by the air, making the pen lid sink.

When you stop squeezing the bottle the pressure on the air bubble decreases. Water moves back out of the lid so the 'submarine' regains its buoyancy and rises to the top again.

Science in the real world

Many fish have an organ called a 'swim bladder' which they use to help stay neutrally buoyant (neither floating upwards or sinking downwards). The swim bladder looks like two small connected balloons, and the fish can adjust the amount of gas inside the swim bladder. If the fish adds gas to the bladder, it expands and the fish moves upwards in the water column. If the fish removes gas from the bladder, the swim bladder shrinks and the fish sinks.

Can you make a liquid sandwich?

Science concepts:

Density

You'll need:

- Glass of water
- Red, blue or green food dye
- Cooking oil
- Honey
- Tall glass
- Objects of different weight and shape (e.g. a marble, a piece of plastic and a wood chip)

Time required:

15 minutes

What to do:

Add a few drops of food colouring to your water.

Pour some water into the glass so it is around one quarter full. Now pour the same amount of honey into the glass. Does the honey sit above or below the water?

Pour the same amount of oil into the glass. Where does the oil sit?

Try dropping the objects into the glass such as marble, plastic wood and see which object sits on which layer. Do any of the objects reach the bottom of the glass?

What's happening?

The liquids settle out in different layers because they have different densities. An object's density describes how much mass a given volume of that object has, or how 'tightly packed' the material that makes up the object is. If you have the same volume of two different fluids (eg, oil and honey), the denser fluid (honey) will weigh more. You could investigate this as an extension to this activity using a set of scales.

Honey is the most dense of the three fluids used. It sits at the bottom of the glass. The next layer is water. Oil is less dense than both honey and water so it sits at the top. If the solid that is placed in the fluid weighs less than the volume of the fluid it displaces (or pushes out of the way), the object will float. You can learn more about the science of floating and sinking by reading the 'can you make a submarine that floats and sinks?' activity.

Can you turn water upside down?

Science concepts:

Water pressure

You'll need:

- Drinking glass or rigid plastic cup
- Postcard
- Water

Time required:

10 minutes

What to do:

Fill the glass 2/3 full with water.

Completely cover the mouth of the glass with the postcard, applying pressure so no air can get in between the mouth of the cup and the cardboard.

Whilst holding the card on with your hand, maintain the pressure and slowly turn the glass upside down. Wait a few seconds and with everything upside down, slowly remove your hand from the cardboard.

What's happening?

The air around us pushes in every direction, with the pressure of about 1kg per square centimetre - which is approximately the mass of balancing a full milk carton on your thumb nail. However, we are really used to this air pressure because we've experienced it all our lives, so we don't notice it. In this experiment, the pressure of the water pushing down on the postcard is low enough compared to the outside air pressure that the air pushing up on the postcard can hold the water in the glass. Other factors that may cause the postcard to stay on the glass include the surface tension of water and the fact that postcards are slightly bendy.

Can you make toothpicks expand into a star?

Science concepts:

Surface tension, capillary action

You'll need:

- 5 toothpicks
- Pipette
- Small plate
- Water coloured with food dye

Time required:

5 minutes

What to do:

Snap all 5 toothpicks half way along their length so that they are bent into a V, but not completely separated - they need to be still connected.

Arrange the bent toothpicks as in the picture, without letting the ends touch.

Using the pipette add 5 drops of water to the centre of the toothpicks. Make sure the drops of water touch the bent corners of all toothpicks.

Watch the toothpicks. You may need to add a couple more drops of water.

What's happening?

The broken wood of the toothpicks absorbs the water they are sitting in by capillary action. As the water is drawn into the toothpick the wood expands. The expanding wood on the inside of the V pushes against itself, which makes the toothpick straighten out. As the toothpicks push out they form the star shape.

Can you make fibre optics using water?

Science concepts:

Bending light

You'll need:

- 1.25L soft drink bottle with label removed
- Drill
- Bright torch
- Water
- Bucket

Time required:

15 minutes

What to do:

Use the drill to make a circular hole (between 5mm and 10mm) in the side of the bottle, quite close to its base. Hold your finger over the bottle while you fill it with water.

Hold the bottle over the bucket, and ask a friend to hold the torch so that it shines through the bottle from the side opposite the hole.

Remove your finger from the hole. A jet of water should flow outwards and downwards into the bucket.

Hold your hand in the stream of water and move it up and down. You should see a spot of light on your hand. If you don't, try moving the torch slightly.

What's happening?

When the stream of water leaves the hole in the side of the bottle, light entering the water from the torch also passes into the jet of water. This light is trapped inside the jet of water (it's doesn't dissipate into the air around it) because the internal surface of the water jet acts like a mirror, and reflects the light back into the water jet whenever it reaches the jet's surface. This is called the 'principal of total internal reflection'.

Science in the real world

Fibre optics cables use this principal to transmit light over long distances. They are made of very thick threads of glass, whose internal surfaces act like mirrors, just like the jet of water. These mirrors contain the light, and allow it to pass around curves and corners wherever the glass bends.

Computers use lasers to transmit very short pulses of light (billions of pulses per second per second) via fibre optic cables to transfer information from one place to another. Some new fibre optics systems can channel many different coloured beams of light through a single cable, to transfer information even more efficiently.

Can you make glass invisible?

Science concepts:

Bending light

You'll need:

- Large glass bowl or jar
- Bottle of cheap cooking oil (eg canola or vegetable oil)
- Small pyrex glass bowl or jug which fits completely inside the large bowl

Time required:

5 minutes

What to do:

Pour the oil into the large bowl until it is about 2/3 full. Immerse the pyrex bowl in the oil (making sure it fills up with oil and is totally surrounded by it. Add extra oil if needed, until the smaller bowl is completely submerged.

Look at the bowl from different angles. Can you see the smaller bowl inside? It should be invisible from some angles.

What's happening?

The speed that light travels changes depending on what it is traveling through. It travels faster through air than through liquids or glass.

When light moves from one medium to another, it bends slightly, as well as changing speed. Even though glass is transparent, we can usually see a glass jars or bowls because the light that passes through it changes direction slightly, distorting our view of other objects we can see through the glass. A small amount of light bounces back (or reflects) off the glass too. Under normal circumstances, this combination of distortion and reflection tells our brain that we are looking at something transparent.

However, light travels at almost exactly the same speed through vegetable oil as it does through Pyrex glass, so as the light moves from the oil to the glass, it doesn't change direction, and your brain has no way of knowing where the cooking oil ends and the Pyrex glass begins.

Can you make your own fire extinguisher?

Science concepts:

Gases are fluids; they flow and can be poured

You'll need:

- Glass or plastic jug
- Bicarbonate of Soda
- Vinegar
- 3 tea-light candles
- Matches

Time required:

10 minutes

What to do:

Place about 1/3 of a cup of bicarbonate soda in the jug, and add the same amount of vinegar. The mixture will bubble and fizz. Light the tea-light candles.

Once the fizzing has stopped in the vinegar mixture, carefully pick up the jug and carefully pour it over the candles, without pouring out the vinegar mixture. The candles should go out .

What's happening?

A chemical reaction occurs when bicarbonate of soda and vinegar are mixed together, which produces carbon dioxide (CO2) gas. This gas can be poured from the jug like water. CO2 gas is more dense than air, so when it is poured from the jug, it sinks down on top of the candle like a blanket, pushing the oxygen out of the way. Flames need oxygen to burn. Without it, they will quickly be extinguished .

Science in the real world

CO2 fire extinguishers are often used in situations where it would be dangerous to put out a fire with water (such as electrical fires)

Can you create a rice vice?

Science concepts:

Particle organisation, friction

You'll need:

- Empty jam jar
- Basmati rice
- Knife (with a blade that is long height of your jar)

Time required:

10 minutes

What to do:

Fill the jar with rice.

Push the knife into the rice and wiggle it around, then remove it. Re-insert it and wiggle it around again, before removing it again. You should see the level of the rice beginning to fall.

Add some extra rice, then keep inserting, wiggling, pulling-out and re-inserting the knife for several minutes. Add extra rice whenever space appears in the top of the jar.

After a few minutes, you should notice that it becomes more and more difficult to insert the knife. Eventually, you should be able to lift up the jar just by pulling up on the embedded knife .

What's happening?

When the jar is first filled with rice, the rice grains will be arranged facing in many different directions, with lots of small holes filled with air in between. By wiggling the knife around, you force the rice grains to line up with each other, and reduce the amount of air space (sometimes called pore space) between the rice.

As the rice grains are packed together more tightly, they push on the knife. Friction is a force that is experienced when two objects rub up against each other. The more the rice touches the knife directly (rather than air touching the knife), the more friction is experienced between the knife and the rice. This allows you to lift the rice up using just the knife.

Science in the real world

The process of rice grains settling and organising themselves more neatly over time is similar to the process that causes pot-holes in roads. Over time, vibrations from cars can cause road-bases to compact and sink, creating potholes.

Can you make a cloud in a bottle?

Science concepts:

Pressure

You'll need:

Version 1

- Empty PET bottle
- Water
- Matches
- Extra-long matches or normal matches and an incense stick

Version 2

- Empty PET bottle
- Alcohol-based hand sanitizer
- Hand-held bike pump with a rubber stopper, that fits snugly in the PET bottle opening

Time required:

10 minutes

What to do:

Version 1

Fill the bottle with water to a depth of one or two centimetres.

Now light the extra-long match or use a normal match to light an incense stick. Blow the match or incense stick out and hold it in the bottle so that smoke fills the bottle. Drop it in the bottle after about 30 seconds. Quickly replace the lid on the bottle and shake it for 10 seconds. Squeeze the sides of the bottle and then release. Observe what happens.

Version 2

You will need to place the needle of the hand pump through the rubber bung, tightly enough that air won't escape. You may need a small drill to achieve this

Add several squirts of hand sanitizer to the bottle. Replace the lid and shake the bottle for 30 seconds. Remove the lid and insert the stoppered bike pump into the neck of the bottle. Hold the stopper tightly while you pump air into the bottle.

Once the sides of the bottle feel hard, release the stopper in one swift motion. Observe what happens. Now replace the stopper and pump more air into the bottle again. Watch what happens before releasing it one more time.

What's happening?

You need three 'ingredients' to make a cloud- water vapour, condensation nuclei (small pieces of solid material like dust particles), and a change in air pressure.

Air pressure and temperature decrease higher up in the atmosphere. This decrease in pressure and temperature allows water vapour to condense (change from a solid to a liquid) onto condensation nuclei like tiny pieces of dust, or smoke particles in the atmosphere. This condensing water vapour creates tiny droplets of water. Millions or even billions of these tiny water droplets close together make a cloud that can be seen from the ground.

In version one of this activity, the smoke from the incense stick or match provides condensation nuclei, and squeezing the bottle then releasing it changes the air pressure (specifically, the air pressure drops when the bottle goes from compressed to not compressed). In version two of the activity, the hand sanitizer provides the condensation nuclei, and pumping extra air into the bottle then releasing it rapidly leads to a drop in air pressure.

Can you make rain in a jar?

Science concepts:

Condensation

You'll need:

- Jar with a metal lid
- warm water
- Ice cubes
- Boiling water
- Hammer and nail

Time required:

20 minutes

What to do:

Use the hammer and nail to push small divots into the upside-down lid of the jar (so that there are raised bumps sticking out from the top of the jar). Be careful not to poke holes into the lid.

Add warm water to the jar, swirl it around and then discard to help prevent the jar cracking during the next step.

Pour about 5cm of boiling water into the jar.

Place the lid of the jar upside down on the mouth of the jar, making sure it is completely covering the mouth of the jar. Allow it to sit for several minutes.

Put the ice cubes in the lid. Put the jar in a darkened area and shine a torch through the jar to observe what happens.

What's happening?

The cold surface of the lid cools the steam from the boiling water in the jar. The steam changes back into water, collecting into drops where the divots are on the lid. As the drops get bigger and heavier, it 'rains'.

Can you make a milk carton generator?

Science concepts:

Every action has an equal and opposite reaction, forces of water

You'll need:

- Empty cardboard milk carton
- Water
- String
- Nail
- Masking tape
- Scissors
- Tray to catch falling water

Time required:

20 minutes

What to do:

Using the nail, punch holes in the bottom right hand corner of each side of the milk carton.

Punch a hole in the middle of the top of the carton and tie a piece of string through this hole to hang the carton.

Use masking tape to cover the holes in the bottom, and hang the carton outdoors or over a tray to catch the water.

Cut a small triangle out of one side of the top of the milk carton and fill it with water.

Take the masking tape off one hole and observe what happens.

Take the tape off the hole opposite to this. Does this make any difference?

Uncover all 4 holes. What happens?

What's happening?

Isaac Newton's 3rd law of motion states that every action has an equal and opposite reaction. The action in this experiment is the water pouring out of the holes. The reaction to this is the force of the water pushing the carton in the opposite direction. The more holes, the faster the carton turns. This is similar to many turbines. Water or steam is forced through holes and is used to make the turbine turn. A shaft connects the turbine to an electrical generator, which makes electrical energy when it is turned.

Can you measure 'global' temperature?

Science concepts:

Temperature, Global vs local temperature

You'll need:

- Classroom wall (away from air conditioning vents)
- Several thermometers (more than 20 if possible)
- Blu Tack
- Ladder or stable chair
- Fan

Time required:

30 minutes

What to do:

Imagine the wall is the world (flattened out) and your challenge is to measure the average temperature of the whole world.

Plan where you will place the thermometers to get a good representation of the whole wall area.

Use Blu Tack to attach the thermometers to the wall.

If needed use a ladder or stable chair to place some thermometers close to the ceiling.

After 10 minutes, record the temperatures from each of the thermometers.

Add all the temperatures and divide by the number of thermometers to get your 'global' average.

Now use a fan to cool an area of the wall (covering 1 or 2 thermometers) and after 10 minutes measure the temperature again. How does the fan affect the temperature in that area of the wall? How does the fan affect the global average temperature?

What's happening?

Temperature changes from day to day, season to season and year to year, but global average temperatures generally stay about the same over long periods of time.

The global average temperature is currently close to 15°C. It has risen by 0.76°C since 1850.

This may not sound like much, especially since the temperature outside your classroom can change by 10°C or more in one day. But the average temperature of the whole planet does not change like the temperature outside the classroom. In fact the global average temperature is very stable, and would not change 10°C over a day, month, year, decade or even hundreds of years.

What is the greenhouse effect?

Science concepts:

The greenhouse effect

You'll need:

- Large glass jar
- Strong lamp (120 watt) or a sunny spot
- 2 thermometers

Time required:

30 minutes

What to do:

Place two thermometers in front of the lamp or in the sun and record the temperatures of both.

After a few minutes cover one thermometer with a glass jar (you may need to stand the thermometer up).

Record the temperatures of both thermometers every minute for at least 10 min.

What's happening?

The heat energy from the lamp or sun passes through the glass and some of the heat energy is trapped inside. This warms the air inside which is unable to mix with the cooler air outside the jar. The glass simulates the layer of greenhouse gases in the atmosphere that trap heat energy.

Greenhouse gases trap heat from the sun in our atmosphere. This is a natural process keeping the average global temperature at around 15°C. Without the natural greenhouse effect the average temperature across the planet would be -17°C, meaning the world would be covered in ice!

However, the greenhouse effect has been enhanced by human activity like burning fossil fuels, tree clearing and farming cows and sheep.

Modern transport, manufacturing and agricultural practices produce large amounts of several greenhouse gases, mainly carbon dioxide (CO2), methane and nitrous oxide. These occur naturally in the atmosphere, but levels are now higher than they have been in the last 650 000 years.

The unnaturally high concentration of greenhouse gases currently in the atmosphere is causing more heat to be trapped. This is called the enhanced greenhouse effect. The enhanced greenhouse effect has caused the average surface temperature of the Earth to rise 0.76°C since 1850.

Can you make a model of an ice core from plasticine?

Science concepts:

Ice cores are samples of ice frozen thousands of years ago. They provide information about what the climate was like in the past

You'll need:

- Plasticine (two different colours)
- Apple corer
- Ruler
- Paper and pencils

Time required:

15 minutes

What to do:

Flatten each piece of coloured plasticine into several flat sheets of somewhat different thicknesses (between 1 and 2 cm). Make the sheets of one colour generally thicker than the other.

Layer the squares on top of each other, alternating the colours. This represents the ice layers in the Arctic or Antarctica.

Push the corer all the way down through the plasticine. Gently remove the corer with the core intact, and push it out of the apple corer.

Count the number of layers and measure them in millimetres. Draw a picture of the ice core sample, include measured numbers in millimetres.

Using the information gathered, find out the age of your ice core by counting the layers. Each layer represents a winter snow fall (thicker layers) and a summer snow fall (thinner layers), so two layers represent a year.

If the top layer represents the snow fall this season, in what year was the heaviest snow fall?

What's happening?

The bands you see in the plasticine core are like the banding observed in ice cores drilled from Antarctica or the arctic, except in a real ice core there would be thousands of bands – each one representing a summer and winter snow fall of previous years.

Ice cores thousands of metres long have been drilled from Antarctica. These show layers of snow deposited over the last 650 000 years. Once an ice core is obtained, tiny air bubbles inside it examined, some of which have been trapped in the ice for hundreds of thousands of years. Ice cores from Antarctica show us that the amounts of carbon dioxide and methane currently in our atmosphere are the highest recorded in 650 000 years.

Models help people better understand complex scenarios. The long climate history in ice cores has given scientists a large amount of data that they use to build models about what will happen in the future.

Can you melt ice to raise the sea?

Science concepts:

Density, sea level rise

You'll need:

- Two large, clear containers
- Two small containers (identical in size)
- Plasticine
- Water
- Marker pen
- Knife

Time required:

30 minutes

What to do:

Fill the two small containers with water. Place them in the freezer to create two ice blocks.

In one large container create a large mound of plasticine with a flat top to hold an ice block - this represents the Antarctic land mass. Pour water into the container leaving the top of the plasticine above the water.

Fill the second large container with roughly the same level of water. This will be the Arctic Sea.

Put an ice block on the plasticine mound in the 'Antarctic' container and one in the water of the 'Arctic' container at the same time. Mark the water level on the side of each container and wait for the ice to melt.

Watch to see what happens to the water level as this ice melts and enters the ocean

What's happening?

The water level in the 'Arctic' container does not rise when the floating block of ice melts. This is because the water in the bowl is already supporting the volume of water when it is frozen as ice. However, the water level in the 'Antarctic' container does rise as the ice melts. This is because the ice is supported on 'land' (the plasticine) and the bowl is not supporting the volume of water frozen as ice.

Global warming is melting polar sea ice, polar glaciers and alpine glaciers. The effect of this ice melting on sea levels will be different in different places, depending on where the melting ice was stored originally - on land or in the water.

The main cause of sea level change is due to the amount of water in the ocean increasing or decreasing. This occurs when ocean water is exchanged with water stored on land. When ice sitting on land melts, water runs off into the oceans increasing the sea level. Melting of ice that is floating on the ocean will not contribute to sea level change. According to measurements from satellites, sea levels rose 3.1 mm per year from 1993 to 2003. Arctic sea ice has shrunk 3 to 5% since the 1950s. In Antarctica and Greenland, large ice sheets are showing signs of global warming related change

Can you measure sea level?

Science concepts:

Water level, measurement

You'll need:

- Large, deep container
- Ruler
- Large spoon or spatula
- Clear plastic cup
- Scissors
- Permanent marker pen
- Blu Tack
- Water

Time required:

20 minutes

What to do:

Half fill the large container with water and measure the water level with a ruler.

Now simulate a rough sea by sloshing back and forth with a spoon or spatula. How easy is it to read the water level now?

Empty the water into another container so you can start again. This time you will use a stilling well to measure the water level.

Using the marker pen, place a mark every 1 cm down the cup (like a measuring cup) Use the scissors to poke holes every 2 cm in a vertical straight line down the cup. Use Blu Tack to secure the plastic cup to the base of the large container.

Pour the water back into the container and watch as the cup slowly fills as well until the water in the cup and the container are at the same level.

Use the spatula to slosh the water in the container. Can you read the level of the water in the cup?

What’s happening?

It’s very difficult to measure the water level when the water is sloshed around in the container. The cup acts as a wave break whilst still allowing water to flow in and out of the small holes. This is the same way a stilling well is used in the sea to protect tide gauges from the rough seas, making it easier to measure the sea level at a given point in time. Many measurements are taken during the day because the tide rises and falls.

In the past, a scientist would go out to the tide gauge and take measurements at particular times every day. Recent tide gauges use electronic measuring devices that are inside a floating buoy. They also require a stilling well to keep them steady whilst the readings are recorded and transmitted back to land or up to satellites.

What happens when the ocean becomes more acidic?

Science concepts:

The ocean absorbs large amounts of carbon dioxide from the atmosphere, and this helps to limit global warming. Increased carbon dioxide in the ocean makes sea water more acidic and this affects organisms that live in it.

You'll need:

- 2 pieces of egg shell
- Vinegar
- Clear plastic cup

Time required:

10 minutes

What to do:

Use Blu Tack and a piece of egg shell to make a sea creature with a shell (e.g. snail, crab, clam). Place the creature in the cup and cover with vinegar. Leave for 10 minutes. What is happening to the shell?

Pull the creature out, remove the shell and break it in half.

Now take a piece of egg shell that was not put in vinegar and break it in half. Was one piece of egg shell harder to break than the other?

Extension: Try putting the shell or a whole raw egg in the vinegar overnight.

What's happening?

Vinegar contains acetic acid which makes it acidic. The egg shell contains calcium carbonate which makes it slightly alkaline.

When the vinegar is added to the egg shell they react. This reaction between the shell and vinegar dissolves the egg shell and produces bubbles of carbon dioxide.

When carbon dioxide is absorbed by the ocean, it makes sea water more acidic.

The pH of a solution indicates how much acid is present in it. A lower pH means more acid is present. The pH of vinegar is about 2.4. Sea water has a pH of 8.1, but the ocean is becoming more acidic and the pH has dropped 0.1 units since humans started emitting large amounts of carbon dioxide.

While this may not sound like much, it actually means that there is a lot more acid in the water. It is predicted that over the next 100 years the pH will continue to fall to between 7.8 and 7.9. This change means there will be 30% more acid molecules in sea water.

This increase in acidity will affect many plants and animals that live in the ocean. Animals that use calcium to build their skeletons like star fish and molluscs will find it harder to get extract calcium from the water. If the ocean becomes too acidic, it will start to dissolve the shells of animals living in it. If their shells weaken they may not be able to survive .

Can you model wind in a bottle?

Science concepts

A global system of air currents and wind move gases around the Earth. Due to this mixing, a reduction in greenhouse gases in one country or area helps other countries and areas.

You'll need:

- Small, clear plastic bottle or a clear balloon
- Liquid hand soap (any will do as long as it has glycol stearate in it)
- Food colouring
- Water

Time required:

10 minutes

What to do:

Fill the bottle ¼ full with hand soap. If you are using a balloon, squirt as much hand soap in as you can.

Add 1-2 drops of food colouring.

Fill the bottle or balloon up using just a trickle of water so the soap and water do not mix and form foam.

Fill the bottle all the way to the top so there is no air, and put the lid on. If using a balloon let all the air out before tying it off.

Twirl and shake the bottle or balloon to see smooth streaks and turbulent swirls.

What's happening?

As the bottle or balloon is twirled, the mixture of hand soap and water inside drags against the inside wall and starts to spin. If you rotate the bottle or balloon slowly, you may see smooth currents that flow parallel to each other. If you spin and shake rapidly, the current becomes more complex, producing many swirls and eddies.

Not all countries produce the same amount of greenhouse gas, so why hasn't the temperature gone up only in areas where there are high levels of greenhouse gas emissions?

The part of the atmosphere where greenhouse gases are accumulating is called the Troposphere. The Troposphere is well mixed because of many global currents and winds.

This pattern of air movement is similar to the movement inside the bottle or balloon. Carbon dioxide completely disperses in the Earth's atmosphere within 1 year of being emitted. If we reduce greenhouse gases in one region, it benefits the whole planet. If one area cannot avoid releasing greenhouse gases, they can pay someone else to offset their emissions for them. This is called a greenhouse gas offset. Due to the mixing of gases in the atmosphere, greenhouse gases can be offset from anywhere in the world.

Can you use the sun to cook?

Science concepts:

Making electricity using coal is not renewable and releases greenhouse gases. Solar energy is renewable and does not release greenhouse gases.

You'll need:

- Pizza box (large or small)
- Newspaper
- Sticky tape
- Scissors
- 2 overhead transparencies
- Aluminium foil
- Ruler
- Chocolate
- Warm, sunny weather

Time required:

60 minutes

What to do:

Draw a rectangle on the lid of the pizza box that starts 3cm in from each edge.

Cut three sides of the rectangle you just drew to make a flap. Lift up the square flap and make a crease at the hinge. Cover the underside of the flap (the side that faces in) with alfoil. Secure it in place with some tape. Now line the inside of the pizza box with alfoil.

Take an overhead transparency and cover the opening in the lid. Secure it with some tape and then attach another piece over the top of the first one.

Open the box and roll up some newspaper and tape this around the inside edges of the box for insulation.

Now the flap needs to be adjusted so that sunlight can be reflected off the foil and into the box. Use the ruler or a stick to prop the flap up, or use string to anchor it. Place the chocolate inside the box and try to melt it.

What’s happening?

The aluminium foil reflects the Sun’s light into the oven. The two sheets of plastic and the newspaper insulate the oven to trap the heat inside. The plastic provides good insulation and the newspaper reduces the amount of heat escaping from the sides of the box.

Most of the global warming since the mid-20th century is due to increased concentrations of greenhouse gases in the atmosphere. Greenhouse gases are released when fossil fuels are burnt. The greatest source of carbon dioxide is electricity production which involves the burning of coal, a fossil fuel.

Most of Australia’s electricity comes from coal-fired power stations. Around the world, more and more electricity is being made using solar energy. Solar energy is light and heat energy from the sun. Making electricity from solar energy does not release greenhouse gases and is renewable. The benefit of a renewable energy is that once the solar panel is built it does not need fuel, like a coal-fired power station does.

Can you make a wind turbine?

Science concepts:

Making electricity using coal is not renewable and releases greenhouse gases. Wind power is renewable and does not release greenhouse gases.

You'll need:

- Thin cardboard
- Scissors
- Skewers
- Masking tape
- Cork or plasticine
- Drinking straw
- Hairdryer/fan

Time required:

30 minutes

What to do:

Cut a skewer at 10cm length from the pointed end. Keep both parts

Push the 10cm skewer through side of the cork (half way along the cylinder) so that you have even lengths of the skewer either side. (you may need to pre-drill the hole).

Cut two rectangles out of the cardboard (approx. 4cm x 7cm).

Tape the rectangles of cardboard to each side of the skewer to make the blades.

Pierce the unused part of the skewer through one end of the cork. Slide the straw over this skewer.

Hold the straw so the turbine is in front of a hairdryer or fan. Does it spin very fast? What happens to the speed of the turbine if you adjust the angle of the blades? Try adjusting the blades to get the turbine spinning the fastest.

Design different size and shaped blades. How does this affect the speed of the turbine?

What's happening?

This is a model of a wind turbine. Engineers use small models to test for the most efficient design before spending lots of money to create a life sized wind turbine. The shape and size of the blades on a wind turbine affect how fast it spins. Larger blades tend to spin faster than smaller blades. The angle of the blades can make a big difference to the speed of the turbine. If the blades are facing the wind flat, they will act like a brick wall and are unlikely to turn the turbine. Similarly, if the blades are in line with the wind, the wind will pass straight over them. The best angle is somewhere between these two positions and will vary depending on wind speed and direction.

Most of Australia's electricity comes from coal-fired power stations. Around the world, more and more electricity is being made from wind. About 2% of the solar energy that reaches Earth is converted into wind energy. Wind is a renewable source of energy. The benefit of renewable wind power is that once a wind turbine is built it does not need fuel, unlike a coal-fired power station.

Can you make a water turbine?

Science concepts:

Making electricity using coal is not renewable and releases greenhouse gases. Hydropower (water power) is renewable and does not release greenhouse gases.

You'll need:

- Drinking straw
- Scissors
- Blu Tack
- Plastic teaspoons
- Permanent marker pen
- Skewer
- Large, deep plastic container

Time required:

30 minutes

What to do:

Cut a piece of drinking straw about 4 cm long. Form a thick ring of Blu Tack around the centre of the straw.

Cut about half the length of the handle off four plastic teaspoons. Make a spiral of spoons around the straw by pushing the end of the plastic spoons into the Blu Tack. Ensure that the spoons all face the same direction in the spiral.

Thread the skewer through the drinking straw. Place the skewer axle onto the top of the container so that the spoon wheel sits half way in and spins freely.

Pour the water from the jug onto the spoon blades of your turbine. Can you get it to spin?

Use a permanent marker pen to mark one of the spoons. Now count the number of revolutions in 10 seconds as you pour water from the jug.

How can you make it spin faster? Try using more or less spoons or pouring the water faster or slower.

What's happening?

The water wheel represents a water turbine and the stream of water from the jug represents the powerful stream of water from a waterfall or dam.

Most of Australia's electricity comes from coal-fired power stations which generate electricity by burning coal to heat water so that it turns into steam. This fast moving steam is used to spin a great big turbine which in turn creates electricity. Hydropower also creates electricity from a large spinning turbine, but it uses water flow instead of steam to drive the turbine. Many hydropower stations use the powerful flows of waterfalls to spin the giant turbines, others use the power harnessed by dams.

Can you make ice melt slowly?

Science concepts:

Insulation

You'll need:

- Ice cubes
- Foam cups
- Plastic cups
- Paper
- Cotton wool
- Different fabrics (preferably the same colour)
- 2 saucers

Time required:

30 minutes

What to do:

Put an ice cube on each of the two saucers, and place a cover over one of the saucers. Leave the other ice cube uncovered. Place both of the ice cubes in direct sunlight. Use a watch or timer. Check the ice cubes every minute to find out how long it takes for each piece of ice to melt.

Extension: Try the experiment using different fabrics to find out which provides the best insulation.

What's happening?

The materials used to create your cover add a layer of insulation to protect the ice cube from the Sun's heat energy. Heat can transfer through different materials at different rates. Materials that are good insulators prevent heat from travelling through them very easily. In a house, insulation can be used in the ceiling, walls or floors to keep heat out in the summer and help trap heat inside in the winter, reducing the need for heating or cooling with fans or air conditioners and therefore reducing electricity consumption.

Can you make solar hot water?

Science concepts:

Solar Energy, albedo effect/reflectivity

You'll need:

- 2 empty soft drink cans
- Black and white paint
- Thermometer
- Water

Time required:

30 minutes

What to do:

Paint one soft drink can black and the other one white. Once the paint has dried, fill each can with water.

Place the cans in a sunny spot. Use a thermometer to record the temperatures in each can every two minutes for 20 minutes.

What happens to the temperature in each can?

Extension: Try painting the cans different colours and see which absorb heat better.

What's happening?

The sun emits ultra violet (UV) radiation in the form of light. When the sun's light hits a dark object, like the black soft drink can, it will mostly be absorbed and converted into heat. When the sun's light hits a light coloured object, like the white soft drink can, it is mostly reflected.

The reflectivity of objects can be described as their 'albedo'. The earth has a global albedo of about 30%, which means it reflects about 30% of the sun's radiation. Snow covered areas such as the North and South Poles reflect a lot of the sun's UV radiation back into space. Clouds also are very good at reflecting the sun's light before it reaches the lower atmosphere. Areas of dark dense forest tend to absorb a lot of the sun's UV radiation, warming the surface.

Cloud activity, deforestation and melting of ice sheets can work on a large scale to change the Earth's global albedo. Large volcanic eruptions release large sulphur clouds into the atmosphere which increase the Albedo Effect by reflecting the Sun's radiation. Throughout history, declines in the Earth's global average temperature have aligned with major volcanic eruptions.

Can you make music from straws?

Science concepts:

Vibrations, pitch, amplification

You'll need :

- A straw
- Scissors
- Pin
- Sticky tape
- Paper

Time required:

15 minutes

What to do:

Flatten one end of the straw. Use the scissors to cut the end of the straw into a triangle (or an upside-down V) shape.

Put the straw into your mouth with the triangle just past your lips and press your lips down firmly enough to hold the straw in place, but not so firmly that it is completely squashed. Now blow a raspberry. You may not get a sound straight away- playing the musical straw takes practice. Try to get the triangular bits of straw vibrating against your lips similar to the reed in a wind instrument like a clarinet or saxophone.

Once you can make a sound using a musical straw, try the following activities:

Cut small holes along one side of the straw using scissors or a pin to create a straw recorder. Cover different numbers of holes with your fingers to play different notes.

While playing a continuous note on the straw, ask a friend to cut it shorter and shorter using scissors. Listen to how the sound changes as you reduce the length of the straw.

Add a bell to the end of your straw by taping a cone of paper to the end of the straw away from your mouth. Compare the sound made with small cones compared to large cones. Try making a giant bell using a cone of newspaper.

What’s happening?

When you blow a raspberry over the straw, your lips shake back and forth, which makes the two plastic triangles of straw shake back and forth, or vibrate. Vibrating objects produce sound- In this case, the sound of a musical straw.

Slowly vibrating objects produce long sound waves and sounds with a low pitch. Increasing the frequency of the vibrations (or the number of vibrations per second), decreases the wavelength of the vibrations and increases the pitch of the sound.

Changing the length of the straw changes the wavelength and frequency of the vibrations. A long straw creates long, low-frequency vibrations which create a deep, or low-pitched sound.

Attaching a bell to the musical straw makes it louder (or amplifies the sound of the straw) because it increases the surface area which is vibrating. This larger surface area ‘pushes’ the vibrations or pressure waves out over a larger area, creating a louder sound

Can you make rain music?

Science concepts:

Vibrations

You'll need:

- 2 polystyrene cups
- A collection of nails
- Dry mung beans, lentils, rice or popping corn
- Masking tape

Time required:

15 minutes

What to do:

Place one of the cups upside down on a table.

Starting at the top and moving to the mouth of the cup, push the nails through the cup in a spiral pattern. Push the nails in until they reach the other side of the cup, or as far as they will go. You should be able to fit around 15 nails in the cup before reaching the mouth of the cup.

Repeat the above steps with the other cup.

Place a handful of mung beans, lentils or a combination into one of the cups, then carefully tape the open ends of the cups together.

Tip the cups slowly and listen to the sound. Try using a tube shape instead of cups.

What effect does changing the number or position of the nails have? How does the sound change if you change the objects inside the cups or the types of cups?

What's happening?

As the beans fall and hit the nails they make the nails vibrate to make a sound. The vibrations are transferred to the cups and then to the air inside the cups and around them creating more vibrations and a louder sound. In other words, the cups work to amplify the sound.

Can you make a kazoo?

Science concepts:

Vibrations

You'll need:

- 2 paddle-pop sticks
- Thick rubber band
- 2 thin rubber bands
- 2 short (1.5-2cm) lengths of straw

Time required:

15 minutes

What to do:

Stretch the thick rubber band over one paddle-pop stick so that it wraps around the stick lengthways.

Place one straw between the band and paddle-pop stick, about 1cm from the end of the stick. Place the other straw on top of the rubber band, about 1cm from the other end of the stick.

Place the other paddle-pop stick on top of the straws, creating a paddle pop rubber band sandwich.

Use the two small rubber bands to hold the two sticks together. Wind them around the sticks on the outside of the straws.

Your kazoo is now finished! Hold it to your lips and blow through it to make a sound.

What's happening?

If you look at the kazoo side-on, you will see that the straws give the rubber band plenty of space to vibrate between the paddle-pop sticks. Blowing over the rubber band makes it vibrate back-and-forth, producing a sound.

Can you make a clucking cup?

Science concepts:

Vibrations and amplification

You'll need:

- 60cm string (not the smooth plastic type, cotton twine is best)
- Paperclip
- Disposable cup or with a small hole in the centre of the base (you can use a pin or drill to make the hole)
- Dishcloth
- Water

Time required:

10 minutes

What to do:

Tie one end of the string to the paperclip, then thread the other end of the string through the hole in the cup, so that the string hangs through the body of the cup, and the paperclip sits outside the base of the cup (it should look a little like a bell with the string hanging down through it).

Wet the dishcloth with the water. Hold the cup firmly in one hand with the string hanging down towards the floor. With the other hand, wrap the cloth around the string and pull it downwards in a jerky motion. The cup should 'cluck' as you do this.

Try repeating the experiment with different sized containers.

What's happening?

As you rub the cloth down the string, it causes friction and makes the string vibrate – this causes the sound. All sounds are caused by some sort of vibration. The vibrating string causes the cup and the air inside the cup to vibrate, resulting in the sound being louder or amplified. Larger containers produce deeper and louder sounds.

Science in the real world

A Zulu instrument called an “Ingungu” (een-goon-goo) is very similar to a clucking cup. It looks like a long drum that is held between the legs while the player is sitting, with a rope coming out from the stretched drum skin on the far end. The player wets their hands and pulls them along the rope causing a vibration that is amplified by the drum skin and barrel. The result sounds like a wounded hippo, and is a bass line for Zulu dance tunes.

Can you make a tube sing?

Science concepts:

Vibrations

You'll need:

- Length of corrugated plastic tubing (note: some tubes work better than others, depending on their diameter and the depth and spacing of the corrugations. Try a swinging few around until you find one that sings well)
- Garbage bag (optional)
- Masking tape (optional)
- Leaf-blower or hair dryer (optional)

What to do:

Check that no other people, or delicate objects, are nearby before starting the activity.

Hold one end of the tube, and spin it around over your head. Start spinning slowly, and then spin faster and faster. You should hear the note produced by the tube change pitch.

See how many notes you can make the tube sing.

Try changing the length of the tube- does this change the pitch it sings at?

Try taping a garbage bag to one end of the pipe, then filling the bag with air from a leaf-blower or a hairdryer on its coolest setting. Once the bag is full of air, hold it under your arm and squeeze the air out. You have just created a singing-tube bagpipe!

What's happening?

Air moves through the tube (in the end near your head and out the far end) as you spin it around. You can check this by holding the tube in a bucket of bean-bag beans while you spin it. They will travel up through the tube and be spat out the end, resulting in a large mess.

As the air moves through the tube, it spins in tiny vortices as it moves past the corrugations. These vortices move back-and-forth, creating vibrations. We hear these vibrations as sound. Spinning the tube faster increases the frequency of the vibrations, and therefore changes the pitch of the sound you hear to a higher sound.

Can you make a balloon tuba?

Science concepts:

Vibrations

You'll need:

- Section of PVC piping, about 20mm in diameter and 20-30 cm in length
- Balloon
- Packing tape

Time required:

10 minutes

What to do:

Use the packing tape to attach the balloon over one end of the PVC pipe.

Blow through the other end of the piping to blow up the balloon. Hold the air inside the balloon by pinching its neck.

Stretch the balloon to one side of the pipe to form a skin over the pipe opening.

Slowly move the balloon, allowing a small amount of air to flow out through the tube. This should make the skin vibrate.

Try stretching the balloon and releasing it, or changing the angle at which you hold the balloon.

Use paper towel and methylated spirits to wipe clean the PVC pipe before and after you have used your balloon tuba.

What's happening?

The section of balloon that forms the skin over the end of the pipe vibrates as air blows out of the balloon. This vibration causes the air inside the tube to vibrate and produces a sound. Higher frequency vibrations create a higher pitched sound.

Can you play a rubber-glove-a-phone?

Science concepts:

Vibrations

You'll need:

- Rigid PVC piping (approx. 30cm long)
- Disposable rubber glove
- Packing tape
- Length of flexible rubber tubing (approx. 30cm)

Time required:

10 minutes

What to do:

Note: this instrument is similar to the Balloon Tuba, which we suggest you try making first.

Place the open end of the glove over the top end of the rigid PVC piping. Tape the glove around the pipe. Make sure the seal is airtight.

Cut the tip off the top of the glove's thumb and feed the end of the flexible rubber tubing into the hole. Tape the tubing into the thumb of the glove, again making sure the seal is airtight.

To make a sound, blow into the plastic tubing and pull the glove back towards yourself, so that the glove is stretched taut over the pipe.

What happens to the sound if you change how tightly stretched the glove is over the end of the pipe?

What's happening?

By pulling the fingers of the glove over the top of the tube you are making a skin over the top of the pipe. When you blow air into the tubing through the thumb, the skin vibrates as the air escapes. This makes the air inside the pipe vibrate, producing the sound. You can change the pitch of the sound by changing how tightly stretched the glove is over the top of the pipe.

Can you make paper scream?

Science concepts:

Vibrations

You'll need:

- A sheet of paper
- Scissors

Time required:

5 minutes

What to do:

Cut out a piece of paper approximately 10cm long and 5cm wide.

Fold the paper in half widthways so that you end up with a doubled-over piece 5cm square.

Bend each of these halves back on themselves so that the paper has three creases. Unfold these halves so that you return to the 5cm by 5cm size.

Cut two small triangles out of the paper at the middle fold.

Bring the paper to your mouth so the sides rest against your face and the section with the holes points away from your face. Hold the paper in place by resting a finger on each side of your mouth.

Blow into the piece of paper. What sort of noise do you hear?

What's happening?

As air rushes through the two small holes, the paper begins to vibrate very quickly. This rapid vibration causes a high pitched screeching noise.

Can you make the most annoying sound in the world?

Science concepts:

Vibrations

You'll need:

- 2 empty soft drink cans
- A big breath of air

Time required:

5 minutes

What to do:

Very lightly hold a can upright with your thumb resting on the bottom rim of the can, and your middle finger holding the outer edge of the top rim of the can.

Hold the other can the same way in the other hand.

Bring the two cans together until they are almost touching.

Blow as hard as possible through this gap to make a high pitched squealing noise.

If you don't hear the sound, move the cans closer together and further apart until you do.

Tip: hold the cans as loosely as possible, and blow using a short, sharp breath

What's happening?

Blowing between the cans makes the air between them move very quickly. The two cans bounce against each other very quickly and they begin to vibrate. The small sound made by these vibrations is amplified inside the cans making a very loud, high pitched sound.

Can you make an oven rack ring?

Science concepts:

Sound propagation through different mediums

You'll need:

- Metal oven rack or bathroom rack
- Metal tablespoon
- String
- Scissors

What to do:

Cut two lengths of string to about 60cm in length, and tie them to the top corners of the oven rack.

Wrap the free ends of the string around your index fingers, then stick your fingers in your ear (they don't need to stick right in, just rest them against the opening of your ear). While standing up, lean forwards slightly so that the oven rack dangles freely in front of you.

Ask another person to strike the oven rack using the tablespoon. What does it sound like?

Now remove your fingers from your ear and ask the other person to strike the oven rack again. Does it sound different?

Repeat the experiment using other kitchen utensils. Try adding many strings to the same oven rack so that multiple people can listen to it at once.

What's happening?

When discussing the science of music, we often talk about sound waves (or vibrations) traveling through air, but they can also travel through other materials.

The molecules (tiny particles) in liquids and solids are much more closely packed together than they are in gases like air. This allows soundwaves to travel through solids and liquids much more quickly and efficiently than it does through gases.

In this activity, when you put your finger in your ears, the vibrations travel directly up through the metal, to the string and to your ears. If your fingers are not in your ears, the vibrations travel from the metal, to the air around the metal, and eventually to your ear, during which time a large proportion of the vibrations are lost in the air around you.

Can you create friction with phonebooks?

Science concepts:

Friction

You'll need:

- Two phonebooks or other soft-cover books of a similar size

What to do:

Starting from the back of the books, interlock each page (lay a page from one book over a page of the other over and over again), until the two books are completely interlocked. This process doesn't have to be perfect- if you fold a few pages two-at-a-time it won't really matter.

Try to pull the books apart. Ask a friend (or several friends) to try to help you to pull them apart. You should find the books are quite firmly stuck together.

What's happening?

The phonebooks are stuck together due to a force called friction. Put simply, friction can be thought of as the resistance encountered by something when it is moved over or across another objects.

Friction holds the pages of the books together and the only way to separate them is to take them apart page by page, the same way you put them together. You will notice that the pages on the book are slightly rough to touch and this causes friction when they try to slide past each other.

There are three main types of friction:

- Static friction, which you experienced in this activity, is the resistance that causes two bodies not to slide past each other.
- Kinetic friction is the resistance when two bodies begin to slide, such as when you fall off your bike and grind your knees. Kinetic friction can create heat – try rubbing your hands together – and, if the surfaces are of different hardness, a lot of damage to the softer body.
- Rolling friction is the resistance of two objects that are in contact but are then peeled away from each other, such as ripping apart Velcro tape or a wheel rolling along the ground. Rolling friction is generally the weakest form of friction.