Dr Graham's

Little book of experiments

DIY Marshmallow Bazooka

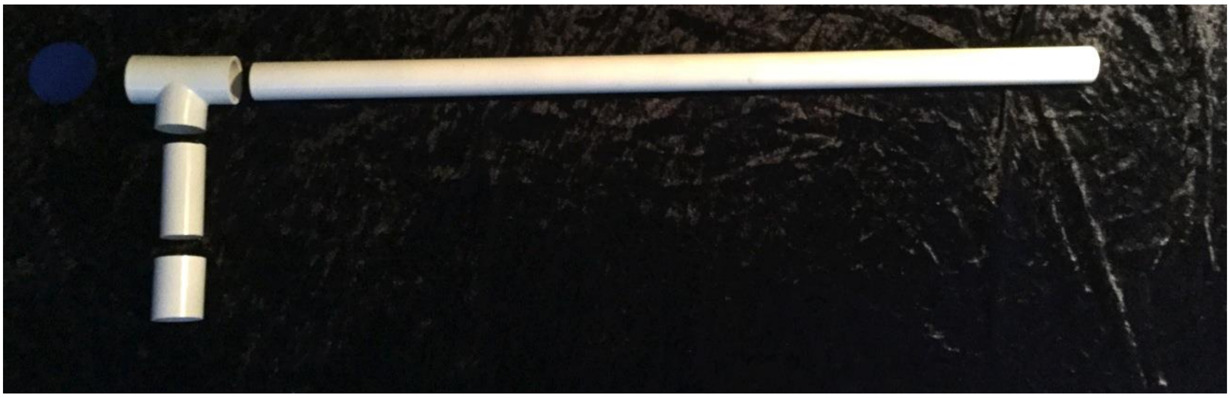
CAUTION: Take care when cutting the pipe. The marshmallows fly fast so don't shoot them at anything fragile. If you must shoot them at people – which we don't suggest – make sure they are wearing eye protection.

Materials:

- 1m of 25mm PVC pipe (same diameter as a marshmallow)
- PVC T-junction to suit above pipe (www.bunnings.com.au/holman-25mm-press-pvc-plain-tees_p3142350)
- PVC pipe joiner to suit above pipe (www.bunnings.com.au/holman-25mm-press-pvc-coupling_p3140756)
- Paper, thin cardboard or light plastic (we cut some off a food package), approx. 10x10cm
- Saw
- Tape

What to do:

1. Cut about 20cm off the end of the PVC tube. Attach the pipe joiner to one end, and the bottom of the 'T' in the T-junction to the other end.
2. Use the pipe joiner to attach the vacuum cleaner – most vacuums fit nicely but if not use some tape to get a good seal.
3. Attach the long remaining piece of the PVC tube to one of the sides of the T-junction (the picture below shows how the pieces fit together).



4. Turn the vacuum on. Hold the paper/plastic square – henceforth called the 'cap' – to the open side of the 'T'. The cap should get pushed ('sucked') onto the opening and held in place.
5. Make sure you're aiming into a clear open space. The marshmallow will fly out the opening where the cap is.
6. To fire, put the marshmallow in the end of the long tube – you may need a helper to hold or load the bazooka. It should shoot out the other end, knocking the cap off.

ATTENTION THRILL SEEKERS: Can you design a cap that stays on and resets with each launch? Hint: a hinging cap could be one answer. Solved it? Behold the fully automatic marshmallow bazooka!

What's happening?

The vacuum cleaner creates lower pressure inside the vacuum than outside, which is at normal atmospheric pressure. Atmospheric pressure is the weight of the air in the atmosphere pushing – all the air all the way up to space is stacked on top of us and it weighs a lot! While people say the vacuum sucks air in, the truth is that the higher atmospheric pressure outside actually pushes air in.

The setup of tubes and the cap allows us to place the marshmallow in the way of this moving air, which applies a force and pushes ('sucks') the projectile along the tube and launches it out. The projectile has kinetic or moving energy.

While the air is being pushed ('sucked') into the vacuum and turns 90 degrees down the T-junction, the marshmallow continues to go in the same direction. Once the marshmallow is going fast one way, it continues to go that way and flies out the end, knocking the cap off. This is an example of Newton's 1st law – an object in motion continues in motion until another force changes that.

Hair dryer ping pong ball levitation

CAUTION: Set the hairdryer to blowing cool air.

Materials:

- Hair dryer
- Ping pong ball

ATTENTION THRILL SEEKERS: this experiment can be done with a leaf blower and inflatable ball for a bigger science buzz!

What to do:

1. Set the hair dryer to blow cool air. If your dryer doesn't have this setting, take care the ball doesn't get too hot.
2. Turn on the blower aiming it straight up and place the ball about 10cm above in the stream of air – it should hover.
3. What happens if you angle the hair dryer? What happens if you tilt the hair dryer? What happens if you use a heavier/lighter ball?

What's happening?

The ball hovers because of two things:

- The air pushes up on the ball, and the force of gravity pulls down on the ball – where those two forces balance is where the ball hovers. To work out if an object will move we need to add up all the forces – pushes and pulls – which, if opposite (up and down in this experiment), can cancel or balance each other out.
- The ball also stays hovering because air rushing past the ball 'sticks' to its sides and curls around the ball holding it in place like two cupping hands. When we tilt the blower those cupping hands of air hold it up. Two principles – the Coanda effect and the Bernoulli principle – can be used to understand exactly how the moving air 'holds' the ball… curious minds will find lots more details online.

Vortex Cannon

Materials:

- (a) Paper cup / (b) rubbish bin
- (a) Balloon / (b) shower curtain or plastic sheet
- Scissors/hobby knife
- (a) Tape / (b) elastic 'ocky' strap
- Pen

ATTENTION THRILL SEEKERS: you can make a small or GIANT vortex cannon by scaling up the design – where option (a) and (b) are given above and below, follow (b) to make a BIG one!

What to do:

1. Air vessel:
    a. If using a cup, use the pen to poke a hole about 1cm in diameter in the middle of the bottom of the cup.
    b. If using a bin, cut a 20cm diameter circle in the centre of the bottom. Take care!

2. Vessel cover:
    a. Tie off the neck of the balloon, then cut off the top of the round part of the balloon and keep the section with the neck.
    b. Cut a section of shower curtain or plastic sheet 25 cm bigger than the top of the bin.

3. Stretch the balloon or shower curtain over the top of the vessel and secure with (a) tape or (b) the elastic strap.

4. To fire:
    a. 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.
    b. Slap the shower curtain sheet with your hand – hard, but not so hard it pulls off.

5. You can see the effects of the air cannon by shooting it at someone's hair, paper or a lit candle.

What’s happening?

As you release the balloon or hit the bin cover, it displaces air and pushes some out the hole. This forward-moving air can travel quite a distance. The air surrounding the displaced air is spun in a doughnut-shaped vortex. The doughnut region travels with the core and acts as a rotating shield between the core and the surrounding air. Just as a rotating wheel lessens friction with the ground, the doughnut vortex lessens friction between the moving core and the surrounding still air. The core puff of air thus travels much further and retains its speed much better than a jet of air with no vortex.

DIY hovercraft

Caution: You must set the hairdryer to cool setting. Take extra care when cutting the hole.

Materials:

- Something flat and thin, approx. 30x30cm, e.g. stiff cardboard, old lunchbox lid, vinyl record, thin plywood, etc.
- Something to cut/drill a hole in the above
- Pipe connector or tape to attach hair dryer
- Tape
- Glue (optional)
- Plastic sheet (builders plastic or thick garbage bag)
- Screw with washer and nut, or paper fastener

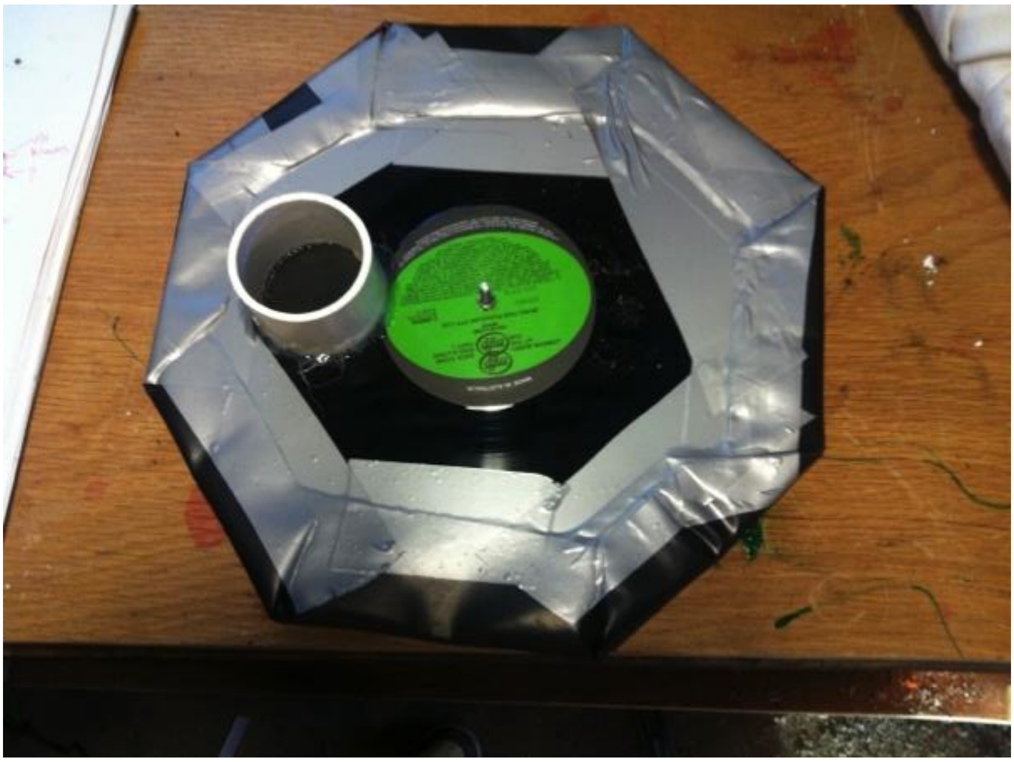
What to do:

1. Find the middle of the flat object – we used an old record (ask the record's owner first!). Make a hole about the size of the hairdryer outlet halfway between the middle and edge.
2. Attach the pipe connector to the hole with tape or glue – this will hold the hairdryer outlet. If you want to just tape the hairdryer on, do this step last (but make the hole now) – a connector works much better.
3. Cut a piece of plastic sheet big enough to cover and wrap over the edges of the flat object.
4. In the centre of this, cut five evenly spaces holes each about 1cm across each, as per the picture.
5. Use the screw and nut, or paper fastener to attach this to the centre bottom of the flat object, as per the picture. You will need to make a hole on the flat object, unless you're using a record as they come with one!
6. Wrap the plastic up around the edges of the flat object and secure with lots of tape.
7. Insert the hairdryer into the pipe connector.
8. Turn on the hairdryer and watch it hover! Does it slide around easily?

ATTENTION THRILL SEEKERS: You can scale this design up by replacing the hairdryer with a leaf blower. This big hovercraft might even be able to carry a person!

What's happening?

The hair dryer pushes air out through the holes in the plastic on the bottom of the hovercraft, creating a thin layer of air underneath. Even though it is only a few millimetres off the ground, this layer of air stops the hovercraft from rubbing on the floor meaning there is hardly any rubbing or friction. Without friction, the hovercraft can slide around easily.



Balloon board

Caution: the balloon board is unstable – make sure there are no hazards to fall on. If you use an upside down table, take extra care with the legs sticking up.

Materials:

- Piece of flat wood, old table top, or similar
- 5-7 good quality balloons (inflated)
- Garbage bag
- Smooth floor, no grit or stones

What to do:

1. Place a balloon under the board – what do you think will happen when you stand on it?
2. Stand on the board – the balloon should pop.
3. Put either 4 or 6 balloons in the garbage bag (use 6 if you have lots).
4. Carefully climb onto the board (you may need to steady it or have a friend help). The balloons shouldn't pop.

ATTENTION THRILL SEEKERS: How many friends can you get on the board before the balloons pop?

What's happening?

The force pushing down – the people on the board – is shared or distributed over all the balloons. With one balloon there is a small area, so a high pressure and the balloon pops. With many balloons each balloon takes a share of the weight, so there is a lower pressure and they don't pop. Each balloon is only holding a fraction of the weight or force – ¼ with four balloons or 1/6 with six balloons.

This shows us that pressure depends on the area a force, or push, is applied over. A good example is to ask yourself if you'd rather someone walked on you in high heels or flat soled shoes.

Strong structures

Materials

- A4 paper
- Tape
- Weights (books, more paper, etc.)

What to do:

1. Take one sheet of paper and roll it lengthwise or width-wise into a cylinder and tape to secure. Make three more identical cylinders. Make sure they are the same size all the way along.
2. Fold up another four sheets of paper to make four square prism columns. To do this make a small fold about 1cm from the long edge, then fold the remaining big section in half, then fold these two halves in half again (make sure the folds will make it wrap up).

3. Arrange the cylinders like the legs of a table, then carefully stack books, weights, etc. on top. Now try with the square prisms. Which are strongest?

ATTENTION THRILL SEEKERS: You may be surprised how much weight you can hold on the cylinders, especially if you stack carefully. What is your record? What if you use multiple sheets of paper in each cylinder?

What's happening?

Cylinders are stronger than square columns because they have no folds. The folds in the square columns are a weak point where the force is concentrated. The cylinders have no folds so distribute the weight evenly, making them much stronger. Have a look around your house and yard, or at big buildings – can you spot engineers also using these ideas?

Two ball bounce – energy transfer

Caution: This experiment is best done outside – especially if you use eggs! Take extra care the small ball and eggs can fly off quite fast – don't stand too close if you're trying to catch them.

Materials:

- Big ball – basketball or soccer ball
- Small ball – tennis ball
- Eggs (optional)

What to do:

1. Hold the basketball at chest height from below.
2. Drop the ball and note how high it bounces up.
3. Now repeat the drop/bounce, but this time place the tennis ball directly on top of basketball.
4. Drop both balls at the same time.
5. The tennis ball should shoot up quite high.
6. Compare the height the ball bounced in step 2 and step 4. Was it different? Why?

ATTENTION THRILL SEEKERS: The same experiment can be repeated with an egg! You can see this in the images. Can your friends catch the flying egg?!

1. Repeat as above, but substitute a raw egg for the small ball. Hold the egg lengthwise with the fat end on the bottom. We'd recommend starting with the big ball about 50cm off the ground – this way it will have less energy to transfer to the egg and it won't fly as far… but you can increase the height – and how far the egg will go – as you get more confident!
2. Drop at same time and make sure any onlookers are ready to catch the egg. Take care with hazards and safety.

What’s happening?

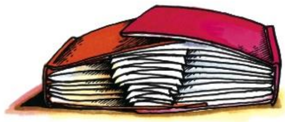
When the basketball is held at chest height it has potential (stored) energy. When it is dropped and bounces, *potential energy* turns into *kinetic (moving) energy*. When both balls are dropped at once, there is a *transfer of moving kinetic energy* from the basketball to the tennis ball in the collision as they hit the ground. This shoots the tennis ball much further than it would go when dropped alone – it has gained kinetic energy from the basketball. The same science applies to the egg.

Friction Books

Materials:

- Two phonebooks or other soft-cover books of a similar size (book may be damaged, don't use good ones)
- Two people

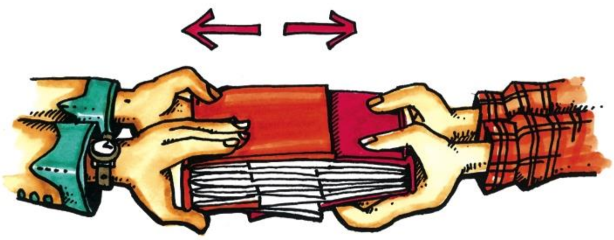
What to do:



1. Starting from the back of the books, interlock each few pages (lay a page or two or three from one book over pages 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 several pages together it won't really matter.
2. Each take the spine of one book try to pull the books apart. Make sure the interlocked pages don't flop apart. Pull harder! You should find the books are quite firmly stuck together.

What's happening?

The phonebooks are stuck together due to a force called friction. Friction is the resistance encountered by something when it is moved and rubs against another object. 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. The pages on the books are slightly rough to touch and this increases the friction when they try to slide past each other.



Clucking Cup

Materials:

- String (cotton twine is best, not smooth plastic string)
- Water
- Disposable cup or similar (yogurt tub, cut off bottle bottom, etc.)
- Scissors/knife/drill to make a hole with

What to do:

1. Make a small string-sized hole in the middle of the base of the cup.
2. Tie a big fat knot in one end of the string as a stopper.
3. Hold the cup upside down and thread the string through the hole entering from the outside of the cup, and pull through until the knot stops it.
4. Hold the cup upside down with the string hanging down.
5. Lightly wet your fingers and the string with water.
6. Hold the top of the string between thumb and forefinger and pluck down in sharp jerky movements – you should hear a sound like an excited chicken.

ATTENTION THRILL SEEKERS: What happens if you repeat the experiment with bigger containers (ice cream tub, bucket or even a rubbish bin) in place of the cup?

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 *vibrations*. The vibrating string causes the cup and the air inside the cup to vibrate, resulting in the sound being louder or *amplified*. Many musical instruments work on the same principal.

String telephone

Materials:

- String
- Scissors/knife/drill to make a hole with
- 2 tins with top taken off (no sharp edges), disposable cups or similar

What to do:

1. Make a small hole in the middle of the base of each cup/tin and tie a knot in one end of the string as a stopper.
2. Thread the string through the hole entering from the inside of a cup, and pull through until the knot stops it.
3. Thread the other end of the sting through the hole in the other cup from the outside, and tie another knot to stop it coming out.
4. To use it, stretch the string out tight. One person talks into one cup, while another person listens with the other cup to their ear.

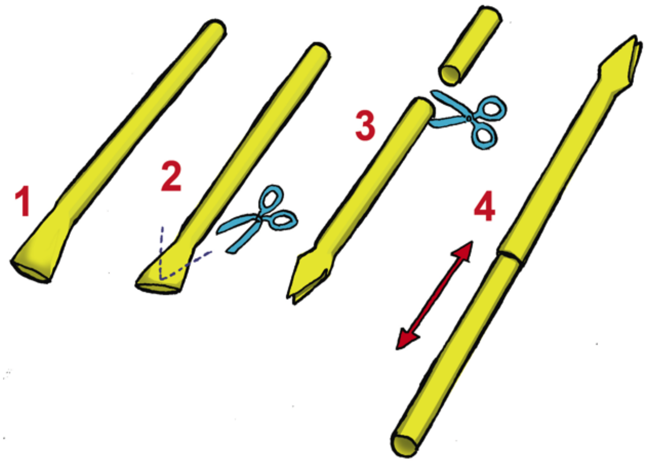
What's happening?

Sound travels as vibrations. Sound vibrations can travel through air and liquids, but they travel really well through solid objects. You might notice this when eating crunchy food – it sounds loud because the sound is travelling through your jaw. When you stretch the string tight, it acts as a solid link between the two cups. Talking into the can makes the string vibrate with the sound of your voice. These vibrations travel along the string to the other can, making it vibrate. The other can makes the sounds louder (*amplifies* it) so the person listening can hear.

Musical Straws

Materials:

- Straws
- Scissors



What to do:

1. Use your fingers to partially flatten about 2cm of the straw at one end.
2. Cut the end of the straw into a point, about 1cm long. It is important the straw has a sharp cleanly cut point.

Now we'll learn how to play the straw:

3. Place the pointed end of the straw between your lips so the point is just past your lips. It helps to curl your lips back slightly.
4. Blow the straw – if you don't hear a buzzing sound try changing the position of your lips, **or** the amount of pressure, **or** how far inside your mouth the straw is. Keep trying – soon you will master it!

ATTENTION THRILL SEEKERS: Once you're a musical straw maestro, here are a few other things you can try:

- **While playing the straw, try cutting about 2cm off the end (see 3). What happens?**
- **Cut small holes in your straw like it was a flute. Try covering and uncovering the holes as you blow.**
- **Try sliding one straw into the other as you play, or making a longer straw (see 4 in the picture).**

What's happening?

Sound is a form of *vibration*, which just means sound is created by things wobbling back and forth. When you blow through the straw, you make the tips of the point vibrate – you may feel this on your lips as you play. The sound waves travel through the air in the straw, then out through the end. The vibration travels through the air until it reaches your ears where you hear it as a sound. By changing the straw's length, you change the speed of the vibration (the *frequency* of the sound). This changes the pitch or note of the sound. Most wind instruments work on this same principle.

Crying cans

Materials:

- 2 soft drink cans or disposable cups
- A person who can blow hard

What to do:

1. Hold the empty soft drink cans with you index finger and thumb at the top and bottom rims of the can (don't hold with your whole hand/palm). If you use cups, hold one upright and one upside down so they fit together.
2. Position so they are almost touching, then blow hard and fast between the cans.
3. They should 'cry' and make a horrible sound.

What's happening?

Blowing between the cans makes them vibrate. The sound is made louder by the air inside the empty cans which amplifies the sound – the empty cans work like the body of a guitar or the space inside a drum. The vibrating can causes the air to vibrate and the more stuff vibrating, the louder the sound gets.

Upside-down Water

Watch the Little Scientists Puppet Show video at https://www.youtube.com/watch?v=Da3_yZb8pzg.

Materials:

- Glass
- Disposable plastic plate or card

What to do:

1. Fill the glass half full with water.
2. Place the plastic plate/card on top. Hold the plate/card on and carefully invert the glass.
3. Remove your hand that's holding the plate – it should stay on.

What's happening?

This demonstration shows two principles. The main one is the strength of atmospheric pressure, or the weight of air pushing on things. Air is actually quite heavy and pushes in all directions. Gravity would usually cause water to fall from the glass, but atmospheric pressure pushes up on the plate holding it on. The air inside the glass is sealed off by the water and glass and as you invert the cup the pressure inside reduces slightly. The atmospheric pressure outside is higher than the pressure inside, causing the plate to be held on. The second principle is adhesion – water sticks to other things and itself. Water is attracted to other molecules of water, and also to the card. This also helps hold the card in place.

Upside-down Water vs. Surface Tension

Watch the Little Scientists Puppet Show video at https://www.youtube.com/watch?v=Da3_yZb8pzg.

Materials:

- Glass
- Rubber band
- Plastic mesh / flywire
- Plastic plate or card
- Water

What to do:

1. Cut out a square of mesh about 5cm bigger than the top of the glass. Use the rubber band to stretch it over the opening of the glass – make sure it is tight.
2. Pour water into the glass. Notice it goes through the mesh.
3. Put the plastic plate on top of the cup and, holding the plate on, turn it upside down. Let go of the plate, it should stay stuck to the cup.
4. Carefully slide the plate off horizontally – do not pull the plate off downwards. The water should stay in!

What's happening?

The explanation for this experiment is similar to the one above. Atmospheric pressure pushes up on the water helping hold it in. The other reason the water does not fall through the mesh is *surface tension*. Water molecules are attracted to other water molecules, holding them together – like the water has a skin. This is the reason water forms into drops and why small insects can walk on the surface of the water. Surface tension is not very strong, it will not hold water in a glass usually. But by adding the mesh the surface tension only has to form a 'skin' over a very small area – just one of the holes in the mesh. With the extra force of atmospheric pressure pushing up, this is enough to stop the water from falling.

Pressure Powered Cartesian diver

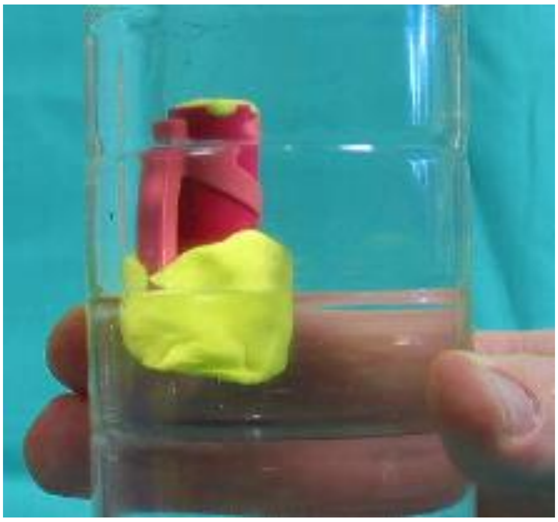
Materials:

- Soft drink bottle of any size with a lid, filled with water
- Pen lid and plasticine / press-stick OR bendy straw and paperclips

What to do:

There are two ways to make the diver:

1. Pen lid and plasticine / press-stick
    - If the pen lid has a hole at the top, cover it with plasticine so that air can be trapped in the lid.
    - Place some plasticine on the arm of the pen lid to act as a weight.
    - This step is best done in a separate cup of water - adjust the amount of plasticine on the arm until the lid floats upright with its top sitting just above the surface of the water.
2. Bendy straw and paperclips
    - Bend the straw over and cut off the long section so both parts are equal lengths.
    - Insert the paper clip into both holes to hold together.
    - This step is best done in a separate cup of water – attach extra paperclips (usually about three) to the first one until it floats upright with its top sitting just above the surface of the water.
3. Put the diver into the bottle and screw the lid on tight.
4. Squeeze the bottle – the diver should sink. If it doesn't sink easily, add more paperclips or plasticine.



What's happening?

Two forces act on the diver: gravity pulls down and buoyancy pushes up. When you put something in water, it pushes some of the water out of the way – this is called displacement. An object in water feels an upward force, called buoyancy, equal to the weight of water it is pushing out of the way (or displacing). You might have felt the force of buoyancy when you float when swimming or try to hold a ball underwater.

So the diver's buoyancy – how much it floats – depends on the volume of the straw/lid, including the air inside it. Normally, the force of buoyancy is greater than the force of gravity, so the diver floats. Squeezing the bottle squashes the bubble inside the lid and reduces the volume, so the diver's buoyant force is less. Basically, a small bubble doesn't float as well as a big bubble. Once the upwards buoyancy is less than the downwards gravity, the diver sinks.

Burn Proof Balloon

CAUTION: An adult MUST supervise the use of fire during the experiment.

Science concept: heat, scientific method

Materials:

- Candle
- 2 balloons
- Water (tap or big bottle)
- Matches

What to do:

1. Blow up one balloon up and tie it off.
2. Fill the other balloon with about 2 cups of water from the tap, pinch it off with your fingers and then blow it up so it contains both air and water. Tie it off.
3. Light the candle.
4. Holding by the knot, lower the air-filled balloon slowly until it touches the flame. What happened?
5. Repeat the process with the water and air filled balloon, holding the balloon by the knot so the water-filled part touches the flame. Be careful not to touch the wick to the balloon.
6. The balloon shouldn't pop this time. Remove it from the flame.

What's happening?

The flame burns the rubber and causes the air-filled balloon to pop, but the balloon with water in it doesn't pop because the water keeps the balloon cool. Water is good at absorbing heat – keeping things cool – and the heat that would usually burn the balloon is instead slowly heating the water.

This experiment shows the scientific method – making and testing a hypothesis, and changing a variable (the water).

A car engine is cooled the same way as the balloon. In a car the burning of fuel creates heat as well as energy to turn the wheels. To stop too much heat building up water is pumped through the engine – where it heats up – and then through the radiator – where it cools back down. The water absorbs the heat from the engine to keep it cool, just as the balloon in the activity stays cool and doesn't burn when it contains water.

Egg/balloon in a bottle

CAUTION: An adult MUST supervise the use of fire during the experiment and perform step 4 below.

ATTENTION THRILL SEEKERS: Try a twist on this experiment with the Little Scientists Puppet Show at https://www.youtube.com/watch?v=ORUMHEGO0g4.

Materials:

- Peeled boiled egg (or egg-sized water balloon)
- Glass bottle with an opening slightly smaller than the egg (e.g. 600mL juice bottle)
- Small piece of paper
- Matches
- Margarine/oil

What to do:

1. Grease the opening of the bottle with the margarine/oil.
2. Pour a small amount of water into the bottle (just enough to cover its base).
3. Roll the paper into a rough stick shape and test that it fits through the opening of the bottle.
4. Have an adult set the bottom of the piece of paper alight and, once burning well, drop it into the bottle. Take care not to burn fingers!
5. As soon as the fire goes out put the egg onto the mouth of the bottle so the pointed end is facing downwards. What happens to the egg?
6. If it doesn't get sucked in, try using more paper – you need to heat the air in the bottle up more.

What's happening?

Inside the bottle, the burning paper heats the air, making the air expand. Some of the air escapes through the neck of the bottle. When the paper stops burning with the egg on top, the air inside the bottle cools down, contracts and creates a lower air pressure inside the bottle than outside. Air will always try to move from an area of high pressure to low pressure, so the air outside the bottle tries to move inside the bottle where the pressure is lower – this pushes the egg into the bottle.

Canister Rocket – CAUTION flying projectile

Caution: Wear eye protection. Never fire the rocket at people or below lights. Only confident adults should attempt the experiments using bigger containers. Wear eye protection.

Materials:

- Film canister, small cream bottle, medicine tube, OR lolly tube with pop-top lid (a container with a pop-off lid)
- Sodium bicarbonate / baking soda
- Vinegar
- Plate

ATTENTION THRILL SEEKERS: Confident adults wearing eye protection might like to try the activity with bigger pop top containers such as big yogurt tubs, washing powder bottles, or tennis ball tubes. This is VERY exciting and extra care should be taken – definitely one to do outside! Onlookers should be well back – take care!

What to do:

1. Take the lid off the canister. Before adding ingredients, practice step 4.
2. Pour a small amount of vinegar, about 5ml deep, into the canister body.
3. Put about ½ cm^2 (~⅓ teaspoon) of baking soda on the inside of the lid.
4. Make sure your plate is level. Hold the body of the canister in one hand and the lid in the other. Quickly press the lid firmly on, place the canister lid down on the plate and stand back.
5. Your canister will blast off 2-10 seconds later!
6. Have a look at the lid and bubbling ingredients left on the plate.

What's happening?

When vinegar and baking soda mix together, a fast *chemical reaction* occurs that produces carbon dioxide gas ($C0_2$). As more and more carbon dioxide gas is produced, the bits of carbon dioxide (called molecules) are squashed together and *pressure* builds up inside the canister. The pressure soon pops the lid off, launching the canister into the air.

As vinegar (dilute acetic acid) is a weak acid and baking soda (sodium bicarbonate) is a weak base, it is an example of an *acid-base reaction*. It is a special example because as it involves a carbonate, so produces carbon dioxide as well.

Homemade Fire Extinguisher

CAUTION: An adult MUST supervise the use of fire during the experiment.

Materials:

- Tall glass or plastic jug
- Bicarbonate of Soda
- Vinegar
- Candles
- Matches/lighter

What to do:

1. Place about 1cm of bicarbonate soda in the glass/jug.
2. Light the candle.
3. Add 1/3 to 1/2 a cup of vinegar. The mixture will bubble and might overflow as it makes carbon dioxide gas.
4. As soon as the bubbles have settled, carefully pick up the glass and carefully pour the gas from the bubbles over the candle, without pouring out the liquid. The candle should go out.

What's happening?

A chemical reaction occurs when bicarbonate of soda and vinegar (acetic acid) are mixed together, which produces carbon dioxide (CO_2) gas. This gas can be poured from the jug like water. CO_2 gas is denser than air, so when it is poured from the jug, it flows down on top of the candle like a blanket, pushing the oxygen in the surrounding air out of the way. The candle flame needs oxygen to burn so is put out by the CO_2 gas. Fire extinguishers filled with CO_2 are often used in situations where using water to put out a fire would be dangerous, such as electrical fires.

How to bake a native BEE HOTEL

Lend a helping hive to solitary native bees with an easy to make bee hotel! Gather the basic ingredients listed below and follow our how to build/bake directions to create a real buzz in your garden.

INGREDIENTS

- 1 piece of PVC pipe (5 – 10 cm diameter and approximately 14cm long)
- A good handful of Un-coated paper straws (enough to fill the PVC pipe). Do not use plastic or wax coated paper straws as these get too hot and the bee larva will die. Or instead of paper straws you can use straight twigs with pithy centres (eg. Fern, bamboo).
- Duct tape

DIRECTIONS

1. Take a piece of white PVC pipe.
2. Cut pieces of duct tape and cover one end of the pipe with the tape.
3. Fill open end of the pipe with paper straws
4. The hotel is almost complete! It just needs a perfect spot to be placed so it can best attract bees. Great locations to place your hotel include: a horizontal branch or other similar place where it is firm, out of the way be easy to still see the holes. It's important to make sure it doesn't swing around or the bees will find it difficult to fly in and out. Also ensure it is protected from the weather.

Tips:

- Don't try to attract bees to the hotel, if it is there, and they need it, they will come.
- Other creatures might also like your hotel, like spiders. If something you don't want nests in your hotel you can remove some straws and replace them (just make sure they are un-waxed paper tubes, you can make your own tube with a piece of paper if needs be).
- Once bees have laid their eggs and sealed their brood cells you can tell by seeing a small cap at the end made by the bee, different types of bees make different type of caps. Once the larva have hatched and left the hotel, replace the paper straw.

Floating leaf disks for observing and investigating photosynthesis

What is Photosynthesis?

Photosynthesis is the most important biological process on Earth! Plants use energy from the Sun to convert carbon dioxide and water, into oxygen we breathe, and sugars we can eat. Without plants to provide food and oxygen, humans simply would not survive. This experiment investigates how well a leaf photosynthesises by observing oxygen produced by part of the leaf.

What you need:

- 1/8 teaspoon bicarbonate of soda (baking soda)
- 1 drop dishwashing liquid
- 300ml distilled or cooled pre-boiled water
- 1 x syringe (no needle!)
- Leaf material, e.g. spinach (3-4 leaves per experiment)
- Hole punch or small cookie cutter
- 2 x plastic cups
- Timer
- Light source (Sunlight or a high powered floodlight work best)

What you do:

1. Create a bicarbonate solution by mixing the baking soda, dishwashing liquid and water together.
2. Cut several shapes of the same size from the leaves. Holepunches are best, but stiff plastic straws and small cookie/icing cutters also work well. Your choice of leaf material is probably the most important part of the experiment. The leaf surface should be smooth and not too thick. Avoid plants with hairy leaves. Ivy and fresh spinach both work well.
3. Remove the plunger of the syringe and place the leaf disks into the syringe barrel. Replace the plunger being careful not to crush the leaf disks. Push on the plunger until only a small amount of air and leaf disk remains in the barrel (<10%).

4. Pull some bicarbonate solution into the syringe, about 4 cm deep. Tap the syringe to suspend the leaf disks in the solution.
5. Holding a finger firmly over the syringe-opening, pull back hard on the plunger to create a vacuum. Hold this vacuum for about 10 seconds.
6. While holding the vacuum, swirl the leaf disks to suspend them in the solution, then push on the plunger of the syringe (with your finger still firmly over the opening) to force water into all the smallest spaces inside the leaf, 'infiltrating' it with bicarbonate solution. This will cause the disks to sink. You will probably have to repeat this 2-3 times in order to get all of the disks to sink. If they don't sink after about 3 repeats, it's usually because there is not enough dishwashing liquid in the solution. Add a few more drops of dishwashing liquid.
7. Pour the disks and solution into a clear plastic cup once they've been infiltrated.
8. Start your investigation by placing your cup and leaves under the light source – the Sun will work best; avoid low powered fluoro globes – and start the timer. At the end of each minute, record the number of floating disks. Then swirl the disks to dislodge any that are stuck against the sides of the cups. Continue until all of the disks are floating.

What's happening?

Leaf disks float, normally. When the air spaces are replaced with water, it makes the leaf heavier and the disk sinks. The bicarbonate serves as the carbon source for photosynthesis. As photosynthesis proceeds, oxygen is released into the interior of the leaf which changes the buoyancy – causing the disks to float.

Extension investigations: Once all the disks have floated to the top, place them in a dark cupboard. See how long it takes for them to sink. Filter the light that the infiltrated disks receive using light filters or cellophane. See if there's a difference in the time it takes for them to float.

This experiment has been recreated by the ARC Centre of Excellence for Translational Photosynthesis from the Science and Plants for Schools website: http://www.saps.org.uk/

Sand Water Filter Activity

One of the biggest issues facing our global community is access to clean water. This activity shows you how to make a small scale version of a sand water filter which is a common design used around the world to filter dirty water and make it drinkable.

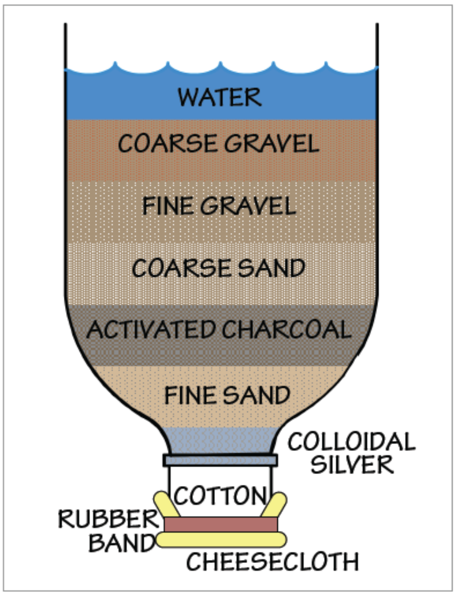
CAUTION: We do not recommend you drink the water that comes out of the filter as we cannot guarantee the filter's effectiveness.

What you need

- 1/2 cup of activated charcoal (in a small porous pouch)
- 5cmx5cm square sheet of cheesecloth
- 1 small sponge (representing colloidal silver)
- 2 cotton balls
- 1 cup each of: coarse gravel, fine gravel, coarse sand, fine sand
- 500mL of clean water
- 1 or 2 small rubber bands
- The top half of a 1.25L water bottle to be used as the filter body (see diagram)
- Dirty water to test
- Container to catch the water

What to do:

1. Place the cotton in the neck of the bottle as a plug.
2. Secure the cheesecloth with a rubber band over the end of the bottle.
3. Place the colloidal silver pad in the filter, and then pour a 1cm layer of fine sand to cover it.
4. Place the activated charcoal pouch in the filter, and then pour in a 1cm layer of coarse sand.
5. Pour 1cm layer of fine gravel then coarse gravel.
6. Place the water filter above the container, then clean by pouring through 500mL of water.
7. Empty your container, then pour your dirty water through the filter and collect your clean water!



What’s happening?

- This filter is very good at filtering out particulates (particulates are bits of sand, dirt, wood, etc. floating in the water)
- After a lot of use the filter can develop antibacterial properties (kill germs such as E. coli)
- Colloidal silver provides antibacterial properties to the filter to kill germs
- Activated charcoal can filter particulates and bacteria
- Gravel and sand both help with filtering particulates of different sizes
- Cheesecloth, cotton and rubber band all help contain the filter materials
- Clean water is used to flush out the filter before its first use. This is to make sure it works correctly.