# Little Scientists' Puppet Show – Activity Book

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Some content adapted (with thanks) from the ANU Centre for the Public Awareness of Science www.cpas.anu.edu.au, and CSIRO's Science by Email – www.csiro.au/sciencemail.

*Please note this booklet contains scientific explanations appropriate for a range of ages. A simple explanation for little scientists is in italics, followed by more details for parents and older children.*

**CAUTION:**
NOTE THESE EXPERIMENTS INVOLVE THE USE OF NAKED FLAMES, SCISSORS AND OTHER HAZRADS FOR EARLY LEARNERS. ADULTS SHOULD CLOSELY SUPERVISE AND BETTER STILL LEAD THE EXPERIMENTS.

**For very young scientists, the process of doing the experiment, playing and enjoying it is the most important thing.**

**This Inspiring Australia initiative is supported by the Australian Government as part of National Science Week.**

**Find more fun activities from the puppet team on**

YouTube

www.scienceshowoffs.net/blog/littlescientists

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## Strong structures

*Materials*

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

*What to do:*

1. Roll up four paper cylinders and tape to secure. 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. Carefully stack books, weights, etc. on top.

*What's happening?*

*Cylinder shaped columns spread out the weight better, so they are stronger than square columns.*

Cylinders are stronger than square columns because they have no folds. The folds in the square columns are a weak point where the force of the weight is concentrated. The cylinders have no folds so distribute the weight evenly, making them much stronger.

## Rocket Balloon

*Materials*

- Smooth string or fishing line
- Straw
- Masking tape
- Balloons

*What to do:*

1. Thread a straw onto the string/line and stretch the line across the room. Get someone to hold it or tie it so that it is tight.
2. Next blow up a balloon and attach it with strips of masking tape to the drinking straw, keeping the end of the balloon closed with your fingers. You may need help here!
3. Now let go of the balloon!
4. You can set up several lines and race. If there are two balloons of different sizes, which one goes the fastest?

*What's happening?*

*When the air is pushed out of mouth of the balloon, it pushes the balloon the opposite way.*

Forces act in pairs – when one thing pushes on another, the other pushes back. The balloon forces the air out at the back – it pushes on the air.  The air pushes back, forcing the balloon in the opposite direction. This is an example of Newton's Third Law, which says that for every reaction, there is an equal and opposite reaction – and they act on different bodies.

## Lava Lamp

*Materials:*

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

*What to do:*

1. Cover the base of one cup with about 5mm of bicarbonate of soda.
2. Slowly half fill this cup with oil.
3. Fill the second cup about 1/3 full with vinegar and add 1-3 drops of food colouring.
4. Gently pour the vinegar into the cup with the oil. Watch what happens.

*What's happening?*

*The vinegar and bicarb soda make bubbles when they mix together. The bubbles are light – like floaties in the pool – so they lift the coloured vinegar/food colouring balls up, which then sink after the bubble pops at the surface.*

The coloured vinegar doesn't mix with the oil, so the vinegar forms globules (small balls) in the vinegar. Because it is more dense than the oil, the vinegar globules sink to the bottom, where they come into contact with the bicarbonate of soda. A chemical reaction between vinegar and the bicarbonate of soda then produces bubbles of carbon dioxide gas. This makes the vinegar and carbon dioxide globules less dense than oil, so they rise upwards through it. 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 sink again. This process will continue for several minutes until the chemical reaction is complete.

## Friction Books

*Materials:*

- Two phonebooks or other old soft-cover books of a similar size.
  Note the books may be damaged sometimes. Don't use good/valuable books.

*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 a few pages together it won't really matter.
2. Hold firmly by the spines and try to pull the books apart. Ask some students 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. 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.

What happens if you repeat the experiment with bigger containers (ice cream tub or bucket) in place of the cup?

*What's happening?*

*Rubbing the string makes it vibrate, or wobble really fast, which makes a sound. All sounds are created by vibrations. The cup makes the sound louder.*

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
- Tin with top taken off (no sharp edges), milo can, disposable cup 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 <u>inside</u> 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 <u>outside</u>, 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.

*What's happening?*
*The sound travels along the string. Sounds can move through solids like string just like they move through air.*

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 it 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.

## Upside-down Water

*Materials*:

- Glass
- 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?*
*Air is actually very heavy, we just don't notice as we are used to it. The weight of the air pushes up on the plate, but can't push through the glass. The water also helps it stick. This holds the plate on.*

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 helps hold the card in place.

## Upside-down Water Part 2

*Materials:*

- Glass
- Rubber band
- Flywire (the lighter plastic sort, not stiff metal)
- 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 (make sure the students notice this too!).
3. Put the plastic plate on top of the cup and, holding the plate on, turn it upside down.
4. Carefully slide the plate off horizontally – do not pull the plate off downwards. The water should stay in!

*What's happening?*
*As with the last experiment, the air pushing up is the first thing keeps the water in. The little bits that make up water also stick together like a skin on the water, which is made stronger by the flywire. These two things hold the water in.*

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*:

- Softdrink bottle of any size with a lid, filled with water
- Pen lid and Plasticine / Blutack 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?*
*The air bubble in the straw/lid makes the diver float. When we squeeze the bottle, we squeeze the air bubble too and it gets smaller. A small bubble does not float as well as a big bubble so the diver sinks.*

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 experience and upwards force and float. This is the principle of buoyancy. 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 diver to sink because the increased water pressure forces water into the lid. This compresses the air bubble in the diver and reduces the amount of water displaced by the air, making the diver sink. When you stop squeezing the bottle the pressure on the air bubble decreases. Water moves back out of the lid so the diver regains its buoyancy and rises to the top again. A submarine and even fish use the same idea to rise and sink.

## Squeezed Leaky Bottle

*Materials:*

- Softdrink bottle
- Pin or thumb tack
- Water

What to do:

1. Fill a softdrink bottle completely with water and put the lid back on.
2. Make 4-8 holes at the <u>same height</u> on the bottle using the pin/tack.
3. Hold the bottle by the lid, or try placing it on your hand. It shouldn't leak.
4. Now, without blocking the holes, hold the bottle normally. What happens if you squeeze it?

*What's happening?*
*Squeezing the bottle pushes water out of the holes.*

When you squeeze the bottle, you apply pressure to it which pushes the water inside out the holes. The more you squeeze, the higher the pressure, and the further the water will squirt! When the bottle isn't squeezed (like step 3), a combination of surface tension, water adhesion and atmospheric pressure keep the water in (see the Upside-down Water experiments above for more info on these). What happens if you take the lid off?

## Burn Proof Balloon – CAUTION flame

*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 or squeeze it in from a full softdrink bottle, 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 and pops.
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?*
*When the empty balloon touches the flame it burns, making the balloon pop. The water balloon doesn't burn because the water keeps the balloon cool, so it doesn't pop.*

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 and dissipating heat and the heat that would usually burn the balloon is instead slowly heating the water. The black soot left on the balloon is a deposit of carbon from the flame, similar to the stuff that collects in chimneys. 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 flame

*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 it's base).
3. Roll the paper into a tube and test that it fits through the opening of the bottle.
4. Set the rolled up piece of paper alight and quickly drop it into the bottle. Leave the paper to burn for a few seconds and then put the egg onto the mouth of the bottle so the pointed end is facing downwards. What happens to the egg?

*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, 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 and forces the egg into the bottle as it does so.

See this activity on Youtube, featuring Charlie the Chicken: http://youtu.be/ORUMHEGO0g4

## Bicarb Soda Vinegar Balloon Inflation

*Materials:*

- Sodium bicarbonate / baking soda
- Vinegar
- Soft drink bottle
- Balloons
- Paper or funnel

*What to do:*

1. Fill the balloon about half full with sodium bicarbonate. A funnel or folded paper guide makes it easier.
2. Add about 5cm of vinegar to the bottle.
3. Carefully attach the balloon to the mouth of the bottle, being careful not to spill any sodium bicarbonate in.
4. Once the balloon is fully on, lift it up and shake the sodium bicarbonate into the bottle.

*What's happening?*
*Mixing vinegar and bicarb soda makes bubbles of gas, which fill up the balloon.*

The balloon will inflate due as the vinegar and sodium bicarbonate chemically react and produce carbon dioxide gas. The chemistry involved is described in the previous activity.