# Science Activities Resource Pack

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# Introduction

- This resource describes a range of hands-on experiments.
- Many are suitable for children, using cheap and readily available resources.
- Some are intriguing and others useful as a starter activity leading to further investigation.
- Some are useful to encourage demonstration skills and talking about science.
- A few are for demonstration only by an adult.
- Various health and safety issues are raised for each experiment, but these are not risk assessments as these also depend on the group, environment and practice.
- If you have any doubts about a particular activity then CLEAPPS (www.cleapss.org.uk) is an excellent organisation for a full range of health, safety and 'how to' advice about practical science, your school may well be a member already.

# Experiment Cards: Air Rockets

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| Description | Make and launch your own air rocket. |
| Equipment | Paper, card, cardboard tubes, tape, glue, felt pens (optional – for decoration), launcher – either a hand pump or a foot stomp rocket launcher will do nicely. |
| Health and safety | Keep participants and spectators away from the line of fire, though as these don't travel at high speed the risks are minimal. |
| How to… | Paper and card can be rolled into tube shapes to give a snug fit on the launch tube, fold the ends over, before nose cones etc. are added. Experiment with a range of shapes and features that will decrease air resistance, e.g. fins, nose cone, curved fins. Best run as a challenge and compare different designs to see which go furthest / highest. |
| Science | A more streamlined shape will reduce air resistance and increase range. Tail fins will keep the rocket moving in a straight line and making it spin reliably also adds to the range. |
| Extras | Links to… investigating streamlining in water, animal shapes for maximum speed and can be extended into areas of sport e.g. Why are golf balls covered in dimples? Why are fish not completely smooth? Why are the latest swimsuits dimply? |
| Curriculum Areas | Forces, Friction, Air / Water Resistance |

# Experiment Cards: Alien Slime

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| Description | Make a rubbery slime, like ‘Silly Putty’. |
| Equipment | PVA glue and water (mixed in the ratio 2 parts glue to 1 part water), borax solution (2 heaped tbsp of borax, chemical name: di-sodium tetraborate, to 1 litre of warm water and stir well to dissolve. Borax can be bought from most chemists and some supermarkets), plastic cups, plastic spoons / wooden stirrers, aprons (if required), poster paint to colour the slime (food colouring works, but it will stain the hands), plastic jugs. |
| Health and safety | In powder form borax is an irritant, it is not toxic, but in a similar category to washing powders / detergents (in fact it is usually an ingredient in the former).<br>If participants are allergic to detergents then wear protective gloves when mixing up the solution / handling the slime, or avoid handling the slime.<br>As with all activities involving chemicals, wash hands afterwards. |
| How to… | To ¼ cup of the glue mix, add a dash of paint and stir well.<br>Add some borax solution (stir the borax solution well before pouring it in) and stir the mixture again.<br>The mixture will rapidly polymerise and can then be handled, rolled, stretched, bounced etc. |
| Science | Borax makes the ‘glue molecules’ join into long chains called polymers, which tangle up to make the slime rather like spaghetti.<br>The slime will slowly dry out and set to a hard plastic resin. |
| Extras | Experiment with the ratio of the PVA glue / water mix to see how it changes the slime. More glue makes it more rubbery. |
| Curriculum Areas | Changing Materials. |

# Experiment Cards: The Astronaut who Forgot his Spacesuit

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|---|---|
| Description | Making a balloon burst in a vacu-tub. |
| Equipment | Water bomb balloons (ordinary balloons are too thick), vacuum food container and pump (‘vacuvin’ brand works fine), balloon pump useful, felt tip pens. |
| Health and Safety | Suitable for all ages, not for latex allergy sufferers. |
| How to… | Inflate the balloon fully and knot the end. Draw a funny face on the balloon and put it wide-end down into the tub. Start pumping out the air until … |
| Science | Pumping out some of the air makes a partial vacuum in the tub (removing all the air is beyond the ability of a humble vacuvin tub). As the air is removed from the tub, the air inside the balloon pushes outwards with a larger force then the air left in the tub pushes inwards. The balloon swells up and bursts.<br><br>Put simply air pressure results from the billions and billions of collisions the gas molecules make when rushing about and colliding with things. If there are more collisions on the inside surface of the balloon than the outside then the balloon is pushed outwards, swells and bursts. |
| Extras | This experiment follows on from Marshmallow Puff. |
| Curriculum Areas | Would fit in with a topic on forces and also illustrates simple ideas about pressure when dealing with space, the atmosphere, or weather. |

# Experiment Cards: Boomerangs

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|---|---|
| Description | Make your own boomerang with a couple of rulers. |
| Equipment | Two 30cm plastic rulers with an aerofoil profile, some sticky tape. |
| Health and safety | Throw them away from other people and they do come back, so keep on your toes. |
| How to… | Tape the two rulers together to make a cross. Make sure that both rulers are facing the same way. For right handers: Hold the boomerang vertically with the flat side on the right, tilt it at about $30^{o}$ to the vertical and throw it at a slight angle upwards. If you're outdoors face into the wind. With a bit of practice you'll soon get them coming back. Younger children can struggle with the throwing technique. For left handers hold with the flat side on the left. |
| Science | Each arm of the boomerang works like a wing, as the air flows over it the lift force pushes the boomerang from right to left. Combine this with the forward motion from the throw and the boomerang is forced to move in a circle. It also turns over and flattens to lie horizontally during the flight, this part of the motion is caused by 'gyroscopic forces' - the ones that stop you falling off your bicycle. |
| Extras | As well as a cross, you can try a T, V or L shape with the rulers. You'll find the cross tends to turn in the tightest circle. I've never managed to get it working with 15cm rulers, if you do let me know! |
| Curriculum Areas | Forces. |

# Experiment Cards: **Borax Snowflake**

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|---|---|
| Description | Borax crystals grow overnight in a strong solution of borax and water. |
| Equipment | Borax powder, hot water, pipe cleaner, lolly stick / pencil, cotton thread, glass jar / transparent plastic tub, food colouring (optional). |
| Health and safety | In powder form Borax is an irritant, in a similar category to washing powders / detergents (in fact it is usually an ingredient in the former).<br>If participants are allergic to detergents then wear protective gloves when mixing up the solution or handling the 'snowflake'.<br>As with all activities involving chemicals, wash hands afterwards. |
| How to… | To 1 litre of hot water add 4 heaped tbsp of borax solution and stir well to dissolve as much as possible. Fold the pipe cleaner into a star shape, tie some thread around one of the points and suspend it in the middle of the borax solution, tying off to the lolly stick across the top of the jar / tub. Leave overnight – in fact the crystals start to grow within a few hours. The remaining solution can be re-warmed to dissolve the borax and the experiment can be repeated with a new pipe cleaner. |
| Science | By using hot water to dissolve the borax, you're making a saturated borax solution – the water can hold no more borax at that temperature. As it cools down the solution becomes super-saturated – it has more borax dissolved in it than it can hold – so it starts to crystallise out on the pipe cleaner. This rapidly builds up and gives good results in a relatively short space of time. The snowflake is fine for hanging up somewhere, but will crumble if the pipe cleaner is twisted or bent. |
| Extras | If you experiment with white pipe cleaners and some food colouring you can also give the snowflake a delicate colour hue. This can be extended to other solutions such as salt or sugar, but the crystals won't grow as quickly. |
| Curriculum Areas | Changing Materials. |

# Experiment Cards: **Cloud in a Bottle**

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|---|---|
| Description | Demonstrates cloud formation. |
| Equipment | 2 litre pop bottle, water, matches, or wooden tapers and a candle. |
| Health and safety | Potential to learn about safe handling of matches / tapers, or you can duck the issue and add the match yourself. |
| How to… | 1/4 fill the bottle with water, screw on the cap. Give it a shake, then squeeze and let go. No cloud forms. Add a lit match, which quickly goes out in the water. Screw the cap back on, shake well, then squeeze and quickly let go again. It's the letting go bit which makes the cloud, younger children can have difficulty with the co-ordination. Best done with a 'new'ish pop bottle, after many repetitions they tend to lose their 'spring'. |
| Science | Shake the pop bottle and the air becomes saturated with water vapour. Adding the match adds smoke particles to the air. We can lower the pressure (and temperature) in the bottle by squeezing it and quickly letting go. As you let go of the bottle it springs back into shape and re-bounds to a slightly larger volume. The water vapour then condenses to form a cloud of water droplets. As the temperature in the bottle rises again the cloud will disappear. These are the conditions needed to form clouds in the atmosphere where there is dust, and water vapour cools when the air is pushed to higher altitudes and lower pressures<br>The experiment can be repeated until all the smoke particles have been absorbed into the water. |
| Extras | Scientists still argue over the exact role of dust particles in cloud formation and whether dust-free clouds can ever form. |
| Curriculum Areas | Weather and Water Cycle. |

# <u>Experiment Cards</u>: **Colour Change Milk**

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|---|---|
| Description | Drops of food colouring spread through milk to create patterns and colours. |
| Equipment | Plates, droppers, cotton buds, washing up liquid, food colouring and milk. |
| Health and Safety | Suitable for all ages. |
| How to… | Put some milk on the plate and add 3 drops of different food colourings into the milk. Dip a cotton bud in a small amount of washing up liquid and touch the surface of the milk close to one of the coloured drops. Don't stir the milk with the cotton bud and try not to let it touch the plate. Repeat this in different places to create swirling patterns. It also works with water, but the milk shows the colours more vividly. |
| Science | A simple observation would be that the washing up liquid pushes the colours around.<br>The full explanation is more complex…<br>Across the water is a force called surface tension, think of it as a stretched rubber sheet. The washing up liquid lowers the surface tension around the cotton bud. The milk and colouring is then pulled away from the cotton bud by the greater surface tension elsewhere in the milk. As if someone had lifted up the rubber sheet by the cotton bud.<br>Eventually the milk becomes saturated with washing up liquid and the colour mixing ceases.<br>The washing up liquid itself consists of large molecules with a water-loving (hydrophilic) and a water-hating (hydrophobic) end. The water-loving end is attracted to and soluble in water. The water-hating end is repelled by the water, but is also soluble in oils and fats, accounting for its degreasing properties. |
| Extras | You can try different versions of this, e.g. using a plate with water and talcum powder, or water and pepper, and a drop of washing up liquid on the end of your finger. |
| Curriculum Areas | Forces and Materials. |

# Experiment Cards: Disappearing Water

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|---|---|
| Description | A version of the magician's coin and cups trick. |
| Equipment | 3 paper cups, disposable nappies, water, scissors. |
| Health and Safety | The super absorbing chemical, typically sodium polyacrylate, has no particular chemical risks or hazards. |
| How to… | It's a good trick to encourage performance, confidence and can be tried out on family and friends. Cut open the nappy and shake out the small white crystals of absorbent granules. Scoop them into one of the three cups. Start the water in a different cup and end up with it in the cup containing the crystals, asking the audience to guess along the way where the water has gone to. Finally when the water is absorbed in the final cup turn it upside down… Practice helps the act! You can also buy super-absorbent powder from first aid suppliers.<br>For the finale stir in a good dollop of salt and wait a few minutes, hey presto, it's all gone runny again. |
| Science | Disposable nappies contain crystals of a super-absorber, typically sodium polyacrylate. Super-absorbers can soak up to 100 times their own weight in water, in doing so they become sticky and clump together. Adding salt will 'draw out the water', like adding salt to a cucumber, as the water moves from areas of high to low concentration. |
| Extras | As well as providing good 'busking' material, there are plenty of investigative avenues you can follow with this chemical, either loose or in nappies. What happens if the crystals are ground up to make a powder? Just how much water will a teaspoon of the powder absorb? It's also used in pellet form as a water retainer for houseplants. |
| Curriculum Areas | Changing Materials |

# Experiment Cards: Floating Coke

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| Description | Bottles of diet coke and normal coke float and sink respectively. |
| Equipment | 1 x 500ml plastic bottle of diet coke, 1 x 500ml plastic bottle of normal coke, 2 clear tubes / old fish tank, water / salt solution, see ‘How to’ … below.<br>(A cheap way to make the tubes is to cut the heads off 2 litre plastic pop bottles). |
| Health and Safety | Tall containers are easily knocked over, for that reason we tend to use plastic ones for pupils. |
| How to… | For this to work reliably … first try floating both bottles in plain water, if one floats and the other sinks perfect … if they both float then top them up with water to get rid of the air space in the bottle**.** Try floating them again in plain water … hopefully this works, but this time they may both sink … in which case try floating them again in saltwater, start with 10g salt per litre of water and adjust the amount of salt until the coke sinks and the diet coke floats.<br>If you have very tall containers tie a piece of string around the neck of the bottle to pull them easily out again. Once you’ve got it set-up keep the bottles and floating solutions ready to go.<br>****** You may be thinking why not just adjust the amount of air at the top of each bottle until one sinks and the other floats – however this is a) not a fair test and b) sharp-eyed children will spot the trick. |
| Science | Objects float if the upthrust is greater than the weight, and sink if the weight is greater than the upthrust.<br>Ordinary coke contains sugar, diet coke does not. The sugar in the coke bottle increases the weight, so it weighs more than the diet coke bottle. The upthrust on both bottles is the same. |
| Extras | Coca-Cola sometimes changes the recipe of one or the other. For example reducing the amount of sugar in the coke subtly changes the point at which they float and sink.<br>Going further than a description of forces, upthrust and weight, soon takes you to some more advanced concepts: Density (mass per unit volume) requires an understanding of mass, volume and division as well as some convincing practical work to support the idea. Upthrust results from Archimedes Principle, and this also requires an understanding of pressure in liquids. |
| Curriculum Areas | Forces – Floating and Sinking. |

# Experiment Cards: Floating Fruit

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|---|---|
| Description | Chunks of fruit & veg, float at different levels in a column of salt solution and water. |
| Equipment | 1 tall see-through tube, 1 litre water, 1 litre salt solution (50g salt per litre of water), 1 litre salt solution (100g salt per litre of water), a selection of fruit and veg chunks e.g. potato, tomato, kiwi. Choose fruit and veg which will normally sink in plain water.<br>1 funnel and a tube long enough to reach the bottom of the cylinder.<br>(A cheap way to make the tubes is to cut the head off 2 litre plastic pop bottles). |
| Health and Safety | Tall containers are easily knocked over, for that reason we tend to use plastic ones for pupils. |
| How to… | Start by pouring the plain water into the bottom of the cylinder, then trickle in the 50g salt solution at the bottom of the cylinder using the funnel and tube, then do the same for the 100g salt solution, until you have roughly equal quantities of each solution in your tube. You end up with water at the top, and the densest saline at the bottom. Add different chunks of fruit & veg to the water and see where they finish up. Try not to move or stir the column once you've set it up and when adding the fruit & veg chunks. |
| Science | The chunks of fruit & veg sink until they find the place in the column where their weight is balanced by their upthrust. Saltwater is a denser liquid than plain water, so the upthrust is greater in saltwater.<br>Many children often anticipate a larger chunk of potato sinking deeper than a smaller one. Not so.<br>Since fruit and veg vary in moisture and mineral content you don't always get the same results. |
| Extras | This is a good one to set-up and leave for a number of days watching what happens as the temperature slowly changes, the fruit & veg absorbs / loses water, and the salt and plain water slowly mix. |
| Curriculum Areas | Forces – Floating and Sinking. |

# Experiment Cards: Fluorescent jellies

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|---|---|
| Description | Make your own jelly that glows under ultraviolet light. |
| Equipment | One packet of lemon jelly, tonic water (containing quinine), suitable mould, one portable uv light (small battery powered ones are fine, unless you have a disco style strip light handy) |
| Health and Safety | We tend to use disposable utensils to manage food hygiene issues. Handheld, battery operated uv lights emit a low overall power. |
| How to… | Make the jelly as per packet instructions substituting tonic water for the water in the recipe. |
| Science | The quinine in the tonic water fluoresces under ultraviolet light. The high energy ultraviolet light is absorbed and radiated back as a blue colour. Using jellies other than yellow will cause some re-absorption of the blue light. Yellow jellies produce the best glow and red jellies re-absorb the most light. If you add some cocktail cherries to the lemon jelly you get a nice blue glow with black bits in the middle. |
| Extras | Needless to say the trick can be extended / repeated with any cocktail using tonic water as a mixer. |
| Curriculum Areas | Light and materials. |

# Experiment Cards: **Fruit Batteries**

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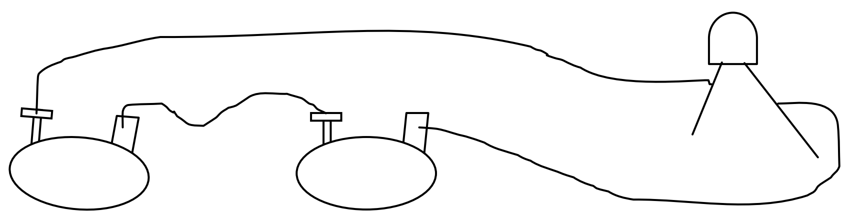
|---|---|
| Description | Light up with oranges and lemons. |
| Equipment | A couple of oranges and lemons, some strips of copper or a short length of copper pipe, some galvanised nails, some wires – useful if they have clips on, a low current LED – we currently use 3mm, super bright, red, low current LEDs made by Kingbright and available from Rapid Electronics, www.rapidonline.com |
| Health and safety | Younger children will probably need assistance pushing the metals into the fruit, alternatively you can use fruit juices or vinegar (much cheaper) – see Extras below. |
| How to… | Unless you've got a very acid lemon you'll need two joined together, so either lemon-lemon or orange-lemon would do, push the copper into one end of the fruit and the nail into the other and join everything up:  Make sure the wire from the copper goes to the long leg of the LED (called the anode, LEDs are a one way street they won't light if you try and push current the wrong way through) |
| Science | The galvanised nail (the metal is zinc) fizzes slowly and reacts with the acid juice in the lemon. This chemical reaction provides the energy that pushes the electric charges around the circuit, the charge can flow (electric current) if wires join up the two metals. With lemons and zinc nails you get about 0.8V and 10mA (milliamps) per lemon, adding a second lemon gives you about double that, enough to make you LED glow quite brightly. Using a metal more reactive than zinc e.g. magnesium and you can light your LED with a single lemon. |
| Extras | Switch to trying other household food acids – Vinegar, carton fruit juices, fizzy pop (works better once it's flat), coffee. You'll also notice that changing the area of the metals (electrodes) in contact with the liquid also makes a difference. |
| Curriculum Areas | Materials / Electricity |

# Experiment Cards: **Hero's Engine**

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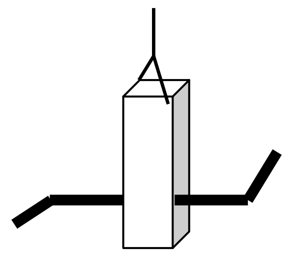
|---|---|
| Description | The earliest recorded example of jet propulsion in history. Hero's original design used steam. |
| Equipment | Juice carton, 2 bendy straws, string, scissors, plastic jug, paddling pool and water. |
| Health and safety | Suitable for all ages. Things do get wet. |
| How to… | Cut the top off the juice carton. Poke some holes into the carton, 2 at the top and 2 at the base, make sure the holes are on opposite sides and make the holes a tight fit for the straws. We tend to use a drill for the holes if we need to mass produce the cartons in advance.  For a longer lived engine you can stick the straws in with a glue gun. Tie a length of string to the top. Working in pairs, pour a jug full of water into the carton and hold the engine over the pool. |
| Science | The pull of gravity forces the water out of the straws. The bend in the straw pushes the water out horizontally. This creates an equal and opposite force pushing the straw and carton the other way. This pair of forces often gets called action and reaction and results from a science principle called 'conservation of momentum'. For primary pupils we often refer to this effect as push-push, to describe the pair of forces in action. With both straws bent the same way (see sketch above) these forces act together to make the carton spin. |
| Extras | There are many ways to extend this experiment into a longer project or investigation. See the additional sheets. |
| Curriculum Areas | Forces and Technology. |

# <u>Experiment Cards</u>: **Hero's Engine Project**

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|---|---|
| Background | Hero's Engine makes a brilliant science / technology project or investigation. It's very easy to change its design and see the effect, and it lends itself readily to 'What if ….?' questions that can be answered by the children themselves. |
| Ideas | Collect together plenty of juice cartons of different sizes, and plastic pop bottles especially those with long necks, so you have plenty of containers of different shapes and sizes.<br><br>Start with the basic 2 straw engine…<br><br>What happens when the straws face the same / opposite ways?<br>What happens if the straws are longer / shorter?<br><br>Try 4 straws… add 2 more holes and 2 more straws to the base<br>…more water…more push…?<br><br>The challenge is to design and build the fastest spinning engine…<br><br>What happens with a larger / smaller juice carton?<br>What happens if the container is a different shape?<br><br>…the ideal container is a long-necked plastic pop bottle upside down…why?....with the water reservoir being higher up, the water falls through a greater height and leaves the straws at a higher speed…this in turn creates a larger pushing force.<br><br>Try and design a Hero's engine to spin continuously…<br><br>Can you provide a continuous water supply?<br>How can you prevent the string winding tight and stopping the engine?<br>(pop to the fishing tackle shop and get some swivels, we also find that wool works better than string as it has more give). |
| Extras | It's handy to have a glue gun to fix the straws in the children's final designs. I'd recommend a cool melt gun, because it does not melt the straw plastic. Also useful is a low power drill / borer so you can readily make regular holes in pop bottles / cartons. We usually prepare the pop bottles / cartons in advance of the project and pare the bottom / top off the bottle with a craft knife. This minimises health and safety issues during any practical work. |

# A Brief History of Hero

- Hero was an Ancient Greek. An inventor, engineer and mathematician, who lived in Alexandria, now in modern day Egypt sometime between 10 and 80 AD.

- Like all good Ancient Greeks he had a beard. This image comes from a translation of one of his works published in 1688, by which time he had already been dead for over 1500 years!

- Hero (also called Heron of Alexandria) wrote extensively about the engineering techniques and machinery in use at the time, as well as inventing his own marvellous machines.

- His book ‘Pneumatics’ describes the workings of 80 different machines, all worked by water or steam. He also wrote and researched extensively into mechanics, pulleys, levers, gears and astronomy. Many of his original inventions have since been recreated as test pieces.

- Amongst many other machines was the first small steam engine, ‘Hero’s engine’, working on a jet propulsion principle. It was over 1500 years before anyone invented anything better.

- Fortunately much of Hero’s work was further developed by the later Arabic and Islamic cultures and their scientists and engineers were generally scrupulous in crediting ideas back to their Ancient Greek sources were appropriate. This makes it possible to trace the ongoing influences of such work in today’s cultures.

## Experiment Cards: **Hot Air Balloons**

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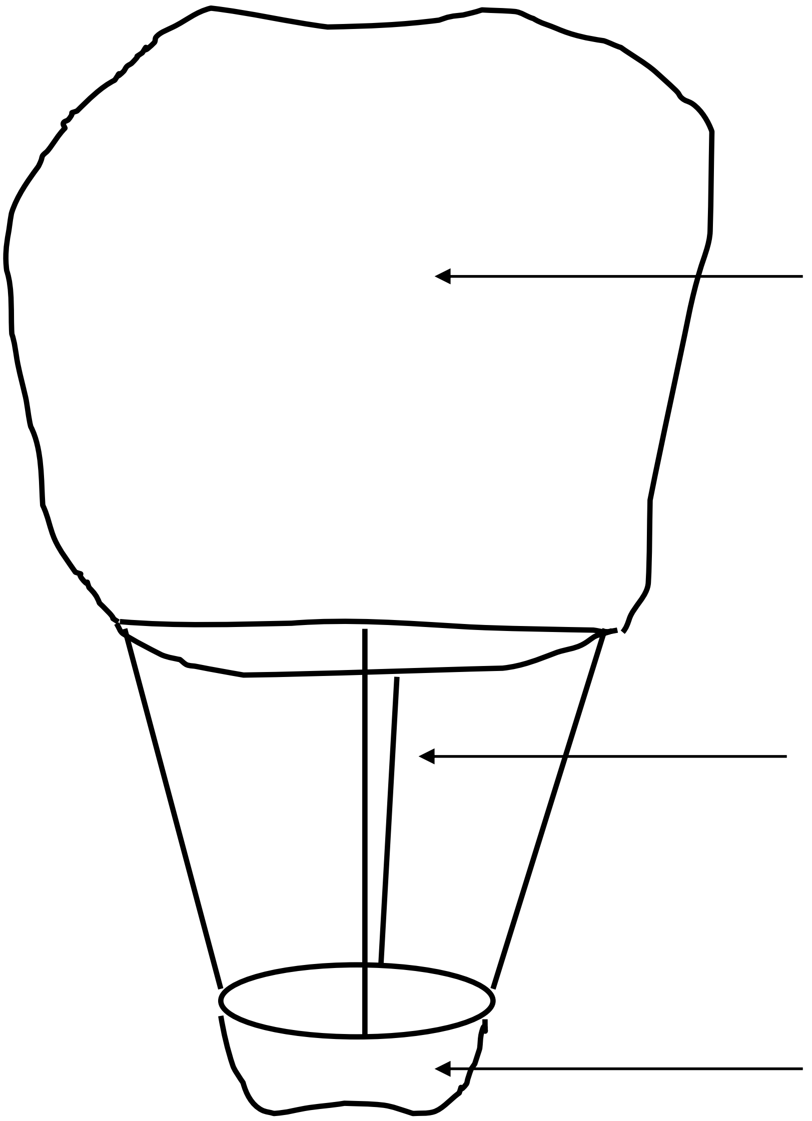
|---|---|
| Description | Make and test a model hot air balloon. |
| Equipment | 1 thin swing-bin liner, 1 small foil tray, sticky tape, thin copper wire, heat mat, dropper, methylated spirits, wooden tapers, lighter. |
| Health and safety | See the 'How to make a model Hot Air Balloon' sheet for details. Testing them is generally demonstration only, and practice before demonstrating. |
| How to… | See the 'How to make a model Hot Air Balloon' sheet for details. We recommend lighting the meths with a wooden taper rather than a match or lighter to avoid burning your fingers. |
| Science | Hot air balloons float and sink in the air. The upthrust depends on how hot the air is and how large the bag is. If the upthrust is greater than the weight, then the balloon will take off.<br>In fact the forces vary continuously throughout the flight. The upthrust varies as the temperature of the hot air changes and the weight reduces as the meths burns off. As the air cools, the upthrust drops, and the balloon returns to earth as the weight is now greater than the upthrust. |
| Extras | This makes a good challenge activity for a science club. Experiment with different sized bags and foil trays. Get the children to make them and then decorate with whiteboard markers. In fact they are very similar to Chinese fire lanterns, popular at weddings and barbecues.<br>Outdoors it's generally more successful if the balloon is re-designed to use solid fuel tablets. These burn for longer, but bear in mind that you will lose control of the balloon once it takes off into the sky! |
| Curriculum Areas | Forces - Floating and Sinking. |

## How to make a model Hot Air Balloon



Thin, ‘value’ swing bin liner. If the plastic is too thick then the bag is too heavy and the balloon won’t rise. If the bag is too small it traps insufficient hot air to create enough upthrust.

4 evenly arranged copper wires about 20cm long taped to the bag. This wire needs to be about 32swg – i.e. thin, it can be stripped from old cabling. Can also use light string, but this may catch fire!

Foil tray from a nightlight candle (best) or small tart dish / ashtray with 0.5 to 1ml meths in the tray. To fasten the wires poke a small hole in the rim of the tray with a pencil, loop the wire through and then twist it to fix.

**Operation Health and Safety**

1/. Design the balloon so that the foil tray is level.
2/. There should be a heat mat underneath when testing.
3/. Use 0.5 to 1.0ml of meths maximum, measured into the foil tray with a dropper. With practice you’ll be able to gauge exactly the amount of meths to use so that the fuel burns out just before it reaches the ceiling.
4/. Make sure the audience are a safe distance away, at least 2-3m from the launching area, and do not let the balloon fly over the audience heads’.
5/. Do not stand underneath the balloon once launched.
6/. Always have a skyhook (pole with a big hook on the end) ready to re-capture the balloon if necessary.
7/. Do not release the balloon in windy conditions, you’ll have better control if this is done indoors.
8/. This may trigger twitchy fire detectors in the area of the demonstration.
9/. Have a fire extinguisher handy just in case.

## Ballooning History

The basic idea behind hot air balloons has been around for a long time. Archimedes, one of the greatest mathematicians in Ancient Greece, figured out the principle of buoyancy more than 2,000 years ago, and may have conceived of flying machines lifted by the force. In the 13th century, the English scientist Roger Bacon and the German philosopher Albertus Magnus both proposed flying machines based on the principle but did not test out their ideas

Nothing really got off the ground until the summer of 1783, when the Montgolfier brothers sent a sheep, a duck and a chicken on an eight-minute flight over France. The two brothers, Joseph and Etienne, worked for their family's famous paper company. As a side project, they began experimenting with paper vessels lifted by heated air. Over the course of a couple years, they developed a hot air balloon very similar in design to the ones in use today. But instead of burning gas (propane), they powered their model by burning straw, manure and other material in an attached fire pit, initially thinking that the smoke was causing the upthrust (rather than the hot air).

A sheep, duck and chicken became the first balloon passengers on 19$^{th}$ Sept 1783, in the Montgolfiers' first demonstration flight for King Louis XVI. The sheep was chosen because at the time its respiratory system was believed to most closely match that of humans. It is worth noting that the 1780s saw the first experiments to identify oxygen and that little was known about the air and atmosphere at the time. Somewhat Ironically the King suggested that a pair of criminals be used instead, he was of course guillotined some 10 years later during the revolution. They all survived the trip, giving the onlookers assurance that human beings could breath the atmosphere at the higher elevation. Two months later, the Marquis Francois d'Arlandes, a major in the infantry, and Pilatre de Rozier, a physics professor, became the first human beings to fly in a hot air balloon.

Hot air balloons as a means of transport soon gave way to gas balloons, which had longer flight times and could be steered. Furthermore the death of Pilatre de Rozier in an attempted flight over the English Channel contributed to their decline. He had built a new balloon which included a smaller hydrogen balloon (yikes!) in addition to the hot air balloon envelope. The fire ignited the hydrogen early in the flight, and the entire balloon burst into flames.

# Experiment Cards: Jet Card

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|---|---|
| Description | Mini-boats (triangles of card) zoom around a tray of water. |
| Equipment | Bright coloured card, cotton buds, washing up liquid, tray, water. |
| Health and Safety | Suitable for all ages. |
| How to… | Cut some small triangles of card (about 0.5 to 1cm across), put the water into the tray and dip the cotton bud into a little washing up liquid, touch the cotton bud to the base of your triangle, drop it into the middle of the tray and watch it zoom. After about 10-15 attempts the water becomes saturated with washing up liquid and the boats are less effective. Empty the tray, refill with water and repeat. |
| Science | A simple observation would be that the washing up liquid pushes the card triangle along.<br>The full explanation is more complex…<br>Across the water is a force called surface tension, think of it as a stretched rubber sheet. The washing up liquid lowers the surface tension behind the card triangle. The card is then pulled forwards by the greater surface tension in front. As if someone had lifted up the rubber sheet behind the card.<br>The washing up liquid itself consists of large molecules with a water-loving (hydrophilic) and a water-hating (hydrophobic) end. The water-loving end is attracted to and soluble in water. The water-hating end is repelled by the water, but is also soluble in oils and fats, accounting for its degreasing properties. |
| Extras | To do this as a demonstration - best done on top of an old OHP in a glass dish.<br>Potential to extend in various ways…<br>Which card shapes work best?<br>Does it work with other things? - try rice krispies.<br>Are all brands of washing up liquid as good?<br>Would it work with a real boat…?<br>Try it with a dispersing oil (e.g. olbas oil) instead of washing up liquid. |
| Curriculum Areas | Forces and Materials. |

# Experiment Cards: **Ketchup Diver**

| | |
|---|---|
| Description | Homemade Cartesian diver. |
| Equipment | Large pop bottle, ketchup sachet, paperclips, water. |
| Health and safety | No issues, suitable for children. |
| How to… | Weight the ketchup sachet with paperclips so it just floats in water you probably about 0.5 to 1cm of the sachet showing above the water line. Do this before putting it into the bottle! Fill the bottle to the top with water, add the sachet and screw on the cap. Squeeze the bottle to make the sachet sink and let go to make it float. |
| Science | The ketchup sachet contains an air pocket, which gives it an upthrust in the water. With the paper clips attached the upthrust is just greater than the weight, so it floats. Squeezing the bottle squashes the water, which squashes the sachet, which squashes the air pocket into a smaller volume. This reduces the upthrust and the sachet sinks, because the weight is now greater than the upthrust. For more information on floating and sinking look up Archimedes Principle. |
| Extras | You may come across a few sachets with no air pockets at all, what happens then?<br>Try adding more sachets with differing numbers of paper clips, leave the bottle in a warm place and observe. This is then like a Galilean thermometer – the ones with the coloured shapes going up and down in the clear liquid. |
| Curriculum Areas | Forces, floating and sinking. |

# Experiment Cards: Marshmallow Puff

| | |
|---|---|
| Description | Making marshmallows inflate in a vacu-tub. |
| Equipment | Marshmallows, vacuum food container and pump (vacuvin brand works fine). |
| Health and Safety | Suitable for all ages. |
| How to… | Put the marshmallows in the tub and start pumping out the air. |
| Science | Pumping out some of the air makes a partial vacuum in the tub (removing all the air is beyond the ability of a humble vacuvin tub). Marshmallows are full of tiny air pockets from which the air cannot escape. The air inside the marshmallows pushes outwards with a larger force then the air left in the tub pushes inwards. The marshmallows swell up, until the forces balance.<br>Put simply air pressure results from the billions and billions of collisions the gas molecules make when colliding with surfaces. As there is more air inside the marshmallow than outside there are more collisions on the inside surface of the marshmallow than the outside. This pushes the marshmallow outwards and makes it swell up. |
| Extras | This experiment can be extended with other materials, see 'The Astronaut who Forgot his Spacesuit'. |
| Curriculum Areas | Would fit in with a topic on forces and also illustrates simple ideas about pressure when dealing with space, the atmosphere, or weather. |

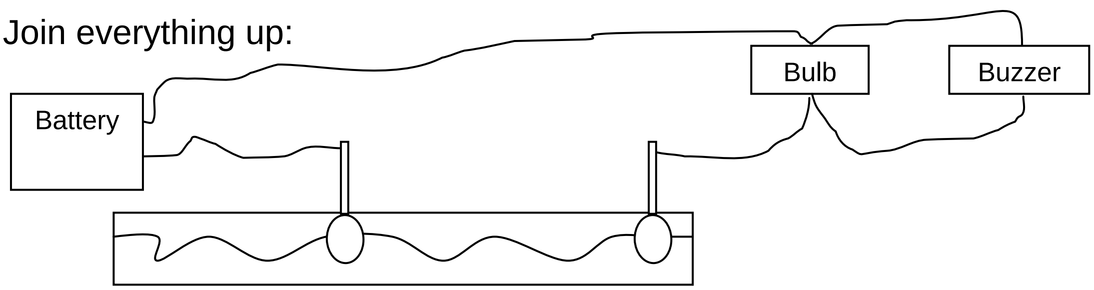
# Experiment Cards: Mentos and Coke

| | |
|---|---|
| Description | Mentos mints are dropped into diet cola, creating a fizz fountain. |
| Equipment | 1 bottle of diet coke (‘proper’ diet coke goes the highest so do this brand outdoors, other diet cola brands do not give the same fountain height), 1 pack of mentos mints, 1 mentos mint dispenser (see below to make your own), paddling pool (if you’re doing it indoors). |
| Health and safety | Messy and sticky, otherwise no known hazards. |
| How to… | You can make your own geyser tube with standard plastic waste piping, 21mm diameter is a great fit for a plastic pop bottle, chop off about 10 to 15cm and burr the end to go into the cola bottle, drill a hole across close to this end and fit a split pin. Load up with half a pack of mentos mints, push the tube into the neck of the freshly opened cola, pull out the split pin and step back. |
| Science | Mentos mints have a rough dimply surface that encourages bubbles of carbon dioxide to form rapidly on them. They sink quickly to the bottom of the bottle and the bubbles floating upwards cause even more bubbles to form in a ‘chain reaction’ effect, this causes the eruption. In particular diet coke and mentos have ingredients which seem to reduce the surface tension in the liquid causing a bigger eruption, though this part of the effect is not well understood. |
| Extras | Extend the investigation to test a wider variety of fizzy drinks, and for a more controlled investigation drop a spoonful of sand / rock salt into a glass each of different fizzy drinks, this will confirm that the rough mentos mint surface is the key to the effect. |
| Curriculum Areas | Changing Materials. |

# Experiment Cards: Pass the Cholera

| | |
|---|---|
| Description | A game to demonstrate how easily diseases are transmitted in untreated water. |
| Equipment | Plastic cups, pasta / rice / potato, water, plastic droppers, milk, iodine solution - this can be purchased from chemists often called tincture of iodine, or brought from a chemical supplier as a 1% solution, and then diluted down with tap water to make a 0.1% solution. At most you will need 100ml starch / iodine per class of 30. If you're going to be playing the game regularly then soluble starch powder can also be purchased cheaply from a chemical supplier. |
| Health and Safety | The iodine solution is diluted and antiseptic. At a concentration of 0.1%, it is considered very low hazard - in chemical terms a concentration of less than 0.01M. Consult CLEAPSS Hazcards for more information. |
| How to… | Boil up the pasta until it is really, really soggy and the water in the pan is a milky colour, this is the starch solution (you don't need much – 50 to 100ml is plenty). Pour out a little milk into the plastic cups about 50ml, and into 1 cup put half milk and half starch solution. The milk hides the starch from the participants. Introduce the game by explaining that one of the group has a dose of cholera, but we don't know who and we can't tell just by looking. Have the group walk around and when you call the swap they find a partner, mix the milk in one cup and then separate it again into both cups. Each time they do the swap they find a different partner. For a group of 30 you need to do about 4 or 5 milk swaps. They then test their milk by adding about 2ml of iodine solution using a dropper into their cup. Be careful that participants do not cross-contaminate by sharing droppers. |
| Science | Iodine solution turns blue-black when it detects starch and even though the starch solution is progressively diluted it still gives a strong colour change. Those participants who are lucky enough to escape contamination will have the iodine solution unchanged in colour (yellow-brown). With 4 changes you have a maximum of 16 contaminated people and 5 changes 32, however you will also get contaminated people swapping with other contaminated people, which reduces the amount of fresh infections. So for groups of 30 'ish' I would change 5 times and 20'ish' 4 times.<br>Any leftover iodine solution will keep indefinitely and starch solution will keep for several weeks before going off. |
| Extras | The game fits in well with work on water treatment and adds a historical angle as it can easily be related to the work of Dr John Snow and the famous '1854 Broad Street Cholera Outbreak' in London. This can also be used to illustrate how easily germs are spread when hands are not washed, or how readily sexually transmitted diseases can spread. |
| Curriculum Areas | Life Processes. |

# Experiment Cards: **Playing the spoons**

| | |
|---|---|
| Description | Brighter and dimmer with spoons and saltwater. |
| Equipment | 1 plastic bowl/trough, light bulb and holder, buzzer, battery (would recommend 6V lantern batteries for long life and durability), wires with clips, salt and water, two metal tablespoons. |
| Health and safety | Some children will get a tingle in the fingers when touching both spoons and the saltwater, this is a small electric shock. The advantage of this is that it leads nicely into the potential dangers of electricity in the home and elsewhere. |
| How to… | Join everything up:   Pour in the salt water, 200g salt per litre of water, (2kg salt per 10 litre bucket). Remember that typically buzzers are polar, they need to go the right way around to work – red to positive side of the battery. |
| Science | Moving the spoons closer together increases the flow of electricity around the circuit and makes the bulb brighter and the buzzer louder, a kind of homemade dimmer switch. You can add other devices as well e.g. a fan. |
| Extras | Leave the spoons in the saltwater for a while and you can notice some interesting changes, one spoon will fizz and the saltwater will slowly change colour. If you're using steel spoons the water goes a yellow/brown colour. The fizz is bubbles of oxygen and the colour change is rust. It's a good example to show electricity changing materials (called electrolysis). As the oxygen levels in the water drop the colour changes to green/black, because there are two types of rust, 'red rust' and 'black rust'. The black rust gets made when there is insufficient oxygen available (it's bubbled away), you'll have seen this before when someone empties a radiator out. The 'red rust' and the 'black rust' are simply the two types of iron oxide. (Chemical formulae $Fe_2O_3$ and FeO respectively) |
| Curriculum Areas | Materials / Electricity |

## Experiment Cards: Pop Rockets

| | |
|---|---|
| Description | Make plastic film canisters go pop by reacting different materials. |
| Equipment | Plastic film canisters + lids, vinegar, water, bicarbonate of soda, baking powder, health salts (e.g. alka seltzer), teaspoons, jugs. Plastic film canisters are getting harder to find, since most people now use digital cameras, but can still be sourced by asking at traditional photography shops. |
| Health and safety | Vinegar, bicarbonate of soda etc. are standard food ingredients and whilst not falling properly into the class of chemical irritants, they do sting if they get in the eyes. |
| How to… | About ½ fill a tub with vinegar and add ½ tsp of bicarbonate of soda. Have the lid ready in the other hand and snap it on cleanly. Take a step or two back from the table and wait. Depending on how tight the lid fits, the rocket will pop shortly … or wait a little longer. Compare with vinegar and baking powder (slower reaction, but just as good a pop) and water and alka seltzer (if you don't like smelling of vinegar). A key point to encourage is placing the tubs upside down as well as the right way up to see which makes the 'best rocket'. Rinse the tubs out with water after each go, to avoid getting them clogged up. |
| Science | Vinegar and bicarbonate of soda react to release carbon dioxide gas, which causes the fizz.<br>The thrust generated by a rocket depends on two things a) How fast you can push stuff out of the back and b) how heavy that stuff is.<br>With the tub upside down both the lid and all the contents are pushed out of the back, this generates more thrust than having just the lid pushed off by the expanding gases. Even though the canister weighs more than the lid it still makes a better rocket upside down. |
| Extras | If you can't find film canisters or fancy a change try using the plastic capsules from inside Kinder Eggs. |
| Curriculum Areas | Forces. |

# Experiment Cards: Sherbet Dips

| | |
|---|---|
| Description | Make your own fizzy sherbet. |
| Equipment | Icing sugar, bicarbonate of soda, tartaric acid (or citric acid – but it's easier to find tartaric acid in the shops), sieves, spoons, bowls, plastic cups, water, lollipops for dipping (optional). |
| Health and Safety | Citric acid and bicarbonate of soda are both food ingredients, but in pure powder form they are both mild irritants, so avoid eye contact and avoid inhalation of the powder. Usual hygiene procedures for food preparation should apply. If you are buying citric acid for sherbet dips from a chemical supplier make sure it is suitable for food use. For this reason you may well find that shop bought tartaric acid is a better alternative. |
| How to… | Prior to the sherbet making mix some bicarbonate of soda and the tartaric/citric acid together in a cup and react with water, pupils can see them fizzing.<br>Quantities are not critical and can be varied to taste: To a ¼ cup of icing sugar add 1 tsp of bicarbonate of soda and 1 tsp of tartaric/citric acid. Sieve them well together – unless you like the taste of bicarbonate of soda, pour them back into the cup, grab the lolly and away you dip. |
| Science | The tartaric / citric acid reacts with the bicarbonate of soda when they come into contact with saliva in the mouth. The two ingredients neutralise each other releasing bubbles of carbon dioxide, which is what causes the fizzing sensation. The icing sugar takes no part in the reaction, but serves to make the experience palatable. |
| Extras | Powdered food colourings can also be added to the sherbet mix, e.g. red beetroot powder and spinach powder are natural colourings that could be used. Turmeric also works, but the taste takes some getting used to! |
| Curriculum Areas | Changing Materials. |

# <u>Experiment Cards</u>: **Super Slime**

| | |
|---|---|
| Description | Make a 'self-siphoning' liquid slime. |
| Equipment | 11g polyethylene oxide (relative molecular mass 4,000,000, this is hard to get hold of – you could try your local secondary school science department - and not that cheap about £80 per 250g. We buy it from chemical supplier - Sigma Aldrich, but this quantity lasts us about 5 years!), 100ml isopropyl alcohol (also called propan-2-ol or just propanol, this can be purchased from an ordinary chemist, they usually sell it at 70% strength and this works fine), 1 litre water, food colouring (green seems to look best), 1 mixing bowl, 1 plastic 30cm ruler (to use as a stirrer). |
| Health and safety | Isopropyl alcohol is flammable and classed as an irritant. Handling polyethylene oxide poses no risks and hazards. |
| How to… | **Make it:**<br>Mix the polyethylene oxide into the isopropyl alcohol and stir well until you get a fine suspension, the polyethylene oxide does not dissolve.<br>Add the water to the bowl and the food colouring (as much or as little as you like). Start stirring the water with the ruler and slowly poor the polyethylene oxide into the water, it will thicken and gain a wallpaper paste like consistency. Keep stirring steadily for another 5 mins, stir it now and again over the next few hours and then leave it overnight covered with cling-film to allow the polyethylene oxide to fully hydrate. Pour it into a spare plastic pop bottle. It keeps for months and the isopropyl alcohol also helps to prevent fungal growth.<br>**Use it:**<br>Pour the slime into a transparent jug or beaker, gently start pouring it into a bowl and then bring the jug back towards upright. The slime continues to empty itself out of the jug. The slime can also be cut with a pair of scissors, best done near the top. In our experience children need to watch it several times before realising how bizarrely this slime behaves. |
| Science | The polyethylene oxide and water forms up into long polymer chains, giant molecules like long strands of spaghetti. It behaves like a siphon without a tube. To understand this put a long chain in a jug and start pulling it out. Once the weight of the chain outside the jug is greater than the length on the inside of the jug, gravity does the rest. |
| Extras | Demonstrate some other siphons… Why does an ordinary liquid need a tube to siphon?... Try siphoning fizzy pop, it won't work, why not? |
| Curriculum Areas | Changing Materials and Forces. |

# Experiment Cards: Upside Down Water 1

| | |
|---|---|
| Description | An upside down bottle of water with a card helping to hold the water inside. |
| Equipment | One pop bottle and square of card. |
| Health and Safety | Suitable for all ages. Best done outdoors, or over a paddling pool. |
| Tips | Fill the bottle with water, put the card on top. Turn it upside down holding the card in place. Then carefully take away your hand. Don’t squeeze the bottle as you hold it upside down. |
| Science | The weight of the water – the downward pull of gravity on the water – is balanced by the upward push of the air on the card. As the bottle is turned upside down the card sags a little under the weight of water. This makes a small vacuum inside the bottle. The pressure inside the bottle is less than the air pressure outside. This pressure difference is what stops the water coming out of the bottle. The card stops any air getting into the bottle, as long as there is a good seal around the edge. |
| Extras | Best done as the first in a sequence of 3 experiments. |

# <u>Experiment Cards</u>: **Upside Down Water 2**

| | |
|---|---|
| Description | An upside down bottle of water with a net keeping the water inside. |
| Equipment | One pop bottle and square of net, enough to cover the mouth of the bottle, rubber band. |
| Health and Safety | Suitable for all ages. Best done outdoors, or over a paddling pool. |
| Tips | Put the net on top and hold it in place with a rubber band. Fill the bottle with water and put your hand over the top. Turn it upside down and carefully slide away your hand. Don't squeeze the bottle as you hold it upside down. |
| Science | The weight of the water – the downward pull of gravity on the water – is balanced by the upward push of the air on the water. As the bottle is turned upside down the water sags through the net. This creates a small vacuum inside the bottle. The pressure inside the bottle is less than the air pressure outside. This pressure difference is what stops the water coming out of the bottle. It is surface tension that creates the 'skin' keeping the water in the bottle. Imagine each hole in the net having an invisible rubber sheet stretched over it. As the water starts to sag out of the hole, the rubber sheet stretches and tries to force the water back into the bottle. The surface tension is also sufficient to stop air bubbling into the bottle through the holes in the net. |
| Extras | Best done as the second in a sequence of 3 experiments. |

# Experiment Cards: Upside Down Water 3

| | |
|---|---|
| Description | A challenge to float cocktail sticks into an upside down bottle of water. |
| Equipment | One pop bottle and square of net, enough to cover the mouth of the bottle, rubber band, cocktail sticks. |
| Health and Safety | Suitable for all ages. Best done outdoors, or over a paddling pool. |
| Tips | Put the net on top of the bottle and hold it in place with the rubber band. Fill the bottle with water and put your hand over the top. Turn it upside down and carefully slide away your hand. Don’t squeeze the bottle as you hold it upside down.<br>Push a cocktail stick into the bottle, then another and another… see how many you can fit in. (Twist the stick gently as you push it in, as this stops it snagging on the net). |
| Science | See cards 1 and 2 for an explanation of why the net keeps the water in the bottle. The cocktail stick only breaks the surface in one hole and it is wide enough to plug that hole as it is pushed into the bottle. There is still enough surface tension across the other holes to keep the water in the bottle. As soon as the net is disturbed too much the surface tension is reduced, and out comes the water. |
| Extras | Best done as the third in a sequence of 3 experiments. |

# Experiment Cards: Vinegar and Bicarb rocket

| | |
|---|---|
| Description | This scales up the pop rocket experiments. |
| Equipment | One plastic drain pipe / wide cardboard tube about 1m long, pop bottle, vinegar, bicarbonate of soda, stopper (21mm rubber bung fits best), tissue paper, target (optional). |
| Health and safety | Vinegar, bicarbonate of soda etc. are all food ingredients and whilst not falling properly into the class of chemical irritants, they do sting if they get in the eyes. If the stopper is a tight fit then these rockets travel fast, so make sure any spectators are a safe distance back. For the rocket firer suggest apron and goggles. Worn out pop bottles will split not burst, which makes for an entertaining mess, but is nonetheless safe…they usually split around the neck of the bottle so check this carefully before loading up! You can buy kits which have an additional metal butterfly nut to further tighten the stopper into the neck of the pop bottle. Whilst these will go further and faster you will need to take extra care that no one gets struck by the butterfly nut zooming backwards at high speed. |
| How to… | Quantities are not critical … ¼ fill the pop bottle with vinegar, check the stopper gives a tight fit. Put a few teaspoons of bicarb onto the tissue and twist it into a sausage. Slide it into the bottle, put in the stopper and shake well. Slide it into the tube and step back. These can be fired upwards or horizontally. The advantage of firing them horizontally is that participants can clearly see the mixture being pushed backwards as well as the consequent forward motion of the rocket. |
| Science | Vinegar and bicarbonate of soda react to release carbon dioxide gas, which causes the fizz. The pressure in the bottle increases until the stopper is forced out of the bottle along with the contents.<br>The thrust generated by a rocket depends on two things a) how fast you can push stuff out of the back and b) how heavy that stuff is.<br>With a little experimentation you will soon arrive at the bottle, stopper and quantities to give you an ideal rocket. |
| Extras | You can also try using washing up liquid bottles with a flip cap and see the effect of having a smaller hole to push the mixture out of the back |
| Curriculum Areas | Forces. |

# Experiment Cards: **Water Rockets**

| | |
|---|---|
| Description | A plastic pop bottle blasts off under pressure with water and air. |
| Equipment | Pop bottle, cycle pump (or stirrup pump), water, safety barrier / some way of keeping spectators a safe distance back, and if indoors, a paddling pool and string to tether the rocket.<br>This can be bought as a kit, search the internet for the cheapest supplier, or you can make your own using a cycle pump, needle adapter and bored stopper. We use 21mm neoprene rubber stoppers, which give a perfect fit into the neck of a standard pop bottle, and it's a lot cheaper than buying a kit! You can also use a wine cork wrapped with some plastic insulating tape to get a tight fit. |
| Health and safety | Best to launch the rocket outside and keep spectators 3 metres away from the launch pad. The main risk is the rocket launching in an unexpected direction, which can happen if the person pumping suddenly yanks on the pump and pulls the rocket over. To avoid this always keep control of the rocket, we do this in 3 ways: 1/. By crouching next to the rocket and holding the pipe linking the pump and the rocket - this has the added benefit of getting you wet and giving the audience a good laugh - or 2/. Use an angled launcher to force the rocket in a particular direction, we use a cut down plastic drainpipe angled at $45^{o}$ – or 3/. Use the spike and retaining ring that usually comes with the kit, if you brought one.<br>We don't recommend air compressors or tyre inflators! …preferring hand pumps as it gives us more control…and keeps us fit! |
| How to… | About 1/3 fill the bottle with water, screw on the cap. Practice first with a 300ml pop bottle as the 2litre ones take a lot of pumping.<br>If you have a helper with the cycle pump, younger children can find it gets a bit hard going as the air pressure builds up. Keep an eye on the rocket to check you have air bubbles, as sometimes you can simply push water back and forth between the pump and the rocket. You can tie string to the rocket to be sure of retrieval and get an estimate of its altitude. |
| Science | The thrust generated by a rocket depends on two things a) how fast you can push stuff out of the back and b) how heavy that stuff is.<br>Compare the rocket with water and air, and with just air, if the stopper gets pushed out with the same force both times, the only difference is the water, which is heavier than the air. Experiment with different volumes of water to see which gives you the greatest thrust. |
| Extras | Afterwards work the pump to clear the water and squirt some WD40 into the cycle pump to stop it from going rusty. |
| Curriculum Areas | Forces. |

# Experiment Cards: **Whoosh Bottle**

| | |
|---|---|
| Description | An empty water bottle is filled with a small amount of meths and the mixture ignited to burn with a whoosh of flame. |
| Equipment | Empty water bottle (they're just less than 20 litres and the construction is rugged which is important here), methylated spirits, measuring jug / cylinder, wooden tapers and matches / lighter. Heat resistant surface to stand it on … metal table, tiles, heat mat etc. |
| Health and safety | If lighting a mix of meths vapour and air makes you nervous …this experiment has become a science standard in both primary and secondary schools and the experiment has been well covered by CLEAPPS (they spell it Woosh). Goggles advised, and only use a taper / other long lighter to light the bottle otherwise you'll burn your fingers. Some other fuels such as ethanol and propanol can be substituted – consult CLEAPPS for more details. After extended use the bottle can become cracked and the plastic crazed – don't use them in this weakened condition. |
| How to… | Add about 40ml meths to the bottle and sluice it around thoroughly inside the container. Invert the bottle and leave the meths to drain out for a couple of minutes. This will leave you with a few ml of meths and a container of air saturated with meths vapour. Stand the bottle upright on the table, light the taper and hold it over the neck of the bottle. |
| Science | The air in the bottle is saturated with meths vapour and these conditions are excellent for burning (combustion), i.e. the meths vapour is surrounded by just the right amount of oxygen. As the mixture catches fire, it heats rapidly and the gases expand, the burning gases are pushed out of the bottle at high speed. It is the gases moving at high speed that make the whooshing sound. The reaction is also quite temperature sensitive, compare the result on a cold and warm day. |
| Extras | The reaction generates a small amount of thrust. Just how small can be seen by standing the bottle on a balance and zeroing the balance before lighting the bottle. A reading of 100g would mean a thrust of 1N. |
| Curriculum Areas | Forces, Changing Materials. |

# Experiment Cards: **Rocket Project**

<table>
<tr><td>Background</td><td>Rockets makes for an excellent extended project around forces, space and materials, and it’s hard to beat for fun and motivation. Here the content and equipment aims it fairly and squarely at KS2, either in class, for a science club or as demonstration stuff for an open evening.</td></tr>
<tr><td>Ideas</td><td>Suggested staging of the practical work along these lines:
<table>
<tr><th>Activity</th><th>Notes</th></tr>
<tr><td>Balloon and Balloon on a wire</td><td>Introduction … why does the balloon move?... how can we make it move in a straight line?... demonstration of ‘action and reaction’ or ‘push-push’…real rockets don’t fly on wires… how can we make it move faster?</td></tr>
<tr><td>Air Rockets</td><td>…give it a larger push … introduce the idea of air resistance and streamlining …use a standard stomp or pump rocket launcher to have the children experiment with different shapes / fins / nose cones to achieve the longest range / highest altitude… but we can only push so hard with the air pump so…</td></tr>
<tr><td>Air and Water Rockets</td><td>… let’s throw something else out of the back… (it’s a good time to show Hero’s engine if they have never seen it before as it illustrates pushing water out of the back very nicely)…this time try air and water…experiment with different quantities of water and see which gives the largest thrust … combine the results of the work on streamlining with the work on water rockets to make the ideal rocket ‘high on thrust and low on air resistance’ …</td></tr>
<tr><td>Vinegar and Bicarb Pop Rockets</td><td>…let’s look at other ways of getting the rocket moving …investigate the reaction…try out the film canisters … which way up gives the best rocket?</td></tr>
<tr><td>Water and Health Salts and Kinder Grenades</td><td>…if you don’t like smelling of vinegar … and you can’t find any film canisters…</td></tr>
<tr><td>Vinegar and Bicarb Rockets</td><td>… let’s see if we can scale it up…</td></tr>
<tr><td>Whoosh Bottle</td><td>… real rockets don’t use vinegar and bicarb…</td></tr>
</table></td></tr>
<tr><td>Extras</td><td>See the individual experiment cards for further details.</td></tr>
</table>