SCIENCE CIRCUS AFRICA

Extraordinary Science with Ordinary Stuff

WORKSHOP BOOKLET

Australia Awards

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This booklet is compiled using the resources of:
Questacon – The National Science and Technology Centre, Australia
Centre for the Public Awareness of Science, The Australian National University
Dr Graham Walker, Science ShowOffs (www.scienceshowoffs.net)

Compiled and written by Graham Walker, Joe Duggan and Laura Shevlin at
The Australian National University.
Inquiries: g.walker@anu.edu.au / graham@scienceshowoffs.net

Introduction

Many students think science is something that happens in textbooks, which is sad because textbooks aren't much fun. The result is bored unmotivated students who don't learn as well – we need to make science learning fun and hands-on.

The aim of these activities is to provide an enjoyable, interactive way for students to discover science. Rather than just remembering things out of a book, the activities allow learners to experience science themselves. Students learn and remember best when they actually do things themselves, rather than just reading or being told about them.

The activities here can be used directly with students as class activities, or used as demonstrations by educators.

Please note though, that some of these activities are more dangerous than others. **Take extra care where CAUTION is noted. Some activities are not suitable for students to try themselves.**

This book contains a huge range of fun, curriculum-related science activities that can be done with everyday items – things that are either low-cost or free. Wherever we could, we selected activities that reuse the same materials so with the same collection of everyday items, there might be 5, 10 or even more different activities you can try.

As you will discover, you do not need a lab and fancy equipment to do engaging practical science.

How to use this book

We've tried to make this book as easy to use as possible. We've divided the book into three sections: Chemistry, Physics, and Engineering. In each section, you'll find sub-topics that align with Kenyan and Tanzanian curriculums. Each sub-topic has a heading like this:

Foundations

KENYA: FORM 1 (2.0.0, 4.0.0) TANZANIA: (P44)

In compiling these references, standard curriculum guides from Kenya and Tanzania have been used. These can be found as:

- Dihenga, H. (2011). Ordinary Level Secondary Education Chemistry Practicals. (Tanzania)
- Dihenga, H. (2011). Ordinary Level Secondary Education Physics Practicals. (Tanzania)
- Elimu. (2017). Chemistry Syllabus KCSE. [online] Available at: http://www.elimu.net/Secondary/Kenya/KCSE_Student/Chemistry/Chemistry.htm
- Elimu (2017). Physics Syllabus KCSE. [online] Available at: http://www.elimu.net/Secondary/Kenya/KCSE_Student/Physics/Physics.htm.

With this information, you should be able to quickly find how the experiments in this sub-topic relate to your curriculum. When you're planning lessons, you'll be able to come back to this and quickly find activities to use in the classroom.

Each experiment has a heading like this:

What fuels a candle?

STATES OF MATTER

The name of the experiment is first, and immediately below you will find the particular concept(s) that it demonstrates. Where possible, the experiments have been presented in a logical order, progressing in difficulty of concept.

Following this are sub-headings of: Materials, What to do, and What's happening? This contains both how to complete the experiment, and how to explain it to the class.

Extra Resources

If you'd like to dig a little deeper into any of the topics covered here, or to inspire your own experiments, we've compiled a list of internet resources you may like.

- General
  - https://www.stevespanglerscience.com/lab/experiments/
  - https://sciencebob.com/category/experiments/
  - https://www.exploratorium.edu/snacks
  - https://www.questacon.edu.au/outreach/programs/science-circus/activities
- Light
  - http://www.optics4kids.org/home/
  - https://www.nasa.gov/audience/foreducators/topnav/materials/listbytype/Optics.Guide.html
- Electricity
  - http://sciencewithkids.com/Experiments/Energy-Electricity-Experiments/energy-experiments.html

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Feedback

We would appreciate hearing how you use the book with your students in the classroom, or if you share it with other teachers. We would also welcome your suggestions for future content. If you need an activity for a particular curriculum area not contained in the book then feel free to contact us and we will be happy to assit.

PLEASE send pictures and any written comments to g.walker@anu.edu.au, WhatsApp +61 438 640 733 or post to our Facebook page "Science Circus Africa-Asia-Pacific".

Chemistry

Foundations

KENYA: FORM 1 (2.0.0, 4.0.0) TANZANIA: (P44)

What fuels a candle?

STATES OF MATTER

Materials:

- Candle
- Matches

What to do:

1. The candle is a marvelous way to see all three states of matter at once! Once a candle is burning well you see solid and liquid wax very easily – two states of matter at the same time. But where is the wax gas?
2. Extinguish the candle quickly between finger and thumb – you will notice a trail of vapour coming from the candle. Quickly bring a burning match over the candle about two centimetres above the wick in the vapour trail. The candle should immediately relight even though the match did not touch the wick.

What's happening?

Although the candle's wick burns, the main fuel in a candle is the wax. The heat of the flame causes the wax to melt – solid to liquid – and then boil – liquid to gas. It is wax gas that is the main thing burning in the candle flame. When you put out the flame, a trail of the hot wax vapour is still present in the air above the wick and it is this vapour that reignites.
This phenomenon is frequently responsible for bad accidents with petrol. A flame does not have to touch liquid petrol – if it touches the petrol vapour the whole lot can ignite. This is why smoking at a petrol station where we can smell the petrol vapour is very dangerous.

Imploding can – CAUTION heat

STATES OF MATTER, VOLUME-STATE RELATIONSHIPS

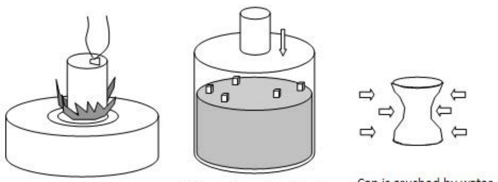
Materials*:*

- Camping stove, hotplate or fire
- Empty aluminium cans
- Tongs or thick gloves/oven mitt
- Water
- Shallow dish or bowl

What to do*:*

1. Place about 10ml of water into the aluminium can – just a small splash.
2. Wearing heavy gloves or using tongs, boil the can over the stove until you hear the water boiling and see steam coming rapidly out of the hole in the can. The can will get very hot – be careful!
3. **Quickly** invert the can into the dish of cold water – it should implode.

1:HTTP://WWW.ALL-SCIENCE-FAIR-PROJECTS.COM/PRINT_PROJECT_1290_150



What's happening?

As the water is heated it turns from a liquid (water) into a gas (steam) and it increases hugely in volume. When it's boiling rapidly, the whole can is full of steam. When we cool the steam quickly as the can is placed in the water, it turns back into liquid water and the volume decreases creating low pressure inside the can. Because the can is a sealed environment, the weight of the atmosphere – atmospheric pressure – pushes on the outside crushing the can.

Exploding can – CAUTION flammable liquids

STATES OF MATTER, VOLUME-STATE RELATIONSHIPS, COMBUSTION

Materials:

- Can
- Methylated spirits
- Drill or scissors to make a hole
- Tongs or thick gloves
- Disposable cup
- Candle and matches/lighter

What to do:

1. Put a small 5mm hole in the bottom of the can.
2. Pour a small amount of methylated spirits into the can, swirl it all around the sides, shake it a little (don't spill), then pour all the methylated spirits out the small hole or the top. Make sure there is no puddle of methylated spirits left.
3. Place a plastic cup upside down on top of the can
4. Ignite the methylated spirit vapour inside the can from the small hole underneath ensuring that the can is away from your body and the cup on top is pointing away from your face as it will shoot upwards.

What's happening?

When you rinse and shake the methylated spirits, which is about 95% ethanol, lots of it evaporates and fills the bottle with ethanol vapour. The ethanol vapour is very flammable because it is mixed with air/oxygen. When you ignite it, the ethanol burns rapidly creating hot gases in the chemical reaction. The hot gases produced have a greater volume than the ethanol gas you started with so the pressure inside the bottle increases, causing gas to shoot out of the opening at the top and push the cup into the air.

Acids and Bases

KENYA: FORMS 1 & 4 (3.0.0, 18.0.0) TANZANIA: (P78-83, 86-92, 97, 102)

Canister Rocket – CAUTION Flying Projectile

ACID-BASE REACTIONS, CHEMICAL REACTIONS, NEWTON'S 3RD LAW, PRESSURE

Materials:

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

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.
For upper secondary learners, the chemistry involved is as follows. 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 as water and a salt. The equations are shown below:

$$HC_2H_3O_2 + NaHCO_3 \dashrightarrow NaC_2H_3O_2 + H_2CO_3$$

Acetic acid (acid) + sodium bicarbonate (base) -- > sodium acetate (salt) + carbonic acid

The H_2CO_3 (carbonic acid) then breaks down into water and carbon dioxide:

$$H_2CO_3 \dashrightarrow H_2O + CO_2$$

Carbonic acid -- > water + carbon dioxide

Balloon Inflation

ACID-BASE REACTIONS, CHEMICAL REACTIONS

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?

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.

Lava Lamp

ACID-BASE REACTIONS, CHEMICAL REACTIONS, DENSITY

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.

2:HTTP://WWW.POC-SSA.COM/GALLERY/MAKE-YOUR-OWN-LAVA-LAMP.HTML

What's happening?

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.

Combustion

KENYA: FORM 1 (4.0.0)   TANZANIA: (P40)

Homemade Fire Extinguisher

COMBUSTION, CHEMICAL REACTIONS

Materials:

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

3: HTTPS://WWW.STEVESPANGLERSCIENCE.COM/LAB/EXPERIMENTS/CO2-EXTINGUISHER/

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 over the candles, 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. See the canister rocket activity above for the chemistry. This gas can be poured from the jug like water. CO_2 gas is more dense than air, so when it is poured from the jug, it covers 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.

Exploding Can – CAUTION Flammable Liquids

STATES OF MATTER, VOLUME-STATE RELATIONSHIPS, COMBUSTION - See entry above

Gases

KENYA: FORM 3 (12.0.0) TANZANIA: (P110-129)

Tea bag rocket

AIR DENSITY

Materials:

- Teabag with the tea emptied out
- Fireproof plate / surface that won't burn
- Matches

What to do:

1. Empty the tea out of the teabag by removing the staple, so you are left with a paper tube.
2. Rest the tube upright on the fireproof plate, so it is standing on end.
3. Carefully light the top end of the tea bag. As the paper burns down, the tea bag will float upwards

4: HTTPS://WWW.MADABOUTSCIENCE.COM.AU/SHOP/FREE-EXPERIMENTS/POST/TEA-BAG-ROCKET/

What's happening?

Hot air is less dense; therefore an amount of hot air is lighter than the same amount of cold air. As the tea bag burns down, the hot air produced by the flame circulates around the teabag and lifts the teabag upwards in the small column of hot air. Hot air balloons work on the principle of enclosing hot air.

Raising water

GAS TEMPERATURE/PRESSURE RELATIONSHIP

Materials:

- Tea light candle
- Plate
- Water
- Glass jar or soda bottle with top cut off

What to do:

1. Pour water onto the plate so that it is close to the rim
2. Light the candle and float in the middle of the plate.
3. Hold a jar or cut off soft-drink bottle over the candle so the air inside heats up, then put it all the way down into the water (you may need to hold the soft-drink bottle down to help create seal). What happens to the water?

What's happening?

The air inside the jar heats up over the candle. Once you put the jar all the way down, the candle extinguishes as it runs out of oxygen. The air inside the jar then cools down, contracts and creates a lower air pressure inside the bottle than outside. The comparatively high air pressure outside the jar then pushes water inside, causing the water level to rise (it is NOT due to oxygen being used up – it is replaced by CO_2).

Egg in a bottle

GAS TEMPERATURE/PRESSURE RELATIONSHIP

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

5: HTTPS://WWW.GREYCAPS.COM/THETEACHER/CLASSENGAGEMENT/EGG-IN-A-BOTTLE

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 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.

Imploding can – CAUTION heat

PRESSURE, STATES OF MATTER, VOLUME-STATE RELATIONSHIPS -See entry above

Exploding Can – CAUTION Flammable Liquids

PRESSURE, STATES OF MATTER, VOLUME-STATE RELATIONSHIPS, COMBUSTION -See entry above

Canister Rocket – CAUTION Flying Projectile

PRESSURE, ACID-BASE REACTIONS, CHEMICAL REACTIONS, NEWTON'S 3RD LAW - See entry above

Heat

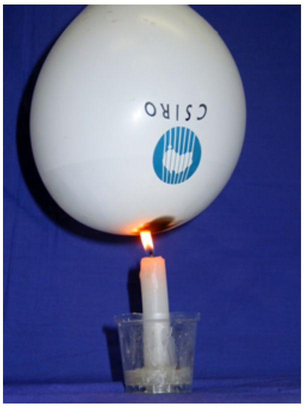
KENYA: FORM 1 (2.2.2) TANZANIA: (P166)

Burn-proof balloon

HEAT CAPACITY OF WATER

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?

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.

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.

Water

KENYA: FORMS 1 & 4 (5.0.0, 18.2.6, 23.2.3) TANZANIA: (P75-86)

Breaking Surface Tension

SURFACE TENSION

Materials

- Bowl of water
- Ground pepper or loose tea (dry grass cut very small also works)
- Toothpick or skewer
- Detergent

6: HTTP://WWW.INSTRUCTABLES.COM/ID/HOW-DISH-SOAP-WORKS-WATER-SURFACE-TENSION-EXPERIME/

What to do

1. Sprinkle pepper/tea/cut grass over the surface of the water.
2. Stick the toothpick into the detergent, then touch it to the surface of the water. What happens?
3. To repeat the experiment, the detergent will need to be thoroughly rinsed from the container.

What's happening?

Water has a high surface tension, which means that each molecule (or tiny piece) of water is very attracted to the water around it, and wants to 'hold on' tightly to the surrounding water. The surface tension of water is strong enough to hold the pepper on top of the water. Adding detergent to water lowers the surface tension making it 'stretchy', because part of the detergent molecule is very attracted to the water, and this interferes with the water's ability to hold tightly to itself.

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

Surface Tension Challenge

SURFACE TENSION

This experiment is nice to do as a challenge activity with groups of students.

Materials:

- Round coin approx. 2-3cm across
- Skewer, stick or dropper
- Cup of water
- Detergent

What to do:

1. Estimate (make a guess) how many drops of water you can fit on the coin.
2. Place the coin on a flat surface. Dip the skewer all the way into the water and use it to drip water onto the coin, 2-3 drops at a time. Count the drops.
3. Keep adding drops until the water overflows. How many drops fit on the coin? Look carefully at the shape of the water just before it overflows.
4. Dry the coin and mix two drops of detergent in the cup of water.
5. Estimate how many drops of the water and detergent mixture will fit on the coin and repeat steps 2-3. How many drops fit on the coin before the water and detergent overflows?

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

What's happening?

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

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

Physics

Energy

KENYA: FORM 3 (24.0.0) TANZANIA: FORM 1 (P40)

Two ball bounce

ENERGY TRANSFER, POTENTIAL/KINETIC ENERGY, CONSERVATION OF ENERGY

Materials

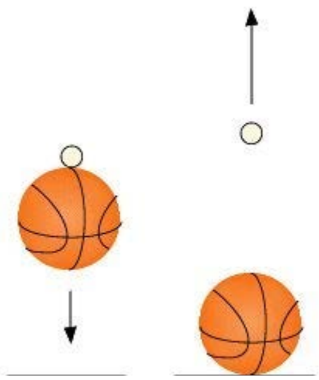
- Big ball – basketball or football
- Small ball – tennis ball
- Eggs (optional)

What to do

1. Hold the basketball at chest height from below.
2. With the other hand, hold the tennis ball directly on top of basketball.
3. Drop at the same time.
4. The tennis ball should shoot up quite high.
5. You can do the activity in a circle of students and let them catch the ball.

Optional: The same experiment can be repeated with an egg. If you like, a student who successfully catches an egg can keep it to eat.

6. Repeat as above, but substitute an egg for small ball. Hold the egg lengthwise with the fat end on the bottom
7. Drop at same time and make sure the students are ready to catch the egg. Take care with hazards and safety.



7: HTTP://WWW2.OBERLIN.EDU/PHYSICS/CATALOG/DEMONSTRATIONS/MECH/DOUBLEBOUNCE.HTML

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 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.

Pendulum of Peril

CONSERVATION OF ENERGY, POTENTIAL/KINETIC ENERGY

Materials

- Ball
- String (use thicker sting if it's a heavy ball)

What to do

1. Tie about 2m of string to the ball and hang from the ceiling or a tree. It should be hanging at about knee height.
2. Bring the ball right up to your nose in an arc so it touches and let go so it swings – don't move, and don't panic it will never hit your nose.

8: HTTPS://UCSCPHYSICSDEMO.WORDPRESS.COM/PHYSICS-5A6A/BOWLING-BALL-PENDULUM/

What's happening?

When you lift the ball from knee height up to your nose you increase its potential energy (stored energy). When you let the ball go the potential energy is converted into kinetic energy (moving energy) as the ball moves through the air. As the ball swings, some of its kinetic energy goes into pushing air out of the way and into friction with the air. This means as the ball swings back up it doesn't have as much kinetic energy, so will never make it back up to your nose.

Electricity

KENYA: FORMS 1, 3 & 4 (9.0.0, 10.0.0, 25.0.0, 34.0.0, 41.0.0) TANZANIA: FORM 2 & 4 (P62-72, 140-165, 181-194)

Ice Tray Battery

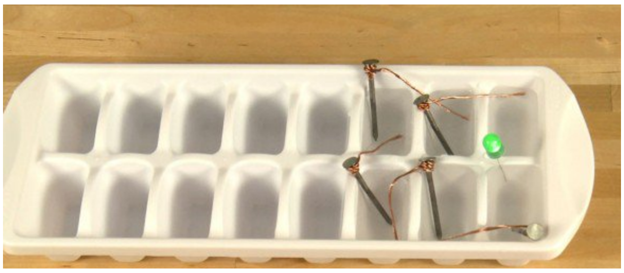
ELECTROCHEMISTRY, CIRCUITS

Materials

- White vinegar
- 5x 13 cm lengths of copper wire
- 5 zinc-coated (galvanized) nails, medium sized
- Plastic ice tray OR small cups
- 1 LED light OR volt/ammeter

What to do

1. Tightly wrap a piece of copper wire five times around a galvanized nail just under the head of the nail. Leave a tail of wire extending straight out from the nail about 8 cm.
2. Repeat Step 1 with the remaining four nails and four pieces of copper wire.
3. Fill six wells of an ice tray with distilled white vinegar, or arrange the small cups in a grid.
4. You'll create a circuit by placing each nail into one well of vinegar and making sure the copper wire is bent so that it goes into the vinegar in the next well. The wire is an electron bridge from one well into the next. Make sure the wire from one nail does NOT touch the nail or wire in any other well. There should be only vinegar between the metals in each well.
5. Place one "leg" of the LED into the well with only a copper wire inside it and place the other "leg" into the well with only a nail in it. If the bulb lights up, you did it! If the bulb doesn't light up, just lift the bulb out of the well, rotate it a half-turn to move the legs to the opposite well, and lower it back into the vinegar. It lights up! Alternatively, connect a volt or amp meter to show the current.



9: HTTPS://WWW.STEVESPANGLERSCIENCE.COM/LAB/EXPERIMENTS/ICE-TRAY-BATTERY/

What's happening?

The two metal components are electrodes. They're the sites in a battery where moving electrons (the current) enter and then leave the battery. With this vinegar, zinc, and copper set-up, the current will flow from the wire bridge (copper), across the vinegar, to the nail (zinc), and then along the bridge to the vinegar and… well, you get the idea. The electricity passes easily through the acidic solution of vinegar in the wells. Some liquids help this flow and some can stop it altogether. Once the Ice-Tray Battery is connected to the LED, you create a "complete" or closed circuit.

Super simple motor

ELECTROMAGNETISM, ELECTRIC MOTORS - See entry below

Magnets

KENYA: FORMS 2 & 4 (11.1.0, 16.0.0, 34.0.0, 35.0.0) TANZANIA: FORM 2 (P72-79)

Magnet not Magic

MAGNETIC ATTRACTION AND REPULSION

Materials

- 2 magnets
- Paper
- Staples (or other small iron items)

What to do

1. Put one magnet under the paper and the other magnet above it on top of the paper. Arrange with opposite poles are facing so the magnets attract.

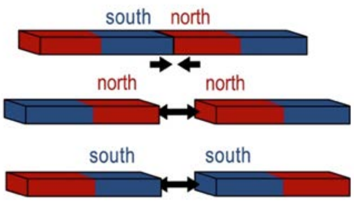
2. Move the magnet under the paper and the one on top will follow it – remember it's 'magnet' not 'magic'! If the magnets are weak, you will need to move it slowly.
3. Now flip the magnet on top over – does it still work?
4. Take the top magnet off and replace it with 10 or so staples. You will be able to make them move around too. Does it still move the staples if you turn the magnet up the other way?

What's happening?

This is a simple application of the science explained in the previous activity. When opposite poles are facing they attract and the top magnet will move around, but when like poles are facing they repel and the top magnet will not follow the bottom magnet's movement. The staples are attracted to either pole of the magnet, so will move regardless of whether the North or South pole is facing up.

Magnetic Fishing

MAGNETS, MAGNETIC MATERIALS, POLES, ATTRACTION AND REPULSION



Materials

- 2 magnets
- small items made from wood, aluminum, iron (nails, paperclips, etc.), paper, etc.
- stick
- 30cm string

What to do

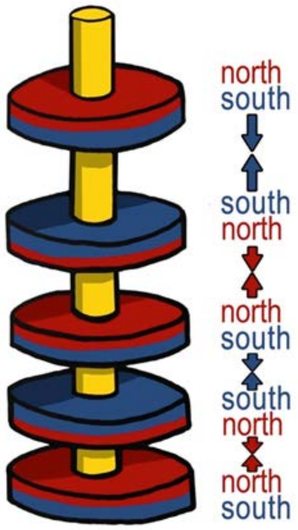
1. Tie the magnet to the end of the string. Try to tie it so one only one pole, north or south, of the magnet is hanging down if possible. You can find out which pole is which by playing with the two magnets.
2. Tie the other end of the string to the stick to make a 'magnetic fishing rod'.
3. Try to pick up the other items and the second magnet. Which end of the second magnet can you 'catch'?

What's happening?

The magnet has two poles – north and south. The opposite poles of a magnet attract (e.g. north attracts south) and the same poles repel. If you try to 'catch' the other magnet only the opposite pole will attract. With the other items, things containing iron (like a paperclip or nail) will be attracted to either pole of the rod magnet, but wood, aluminum, paper and many other things will not be attracted.

Repulsive Magnets

MAGNETIC REPULSION



Materials

- 5-10 magnets with holes (ring, flat with hole, etc.)
- Skewer or pencil, diameter a bit smaller than the hole
- Plasticine or something to make a base (optional)
- Marker pen

What to do

1. Lay the magnets out and use another magnet to test which pole is facing up – we want all the same poles facing up – e.g. they are all repelled by one side of the test magnet – so flip them where needed. Mark these sides/poles with the marker.
2. Thread the magnets onto the skewer/pencil so that the same poles are facing each other.
3. The magnets will now 'hover' if you hold the skewer/pencil upright, or push each other around if held horizontally.
4. You can make a base to hold it upright if you like. What happens if you push all the magnets down then let go?

What's happening?

Each side of the magnet has a different pole – North or South. Opposite poles pull together – they attract (e.g. South attracts North). The same poles push apart – they repel (e.g. North repels North). The magnets are arranged so they have the same poles facing each other, so they all repel. This holds the magnets apart. If you push them together the magnetic force pushes them apart again. You can feel this force when you move the magnets.

Floating Paper Clip

MAGNETIC FIELDS, MAGNETS ATTRACT IRON

Materials

- Magnet – strong works best
- Paperclips
- Light fishing line or cotton
- Scissors

What to do

1. Tie about 10cm of fishing line/cotton to the paperclip.
2. Keep the end of the fishing line on the table with your finger and pick the paperclip with the magnet.
3. Lift the paperclip into the air keeping the line tight.
4. Now move the magnet just slightly away from the paperclip – it will hover!

What's happening?

The magnetic field of a magnet extends beyond the actual magnet. The iron paperclip is attracted to the magnet and will stick, but when you move the magnet slightly away the paperclip is still attracted by the magnetic field surrounding the magnet, so is held in mid-air.

Compass

EARTH'S MAGNETIC FIELD, COMPASSES

Materials

- Magnet
- Paperclip
- Bottle lid
- Water
- Shallow dish or equivalent (we used an upside-down drink can)

What to do

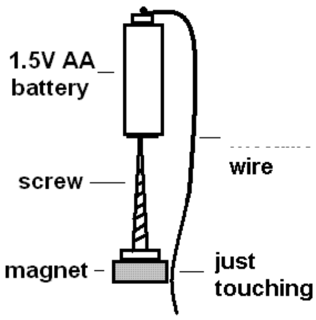
1. Straighten the paperclip out. Stoke the magnet from one end to the other <u>many times in one direction only</u>. The more times you stroke the better it will work – try 50!
2. Put a little water in the dish and float the bottle lid in it.
3. Place the paperclip wire on top of the lid. Does it rotate? If not try putting it on at a different angle.

What's happening?

You have just made a compass. When you stroke the paperclip it becomes magnetised. There are small areas in the paperclip that are already magnetic, but they are pointing different directions so they cancel each other out. Stroking the iron paperclip aligns the small magnetic areas so they all point the same way, turning the paperclip into a weak magnet. The magnetic paperclip wire turns until it is aligned with the Earth's magnetic field – our planet is actually a giant magnet. One end will point to magnetic North and the other to South. Floating the lid in the water allows it to rotate easily with hardly any friction.

Super simple motor

ELECTROMAGNETISM, ELECTRIC MOTORS



Materials

- Neodymium disc or cylinder-shaped magnets (strong magnets)
- Battery
- Electrical wire
- Screw

What to do

1. Strip 1-2cm insulation off both ends of the wire.
2. Attach the magnet to the head of the screw.
3. Attach the point of the screw to the negative end of the battery – it should be magnetically held so it hangs from the battery (or use a smaller screw).
4. Hold one end of the wire to the top (positive end) of the battery and lightly touch the magnet with the other end – it should begin to spin.

What's happening?

You've just created a simple electric motor. The motor is made from a magnet (on the bottom), a battery and a wire. When you put the wire in place, it completes an electrical circuit between the positive and negative ends of the battery. The electrical current flows through the wire and makes a magnetic field. This magnetic field is repelled by the magnetic field of the magnet. This produces a push on the magnet, causing it to spin. All electric motors, such as in a battery powered toy car, work in a similar way.

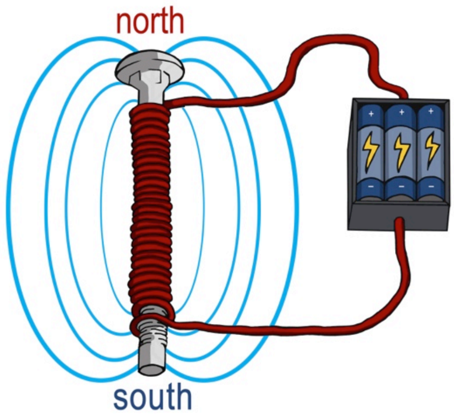
Electromagnet

ELECTROMAGNETISM

Materials

- Thick nail or bolt
- 50cm insulated electrical wire
- AA battery
- Paperclips, washers or other small steel objects
- Tape
- Magnet (optional)

What to do



1. Strip about 1cm of insulation off both ends of the wire
2. Wind the wire round and round the nail/bolt moving along the nail/bolt as you wrap. You may want to do more than one layer if you have enough wire (this will make a stronger electromagnet, but will use batteries faster). **Leave about 15cm on each end not wound on.** Tape to keep the wire in place.
3. Tape one wire to the end of the battery. Make sure there's a good connection.
4. To operate, hold the other piece of wire on the other end of the battery. Put the tip near a steel object – it should be attracted.
5. Optional – put your electromagnetic near a regular magnet. It will either repel or attract, depending on which way round the battery is, and which pole of the magnet is facing the electromagnet.

What's happening?

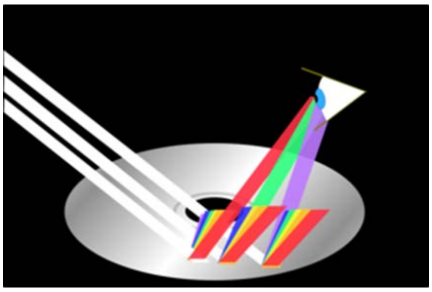
When you attach the wire, an electric current travels through the coil of wire wrapped around the bolt. This creates an electromagnet – the bolt becomes magnetic and can pick up things made of iron like the washer.
Like regular magnets, the electromagnet has a North and South pole. Opposite poles attract (e.g. South attracts North) and the same poles repel (e.g. North repels North). This is what causes the regular magnet to be attracted towards or repelled away from the electromagnet.

Light

KENYA: FORMS 1-3 (8.0.0, 15.0.0, 22.0.0) TANZANIA: FORMS 1 & 3 (P57-62, 99-108)

CD Spectrums

VISIBLE LIGHT SPECTRUM



Materials

- CD or DVD
- Sunlight

What to do

1. Find an area where direct sunlight is coming into a room.
2. Hold the CD so it reflects the light up onto the ceiling or a piece of paper. Wiggle the CD to change the pattern.

What's happening?

Sunlight or white light is made up of many different colours – we see them separately in a rainbow. When the sunlight hits the CD, the different colours are reflected at slightly different angles due to their different wavelengths. The different colours interfere and mix with each other, creating the swirling rainbow patterns you see reflected. For more details visit
http://www.thenakedscientists.com/HTML/experiments/exp/colours-in-cds/

Fountain of Light

LIGHT REFLECTION, TOTAL INTERNAL REFLECTION, FIBRE OPTICS

Materials

- Clear plastic bottle with label removed
- Duct tape
- Dark room
- Sink or bucket
- Thumbtack
- Corkscrew
- Flashlight/laser

HTTPS://WWW.THENAKEDSCIENTISTS.COM/GET-NAKED/EXPERIMENTS/WATER-FIBRE-OPTICS

What to do

1. Using the corkscrew/thumbtack make a small round (~5mm) hole in the side of the bottle near the base.
2. Put your finger over the hole and fill the bottle up with water.
3. Shine the torch through the bottle at the back of the hole. Try covering up some of the torch's light with tape to create a narrow beam of light (or use a laser pointer) for better results.
4. Remove your finger from the hole and move it down the stream of water.
5. How does the light enter the bottle and what does it do as it comes out of the hole in the side? Now place the tip of the corkscrew into the hole you already have made and turn it to make the hole a little larger. What do you see now? How about if you catch the water in another container like a bowl as it drains?

What's happening?

The light ray inside the stream of water behaves as it would inside an optical fibre. Optical fibres work like this: you send a light beam into one end of the fibre and it comes out the other end, just as light travels through the stream of water in your experiment. This is called total internal reflection. The light beam bounces around inside the fibre, reflecting back and forth off the walls. It doesn't pass through the walls and out of the fibre, and it doesn't stop until it comes out the far end.

Force

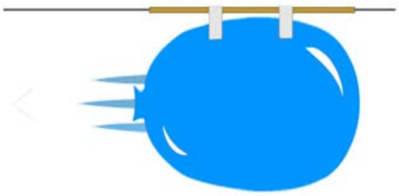
KENYA: FORM 1 (3.0.0) TANZANIA: FORM 1 (P36,42)

Rocket balloon

FORCES, NEWTON'S 3RD LAW OF MOTION

Materials

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



10: HTTP://SCIENCE4FUN.INFO/HOW-TO-MAKE-A-BALLOON-ROCKET/

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?

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.

Motion

KENYA: FORM 3 (21.1.0, 23.0.0)   TANZANIA: FORMS 2 & 3 (P79-88, 95-99)

Rocket balloon

FORCES, NEWTON'S 3RD LAW - See entry above

Canister Rocket – CAUTION Flying Projectile

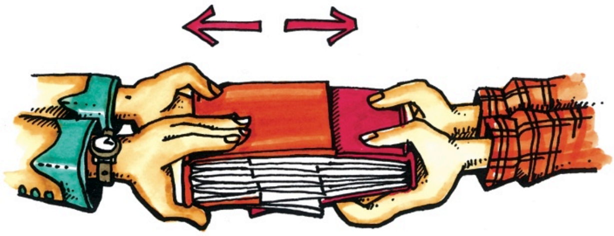
ACID-BASE REACTIONS, CHEMICAL REACTIONS, NEWTON'S 3RD LAW, PRESSURE - See entry above

Friction Books

FRICTION

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.

Pressure

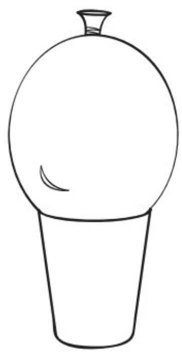
KENYA: FORMS 1 & 4 (4.0.0, 33.0.0)   TANZANIA: FORMS 1 & 3 (P46-57, 135-140)

Cups on a balloon

PRESSURE

Materials

- Plastic cup(s) and/or a coffee mug
- Balloon



11: HTTPS://WWW.SCIENCEWORLD.CA/RESOURCES/ACTIVITIES/BALLOON-AND-CUP-ATTRACTION-WINDBAG

What to do

1. Half inflate the balloon, then hold two cups on it and fully inflate. You may need someone to help hold things.
2. When you've blown the balloon right up, the cups should 'stick'.
3. A cool variation is to blow the balloon up on top of a mug, like in the diagram – you can actually pick up the heavy mug by the balloon!

What's happening?

When you blow up the balloon the surface expands, the balloon surface inside the cup flattens and some of the balloons volume is pulled out of the cup, which results in a greater volume of space inside the cup, but still the same amount of air. This leaves us with a lower air pressure inside the cup. This difference in pressure results in a force that presses the cup onto the balloon.

Upside-down water

ATMOSPHERIC PRESSURE, ADHESION

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?

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.

12: HTTP://COOLKIDSSCIENCE.COM/UPSIDE-DOWN-WATER-GLASS/

Upside-down water vs. Surface Tension

AIR PRESSURE, SURFACE TENSION

This experiment is a great one to follow the one above.

Materials

- Glass
- Rubber band
- Plastic mesh / flywire / mosquito mesh / mutton cloth
- 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?

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.

Cloud in a bottle

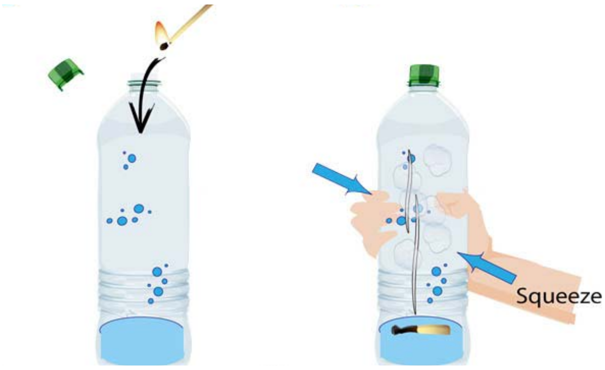
PRESSURE, TEMPERATURE, CLOUDS

Materials

- Large soft-drink bottle
- Matches
- Water

What to do

1. Put a teaspoonful of water in the soft drink bottle. Have the lid ready.
2. Light a match and let it get burning properly, then drop it into the bottle. The water will put it out.
3. <u>Quickly</u> screw the lid on tightly.
4. Squeeze the sealed bottle and then release the pressure suddenly. A cloud will form!



13: HTTP://WWW.THECRAZYSCIENTIST.COM/LOONEY-LAB/EXPERIMENTS-2/AMAZING-AIR/MAKING-CLOUDS-101/

What's happening?

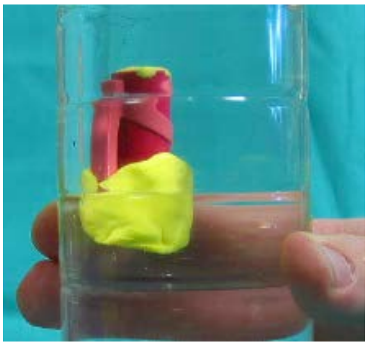
When you release the bottle very quickly, two things happen. There is a sudden increase in the *volume* of air and there is a *decrease* in temperature. This temperature change causes the water vapour in the air to condense and become visible – a cloud. The cloud will clear quickly but the experiment can be repeated several times.
The match is important. The burning produces small invisible carbon particles in the bottle and it is these small particles that act as points for the water vapour to condense on. This is the reason why fog is more likely to form in industrial areas where there are a lot of particles in the atmosphere.
Many students have misconceptions about clouds. They may not even know that clouds are water droplets. This experiment enables students to answer questions such as "Why are there clouds in some parts of the sky and not others?" because they understand it is a combination of pressure, temperature, and atmospheric dust and particles.

Pressure Powered Cartesian Diver

PRESSURE, FLOATING AND SINKING, BUOYANCY

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

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?

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.

Leaky Bottle

PRESSURE

Materials

- Soft-drink bottle
- Pin or thumb tack
- Water

What to do

1. Fill a soft-drink bottle completely with water and put the lid back on.
2. Make 4-8 holes at the same height 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?

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?

Bernoulli Cans

PRESSURE

Materials

- 2 empty soft drink cans

What to do

1. Arrange the cans side by side.
2. Blow between cans from about 30cm above – they should roll apart.
3. Place the cans side by side again and blow from as close as you can directly above – they should stay together.

What's happening?

This experiment shows Bernoulli's Principal – fast moving air has lower pressure. When you blow from 30cm above there is fast moving air all around the cans; some of this air pushes the cans apart. When you blow from very close, there is only fast-moving air between the cans and your face, creating a lower pressure in this area than on the outer sides of the cans. The higher pressure on the outer sides of the cans pushes them together.

Raising water

GAS TEMPERATURE/PRESSURE RELATIONSHIP - See entry above

Egg in a bottle

GAS TEMPERATURE/PRESSURE RELATIONSHIP - See entry above

Canister Rocket – CAUTION Flying Projectile

ACID-BASE REACTIONS, CHEMICAL REACTIONS, NEWTON'S 3RD LAW, PRESSURE - See entry above

Imploding can – CAUTION heat

PRESSURE, STATES OF MATTER, VOLUME-STATE RELATIONSHIPS - See entry above

Exploding Can – CAUTION Flammable Liquids

PRESSURE, STATES OF MATTER, VOLUME-STATE RELATIONSHIPS, COMBUSTION - See entry above

Sound and Waves

KENYA: FORMS 2 & 3 (18.0.0, 19.0.0, 26.0.0) TANZANIA: FORM 4 (P165-181)

Clucking cup

SOUND, VIBRATIONS

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.
7. What happens if you repeat the experiment with bigger containers (ice cream tub or bucket) 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

SOUND, VIBRATIONS, SOUND IN DIFFERENT MEDIUMS

Materials

- String
- Scissors/knife/drill to make a hole with
- Tin with top taken off (no sharp edges), 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?

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.

Musical Straws

SOUND, VIBRATIONS, FREQUENCY, PITCH

Materials

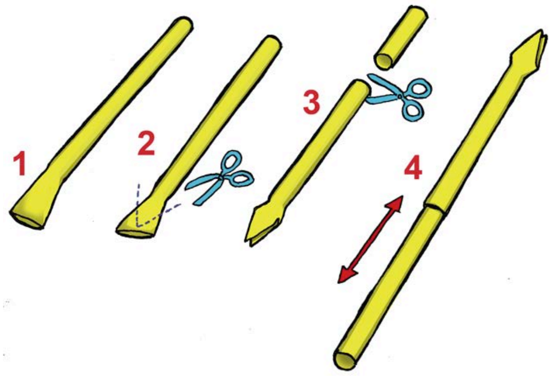
- Straws (note: don't share straws between students)
- Scissors

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!



5. 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 diagram 3). What happens?
   - Cut small holes in your straw like it was a flute. By covering and uncovering the holes, you can change the pitch.
   - Try sliding one straw into the other as you play, or making a longer straw (see diagram 4).

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 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 including many traditional African instruments work on this same principle.

Crying cans

SOUND, VIBRATIONS, AMPLIFICATION

Materials

- 2 soft drink cans
- A person with good lungs 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).
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.

Engineering

Strong structures

STRUCTURES, DISTRIBUTION OF FORCES

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?

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.

Balancing Nails

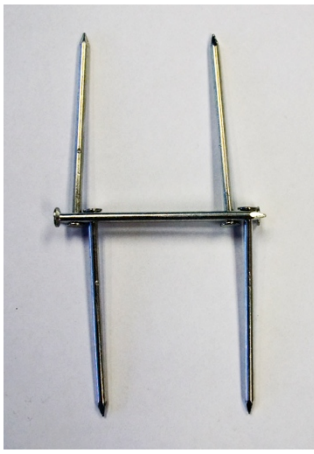
BALANCE, CENTRE OF MASS, TEAMWORK

Materials

- 6 flat head nails
- 1 flat head nail hammered into a piece of wood/plasticine as a stand

What to do

1. Can you balance the nails so all six are balancing on the stand without any touching the table?
2. Hint: to make them balance, you need the same weight on the left and right, and the front and back – see the pictures. If you think of the shape of a roof you might get a clue. *Remember the solution as it is tricky to build and the learners will need your help the first time.*



The image on the left is how to arrange the nails lying flat so they balance (image on right). Each nail is balanced by the nails opposite.

What's happening?

This activity is mainly about developing problem solving skills, however the solution relies on balance. To make the nails balance, you need the same weight on both left and right, and front and back. To get the same weight, each nail is arranged so it has another nail opposite to balance it. When this happens, the nails' *centre of mass* or balance point is actually in mid air below the middle of the horizontal nails (see X on picture) – above this point is where it will balance. The way the nails are arranged creates a structure that holds itself together as the nails hang.

Balance yourself and friends

BALANCE, CENTRE OF MASS

Materials

- 1-2 people
- Wall

What to do

1. Stand against a wall with your heels touching the wall. Now touch your toes.
2. Repeat standing back to back with a friend with your heels touching. Both touch your toes on the count of three.
3. Why doesn't it work? Observe someone touching their toes normally. What happens?

What's happening?

For something to balance, its *centre of mass* or balance point needs to be above its base. In a person that means the centre of mass – usually in line with the belly button halfway between belly and back – must be above the feet. When we touch our toes, our bottom sticks out one way to balance our head and shoulders going out the other way. In these experiments, your bottom couldn't move to balance the rest of the body, meaning your *centre of mass* wasn't above your base, so you can't balance.

Conclusion

If you've found this book useful, or have any suggestions, please let us know! We want this book to help you bring the best of science to your students, but we need your help to do it. Please speak to one of the fantastic workshop coordinators.

Feedback

We would appreciate hearing how you use the book with your students in the classroom, or if you share it with other teachers. We would also welcome your suggestions for future content. If you need an activity for a particular curriculum area not contained in the book then feel free to contact us and we will be happy to assist.

PLEASE send pictures and any written comments to g.walker@anu.edu.au, WhatsApp +61 438 640 733 or post to our Facebook page "Science Circus Africa-Asia-Pacific".

Notes:

This booklet was produced with support from the Australian Government via the Australia Awards Fellowships

Science Circus Africa is a partnership between the Australian National University and organisations throughout Africa. We acknowledge the friendship, partnership and enthusiasm of our partners in Kenya, Uganda and Tanzania:

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