Student Science Communicator Manual
February 2010

School of Life Sciences
University of the West of England, Bristol

Contents

Introduction

As a UWE Student Science Communicator you will be trained to deliver a range of entertaining and educational science demonstrations ('tricks') for use with public audiences. You will initially have the opportunity to perform these demonstrations at a variety of events including schools visits, UWE Open Days, National Science and Engineering Week and the Bristol Festival of Nature. We are also open to suggestion for other locations which might be appropriate, so feel free to utilise your creativity!

This document contains an outline of various demonstrations, including full instructions, list of ingredients, and explanations of how they work. It is designed to be used as a resource; you are recommended to review the document prior to each event you are involved in, to refresh your memory about how each demo works, and ensure you can explain each one clearly and simply.

Each demo is designed to be simple, entertaining, safe, and easy to perform in a public environment. A range of core scientific principles are covered, although it is not necessary to be a specialist in any of these areas in order to be student science communicator. Lots of enthusiasm, common sense, and an ability to communicate are all that is needed.

Best of luck, and remember: the main thing is for you and the people you are working with to enjoy yourselves!

Contact Details

- Event organisation will be managed by the Marketing & Communications team within the Faculty of Health and Life Sciences. Your main contact will be Justin Iriajen:

  email: Justin2.Iriajen@uwe.ac.uk

  telephone: 0117 32 83285

- Queries or questions relating specifically to the demonstrations or science communication more generally may be directed to Karen Bultitude within the Science Communication Unit:

  email: karen.bultitude@uwe.ac.uk

  telephone: 0117 328 2146

  mobile: 07775 998 005

Additionally, if you have any ideas of wider events that might be suitable for the Student Science Communicators to get involved in then do let Justin and/or Karen know – they are only too happy to support other initiatives if possible.

Benefits

As a Student Science Communicator you will receive:

- payment (standard ambassador hourly rates)
- professional training in communicating science to public audiences
- experience of communicating with a wide range of people
- excellent CV credit: team work, responsibility, communication skills, enthusiasm…
- opportunities to be involved in fun and exciting events!

Responsibilities

As a Student Science Communicator you will be responsible for:

- unpacking the equipment and setting up the demonstration area
- performing the demonstrations (taking regular breaks as appropriate)
- packing up after the event, including cleaning up the demonstration area and kit
- ensuring you wear your UWE t-shirt for each event
- submitting time sheets (and receipts where expenses have been incurred)
- minimising risks and hazards as outlined in the risk assessment (separate document)

Logistics

- Initial training sessions will provide an introduction to a range of suitable demonstrations. If you have ideas for other demonstrations then let Karen know.
- When an event approaches, you will be invited to participate via email. Please respond, indicating your availability. Please ensure you inform Justin Iriajen of any change to your contact details.
- For each specific event, one or two students will take on the role of Event Coordinator. They will be responsible for checking the equipment in advance (key available through Justin Iriajen) and purchasing any necessary consumables. The costs for these consumables will be reimbursed upon submission of receipts. The Event Coordinator will be paid for the extra time associated with the role, at the usual hourly rate. Please contact Justin Iriajen if you are interested in taking up this role.
- When you are performing demonstrations it is recommended that you take regular breaks in order to maintain your enthusiasm and energy. The length and frequency of the breaks will depend on the audience sizes and session lengths, so plan these in advance and discuss them with your colleagues. You will get paid for these breaks, although you will not get paid for the statutory lunch break (usually half an hour).
- If for some reason you can't attend an event you were scheduled to perform at, please let us know ASAP: contact Justin Iriajen and/or the Event Coordinator.

Tips and Advice

Some general tips about how best to prepare for your event:

- Rehearse with a small friendly audience, such as selected non-science trained relatives or friends.
- Think about the questions you are likely to be asked. One of the most rewarding parts of these kinds of events is how they trigger questions and enquiries.
- Come over as being enthusiastic and accessible.
- Avoid using scientific language – especially jargon – where possible. Stick to words and phrases that are familiar to your audience, and clearly explain new terms if you do have to use them.
- Try to see things from the audience's point of view.
- Enjoy yourself!

Performances

The demonstrations included in this document will all work well with public audiences of various sorts. However, a little thought about the order of the tricks, and careful selection of which ones are most appropriate to your venue and audience, will maximize the success of your event. One possible running order is outlined below for guidance. Of course this list is not prescriptive: adapt your own shows to reflect your venue, audience, and personal preferences.

Possible Running Order

1. Balloon Kebabs
2. Straw Oboes
3. Water-Proof Hanky
4. Celery Colour & Lettuce Sap
5. Banana Colour Change
6. Alka-Seltzer Rocket

Start with an attention-seeking demonstration – something visual or noisy usually works best. Targeting children first (using a demonstration that particularly appeals to them, such as balloon kebabs) is a very effective way of attracting an audience. The adults will drift along after the children to see what is happening.

Once you have a few people gathered, try to involve them. Walk amongst your audience and invite them to try some tricks. Straw Oboes and Water-Proof Hanky are good for this. Again, these tricks are highly visual/noisy so will assist in attracting a crowd.

You should now have an audience – who are probably wondering what strange and interesting things are going to happen next. You can now begin to perform demonstrations that require more attention and a closer inspection, e.g. Celery Colour & Lettuce Sap and Banana Colour Change.

Remember that your audience is likely to consist of very different age groups and backgrounds. So try to arrange the order of the tricks to cater for both adults and children. For example, the Celery Colour demonstration is fairly complex and needs time to work, so it's important that you show your audience what's happening by having a second pre-prepared set available. The 'yuck factor' aspect of the Banana Colour Change trick also keeps the audience's interest and maintains enthusiasm.

Finishing the show with a bang – literally! – will impress your audience and give them something to remember. You also want to use a trick that appeals to all age groups. The Alka-Seltzer rocket is the perfect finale in this respect.

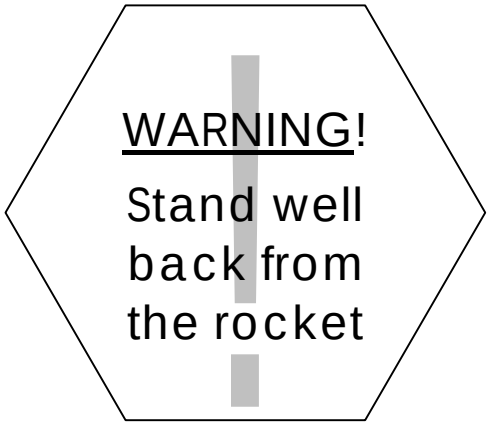
In a public venue you will most likely have a rolling audience, with people dropping in and out throughout the show. So keep the show short, fun and entertaining, and immediately start again from the beginning to keep the enthusiasm and audience interest alive.

Demonstrations

Full instructions, list of ingredients and scientific explanations are included for the following demonstrations. Prompt questions are also included, which you can use to encourage participation amongst your audience.

- Alka-Seltzer Rocket
- Straw Oboes
- Water-Proof Hanky
- Erupting Fizz
- Balloon Kebab
- Amazing Marshmallows
- Banana Colour Change (& D.I.Y. DNA)
- Celery Colour & Lettuce Sap
- Lifting Lemon
- Lemonade Lamp
- One in the Hand
- Music Box Amplifier
- Musical Coathangers
- Clucking Cups
- Silly Putty
- Cornflour Slime
- Magic Milk
- Balloon Bottom Burps
- Race to Digest

Alka-Seltzer Rocket



Ingredients

- empty film canister
- Alka-Seltzer tablet
- water

Instructions

1. Place the Alka-Seltzer tablet in the film canister.
2. Add ~1cm of water.
3. Fit the lid on the canister, making sure the seal is tight.
4. Turn the canister upside down and place it on a flat surface. Stand back!

Q: How does it work?

Q: What gas is produced; what general reaction is involved?

(Hint: look at the ingredients label on the Alka-Seltzer packet)

How does it work?

When the Alka-Seltzer tablet is added to the water, bubbles of gas are given off. When the lid is fitted tightly to the canister this gas is contained within an enclosed space. As more gas is given off the pressure inside the canister rises until there is enough force to overcome the seal of the lid. The built up pressure exerts enough force to shoot the canister into the air, forming the rocket.

What gas is produced; what reaction is involved?

The gas given off is carbon dioxide gas.

The main active ingredients in Alka-Seltzer are

- aspirin,
- sodium acetylsalicylate (an analgesic; a medication that reduces or eliminates pain),
- sodium citrate (an antacid; a substance that neutralises acids),
- sodium bicarbonate,
- citric acid.

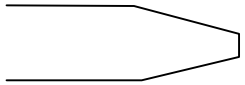
The sodium bicarbonate and citric acid don't react in the dry Alka-Seltzer tablet but when water is added they react in a standard acid + bicarbonate reaction:

sodium bicarbonate + citric acid → carbon dioxide (gas) + water + sodium citrate (salt)

Did You Know?

The Chinese began building chemically powered rockets as long ago as the 1150's. One of the great pioneers of modern rocketry, N. I. Kibaltchich was executed in 1881 after manufacturing the bomb that was used to assassinate Tsar Alexander II.

Straw Oboes



The tip of the straw oboe

Ingredients

- drinking straws
- scissors

Instructions

1. Flatten one end of the straw ~2cm from the end to the tip.
2. Make two cuts in the now flattened end of the straw, to form a triangular tip (see diagram).
3. Insert the triangular tip of the straw into your mouth. Grip the straw fairly tightly between your lips (not your teeth) and blow hard. You should hear a loud sound!

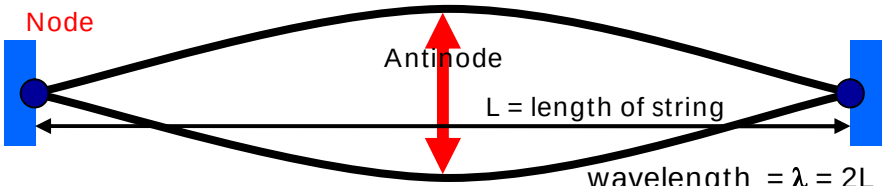
Q: How does it work?

Q: What do you think will happen to the note if you shorten the length of the straw? (try it out!)

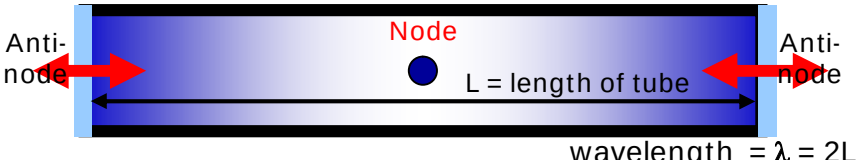
How does it work?

The flattened triangular tip acts like the reed found in some wind instruments. Blowing causes the cut ends of the straw to vibrate which in turn makes the air column in the straw vibrate. A standing wave pattern is created along the length of the straw, which we hear as sound.

Standing Wave on a String



Standing Wave in a Tube
~open at both ends~



What do you think will happen to the note if you shorten the length of the straw?

The note goes up! Why does this happen? As you shorten the straw (reduce the length L) you shorten the wavelength (λ) of the standing wave pattern and therefore increase the pitch of the note.

Did You Know?

As long ago as the fifth century BC Pythagoras and his followers were experimenting with standing waves and calculating the values of their harmonics.

Another way to set up a standing wave is to blow across the top of a glass bottle. In this case the note gets deeper as you drink (tune the instrument).

Water-Proof Hanky

Ingredients

- pint glass (must be fairly robust, i.e. not a disposable one)
- plastic plate
- water
- cloth handkerchief

Instructions

1. Push the centre of the handkerchief loosely into the glass, so that the edges are hanging over the outside of the rim of the glass.
2. Pour water into the glass, through the loose handkerchief. Keep pouring the water until the glass is roughly half full.
3. Pull the corners of the handkerchief so that the material is tightly stretched over the top of the glass, with no lumps or bumps. Hold the glass and handkerchief with one hand so that the material stays tightly stretched over the opening.
4. Place the plate on the top of the glass and tip it all upside down, being careful to keep the handkerchief pulled tight.
5. Say the magic words to make the handkerchief waterproof: ABRACADABRA!
6. Remove the plate and voila - the water stays inside the glass!

Q: How does the water stay inside the glass?

How does the water stay inside the glass?

This demonstration is based on surface tension and air pressure. When the handkerchief is loose, the water can pour through the gaps in the fabric. However, when the handkerchief is pulled tight, the water molecules can form a single surface or membrane across the handkerchief due to a property called surface tension.

The air surrounding us is exerting a force in all directions - air pressure. When the membrane is formed on the surface of the handkerchief, it provides a uniform surface for the air pressure to act upon. The force of the surrounding air acting upon this membrane is sufficient to overcome gravity, and so the water stays in the glass.

Did You Know?

Galileo was among the earliest to demonstrate the existence of surface tension on water by showing that an iron needle can be floated lengthways on water, but not on its point.

Erupting Fizz

Ingredients

- pint glass (any type of plastic that you can see through is fine)
- lemonade
- vegetable oil
- food colouring
- salt
- stirrer (e.g. a spoon)

Instructions

1. Half-fill the pint glass with lemonade.
2. Pour in vegetable oil until the glass is roughly 2/3 full.
3. Add a few drops of food colouring and stir the mixture – what happens?
4. Add approximately 2 tablespoons of salt to the liquid in one go and watch carefully!

Q: What happens?

Q: How does it work?

What happens?

- The oil forms a separate layer on top of the water.
- The food colouring will not mix with the oil; only the bottom layer becomes coloured.
- A huge fizzing eruption occurs when the salt is first added to the glass. Afterwards a 'lava lamp' style effect may be observed.

How does it work?

Water and oil do not mix; they are called immiscible liquids. Lager or other fizzy drinks are mainly made of water, so they will not mix with oil either. Water is more dense than oil therefore all the water will sink to the bottom of the glass, leaving a separate layer of oil on top. Food colouring is a water-based substance therefore it will only mix with the water layer, leaving the oil layer in the original colour. Sometimes small droplets of pure food colouring will get stuck in the oil layer, creating highly visible blobs, but they will not colour the oil layer.

Adding salt to a fizzy drink causes a release of large quantities of the carbon dioxide trapped within the drink, creating the highly visible eruption. After the initial reaction has slowed down you should be able to see salt crystals at the bottom of the glass – salt is more dense than water so sinks to the bottom. Pouring the salt into the liquid in one go also causes some oil (stuck around the salt crystals) to be dragged down into the water layer. As the salt dissolves in the water the oil is released, which rises back through the water layer, creating the lava lamp effect. Some air may also be trapped with the salt, which will also travel up through both layers of liquid.

Balloon Kebab

Ingredients

- balloons (& pump inflator if necessary)
- wooden kebab skewers

Instructions

1. Blow up the balloons (not full) and tie them off.
2. Make a 'balloon kebab' – insert the wooden skewer all the way through the balloon without popping it!

Q: What's the solution? (No, you don't need any other equipment!)

Q: How does this work?

What's the solution?

1. Start by lining up the skewer point with the darker patch on the balloon, opposite the tie end. Gently push the skewer through. You may find that a twisting motion works best.
2. Once the skewer is through one side, push it gently through the balloon until the point of the skewer is at the opposite end – the darker area around the tie.
3. Push the skewer tip gently through the soft part of the balloon where the tie is – again use the twisting motion if it helps. Voila – you have made a balloon kebab!

How does it work?

This trick works through an understanding of surface properties. A balloon is formed by inserting air into a flexible thin rubber sheet. Most of the balloon is stretched evenly, but there are two points where the rubber is least stretched with the lowest surface tension. These correspond to the tied section and the darker patch at the opposite side of the balloon – in fact the darker colour indicates that the balloon is less stretched over that region. Most of the balloon is under high tension, so attempting to push the skewer through just makes the balloon pop. But at the low tension sections it is possible to make a small hole without breaking the overall surface of the balloon.

Amazing Marshmallows

Ingredients

- marshmallows
- vacuum container + lid
- vacuum pump

Instructions

1. Add some fresh marshmallows to the vacuum container and place the lid on top.
2. Place the vacuum pump over the stopper in the vacuum container lid.
3. Pump the vacuum pump a few times and watch the marshmallows – you may need to shake the container gently up and down to evenly distribute the marshmallows, then pump again. Repeat until the pump becomes difficult to operate.
4. Remove the vacuum pump and place your finger and thumb on the valve of the stopper (where it says 'press here'). Have a countdown with your audience and watch the marshmallows carefully as you press the valve!

Q: What happened to the marshmallows?

Q: How does this work?

Note: you will need to replace the marshmallows fairly often, when they dry out or become over-stretched. It's usually best to have a fresh packet for each day of activities.

What happened to the marshmallows?

Using the vacuum pump caused the marshmallows to grow (expand). When the valve was released the marshmallows quickly shrunk back to their original size.

How does it work?

The vacuum pump removes the air from inside the container, thereby reducing the pressure.

Marshmallows have small bubbles of air trapped inside them. These bubbles are at atmospheric pressure. When the air inside the container is removed the pressure is reduced. The air bubbles inside the marshmallows are therefore at a much higher pressure than the air surrounding the marshmallows, so those bubbles push outwards, causing the marshmallows to expand. When air is let back into the container, the surrounding pressure increases again, and the marshmallows squash back to their normal size.

Did You Know?

Although aircraft cabins are pressurised, they are not kept at sea level pressure. A similar effect to the marshmallow experiment can be observed by drinking half a bottle of water during a flight. When the aircraft lands you will see that the sealed plastic bottle is slightly crushed by the higher atmospheric pressure. This will happen at about the same time as your ears pop on the approach to landing.

Banana Colour Change

Note: This demonstration can only be performed in venues where power facilities are available. If electrical power is not available then this demonstration may be approximated by mashing a banana in a bowl with a fork: within minutes it will turn noticeably brown.

Ingredients – Banana Colour Change

- bananas
- water
- food processor + power extension cord

Instructions – Banana Colour Change

1. In advance: Partly peel a banana and leave it on the side. Compare it with a fresh banana, especially the colouring.
2. Put the fresh banana (with skin and everything) into the blender. Add some water so there is a layer of a couple of centimetres.
3. Switch on the blender till the banana has been completely homogenised.
4. Hold up the container so the audience can see the banana mixture go from yellow to brown (takes about 30 seconds).

Q: Why are bananas yellow? Q: What happens when they turn brown?

Why are bananas yellow? Why do they turn brown?

There is a chemical (colouring) within the banana known as a pigment. If you leave a banana it will go brown because the pigment is reacting with oxygen in the air and creating a brown chemical known as melanin. Technically, the banana pigment is reduced i.e. oxygen is added to the banana pigment molecule to make a new chemical called melanin.

This process may be speeded up by blending the banana: the smaller pieces of banana mix together and react with the oxygen in the air very quickly. This is why the blended banana changed colour much faster than one that is left on the side. By blending the banana (or, to describe the process more scientifically, by homogenising it), the surface area was increased. This meant that the oxygen can more easily reach the pigment molecules (compared to when only the outside surface of the banana is available), so the reaction is speeded up.

Did You Know?

Banana and humans share about 50% of the same genes!

D.I.Y. DNA

The next demo can either follow the Banana Colour Change demo, or be done on its own.

D.I.Y. DNA

Ingredients – Banana Colour Change

- Bananas
- Water
- Washing up liquid
- Methylated spirit or methanol

Instructions – DIY DNA

1. Into a small (~10cc) beaker place ~3ml of blended banana mixture, or better still mash up a 4-5mm thick slice of banana with a fork, in the beaker, adding some water at the end.
2. Add a generous squirt of washing up liquid to the mixture, and stir well.
3. Finally carefully float a 3-4mm layer of methylated spirit or methanol on top of the mixture.
4. Observe what forms in the alcohol layer, take samples onto matchsticks and distribute them to the audience for them to feel the texture.

Tip: More DNA seems to clump when mashing up the banana rather than blending it.

Tip: Use a washing up liquid that has a strange colour like green or blue… avoid yellow, else the DNA will not be so conspicuous.

Q: What is DNA? Q: What is happening? Q: Why use soap and alcohol?

What is DNA? What is happening? Why use soap and alcohol?

DNA (deoxyribonucleic acid) is found in all living things. It is sometimes called "the book of life." The 4 bases (Adenine, Guanine, Cytosine, Thymine) usually referred to by their initials, are the letters of the alphabet for "the book of life," and they form 3 letter words. Each word stands for an ingredient, as the book of life is like a cookery book for the cells.

Mashing up the banana breaks some of the cells free from each other, while the soap breaks them open. The cells have an outer layer/skin of fat; soap attacks fat, so the contents of the cells (including DNA) are released into the mixture. DNA is hydrophobic (i.e. hates water), so when the alcohol is added to the mixture, the DNA strands move towards the alcohol, and clump together.

The DNA strands should have a stringy gritty texture, like wet cotton wool. This is because the DNA strands are like long fine threads.

The resulting DNA strands can be processed further by adding pineapple juice or meat tenderiser to get rid of the proteins around which DNA is twisted.

Did You Know?

This procedure can be carried out at home using Gin or Vodka instead of Methylated Spirit… in this case it might take longer for the result to become apparent. DO NOT DRINK THE RESULTING MIXTURE!

Note: A helper from the audience is always a good idea, especially if they are children, keen on cooking, or very keen on seeing DNA. If you find too many volunteers, get them to do a step each.

Celery Colour & Lettuce Sap

NOTE: The celery demonstration needs to be set up in advance.

Ingredients

- celery
- food colouring
- 2 beakers
- Romaine lettuce

Instructions

1. Half fill each beaker with water and add a few drops of (different) food colouring to each.
2. Split the stem of a stalk of celery from the base until approximately half-way up the stalk. Place each half into a different beaker of coloured water.
3. After about half an hour the demonstration should be ready to show the audience: the leaves of the celery will have turned different colours. Pass the celery stalk around the audience and invite them to break it open and see the coloured channels inside the celery stalk.
4. Take the Romaine lettuce and break the leaves. Pass them around the audience, instructing them to look closely at the white substance coming out of the stem.

Q: Why do the celery leaves change colours?

Q: What is the white substance coming out of the lettuce?

Why do the celery leaves change colours?

Just like an animal body, plants need a way to transport chemicals around the plant. Whereas animals drink, the plant sucks up water from the soil, much in the same way you can use a drinking straw to do the same.

The water passes through vessels within the celery called xylem. Breaking the celery stalk open allows the audience to see the coloured xylem (the channels) directly. The leaves change colour because the coloured water in the beaker has been sucked up through the celery by these xylem.

What is the white substance coming out of the lettuce?

The white substance is sap, which contains sugars and starches which are important for the plant. The vessels which contain the sap are known as the phloem. They carry the plant's food (the sap) around the plant.

Did You Know?

Plants are very important medically. A good example is Aspirin, which is found in the bark of the Willow, and was chewed in Roman times to fight fever and sickness. It is now the most used drug in the world.

Lifting Lemon

Ingredients

- slice of lemon
- matches
- pint glass
- shallow bowl / plate or ashtray
- water

Instructions

1. Pour water into the ashtray until the water is ~1cm deep.
2. Push three matchsticks into the slice of lemon, in the shape of a triangular pyramid, with the match heads together at the top point of the pyramid.
3. Place the lemon and matchsticks in the centre of the ashtray, so that they float on the water.
4. Use a fourth match to light the three in the lemon.
5. Invert the pint glass over the lemon and matches, letting it sit inside the ashtray.

Q: What happens? Q: How does it work?

(Hint: There are TWO correct answers!)

What happens?

The water level inside the pint glass greatly increases, lifting the lemon with it.

How does it work?

Firstly, there is a simple air pressure effect caused by the expansion and contraction of the gas within the pint glass as it heats up and cools down. The heat from the three matches causes the air inside the pint glass to get hot. When all the oxygen within the glass is exhausted, the matches go out and the air inside the glass cools down. The cooler air takes up much less space, so water gets sucked up into the glass to take up that extra volume.

Secondly, the combustion reaction affects the volume of gas within the glass. When the matches burn they consume the oxygen from the air within the pint glass. The products of this reaction are carbon dioxide and water. The water will be a liquid, thus there will be less gas in the glass, causing the water to be sucked up into the glass to fill the volume

Did You Know?

This demonstration is based on the methodology used by Joseph Priestley to demonstrate that oxygen is a component of atmospheric air, and to estimate the proportion of oxygen in the air.

Lemonade Lamp

Ingredients

- lemonade
- raisins
- pint glass
- stirrer (spoon or similar)

Instructions

1. Pour lemonade into the glass until it is roughly 3/4 full.
2. Drop in a small handful of raisins.
3. Watch carefully!

(Hint: It may help to stir the lemonade a little. Also, don't use stale lemonade; it must be fresh.)

Q: What gas is inside fizzy drinks like lemonade?

Q: What happens? Q: How does it work?

What gas is inside fizzy drinks like lemonade?

Carbon dioxide (CO_2)

What happens?

Some of the raisins gradually float up to the surface of the liquid, then sink back down, and repeat the process over and over again.

How does it work?

This effect relies on the gas contained within the fizzy drink. Raisins have rough surfaces; ideal for bubbles to form on. The longer they stay still, the larger the bubbles of CO_2 that will accumulate. Eventually the bubbles will be large enough to provide enough buoyancy to counter the weight of the raisins and lift them off the bottom of the glass. When they get to the top, the bubbles burst, removing the buoyancy from the raisins, causing them to fall back to the bottom of the glass

Did You Know?

This demonstration has been in use for several centuries and was very popular at Versaille where a single raisin would be dropped into a flute of champagne and would then bob up and down all afternoon.

Music Box Amplifier

Ingredients

- music box
- large table

Instructions

1. Hold the music box in your hand and turn the handle. Can you tell what song it is playing? How easy or difficult is it to hear the sound?
2. Try placing the music box directly onto the large table and then turning the handle.

Q: When can you hear the music box better – in the air or on the table?

Q: How does this work?

When can you hear the music box better – in the air or on the table?

It is much easier to hear the music box when it is in contact with the table.

How does this work?

Winding the handle of the music box causes small metal 'keys' to vibrate, which creates sound. When you hold the music box in your hand then only the music box itself is vibrating, and so the sound is very quiet. However, when you put the music box in contact with a solid object, such as a table, then that object will also vibrate. The table has a much larger surface area so acts as an amplifier. So you can hear the tune much better when the music box is in contact with the table.

Did You Know?

This is the reason why traditional stringed instruments (guitars, violins, pianos etc.) tend to have a lot of wood on them: the wood acts as a 'sounding board' to amplify the notes produced by plucking or hitting the strings of the instrument. Without all the wood on a piano we would hardly hear a thing.

Musical Coathangers

Ingredients

- Wire coathangers
- String
- Metal object (e.g. a spoon or pair of scissors)
- A friend

Instructions

1. Tie a piece of string to each corner of the coathanger.
2. Wrap the other end of each string to the index finger of each hand.
3. Hold the coathanger so that it can swing freely out in front of you. Get someone else to tap on it with the metal object. What do you hear?
4. Lean over and (carefully!) place the fingers with the string round them into your ears. Let the coathanger swing freely.
5. Get someone else to tap the coathanger with the metal object. What do you hear now?

Q: What do you hear?

Q: How does this work?

What do you hear?

When the coathanger is held out in front of you there is a slight sound, but nothing very impressive. However, when you repeat the experiment with your fingers in your ears then you will hear a very loud sound which lasts for much longer.

How does this work?

When the metal object hit the coathanger it caused vibrations within the coathanger. When the coathanger is held out in front of you then the only way the sound can really get to your ears is through the air. Sound doesn't travel very well through air, so you don't hear it very well. When you put your fingers in your ears there is a direct (solid) path from the coathanger to your ears. Sound can travel much more easily through solids so you hear it much better.

Did you know?

Different people hear different sounds during this demonstration. Some people think they hear a bell, others hear chimes or a bass drum. It all depends on how much space you have between your ears as to what notes resonate best inside your head!

Clucking Cups

Ingredients

Plastic cup with string attached to the base

piece of cloth

water spray

Instructions

1. Spray a small amount of water onto your piece of cloth to make it damp.
2. Grasp your plastic cup in one hand, and wrap your piece of cloth around the string with the other hand.
3. Draw your cloth down the string, holding the string fairly firmly all the while.

Q: What happens?

Q: How does it work?

What happens?

A loud ‘clucking’ noise is heard!

How does it work?

Drawing the cloth down the length of string causes vibrations to be set up along the string. These vibrations produce sound. Without the cup the sound produced is very quiet so we wouldn’t hear it. By placing the cup at the end of the string we create an amplifier because the cup has a much larger surface area than the string. The larger the surface area the louder the sound that is created, and we can then hear the ‘clucking’ noise.

Did you know?

You can also perform this demonstration on a larger scale with a bucket and a rope – a ‘mooing bucket’!

Silly Putty

Ingredients

Silly Putty

Instructions

Use your imagination to test the properties of Silly Putty:

Does it bounce?
Does it stretch?
Does it flow?
What happens if you pull it apart slowly?
What happens if you pull it apart quickly?

Q: How does it work?

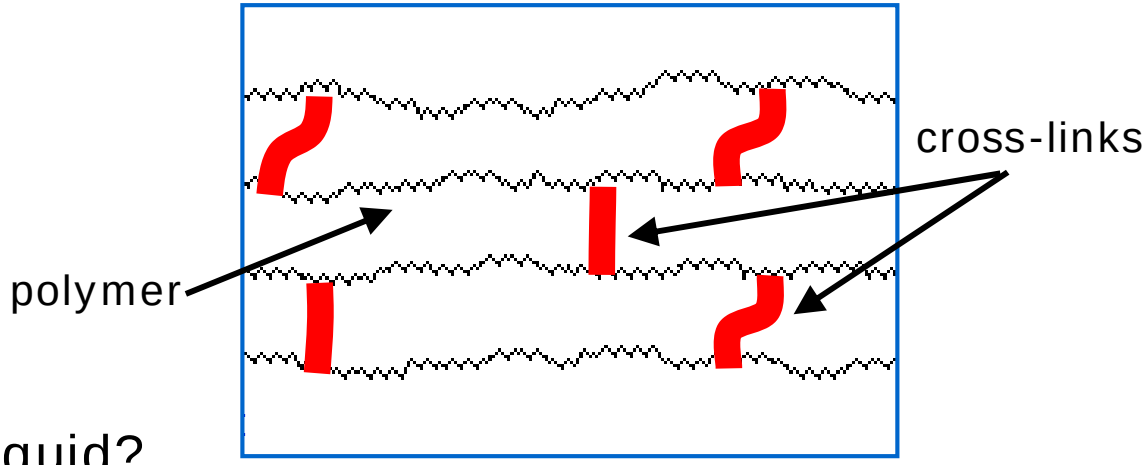
Q: Is Silly Putty a solid or a liquid?

What properties does Silly Putty have?

Silly Putty bounces, stretches and flows (albeit fairly slowly). If you pull it slowly it stretches, but if you pull it quickly it snaps.

How does it work?

Silly Putty (or polyborosiloxane) is a plastic, which refers to any material (either natural or man-made) which contains long chain molecules called polymers. Plastics such as Silly Putty have a small number of bonds, called cross-links, which join the polymer chains together. If a force is applied suddenly (such as pulling Silly Putty apart quickly) then the cross links snap, and so the material acts like a solid. But if a force is applied slowly then the polymers can slide past one another, and the material acts more like a liquid (it stretches and flows).



Is Silly Putty a solid or a liquid?

Silly Putty is a solid and a liquid! Materials that can behave like a solid and a liquid are called dilatent materials.

Cornflour Slime

Ingredients

- cornflour (also known as cornstarch)
- mixing bowl & spoon
- water
- newspaper or paper towel

Instructions

1. Put about a cup of cornflour into the bowl and add a similar amount of water.
2. Carefully (slowly) mix the cornflour and water together. This may take some time, but persevere until you have a uniform mixture. The mixture should form a fairly thick gloopy slime. Try adding more cornflour if it's too runny, or more water if it's too hard.
3. Start playing!

(Note: cornflour shouldn't be poured down the drain as it will cause severe blockage – the grains of cornflour will eventually separate from the water and will cause a large solid clump in the drainpipe). Instead, wrap it in the newspaper or paper towel and throw it in the bin).

Q: What happens if you stir it slowly? What happens if you push it fast?

Q: How does it work?

What happens if you stir it slowly?

If you push your finger slowly into the mixture, or let it drip of a spoon, the cornflour slime oozes around your finger / spoon – it appears to act like a liquid.

What happens if you push it fast?

If you push it hard (e.g. by punching it or hitting the spoon against it) then the slime seems to become dry, and you can't get your hand / spoon into it – the cornflour slime appears to act like a solid.

How does it work?

A fluid is anything that flows. Normal fluids do not change thickness (viscosity) when they are stirred, however there are some fluids that do change thickness when you stir or apply pressure to them. These are called non-Newtonian fluids. Examples are tomato ketchup, toothpaste and ink (all of these get thinner when stirred) and cornflour slime, which gets thicker when stirred.

Cornflour slime is a mixture of long, jumbled up cornflour particles (polymers), and small water particles. During slow stirring the long cornflour particles have time to roll or slide past one another. Your finger (or the spoon) can easily move through the slime, and the slime stays runny. However, during rapid stirring the particles do not have time to roll past one another. Their shape causes them to 'lock' into position. They faster they are stirred, the tighter they lock. The slime becomes thick and hard to stir.

Did You Know?

Some paints (especially non-drip paints) are also stir-thinning. While on the brush they are thick so they don't drip. When you move the brush along the wall or ceiling, you stir the paint, thereby making it thinner so it comes of the brush and produces an even coat of paint on the surface.

Magic Milk

Ingredients

- A shallow tray or dish
- Yellow and green food colouring
- Washing up liquid
- Milk
- Drinking straws or a pipette

Instructions

1. Pour approx 1cm depth of milk into the dish. Leave it to settle for approx 30 seconds.
2. Using the straws or the pipette, put a drop of each colour into the middle of the milk.
3. Squeeze a small drop of washing up liquid down the side of the tray so that it slides down into the milk.
4. Watch what happens!

Q: What happens?

Q: How does it work?

What happens?

The colours move around on the surface of the milk.

How does it work?

Washing up liquid, like bile salts, is a detergent. It rearranges the fat globules in the milk, which makes the colours move.

Did You Know?

The same thing happens when bile emulsifies fats in our bodies.

Balloon Bottom Burps

Ingredients

- A small plastic bottle
- A balloon
- Sodium bicarbonate (available in the home baking section of most supermarkets)
- Vinegar
- Water
- A funnel

Instructions

1. Pour approx 1cm depth of water into the bottle followed by approx 2cm depth of vinegar.
2. Using the funnel put two teaspoons of bicarbonate of soda into the balloon.
3. Place the end of the balloon over the top of the bottle, making sure that none of the sodium bicarbonate falls into the bottle at this stage.
4. When the balloon is secured to the top of the bottle, have a countdown with your audience and then tip the contents of the balloon into the bottle.

Q: What happens?

Q: How does it work?

What happens?

Bubbles can be seen inside the bottle and the balloon self-inflates!

How does it work?

Sodium bicarbonate is an alkaline chemical. When it is added to an acid (the vinegar) a reaction occurs between the bicarbonate and the acid, producing carbon dioxide gas (CO_2). This is the gas you can see bubbling away inside the bottle. Gases take up much more space than solids or liquids therefore the gas pushes against the only flexible portion of the container – the balloon – and the balloon inflates.

Did You Know?

Younger children are very amused to find out that it's the same reaction that creates 'wind' in our bodies. Acid from the stomach is neutralised when it reaches the small intestine by an alkaline (in this case represented by the sodium bicarbonate). This reaction produces bubbles of CO_2 which then need to find somewhere to escape...

Race to Digest

Ingredients

- 2x 22ft woollen intestines (made from lengths of legwarmers sewn together)
- 2x medium sized balls or grapefruits

Instructions

1. Split the group into two teams. Give each team one of the 'intestines' and get them to spread out so that the intestine is supported between them.
2. Tell the teams that the 'race' is to get the bolus of food (the ball or grapefruit) through the intestine and out the other side. The participants' hands are used to relax and contract the intestine to move the bolus of food through.
3. Ready, steady, go! to start the race... Some groups very much enjoy running this race more than once!

Q: How does it work?

How does it work?

This race is an analogy for how peristalsis works in our body. Peristalsis is the movement of food and drink through the digestive system by the contraction and relaxation of muscles. Our small intestines really are 22ft long, so highlighting this fact to the participants gives them a better sense of scale.

Did You Know?

Peristalsis occurs mostly in the small intestines and the oesophagus and explains why we can still eat and drink upside down!

Cloud in a Bottle

Ingredients

- colourless plastic bottle (~500mL) with cap
- water
- box of matches

Instructions

1. Place a splash (~1 tablespoon) of water into the plastic bottle. Swirl the water around inside the bottle.
2. Light the match and make sure it is burning well, then drop it into the bottle.
3. Immediately screw the cap on, and squeeze the bottle quickly five or six times.
4. Look closely inside the bottle while you squeeze it slowly and then release it slowly. Pass the bottle around so everyone can have a closer look for themselves.

Q: What can you see?

Q: How does it work?

What can you see?

You should see a cloud has filled the bottle; the cloud disappears when you squeeze the bottle.

How does it work?

Clouds are formed when water droplets in the air cool and then collect on dust particles. In this demonstration, the dust particles were provided by the smoke from the match. The air inside the bottle was cooled by releasing the pressure after the bottle was squeezed. The temperature is changed by squeezing the bottle: the amount of air within the bottle is constant, but squeezing the plastic bottle changes the volume of the gas. Expanding the bottle causes a lowering of the air temperature – in this case, enough to cause the water gas to form a liquid – the cloud.

Did You Know?

This demonstration involves building a small cloud chamber exactly like those used to first record the tracks of subatomic particles (alpha and beta radiation) by Charles Wilson in 1911. Wilson (who was born on St Valentine's Day) was awarded the Nobel Prize in 1927 for this discovery.

There are however some more worrying consequences... Next time you see a fantastic sunset over an urban area, take a moment to think about what is causing the beautiful colours. The origin is actually the tiny smoke particles and other pollutants that have been emitted into the atmosphere. Just like in the bottle, these smoke particles encourage water droplets to condense around them, forming clouds. The scattering of the sun's rays amongst the clouds is what creates the beautiful sunset.

Tame Tornado

Ingredients

- tornado contraption (two large plastic bottles connected together)

Instructions

1. Hold the tornado contraption vertically with the bottle with the water in it is at the bottom.
2. Turn the whole contraption upside-down.
3. Grasp the top and middle of the contraption and spin it in a circular motion – either clockwise or counter-clockwise.
4. Once a vortex (whirlpool) forms in the upper bottle, stop spinning – you should see the tornado form throughout the liquid, and continue as long as there is liquid in the upper bottle.

Q: How does it work?

Q+: Would there be a difference if we did this experiment in Australia?

How does it work?

This demonstration produces a 'vortex' such as those observed in cyclones, tornadoes and whirlpools. As the water spins around the bottle there is a downward pull formed due to the water passing through the opening into the empty bottle below. The initial small rotation caused by spinning the bottles gains speed as the water is sucked through the opening. As the rotation speeds up the vortex forms.

Would there be a difference if we did this experiment in Australia?

It is well known that water always goes down the plughole in a clockwise direction in the northern hemisphere and counterclockwise in the southern hemisphere. Unfortunately this is not scientifically valid! The direction the water goes is much more dependent on initial conditions e.g. if the bathtub is on a slope, or the orientation of the plughole... You can try this for yourself – try rotating the tornado contraption in the opposite direction and you should be able to get a tornado spinning in the opposite direction!

Did You Know?

The whirlpool was first mechanically induced in a bathtub in 1968 by Roy Jacuzzi. Now, whatever became of him?

One In The Hand

Eggs are traditionally thought of as being very fragile, but the science behind their shape is astounding.

Ingredients

- raw egg
- plastic bag or glove (for the unconfident!)

Instructions

Challenge audience members to break the egg just by squeezing it. Let them wrap the egg in a plastic bag or wear a glove if they're worried… Believe it or not, it can't be done!

How does it work?

The shape of an egg is actually one of the strongest designs possible. The curved structure means that applying pressure to any particular area actually spreads the force out over the entire egg. So just squeezing it won't cause it to break. Of course applying a very sharp force to one point WILL cause it to break – which is why we usually tap the egg on the side of a bowl to break it when cooking.

Tips for Success

Ask your volunteers to remove any rings etc. before trying this trick – the sharp uneven force from such metal objects can cause the egg to break. Check your eggs for hairline fractures before attempting this trick – if there is any existing damage to the egg it won't work.

Did You Know?

The ornate and intricate arched doorways and ceilings in many old buildings aren't just there for their aesthetic qualities. Arches are in fact one of the strongest building structures. In effect, every brick or piece of masonry within the arch is falling on all the others, distributing the weight evenly over the structure.