# THE MAGICAL SCIENCE & ENGINEERING SHOW

A Science2Life Production

**Susan Carvell**
BSc Hons PGCE CEd DASE MEd FInstP

This highly creative and magical scientific journey of discovery focuses on invisible forces that are constantly acting on us whether we realise it or not!

Gravitational
Static Electric
Magnetic
Electromagnetic

Levitation tricks use the principles of physics – physics is the modern-day name for MAGIC!

… and yes, scientists and engineers are WIZARDS!

This show is about magical people, magical creatures and invisible magical forces and one of its aims is to reveal the secret ways of a wizard's art and hopefully teach you how to learn to wield them too!

This virtual experience is the next best thing to a live show!

There are multiple opportunities for the pupils to engage throughout the show… **yes volunteers are still required!**

**Part 1**: Focuses on what forces can do and then on the magical properties of our invisible Gravitational Force.

The **'make and take'** section has the children investigating the centre of mass of an acrobatic dragon, then using this knowledge, they will train their dragon to balance on the end of its nose.

**Part 2:** An introduction to Electric and Magnetic Forces. Here we also explore sound plus 4 amazing wizards and how their discoveries brought about the record player and the disco ball!

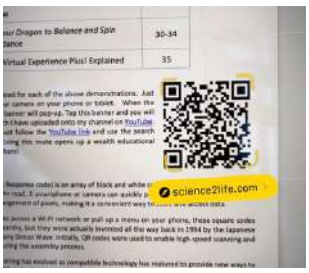
## We are using QR codes!


## Enabling your camera to scan QR codes:

Go to settings and scroll down for Camera.
Tap the toggle next to Scan QR codes so that it is enabled.
Your camera app will automatically scan codes until you choose to disable the function

A QR code has been generated for each of the above experiments. Just scan the QR code using your camera on your phone or tablet. When the code is recognised, a small banner will pop-up. Tap this banner and you will be taken to the videos which I have uploaded onto my channel on YouTube. If the code doesn't work just follow the YouTube link and use the search engine to find the topic. Going this route opens up a wealth of educational videos for you to use and share!

## What is a QR code?




A QR code (short for Quick Response code) is an array of black and white squares or pixels set in a grid that stores data for a machine to read. A smartphone or camera can quickly process the information contained in a QR code's specific arrangement of pixels, making it a convenient way to store and access data.

If you've used a QR code to access a Wi-Fi network or pull up a menu on your phone, these square codes may seem like **modern wizardry**, but they were actually invented all the way back in 1994 by the Japanese auto manufacturing company Denso Wave. Initially, QR codes were used to enable high-speed scanning and tracking of components during the assembly process.

Although the QR code meaning has evolved as compatible technology has matured to provide new ways to engage customers, most QR codes (also called qcodes) are designed simply to transmit URLs. As such, **using a QR code is like typing a web address into your browser, only faster and more convenient.**

# Science2Life's Virtual Experiences Explained

***Science education in a fun format***
***The science show is interactive!!!***

The most exciting part about our Virtual Experiences is the fact that you, the teacher, is now in charge of the speed at which the show takes place. You can stop and start the video to check on your children's understanding, to repeat a section they really enjoyed and to carry out one of the many interactive sessions which requires a volunteer…. Yes, volunteers are still required!

**Flexible learning – the timetable is set by you!**

You may choose to split the viewing of the show over several days; you may also want to choose more than one volunteer or to allow the whole class to do one or more of the activities!

**All of Science2Life's STEAM ACADEMY shows and workshops are designed to not only motivate and fire the spirit of discovery within your children but also ignite curiosity in their minds.**

**Age: Upper Primary / Lower Secondary**

Science2Life currently has 3 Virtual Experiences on offer. They all consist of an interactive show and a make and take activity:

| | Show | Price Includes postage |
|---|---|---|
| 1 | Science of Bubbles | £255 / €300 |
| 2 | Science of Dragons | £255 / €300 |
| 3 | Magical Science & Engineering | £255 / €300 |

**When you book your Virtual Science Experience you will be:**

1- Asked for your logo and your introductory statement which is incorporated into the video.
2- Sent a link via WeTransfer for your choice of video for you to down load so that it can be loaded onto your media platform of choice – or an unlisted YouTube link will be sent if you don't have this facility. This link must be downloaded within a given timeframe.
3- Sent the 'Experience Box' by post. This box contains the items and chemicals required for the interactive sections of the show. Extra Experience boxes can be purchased from our online store.

**Plus, you will have a personalised introductory message for the show. Your logo/logos will be used as transition links throughout the show!**

# 1 The Science of Bubbles Show

This awesome bubble kit contains a range of traditional and modern bubble toys and chemicals all of which offer great STEM (Science, Technology, Engineering and Mathematics) teaching and learning possibilities; plus, they will help you and your young Bubbleologists make a range of amazing bubbles: big, small, touchable, bouncing, floating & sinking.

Bubbles hold many wonders and create lots of excitement, and investigating the science methods behind the creation of different bubble solutions is sure to fascinate young minds and help them think like a scientist.

Bubbles are a fantastic material to introduce children to a whole range of STEM topics. They are a familiar plaything for children, they are inexpensive and portable. Children can participate verbally or nonverbally during bubble play which is why this activity can be adapted for young children at any stage of development.

### Active Learning

- Blowing bubbles and making bubbles with the wands requires concentration.
- Children get to practice control in their fluid, flowing movements.


The stability, size, and colour of soap bubbles depend upon chemistry and physics. Through designing long-lasting soap bubbles and discussing the reasons behind their longevity, students can experience basic material chemistry.

### What's in the box?

| Items for Interactive Show | Items for the Workshop |
|---|---|
| 1 x 50 ml Tub of bubbles | 30 x 3 ml Pipettes |
| 1 x Small pot | 30 x 30 ml Measuring cups |
| 5 x 3 ml Pipette blowers | 30 x Straws (paper)/stirrers |
| 2 rocket balloons | 30 x 300 ml Tubs with lids |
| 1 x Test tube of touchable bubbles | 30 x Magic gloves |
| 1 x Giant bubble Kit | 2 x 200 ml Glycerine |
| 1 x Can of Bouncing Foam | **Teachers notes** |

# 2 The Science of Dragons Show

**Join Scientific Sue on this most historical and creative journey of discovery.**

Her fire and icy fog breathing dragons are celebrating the hatching of their latest baby, there is just one problem this little dragon can't fly yet.

**The Vikings are partying too!**

Scientific Sue creatively combines drama and story-telling skills throughout this engaging show. She investigates and explores the science of how dragons fly and then, using some of the science behind the different dragon fire types (steam, icy fog, explosive gases, flammable liquids and of course big flames and tornado type fire!), she hopes to engineer a way which will allow the baby dragon to fly and join in with the celebrations!

**Danger Science Magic: Fun Guaranteed!**

Inspiration from the stories by Cressida Cowell on 'How to Train your Dragon'

Curriculum Links: Science, Engineering plus Literacy and Story Telling

**The Science:** Chemical reactions, combustion, states of matter, flight, buoyancy, forces, energy, digestion, and respiration, tests for oxygen, carbon dioxide and hydrogen

## What's in the box?

| | |
|---|---|
| 1 x Sachet of dried red cabbage powder plus pH colour chart | 1 x 200 ml 6 % Hydrogen peroxide |
| 100 g Citric acid | 10 x wooden splints |
| 200 g Baking Soda | **Items for the Workshop** |
| 1 x Tea light candle | 30 x Balancing Dragon cut out cards |
| 1 x Box of matches | 60 x Adhesive magnet dots |
| 10 x Balloons | 300 metallic paper clips |
| 56 g Sachets of yeast | 30 x pencils |
| FriXion Colour felt pens (6) | **Teachers Notes** |
| 500 ml Bottle | |

# 3 The Magical Science & Engineering Show

## A scientific journey of magical discovery

Sue's wacky combination of science and drama makes this Educational Show both magical, entertaining and thought provoking.

**This show is about magical people, magical creatures and invisible magical forces.** A Chief Wizard and their magical apprentices will be needed to help Scientific Sue find out the science and engineering behind many amazing illusions and magical tricks.

We are surrounded by invisible forces which can be used to push and pull. Using these mystical properties Scientific Sue will show you how the 'magical' properties of magnets can be used to make items spin! Demonstrate how the science of spin can also be used to defy the pulling forces of gravity; and how electric forces can be used to 'magically' make things fly.

*Hubble Bubble Toil and Trouble... Fire Burn and Cauldron Bubble*

**The show aims to reveal the secret ways of a wizard's art and hopefully teach you to learn how to wield them too!**

Magical spells will be used to make items fly, disappear and reappear! All of the activities will not only stimulate curiosity and imagination within your young audiences but will also highlight the relevance and impact of science and engineering on our everyday lives.

## Warning: Danger Science Magic - Fun Guaranteed!

**Curriculum Links:** Forces and Energy, Electricity, Magnetism, Gravity, Polymers.

## What's in the box?

| | |
|---|---|
| 10 x Magically Appearing Pop Up Wand | Balloon Pump |
| Magic Rope – flexible to stiff | 2 balloons, sachets of salt and pepper |
| Static Electric Balloon x 1 | Alien bug |
| Cosmic Energy Ball | Acrobatic Dragon Activity: 30 Dragon templates, Magic wand, 3 neodymium magnets, 10 paper clips, kebab stick |
| Flower from Wand Trick | |
| Evanesco Spell: 50g Gelli Baff, 50g salt, 3 opaque paper cups | |
| 'Science is Fun' sound ribbon | Tube of effervescent tablets |
| Rocket balloon | **Link to Teaching notes** |

# A bit about Sue

Sue began her career as a teacher of Physics and Chemistry in 1991.

After graduating with a Masters in Educational Studies. She left the classroom in 2000 to join the start-up management team of the world-renowned science centre W5 whowhatwherewhenwhy, which opened its doors to the public in 2001, with the responsibility for all Educational Programmes. During this period, she was awarded a Fellowship for the Institute for Physics in recognition for her work within the field of physics education.

Sue left W5 in 2006 to start her own business Science2Life. A company which brings highly interactive and innovative STEAM focussed shows and workshops to schools, colleges and special events.

## What is STEAM and why is it important for our children?

STEAM is an acronym for Science, Technology, Engineering, Art and Mathematics. STEAM education uses art, drama and design to bring the STEM subjects to life and make them real and relevant to the world we live in today – check out our shop to find out how we have incorporated the arts into our STEM modules.

**Create a buzz about Science and Engineering by booking one of our inspirational shows or workshops which will fill your audiences with wonder and excitement!**

Science2Life's dynamic and innovative approach to teaching and learning not only promotes lifelong learning and the development of creativity and thinking and problem-solving skills, but also makes STEAM (science, technology, engineering, art and mathematics) subjects simple, real and relevant.

Sue has performed and delivered her educational programmes and training sessions throughout Ireland and the United Kingdom but also to countries further afield such as Switzerland, Saudi Arabia, Nigeria, United Arab Emirates and Qatar.

In 2015 in partnership with the N Ireland Science Festival and the Royal Society of Chemistry Sue led the Class of 1339 students which gained the Guinness World Record for the Largest Practical Science Class!

# A Bit about the Show

If today's scientists and inventors were able to travel back in time, they would all be considered to be very powerful wizards and magicians indeed.

- A wizard studies the world around them.
- They understand they are part of the world they are studying.
- This understanding leads them to see hidden patterns and connections that others do not.
- A wizard's knowledge is practical and hands on.

This show is about wizards and wizardry. It will reveal some of the secret ways of the wizard's art, and will help you, as chief wizard, to guide your young apprentice wizards in following some of these magical arts.

It also contains some history of magic, telling how, by observation and experimentation four Chief Wizards, Volta, Oersted, Sturgeon and Faraday were instrumental in the development of magical machines which play music!

As you may have already guessed the modern-day word for wizard is scientist … but what you might not know is the modern-day words for magic are PHYSICS and CHEMISTRY. This show focuses mainly on PHYSICS, the physics of forces and in particular 3 magical invisible forces:

- Gravitation
- Static Electric &
- Magnetic

All three of these forces can be used to make an object appear to LEVITATE – to defy gravity!

Using the invisible force field around magnets we can also make objects vibrate. If they vibrate between 20 and 20000 times per second, we can hear these vibrations as SOUND. The faster an object vibrates the higher the pitch of the sound will be. The size of the vibrations determines the volume. Part 2 of the video will explore two amazing magical properties of moving electrical charges and moving magnets and will then demonstrate how record players and other electronic devices can be used to play music.

## The Magical Science & Engineering Show is split into 3 sections:

1. **Part One: An Introduction to FORCES and Earth's Invisible Gravitational Force Field.**
   There are 3 opportunities for your apprentice wizards to become volunteers in this section.

2. **Make and Take Activity: The Acrobatic Dragon**
   This activity is for up to 30 children.
   Using small masses added to the wing tips, such as paperclips, the children are to move the centre of mass of their dragon from the middle of its back to the tip of its nose enabling them to balance the dragon on its nose.
   More templates can be downloaded from our website: click here
   Or purchased from our online store.

3. **Part Two: An Introduction to Static Electric and Magnetic Forces.**
   Sound is also explored and explained
   There are 5 opportunities for your apprentice wizards to become volunteers in this section.

As Chief Wizard you will also have opportunities to wow your young audience .. and maybe later your friends and family!

Sue will be asking for one volunteer to help in each interactive session – remember you can vary this number! You may even decide that one or more of the activities are perfect for the whole class to do!

## The Magical Science & Engineering Show is made up of the following sketches:

### Part One

1. Magically Appearing Pop-Up Wand - Chief Wizard
2. Rocket Balloon and the 6 Force Actions - Experiment 1 – *1 volunteer*
3. Gravity Defying Balloon Ring
4. The Fizz Pop Rocket - Experiment 2 – *1 volunteer*
5. The 3 Little Pigs
6. The Evanesco Spell - Experiment 3 – *1 volunteer*
7. The Magic Rope Trick - Chief Wizard

### Part Two

1. Magically Appearing Flower - Experiment 4 – *1 volunteer*
2. Visualising a magnetic Field
3. Using Magnetic Forces to get Something to Spin
4. Wingardium Leviosa Spell - Experiment 5a – *1 volunteer*
5. Visualising an Electric Field - Experiment 5b – *1 volunteer*
   i. *Whole Class*
6. Cosmic Ball - Experiment 6 – Chief Wizard
   i. *Whole Class*
7. The Magical Wizards Who Brought Music to the World
8. 'Science is Fun' Sound Ribbon - Experiment 7 – *1 volunteer*
9. How a Record Player Works

# "May the FORCE be with you!"

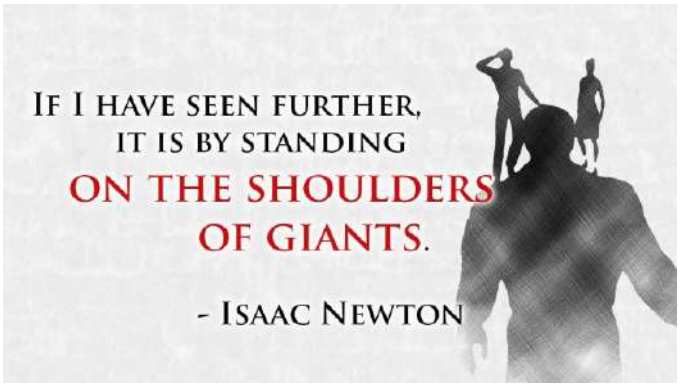
Whilst uttering "May the Force be with you!", cut through the atmosphere with your 'all singing and dancing' Jedi sword. You may even want to wear your voice changing helmet. What you don't have these toys?? Too old? Rubbish! They are fantastic examples of transducers; the wizards, sorry the physicists' fancy word for objects, live and animate, which change energy from one form to another – a must for all households and classrooms.

The driving force behind the Star Wars world of exploding planets and intergalactic wars is also the force that is explored in this show! 'The Force' which gives a Jedi knight his power is the same as the force that we use and abuse in the world we live in; the force we draw upon from the energy fields which surrounds us and penetrates us.

The force, which keeps our planet in orbit around the Sun; our closest star, which is by the way on its own life journey and, whose discarded energy feeds us. The same force which binds the galaxies together – a mysterious, force.

Most books depict Sir Isaac Newton as the man who, whilst sitting under a tree had an apple land on his head… instead of just accepting that's what apples do…fall down and land on your head…. he proceeded to ask lots of questions. He wanted to know why they moved downwards towards the earth rather than side-wards or upwards.

In his quest for answering these questions Newton became responsible for laying down the fundamental laws of the physical universe. He combined his knowledge with that of the work of the great scientific minds of his day and those that came before him; Galileo, Copernicus and Kepler, to produce a set of laws which describe not only how things work but why they work. He once confessed "If I have seen further than other men, it is because I stood on the shoulders of giants". The trouble with standing on the shoulder of giants is that if you fall off, you will experience a force far greater than the one felt if you fell off the shoulders of a dwarf!




Joking aside, the physical laws explained by Newton have allowed us to walk on the moon and build wonderful play parks such as Emerald Park (formerly Tayto Park) and Disney World; magical places full of fun, wonder and of course physics!

These laws have also allowed us to remove some of the mystery surrounding many magicians' tricks. This is good news for us because by understanding how and why things work, we can not only repeat the tricks but improve upon them, or better still come up with our own magical tricks and mind-boggling demonstrations.

*Susan Carvell*

# THE 6 SCIENCE PROCESS SKILLS

Scientists engage in procedures of investigation to gain knowledge of natural phenomena. The tactics and strategies, the skills scientists use in their pursuit of understanding can be broken down into 6 Science Process Skills, and engagement with the activities in all of **Science2life's STEAM ACADEMY** workshop kits will help to naturally develop these skills within your children:

**Observing**
This is the most basic skill in science. Observations are made by using the 5 senses. Good observations are essential in learning the other science process skills.
One of the best things we can do for our children's science learning is to help them *observe more closely* – look for more details. **We do this by asking questions**.

**Communicating**
It is important to be able to share our experiences. This can be done with photographs, videos, graphs, diagrams, maps, and of course, the spoken word.
Observing and communicating those observations go hand-in-hand. Children need to learn lots of adjectives. Words that are used to help describe or give description to people, places, and things. These descriptive words can help give information about size, shape, age, colour, origin, material, purpose, feelings, condition, and personality, or texture.
**When talking with a child about what they observe, we often teach new vocabulary**.

**Measuring**
Measuring is important in collecting, comparing, and interpreting data. It helps us classify and communicate with others. The metric system should be used to help understand the scientific world.
Measuring is a special case of observing and communicating. Observing how big something is by measuring it against something else, and then communicating that information to someone else using commonly agreed upon units.

**Classifying into Groups/ Sorting**
After making observations it is important to notice similarities, differences, and group objects according to a purpose. It is important to create order to help comprehend the number of objects, events, and living things in the world.
One way of classifying is putting things in order say by lining them up from smallest to biggest or sorting them by colour, or if dealing with liquids, runniest to thickest.

**Inferring**
An inference is an explanation or interpretation based on an observation. It is a link between what is observed and what is already known.
We observe with all five senses, but we interpret what we sense based on our prior experiences and knowledge. Observation results can be called data or facts. **The inference is what those facts mean.**

**Predicting**
What do you think will happen? It is an educated guess based on good observations and inferences about an observed event or prior knowledge.
Predictions are always based on data. We identify trends in the data which let us predict what will happen. Predictions can be tested: if I do X, does Y happen?

# FAIR TESTING

Conducting a fair test is one of the most important ingredients of doing good, scientifically valuable experiments, and is most probably the one most of us remember from our own science lessons.

> Change one variable to see its effect on another, whilst keeping all others the same

Fair test questions involve making comparisons, often trying to find out which is the 'best' or 'most'. Through fair testing, children are encouraged to see that one thing has an effect on another, identifying the differences they have noticed and exploring all the variables (any factor subject to change) that may have an effect. Children decide which variable to investigate and how to measure or observe the effects.

In most experiments we usually start with a question; questions suitable for experiment 5 (Making carbon dioxide gas) could be:

- What other household chemicals react with baking soda to produce carbon dioxide gas?
- How can we measure the volume of carbon dioxide produced?
- How does the amount of baking soda affect its reaction with citric acid or vinegar?
- Does the temperature of the water (for citric acid) or vinegar affect the rate of reaction?
- What effect will different vinegars have on the baking soda/vinegar reaction? Will the balloon blow up more?

What are the variables? To answer this, you need to think about all the factors that could change in the experiment. When you carry out the experiment all of these factors should be the same except the one you are testing.

**Scientists call the changing factors in an experiment - VARIABLES**

So, in a nutshell, fair test experiments require us to observe and measure the effect changing one variable has on another whilst keeping all other variables the same.

The variable you choose to **deliberately change is called the independent variable**. Whilst carrying out the experiment we want to find out what effect this change has on another factor – **we call this factor the dependent variable**.

You can think of the independent variable as being the '**cause'** of the change and the dependent variable as being the '**effect'** that the change you make has during the experiment. In other words, **the dependent variable is the thing that changes as a result of you changing something else.**

Fair testing is not the only key practice a good scientist should know, in fact, there are five approaches that children need to learn to recognise and use: **fair testing; observing over time; pattern seeking; identifying and classifying; and research.**

It is strongly recommended that you watch the show video and practice some of the tricks before you engage in this activity.

Each activity will allow you to explore and engage in many of the science process skills and can be extended into investigations which will allow you to conduct fair tests in fun and creative ways.

# Items in your Experience Box

| Item | Quantity | Item | Quantity |
|---|---|---|---|
| Magically Appearing Pop Up Wand | 10 | Dragon Templates | 30 |
| Magic Rope – flexible to stiff | 1 | Magic Wand | 1 |
| Static Electric Balloon | 1 | Neodymium Magnets | 3 |
| Cosmic Energy Ball | 1 | Metallic Paper Clips | 10 |
| Balloons | 2 | Kebab Stick | 1 |
| Sachet of Salt | 1 | Tube of Effervescent Tablets | 1 |
| Sachet of Pepper | 1 | Alien Bug | 1 |
| Gelli Baff Crystals | 50 g | Sound Ribbon | 1 |
| Rocket Balloon | 2 | Paper Cups | 3 |
| Balloon Pump | 1 | Flower from Wand | 1 |

## SHOW CHECKLIST

| This list will guide you on what you need to do with the items in the box and will also let you know what other items you will need to gather before the experience.<br>Items in the box have been marked with a **√** | | **CHECK** |
|---|---|---|
| **Open the Activity Box** | Check p 14 for the items that should be in the box | |
| **Prepare the performance space** | Set a small table beside the screen on which you will be watching the show – the volunteers need to see the screen and, the children in the class need to see both the screen, you and the volunteers.<br>Collect 8 trays | |
| **Safety** | Safety glasses – these can be proper safety glasses or a visor, swimming goggles, reading glasses – anything that protects the eyes from splashes | |
| ***Trays 1-4 are used in Part One*** | | |
| **Tray 1**<br>**Chief Wizards Tray** | The Magically Appearing Wands – Wind up 8 of them, securing them with the small white elastic bands found in the small resealable bag.  | √ |
| **Tray 2**<br>**Experiment 1** | Balloon pump | √ |
| | Rocket balloons | √ |
| **Tray 3**<br>**Experiment 2** | Tube of effervescent tablets | √ |
| | Resealable bag | √ |
| | Open the tube and pour the tablets into the resealable bag | |
| | The lid contains silica gel beads. These can be removed either by soaking the cap for 15 minutes or by carefully removing the paper cap and pouring the small beads into the bin. | |
| | Alien bug | √ |
| | Stick the bug onto the top of the lid | |

| | | |
|---|---|---|
| | ¾ fill a glass with water | |
| | 20 ml water - enough to ¼ fill the tube. | |
| **Tray 4 - Chief Wizards** | Magic Rope Trick | √ |
| | Cosmic Ball – this is used in part 2 | √ |

| | | **CHECK** |
|---|---|---|
| ***Trays 4-8 are used in the part 2 of the video*** | | |
| **Tray 5 Items for the Make and Take Activity: The Acrobatic Dragon** | 30 Dragon Templates | √ |
| | 10 paper clips | √ |
| | 10 paper clips per pupil | |
| | Kebab stick | |
| | Playdoh pot – optional – to stick the kebab stick into | |
| | Magic wand with a magnet stuck to one end | √ |
| | 2 neodymium magnets | √ |
| **Tray 6 Magically Appearing Flower** | Flower pot | √ |
| | Wand with flower hidden inside | √ |
| | Small sticker – place this sticker on the end of the wand by the hidden magnet | |
| **Tray 7 Wingardium Leviosa Spell** 2 volunteers are used here – one after the other. Then it changes into a whole class activity. | 1 sachet of pepper | √ |
| | 1 sachet of salt | √ |
| | Plate – mix the pepper and salt on the plate | |
| | Balloon pump | √ |
| | Balloon | √ |
| | Permanent marker pen - optional | |
| | Balloon filled with polystyrene beads | √ |
| **Tray 8 'Science is Fun" Sound Ribbon** | Red Sound Ribbon | √ |
| | Paper cup | √ |
| | Scissors | |
| | Cable tie - Optional | |

# Experiment 1: Rocket Balloon

## What you have:

- Rocket Balloon
- Balloon Pump

## SAFETY:

Balloons can go bang very loudly at unexpected moments.
Bursting balloons are noisy.
Some children are scared of bursting balloons. **Globophobia** is an extreme and irrational fear of balloons.

## Nuts and Bolts

- Air will be pumped into the balloon a couple of times in the show – If the children love this part, it can be repeated many times!
- The first time just a few pumps and the second time a few more. It is important not to push too much air into the balloon – we don't want it to burst.
- When the balloon is released, it will fly around the room making a high-pitched buzzing sound as it does.
- Point the balloon towards the ceiling before releasing to ensure the flight time is a long as possible.

## Secrets for Success

- Attach the rocket balloon to the balloon pump before the show.
- In the show Sue will not be getting the children to fully inflate the balloons.
- Any balloon can be used in this section – a rocket balloon has been chosen as one of the focuses of the show is how vibrations cause sound.

## Science in a Nutshell

**Pushes and pulls are examples of forces**

Balloons are fantastic toys which allow us to easily illustrate energy changes, motion as well as the properties of materials.

Forces acting on an object can make the object do one, some, or all of the following 6 force actions:

1. Start to move
2. Speed up
3. Slow down
4. Stop moving
5. Change direction
6. Change shape

When you start pushing air into a balloon the balloon starts to change shape and gets bigger, the skin starts to stretch to facilitate the added air, the air pressure inside the balloon increases. Potential energy is stored in this stretched rubber.

We can use this energy to demonstrate the Law of Conservation of Energy:

**Energy cannot be created or destroyed just changed from one form to another.**

If you just keep pushing air into the balloon there will come a point when the pressure inside the balloon is too high for the rubber material to support. The skin weakens rapidly and the balloon bursts. The stored potential energy is converted mainly into sound energy but also into the kinetic energy of the moving pieces of the broken balloon and a little bit of heat energy.

When the rocket balloons are released, they will whizz around the room, not only changing direction and shape but also its speed will vary. They will sometimes gain height, which means they gain gravitational potential energy, this is converted back into motion energy as they fall again.

The elasticity of the balloon contracts the air out through the opening. These air molecules are moving away from the balloon. The air remaining in the balloon causes the balloon to move forwards and wiggle from side to side.

Aside from the shape, rocket balloons are also characterised by their distinctive loud buzzing noises due to the tight, reed-like opening designed to make noise as the air rushes through.

To propel a rocket, some kind of a force must be used to push it forwards. When you blow up the balloon, you are filling it with millions of gas particles. The gas particles move freely within the balloon. As more gas particles are pushed into the balloon the number of opportunities for them to hit the inner sides of the balloons increases. Pressure is the amount of force exerted on an area; the pressure inside the balloon is now much bigger than the pressure outside of the balloon.

The pressure inside the balloon acts as the fuel for the rocket. When you release the opening of the balloon, gas quickly escapes from the balloon. The forces on the inside surface of the balloon, caused by the gas molecules moving forward, are now not balanced by the backward moving molecules (these molecules have excited the balloon). These unbalanced forces push the balloon forwards. We call this forward push **THRUST**

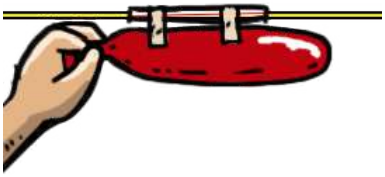
## Whole Class Activity Idea

**What you need:**

- Balloons – which shape/size of balloon makes the best balloon rocket?
- Straws – extra-large works best
- String – 2 m plus per group
- Tape
- Permanent pen – optional
- Sealing pegs - optional

- The string can be held by 2 helpers or attached to two objects e.g., chairs.
- The sealing pegs traps the air inside the balloon until you are ready to fly it.
- The pen can be used to draw a rocket on the balloon after it has been inflated.
- Tape a straw on the top.
- Thread the string through the straw.
- The string must be pulled tight otherwise the balloon rocket won't fly straight.
- Remove the pegs and pinch the neck of the balloon. When everyone is ready, carry out a count down 3… 2… 1… and release the balloons.

1. Does the shape of the balloon affect how far (or fast) the rocket travels?
2. Does the length of the straw affect how far (or fast) the rocket travels
3. Does the type of string affect how far (or fast) the rocket travels? (try using fishing line, nylon string, cotton string, etc.)



# Experiment 2: The Fizz Pop Rocket

## What you have:

- Tube of effervescent tablets
- Alien Bug
- Resealable bag

## What you need:

- Glass of water
- Safety glasses
- 20 ml water
- Plastic tray (optional)
- Paper towels

## SAFETY:

- Always wear safety glasses.
- The bug adds weight to the lid. This will reduce the height the lid will fly – however, it could still reach a height of 3 m+. If your ceilings are low, you must aim the tube at an angle of about 45 degrees across the width of the room – away from any children.
- If you choose to do this experiment as a class activity – use the hall or go outside.
- Draw up a safety line that the children have to stand behind.
- Children with sensitive skin are advised to wear gloves.

**Note: In the lids of these canisters, there is a cardboard disk and under that are little beads – silica gel crystals. Before using these canisters for an experiment, you should soak the lid for about 15 minutes and dispose of the cardboard disk and those little beads in the bin.**

## Nuts and Bolts

- The tablet can be dissolved in any transparent vessel – we just want the children to see the bubbles being created. If you put the water in a bottle, a balloon could be placed on top and you could capture the gas!
- The amount of water that goes into the tube is one of the quantities that could be investigated. Does the amount of water used affect the lift off time?

## Acids and Bases

The word acid comes from a Latin word meaning sharp or biting to the taste. You would have experienced this sensation if you have ever sucked a lemon! Many acids occur naturally and, in the kitchen, the two most common are citric acid (found in citrus fruits) and ethanoic acid (vinegar – a dilute solution of ethanoic acid). Most of the acids found in and around the home are weak but some are very strong, they are poisonous and extremely dangerous. One of the strongest acids is hydrochloric acid, HCl, a compound made up of two atoms; one hydrogen atom and one chlorine atom. This acid is used for soldering but we also find it in our stomachs which is why, if you have a stomach ulcer, you suffer so much pain. Sulphuric

acid is another strong acid and it is found in the battery of cars. These 2 acids most definitely should not be tasted!!

The chemical opposites of acids are bases. Bases are usually found as a solid compound and for it to react with an acid it is usually dissolved in a solvent, such as water, to form a solution. **Bases in solution are called alkalis**. At home the most common place to find bases and alkalis is under the kitchen sink! They are very good cleaners; examples would be washing soda crystals and bleach. You will also find some bases in the food cupboard; baking soda (sodium bicarbonate) being the most common.

When a base (or alkali) is added to an acid, it will neutralise the acid's properties and vice versa.

## Secrets for Success

- In this show Sue uses two tablets as she wants a quick launch. The amount of gas made is dependent on the quantity of chemicals present. In this reaction it is the citric acid and the sodium hydrogen carbonate (base) which is present in the tablets.
- Once the lid takes off it can be collected and pushed back onto the tube again. The take-off times increase between each take-off, until no more gas is made and the bug will therefore not fly. At this point gently remove the lid, pointing it away from you and discard the liquid contents.
- In the show Sue's apprentice wizard will only be asked to hold the launcher vertically – depending on your ceiling height you may have to guide them to hold it at a 45-degree angle to the horizontal (Note you will achieve maximum distance travelled at this angle.)
- It is really important for the children to be told not to point the tube at anyone and they are not to look down onto the lid. When the lid and bug fly, they do so at a great speed!
- Do not point it horizontally. If this is done, when the lid leaves the tube all of the liquid will pour onto the floor! **See below for ideas on an investigation and a template for turning the tube into a rocket.**
- You could decorate the tube like a rocket. The bug is then not used and your rocket will only fly once.

## Science in a Nutshell


When the effervescent tablets dissolves in water, a chemical change takes place and carbon dioxide gas is formed, this causes the fizz. These tablets contain sodium bicarbonate ($NaHCO_3$), a base, and citric acid ($C_6H_8O_7$), an acid.

Sodium bicarbonate is also known as Sodium Hydrogen Carbonate (a much more wizardly word) and bread soda.

In the solid tablet form the acid and base do not react; the atoms and molecules are tightly bound in a crystalline structure and hence cannot react with each other. But when placed in water the tablet dissolves and the chemicals are free to move around; with the result that the sodium bicarbonate reacts with the citric acid and carbon dioxide gas is formed.

$$NaHCO_3\ (aq) + C_6H_8O_7\ (aq) \rightarrow NaC_6H_7O_7\ (aq) + H_2O\ (l) + CO_2\ (g)$$

By using these symbols scientist cut down on a lot of writing time which ultimately gives them more time to experiment, think and solve problems. By mastering the scientific language, a whole new world is opened up for you to play in – just like learning Spanish will allow you to enjoy the company of the Spanish speaking communities as well as appreciate their culture and history. More books to read, more songs to sing!

**So, let's make some carbon dioxide gas.**

The tablets can be broken into small pieces, or can even be crushed to become a powder, thus the amount of tablet and particle size can be investigated. The volume of water can also be investigated.

In the closed container, the newly formed $CO_2$ gas mixes with the air that was already in the canister. The pressure inside the container builds up because more and more gas particles are hitting the sides of the container. This pressure acts in all directions and builds up until the force is large enough to separate the canister from its lid. The gas rushes out, making a whoosh sound.

The lids can be propelled up to heights of about 5 m! – The height reached is dependent on how tightly the lid fits the canister.

**If the ceiling in your room is very low your young wizard will have to point it away from themselves, parallel to where the rest of the students are sitting, otherwise the lid will hit the ceiling and could rebound and hit one of the children!**

This experiment can be used to help illustrate Newton's Third Law of Motion. This law states that **for every action there is an equal and opposite reaction**; the 'rocket' travels upwards with a force that is equal and opposite to the downward force of the propelling the water, gas and lid.

The 'rocket' lids lift off because they are acted upon by an unbalanced force (Newton's 'First Law'). This unbalanced force which causes the lid to blow off is due to the increased pressure due to the gas formed in the canister. The amount of force is directly proportional to the mass of water and gas expelled from the canister and how fast it accelerates (Newton's 'Second Law'). Phew… lots of science here!

**Fair Test:** If you decide to turn this demonstration into an investigation your assistants will need to ensure they understand they can only change one variable at a time.

Before you do the experiment get them to come up with their own ideas on what they need to change to make the reaction speed up or slow down. Some examples could be (these are the variables):

1. amount of tablet (i.e., all, ¾, ½, ¼)
2. volume of water
3. temperature of water
4. container size
5. particle size (large pieces of tablet or powder samples)

To ensure that they all start the experiment at the same time the tablets are attached to the film canister lids with blu-tac, whilst the water is poured into the canister itself. If powder is used, pour the water in to the canister then place a very thin sheet of tissue paper over the open top; carefully add the powder to the tissue paper making sure none drops into the water. Put on the lid to secure the tissue paper in place.

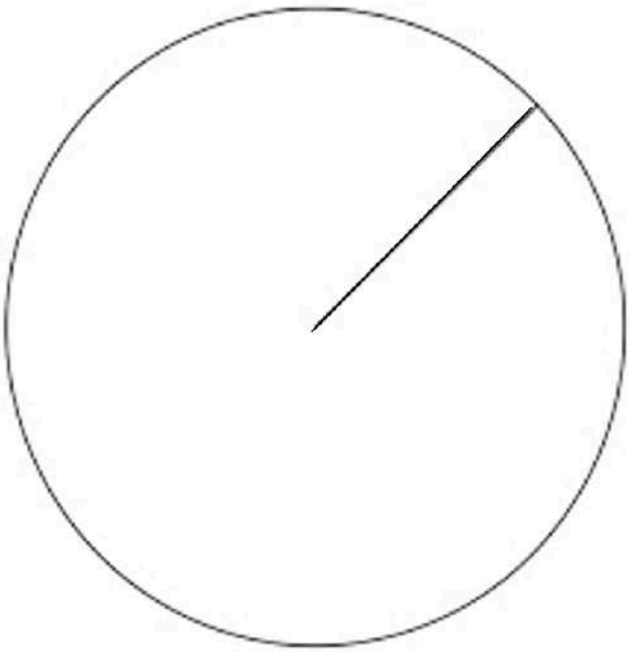
Your young science investigators can work on their own or in small groups. When everyone in the group is ready to start – have one of them do a count down so that they all turn their canisters over at the same time.

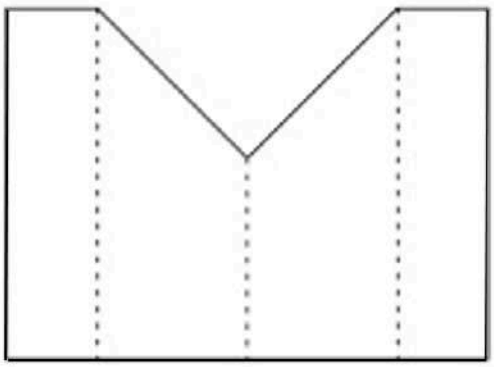
Use the template below to design a casing for your canister so that it looks more like a Space Rocket.

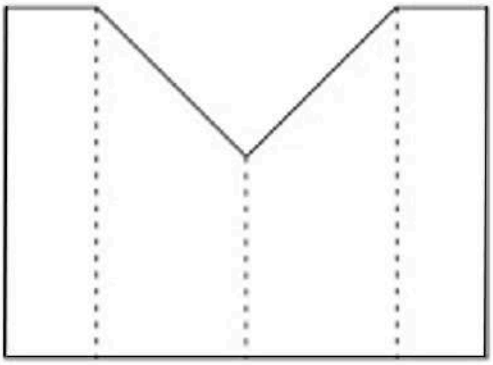
# 3 2 1...Lift off Rocket Template

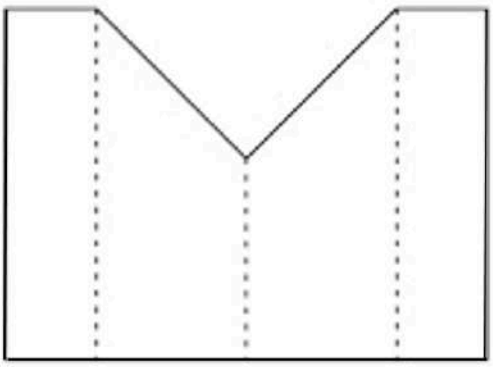
cut

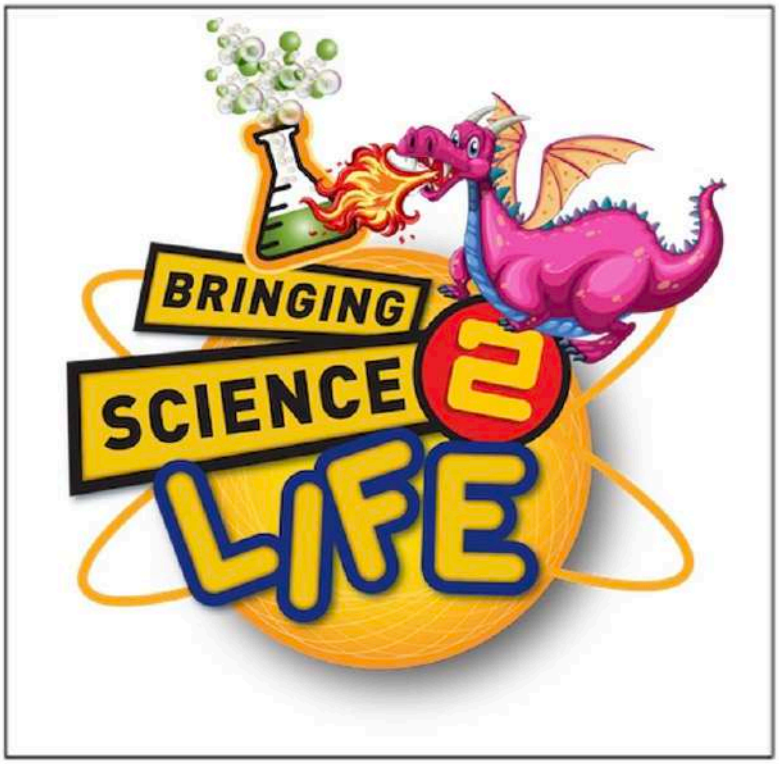
fold












# Experiment 3: Evanesco Spell

## What you have:

- Sachet 1 - Gelli Baff Crystals
- Sachet 2 – Salt
- Paper Cup
- Pop-up Wand

## What you need:

- Yellow colouring
- 2 x 30 ml Water
- Glitter (optional)
- 2.5 ml Spoon
- Clear beaker

The QR code above gives you another way to perform this spell in front of your young wizards – filmed for the NI Science Festival.

**Pronunciation:** */**EV**-ə-**NES**-koh*
**Description:** Makes the target vanish.
**Seen/mentioned:** Used in ***Order of the Phoenix*** by Snape to make Harry's potions disappear from his cauldron.

## SAFETY:

GELLI BAFF is slippery!!
If any of the Gelli Baff lands on the floor it must be cleaned up immediately to ensure no one slips.

Gelli Baff is certified bio-degradable.
It will not block sinks or toilets.

## Nuts and Bolts

- Before the show starts add ½ teaspoonful (2.5 ml) of the Gelli Baff crystals to the paper cup and the clear beaker.
- Prepare 60 ml of Unicorn's urine – split it between two small clear beakers.

## Secrets for Success

An example of a story line: Place Death Eater Crystals **(Gelli Baff Sachet 1)** into the paper cup – do this before you have gathered your audience. When they are all present and sat in front of your table introduce your audience to your bottle of Unicorn's Urine (YUK!) (yellow water – you can also add glitter and a nice fragrant oil).

Bring up a volunteer to stand beside you making sure they cannot see into the cup.

Pour 30 ml of the 'wee wee' into the cup.

Wave the wand over the cup uttering the following Spell:

*IN REALITY,*
*THIS COULD BE A TRAGEDY!*
*LET'S USE MAGIC,*
*TO OVERCOME GRAVITY!!*

Finish the spell with everyone shouting out EVANESCO!
**At this point, when you look into the cup you will have noticed that all of the liquid has been absorbed by the crystals.**

Lift the cup up and pour it over the head of your apprentice wizard.

Take a bow!

Repeat above as per the video.

This time your Apprentice volunteer will carry-out the spell using the clear beaker. You will have already put the crystals into the beaker – they will add the unicorn's urine and carryout the spell.

When on your own scoop out the gel and place it in the bin **NOT down the sink as it could block the drain – adding a spoonful of the salt in sachet 2 will break the bonds between the Gelli Baff polymer – this liquid could then be poured down the sink.**

## Science in a Nutshell

Gelli baff crystals are an example of water absorbing polymers.

A **polymer** is a molecule, made from joining together many small molecules called monomers. The word "**polymer**" can be broken down into "poly" (meaning "many" in Greek) and "mer" (meaning "unit"). Sodium polyacrylate are the water absorbing polymers found in babies' nappies.

Water absorbing polymers soak up water through a process called osmosis and they swell up. Some, like Gelli Baff, just absorb a small amount of water. Others, like the crystals in nappies absorb huge amounts of water.

The polymer chains have an elastic quality. The amount they stretch depends on the polymer.

If you like this product, you will love our Magic Snow Snowman!

Gelli Baff is a product that turns water into a jelly that you can put in your bath – This idea sounds extremely disgusting and messy to me – however I am not a child lol.

I tend to use Gelli Baff more for sensory play and magic. You have received this sachet of Gelli Baff to perform the EVANESCO SPELL, however the contents can also be used to make between 4 – 10 litres of jelly. The more water you use the thinner your jelly will be and vice versa.

The main ingredient in Gelli Baff is sodium polyacrylate. It absorbs from 800 – 1000 times its weight in water and is actually the secret ingredient that's used to absorb urine in baby nappies. Yukk!!! This is why I use Unicorn's Urine as the liquid in this demonstration.

Gelli Baff is a polymer. Polymers are long chain molecules. Water absorbing polymers soak up water through osmosis and swell to a very large size. The polymer chains have an elastic quality, but they can stretch only so far and hold just so much water.

When the fun is over the powder in sachet 2 contains a salt which dissolves the polymer allowing it to wash down the drain.

## Instructions for Sensory Gelli Play

### Step 1: Make your Gelli

1. Start with 4 L of warm water.
2. Gently sprinkle 50 g (**sachet 1**) of Gelli powder slowly and evenly over the surface of the water. Stir occasionally with a large spoon. To avoid possible staining, do not let skin come in contact with the powder prior to adding to water or the Gelli forming. The longer you mix the thicker it will get.
3. *With just 4 L of water the Gelli will be thick enough to use mould shapes – the children could even make a Gelli Castle!*
4. Once the Gelli is fully formed, you can then add more water to thin it out. Do not exceed 10 litres.

Why not try adding some dinosaur or ocean figures to create a prehistoric or sea sensory tub? Do you have easy grip tweezers? This activity could help little ones practice their fine motor skills whilst they are rescuing all of the animals.

### Step 2: Disposing of your Gelli

Note: this should be done by an adult.

1. When you are finished, you can evenly sprinkle the contents of **sachet 2** powder over the Gelli Play. These salt crystals will help to dissolve the Gelli into a drainable liquid.
2. The water will remain coloured, but the Gelli will be thinner and can easily be drained away. Carefully pour your Gelli down the toilet and flush.
   Gelli Play is certified bio-degradable and will not block toilets.
3. Rinse your container in the sink to remove any excess Gelli.

**Remember Gelli Baff is a slippery product. Take care when using it at all times.**

# Chief Wizard: The Magic Rope Trick

**What you have:**

Cosmic Ball

**Spells:**

PETRIFICUS TOTALUS & REPARIFORS

**Pronunciation:** */pe-TRI-fi-cus TOH-tal-us*
**Description:** Makes the object turn into stone
**Seen/mentioned:** Used during the 1986-1987 school year at Hogwarts School of Witchcraft and Wizardry, Professor Filius Flitwick taught his third-years how to cast this particular spell in Charms Class.

Hogwarts is a school for budding wizards. They are given access to a wide variety of spells to both use in combat and interact with the magical world.

The PETRIFICUS TOTALUS is a spell used in the ***Harry Potter*** universe that will paralyse its victims and turn them into stone.

In this activity you are going to use this spell to petrify your flexible rope so that it changes from being a flexible rope to one that is petrified.

REPARIFORS is the incantation used to repair small damages caused by spells that were meant to paralyse or poison the victim. When the word REPARIFORS is used with a magic wand it can reverse the effects of the PETRIFICUS TOTALUS spell.

## Secrets for Success

Follow this QR code which shows you how to prepare you rope.

This magic rope is an ingenious piece of engineering. Held at one angle it looks and feels like an ordinary rope, but with a twist of the wrist the internal plastic connectors align and the rope stands rigid like a stick!

All you need to do is to hone your performance skills and you will be able to astonish your audiences.

Demonstrate it as an ordinary rope coiled over your hand.

Now stretch the magic rope out between two hands horizontally and pretend to hypnotise it. Release one hand – Voila! – the rope stays horizontal like a stick. Use your free hand to hold it horizontal from the sticks middle.

Blow onto the rope and watch it fall down, limp again.

So long as you don't tell anyone about the engineering you will be able to repeat this magic again and again!

No strings, no extra attachments – just amazing engineering.

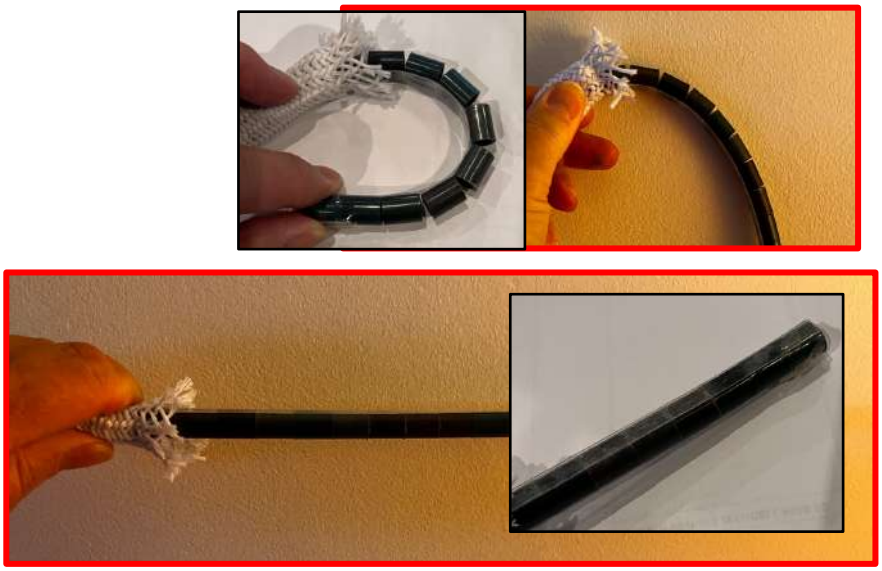
It will bring you lots of fun.

## Science in a Nutshell

When you handle the rope, you will notice a flat section that runs the length of the rope.

The outer netting covers a long tube which has been cut into just under 80 sections. These sections are glued onto the flat section that you feel.

When the flat section is facing the floor, the strip acts like a flexible 'rope'. When the flat strip is pointing upwards it acts like a 'stick'. In this formation you can hold it at either end or at its centre.



# Experiment 4: Magically Appearing Flower

## What you have:

- Flower in wand
- Plant pot


**Safety:** Keep magnets away from credit cards - magnets can erase the data stored on them. Follow URL on this QR to find out more about magnet safety

## Nuts and Bolts

Using the 'magical' pulling power of magnets you can amaze your audience by making a beautiful flower appear in the flower pot!

Hold the wand in the hand that you write with and the flower pot in the other hand.

Wave the wand over the pot and chant your magical incantation – this is my one!

*ABRACADABRA*
*PARTY POWER*
*LET'S DO MAGIC*
*TO CREATE A FLOWER!*

## Secrets for Success

Add a small dot onto the silver section of the wand that has the magnetic base of the flower. When you hand the wand to your young wizard, they have to hold it so that that end goes into the pot – otherwise nothing will happen!

During the video they will be guided by Scientific Sue to place the tip of the wand into the pot – when they do this the magnet on the flower will touch the base of the pot and will be attracted (pulled) to the magnet hidden in the base of the plant pot. When they pull the wand upwards and away as fast as you can the flower will appear in the plant pot… and voila!

### Setting the trick:

1. Always place the flower into the wand by the magnet end. This will protect your 'feather' flowers.

2. The magnet end of the flower must be flush with the end of the wand. This is to make sure that when the wand touches the magnet in the bottom of the flower pot the two magnets will pull together.
3. Lift the wand up and away quickly, follow the wand with your eyes. This will lead your audience's eyes away from the pot – when they look back, they will be astounded to see your beautiful flower inside the pot.

## Science in a Nutshell: Magnetism and Magnets

Magnetism is an invisible force, caused by the electrons in the atoms that make up everything around us.

A magnet is an object that has a magnetic field (an invisible pattern of magnetism).

Magnets come in different shapes and sizes but they all have a south seeking pole and a north seeking pole – we usually just say south pole or north pole.

- Opposite poles attract: this means the north pole of one magnet will attract (pull towards) the south pole of another magnet.
- Like poles repel: this means that the north pole of a magnet repels (pushes away) the north pole of another magnet and the south pole of a magnet repels (pushes away) the south pole of another magnet.

Objects which contain the elements iron, nickel or cobalt will be attracted (pulled towards) to a magnet. We can only get an object to be pushed by a magnet if that object itself is also a magnet and the facing poles are the same; north-north or south-south.

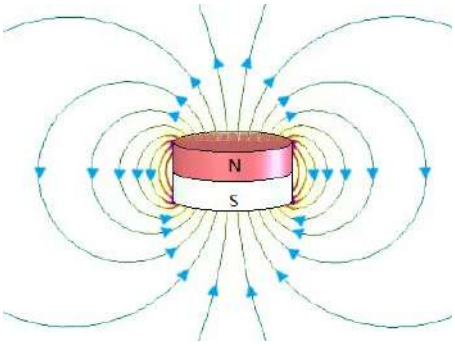
The Earth is a giant magnet, this means there is a magnetic field all around us. The north (seeking) pole on a magnet or a magnetized compass needle is often coloured red.
The opposite poles of two magnets are attracted. Therefore, when the red end of a magnet or compass is pointing north, it is because it is being attracted in that direction by the south end of another magnet (often coloured blue). So, when we think of the Earth as a big magnet, it is the south pole of the magnet that is underneath the North Pole of the Earth – The North Pole is actually a south seeking pole!

The means that the Earth's North Magnetic Pole is actually a magnetic south pole and the Earth's South Magnetic Pole is a magnetic north pole!

## The Compass

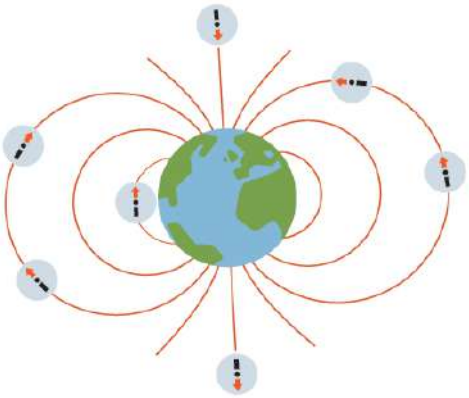
A compass comprises:

- a magnetic needle mounted on a pivot (so it can turn freely)
- a dial to show the direction




The north pole (north-seeking pole) of the compass needle points towards the Earth's North Pole. If the needle points to the N on the dial, you know that the compass is pointing north. This lets you navigate outdoors using a map.

***Using compasses, we can map the direction of the magnetic field lines surrounding a magnet. This is the pattern you would find around neodymium magnets in this kit.***



*The Earth's magnetic field affects the needles in compasses.*


## Earth's Magnetic Field

Magnets are simple examples of natural magnetic fields. But guess what? The Earth also has a huge magnetic field, due to the core of our planet being filled with molten iron (Fe). This large magnetic field protects the Earth from space radiation and particles such as the **solar wind**. When you look at tiny magnets, they are working in a similar way.

## The Floating Globe - explained

**Magicians can create magic by levitating objects using magnets.** The anti-gravity levitating Earth used in this show uses both a permanent magnet and an electromagnet.

The permanent magnet is hidden inside of the globe and the electromagnetic is hidden in the top section of the horseshoe shaped frame.

The electromagnet is pulling up on the magnet in the globe just enough to balance the earth's gravity pulling on it.

The two forces are equal and opposite so the globe floats in mid-air!

# Experiment 5a: Wingardium Leviosa Spell

### Using Static Magic

## What you have:

- Balloon Pump
- Balloon
- Sachets of salt and pepper

## What you need:

- Plate

## Nuts and Bolts – possible group exploration

- Balloon
- Balloon pump
- Black pepper
- Selection of cloths such as: fur, silk, nylon, cotton, wool
- Paper plate

## Secrets for Success

1. Sprinkle pepper on to the paper plate.
2. Blow up the balloon using the pump. Remove it when it is nearly fully blown up and tie it off. (You may wish to have a bag of blown-up balloons ready before this activity if time is restricted)
3. Get your students to rub the balloons on their hair or on a sample of cloth.
4. Can they see any of the charges that have moved? No!
5. Now get them to lower the balloon slowly downwards over the pepper on the paper plate. What happens?
6. Repeat on different parts of the balloon using different materials. Do some materials charge the balloon up more than others?
7. What is the maximum distance the balloon can be above the plate before the pepper starts to jump up?
8. Does this height change when different materials are used to rub it?
9. Does this experiment work best on dry or wet days?

## Science in a Nutshell - Why does the pepper jump upwards?

This experiment demonstrates static electricity. When the balloon was rubbed against the hair or cloth, it picked up a few extra electrons. These are small negatively charged particles that form the outer part of an atom.

This happens because the balloon is made of rubber which doesn't conduct electricity, it is an electrical insulator.

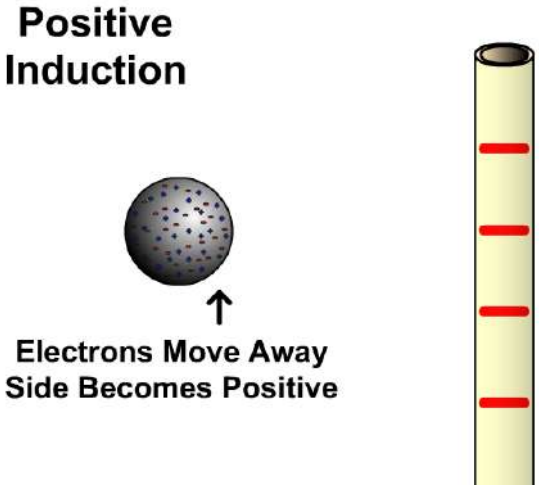
Electrons can be moved from one place to another on an insulator, usually by friction, but once moved they stay in place. Scientific Sue demonstrates this in part 2 of the Magical Science & Engineering Show, with the Magic Static balloon filled with polystyrene beads.

The balloon gains some electrons; the electrons sit on the surface of the balloon; they do not move around but remain stationary; static. This gives the balloon a negative over all charge.

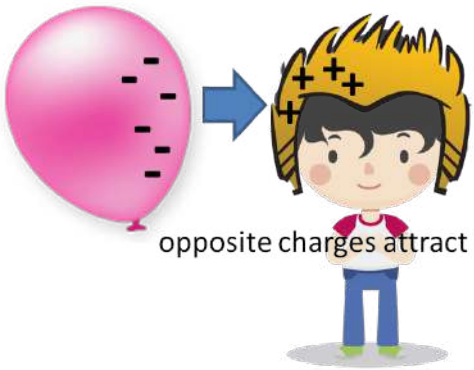
Pepper has a neutral charge meaning the particles contain an equal amount of positive (protons) and negative (electrons) particles.

In solids the positive particles are fixed in position in the nucleus of the atoms, but the negative electrons exist in the outer orbits around the nucleus and can move.

When the balloon is brought down towards the pepper the electrons on the surface or the pepper particles are pushed away because they are repelled by the extra negative electrons on the balloon, leaving the top of the pepper grains positively charged.




These positive charges are weakly attracted to the negatively charged balloon, causing the pepper to jump up and cling to the balloon. A weak electrical force holds the particles in place and makes them stick to the balloon.




# Experiment 5b: Visualising an Electric Field

## What you have:

- Translucent latex balloon
- Polystyrene beads
- Balloon pump


## SAFETY:

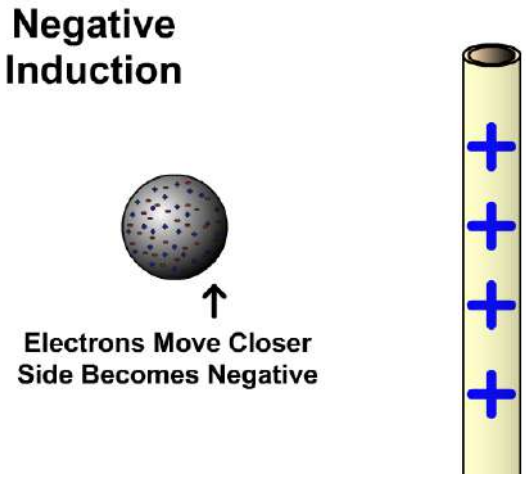
**Sometimes the balloons do burst, so be aware of students with a latex allergy.**

**Safety glasses must be worn.**

## Nuts and Bolts

During the WINGARDIUM LEVIOSA sketch and this one your students will:

- Discover electrical charges can be removed from or attached to materials using rubbing (frictional) forces.
- Frictional forces can be pulls or pushes.
- Some materials will let you move charges around on their surfaces but once the pulling or pushing force is removed the charges will remain at rest at their new position. We call these types of materials INSULATORS.
- Positive charges repel positive charges - Like charges push away from each other (repel).
- Negative charges repel negative charges.
- Positive and negative charges pull (attract) together - Unlike charges pull together (attract).
- Charged balloons can be used to attract a range of materials such as paper, pepper and salt by pushing (if the balloon is negatively charged) or pulling (if the balloon is positively charged) electrons on the surfaces on the materials away or towards the balloon. This movement results in positive and negative surfaces 'facing' each other and a resulting pulling force is experienced. Scientists call this redistribution of electrical charge on an object **Electrostatic Induction**.




- Forces due to positive or negative charges are called **electric forces**.

## Secrets for Success

Attach the balloon to the hand pump. Explain to your safety-glasses wearing volunteer that they will be using pushing and pulling forces to push air into the balloon. They must pull and push as fast as they can!! If they pump slowly, the beads will not charge enough.

In Scientific Sue's live shows she uses a double action hand pump. A link to Decathlon Stores has been added to the image.

As the beads whizz around the inside of the balloon they will gain electrons due to friction.

When the balloon is nearly blown up, remove it from the pump. Tie it quickly (**Only pull half of the neck of the balloon through the loop, this means you can easily untie it at the end of the session. Release the air slowly so that the polystyrene beads remain in the balloon!),** and then show your young wizards the beads surrounding the inside of the balloon.

The polystyrene beads are spread out on the inside surface of the balloon. Each bead is pushing against the others surrounding it, showing us that **like charges repel**. However, they also appear to be 'stuck' to the balloon. They are pulled towards the balloon. This is due to the balloon now being positively charged, due to the fact that the balloon has donated its outer electrons to the beads. **We can see that positive charges and negative charges attract**.

See the notes below on the triboelectric series for further clarification.

Your students will get very excited in this demo as they expect the balloon to burst - **the aim is that it doesn't.** However sometimes it does, much to the joy of the children, and to our annoyance - hence the need for safety glasses. Translucent balloons can be purchased from most balloon party stores and of course from the Science2Life website – links are given throughout these teaching notes.

Holding the charged balloon with 2 hands gently rub the balloon on the head of your volunteer in three places to make a face – if your volunteer isn't willing to have their head rubbed get them to rub it on your head – or a sleeve.

Hold the balloon above the hair that has been rubbed; the hair will be attracted upwards towards the balloon. Move the balloon sideways and the hair moves. This is always good for a laugh.

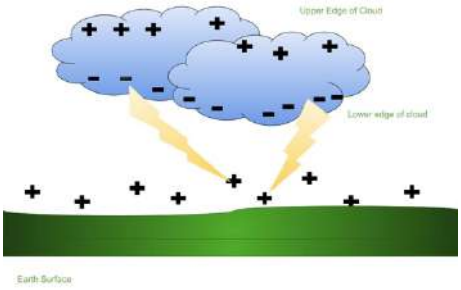
## Science in a Nutshell

*Latex does not have any free electrons. All the electrons are tightly bound to the atoms (hence the need for a frictional force to steal them). Thus, when electrons are moved by a frictional force, they stay put in the position they have been moved to.*

**Static Charges:** Electrons can move more easily in some objects than in others. If you put a charge on things like glass, plastic, rubber, and wood; that charge stays where you put it.

We say the charges are static, and we call this phenomenon **static electricity**. Materials like glass and plastic are called insulators, or non-conductors. You can sometimes experience static electricity build-up on dry days when you walk across a carpet. You are actually building up loads of electrons on your skin. Charges don't "want" to stay separated, however. There is always a tendency for charges to return to their original locations, and all that is needed is a pathway for charges (electrons) to use. When you touch a metal doorknob, for example, electrons can jump and give you a shock.

Static charges build up on clouds, **until** they can hold no more. At that point, lightning can occur. The study of electricity where the charges are not moving is called electrostatics.



## Triboelectric Series

Two materials only need to touch each other for there to be a transfer or exchange of electrons. After coming into contact, a chemical bond is formed between some parts of the 2 surfaces and electrons move from one material to the other to equalise their electrochemical potential.

If the 2 materials are now separated, we could end up with a net charge imbalance between them. This is due to the fact that when separated, some of the bonded atoms have a tendency to keep extra electrons, and some have a tendency to give them away.

We call this effect the **triboelectric effect.** This transfer of electric charge is greatly enhanced by rubbing the materials together, as they touch and separate many more times.

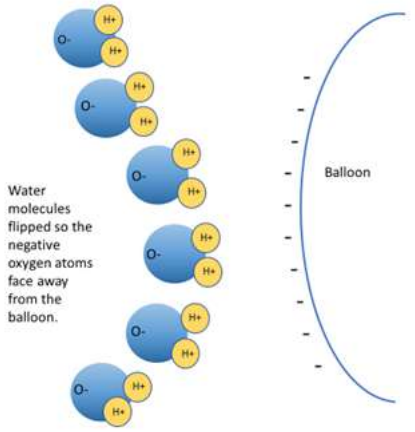
Because the surface of the material is now electrically charged, either negatively or positively, any contact with an uncharged conductive object or with an object having substantially different charge may cause an electrical discharge of the built-up static electricity; a spark.

As discussed earlier a person simply walking across a carpet may build up a charge. This charge build up could be of many thousands of volts, enough to cause a spark one centimetre long or more!

Low relative humidity in the ambient (surrounding) air increases the voltage at which electrical discharge occurs by increasing the ability of the insulating material to hold charge and by decreasing the conductivity of the air.

These conditions make it difficult for the charge build-up to dissipate gradually however on damp, humid days the extra water in the atmosphere increases the conductivity of air due to the dipolar nature of the water molecule.

Simply removing a nylon t-shirt can also create sparks. Car travel can lead to a build-up of charge on the driver and passengers due to friction between the drivers' clothes and the leather or plastic furnishings inside the vehicle. This charge can then be relaxed as a spark to the metal car body, fuel dispensers or nearby door handles, etc.




Click on this link to find out how your young wizards could make a stream of water bend – like magic!

The car/vehicles body itself can also build up a static charge (the car body acts as a Faraday cage) it can relax through the carbon in the tyres. If it remains charged when parked, sparks may jump from the door frame to the driver / passenger as they make contact with the ground.

This type of discharge is often harmless because the energy of the spark is very small, being typically several tens of micro joules in cold dry weather, and much less than that in humid conditions. However, such sparks can ignite flammable vapours.

The most famous historical example of this being the Hindenburg disaster.

The Swedish wizard (physicist), Johan Carl Wilcke published the first Triboelectric Series in 1757. This list ranks materials according to their tendency to gain or lose electrons and therefore how quickly a material develops a charge relative to other materials on the list.

When you rub a balloon on your hair, from the table we can see that the hair will donate its electrons to the balloon. The balloon will become negative charged.

When the polystyrene beads are in the balloon the beads become negatively charged and the balloon positively charged!


***HAIR** donates its electrons to the **POLYSTRENE***

# Experiment 6: Cosmic Ball

## What you have:

- Cosmic Ball

## Secrets for Success

By simply touching the cosmic ball's metal strips (electrodes), the ball becomes a mini light and sound show; it emits a red light and creates a buzzing sound. Even though it is sold as a toy, this toy allows us to safely demonstrate conductivity, connectivity and electrical currents.

At this point you, as Chief Wizard will have been guided by Sue to arrange your young apprentice wizards so that they form a circle in experiment 5b – they will have been pushing the charged balloon around in the circle.

To begin the activity, you as Chief Wizard will be outside of the circle, the children will be looking at you. In the video Sue will ask you to switch the cosmic ball on and off with the click of your fingers!

You will need to hold the ball so that your thumb is touching one of the electrodes. As soon as the second electrode is touched by one of your fingers the light and sound show will begin – practice working with Sue in the video section so that the biggest impact on the children is made.

Once it has been activated by you clicking your fingers, it will be activated again by the children clapping their hands.

You, as Chief Wizard will then join the circle.

Let them know they will be human wires and to connect them together they have to hold hands.

Some children may not like the idea of holding hands – metal spoons could be added into the circuit to overcome this problem.

You will hold the cosmic ball so that your thumb is covering one of the electrodes.

All the other children are holding hands – you are holding the hand of the child on the other side of you. The only gap in the circuit is to be between you and the child who is going to touch the cosmic ball.

This child will touch the other electrode with a pointing finger. That child now becomes the switch in the circuit. When they touch the electrode electricity will flow through everyone in the circle and the ball will glow and buzz. When they remove their finger, they break the circuit.

If the ball is lighting and there is a gap in the circle you will find that the child is touching the electrode **and you**. Electricity will always choose the easiest route to flow through. It takes the shortest route – hence the term short circuit.

What happens if they one of the children pull their sleeve over their hand? Clothes behave in exactly the same way that the plastic coating covering our wires does. These materials are insulators and the ball will not be activated.


## Science in a Nutshell

An electric circuit is like a pathway made of wires that electrons can flow through. A battery or other power source gives the force (voltage) that makes the electrons move. When the electrons get to a device like a light bulb, your computer, or a refrigerator, they give it the power to make it work.

The word "circuit" sounds like "circle," and a circuit needs to be complete like a circle to work. The wires have to go from the power source to the device and back again, so that the electrons can move through every component in the circuit.

Many circuits have a switch so that they can be turned on and off. When the switch is off, it makes a gap in the circuit and the electrons are not able to cross that gap hence they can't flow around the circuit. When the switch is turned on, it closes the gap and the electricity is able to move and make the device work. An electric circuit is in many ways similar to your circulatory system. Your blood vessels, arteries, veins and capillaries are like the wires in a circuit. The blood vessels carry the flow of blood through your body. The wires in a circuit carry the electric current to various parts of an electrical or electronic system.

Your heart is the pump that drives the blood circulation in the body. It provides the force or pressure for blood to circulate. The blood circulating through the body supplies various organs, like your muscles, brain and digestive system. A battery or generator produces voltage; the force that drives current through the circuit.

Take the simple case of an electric light. Two wires connect to the light. For electrons to do their job in producing light there must be a complete circuit so they can flow through the light bulb and then back out.

In this demonstration we use a cosmic ball to help illustrate the fact that for electricity to flow we need (1) a complete circuit and (2) the components in the circuit need to be conductors of electricity.

Electricity is a basic part of nature and it is one of our most widely used forms of energy. It is a source of energy that has allowed us, in only 200 years, to make such huge technological advances that today we treat this source of energy with nonchalant disregard.

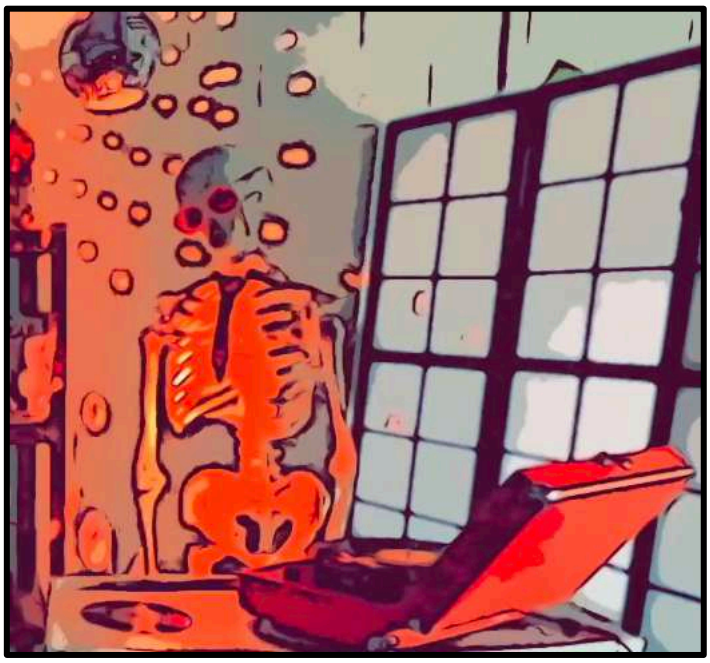
The historical story behind the scientists who have, over the past 200 years, discovered and developed the uses of electricity, embraces many countries and is a wonderful example of people working together and learning from each other. This show introduces you to just four of them.

We get electricity, which is a secondary energy source, from the conversion of other sources of energy, like coal, natural gas, oil, nuclear power and other natural sources, which are called primary sources such as the sun and wind.

Many cities and towns were built alongside waterfalls (a primary source of mechanical energy) that turned water wheels to perform work. Before electricity generation began slightly over 140 years ago, houses were lit with kerosene lamps, food was cooled in iceboxes, and rooms were warmed by wood-burning or coal-burning stoves.

Beginning with Benjamin Franklin's experiment with a kite one stormy night in Philadelphia, the principles of electricity gradually became understood. In the mid-1800s, Thomas Edison changed everyone's life -- he perfected his invention -- the electric light bulb. Prior to 1882, electricity had been used in arc lights for outdoor lighting. Edison's invention used electricity to bring indoor lighting to our homes.

## And we have to give Edison a big thank you for our disco lights!



# Experiment 7: Sound Ribbon

## What you have:

- Sound ribbon
- Paper cup

## Nuts and Bolts

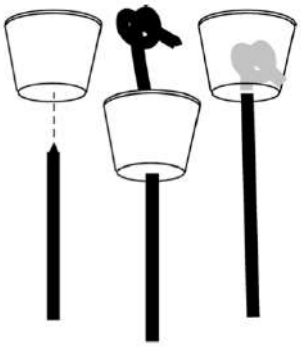
Sound ribbons are plastic strips less than 3 mm wide with a thickness of 2 or 3 sheets of paper and about 61 cm long. These strips are specially moulded so that, which vibrated in just the right way, they produce audible speech.

This sound ribbon physically resembles cable ties: one side of a thin plastic strip has a series of ridges and the other side is flat.

On this strip the words SCIENCE IS FUN is recorded on one side and easily played by running your thumbnail over the grooved side of the strip.

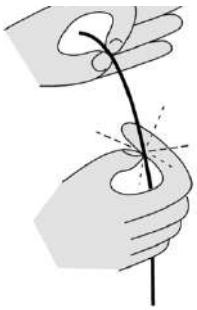
The principle is the same as a diamond needle travelling through a record groove.

## Secrets for Success



- Pinch the strip near at its pointed end using your non-writing hand
- Maintaining the pinch, grasp the tape with your writing hand so that


your thumb nail can be pressed against the side of the tape that has the bumps.



- Pull the tape through your thumbnail – forefinger so that your thumbnail passes across the bumps
- Experiment with the thumbnail pressure and the pull speed to hear the message SCIENCE IS FUN!
- To amplify the sound emitted hold the strip again the side of the paper cup or against any other amplifier such as a sheet of paper, a balloon, a foam cup, or a desk. Which surface gives the greatest amplification?

### An Amplification Suggestion

- Use a pointed end, say of a pen, to poke a hole in the bottom of the cup.
- Pull enough tape into the cup so that you can tie a simple knot near the pointed end.
- Pull the tape back until the knot rests against the inside of the cup.
- Use your non-writing hand to hold the cup, and once again run your thumbnail across the bumps.

## Class activity

Repeat above using a selection cable ties and paper cups.
The pointed end of the cable tie is thread through the inside of the cup

# Science in a Nutshell

Sound is created and transmitted through the air by vibrations. As your fingers slide across the strip, they create small vibrations. The sound created by the vibrations is then amplified by the cup, creating the strange speaking sound.

The Sound ribbon works on a similar principle to gramophone records, using grooves to store sound albeit in a linear manner opposed to a spiral. The tapes come pre-moulded.

The storage capacity is determined by the length of the strip and speed at which the user pulls their fingernail over the grooves. Tapes are typically only long enough to store a short sentence, up to around 3 seconds long. However, there is no physical limitation on length: the tape could theoretically be wound onto a spool and played back like a wire recording.

Each strip can be played back many times until the grooves wear out.

Want to investigate sound a little more? Click on this link: Investigating Sounds or Fuaimeanna a Fhiosrú

## The Straw Oboe – As demonstrated in the show

### Nuts & Bolts

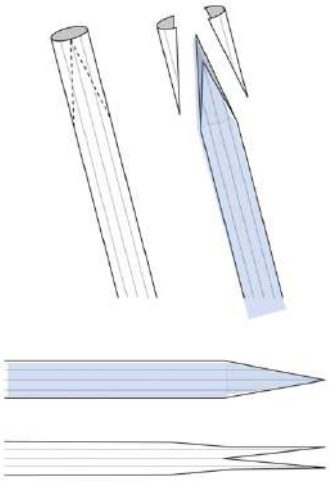
- Plastic Straws
- Scissors
- Scissors

### Secrets for Success

Using your fingers flatten one end of the straw. Use the scissors to cut the flattened end so it looks like this shape _/, note the angled lengths should be between 1 and 1½ cm in length. Ask your assistants to place the cut end, the reed, into their mouths. Ask them to place the 'reed' onto their lower lip – then with their lips barely touching they have to blow steadily whilst gradually increasing the pressure from their lips until they get a sound. The teeth should not be used!

Note the whole of the cut section must be fully inserted into the mouth. If you are lucky enough one or all of them will get a sound first time round. However, if no sounds are forth coming check that the straw

is far enough in the mouth, and or ask them to tighten their lips and gently squeeze the straw with their fingers as they blow – not too much though as air is required to move through the straw!



This demo will produce lots of laughter from everyone – the flattened _/ shaped tip acts like the reed found in most wind instruments. Blowing on the reed causes the straw to vibrate. The vibrations are felt by the lips of the blower and they usually stop blowing first off because the experience is very weird. The buzzing sound is a bit like a musical duck call!

Once you have an assistant that can give you a long note, get them to hold the straw close to their mouth. With the scissors try cutting the end off of the straw, notice what happens to the change in the sound of the note. Keep cutting until the straw is a third of its original length – let your assistant know what you are going to do as they will get fearful for their fingers!!

Safety: Wearing safety glasses is recommended if you are cutting the straw to prevent the plastic end pieces going into eyes.

## Science in a Nutshell

When the flattened end of the straw is cut into a V shape and placed into the mouth, the '_/' shaped reed vibrates when you blow gently, this is because when you blow a pulse of compressed air flows down the straw. The pulse travels down the straw at Mach 1, the speed of sound, and bounces off the distant open end. At this point the compressed air changes into a low-pressure expansion (low pressure because, due to the expansion of the air, there are less air molecules per unit volume, in other words the density of the air has decreased). When the expanded air reaches the two flattened edges of the straw, they are forced closed they then bounce open again to admit more air. Thus, the sound bounces back and forth inside the straw and the flattened edges, our reed, opens and closes (vibrates) creating the duck like sound.

## A little bit of background on the Magical Wizards who brought music to the world!

**Scientist**

### ALESSANDRO VOLTA (1745 – 1827)

An Italian physicist whose invention of the electric battery provided the first source of continuous current.

**Invention**

### Battery


For most of the 18th century scientists believed that electricity could only be generated by living organisms. The person that challenged that mistaken belief was Alessandro Volta.

In 1799, Alessandro Volta developed the first electrical battery. It was known as the voltaic pile (cell) because it consisted of a pile of alternating zinc and copper discs separated by paper or cloth soaked in salt water or sodium hydroxide.

He reported the results of his experiments in 1800 in a two-part letter to the president of the Royal Society.

Volta's development of the first continuous and reproducible source of electrical current was an important step in the study of electromagnetism and in the development of electrical equipment.

The Voltaic pile stimulated so a huge amount of scientific enquiry. Without Volta's work, many of our modern technologies would not exist.

In recognition of Alessandro Volta's contribution to science, the unit of electric potential is called the ***volt.***

**Scientist** **HANS CHRISTIAN OERSTED (1777-1851)**

A Danish physicist and chemist who discovered that electric currents create magnetic fields, which was the first connection found between electricity and magnetism.

**Discovery** **When electricity flows through a wire a magnetic field is produced around that wire.**

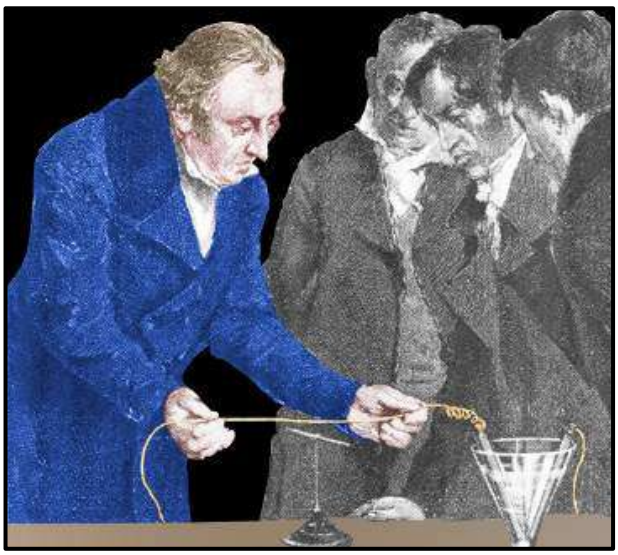
Ørsted (Danish spelling) began a new scientific epoch when he discovered that electricity and magnetism are linked. He showed by experiment that an electric current flowing through a wire could move a nearby magnet.

The discovery of electromagnetism set the stage for the eventual development of our modern technology-based world.

Ørsted's famous experiment showing that electricity and magnetism are linked, took place during a lecture on April 21, 1820. In the experiment he passed electric current through a wire, which caused a nearby magnetic compass needle to move.

Over the ensuing months he carried out more experiments, discovering that the electric current produces a circular magnetic field around it.

Just as Volta's invention of the battery has opened new horizons in physics and chemistry, Ørsted's discovery unleashed a revolution in physics leading us into our current digital world.



**Scientist** **WILLIAM STURGEON (1783-1850)**

An English physicist and inventor who made the first electromagnets, and invented the first practical electric motor.

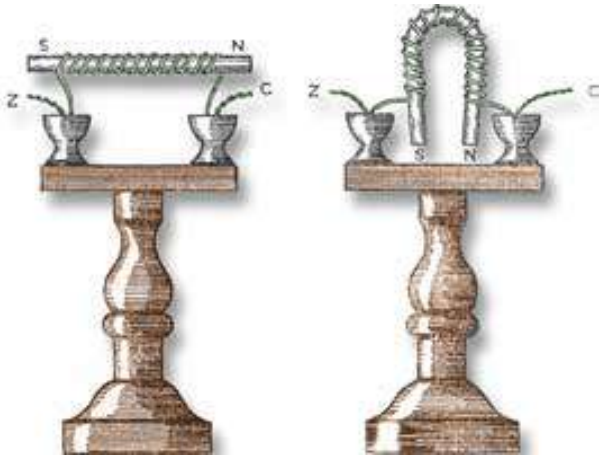
**Invention** **Electromagnet**

Sturgeon invented the electromagnet in 1825, 5 years after Ørsted discovered that electricity emitted magnetic waves. Sturgeon harnessed this idea and conclusively demonstrated that the stronger the electric current, the stronger the magnetic force.

Sturgeons first electromagnet was a horse-shaped piece of iron that was wrapped with a loosely wound coil of several turns. When a current was passed through the coil the piece of iron in the coil became magnetised, and when the current was stopped both coil and piece of metal were de-magnetised.

Sturgeon displayed the power of his electromagnet by lifting nine pounds (4.08 kg) with a seven- ounce (0.2 kg) piece of iron wrapped with wires which the current of a single cell battery was sent.

Sturgeon could regulate his electromagnet – that is, the magnetic field could be adjusted by adjusting the electrical current. This was the beginning of using electrical energy for making useful and controllable machines and laid the foundations for large-scale electronic communications.



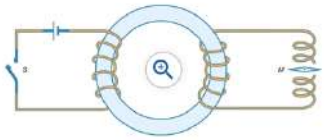
## Scientist

## MICHAEL FARADAY (1791-1867)

An English scientist who contributed to the study of electromagnetism and electrochemistry. Faraday, the greatest experimentalist in electricity and magnetism of the 19th century is also considered to be one of the greatest experimental physicists of all time, proved that a magnet could induce electricity.

## Invention

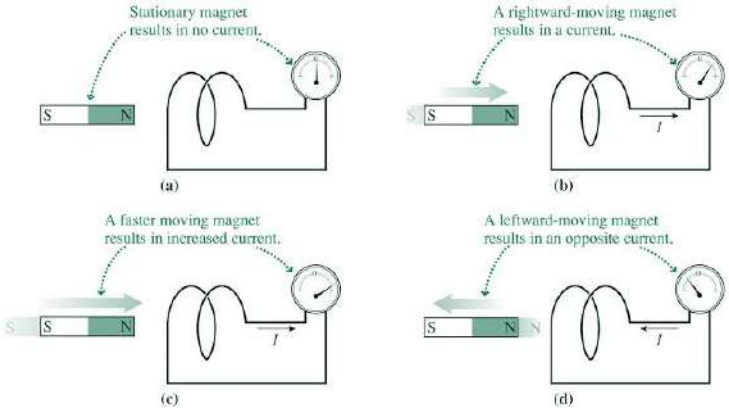
## Electromagnetic Induction & Electromagnetic Rotary Devices

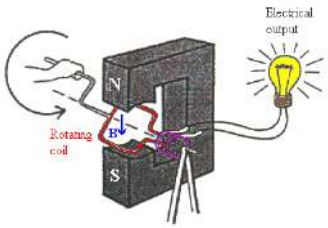


In 1831 Faraday was able to demonstrated that changes in the magnetic field around a coil of wire were responsible for inducing a current in a second coil of wire.

His original set up consisted of 2 coils of wire wound around opposite sides of a ring of soft iron. The first coil was attached to a battery; when a current passed through the coil, the iron ring became magnetised. A wire from the second coil was extended to a compass needle a metre away, far enough away so that it was not affected directly by any current in the first circuit.

When the first circuit was turned on, Faraday observed a momentary deflection of the compass needle and its immediate return to its original position. When the primary circuit was switched off, a similar defection of the compass needle occurred but in the opposite direction.




Faraday also showed that an electric current can be induced by moving a magnet,
by turning an electromagnet on and off, and even by moving an electric wire in the Earth's magnetic field.

Within a few months, Faraday built the first, albeit primitive, electric generator.

# The Acrobatic Dragon Activity

## Method

1. Cut out the Dragon.
2. Add more decoration using coloured pencils or crayons.
3. Balance the Dragon on a finger. Where is this balancing point?
4. Add one paperclip to each of the Dragon's wings.
5. Balance the Dragon again. Where is the balancing point this time?
   You will notice the point – we call this point the Centre of Mass – will have moved closer to the dragons' nose.
6. Repeat this process until the Dragon can balance horizontally on a fingertip.
7. Encourage the children to explore balancing the dragon on other objects around the room.

**You will need:**

Dragon Template
Coloured pencils or crayons
Paperclips

Optional:
1 or 2 pence coins

## Using Magic to get your Dragon to spin

Abracadabra
Alakazin
Locomotor magic
Make my dragon spin!

### The *LOCOMOTOR* Charm moves targets.

In your kit there would also have been a kebab stick, a Magic Wand and 3 neodymium magnets

One magnet is attached the end of the wand with a sticky dot

The other magnets are placed on each of the wings of your balancing dragon.

When you bring the magnet on the wand close to the magnets of the wings of the dragon the magnet fields will interact and the Dragon will either be pushed away or pulled towards the wand.

## Magnet Safety

**This QR Takes you the First4Magnets safety page**

# Science2Life Online Store

**Needing extra stock? Check out the links below to see what we have on offer for you!**

| Item | QR code | Item | QR code |
|---|---|---|---|
| Magically appearing pop-up wands x 10 | | Flower from Wand Trick | |
| Magic Rope – Flexible to Stiff | | Sound Ribbon x 10 | |
| Static Electric Balloon Trick x 10 | | Balancing Dragon Activity x 30 | |
| Gelli Baff Crystals 12 x 50 g bags | | Cosmic Ball | |
| Rocket Balloons x 10 | | Soft edged safety glasses | |
| Wandarama | | Magic Snow Snowman | |