STEAM

SCIENCE-TECHNOLOGY-ENGINEERING-ART-MATHEMATICS

ACADEMY

A VIRTUAL SCIENCE2LIFE EXPERIENCE

SME news
Northern Irish Enterprise Awards 2023
Science2Life
Most Innovative Children's Science Workshop Provider Northern Ireland

Science of Dragons

An interactive event designed by Science2Life to encourage children to:

- discover the amazing world of science and engineering
- perform engaging activities that show how science is at work in their everyday lives.

An innovative, Friendly Learning Experience

Science Education in a Fun Format

Flexible Learning

The Science Show is Interactive!!!

Susan Carvell BSc Hons PGCE CEd DASE MEd FInstP
www.science2life.com

Dear Teachers

Science of Dragons – A Virtual Science Experience

The most exciting part of this Virtual Experience is the fact that you, the teacher, is now in charge! 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 6 activities this interactive session requires volunteers for!

There is no set timetable to adhere to.

You may choose to split the viewing of the show over several days; you may want to choose more volunteers than I ask for, or to allow the whole class to do all of the activities!

The show video has been uploaded onto my YouTube page – you will have been sent the link to this page by your science festival provider. The link to these notes and the teacher guidance video were found description section under the video. The show video can be shown to individual classes or to larger groups in the school hall and can even be shared with parents! You can buy extra kit boxes from our online store – see below.

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.

The contents of the interactive kit boxes have been chosen so that they can be readily purchased by yourselves from supermarkets or pharmacies – you will also find links within this teacher's guide that takes you to our own Science2Life Online Store .

There are no time limits set on when you can share this virtual experience with your children.

FANTASTIC VALUE FOR MONEY!

For just £185 | €220 (including postage!) you get the full virtual experience: The activity box, an engaging show, teacher guidance video, detailed notes, and a personalised 20-second intro for your class!

A bit about Sue

Sue began her career teaching Physics and Chemistry in 1991. After completing a Master's in Educational Studies, she left the classroom in 2000 to join the founding management team of W5 (whowhatwherewhenwhy), now a globally renowned science centre that opened to the public in 2001. At W5, Sue was instrumental in developing a suite of Educational Programmes tailored for audiences of all ages, from primary and post-primary students to adult learners.

During her time at W5, Sue joined the editorial team for *Physics Education*, the Institute of Physics' magazine, and it was in this role that she was awarded a Fellowship in recognition of her contributions to physics education.

In 2006, Sue launched Science2Life, a company devoted to bringing highly interactive and innovative STEAM shows and workshops to schools, colleges, and special events.

Science2Life also provides teacher training sessions.

Sue's programmes have reached audiences across Ireland and the United Kingdom, and internationally in Switzerland, Saudi Arabia, Nigeria, Lebanon, the United Arab Emirates, and Qatar.

In 2015, partnering with the Northern Ireland Science Festival and the Royal Society of Chemistry, Sue led a record-breaking class of 1,339 students, setting a Guinness World Record for the Largest Practical Science Lesso

Science2Life now offers virtual programmes, including this one. Details about the current virtual experiences available through Scientific Sue's STEAM Academy can be found at the end of this teaching guide.

We understand that virtual teaching may be as new for you as it is for us – your feedback is invaluable in helping us improve and make these experiences even more effective. Please don't hesitate to share your thoughts and suggestions so we can continue to enhance our programmes for you and your students!

Any questions you can contact Sue via email or telephone:

scientificsue@science2life.com +44 7970 884728

A bit about the Show

The Science of Dragons Show draws inspiration from Cressida Cowell's much-loved books and the thrilling DreamWorks films that followed.

While Cressida may not explicitly mention science or engineering in her tales, the creative challenges and feats her young Vikings and dragons tackle open the door to a world of science and technology – all explored in a fun, imaginative, and interactive way. In every format of The Science of Dragons Show, Sue highlights that Cressida is not only a remarkable storyteller but also something of a 'hidden scientist'!

All of Sue's virtual shows are interactive, and The Science of Dragons Show offers six exciting opportunities for volunteers to join in the adventure.

Science and Literacy

One of the key goals of this educational programme is to inspire children to pick up the How to Train Your Dragon books and develop a love of reading – a vital skill that supports not only their academic success but also their future careers in fields like science and literacy.

Many of the children may have seen the How to Train Your Dragon films or cartoons, but far fewer will have delved into the books themselves. This activity offers an excellent opportunity to encourage them to read for pleasure. Research has shown a strong link between time spent reading for enjoyment and overall reading achievement (Twist, 2007). Furthermore, children who read for pleasure tend to make significantly greater progress in vocabulary, spelling, and even mathematics, compared to those who read less frequently (Sullivan & Brown, 2013).

Unleashing Dragon Science: A Six-Part Adventure

The show is divided into six independent sections, allowing you to either engage with them all at once or spread the activities across multiple sessions to suit your schedule.

1 Toothless Flies Again: Spin, Dodge and Defend.
2 Stormfly's Spectrum: The Science behind Colour and Camouflage.
3 Science Showdown: Neutralising a Changewing's Acidic Spit.
4 Unmask the Gas: Discovering a New Dragon Firetype!
5 Blast off! Training Meatlug to Hit the Target.
6 Training your Dragon to Balance and then spin!

It is strongly recommended that you watch the teacher guidance video and the show video a couple of days before you engage in this activity so that if you have any queries and need to ask me a question, I have time to get back to you!

Email: scientiicsue@science2life.com

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.

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.**

Items in your Science of Dragons Box

Item	Quantity	Item	Quantity
Dried Red Cabbage	10 ml	Dragon Templates	31
pH Colour Card	1	Dragon Mask Template	1
Citric Acid	125 g	Marker Pen	1
Baking Soda	125 g	Metallic Paper Clips	30
Linking Balloons	10	Tube with Spring Lid	1
Small Candle	1		

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

Sparks of imagination are at the heart of creativity!

SHOW CHECKLIST: WHAT YOU HAVE (√) – WHAT YOU NEED

Before the Virtual Experience		CHECK
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 and the volunteers!	
	Hair dryer – if you are not going to hold it – follow the instructions in the teacher video and tape it to the edge of the table.	
	Extension lead – this is only required if the socket for the hair dryer's lead is not long enough.	
	Safety glasses – these can be proper safety glasses or a visor, swimming goggles, reading glasses – anything that protects the eyes from splashes	
	Paper towels	
	Bucket of warm water for washing hands – if you don't have a sink in the room.	
	6 trays and a spillage tray	
	Sachet of dried red cabbage – this could be done in front of the children during the show	√
	Add a teaspoon of dried red cabbage to 500 ml warm water. This will be your **Dragon's Drool.** If you don't want the rehydrated cabbage bits pass the liquid through a sieve.	
TRAY 1: Toothless Flies Again	Packet of Linking balloons (10) Inflate 5 of the linking balloons and join them together to form a loop.	√
	Marker pen	√
	Dragon face template	√
	Draw a face of a dragon using the marker pen and template for guidance	
	A hairdryer (2400 W)	
	An extension lead	
	Gaffa tape – if you choose not to hold the hairdryer	
	Selection of items to throw at the dancing loop of balloons: bean bags, small balls, plastic bow and arrow (with suckers)	

TRAY 2: Stormfly's Spectrum	Red Cabbage Powder – 10g + pH colour card	√
	Citric acid – 125 g	√
	Baking soda – 125 g	√
	500 ml of warm water	
	2 Small clear beakers (200-300 ml)	
	1 Large clear beaker (500-1000 ml)	
	2 Spoons	
	1 teaspoonful of cabbage powder added to 500 ml of warm water in a clear beaker or jug (500 – 1000 ml)	
	2 x Safety glasses	
	1 Spoonful of citric acid pre-measured into a small pot	
	2 Spoonful's of baking soda pre-measured into a small pot	
TRAY 3: Science Showdown	The larger beaker/jug with 1cm depth of cabbage juice – left over from Activity 2	
	Beaker containing the citric acid – RED solution	
	Beaker containing the baking soda – BLUE solution	
	Drip tray – if it has high sides place something inside onto which the larger beaker can be placed so that everyone in the class can see it's contents.	
	Safety glasses	
TRAY 4: Unmask the Gas	Citric acid	√
	Baking soda	√
	Tea light candle	√
	500 ml Bottle	
	Matches or a lighter	
	Small clear beaker for candle	

	Funnel	
	2 Spoons	
	Balloon	
	100 ml warm water	
	Safety glasses	
	Long tongs or Peg secured to a stick (I use a litter picker in the show)	
TRAY 5: Blast Off!	Tube with spring lid	√
	Citric acid	√
	Baking soda	√
	Jug or bottle of water	
	Tube of effervescent tablets e.g., Vitamin C tablets	
	Bin or box (target	
	Many families use these tablets – ask the children to bring in the empty tubes – they could be used for a class activity at a later time, but the extra lids will be useful in this activity.	
TRAY 6: Balancing Dragon	31 x Templates of the balancing dragon	√
	Marker pen	√
	30 x paper clips	√
	Scissors	
	Sellotape	
	Colouring and art materials	
	Pencil or kebab stick (I have my kebab stick stuck in a tub of playdough)	
	2 x coins of the same denomination (children to supply) OR (if you have enough) each child would need 12 paperclips – 6 for each wing.	

Activity 1: Toothless Flies Again!

Spin, Dodge and Defend

What you have:

- 10 Linking Balloons
- Marker Pen
- Dragon Face Template

What you need:

- Hair Dryer 2400W
- Extension Lead
- Gaffa tape (optional)
- Bean bags, balls etc

SAFETY:

Ensure the hairdryer is set to the **cool** setting to avoid blowing hot air toward the children or yourself during the demonstration. This will keep the activity safe and comfortable for everyone involved.

Nuts & Bolts

Inflate five balloons and tie them together as shown in the guidance video. Use a marker to draw a dragon face on one of the balloons—feel free to follow the template or create your own design! If there's no power socket near your demonstration area, make sure to have an extension lead handy.

Secrets for Success

Note: Any round balloons will work – just connect them using double-sided sticky tabs. If the balloons are small, you can connect more together.

Your students will watch you bring this dragon balloon loop to life! With the help of a hairdryer, you'll create airflow across one side of the dragon's curved surface. This faster airflow on this side lowers the pressure, while the slower-moving air on the opposite side increases pressure, causing the dragon to hover and spin in the air.

You then ask a brave young Viking volunteer to step up to capture the dragon, throwing various objects you have gathered together to try to knock it out of the sky! This live demonstration will have your students captivated by the sight of a floating, spinning dragon they can interact with in real time.

Activity 2: Stormfly's Spectrum

The Science Behind Colour and Camouflage

What you have:

- Dried Red Cabbage
- pH Colour Chart
- Citric Acid
- Baking Soda

What you need:

- 500 ml Warm Water
- 500 ml Jug
- 2 Clear Beakers
- 2 Stirrers
- 2 small sauce pots (optional)
- Measuring Spoons
- Safety Glasses x 2

You may also wish to gather:

- Washing soda
- Lemon juice
- Toothpaste
- Vinegar
- Ammonia
- Baking powder
- Cucumber

SAFETY:

Safety glasses to be worn by volunteers when mixing the 2 solutions together to prevent any splashes going into their eyes.

None of the chemicals are for human consumption.

If any splashes land on your volunteer's hands, make sure they wash their hands thoroughly after the demonstration.

Nuts & Bolts

Divide most of the 500 ml of cabbage juice between two smaller beakers, leaving about 1 cm of juice in the larger beaker – this will be used in Activity 3.

Adding citric acid to the purple juice will turn it red—what mood might this colour represent?

When baking soda is added to the cabbage juice, it turns blue—what mood might this colour represent?

Secrets for Success

For fresh cabbage:

- Chop up the red cabbage, place it in a saucepan
- Add enough water to cover it.
- Bring the water to the boil, and simmer for about 15 minutes.
- Pour the water through a sieve. This purple water is your indicator dye – store in a clear plastic drinks bottle.

Can't find purple cabbages in the shops? Click on this link to buy dehydrated powdered cabbage from the Science2Life online store
Or this link 75g

Science in a Nutshell

Red Cabbage (Brassica Oleracea L.) Powder

Whether or not you like to eat red cabbage, you are going to love experimenting with it. This dried cabbage powder will allow you to make your own **red cabbage pH indicator**.

Making a red cabbage indicator is a fantastic STEAM activity to introduce children to acid/base chemistry.

What is red cabbage?

Red cabbage is a cruciferous vegetable of firmly packed dark red-purple leaves. It belongs to the brassica group of vegetables along with Brussels sprouts and kale, and has a peppery taste and crunch when eaten raw, and becomes sweeter and softer in texture when cooked.

The purple colour in the red cabbage comes from a class of pigments called anthocyanins; this pigment is also found in the skin of red apples, grapes, plums and is the pigment in leaves which turn red in the autumn.

Red cabbage has a good mix of vitamins and minerals, especially *folate*, which is essential during pregnancy and also helps the body to *produce red blood cells*. It also contains *vitamin C*, which helps protect our cells by *acting as an antioxidant*, and *potassium*, which we need for a *healthy heart*.

A *2019 study* indicates growing evidence that anthocyanins play a positive role in cardiovascular health and that those who eat foods with anthocyanins have a lower risk of heart attacks and heart disease-related death.

Activity 3: Science Showdown

Neutralising a Changewing's Acidic Spit

What you have:

- Dried Cabbage Power 10g
- pH Colour Card
- Baking Soda 125g
- Citric Acid 125g

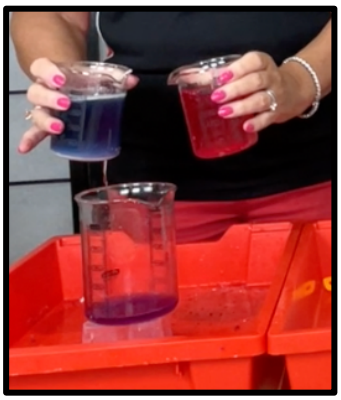
What you need:

- 500 ml Jug/Beaker with a small amount of cabbage juice from Activity 2
- 2 smaller Jugs/Beakers from Activity 2
- Safety Glasses
- Splash tray

SAFETY:

Safety glasses are to be worn to prevent any splashes in the eyes.

Hands must be washed after handling chemicals



Nuts & Bolts

Set up the demonstration by placing the 500 ml beaker with a small amount of purple cabbage juice (from activity 2) in the center of the splash tray. Position this beaker on top of another beaker or cup to raise it, ensuring everyone in the class can see clearly. The purple colour indicates a pH of 7, or a neutral solution.

Now, invite your Viking volunteer to take the two beakers from Activity 2—one with the red acidic solution and the other with the blue alkaline solution—and slowly pour both into the raised beaker with the cabbage juice.

As the solutions mix, the colour will shift back to purple, indicating neutralisation. But be ready for a show! The reaction will release plenty of gas, causing the mixture to bubble vigorously and overflow the beaker!

Secrets for Success

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!

When the vinegar (ethanoic acid) or a citric acid solution is mixed with the baking soda (sodium hydrogen carbonate) a chemical reaction occurs, producing a burst of carbon dioxide bubbles almost instantly.
When the vinegar (ethanoic acid) or citric acid is mixed with the baking soda (sodium hydrogen carbonate) a chemical reaction takes place. Lots of carbon dioxide bubbles are formed in a very short period of time.

This experiment is an example of a reaction between an acid and a base. Such reactions typically form a "salt" and water.

ACID + BASE → SALT + WATER (+ CARBON DIOXIDE)

If using vinegar, the acid component in this experiment is ethanoic acid, it allows the production of one of the products to be sodium ethanoate. That is the stuff referred to as the "salt." In this experiment, the base has a **carbonate component; hence carbon dioxide is also formed.**

If using citric acid: sodium citrate, water and carbon dioxide will be formed.

Acids and Alkalis in Nature

One unusual wasp repellent is sliced cucumber! This vegetable has a chemical property which wasps just don't like. Use your purple cabbage to juice to find out what it is!

Wasp sting venom is alkaline and so its effects can be neutralized with vinegar or another weak acid and this neutralisation then reduces the pain.

Bee sting venom is acidic and so its effects can be neutralized with bicarbonate of soda or another weak base or alkali solution and this reaction also reduces the pain.

Wasps naturally prey on other animals. They feed insects and other arthropods to their young, which develop in the nest. They are beneficial because they prey on caterpillars, flies, crickets and other insects which are considered to be pests.

During late summer and autumn, as queen wasps stop laying eggs and their nests decline, wasps change their food gathering priorities and are more interested in collecting sweets and other carbohydrates. Some wasps may become aggressive scavengers around human food and are commonly found around outdoor activities where food or drinks are served.

Bees feed only on nectar (carbohydrates) and pollen (protein) from flowers. Honey bees sometimes visit rubbish bins and soft-drink containers to feed on sugary foods.

Pupil Activity Sheet

Name: _____

Neutralisation

Date: _____

In the 'Science of Dragon Show' Scientific Sue used the juice from purple cabbages to produce the colours: Yellow, Green, Blue, Purple, Pink/Red

Can you remember why purple cabbages are labelled as RED cabbages in the shops?

Bee and wasp stings can be both painful and itchy, but with a little chemistry know-how, we can neutralise the toxins from these stings. Wasp toxins are generally alkaline, so an acid, like vinegar, should be applied to neutralise them and relieve the pain. Bee stings, however, contain acidic toxins, so an alkaline solution should be used to neutralise them. Baking soda mixed with cold water is typically the most effective way to create an alkaline solution.

Chemical	Colour change with purple cabbage juice	Acid	Alkaline
Vinegar	**Red**	**Yes**	**No**
Bicarbonate of Soda	**Blue/Green**	**No**	**Yes**
Honey			
Toothpaste			
Lemon			
Onion			
Cucumber			

Activity 4: Unmask the Gas

Discovering a New Dragon Firetype!

What you have:

- Citric Acid
- Baking Soda
- Candle

What you need:

- Vinegar – optional
- Clear glass beaker to place the candle into – optional
- 100 ml Water if using citric acid
- Funnel
- Safety Glasses
- 500 ml Bottle
- Balloon
- Lighter or matches
- Tongs to hold the inflated balloon with
- 2 Spoons

SAFETY:

Safety glasses must be worn.

Hands must be washed after handling chemicals

When lighting the match strike away from your body. Store matches out of sight and reach from children

When the candle is lit avoid drafts, vents or air currents. Never leave the burning candle unattended.

Nuts & Bolts

- Baking soda – Chemical name sodium hydrogen carbonate (bicarbonate of soda) with formula $NaHCO_3$
- Citric acid with formula $C_6H_8O_7$
- Vinegar – a dilute solution of ethanoic acid in water with the formula CH_3COOH

Secrets for Success

- Using the funnel add 1 tablespoonful of baking soda to the balloon.
- Add 1/2 tablespoon of citric acid to 100 ml of warm water.
- Slowly add the water and citric acid solution to the 500 ml bottle.
- Carefully stretch the opening of the balloon over the mouth of the bottle without allowing any of the powder to enter the bottle.
- Hand this bottle back to the volunteer – they will be asked by Sue to gently lift the balloon holding the powder up – allowing the powder to drop on to the liquid in the bottle.
- At this stage lots of carbon dioxide gas will be made and the balloon will inflate – much to the joy of the class.
- The bottle will be handed back to you for you to remove the balloon and tie it off.

- Hand the balloon back to the volunteer – they are to hold it using the tongs (or a peg secured to a stick)
- You will then be asked to light the candle.
- The volunteer will then lower the balloon onto the flame – the balloon will burst but will not burst into flames! The volunteer will then be asked to go back to their seat.
- Place the candle into a small glass. This will help prevent any drafts from blowing the gas you will pour over the flame.
- Pour the invisible gas (carbon dioxide) carefully from the bottle over the candle. Pour it as though it were water or some other liquid.

Because carbon dioxide is heavier that air, it will pour out of the vessel and over the candle and extinguish the flame.

Science in a Nutshell

Carbon dioxide, in liquid form, is found in some fire extinguishers. To maintain this liquid state, it's kept under specific pressures and temperatures, meaning an extinguisher can only be used once. When released, the liquid CO_2 quickly transforms into a gas, which is heavier than air and settles downward. When aimed correctly, this gas creates a protective "blanket" over the fire, cutting off oxygen needed for combustion and extinguishing the flames.

Carbon dioxide is also the gas responsible for the fizz in soft drinks and can be frozen under pressure to make dry ice, which sublimates directly from solid to gas under normal atmospheric pressure.

There is a lot of chemistry behind the simple lighting of a flame. In this experiment we are going to relight a fire using an invisible gas called oxygen.

Meet the fire triangle!

The fire triangle, or combustion triangle, is composed of the three ingredients needed to ignite and sustain a fire: Heat, Fuel and Oxygen.

If just one of these components is removed, the fire triangle will collapse and the fire will be extinguished.

Activity 5: Blast Off!

Training Meatlug to Hit the Target

What you have:

- Citric Acid 125g
- Baking Soda 125g
- Tube with Spring Lid

What you need:

- Tube of Effervescent tablets
- Pot of extra lids (optional)
- Water
- Target (bin or box)
- Safety glasses
- Protractor (optional)

SAFETY:

Ensure the rocket canister is pointed away from people, and keep everyone at a safe distance during the launch process.

If conducting this experiment indoors, promptly clean up any spilled liquid from the floor to prevent slips.

Watch out for low ceilings! The lids launch at high speeds and can bounce off surfaces unexpectedly.

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 remove the cardboard disc and dispose those little beads in to the bin.

Nuts & Bolts

As shown in the teaching video, this demonstration works well with the citric acid and baking soda – but the reaction is very fast and your volunteer will need to have the skill set to push the lid on to the tube containing the water and reacting chemicals really fast.

For this reason, I suggest also having effervescent vitamin C tablets as a replacement as the reaction is much slower but still just as explosive!!

Secrets for Success - Try this before you do it with the children.

1/3 fill your canister with water.

Drop your powders or Vitamin C tablet into the water and quickly push on the lid. Hold the tube at arm's length, ensuring the lid is pointing towards the ceiling.

The bubbles emitted are trapped inside the tube, which unlike the balloon cannot expand; this means that the pressure will build up due to the many molecules of carbon dioxide gas hitting the sides and the lid.

After a short while the pressure becomes so great the frictional forces keeping the lid on are overcome and the gas pressure forces the lid and the canister to separate. The lid will leave at great speed and could travel up to 5 metres.

If the ceiling in your room is very low your young volunteer 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!

The lid will travel the greatest distance when the tube is held at an angle of 45 degrees.

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 lid will therefore not fly. At this point gently remove the lid, pointing it away from you and discard the liquid contents.

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.**

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 hydrogen carbonate – baking soda ($NaHCO_3$), a base, and citric acid ($C_6H_8O_7$), an acid.

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.

- 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.

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.

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.

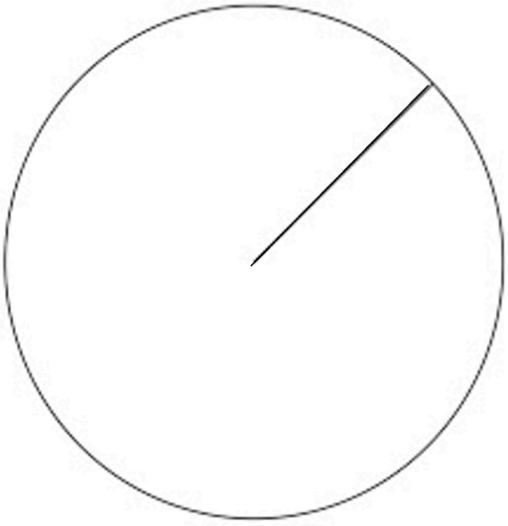
Your young science investigators can work on their own or in small groups. When everyone in the group is ready to start – have one of them do a count down so that they all turn their canisters over at the same time.

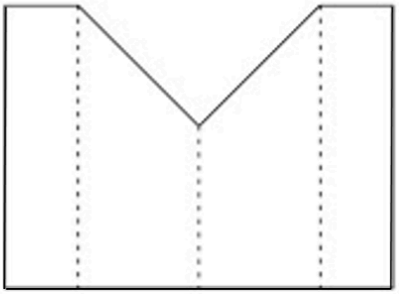
Use the template below to design a casing for your canister so that it looks more like a Space Rocket.

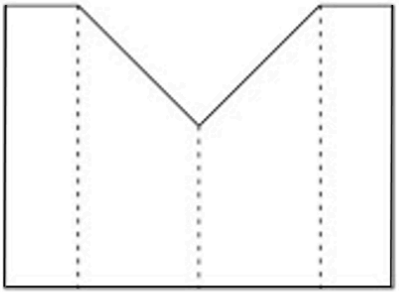
3 2 1...Lift off Rocket Template

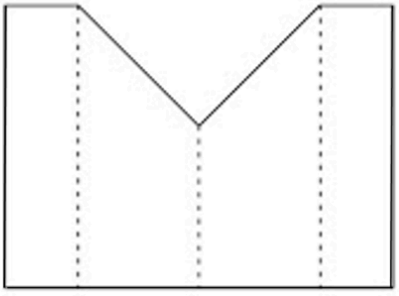
cut

fold









Activity 6: Train your Dragon

The Science of Balance

What you have:

- 31 x Dragon Templates
- Marker Pen
- 30 x Paper Clips

What you need:

- Scissors
- Colouring and art materials
- Pencil or wooden kebab stick
- 2 coins of the same denomination per child.
- Sellotape

SAFETY:

Care must be taken with scissors

Nuts & Bolts

With the aid of the template train a cardboard Dragon to balance on its nose!

The dragon can be balanced on a pencil tip or wooden kebab stick. Once balanced you can train it to spin by gently blowing it.

The balancing dragons are for the children to keep.

Secrets for Success

1. Cut out the dragon shape. You can colour it in and add decorations if you'd like.
2. Try to balance the dragon on your fingertip. Does it stay? No.
3. Where does it balance? This balancing point, located around the chest area, is called the *centre of mass*.
4. To make the dragon balance on its nose, we need to shift its natural balance point from the chest to the nose by adding weights to the tips of its wings.
5. Suitable weights include paperclips (provided), pennies, or plasticine.
6. The size of the weights needed depends on the thickness of the card you're using. If you need additional templates, you can print one from the teaching notes, glue it to card—such as a cereal box—and cut it out. The number of paperclips required will vary depending on the weight of the card used.
7. Once your dragon is balanced, try blowing it to make it spin.

8. The metal paperclips will be pulled towards a magnet – so you could use the invisible pulling for of a magnet to make it spin also!

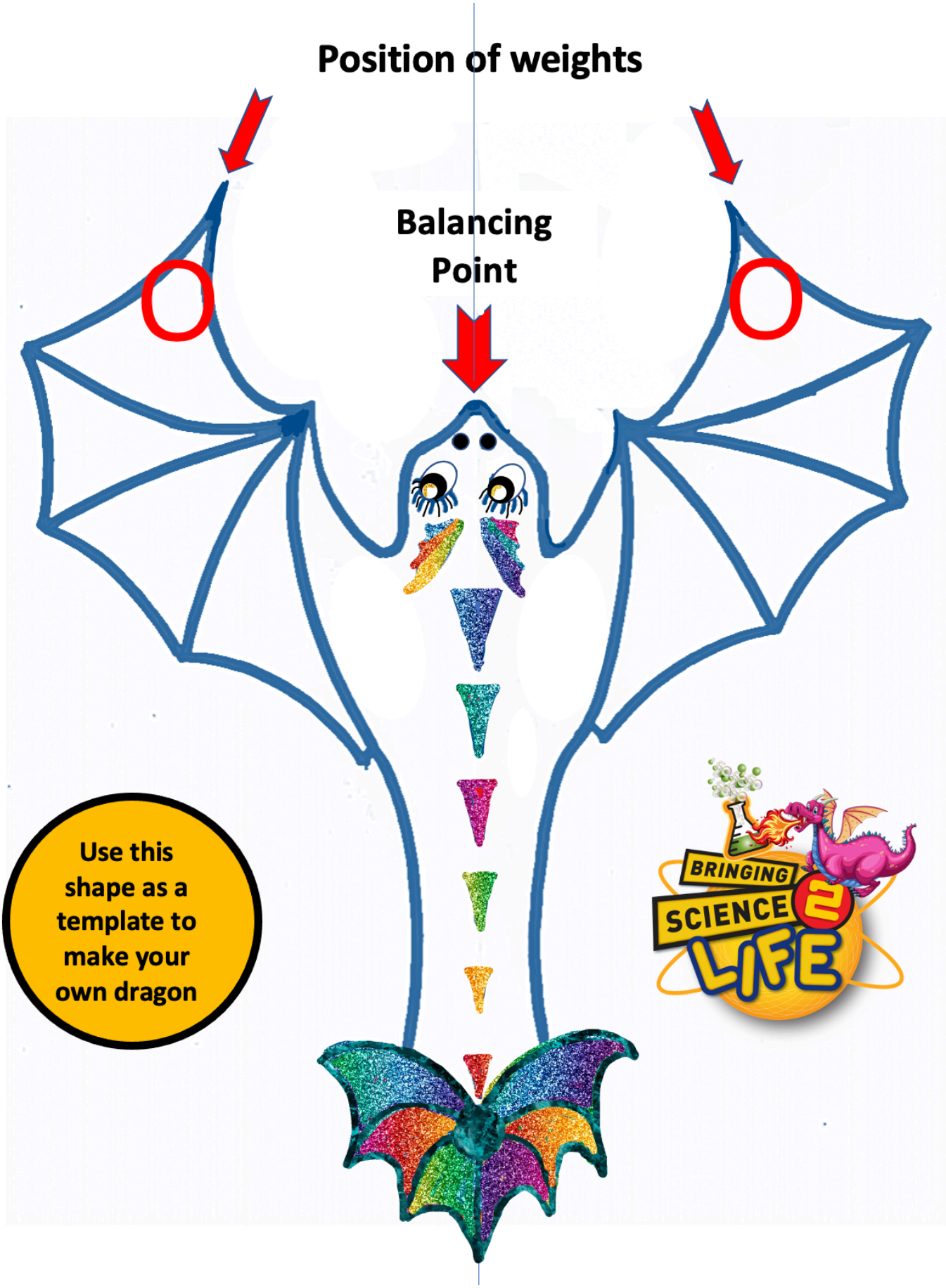
Science in a Nutshell

1. Every object has a balancing point, known as the *centre of mass*. The lower the centre of mass, the more stable the object becomes.
2. The centre of mass is also commonly referred to as the *centre of gravity*.
3. This balancing dragon toy has its centre of gravity located at the tip of its nose. The centre of gravity is a unique point where the weight of the object is perfectly balanced.
4. To position the centre of gravity at the nose, the wings are designed to extend just far enough forward and made heavy enough (by adding paperclips or other weights) to counterbalance the dragon's weight at its nose.
5. For most objects, it's not immediately obvious where the centre of gravity is. If an object has an unusual shape, it's difficult to determine the centre of gravity by sight alone.
6. For objects with uniform shapes, like a pencil or a square, the centre of gravity is easy to locate—it's right in the centre. However, for objects with irregular shapes, the centre of gravity isn't immediately known and must be found by trial and error.
7. To find the centre of gravity in such objects, try balancing it on various points until you find the exact spot where the object remains stable and doesn't tip over.

This point, once found, is the centre of gravity (centre of mass).

Mass is the amount of matter in an object. Mass is measured in kilograms (kg).

Weight is a force due to the pull of gravity on an object's mass. Weight is measured in Newtons (N).


Position of weights
Balancing Point
Use this shape as a template to make your own dragon
BRINGING SCIENCE 2 LIFE

We really hoped you enjoyed the show and workshop experience and would love to hear your feedback! Scientificsue@science2life.com

Please also share your experiences with us we would love to see you and your children in action:

@scientificsue

#science2life

Your feedback (short or long) is invaluable in helping us enhance this experience for both you and your students. As this is a relatively new programme, your insights will be essential in shaping future improvements. Please let us know how we can better meet your needs!

Sue - scientificsue@science2life.com

The Science of Dragons Show