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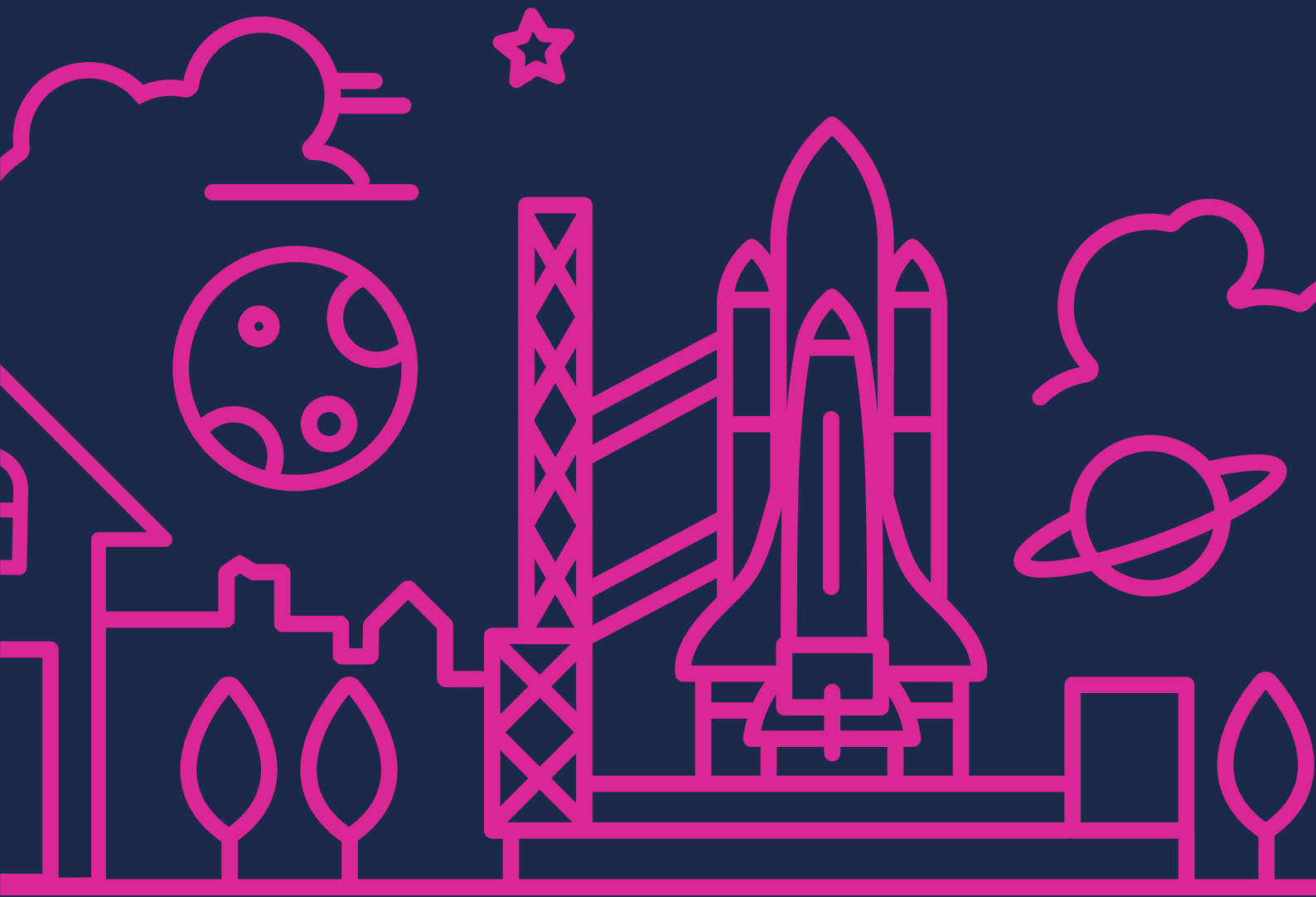
The network of youth groups

STEM+ Activity Toolkit



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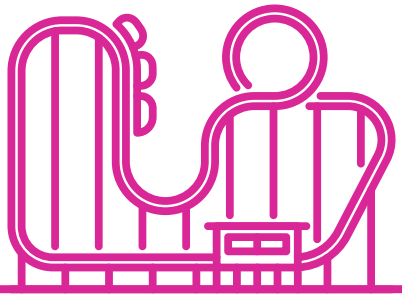


Stem+ Activity Toolkit

STEM+ has been developed to encourage young people from age 10+ to get involved in STEM in a fun and engaging way. Young people can use these activities to achieve a Hi5 or Dynamic Youth Award through Youth Scotland Awards. The Hi5 Award has been credit scored by the Scottish Qualifications Authority (SQA) and placed on the Scottish Credit and Qualifications Framework (SCQF) at Level 2 and is suitable for primary aged children (5 years +). The Dynamic Youth Award has been credit scored by SQA and placed on the SCQF at Level 3 and is suitable for older primary school and secondary school age (10 years +).

As a responsible adult please be aware of any risks associated with the environment you'll be working in. It is recommended that children and young people are supervised at all times and your own organisation's Health and Safety policy and any other relevant policies and procedures are followed. Please note that to the extent permitted by law, Youth Scotland shall not be liable to any person for any loss or damage that may arise through using this toolkit. We have given a guide age of 10+ for all of the activities in this toolkit. These should be used as a guide only as we recognise you know your children/ young people best and know what activities would suit them. It is always a good idea to try any activity yourself in advance, especially if it involves making something. Some activities will need tables/work surfaces to be covered to prevent any damage.

Where possible, try to use and reuse recyclable materials, and make sure that if you do an activity it's fully cleaned up to avoid any harm to the local environment.

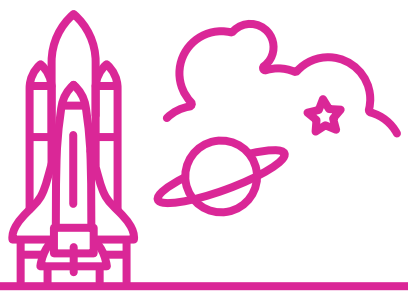
All the materials in this toolkit should be readily available from most supermarkets and online retailers.

After each activity we recommend that you ask 'what skills did you use during the activity' or phrase any open questions to acknowledge the young people's learning — for example, working with a partner, team building, counting, reading, following instructions, listening to each other etc. A lot of young people may not enjoy Maths or English but when carried out during fun activities they can start to see that they apply these to everyday activities without realising and can help to improve confidence and self-esteem along with many other added benefits. Take photographs or record on reflection sheets — we have loads of great templates already available on our website to record on — you choose:

https://youthscotland.org.uk/awards/current-awards-providers/completing-your-award/

We'd love to see your STEM activities in action!

Share pictures and videos of your STEM activities with us on social media: **https://linktr.ee/youthscotland**



Build a balance scale

What you need:

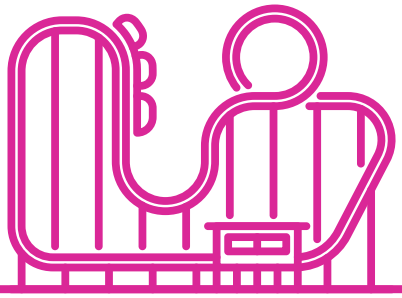
- Paper cups (2 per balance scale).
- Coat hanger.
- String (approx. 50cm).
- Items to weigh, for example, pasta and rice.

What to do:

- Take your paper cups and measure 1 inch from the top, then create a hole in the cup (you may want to use a pen to pierce a hole with a piece of blue tack at the other side of the cup where you are piercing — be careful) then do the same on the opposite side of the cup (a hole punch can be useful).
- Thread the string through both holes and do the same on the other cup.
- Use the string to attach cups to either side of the hanger.
- Place the hanger on a hook — this could be a jacket hook, an open door (that is secure, do not use a closed door as people could open etc.).
- Now measure out rice to pasta, can you balance the scales?

Explanation:

- What you have made is commonly called a pan or mass balance, it contains the following parts — two pans (your two paper cups), a horizontal beam (the coat hanger which you have attached the cups to) and a rotation point (the hook of the coat hanger).
- A pan balance allows you to balance two masses — by adding your rice to one cup then adding pasta to the other until your coat hanger is horizontal you are balancing the masses of the rice and pasta.
- Our balance works because when you add something (rice or pasta) to one of your cups this cup gets lower as gravity is pulling the cup with more mass towards the ground, by adding something to the other cup (pan) the balance begins to rotate back towards horizontal as gravity acts on the other cup. Once the mass in each cup is equal your balance is at equilibrium — it's most stable position.
- Pan balances are used all over the world from markets to science labs to allow accurate weighing of materials by measuring against known weights (1g, 10g, 100g etc.).



Cloud in a jar

What you need:

- Jar (for example an empty cleaned out jam jar).
- Water.
- Shaving cream.
- Dropper.
- Liquid food colouring.

What to do:

- Pour water into the jar until it's filled ¾ full.
- Add the shaving foam on top until full.
- Add a few drops of liquid food colouring onto the shaving foam.
- Watch the food colouring drop down into the water.

Explanation:

- In this experiment the clouds are the shaving foam and the liquid food colouring is the rain, as soon as you add in the liquid food colouring onto the shaving foam the shaving foam can't hold any more water and the liquid food colouring drops down. Clouds are made up of lots of tiny water droplets, when the droplets grow they become too heavy and they fall, creating rain.

Lemon volcano

What you need:

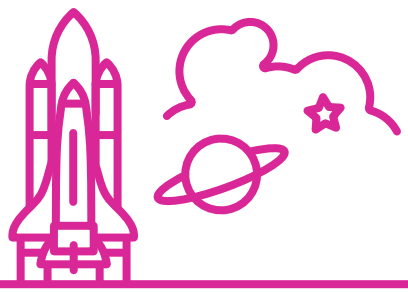
- Lemons (1 per person).
- Wooden lollipop stick.
- Baking soda (1 tsp).
- Food colouring.

What to do:

- Cut the lemon in half.
- Put a couple of drops of food colouring onto the centre of the half lemons.
- Use the lollipop stick to mix the food colouring and the lemon.
- Next add baking soda to the lemon and mix with your lollipop stick.
- Watch the lemon fizz and erupt.

Explanation:

- When you add Sodium bicarbonate (baking soda) to citric acid (lemon juice) it creates carbon dioxide bubbles that create the fizz.
- This is an example of an acid-base reaction, where bicarbonate is the base and citric acid is the acid. These react to form sodium citrate and carbonic acid, the carbonic acid is not very stable in the presence of water and breaks down to form carbon dioxide and water.
- So where might this reaction be used? Have you ever eaten sherbet? Or taken some medicine that had to be popped in a glass of water to fizz first? These both contain citric acid and baking soda to create the fizz!



Diet vs sugary drink — which one floats

What you need:

- Can of diet fizzy juice.
- Can of full sugar fizzy juice.
- Tub of water.
- 2 balloons.

What to do:

- Write SUGAR on one balloon, fill it with full sugar fizzy juice and tie the balloon. Write DIET on the other balloon, fill it with diet fizzy juice then tie the balloon. Place both balloons in the tub of water and see which one floats.

Helpful hints:

- Coca cola original (39g sugar per 330mL can) and diet coca cola (0g sugar per 330mL can) work well for this activity.
- This activity can be done with full, unopened cans of juice instead of using balloons.

Explanation:

- The balloon with the sugary fizzy juice will sink as there is lots of sugar in it, therefore it is denser and will sink. Whereas the sugar free fizzy juice, which contains a small amount of sweetener to replace the sugar, is less dense than water and will float.
- This is based on Archimedes' Principle which states that a body immersed in a fluid experiences an upwards force (called buoyant force) equal to the weight of the fluid it displaces. If the body is denser than the fluid, the force of gravity (pulling the body down) is stronger than the buoyant force so the object sinks. Archimedes' Principle is what keeps ships afloat.

Make a projector

What you need:

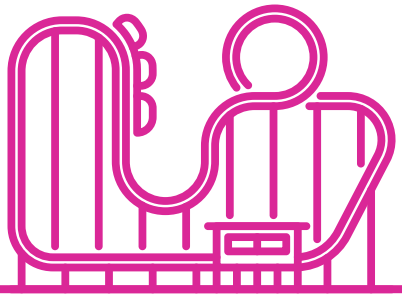
- Toilet roll tube.
- Cling film.
- Torch.
- Permanent felt tip pen.
- Rubber bands.

What to do:

- Cut a piece of cling film that is wider than the toilet roll tube.
- Secure the cling film to the opening of the toilet roll tube with a rubber band.
- Use the permanent felt tip pen to write/draw on the cling film.
- Put the torch at the other end of the toilet roll tube and look at your message or picture projected onto the wall.

Explanation:

- Light travels as waves in a straight line from the light source — your torch in this case. As the rays of light reach the cling film, light passes through the transparent cling film but is absorbed by the ink you used to write or draw your message or picture. This means that your message or picture is cast as a shadow onto the surface (wall) you are projecting onto.



Make a balloon blow up by using a chemical reaction

What you need:

- Plastic bottle.
- Balloon.
- Vinegar.
- Baking soda.
- For this activity we tested using a 1.5L plastic bottle, 100mL of vinegar and 20g of baking soda — you may need to adjust your amounts depending on the bottle you use.

What to do:

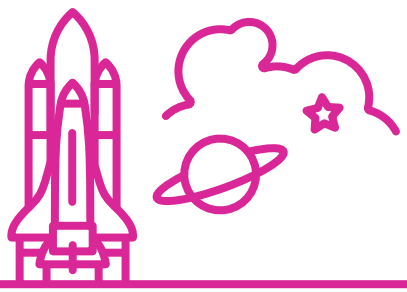
- Pour vinegar into a plastic bottle.
- Measure your baking soda into the balloon (use a funnel or make one from a toilet roll tube).
- Stretch the balloon over the bottle and tip in the baking soda.

Helpful hints:

- Be careful how much you use as you do not want the balloon to pop! You could experiment with different amounts to try and blow your balloon up.
- You can also add food colouring to the vinegar before you add the baking soda to make it more interesting.

Explanation:

- When you mix vinegar and baking soda together it releases carbon dioxide, this is what blows up the balloon.
- When vinegar (acetic acid) is mixed with baking soda (sodium bicarbonate) an acid-base reaction takes place. This reaction creates sodium acetate and carbonic acid, the carbonic acid is not stable in the presence of water and decomposes/breaks down to form carbon dioxide (a gas) and water. As the carbon dioxide is made the pressure builds and inflates your balloon!
- Ever had a self-inflating balloon (one that blows itself up)? Well it may well have contained baking soda and either vinegar or citric acid.
- This activity is also a great example of how states of matter can change, we have mixed a solid (baking soda) with a liquid (vinegar) to create a gas (carbon dioxide).



Make an egg bounce

What you need:

- White vinegar.
- Uncooked egg.
- Glass.

What to do:

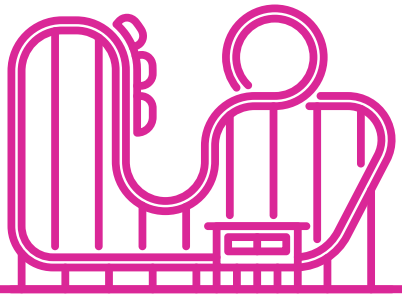
- Carefully place an uncooked egg in a glass.
- Pour white vinegar over the egg until the egg is fully submerged in vinegar.
- After 24 hours check on your egg, you are waiting for the egg to become translucent (this can take anywhere between 1–3 days).
- When the egg is translucent, carefully tip it out of the glass and wash it under the tap (make sure the water pressure isn't too strong) rub the egg to remove the egg shell and outer white film.
- Bounce the egg close to the surface (do not bounce it from a height).

Explanation:

- An egg's shell is primarily made of calcium carbonate, when you place the egg in vinegar (acetic acid) an acid-base reaction takes place between the calcium carbonate (a base) and the acid. This reaction breaks down the egg shell forming calcium acetate and carbonic acid.The carbonic acid is unstable in water so breaks down to carbon dioxide and water. If you watch your egg you may see the bubbles of carbon dioxide coming from the shell.
- Once the calcium carbonate in the egg shell has reacted you are left with the membrane of the egg which lined the inside of the shell.
- Have you ever been to some areas of England and noticed the white chalky layer on the inside of the kettle or on the shower screen? Well this is limestone (calcium carbonate) and to remove it many cleaning products contain an acid (citric acid which is a bit stronger than our vinegar) to help dissolve it.

Climate change:

- This activity also helps us demonstrate what is happening as a result of increasing carbon dioxide emissions. Increased carbon dioxide in the atmosphere results in more dissolving in the ocean causing it to become more acidic — the average ocean pH has changed from 8.2 to 8.1 since the industrial revolution and it is estimated to reach 7.8 by 2100. (Source: National Oceanic and Atmospheric Administration).
- Organisms in the ocean such as pteropods (tiny sea snails) have shells made from calcium carbonate, so with increasing ocean acidity the shells of these organisms may dissolve faster than they can be rebuilt. Pteropods are important in the food chain of many larger organisms.



Magic milk — food colouring, soap and milk

What you need:

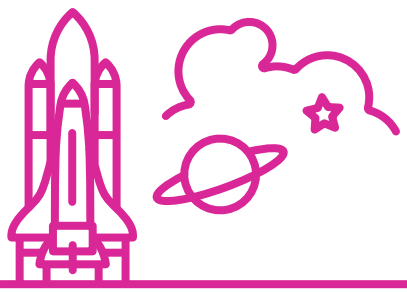
- Whole milk.
- Food colouring.
- Ear bud.
- Liquid soap.
- Plate.

What to do:

- Pour some milk onto a plate to cover the surface.
- Add drops of food colouring all over the surface of the milk — using different colours will lead to cool patterns later.
- Put a small amount of liquid soap onto the ear bud.
- Then place the ear bud with the liquid soap into the middle of the milk and watch the colour spread.

Explanation:

- Milk is mainly made up of water but also contains proteins, minerals, vitamins and fats.
- Since milk is mainly made up of water it also has a high surface tension like water, this means that when we add food colouring it is supported on the surface of the milk and doesn't spread out.
- Soap molecules have parts which can dissolve in water and parts which can dissolve in fat/grease/oils. This means that when we add soap to milk it reduces the surface tension which causes the food colouring to be pushed toward the outside of the plate.
- In addition, the soap molecules are moving around to 'mop up' the milk fats and proteins. Since we have added a food colouring into the milk, we can see the movement caused by these molecules moving around.
- You could try this experiment with different types of milk (semi-skimmed, skimmed etc.) and different types of soap — what differences do you see?
- This experiment is showing us:
  - How soaps work, by mopping up fats but at the same time being attracted to water molecules — this is what allows us to wash a greasy stain from our clothes.
  - The effect of soap on surface tension. The strong surface tension of water is what causes it to form drops rather than spread out on a surface, it is also what allows some insects to be able to walk on water.



Paper aeroplane challenge — can you fly the plane with the most weight?

What you need:

- Cardboard.
- Sticky tape.
- Small weights — i.e. gummie bears, pieces of pasta.

What to do:

- Create a cardboard plane (similar to a paper plane).
- Stick the gummie bears to the cardboard plane.
- See how many gummie bears you can fly.

Why not set this as a team challenge and create a scoreboard: furthest distance, how many items on the plane etc.

Make S'mores with science

What you need:

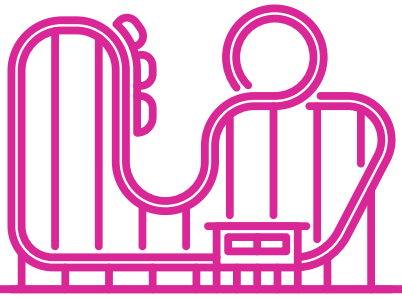
- Pizza box.
- Tin foil.
- Marshmallows.
- Chocolate.
- Tea biscuits.

What to do:

- Take your empty pizza box and cut a large square in the middle of the top/lid.
- Cover the bottom of the pizza box in tin foil and add your tea biscuits, chocolate and marshmallows.
- Place cling film over the square hole in the box and close the lid.
- Using the cut out square, cover it in tin foil and position it so that it reflects the sun into the hole where the tea biscuits, chocolate and marshmallows are.

Explanation:

- The sun that is reflected from the tin foil heats up and melts the chocolate and marshmallows. The heat from the sun comes from light waves which we cannot see, these are called infrared waves. The tin foil reflects the infrared light waves into your box and heats it up!



Make your own kaleidoscope

What you need:

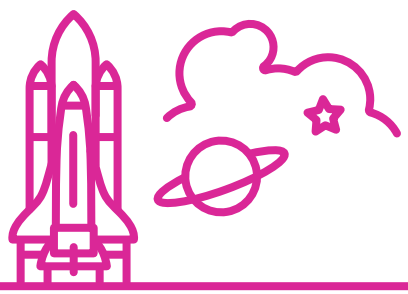
- 2 toilet roll tubes.
- Mirrored paper.
- Sticky tape.
- Paper/pens to decorate the outside of the kaleidoscope.
- Coloured beads.
- Clear flat plastic (for example, recycled from a plastic food container).

What to do:

- Decorate the outside of one of the toilet roll tubes with pens or paper.
- Cut a piece of mirrored card to 4”x 6”.
- Make two folds to create a triangular prism and use sticky tape to hold it in place.
- Slide the triangular prism into the decorated toilet roll tube (you now have an open kaleidoscope).
- Take your plastic sheet and trace the end of the toilet roll tube (do this twice so you have two circles).
- Cut out the circles and make sure there are no sharp edges to the plastic.
- Place one of the plastic circles at the front of the decorated toilet roll tube, make sure it is securely wedged into the toilet roll tube and touching the mirrored card.
- Then take your second toilet roll tube and cut off a piece about 1 inch long. Then cut this piece down the middle and fold it over half an inch and secure with a piece of sticky tape.
- Take your second plastic circle and place it onto the cut piece of cardboard, secure this with sticky tape.
- Place the coloured beads into this lid and place the lid inside the decorated toilet roll tube at the end with the plastic circle in the tube.

Explanation:

- Light travels in straight lines, so when it enters your kaleidoscope it will reflect (bounce) off your mirrored paper triangles.
- Since you have multiple mirrored surfaces and also the beads in your kaleidoscope the light will reflect off all these shiny surfaces and create a pattern of colours.
- Each time you move your kaleidoscope a unique circular repeating pattern will be created—a new piece of art every time!



Making plastics from potatoes!

Plastics are polymers which are made up of smaller building blocks called monomers (think about creating a daisy chain when you were younger — each daisy would be a monomer, whilst the daisy chain is like a polymer). In this activity you will make a plastic (starch — which is made up of glucose monomers) from a potato.

What you need:

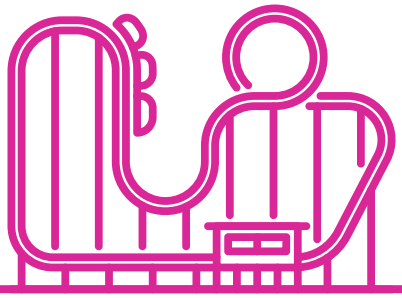
- Potatoes (use approx. enough to weigh 200g).
- Glycerin (2tbsps per activity).
- Vinegar (2tbsps per activity).
- Food colouring (few drops).
- Water (1pt).
- Grater (or a blender/food processor).
- Mortar and pestle (could use a bowl and a fork).
- A jar.
- Coffee filter or a sieve.
- Greaseproof paper.
- Baking tray or tin.
- Knife.
- Bowl.
- Pot/pan.
- A hob.
- Tablespoon.
- Small measuring jug.

What to do:

- Cut each potato (use about 200g) into a few pieces and blend, or grate the potato.
- Put your grated/blended potato into a mortar (or bowl), add 100mL of water and grind with your pestle or fork. This step extracts the starch into the water.
- Filter off your water into a jar and repeat Step 2 two more times with the leftover potato.
- Leave your mixture to settle — allowing the starch to settle at the bottom of your jar.
- Carefully pour off the water whilst not disturbing the starch layer at the bottom of your jar.
- Add 100mL of clean water to your jar and give it a gentle stir, let the starch settle and pour off the water again. You should now have your starch ready to make your plastic.
- You will need around 2tbsps of your starch for this part, so if you have extracted more you can simply take 2tbsps out of your jar and add them to a pot with 8 tbsps of water. If you have around 2 tbsps of starch in your jar add half the water to the jar, empty into the pot and repeat.
- Add 2 tbsps of glycerin, 2 tbsps of vinegar and a few drops of food colouring to your pot and stir.
- We need to heat our reactants now — use a low heat to heat your pot and continuously stir your mixture until it becomes thick like caramel. Don't overheat!
- Transfer your plastic using a spoon to a mould (you could use an ice cube tray for example) or to greaseproof paper — be careful as the hot plastic can cause burns!
- It's time to let your plastic set — this will take at least 24 hours.

Helpful hints:

- Make sure there is adult supervision when children/young people are using knifes and graters.



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Explanation:

- In this experiment we extract starch from potatoes using water, since starch doesn't dissolve in water the tiny particles we have extracted will sink to the bottom of our mixture.
- When we add vinegar (an acid) to our starch we break down one of the parts of the starch to give us a better plastic.
- By adding glycerin (a plasticiser) to our starch we make the plastic less brittle — the glycerin molecules sit in between the polymer chains of starch preventing them lining up really well.
- A lot of the plastics we use today start out as crude oil and once made are very slow to decompose (sometimes taking hundreds of years). Plastics that come from renewable materials like potato are able to decompose a lot quicker and can often be composted.

Helpful links/where to find out more:

- **https://thestemhub.org.uk/stem-at-home/item/potato-polymers**
- **https://www.teachengineering.org/activities/view/usm-2287-engineering-polymers-potatoes**
- **https://www.jamesdysonaward.org/2018/project/potato-plastic/**

Robotic arm

This activity will challenge you to design and build a robotic arm to lift and move objects.

What you need:

A range of crafting supplied such as:

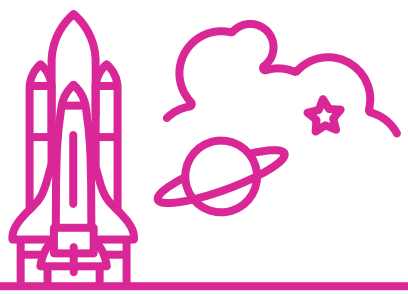
- String.
- Rubber bands.
- Tape.
- Clips.
- Lollipop sticks.
- Card.
- Paper.
- Pipe cleaners etc.
- Where possible make use of recycled materials like cereal boxes, packaging and postage tubes.
- You will also need somewhere to fix your robotic arm once built, this will need to have space around it to test out your arm's ability to pick up and move objects. (A table/desk would be ideal for this.)

What to do:

- It's over to you now! Design and build a robotic arm using the materials you have available. You may want to do some research to get some ideas of what different robotic arms look like and how they work before creating your own design.
- If doing this as part of a group, create smaller teams and make this into a competition between the teams as to which team can move the heaviest object or move an object the furthest distance.

Helpful links/where to find out more:

- **https://www.jpl.nasa.gov/edu/teach/activity/robotic-arm-challenge/**



Land ice/sea ice

What you need:

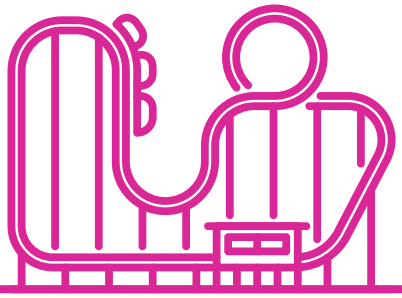
- Two small plastic trays.
- Rocks or clay.
- Ice (10 ice cubes).
- Water (you can add food colouring to make it blue like the sea).
- Pen.

What to do:

- Take the two containers and fill the left side with the same amount of small rocks or clay.
- Add in the same amount of water to each container.
- In one container place 5 ice cubes on the stones/clay and in the other container place the 5 ice cubes in the water.
- Draw a line on the container showing where the water level is up to.
- After the ice has melted look at the sea level again, which one has a raised sea level?

Explanation:

- When the ice in your sea melts it will not lead to a sea level rise as the total volume of water in the sea is the same. However, when your land ice melts some of this will run into the sea adding more volume of water to the sea and causing a sea level rise.
- Due to global warming, glaciers (on land) around the world are melting faster than they can accumulate new snow each year, the melt water from these glaciers eventually makes it to seas and oceans causing the sea level to rise. When icebergs (in the sea) melt they don't lead to a sea level rise as they already contribute their volume to the sea level.



Oil spill

What you need:

- Water (approx. 200mL).
- Vegetable oil (1tbsp).
- Container.
- Dish soap.
- Cotton wool.
- Paper towel.
- Spoon.

What to do:

- Pour water into a container.
- Put a tablespoon of vegetable oil in the container with the water.
- Ask the young people to experiment with how you can get the oil out of the water using the spoon, cotton wool, and the paper towel.
- Then add the dish soap and observe what changes take place. Now try to remove any remaining oil. (Note: you may have to add a little more oil before this step if the young people have removed lots previously).
- Measure which technique was the most effective.

Helpful hints:

- You can use food colouring to make it more colourful and help see the oil.

Explanation:

- Oil floats on water and can be quite difficult to separate from water. Soap molecules have 2 different ends — one which likes water and one which likes oils/fats. By adding soap into oily water the soap molecules will 'mop up' the oil molecules. The soap molecules create structures called micelles with oils at the centre of sphere and the soap forming a layer around the oil sphere. On the outside of the sphere is the end of the soap molecule which likes water and this allows the micelle to dissolve in the water.
- The techniques the young people have used to remove the oil from the water included skimming (with the spoon), absorption (with the cotton wool and paper towel) and dispersion (with the soap). These are all used in cleaning up real life oil spills.

Making microscopes — water microscope

A quick and fun way to make your very own microscope using water!

What you need:

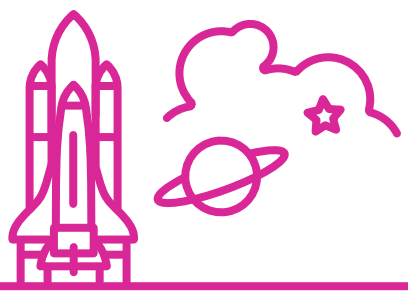
- Clear plastic bottle.
- Cling film or clear plastic (like a ruler).
- Elastic band/bobble.
- Few drops of water.
- Something to magnify!

What to do:

- Cut the top off the plastic bottle to create a beaker.
- Get your thing you want to magnify ready and waiting — it needs to be small enough to fit in your beaker though. Put your item at the bottom of your beaker. (Alternatively you could cut a hatch in the side of your beaker to allow you to change objects in an easier way).
- Assemble your microscope by placing a piece of cling film over the top of the beaker and secure it with the elastic band/bobble. The cling film doesn't need to be stretched tight over the top of your cup. Finally put a few drops of water on top of your clingfilm to make a wee puddle.
- Now you should be able to look at your object through the water and it should be magnified!

Explanation:

- Water drops are spherical (ball shaped) due to the attractive forces between the molecules of water, this is called surface tension.
- The curve on the water droplet is similar to that of a lens (in a camera, for example) and since it curves outward it is called a convex lens.
- The water droplet bends light rays to focus on a single point beyond the lens resulting in a magnification. Water drops can magnify by up to a factor of 4–5.
- Smaller droplets give more magnification but also make it harder for our eyes to look through them and focus on the object being magnified.



Making microscopes — smartphone microscope

A quick and fun way to make your very own microscope!

What you need:

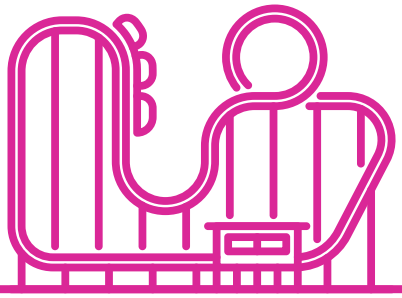
- Smartphone with camera.
- Sticky tape.
- A hair pin/clip.
- Convex (converging) lens—you can get one from a cheap laser pen/pointer or buy some.

What to do:

- Clip your lens between the legs of your hair clip/pin (you could also glue this in place with a small amount of super glue or similar, if your lens isn't staying in place).
- Tape your hair clip to the back of your smartphone with the lens covering the camera of your phone.
- You are ready to go! Open up your camera app, next you need to find the correct distance away from your object you want to magnify so that your image is in focus. Try laying your phone down on a book with the camera over the end and the object underneath, adjust the height of your camera until the image comes into focus (this will be different for different lenses).

Explanation:

- The convex lens works exactly like the water droplet in Activity 16, by focusing light onto a single point beyond the lens leading to magnification.
- When we place the lens in front of our smartphone camera, we can focus the camera on the much smaller lens and view the magnified image on the screen. As we mentioned before, smaller water droplets give better magnification but it is also harder to look through these and focus on the image.
- Our smartphone microscope is also more useful as we can take this to the objects we want to magnify rather than having to place the objects under our water droplet.



Submarine

Build a submarine which is powered by a rubber band.

What you need:

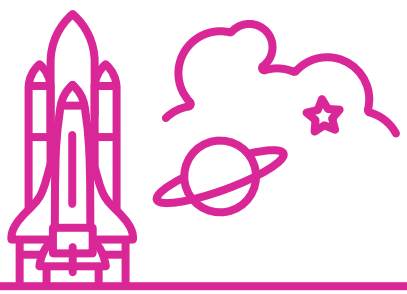
- 2 plastic bottles.
- Rubber bands.
- Lollipop stick.
- Scissors.
- String or paper clip.
- Container of water to test your submarine.

What to do:

- Creating the submarine body — in the bottle top cut a small hole in the centre and another in the bottom of the bottle — this should be just big enough to fit the rubber band through.
- Tie your rubber band to a piece of string the length of the bottle and feed the rubber band through the hole in the bottom of your bottle. Pull the band through the top of your bottle whilst keeping the string out of the bottom hole.
- Feed the rubber band through the bottle cap and pop the lollipop stick through to secure the band in place. Now screw your bottle cap back on.
- Pull the string out of the bottom of the bottle to stretch the rubber band the length of the bottle, secure this by tying a knot in the string so it doesn't pull back through into the bottle. Remove any extra string.
- Now it's time to test! Simply twist the lollipop stick whilst holding your bottle in place until there is a good amount of resistance – careful not to snap your rubber band!
- Pop it in your water container and see how it moves, you can try adding some water to your bottle to submerge your submarine too.
- Using the 2nd bottle you can adapt your submarine by creating a propeller! To do this, first cut the top quarter off your 2nd bottle, keeping the top part with the lid.
- Now you want to make a small hole in the lid like you did before, and on the body of the bottle cut straight lines up toward the lid creating about 6 strands. With each strand twist it slightly in the same direction to create your propeller.
- To secure your propeller to your submarine, you need to feed the rubber band through the 2nd bottle lid (from the lollipop stick end) and secure with string. Then screw on your propeller to the lid.
- Again it's time to test your sub out!
- Once you've done your testing have a chat about what effect the propeller had, how did adding water compare to your empty submarine? How much water could you add to your submarine before it stopped moving?

Helpful links/where to find out more:

- **https://www.babcockinternational.com/wp-content/uploads/2020/10/STEM-Activity-Rubber-Band-Powered-Submarine-1.pdf**



Homemade ice cream

Making ice cream through the power of science!

What you need:

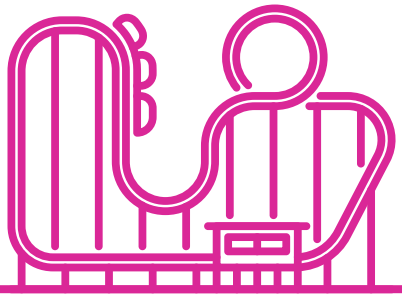
- 2 Ziploc freezer/food bags.
- Lots of ice cubes.
- Salt (rock salt is best, but table salt will work).
- 250mL milk (whole milk is best, coconut milk is a suitable veggie/vegan option).
- 250mL cream.
- 50g sugar.
- Flavouring (vanilla or anything else you like!)
- Tea towels/hand towel.

What to do:

- In one of your Ziploc bags (or in a jug) add your milk, cream and sugar and mix well to dissolve as much of the sugar as possible. If you do this in the jug, add the mixture to the Ziploc bag once mixed.
- Before sealing your bag, add in your flavouring, and squeeze out as much air as possible, now seal up your bag.
- In your second Ziploc bag add ice cubes and salt.
- Place your ice cream mixture bag into the salt/ice cubes bag, squeeze air out of your ice cube/salt bag and seal.
- Now you need to do some shaking! Best to wrap your bag in a towel as it gets very, very cold. You may need to stop shaking and add more ice and salt after a few minutes.
- Shaking for 10 minutes should be enough to create some lovely soft ice cream!

Explanation:

- If suitable for your young people, you might want to make this a research activity for them to find out how it works — looking up the reaction between ice and salt will help them discover the science behind this.
- When we add salt to ice it lowers the melting point of ice to around -21°C, since our ice is now way above its melting point it will begin to melt. In the process of melting, hydrogen bonds in the ice are broken to change from solid water to liquid water — the process of breaking bonds requires energy, which is pulled in from the surroundings. As energy is pulled in from the surroundings the temperature of the surroundings decreases — gets colder!
- Since our ice and salt is in the outer bag and our ice cream ingredients are in the inner bag, the melting ice cools down the ice cream ingredients to freeze them!



Straw rollercoaster

Build your very own rollercoaster

What you need:

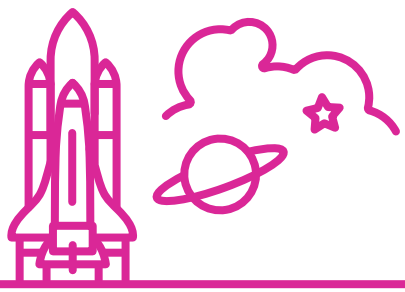
- Large piece of cardboard (or a clean pizza box).
- Paper straws (20+).
- Sticky tape (you could also use glue dots or a glue gun — be careful!).
- Scissors.
- 1 marbles/small round sweet.
- Optional: toilet/kitchen roll tubes, plastic bottle.

What to do:

- Cut out a base for your rollercoaster from the cardboard box — this could be a rectangle, square etc.
- Build a straw rollercoaster using straws and sticky tape:
  - Draw out a plan for your rollercoaster.
  - Work out the width of your rollercoaster track using your marble/round sweet. Set the width of your track by sticking small pieces of straw to your 2 tracks — this will make your rollercoaster more stable!
  - Make 2 holes in your cardboard base for upright straws that will give your rollercoaster some height.
  - Stick your first section of track to your first two upright straws.
  - Add another two upright straws to the end of the first section of track, securing them with tape and putting them through holes in your base.
  - Repeat the process of creating a section of track, adding uprights and sticking them together.
  - If you add in turns you may need to make some bumpers to stop your sweet flying off the tracks!
  - You could also add in extras like a tunnel or a chute using toilet/kitchen roll tubes and the top of a bottle.
  - For added challenge say that the structure should be 10cm, 20cm or 30cm high as an example.

Explanation:

- In order to build a safe rollercoaster, where our ball doesn't fly off, you'll have to use your design and construction skills.
- We want a rollercoaster which is fast, but not too fast that our ball flies off the rails!
- The height of our structure, steepness of the tracks and number of turns and features will all affect the speed our ball can reach.



Create your own game — guess the number

What you need:

- Device which can access the internet via a browser (laptop/PC, smartphone, tablet).
- Internet access.

What to do:

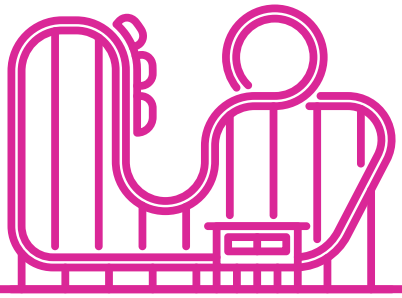
- First of all make sure your device is connected to the internet, then open your browser (Safari, Chrome, Edge, Firefox etc.) and head to **https://www.online-python.com/**
- Delete all the code in the top window (from lines 1–11).
- We are now going to type in our code to create a guess the number game!
- Type all the below code into the main.py window (after each line press enter to go to the next line):

```
# Guess the number game by Your Name

import random

num = random.randint (1, 10)
guess = None

while guess ! = num:
guess = input (“guess a number between
1 and 10:“)
guess = int(guess)

if guess == num:
print (“Congratulations! You guessed correctly!”)
break
else:
print (“Nope you guessed wrong! Try again!”)
```

- Once you have typed all this code in, check you have typed it all correctly.
- Press the Green “Run” button to run your script and play the game — how many tries did you need to guess the number correctly?

Explanation:

- You have created a script using the scripting language Python. A scripting language is similar to any other language, we can learn how to read it, write it and structure it correctly.
- So what are the parts of our games code?
- On line 1, “# Guess the number game by Steven” is a comment line which is defined by the hashtag (#) at the start of the line, this tells Python to ignore the rest of the line when we run the script.
- On line 3, “import random” tells the programme to load in a module called random (a module is a piece of code that someone else has written and is saved in the Python programme).
- On line 5, “num” is a variable and we are setting it to equal a random integer number between 1 and 10 by calling the “random” module and the “randit(1, 10)” function which generates a random integer number between 1 and 10.
- On line 6 “guess” is a variable and we are setting it to equal “None” which is a null object (has no value yet), but we must define our variables before we use them.
- On line 8, “while” is a loop which lets the code after it be repeated until we break the loop. “while guess != num:” means while the variable guess does not equal (!=) the variable num go to the next line.
- On line 9, we are indented (by 4 spaces) since we are in the While loop. We are setting the variable guess to equal an input from the user, this prints the text “guess a number between 1 and 10: “ first then lets the user type a number.



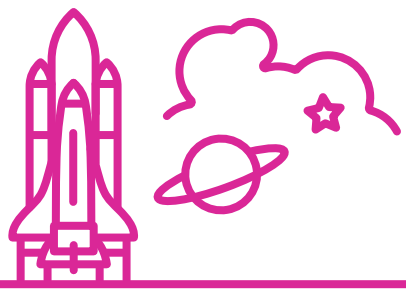
- On line 10, we are changing the variable type of guess from string (text) to integer (number), this is because input always produces a string variable.
- On line 12, we use an if statement to check whether guess is equal to (==) num, if guess is equal to num then we print “Congratulations! You guessed correctly!” on the screen.
- On line 14, we break the loop if guess was equal to num.
- On line 15, we have an else statement which runs when guess was not equal to num, this then prints “Nope you guessed wrong! Try again!” and goes back to the start of the loop.

Helpful links/where to find out more:

- For a step by step tutorial for learning more Python coding check out: **https://www.w3schools.com/python/default.asp**
- Python also have a list of tutorial sites which can be found here: **https://wiki.python.org/moin/BeginnersGuide/Programmers**
- To learn more about Python code and for a fantastic challenge on fixing Python bugs head to:
  - **https://cyberskillslesson.com/activity/debugging-coding-disasters/**
  - Cyber Skills Live also have loads of great lessons to learn cyber skills such as “How to Rob a Bank” and “Defend the Rhino with Data Science.” Head to **https://cyberskillslesson.com/** to see all their great resources!
  - Scratch (**https://scratch.mit.edu/**) is also a fantastic free tool for creating stories, games and animations online, with lots of help and tutorials to support you.

main.py +

```
1  # Guess the number game by Your Name
2
3  import random
4
5  num = random.randint(1, 10)
6  guess = None
7
8  while guess != num:
9      guess = input("guess a number between 1 and 10: ")
10     guess = int(guess)
11
12     if guess == num:
13         print("Congratulations! You guessed correctly!")
14         break
15     else:
16         print("Nope you guessed wrong!  Try again!")
17
```



Climate change: adapting for the future — growing food

In many parts of the world land where we currently grow crops is at risk of flooding in the coming years as a result of climate change and rising sea levels. This activity challenges you to create a solution to growing crops in flooded areas.

What you need:

- Use recycled materials such as plastic bottles, cans, cardboard etc. to construct your garden.
- Sellotape, blue tack, glue dots etc. for joining your materials together.
- Soil.
- Seeds/plants to grow.
- Container to float your garden on (such as a basin).

What to do:

- Design and make a floating garden using the materials you have available, put it to the test by growing something on it to see how successful it was. Try growing something small and simple like herbs (thyme) or salads (cress, rocket or spinach).

Climate change: adapting for the future — floating house

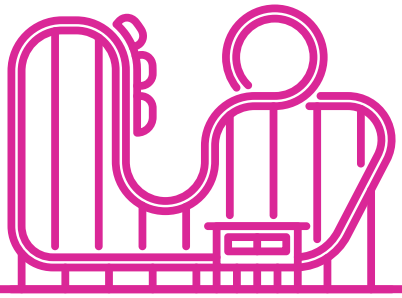
In many parts of the world our houses are built on areas at risk from rising sea levels caused by climate change. This activity will challenge you to design and create a house which works on both unflooded and flooded land.

What you need:

- Use recycled materials such as plastic bottles, cans, cardboard etc. to construct your house.
- Sellotape, blue tack, glue dots etc. for joining your materials together.
- Container to float your house on (such as a basin).

What to do:

- Using the materials you have design and build a house which can float when flooding arrives.
- Test your house on the water, does it float?



Vinegar rocket

Design your own rocket ship and blast it into orbit!

What you need:

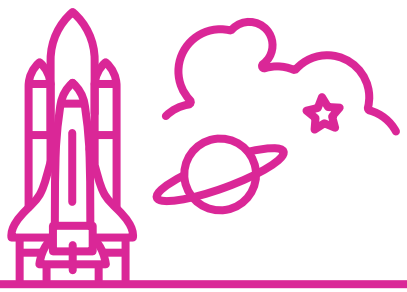
- Plastic bottle.
- Cardboard.
- Cork or stopper.
- Vinegar.
- Baking soda.
- For this activity we tested using a 1.5L plastic bottle, 200mL of vinegar and 35g of baking soda — you may need to adjust your amounts depending on the bottle you use.

What to do:

- Create your design and build your rocket, include fins and a nose cone!
- Check that your cork or stopper fits snuggly into the bottle opening, you may need to wrap some sellotape around it to make it fit better. It needs to be snug but not stuck as we want it to be pushed out during take-off.
- Make sure you are setting up your launch pad in an open outdoor space, keep a space clear of other people so that your rocket doesn't hit them during take-off.
- Pour vinegar into your rocket.
- Measure your baking soda.
- Quickly add the baking soda to your rocket, put the stopper in and turn it the right way up ready for take-off.
- Get clear of the launch pad and watch your rocket blast off!

Explanation:

- When you mix vinegar and baking soda together it releases carbon dioxide, the pressure of gas builds up and eventually forces your stopper out and blasts your rocket into orbit!
- When vinegar (acetic acid) is mixed with baking soda (sodium bicarbonate) an acid-base reaction takes place. This reaction creates sodium acetate and carbonic acid, the carbonic acid is not stable in the presence of water and decomposes/breaks down to form carbon dioxide (a gas) and water. As the carbon dioxide is made the pressure builds and blasts your rocket into space!



What's next for your STEM journey?

Young STEM Leader Programme

The Young STEM Leader programme allows young people to inspire, lead and mentor their peers through the creation and delivery of STEM activities, events etc. through a formal (SCQF 4/5/6 rated qualifications) or non-formal (digital badge/certificate at Curriculum for Excellence Level 2/3/4) route.

- Find out more about the YSL Programme: **https://www.youngstemleader.scot**

STEM Ambassadors in Scotland

STEM Ambassadors are volunteers working in or studying STEM subjects who work with young people to bring STEM subjects alive through real-life experiences.

Over 5000 Ambassadors in Scotland deliver engaging STEM experiences for schools, community and youth groups.

- Find out more about STEM Ambassadors in Scotland: **https://www.stem ambassadors.scot**
- Create an account and request a STEM Ambassador now by visiting: **https://www.stem.org.uk/user/register**

STEMettes

STEMettes aims to engage, inform and connect the next generation of women and non-binary people into Science, Technology, Engineering, Arts and Maths (STEAM) by showcasing the diversity of people working in STEAM.

Head to https://stemettes.org to see the range of fantastic programmes, events and content that STEMettes deliver for girls, young women and non-binary people (aged 5-25).

CREST Awards

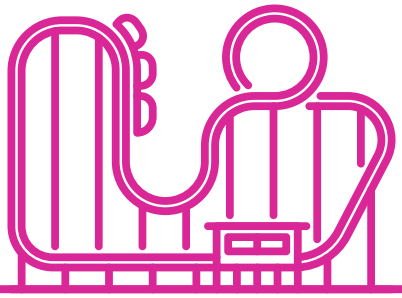
These awards give young people aged 5-19 the chance to choose their own subject and methodology when completing their hands-on investigation. CREST provides a range of project ideas and activity resources including a range developed by partner organisations and companies.

- Visit the CREST website for some fantastic free STEM resources to broaden your scope of activities: **https://library.crestawards.org/**

iDEA (Inspiring Digital Enterprise Award)

- **https://idea.org.uk**

iDEA offers free online learning, compatible with any modern device, where you can earn badges and awards by completing modules on a variety of subjects such as GIF making, Animation, Big Data, GDPR, Online Safety and so much more.



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