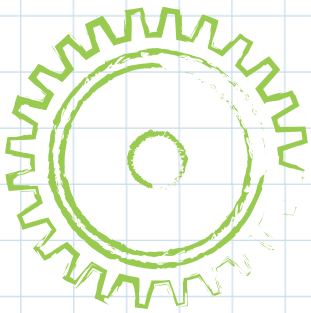
WE DISCOVER, WE GROW
Girlguiding
North West England

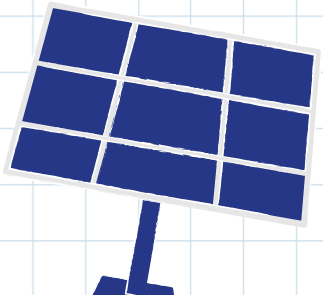
BAE SYSTEMS

CLEVER COGS CHALLENGE

SAVING PLACES

Contents





Introduction

About this Challenge:

Make way for our brand-new Clever Cogs Engineering Challenge! This one's all about Environmental Engineering; giving you a taste of different kinds of innovation that you might find within this field. Clever Cogs – Saving Places has been designed to complement the 'Take Action' theme of the new programme. Each activity is based on a different area of Environmental Engineering. This challenge is also jam-packed with incredible female engineers who have done some tremendous things to help us protect our planet! As you complete the activities, think about how engineering has helped and what you could do to help create a positive impact on the environment.

What is Environmental Engineering?

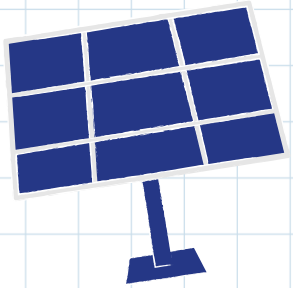
Environmental Engineering brings together many different types of science, such as Biology, Geology, Chemistry, Microbiology, and even Maths. Environmental Engineers come up with solutions to protect and improve our environment and to protect people from environmental effects such as pollution. They also help to improve the way we dispose of waste, control air and water pollution, and how we recycle in the best way possible. Environmental Engineers are interested in things like climate change and how we can create electricity in a more sustainable way. They look at things like drought, population growth and deforestation.

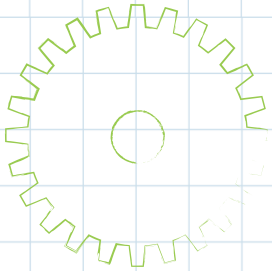
Overall, Environmental Engineers solve complex problems relating to the environment and come up with innovative solutions to make sure that we live our lives in the cleanest, most efficient way.

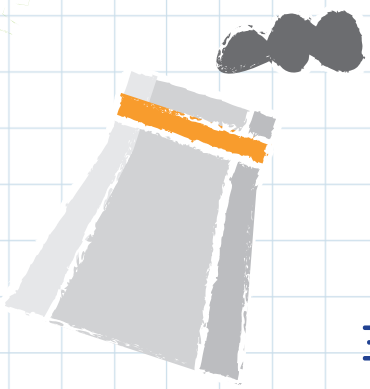
Women in Engineering:

According to Engineering UK, the percentage of female engineers within the UK has increased in recent years and - as of 2018 - is reported to be 12.37%.

Despite this gender gap, women have achieved some of the greatest engineering feats of all time. Throughout this challenge, you will be able to find out much more about some incredible engineers and we hope they inspire you to believe you can achieve great things within the field of science, technology, engineering and maths too!







FAQs

How to complete this Challenge:

The Clever Cogs – Saving Places challenge is suitable for all sections to take part in. You can choose to complete activities as a Six, Patrol, unit… or another grouping of your choice! We recommend you spend a minimum of two meetings working on the challenge. Rainbows and Brownies should aim to complete 3-4 activities; Guides and Rangers, 5-6.

Leaders:

At the end of each activity there is a 'Guidance for leaders' section, giving extra information on how to support delivery of the activity, as well as details of how you can adapt it to make it easier or more challenging, as appropriate to the section you're supporting with the challenge.

Remember: You, our young members, should decide which activities you would like to do. Why not get everyone together for a Rainbow Chat, Brownie Pow Wow, Patrol Meeting, Rangers' planning meeting or just a simple discussion. This is a fun badge, not a qualification, and a flexible approach is required. As long as you have taken a full and active part in the challenge, you should receive the badge.

How to order your Badges:

Badges are £1 each and can be ordered from the Girlguiding North West England shop. They can be purchased in store or online.

Why not try some of our top tips to make this challenge printer friendly:

Print multiple pages to one sheet – make sure you can still read it though!
Set your printer to double-sided, for optimum paper economy
Only print the pages and sections you need
Print the challenge in black and white, to save on ink

Produced in partnership with:

BAE SYSTEMS

CLEVER COGS CHALLENGE SAVING PLACES
Girlguiding North West England

BAE Systems is committed to promoting diversity in engineering and is proud to sponsor the engineering challenge badge.

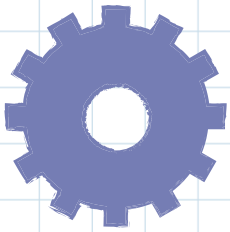
Adapting this challenge pack to the home, due to COVID-19

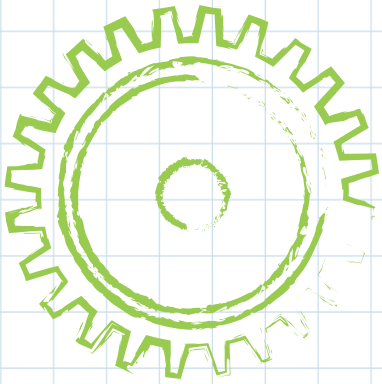
During the current pandemic, we understand the need to be flexible with the activities we undertake. With that in mind, please feel free to adapt this challenge pack to suit you. Whilst the activities within the challenge would normally be completed as part of a unit meeting, should this not be possible, the pack can be shared with parents/carers to complete with their girls at a time to suit them.

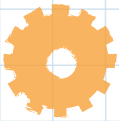
We hope that you will be able to access all of the materials needed for this challenge, but please only complete the activities you are able to, using materials you are able to access easily and safely. Discuss as a unit which activities you feel would be best to undertake virtually and which ones you feel might be best completed in the unit meeting place, once guiding returns to normal.

Alternatively, if your unit isn't meeting at the moment, leaders may wish to choose a few activities for girls to do at home, while reserving some engineering excitement for when guiding units are back up and running as normal.

With any activities involving outdoor contact, we highly advise any members involved to wear a mask and gloves, and ensure that they observe social distancing rules and any developing UK Government Guidelines.







Sustainable Spinning

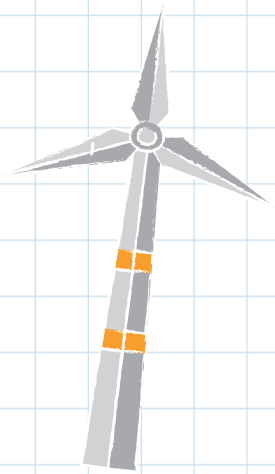
Wind Power & Hydro Power are both renewable and clean energy sources, which means that we can use as much as we like and they will never run out. This contrasts our current main energy source - fossil fuels such as coal, oil and gas - which are running out. It also means that we can use the power of the wind or moving water to create electricity with minimal impact on the environment.

To create electricity from the wind, wind turbines transform the energy of the wind, turning the turbine blades into electricity, which we can use to power light bulbs in our homes or to charge our mobile phones.

Hydropower (or hydroelectricity) is when electricity is created by transforming the energy from moving water. Moving water can turn turbines; transforming energy from the turbine into electricity. The more water that is moving, the more electricity is created. So, a waterfall would produce a lot more electricity than a stream.

Rainbows & Brownies: Wind Power

Equipment (per mill):

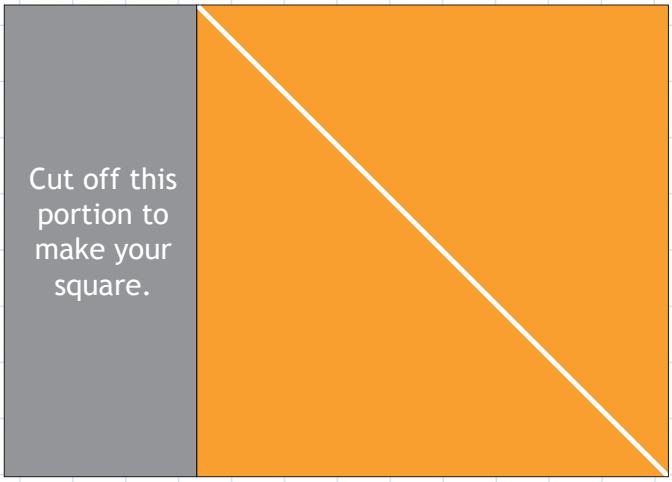


- 1x wooden lollypop stick
- 2x sheets of coloured paper (different colours)
- 1x push pin/drawing pin/tack
- Scissors
- Blu tack

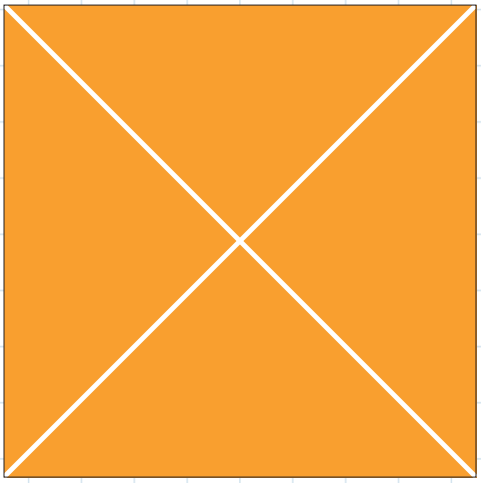
Estimated Time: 10 minutes

Method:

1. With a leader's help, cut both of your coloured sheets of paper into squares. A trick to doing this is to fold one corner of the sheet down diagonally, and that will show you how much of the rectangle to cut off (see diagram below):

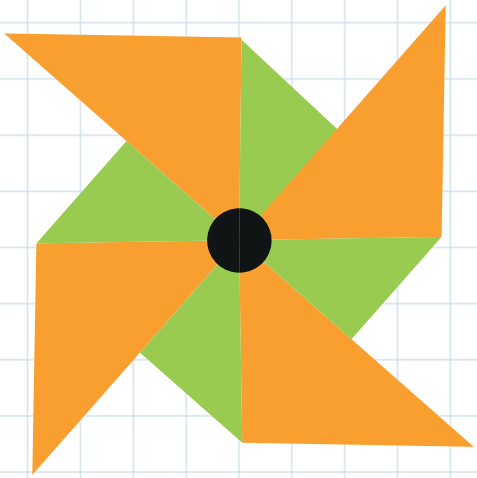


2. Now, with one coloured sheet on top of the other, fold them across diagonally both ways (like you have just done, but with the other corner too) and then open them back up. Your coloured squares should both now look like this:



3. Now, with a leader's help, cut about **halfway** along each of the folded lines (remembering to keep both sheets on top of each other).

4. Next, take one corner of each triangle, and pull the tip into the centre, so that you've got one tip of each triangle overlapping in the middle of the square. Then ask a leader to help push the pin through all four triangle tips, into the centre of the squares - like this:



5. Now, ask a leader to help you push the pin into the top of the lollypop stick; making sure that the hole in the windmill is big enough (wiggle it around a bit) so that the windmill spins freely.

6. Your windmill is complete! Try blowing on it and watch it spin round!

Guides & Rangers: Hydro Power

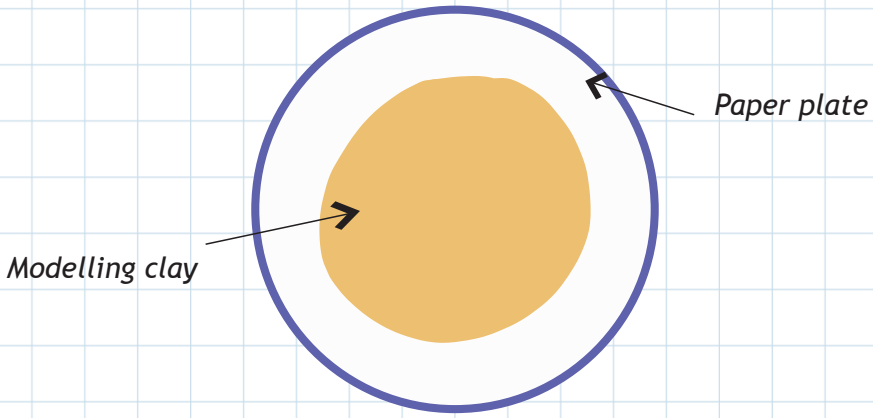
Equipment (per water mill):

- Block of modelling clay
- 8x wooden/biodegradable spoons
- 2x paper plates
- 1x wooden skewer
- 1x medium-sized bucket (mop bucket would do)
- Scissors
- Ruler
- Felt tip marker
- String

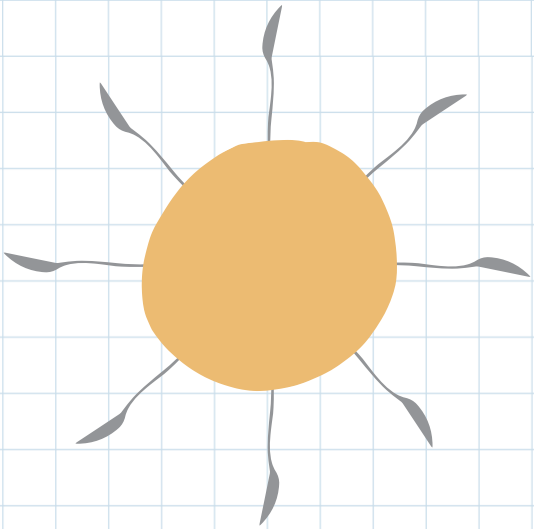
Estimated Time: 30 minutes

Method:

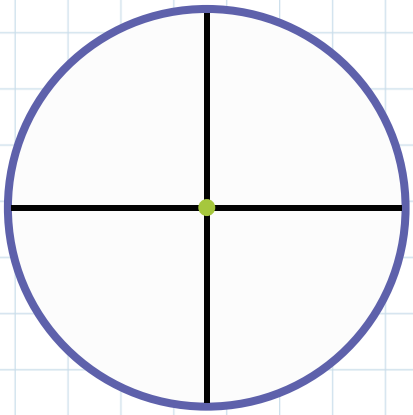
1. Firstly, prepare your modelling clay by rolling it into a ball and then squashing it so that it forms a round, flat disk. Make sure it is smaller than your paper plates (see diagram below):

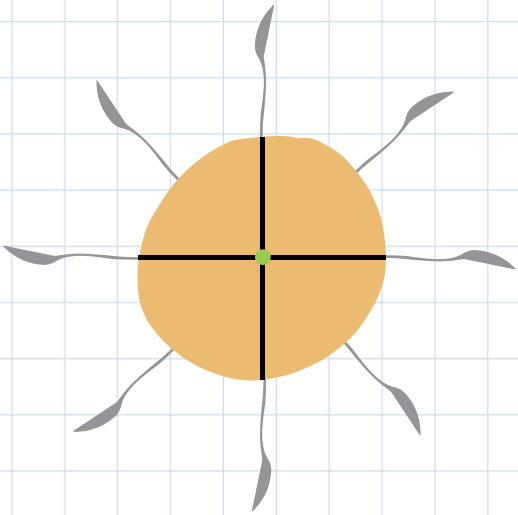


2. Next, take your spoons and stick them all around the edge of the modelling clay, with the spoon end facing outwards and all in the same direction, as in the diagram below:



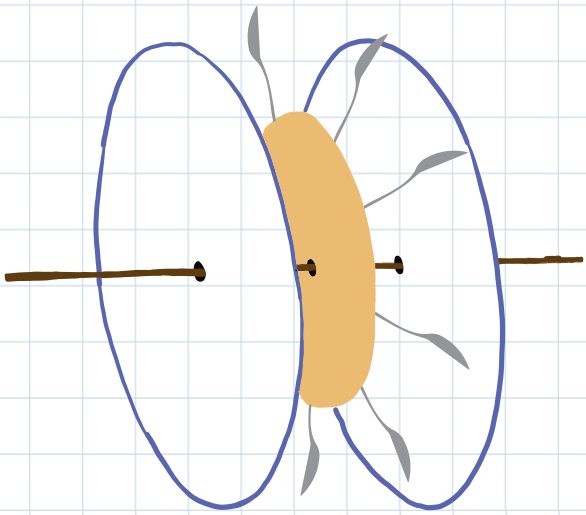
3. Find the centre of the paper plates using your ruler. Draw lines across the plate at exactly half-way and mark the point where they cross with your felt-tip marker. Then, do the same with your modelling clay circle, to find the centre of that too.





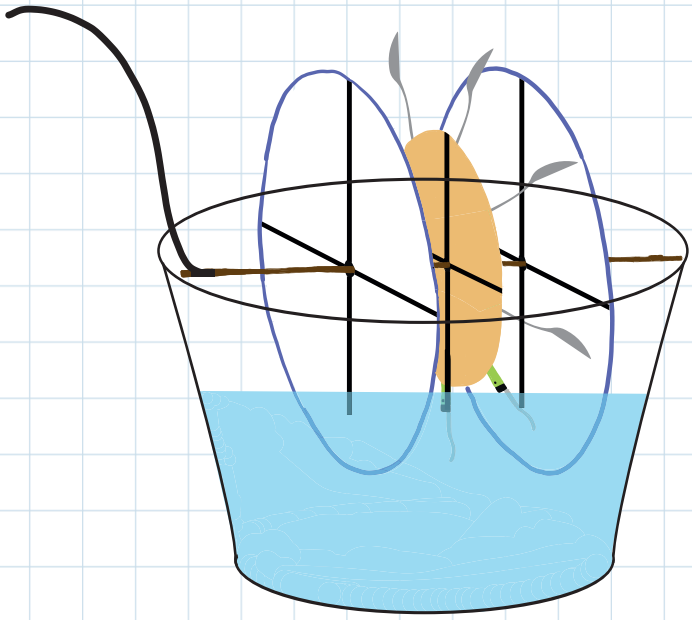
4. With the help of a leader, push the wooden skewer through the centre of the paper plates, at the point you have marked with your felt-tip marker, to create a small hole. Do the same with the modelling clay circle.

5. Now, place your modelling clay circle carefully between the two paper plates, like a sandwich. Then, push the wooden skewer through all three pieces until it is all the way through (see diagram below for help):



6. Next, tie a piece of string to one end of the wooden skewer and wrap it around the wooden skewer a few times; making sure that the string is wrapped around the water mill so that, when it unravels, it spins your water mill the same way as the spoons are facing (ask your leader for help with this if you are stuck).

7. Now your water mill is ready to be tested! Fill your bucket with enough water so that, when you rest the ends of the wooden skewers on the sides of the bucket, the spoons at the bottom are under water, but not the modelling clay! (See diagram):



8. Once you have set up your water mill, pull gently on the end of the string and see if your water mill spins around.

9. In real-life, the water mill would be turned by a river or stream and it would be connected to a generator which transforms the energy created by moving the water mill into electricity.

Guidance for leaders:

Split the girls into groups of 4 or 5 to complete the water mill activity. Make sure that each girl understands the concept of wind and hydro power; some information is included in 'How this relates to Engineering', but there are also plenty of examples online, as well as diagrams to explain how it works.

How this relates to Engineering:

Wind turbines and water mills both utilise mechanical and electrical technology to transform the potential energy of wind/moving water into electricity.

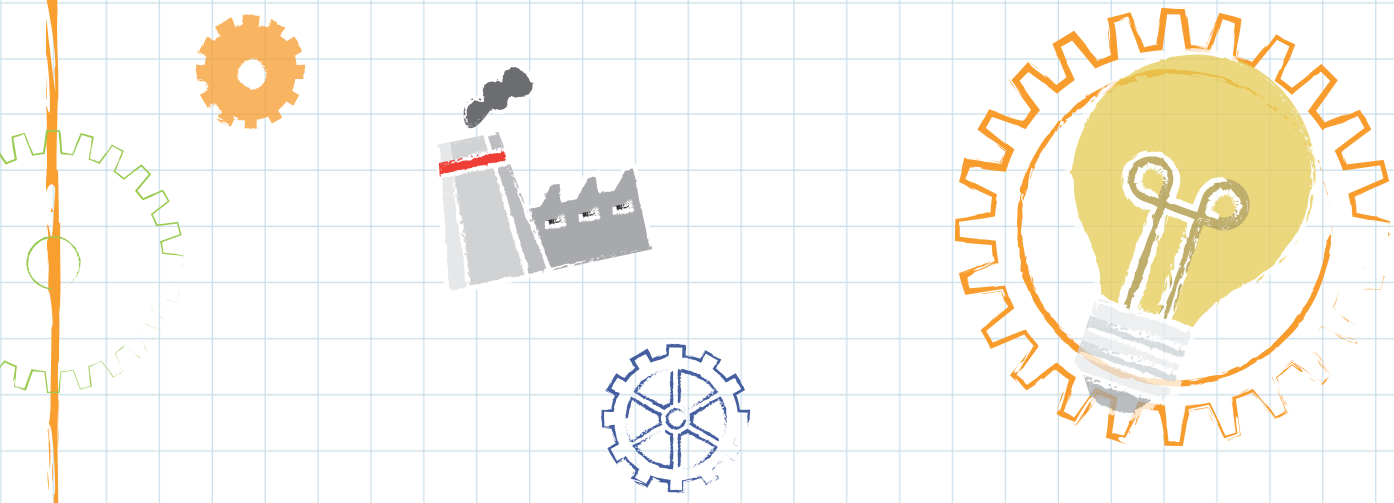
In real-life, both the wind turbine and the water mill would be connected to a mechanical system. The force of the wind/water spins the turbine/mill, which in turn spins the rotor of a generator. This is what produces the electricity.

Environmental Engineers work with renewable energies to help design, test and install them around the world. Mechanical and Electrical Engineers also play a big part in the design and production of renewable energy solutions. This is a field which is getting more and more attention due to the growing need to tackle Global Warming. Environmental Engineers working in Renewable Energy really can help to change the world!

Inspiring Female Engineer: Dr Nina Skorupska

Dr Nina Skorupska is the Chief Executive of the UK's Renewable Energy Association, and is one of the UK's most influential women in the energy sector. Nina has a degree in Chemistry and a PhD in Coal Combustion. She is the daughter of a Polish immigrant and was the first woman to run one of the Renewable Energy Association's UK power stations. She has over 30 years' experience in the energy sector, working in the UK, Germany and the Netherlands.

Initially, Nina wanted to study astrophysics and astronomy, but realised that her maths wasn't as strong as it needed to be for that sector. Her plan B was to join the energy sector and it's a good thing she did (!), as she has made a fantastic contribution to this sector. She was named one of the Women's Engineering Society's Top 50 Influential Women in Engineering in 2016 for the great strides she has made.



Take-it-Home Activity: Where Does Your Electricity Come From?

Do you know how much you depend on Fossil Fuels to live your life? Why not do some research into your local electricity supply, and find out where your electricity comes from. There are many different ways that electricity can be produced, so find out what the biggest contributor is for your area.

Why not assess your home and keep a diary of all of the ways that you could reduce your house's impact on the environment? For example, could you remind everyone in your house to turn the lights off when they leave the room? Could you make sure that everyone is recycling and using plastic as little as possible? Perhaps you could remind them to turn the tap off whilst brushing their teeth, to save water! Write all of your ideas down and bring them back to your unit meeting to discuss with the rest of your unit.

Engineering Ecosystems

Rainbows & Brownies:

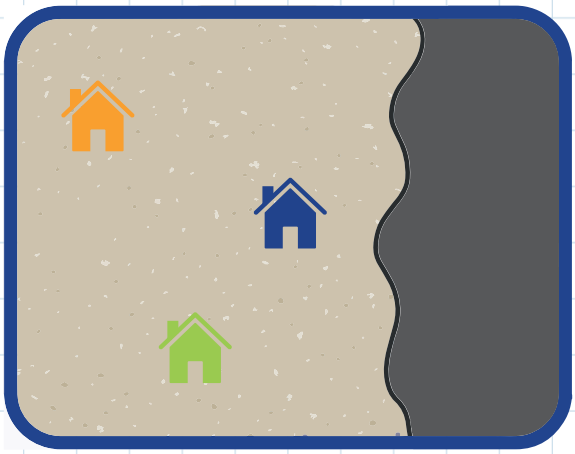
Equipment (per group):

- Washing up tub/large, deep baking tray
- Bag of gravel/small stones/grit
- 3x different coloured bottles of food colouring (a few drops of each)
- Jug of water
- 4x small glass jars/beakers
- Something to represent 3 little houses (e.g. board game tokens, marbles, dice)

Estimated Time: 30 minutes

Method:

1. First, you need to set up your neighbourhood. Fill your tub/tray with gravel/grit, so that it is about an inch deep; leaving a portion at the end of the tray free of gravel/grit. Then, place your little 'houses', spaced out on the gravel. Your neighbourhood should look roughly like the below diagram:



2. Now, add some water to your neighbourhood. Take your jug of water and pour it evenly over the gravel until you've got about an inch of water in the gap you've left without gravel (judge this based on how much gravel you've got). Be careful not to add too much water, otherwise your houses will flood!

3. Take a sample of the water using your little glass jar/beaker - it should look nice and clear. As you can see, the houses are all using eco-friendly products and detergents, so the water in the neighbourhood is nice and clean.

4. Now, one of the houses decides to start using a cheaper detergent, which has harmful chemicals in it. With the help of a leader, add a few drops of food colouring (one colour) to where one of the houses is sitting.

5. Take another sample of the water using a different glass jar/beaker. Can you see how the harmful chemicals are contaminating the water? Do you think this is nice for everyone else living in the neighbourhood?

6. Now, a second house decides to start using a more powerful bleach when they are cleaning their bathrooms. With the help of a leader, add a few drops of food colouring (a different colour) to another house.

7. Take another sample of the water using a different glass jar/beaker. Is the water getting worse as more pollutants are being added to it? What do you think is starting to happen to the fish living in the water?

8. Now, a third house decides to wash their car with some harmful chemicals. With the help of a leader, add a few drops of food colouring (a different colour again) to the third house.

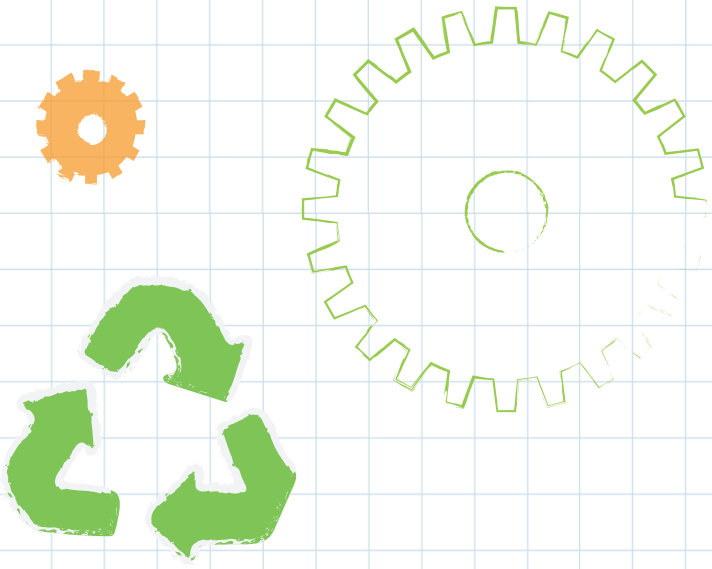
9. Take a final sample of the water. What does it look like now? Do you think you would want to use this water to wash with, or brush your teeth with?

10. Compare your water samples side-by-side and see how the water quality has worsened with the addition of more pollutants.

11. Talk to your group about what could happen to the local wildlife if they had to use this water to wash in and drink from.

12. What do you think the houses could do differently to stop contaminating the water in their neighbourhood?

13. How do you think engineers could help to reduce the effects of water pollution?



Guides & Rangers:

This activity will show you how to engineer your own ecosystem - putting together multiple parts to create a whole, working product (the ecosystem).

Equipment (per ecosystem):

- Large (2L), empty soft drinks bottle (clear if possible)
- Small plant
- A few small rocks/aquarium rocks or sand
- String
- 2x paper coffee filters
- Jug of water
- Pencil

Estimated time: 30 minutes

Method:

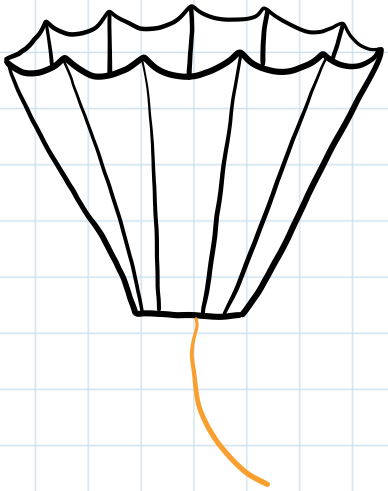
1. Take your plastic bottle and cut the top off, just below where the bottle starts to curve inwards (see diagram below). Once you've cut the top off, keep it to one side as you'll need it later.

2. Now, place some of your small rocks into the bottom part of the bottle, and fill with water using the jug, until it is approximately half full.

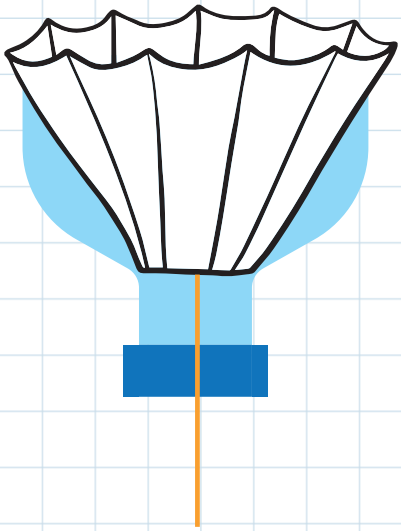
3. Using the pencil, pierce a hole in the centre of both paper coffee filters. Then, cut a piece of string, a little longer than the length of the bottle (without the top part that you've cut off).

4. Keep the two coffee filters together and push the end of the string through the hole in the centre of the filters.

5. Knot the end of the string that is inside the filter, to stop it falling all of the way through.

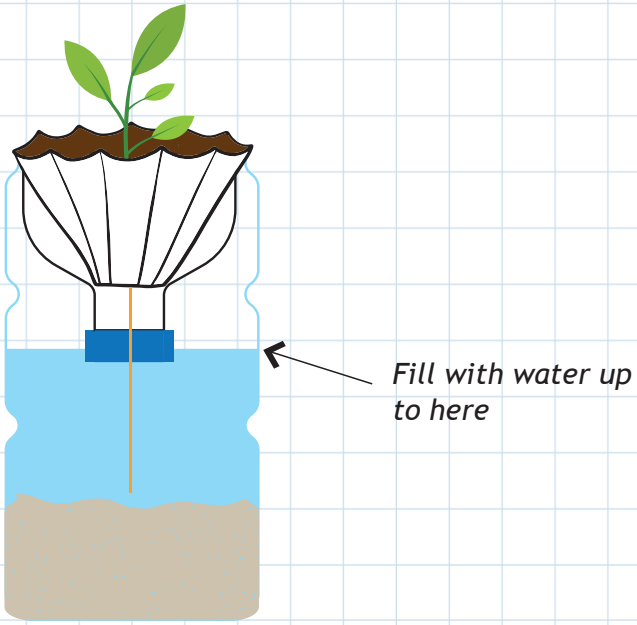


6. Next, take the top of the bottle that you cut off and set aside earlier, turn it upside down and remove the lid. Place your coffee filter papers inside the top and let the string come through the bottle opening (see diagram for help):



7. Now, place your small plant inside the coffee filter. If it doesn't completely fill the space, use some gardening soil to fill it up. The top of the soil should just about line up with the top of the cut bottle.

8. Then, place the top portion of the bottle (the one with the plant in it) into the bottom half of the bottle, as shown. The water level should be high enough to cover the bottle opening, as shown:



9. Your ecosystem is now complete! Your ecosystem will support itself – the plant will get its water by drawing it up the string.

Guidance for leaders:

For the Rainbows' & Brownies' activity, make sure the girls use enough food colouring so that the water changes colour. Leave a little bit of time for the food colouring to seep through the gravel and into the water too.

For the Guides' & Rangers' activity, you might need to give quite a lot of help at times. Perhaps print this challenge out and let them go through the diagrams for help. You could turn this into a project for them, so that they look after their ecosystems at home. Perhaps award a prize to whoever manages to keep their ecosystem alive for a month! You could even challenge them to grow their own plant from seed first, to then add to their ecosystem.

How this relates to Engineering:

While these activities aren't engineering specifically, they present an important lesson about pollutants and how ecosystems work, as well as how we can improve our engineering practices to ensure we aren't harming the environment, whether that be in design, testing, production or maintenance. The engineering industry is looking more and more towards sustainable engineering solutions and ensuring that they take precautions not to harm the environment at any stage of the engineering lifecycle.

Inspiring Female Engineer: Dr Mehreen Faruqi

Dr Mehreen Faruqi moved from Pakistan to Australia in 1992 to complete a PhD in Environmental Engineering at the University of New South Wales. After completing her PhD, she went on to work as a Civil and Environmental Engineer. As part of her job, she was able to work across lots of different areas, including consulting, local government, research and teaching.

Mehreen worked to restore rainforests, build cycleways, reuse storm water and establish large-scale, renewable energy projects.

As well as being invested in Environmental Engineering, Mehreen is also interested in feminism and environmental activism, which led to her entering the world of politics.

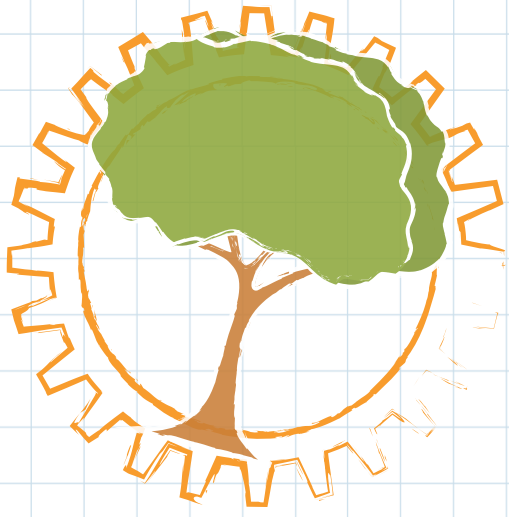
In 2013, Mehreen was appointed to the upper house of the New South Wales Parliament in Australia. In 2018, she was sworn into the Australian Senate as the first female Muslim senator in Australia's history.

She said "Engineering is as much about visionary thinking as it is about analysis, design and transforming ideas into reality".

"We need this innovative thinking more than ever before, to shape a future where we take radical action on climate change, protect our ecosystem, create an equal society and have prosperity and sustainability across the globe".

Take-it-Home Activity: Grow Your Own Tree

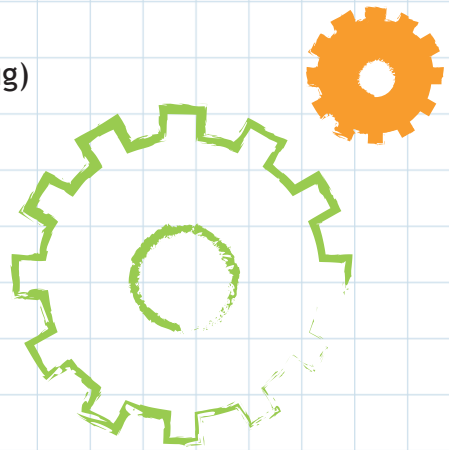
Why not plant your own tree and help the planet to get rid of carbon dioxide? Trees breathe in carbon dioxide and breathe out oxygen, so are natural filters for the pollution that we create. Can you think of somewhere that you could plant a tree? Perhaps in your garden, or in the park. You could plant one in a pot if you can't find any suitable space in the ground.



Make Your Own Plastic:

Equipment:

- 3tsp white vinegar
- Whole milk/cream (enough to half-fill your microwave-safe mug)
- Access to a microwave/stove
- Microwave-safe mug
- 4-5x paper towels
- Moulds/biscuit cutters
- Food colouring/glitter (optional)
- Spoon
- Sieve
- Bowl



Estimated time: 45 Minutes + 48 Hours drying time at home

Method:

1. Half-fill the microwaveable mug with whole milk/cream.

2. Heat the mug containing the milk in the microwave (or in a pan on the stove if you do not have access to a microwave) until it is warm - about the temperature of a cup of tea. Please ask for help from a leader when doing this.

3. Remove the mug from the microwave (take care when doing this and, members of our younger sections should ask a leader to do this for them) and, if you are using food colouring or glitter, add these to the mixture now.

4. Stir in three teaspoons of white vinegar and stir the mixture well for a couple of minutes - you should notice some lumps starting to form.

5. Sieve the mixture into the bowl. Discard the liquid which falls through into the bowl and keep the curds which are caught in the sieve - these will form your plastic.

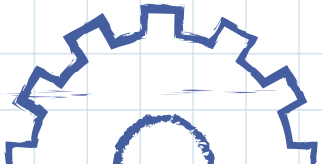
6. Tip the curds out onto a paper towel and squeeze them with another paper towel to release as much of the liquid as possible.

7. Knead the curds for a couple of minutes, using a spoon or your hands, to make them more pliable.

8. Once the curds are sticking together, they are ready to be moulded into their final shape. Place your chosen mould/biscuit cutter onto a plate, on top of a paper towel, and press the curds into it. Be sure to press them into the very corners of the cutter.

9. Leave the plastic in the mould for at least 48 hours, to allow it to air dry.

10. Once the plastic is totally dry, you can remove it from the mould and it should be solid. You can then paint your plastic, if you choose to!

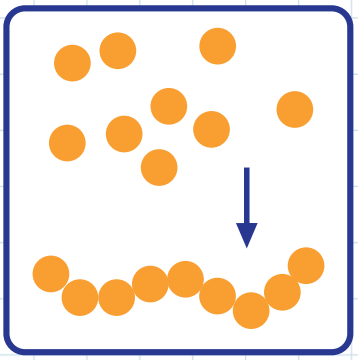


Guidance for leaders:

To make this activity more challenging for Rangers and older Guides, get the girls to attempt to shape the plastic by hand, rather than using a mould. You could also use cocktail sticks to poke a hole in the plastic whilst it is drying, and then pass thread or elastic through this hole to create a keyring. You may wish to provide gloves for girls to use whilst completing this activity, in case they aren't comfortable with handling the milk curds. Be sure to check for latex allergies before handing these out!

How this Relates to Engineering:

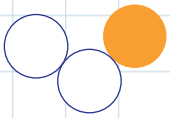
The material that you have created in this activity is called casein plastic. Casein is a molecule which is found in milk. When it is in the milk, it is known as a monomer – a very short molecule. When you add the acidic vinegar to the milk, these monomers clump together to form a polymer – a very long chain. These polymers then stick together to form the curds! Have a look at the diagram below, which shows how polymers are formed:



What is a Polymer?

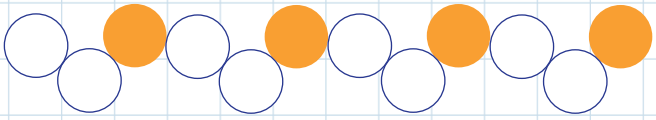
A long molecule made up from lots of small molecules called monomers.

Monomer



A monomer is a small molecule.

Polymer

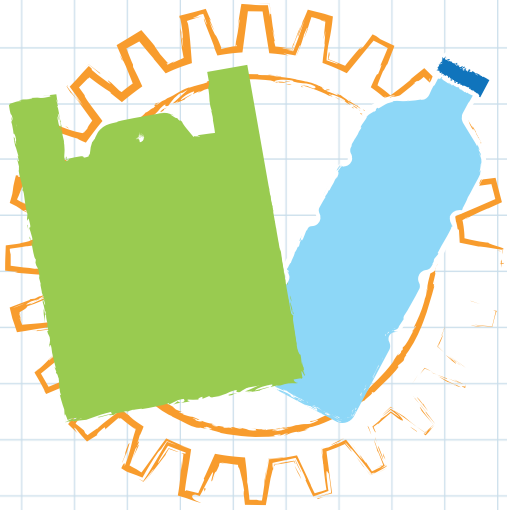


A polymer is a long-chain molecule made up of a repeated pattern of monomers.

Casein Plastic was very popular in the 20th Century and was used to make buttons, beads, jewellery and pens! Today casein plastic isn't used much; instead we rely on plastic from the non-renewable (it will one day run out) source of oil extracted from deep under the sea. Engineers can help to find new sources for materials like plastic, which are renewable, therefore reducing our reliance on fossil fuels and helping to protect the environment. Engineers and scientists are working on lots of exciting projects in this field.

Inspiring Female Engineer/Environmental Activist: Rebecca Hosking

Rebecca Hosking is a film-maker and environmental campaigner from Devon. In 2005 she visited Hawaii to film a documentary on the effects of plastic pollution. Her film highlighted the impact of single-use plastics around the world; items which we regularly use and throw away can be blown into the sea on their way to landfill and can travel thousands of miles through the ocean, until they wash up on beaches or are eaten by sea creatures. When Rebecca returned to the UK, she decided to take action to reduce our own plastic use. She spoke to shop owners and traders in her local home town and showed them the documentary she had made, asking them to take action and stop selling plastic bags. In 2007, her home town of Modbury in South Devon became the first town in Europe to completely ban plastic bags! Take a look at Rebecca's website to learn more about how she achieved this: https://www.rebeccahosking.co.uk.



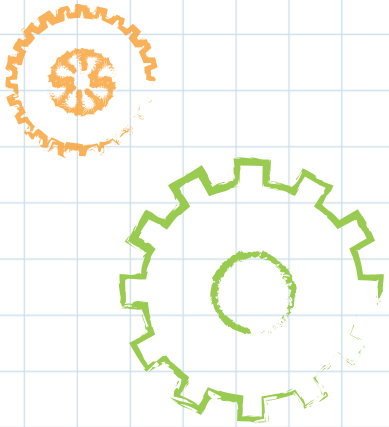
Take-it-Home Activity: Eco-Bricks

We can all do our bit to reduce plastic pollution and the use of fossil fuels. Whilst the best option is always to reduce the amount of plastic you buy, or to re-use the plastic you do have available, sometimes we can't avoid buying single-use plastics. In these cases, it is important to do whatever we can to recycle our plastics. Most of us are familiar with the idea of plastic recycling in our homes (through blue bags/boxes), but the type of plastic which can actually be recycled in this way is very limited.

There are lots of schemes available to help you to recycle as much plastic as possible – one of these is the eco-brick scheme. The idea is simple – you collect all of the non-recyclable plastic you can (things like thin plastic wrappers are great) and pack them into a plastic bottle as tightly as possible. Once the bottle is full, screw the lid on and post it to be used in eco-friendly build schemes! There is more information available at: https://www.ecobricks.org/. Why not see how many eco-bricks your unit can create? Or, see if you can fill a plastic bottle with your non-recyclable plastic whilst on camp? Send us your photos so we can see the fantastic work you are doing!

Convey the Message!

Equipment:



- 3x toilet roll inner tubes or similar
- 6x wooden skewers (straight)
- Recycled cardboard to cut up
- 2x lollipop sticks
- Glue (ideally a hot glue gun, if you have one)
- Sticky tape

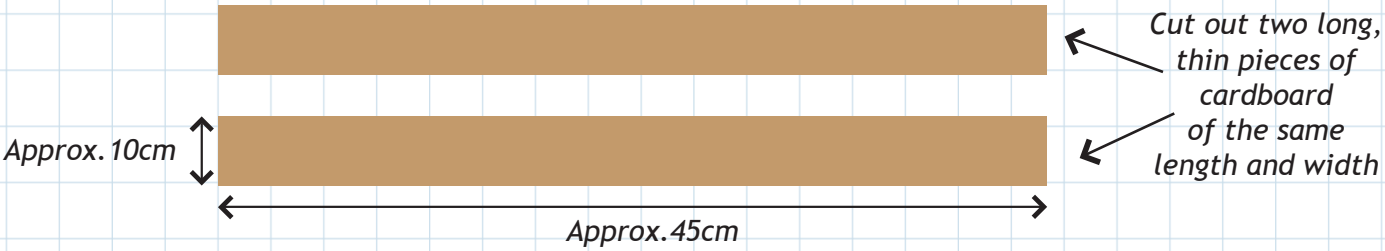
Estimated time: 1hr

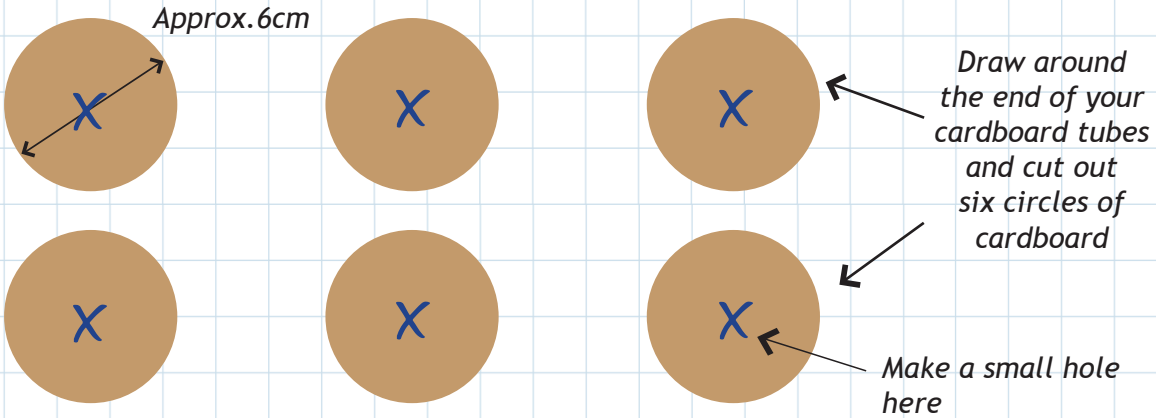
Method:

There are four different steps to creating your conveyor belt.

Step One - Cut the Cardboard

You'll need to cut a few different shapes from your cardboard, shown by the diagrams below. The diagrams have dimensions to help you know what size to aim for - but you can scale these up or down, depending on how much cardboard you have available! Rainbows and Brownies, ask your leader to help with measuring and cutting out your cardboard.

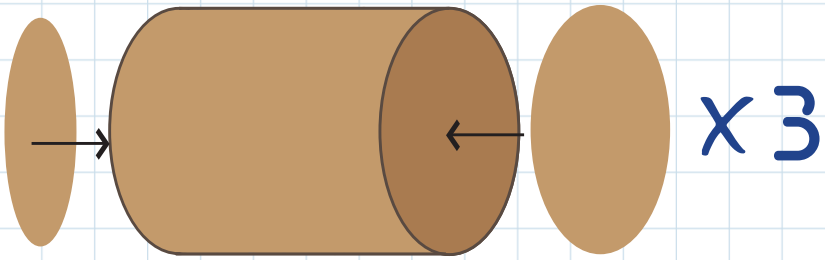




Mark the centre of all of the circles and make a small hole in the cardboard using the tip of a pen or pencil, or the wooden skewer.

Step Two: Create the Rollers

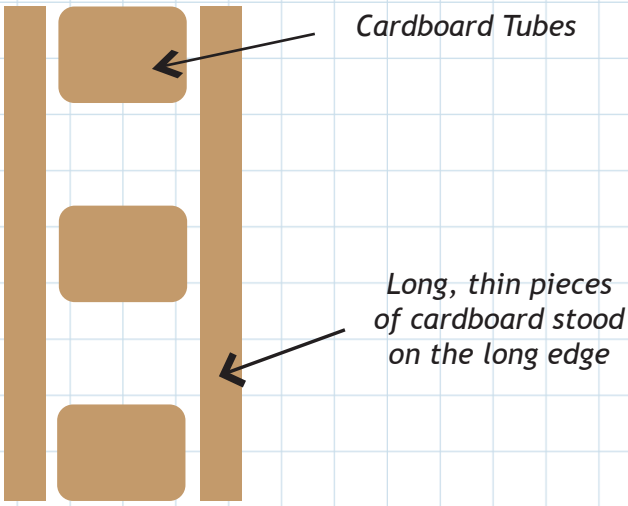
Take two of the circles that you cut out in Step One and, using the glue or hot glue gun, secure them to either end of the cardboard tube. Hold them in place until they are secure! Rainbows and Brownies, be sure to ask your leader for help if using a glue gun!



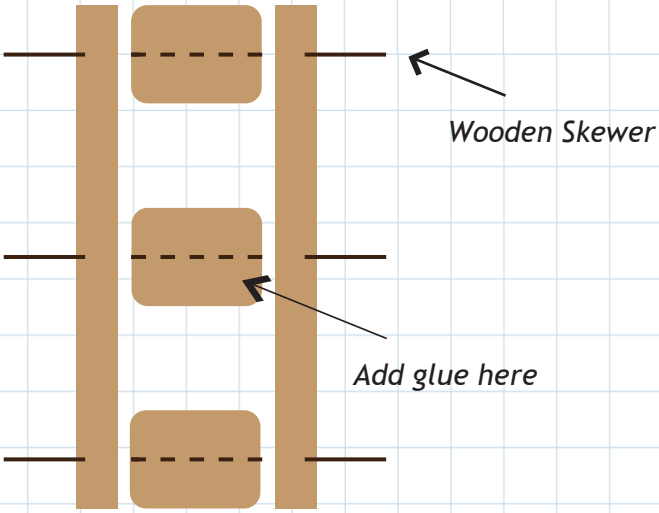
Repeat this for all three cardboard tubes, so that you have three rollers.

Step Three: Assemble the Conveyor Belt

Lay out what you have so far in the arrangement below:



The next step is to secure your rollers in place using the wooden skewers (Rainbows and Brownies should ask a leader for help with this). Poke each skewer through the long, thin pieces of cardboard, and then through the holes in the centre of the circles. Once you've finished, it should look like the diagram below. Add a small amount of glue to secure the skewers to the cardboard circles, as shown below:



Step Four - Add the Belt

Cut the paper into strips which are the width of the cardboard tube. Use the sticky tape to join these pieces of paper together, in a long line, as in the diagram below:

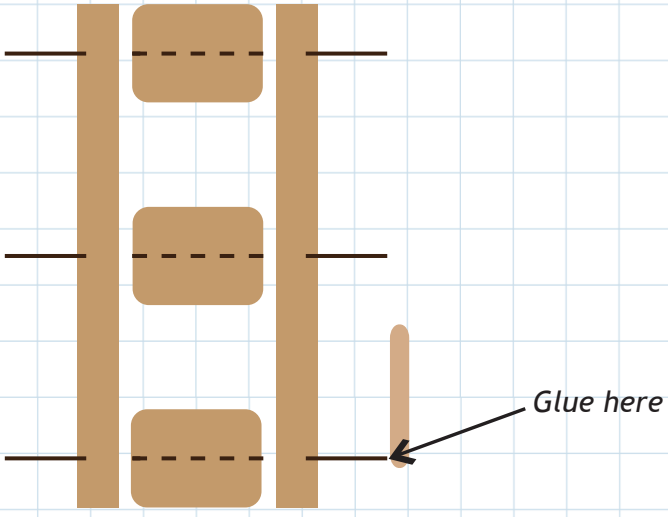
Approx. 90cm

Once your long strip of paper reaches at least 90cm long, wrap it around the rollers and tape the two ends together, as in the picture below:

An extra pair of hands is needed for this step

Step Five - Add the Handle

Use the glue to secure a lollipop stick to the end of the wooden skewer at the front of the conveyor belt:



Your conveyor belt is now complete! Try turning the handle - you should notice that the belt moves. Take some time to think about how a conveyor belt can be used to help waste sorting and recycling efforts; read the Guidance for leaders section for some ideas!

Guidance for leaders:

This activity might be challenging for Rainbows, so why not split your Rainbows into groups and give each group a task e.g. Group One measures and cuts out the rectangular shapes, Group Two measures and cuts out the circular shapes etc. If you still don't feel this activity is achievable, why not build the conveyor belt in advance and use it to play a game?

You could bring in different types of waste e.g. plastic, paper, foil and metals, and put them on the conveyor belt. Get the girls to think about ways the waste could automatically be sorted to allow for effective recycling – for example, if you blow on the conveyor belt, you could remove all of the paper – but you might get some bits of plastic in there too! Guide/Ranger leaders could also introduce this element of the activity, to get the girls thinking about how to sort and recycle waste effectively. You could explore magnetism and test which metals are magnetic, and which aren't.

How this Relates to Engineering:

Waste sorting and disposal plants might not seem very exciting, but they are essential in ensuring that waste is properly sorted and can be recycled properly. Did you know that, in most parts of the UK, black plastic can't be recycled, as its colour means that the lasers used in waste sorting plants can't identify it as plastic? If engineers can design new, more effective methods of sorting waste, they can reduce the amount of waste being sent to landfill.

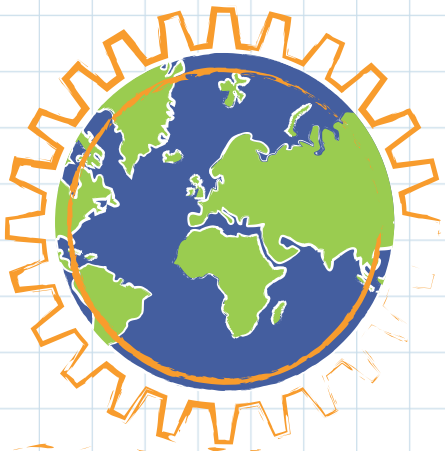
One example of the huge impact this can have can be found in the city of Eskilstuna in Sweden. Here, Engineers have designed a waste sorting system which identifies household waste so accurately that the city now sends no domestic waste at all to landfill! This system is based on seven, brightly coloured bags, which people sort their household waste into. The waste sorting system then uses lasers to recognise these colours and sort the bags of waste into piles. These piles are then compacted down and sent for recycling.

Inspirational Female Engineer: Lisa Jackson

Lisa Jackson is an American Chemical Engineer who has spent most of her career focussing on Environmental protection issues. In 2008, she was appointed to the position of Administrator of the American Environmental Protection Agency by Barack Obama and was the first African American woman to hold this position. Some of her achievements include:

• Introducing stricter regulations regarding Carbon Dioxide (CO_2) emissions. This is important as Carbon Dioxide is a Greenhouse Gas and contributes to global warming. Try the 'Build Your Own Greenhouse' activity in this pack to learn more about the Greenhouse effect.
• Managing the environmental response to the Deepwater Horizon oil spill, where 4.9 million barrels of oil were leaked into the ocean – considered to be the largest oil spill into a marine environment ever.
• Declaring Greenhouse gases an official threat to public health, and focussing her work on protecting the most vulnerable parts of the population – the elderly and the very young – from pollution threats.
• Chairing the Gulf Coast Ecosystem Restoration Task Force, to protect and restore the delicate ecosystem in the Gulf of Mexico. Try the ecosystem activity in this pack to learn more about this topic!

WOW, they are amazing achievements! After leaving the Environmental Protection Agency in 2012, Lisa joined Apple, where she is now the Vice President of Environment, Policy and Social initiatives. She oversees the company's work with renewable energies and resource conservation, and the use of 'green' materials.



Take-it-Home Activity: Beach Clean

When waste isn't properly sorted, managed and recycled, it can end up seriously damaging the environment; for example, when plastic blows into the sea on its way to landfill, it can be mistakenly eaten by sea animals who think it is food. Why not organise a beach clean or a litter pick with your unit, to help get rid of plastic and other waste, and to keep local wildlife safe? Remember to ask your leader for help in organising this - you'll need some safety equipment, including waterproof clothing (in case it rains!), thick gloves, and grabbers to pick up the litter. Don't forget, we'd love to see pics!

Remember, you don't have to go to a local beach to care for your community, you can always do a local area rubbish clean for the time being, while observing social distancing guidelines, and wearing gloves! But, we advise you not to do so, unless you feel comfortable and have the means to stay safe. You can always save the beach clean for when we can go back to guiding as usual.

Fresh Water Factory

Equipment (per group):

- Flat-bottomed plastic bowl - 15-20cm deep
- 4x short glasses
- Saucer
- Jug
- 5tsp Salt
- Kettle
- 500ml water
- Cling film
- Sticky tape
- Coin
- Teaspoon

Note: For the Guides' & Rangers' version of this activity, all of the above will be required, plus the following additional materials (per group):

- A potato
- Knife
- 2x bottles of food colouring (2 different colours)
- 4 more short glasses
- Pipette
- Pen
- 2 pieces of paper

Estimated time:

Rainbows and Brownies:
- Preparation time - 15 minutes
- Total activity - 2-3 hours

Guides and Rangers:
- As above, with extra time required for testing - 15 minutes

Method (Rainbows and Brownies):

1. Place the flat-bottomed plastic bowl on a flat surface outside in the sun.

2. Ask your leader to pour 500ml water into the kettle and bring it to the boil. Once boiled, ask your leader to pour the boiling water into a jug for you and carefully supervise while you add 5 teaspoons of salt to the water. Then, watch as the salt dissolves in the water.

3. Pour approximately 5cm of the water into the bottom of the bowl. Depending on the depth of your bowl, you may need to make more salt water to use the same ratio of 1 teaspoon of salt for every 100ml of water (your leader will be able to help with this).

4. Place the saucer upside down in the middle of the salty water and then place the short drinking glass on top of the saucer.

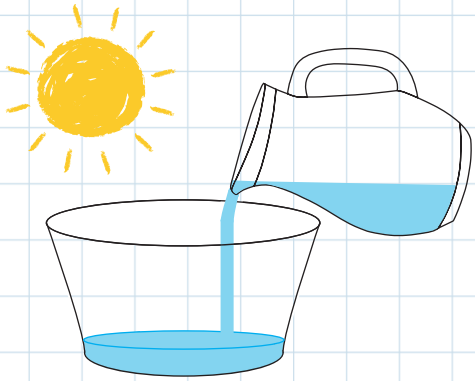
5. Cover the plastic bowl with cling film and tape down the cling film around the edge of the bowl, but make sure it isn't stretched too tight.

6. Place a coin in the middle of the plastic, so that it weighs down the plastic in the middle, just above the glass inside the bowl. Check on the progress of the desalination plant after a few hours in the sun - you will see that there will be water in the glass.

The salt water has undergone evaporation, using the heat of the sun; leaving the salt behind, in the water at the bottom of the bowl. The water has then undergone condensation, when it reached the cling film and then dropped into the glass, creating fresh water.

7. Why not pour some of the water in the glass into a few glasses and taste it? You should notice that the water in the glass isn't salty at all! The water left over in the bowl will be salty and will have a greater ratio of salt to water, as some of the water previously there has evaporated.

1.



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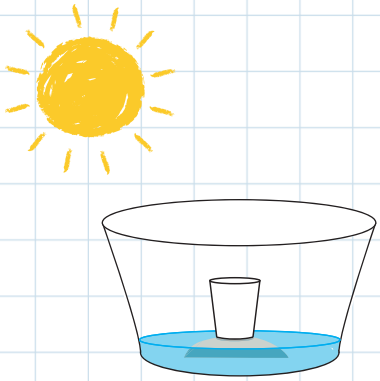

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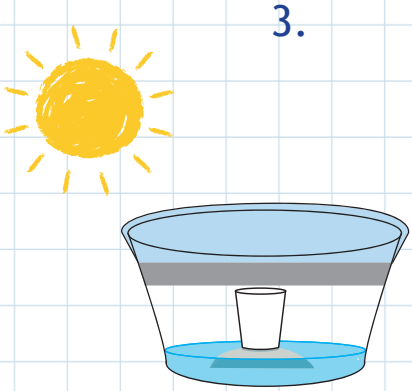

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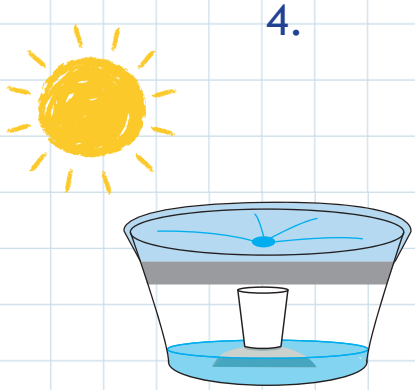

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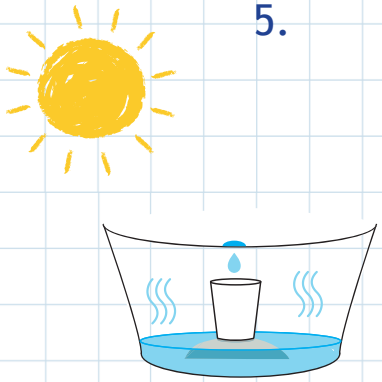


Method (Guides and Rangers):

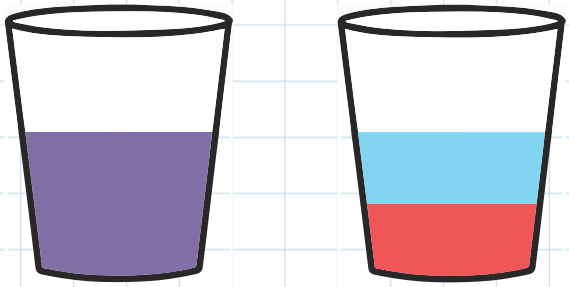
Firstly, complete the same activity as stated above for the Rainbows and Brownies, and then give the rest of this activity a go. Another way of testing the difference between the water in the cup and the water in the bowl is through exploring the differences in density of the water.

1. Pour some of the salty water from the bowl into a glass that is a similar size to the glass of fresh water in the middle of the bowl. Take the two pieces of paper and, on one, write 'freshwater' and, on the other, write 'saltwater'. Now, place the respective glasses onto the pieces of paper, to help keep track of which glass contains which type of water.

2. Add a few drops of one coloured food colouring into one glass and add a few drops of another coloured food colouring into the other glass.

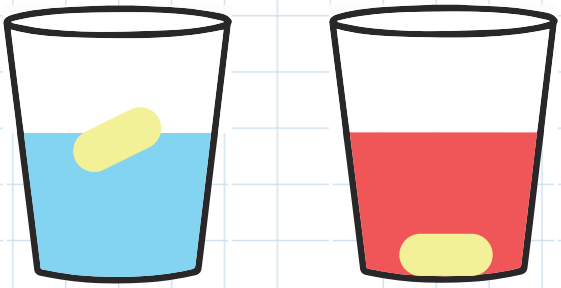
3. Pour some of your saltwater into a separate glass and then, using a pipette, add some of the freshwater to the saltwater glass. Add one drop at a time; placing the pipette against the wall of the glass, so that the water slowly flows down. You should see that the freshwater sits on top of the saltwater.

4. Now try the other way around; pouring some of the freshwater into a separate glass and then using a pipette to add some saltwater into the freshwater glass. You'll notice that water mixes when the freshwater is added first - this is due to the saltwater being denser than the freshwater and therefore it falls to the bottom of the glass, causing the waters to mix. However, when the saltwater is added first, the freshwater will sit on top of the saltwater, as it is lighter. Your glasses should look like the image below:



5. Now, pour the rest of the freshwater into a glass and the rest of the saltwater into a separate glass; ensuring that you put these glasses back onto the labelled pieces of paper.

6. Now, cut two similar-shaped slices of a potato and place one in each of the glasses of water. You'll notice that the potato floats in saltwater, but sinks in freshwater - this again is due to the density of the saltwater and the fact that the potato will be lighter than the dense saltwater.



Guidance for leaders:

The bowl needs to be placed in direct sunlight, if possible, and the longer the bowl is placed outside, the more freshwater it will be able to make. The girls may need to make their desalination plants in their unit meeting and then take them home to place in the sun at the weekend, to make the most amount of freshwater. Only allow the girls to taste a small amount of the saltwater, as it will be highly concentrated, so very salty. Please make up the saltwater solution for the Rainbows and Brownies, to avoid them having to use the kettle.

How this Relates to Engineering:

Desalination is a process used throughout the world to remove excess salt and other minerals from water (usually seawater, in order to obtain fresh water). Only 2.5% of the world's water is freshwater and, therefore, desalination is a very important process to enable people to have access to drinkable water. Desalination plants can be used to produce clean drinking water from sea water and can be used in emergency situations where no freshwater is available.

The desalination process for this activity works through the cling film trapping the heat of the sun, which warms up the salt water. The water then evaporates, turning into a vapour and leaving behind the salt in the bowl. When the water vapour comes into contact with the plastic at the top, it condenses on the plastic and turns back into liquid water. The water droplets start to form and, because the coin is weighing down the plastic in the middle of bowl, the drips run down the centre and into the glass.

For Guides and Rangers: Saltwater is heavier and denser than freshwater and, therefore, when the saltwater is added to the glass first, the freshwater will sit on top of the denser saltwater and form a layer. However, when the saltwater is placed on top of the freshwater, it is heavier and causes the saltwater to sink immediately into the freshwater, causing it to become completely mixed.

In the potato experiment, the high density of saltwater makes the potato float, as it is lighter than the water; this is why it's easier for people to float in the sea on holiday, compared to in a swimming pool!

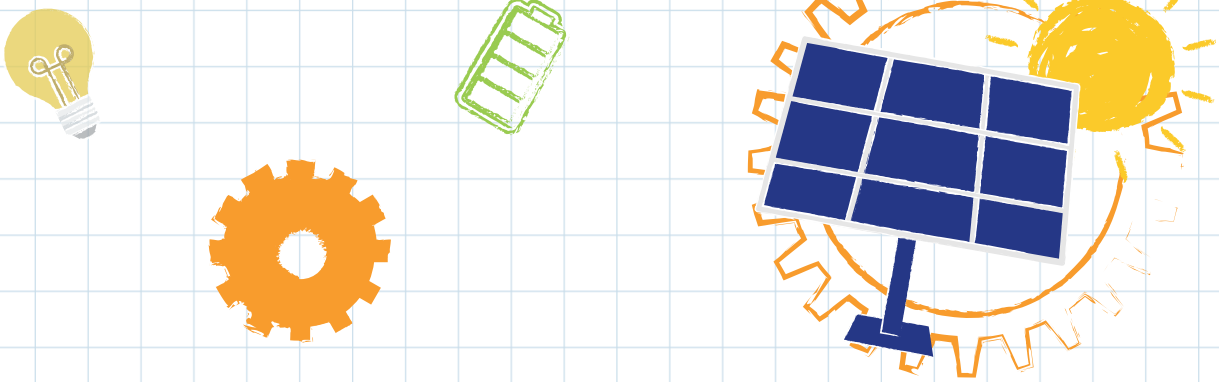
Inspiring Female Engineer: Dr Mária Telkes

Dr Mária Telkes was a Hungarian-American Biophysicist, Scientist and Inventor who devoted her career to the enhancement of solar energy technology. Mária studied Physical Chemistry at the University of Budapest, where she gained her PhD. She was one of the founders of solar thermal storage systems and was known as 'The Sun Queen'.

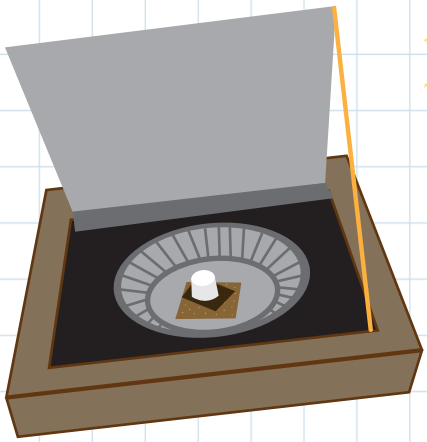
During World War Two, Mária served as an advisor to the Office for Scientific Research and Development, where she developed a solar powered desalination machine which helped soldiers obtain clean water in difficult situations, where no freshwater was available.

Mária was an inventor of thermal devices, including a miniature desalination unit (solar still) for use on lifeboats. This invention used solar power and condensation to collect portable water, and was used to help save the lives of many people who worked on lifeboats, or were sailors who had been abandoned at sea with no freshwater. She went on to develop a solar-powered oven for the Ford Foundation, to help people who lacked the ability to have the right equipment to cook food. In the 1980s, she helped to develop the first solar powered home in the US.

Mária won many awards, including the Society of Women Engineers' Award in 1952. She earned more than 20 patents over the course of her career.



Take-it-Home Activity: Solar-Powered Oven

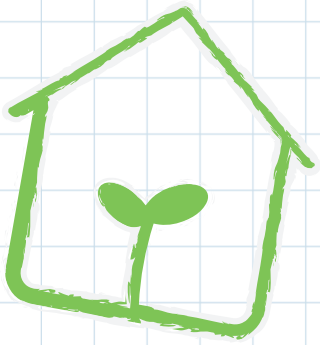


Why not try making your own solar-powered oven? There are lots of designs online, where you can make an oven powered by the sun that can cook s'mores or pizzas!

Build Your Own Greenhouse

Equipment (per group):

- A cardboard box (shoebox sized/A4)
- Scissors
- Lollipop sticks (approximately 30)
- Sticky tape
- Cling film
- Paper
- PVA glue
- Coloured pens
- Lamp
- Ruler
- Pens & pencils
- 2x thermometers
- Jug
- 2x small glasses/cups



Note: For the Guides' & Rangers' version of this activity, all of the above will be required, plus the following additional materials (per group):

- A second cardboard box (shoebox sized/A4)
- Extra lollipop sticks (approximately 30 more)
- A second lamp
- Graph paper/lined paper
- Another small glass/cup
- Another thermometer

Estimated time: Preparation time - 30 minutes, Total activity - 1 hour

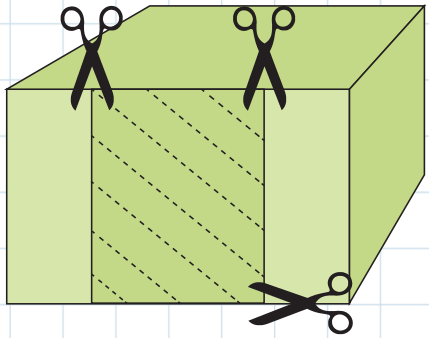
Method (Rainbows and Brownies):

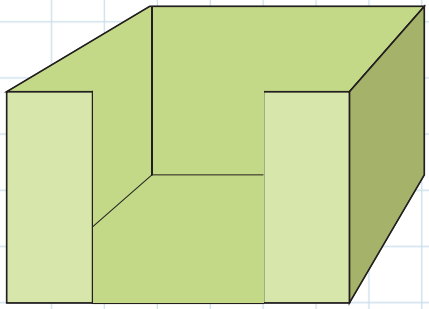
This activity can be completed in groups or individually.

1. Pour water into two small glasses and set them to one side, to allow the water to reach room temperature.

2. Take your shoebox and, using your ruler and pen, mark a 5cm gap in the middle of the short edge of the box. Your leader will be able to help with this.

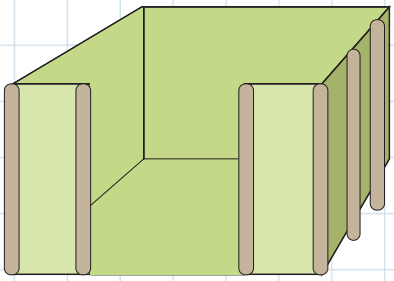
3. Using the scissors, cut out a 5cm piece of cardboard from the box; making sure you cut down to the base of the box as this will act as your door and will allow you room to place a thermometer in the greenhouse later. Be sure to ask your leader for help with cutting the cardboard.

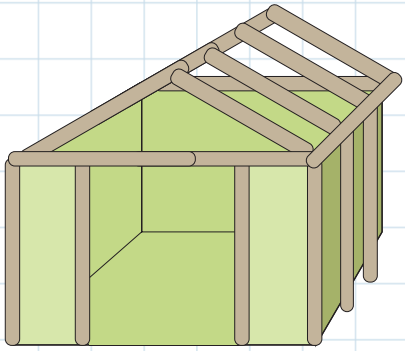


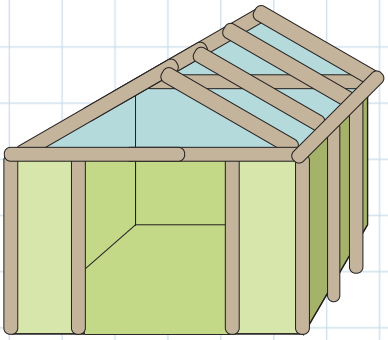


4. Now, start building the structure of your greenhouse. Use your lollipop sticks and tape/PVA glue, and stick the lollipop sticks along the edges of the cardboard box.

5. Then, use your lollipop sticks to build a structure with a roof that can keep the heat in. You can create any shaped roof you want, however, a shallower roof will be able to heat up more quickly. Have a look at the image below for inspiration.







6. Once you've built your structure, place a small glass of water in the middle of the greenhouse. Then, place another small gas of water in the middle of the room.

7. Place one thermometer in each of the glasses of water and leave them for 5 minutes. Then, check the temperatures on each of the thermometers and write them down on your piece of paper.

8. Now, place cling film over the greenhouse structure and tape down the edges of the cling film; making sure to leave an opening where the door is.

9. How about designing a small sign for your greenhouse, using the paper and coloured pens? Stick this onto the front of your greenhouse, so you know which one is yours.

10. Now, take your lamp, place it directly above your greenhouse and turn it on. Place one thermometer back in the greenhouse and the other thermometer back in the middle of the room.

11. Leave your greenhouse under the light for 30 minutes, if possible, but check the temperature on both thermometers every 2 minutes. Record your values so you can compare with each other. You should notice that the temperature in the greenhouse rises quicker than the temperature in the room.

Method (Guides and Rangers):

1. Complete the same activity as stated above for the Rainbows and Brownies. However, either individually, or in your groups, build two greenhouses and record the temperature for both greenhouses and the middle of the room. Make sure that you build a different shaped roof for each of your greenhouses; try one tall and one short roof.

2. Now, get your graph paper ready. Using a ruler and pencil, draw an x-axis and y-axis; labelling your x-axis, time (in minutes) and your y-axis, temperature (in degrees Celsius).

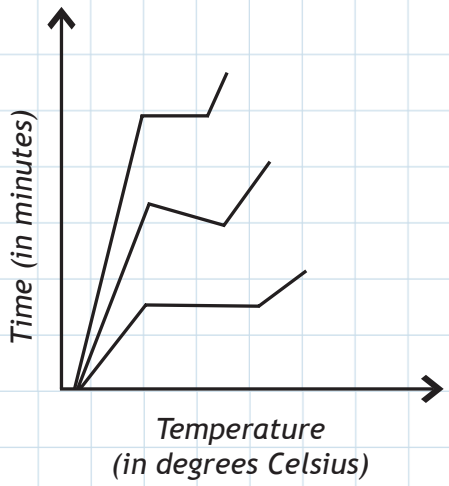
3. Write down a scale on each of your axes; your x-axis should be between 0 and 30 minutes and your y-axis should include your start temperature and final temperature.

4. Now, plot the readings from your first thermometer on the graph paper and draw a line to connect the points.

5. Repeat the step above on the same graph paper, using different coloured pens for each of the thermometers. Once finished, you should have 3 lines on your graph paper.

6. What do you notice about the readings? Why do you think there are different readings for each area?

Graph example:



Guidance for leaders:

When the girls are constructing their greenhouses, make sure they build the roof high enough so that a thermometer can be placed in the water and leaned against the side. Also, before deciding on which glass/cup to use, ensure that the glass/cup can stand upright with the thermometer and water in it, without toppling over.

How this Relates to Engineering:

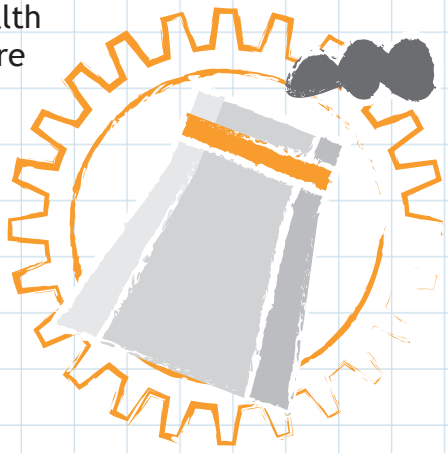
Like the glass of a greenhouse traps the sun's heat during the day, to keep the plants warm at night, gases in the atmosphere also trap heat from the sun to keep the Earth warm. This is usually beneficial, as it makes the Earth a comfortable place to live. However, too much of certain gases, such as water vapour, CO_2 and methane, which are produced by industries, can cause excessive or overheating of the planet. This is known as the greenhouse effect and can contribute to global warming.

Like Mary Walton (see the Inspiring Female Engineer below), one way we can reduce the impact of the greenhouse effect is through controlling the amount of greenhouse gases we release into the atmosphere. Engineers all over the world are currently finding new, innovative solutions to combat the effects of global warming. Some of these include: harnessing renewable energy (solar, wind, tidal), creating new technologies (electric cars), and researching how to treat the atmosphere to remove the greenhouse gases.

For Guides and Rangers: You should notice that the temperature in the shorter greenhouse increases more rapidly in comparison to the taller greenhouse and the temperature of the room. This is due to it having a smaller volume of air inside, so less energy is needed from the lamp to raise the temperature. It is similar to a kettle, where, if there is less water in the kettle, then less energy (heat) is required to boil the water. The shorter roof also has a smaller surface area, which means that less heat can escape from the greenhouse.

Inspiring Female Engineer: Mary Walton

Mary Walton was a 19th century American inventor who patented two pollution-reducing devices with the aim of improving the health of the public. In 1879 in America, following the huge infrastructure and power developments made during the Industrial Revolution, Mary wanted to invent something to reduce the air pollution. She developed a method to reduce the pollution from chimneys, by deflecting the emissions into water tanks and flushing them through the city's sewage systems. She went on to apply this method to trains, reducing the coal smoke from the engines.



Mary also invented a system for reducing the noise pollution from the railway systems in New York. Her system worked by cradling the tracks in a wooden box lined with cotton and sand - this reduced the vibrations caused by the trains and thus reduced the noise they admitted. Her invention was patented in 1881 where it was sold to the New York City's Metropolitan Railroad.

Take-it-Home Activity: What's Your Carbon Footprint?

Why not calculate your personal carbon footprint using one of the many calculators online? Maybe have a think about how you could make small changes in your day-to-day life, to reduce the amount of CO_2 you contribute towards creating each year.

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BAE SYSTEMS

We would love to hear about your unit's engineering journey and to share your experience on our Girlguiding North West England website and social media pages, in the press, online and in our promotional material, so that our members of all ages, potential members and potential supporters can be inspired by everything you've done.

Share your story with us by emailing northwesthq@girlguidingnwe.org.uk.

Badges will be available from 17/07/2020. Please visit our online shop to purchase: https://shop.girlguidingnwe.org.uk/. Badges will also be stocked at our region store which you can visit once we re-open as usual: Girlguiding NWE, Guiding Road, Preston, PR2 5PD. For now, we suggest using our online store.

We value your feedback so that we can continue to improve our challenge packs. Please spare a few minutes to complete the short survey upon completing the challenge.

https://www.surveymonkey.co.uk/r/ccsavingplaces