Glasgow Science Festival 2022: Glasgow's Making Waves

Primary STEM Activity Pack

Glasgow Science Festival 2022 will be in-person from 2nd to 12th June and online from 2nd to 30th June.

Please visit the website for our programme and digital content.

www.glasgowsciencefestival.org.uk

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Shadow Puppets

The Science

When outside, the main light source comes from the sun which is 150.54 million km away. The light generated by the sun travels at 300,000 km per second so it takes ~8 minutes to reach Earth. Shadows are basically the absence of light. They are formed when light gets blocked, either by an opaque or translucent object, for example your body when outside. Transparent objects would not create a shadow.

Transparent materials let light pass through in straight lines, meaning we can see through them clearly, e.g. a glass window.

Translucent materials scatter the light wave in different directions, some will pass through whereas other light waves will not. This means we cannot see clearly through them but can see some things, e.g. single sheets of tissue paper.

Opaque materials do not let any light pass through, we will not see anything through these materials, e.g. a wooden table.

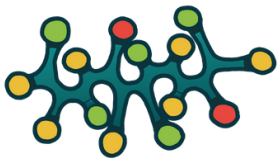
Light waves travel in straight lines from the source, meaning an object must be directly in front of the light to create a shadow. Moving the object closer to the light source will create a bigger shadow, this is because more light is being blocked. If the object is further away less light gets blocked so a smaller shadow will be created.

The shape of the shadow is also affected by the angle of the light source, have you ever noticed how your shadow looks different in the morning than it does at lunchtime? This is because in the morning the sun is at a lower point in the sky and the light is hitting your body from the side, so more light is blocked by your body and your shadow looks longer. At lunchtime the sun is almost directly above you, the light is hitting your body from above so less light gets blocked and your shadow looks shorter.

Shadow Puppets

Kit List

- Light source e.g. torch
- Cardboard (optional: frosted paper e.g. crepe paper
- See-through material e.g. glass
- Scissors
- Pencils
- Markers and things for decoration
- Wooden stick or skewer
- Tape or blu-tack
- A wall (ideally light coloured without too much decoration)



How To

1. Draw and cut out your puppet shape on the cardboard. The shape could be e.g. a person or animal
2. Decorate the puppet however you like
3. Place your torch (or other light source) on a surface pointing straight at the wall
4. Attach your wooden stick to the puppet using tape or blu-tack
5. Hold the puppet up in front of the torch light so that it casts a shadow on the wall.
6. Play around with the puppet. What happens to the shadow if you:
   - Move the puppet closer or further away?
   - Hold the puppet at different angles?
   - Position the puppet from the centre to the edge of the torchlight?
   - Change the angle of the light source by shining from above, below or to the side

Additional Activity: What does the shadow look like it you hold crepe paper or something transparent in front of the light?

Rainbow Spin Wheel

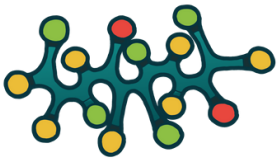
The Science

White light is made up of all colours of light mixed, which gives the light no colour at all. In this activity you should be able to mimic the colours combining to appear as white light, when really, they are the individual colours of the rainbow.

If the wheel spins fast enough the colours should appear to combine, and you should just see white instead of the individual colours.

Kit List

- Drawing pins
- White card
- Colours of the rainbow felt pens (red, orange, yellow, green, blue, purple)
- Pencils
- Scissors
- Cardboard



How To

1. Draw and cut it out a circle on card
2. Divide the circle into six equal sections
3. Fill each section in with a different colour of the rainbow
4. Cut out a strip of cardboard that measures at least as long as the circle diameter
5. Use a drawing pin through the centre of the circle to attach it to the cardboard, so it resembles a pin wheel
6. Spin the wheel

Rainbow in a Bottle

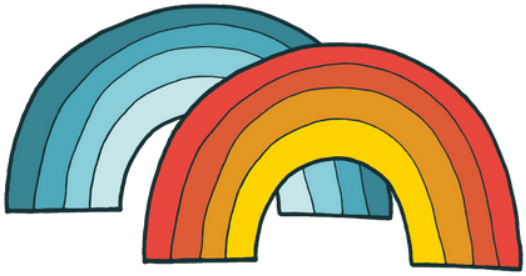
The Science

Light is a wave, which means it has wavelengths. 1 wavelength is the distance from peak to peak, or trough to trough of a wave. Think of waves out on the open ocean where it looks like the sea is bobbing up and down, this is the work of waves. The peaks are the high points and the troughs are the low points.

Light exists across a spectrum of wavelengths from radio waves which have a wavelength of 1mm-100km down to gamma rays which have a wavelength of less that 100 picometers (0.0000001 mm). Humans can observe light within a specific range of wavelengths that is about 400-700nm (0.0004-0.0007mm) where the longer wavelengths are red and shorter wavelengths are violet. The spectrum of light that humans can observe corresponds to the rainbow and white light is the combination of all the different colours.

White light is made up of all colours of light mixed, which gives the light no colour at all. In this activity you should be able to mimic the colours combining to appear as white light, when really, they are the individual colours of the rainbow. Rainbows occur in the sky when white light is split into its constituent colours, which all have different wavelengths. Red light has the longest wavelength and purple light has the shortest wavelength.

Have you noticed how rainbows only appear in the sky after it has been raining? This is because rainbows form in the sky when sunlight gets bounced around a raindrop and then gets reflected back into your eyes. The sunlight has to hit the raindrop at ~42° angle in order to be bent (refracted) inside the raindrop in a way that separates the different wavelengths of light.



Rainbow in a Bottle

Kit List

- Clear bottle, jar or glass
- Water
- Small mirror that will fit in your container
- White paper or cardboard or wall
- Torch

How To

1. Fill the container about 3/4 full of water
2. Submerge the mirror in the water, balanced against the side of the container so it sits upright
3. Hold the white paper or cardboard in front of the mirror. If you are using a white wall, ensure the mirror is facing the wall and is close
4. Shine your torch into the mirror to see a projected rainbow

Additional Activity: Hang it in the window to see if different times of day affect the rainbow.

Leaf Chromatography

The Science

Chromatography literally means 'colour writing' (from the Greek words 'chroma' and 'graphe').
Chromatography is a way of separating out a mixture of chemicals. Chromatography is like a race. Waiting on the starting line, you've got a mixture of chemicals.
When a race starts, runners soon spread out because they have different abilities. In the same way, chemicals in the experiment will spread out because they travel at different speeds over our filter paper due to their size or structure. Lighter chemicals tend to travel further than heavy chemicals.

Scientists use chromatography for lots of experiments like checking water for pollution, analyzing blood samples from crime scenes and checking how pure chemicals are.

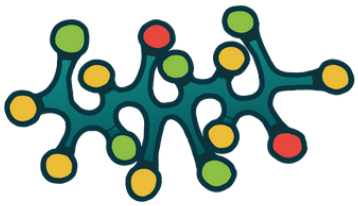
Here we will use chromatography to investigate what different coloured pigments there are in leaves and how they combine to give your leaf its green colour.

Why do leaves change colour in the autumn?
The green pigment in the plant is chlorophyll, which plants use to make food during the spring and summer. There are other pigments in the plant too, like red, yellow and orange, but the chlorophyll is the strongest pigment and so the leaf appears green. In autumn, the green chlorophyll breaks down and we can see the other pigments, like red, yellow and orange.

Leaf Chromatography

Kit List

- Green leaves from a plant or tree (e.g. one large, several small leaves)
- Plastic beaker
- Ethanol (substitute option: nail polish remover)
- Bowl deep enough to submerge your beaker approximately halfway
- Hot water (hot tap is fine)
- Filter paper (alternative: coffee filters).
- Scissors.
- Peg or pencil.
- Tape



How To

1. Tear your leaves into pieces and put them in the beaker
2. Pour enough ethanol into the beaker to cover the leaves
3. Sit the beaker in your bowl of hot water for about half an hour
4. It is ready when the alcohol turns green
5. Take the beaker out of the hot water, be careful not to burn yourself
6. Cut a rectangular strip of filter paper, about an 3cm wide
7. Sit the strip of filter paper on the side of the beaker, so that the bottom is submerged in alcohol. You can use a peg to fix the strip to the side, or tape it to a pencil to stop it from falling into the beaker.
8. Watch the ethanol move up the filter paper. As it moves, so will the leaf pigments
9. After 30-90 minutes, you should be able to see the green colour split up into different shades or colours.

Additional Activity: Test different coloured leaves or leaves with different shades of green.

Waves in a Bottle

The Science

Waves in the ocean are caused by energy moving through the water, causing the water to move in circles. This creates the up and down motion seen on the surface. The energy for this usually comes from interactions with the air (wind). The waves moving in circles nudge the water next to them and cause that water to move in circles too by transferring energy. This makes the waves look like they are moving across the surface.

Imagine you're at the beach watching the waves. The wave breaking on the beach is caused by the slope of the beach disturbing the circular motion of the waves, changing it to become elongate or elliptical. The waves also get affected by the air itself. Air sits as a layer on top of the ocean, compressing the waves as they move along the surface, slowing the waves down.

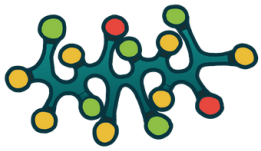
In this experiment, the oil sits on top of the water as it is less dense- same as the air. The bottle when shaken or disturbed demonstrates the interactions of the ocean (the water) with the air (the oil) and how this affects the waves.

Bonus science: why do you think the oil and water do not mix? The food colouring has fully mixed into the water. Oil molecules are hydrophobic, which means they don't like to mix in water and they repel each other.

Waves in a Bottle

Kit List

- Plastic bottle with cap (the bigger the better so ideally a 2 litre one). Alternatively, could use a glass jar for a more sustainable and reusable alternative. You could reuse the same bottle or jar from the Rainbow in a Bottle activity.
- Clear oil (e.g. baby oil) or cooking oil
- Water
- Food colouring, any colour is fine but blue/green is best to represent the sea
- Funnel
- Duct tape
- Optional: sand and small sea creatures for decoration. Make your own sea creatures from e.g. plasticine or blu tack



How To

1. Fill the container with water to between one-third and one-half full
2. Add the food colouring. Experiment with mixing colours to get that perfect sea colour!
3. Add in any extra items at this point e.g. sand, sea creatures.
4. Using the funnel fill the remainder of the bottle with oil to a few inches from the top
5. Screw the lid on tightly and secure with duct tape to avoid mess
6. Turn the bottle on its side and gently shake to produce waves.

Important: When clearing up do not pour oil down the drain as this will clog it, instead because the oil will be the top layer pour it out separately and dispose of in a food waste bin.

Additional Activity: As the container is see through, instead of disposing of it how about planting some seeds? The see-through nature of the container means you will be able to see the roots grow as well.

String Telephone

The Science

When you speak, your voice transmits sound waves. When you speak into a landline telephone (remember them?!) the sound waves get converted into electrical energy which get carried through wires to allow for communication.

The string telephone works in a similar way. When you speak into the cup, the sound waves produced cause the bottom of the cup to vibrate. These vibrations transfer to the string which carries them into the cup your friend is holding. They should be able to hear what you said as if you were chatting on the phone. This works the same if you manually cause the string to vibrate by holding it tight and plucking it. You should hear sound out of both cups.

Kit List

- Yoghurt cups
- String
- Scissors
- Paper clips
- Nail

How To

1. Use the nail to poke a hole in the centre of the bottom of each yogurt cup
2. Cut a piece of string about 2 metres long
3. Poke the end of the string through the hole into the cup
4. Reach into the cup and pull the string through a few inches
5. Tie the end of the string to a paper clip
6. Repeat the previous two steps with the other cup
7. Now you've got an Ear Guitar! Hold one cup up to your ear, and give the other cup to your friend. Tell your friend to walk away from you until the string is tight, and then hold his cup up to his own ear. When one of you plucks the string, both of you can hear the sound!
8. Is the sound you hear when you pluck the string different from the sound when your friend plucks the string? Does the sound change when the string is tighter or looser?
9. What happens if you talk into your cup?

Additional Activity: Use yoghurt cups as plant pots - already has one hole for drainage, poke a couple more for extra drainage.

Make Your Own Harmonica

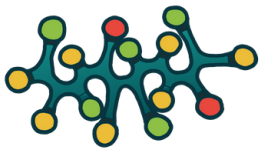
The Science

Sound waves are generated by the vibrations of objects, including our vocal cords. In this activity the sound is generated by the paper vibrating inside the harmonica. Sound travels through the air by causing neighbouring air particles to vibrate at the same frequency as the object producing sound.

Pitch is the frequency of the vibration; lower pitch sounds are low frequency sound waves. People with lower pitched voices have longer vocal cords than people with higher pitched voices. Frequency refers to how many complete waves per second are generated by the vibrations. A complete wave means one full wavelength peak to peak. The pitch of the harmonica sound should change as you shorten the gap the sound can move through, as you press down on the middle of the harmonica and blow through one side the sound should get higher pitched.

Kit List

- Elastic bands
- Greaseproof paper
- Lolly sticks
- Wooden matchsticks or toothpicks
- Felt tips for decorating (non-toxic)
- Pencil
- Ruler
- Scissors



How To

1. Take 2 lolly sticks
2. Cut a piece of greaseproof paper the same length and width as the lolly sticks and place in between them
3. Cut the matchsticks/toothpicks to about 2cm long and place vertically between the lolly sticks at either end. The matchsticks should stick out at the ends
4. Tie elastic bands around the matchsticks to secure in place
5. Blow through the gap to create sound. Try pressing down on the harmonica to shorten the length of the part you blow through, what happens to the sound?

Bell Pepper Shaker/Drum

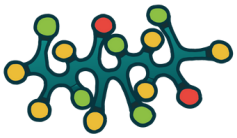
The Science

Hitting the head of a drum produces sound by causing the air inside to compress and change shape. This causes the drum shell to vibrate which creates sound waves. Imagine a cymbal in a percussion kit, you can see the plates vibrating and this is what causes the sound. It is the same principle for our pepper shaker. With the vibrations coming from the pepper.

If you're feeling creative, why not try making a shaker out of other materials and see what affects this might have on the sound created. For example, shaking things in a Tupperware container should make a louder noise as the material that is vibrating is harder. A shaker produces sound as shaking the instrument causes the interior (rice, nuts or seeds) bounce of the walls of the shaker (pepper) causing the walls to vibrate and produce sound waves.

Kit List

- Large bell pepper
- Kitchen knife
- Rice or seeds. (If seeds can use later for a growing based activity)
- Nuts (e.g. pine nuts or peanuts)
- Duct tape or similar



How To

1. Cut the pepper around the stalk, so you end up with a 'lid'
2. Remove the seeds and the insides of the pepper, being careful not to pierce the outside.

Additional Activity: How about planting the seeds and see if you can grow more peppers?

For a shaker:

1. Fill the pepper with rice and nuts, then replace the lid
2. Hold onto the lid and shake the pepper to see what noise you can create

For a drum:

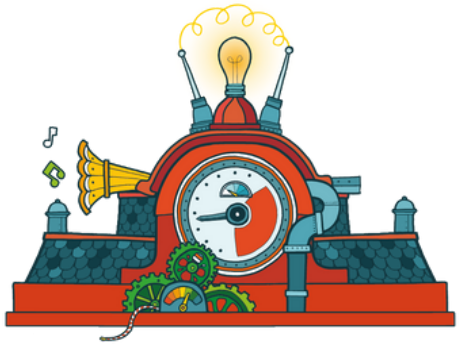
1. Once you have a pepper with an empty air cavity, tightly stretch a piece of tape over the hole
2. Ensure the whole hole is covered and then tap, see what sounds you can make

Seeing Sound

The Science

Sound travels through the air as waves caused by the vibration of air molecules. When you make sounds, your vocal cords are vibrating (try putting your hand on your throat gently and hum and you should feel this vibration). When the vocal cords start vibrating, they cause the molecules next to them to vibrate too and they cause the molecules next to them to vibrate and so on.

In this experiment, humming next to the bowl should mean you see the clingfilm vibrating at the same frequency as your hum, causing the hundreds and thousands to dance around. Have you ever dropped a pebble in a pond and seen the rings of disturbance move outwards? This is the vibrations affecting their surroundings in the exact same way the sound waves affect the clingfilm.



Kit List

- Bowl (any size is fine)
- Cling film (enough to cover the bowl)
- Something small and grainy (e.g. hundreds and thousands, confetti, small gravel)

How To

1. Stretch a piece of cling film over the bowl making sure it's tight with no wrinkles
2. Carefully spread about a teaspoon of hundreds and thousands (or alternative) evenly across the cling film
3. Put your face close to the bowl and hum as loud as you can
4. Try changing the volume and pitch and see what happens
5. If you have done the Harmonica activity, try using that to see what happens

Seismograph

The Science

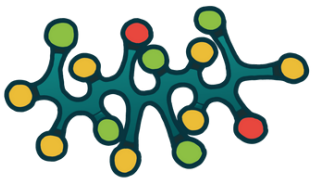
Earthquakes are caused by sudden movements of Earth's crust. This movement releases energy causing shockwaves known as seismic waves. These seismic waves cause shaking at the surface which can be picked up by seismographs (earthquake detecting machines) and produce a line with peaks and troughs recording the intensity of the shock wave.

Waves travel differently through different substances, have you ever put your head under water at a swimming pool and noticed how the noises gets louder and distorted? That is because sound waves travel faster through liquids than they do in gases (air). The molecules in liquids are packed tighter together than in gases, and even tighter still in solids so waves move even faster through solids. This principle is the same for seismic waves, and scientists have been able to identify what's below our feet based on how fast the seismic waves travel from an earthquake to the seismograph.

In this activity, you will recreate the seismograph line. You should be able to pick out features of the 'seismic' wave, such as peaks, troughs and wavelengths. A peak is the highest point of the wave, which will look like a lower-case 'n' and a trough is the lowest point of the wave which will look like a lower case 'u'. A wavelength is one complete wave measured from peak to peak or trough to trough.

Kit List

- Cardboard box (medium sized)
- Paper cup (alternative- re use yoghurt pots from String Telephone activity)
- String
- Marker pen
- Scissors
- Paper
- Tape
- Pebbles or marbles or similar



Seismograph

How To

1. Cut any lid or flaps off the cardboard box and stand it up on one of the smaller sides. What was originally the base of the box should now be the back
2. Poke two holes opposite each other near the rim of the cup
3. Tie a piece of string to each hole. The string should be slightly longer than the box
4. Poke two holes in the top of the box the same width apart as the holes in the cup
5. Take the strings attached to the cup and poke them through the holes in the box
6. Tie the strings together so that the cup hangs about an inch above the bottom of the box
7. Poke a hole through the centre of the bottom of the cup
8. Remove the lid from the marker pen and push it through the hole in the bottom of the cup so the tip only just touches the bottom of the box
9. Fill the cup with the pebbles or other small heavy objects. Make sure the marker stays vertical
10. Cut the piece of paper into equal strips and tape them together to form one long strip
11. Cut two slits on opposite ends of the cardboard box at the bottom
12. Feed the paper through these slits so the base is covered in paper
13. Make sure the marker is centred on the paper strip
14. Stabilise the box with your hands as someone pulls the strip of paper out of one end of the box
15. Start to shake the box back and forth (perpendicular to the paper strip) as the paper is being pulled out
16. Vary the intensity of the shaking to see what happens
17. Pull the paper strip out of the box to see the line that has been drawn.

STEM Pack Kit List

	Leaf chrom	Shadow Puppets	Rainbow Spin	Rainbow Bottle	Waves Bottle	String Telephone	Harmonica	Pepper Shaker	Seeing Sound	Seismograph
Leaves	x									
Beaker	x									
Ethanol	x									
Plate	x									
Water	x			x	x					
Filter paper	x									
Scissors	x	x	x			x	x			x
A peg	x									
Torch		x		x						
Cardboard		x	x							
Pencils		x	x				x			
Rainbow Markers		x	x				x			x
Wooden lolly sticks		x					x			
Tape/ Bluetac		x								x
Wall or white card		x	x	x						
Drawing pins			x							
Jar				x	x					
Mirror				x						
Oil					x					
Food colouring					x					
Funnel					x					
Duct tape					x			x		
Sand (or similar)					x				x	
Yoghurt cups						x				x
String						x				x
Paper clips						x				
A nail						x				
Elastic bands							x			
Toothpicks							x			
Greaseproof paper							x			
Ruler							x			
Pepper								x		
Knife								x		
Rice/seeds								x		
Nuts								x		
Bowl									x	
Clingfilm									x	
Pebbles										x
Cardboard box										x
Paper										x

Curriculum for Excellence Links

	Leaf chrom	Shadow Puppets	Rainbow Spin	Rainbow Bottle	Waves Bottle	String Telephone	Harmonica	Pepper Shaker	Seeing Sound	Seismograph
Predicts and investigates how the position, shape and size of a shadow depend on the position of the object in relation to the light source.		x								
Demonstrates that white light/sunlight can be dispersed to show the colours of the visible spectrum and identifies the colours and order of the rainbow as red, orange, yellow, green, blue, indigo and violet.			x	x						
Explains how we can recognise the colour of an object due the reflection and absorption of particular parts of the visible spectrum.	x									
Discusses and demonstrates through experiments how sound travels differently through air, water and solids.						x	x	x	x	
Other- Could be used in discussions around renewable energy, the water cycle or wave properties.										
Other- Could be used in discussion of energy transfers, or topical stories surrounding an earthquake.					x					x