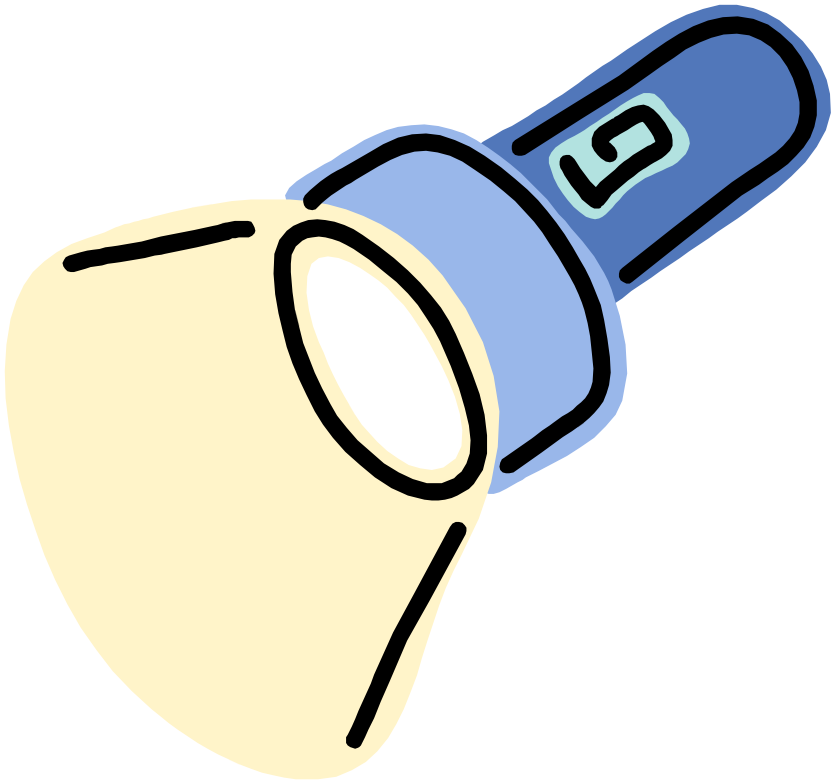
CAMERA OBSCURA
&
WORLD OF ILLUSIONS

Vibrations and Waves —Teacher Resources

The following activities will enable you to build on the educational topics encountered during your visit to Camera Obscura and World of Illusions by familiarising your pupils with vibrations, waves and how they work in our world.



Some of the activities are recommended for before your visit—these focus on familiarisation and scientific literacy. The other activities are best undertaken after your visit and work on extending some of the concepts encountered at Camera Obscura.

This pack has been created alongside the Second stream of the Curriculum for Excellence and as such is best suited to those in Primary 4 to Primary 7.

Contents

This document has been laid out so that one printed version should included everything you need. It is recommended that you print one single-sided copy for your own reference and then make copies of the pupil handouts as required.

Pre-visit Activities

A Slinky and a Tuning Fork

This exercise will demonstrate that sound is a vibration that travels in a wave. Pupils should be able to visualise different types of waves and understand that sounds are affected by the materials they travel through.

Slinky

Print out the activity sheets found at the back of this pack.
In an open space get two pupils to stand about two meters apart and hold either end of a slinky,
By gently shaking the slinky, they can demonstrate different types of waves.

Different sound waves produce different sounds:

A slow wave will produce a low sound, and a fast wave will produce a high sound.
A big wave will produce a loud sound and a small wave a quiet sound.

Pupils can experiment with other instruments to confirm these hypotheses.
For example, pluck a guitar string and it will produce a low sound (a slow wave as it vibrates the whole string), but if pressed down in the middle the same string will produce a high sound (a fast vibration as less of the sting is able to move).

Tuning Fork

You can then look at how the material that a wave travels through affects its behaviour.

The sounds we hear are from vibrations travelling through air - which is made of loosely scattered particles.
Demonstrate this by striking a tuning fork and asking pupils to listen for the sound.

The particles that make up water are more closely packed together, changing the way a vibration will move.
Demonstrate this by dipping a ringing tuning fork into a glass full of water. The vibrations will be so much stronger that you can see them, making the water jump from the glass.

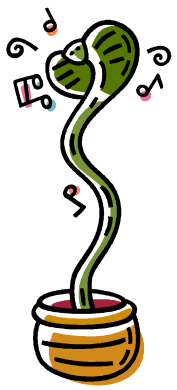
Another fun way of demonstrating this is to ask a pupil to hold the cup of water very close to their nose and look carefully at the surface as you dip in the tuning fork.

Pre-visit Activities

The particles that make up something solid - like a desk - are packed right next to each other, which again changes the way a vibration moves through it. You can demonstrate this by touching a ringing tuning fork to a solid object.

The vibration will behave differently when touched to something hollow (the sound becomes amplified as it travels through the air inside) than when touched to something solid (the sound will travel but not be heard unless your ear is also touching that object).

As an extension, you can lead a discussion on the different ways that animals create sounds: by using vocal cords, wings, hands, legs, and so on, and the different ways that these sounds travel through air, water or even earth.



<u>Research Project:</u>
How have film sound effects technicians been able to use their knowledge of waves and vibrations to produce different sounds for their movies?

There is an assignment outline found at the back of this pack.

Teachers' note: the sounds can be as creative as you like - but in the vacuum of space there are no particles for the sound to travel through so the last challenge should produce silence.

SCN 2-11a TCH 2-01a EXA 2-02a

Pre-visit Activities

Mirror Mirror

This activity explores the way in which our eyes and brain work together to interpret reflections. When we see ourselves in a mirror, our brain can become confused about where parts of the body really are, as our *proprioception* (the sense that tells you the relative position of your body parts) and our vision are sending different messages. As the brain tries to interpret both signals it sends conflicting messages to the hand, resulting in confusion.

What to do:

Print out the activity sheet found at the back of this pack.
Pair up pupils and give each pair a mirror and a piece of cardboard.
Challenge pupils to trace the shape as accurately as possible whilst looking into a mirror.
Their partner must hold the cardboard above their hands - it should block their view of the paper so that the only way to see is in the mirror.
Swap over.
Instruct pupils to try to write their name using the same technique.
Instruct them to do the same with their eyes closed.
Then instruct them to turn the paper over and answer the questions that relate to this exercise.

SCN 2-11a SCN 2-12b

During Your Visit

The Camera Obscura Show

This 15-minute presentation takes pupils on a tour of Edinburgh by using a mirror and lenses to reflect an image of the city onto a table in the darkened room of the Camera Obscura tower. This was built in 1853 by optician Maria Teresa Short, and is the oldest purpose-built attraction in the city.

To tie in with curricular benchmarks we will explain how the image is produced using a combination of mirrors, lenses and light.

SCN 2-11b EXA 2-01a

The World of Illusions

The World of Illusions is spread over five levels, from Bewilderworld on level 2, to the Rooftop Terrace views on level 6. Pupils are free to explore but should at all times be accompanied by a supervising adult. We recommend breaking your class into small groups with one supervising adult each and starting them off in different areas to prevent queues forming around exhibits.

The following areas are particularly relevant to the Vibrations and Waves area of the curriculum. To help pupils find these areas, we have included a visit tracking sheet in the Appendix section at the back of this pack.

- Pinhole cameras
- Help Yourself
- Coloured Shadows
- Shake Hands
- The Camera Obscura Show

SCN 2-11b TCH 2-01b

Post-visit Activities:

Listening Oobleck

This is a rather messy activity but can have amazing results as the vibrations produced by sound waves interact with the stir-thickening fluid. Pupils will get to see the vibrations produced by a speaker and play with slime.

You will need:
A powerful speaker
A strong plastic bag
Cornflour
Water

What to do:
Place a strong speaker (a bass unit if possible) on its back so that the sound will come from the top.
Get a good track ready on the sound system, something with a lot of bass.
You may want to wrap a plastic bag around the speaker for protection - but it could reduce the results.
Cover the top of the speaker with a strong plastic bag (a ziploc bag is ideal.)
Mix cornflour and water in a bowl at a ratio of about 1/3 solid to 2/3 liquid until the mixture is the consistency of syrup.
Pour a small amount of the mixture onto the plastic bag directly over the hole where the sound comes out of the speaker.
Turn the music on!

Experiment with the bass levels on your sound system and observe as the different notes produce different effects.

Depending on your sound system the results will be amazing or just jiggly—for a really good example take a look at this video, with thanks to Steve Spangler Science:
www.stevespanglerscience.com/experiment/the-force-of-sound-sick-science

SCN 2-11a

Post-visit Activities

Make a Pinhole Camera

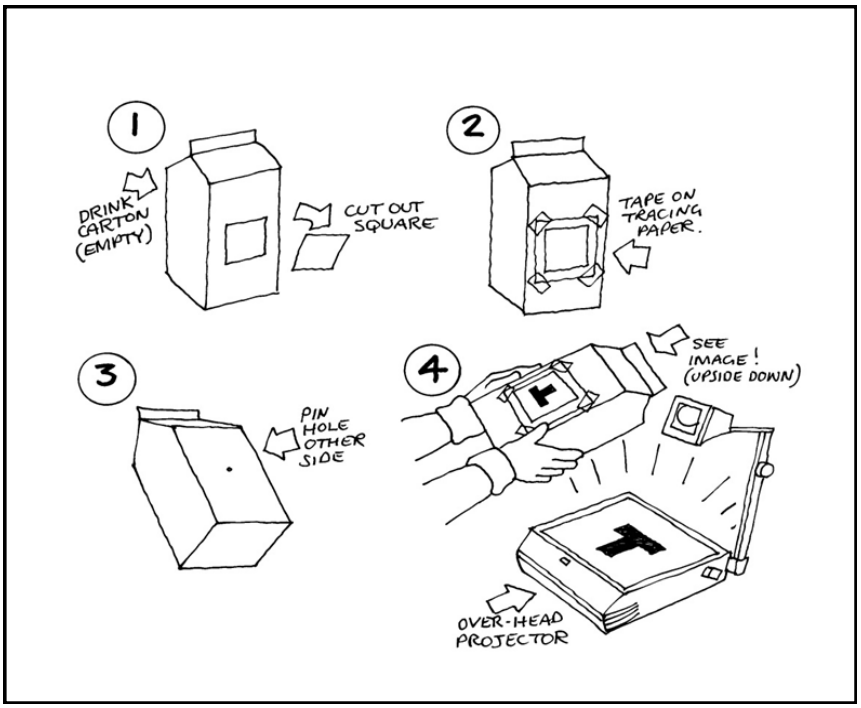
In this activity pupils will be able to use what they have learned about light to create something unique and explore the ingenuity of scientists and artists in times past.
If you intend pupils to complete this project, it is recommended that you hand out and read the assignment sheets before your visit so that pupils can direct their attention to the pinhole exhibition on the third floor of the World of Illusions.

You will need:

- Craft knife
- Scissors
- Tracing paper
- Sellotape
- Ruler
- Pencil
- Drawing pin
- Juice or Milk carton (something that will not let any other light in)

What to do:

- Measure and mark a square of 6cm by 6cm on the back of their carton.
- Cut a square in the back of the carton. The initial incision may need to be done by an adult with a craft knife, the rest can be cut by pupils with scissors .
- Measure and cut a piece of tracing paper 7.5cm by 7.5 cm.
- Tape the tracing paper over the hole in the carton. There should be a 1.5cm overlap on each side.
- Make a hole with a pin on the front side of the carton, then use a skewer to enlarge the hole so that just a little light can enter the 'camera'.
- To test the camera, either point the pinhole end towards a window or other light source, or use an overhead projector to create a distinctive shape. (You will find our letter templates at the back of this pack - simply print them onto thick paper and cut out. These letters work best as they allow pupils to see that the image on their tracing paper is upside down compared to the original.)
- Direct pupils to look at the tracing paper in the same way that they would look at a digital camera screen. They should see an upside down image on the screen.



Discuss with the class:

- Why does the image look upside down on the tracing paper screen?
- Does this happen in our eyes? In a camera? What turns the image back the right way?
- Where in Camera Obscura did you see upside down images? What created them?

Extension:

Create an art project using the pinhole camera.

There is an assignment sheet in the back of this pack to print and give to pupils.

We also have pinhole camera kits at Camera Obscura if you wanted to build something that the whole class can use (and looks pretty nifty too).

Ideas for capturing the image:

- Try making the pinhole bigger and bigger again. This will make the image brighter, but more blurry. Make a series of tracings that show the difference.
- Use different colours of tracing paper to trace the same image, layering for artistic effect.
- Use photosensitive paper or film to capture part of the image (this will need to be inside the camera, and kept dark until processing), trace the rest to show the difference between styles.
- Look at many images and trace on the one sheet of paper to make a composite picture.

SCN 2-11b TCH 2-01b EXA 2-02a MNU 2-11a

Curriculum for Excellence

By completing the activities in this pack and taking the time to visit Camera Obscura and World of Illusions your pupils will gain experience of: sound waves and the transport of sound through vibrations, the behaviour of light and the effects of shadows, colours and reflections on the production of images.

This module has focused on the **Forces, Electricity and Waves—Vibrations and Waves** area of the Science Curriculum:

Learners explore the nature of sound, light and radiations in the electromagnetic spectrum. They use musical instruments to explore the relationship between vibrations and sounds produced. They develop their understanding of the properties of light and other forms of electromagnetic radiations, They explore how different waves relate to the environment and how we make use of them in health, medicine and communications.

The pack targets the following areas of the science curriculum:

SCN 2-11a
Through research on how animals communicate, I can explain how vibrations are carried by waves through air, water and other media.

SCN 2-11b
By exploring reflections, the formation of shadows and the mixing of coloured lights, I can use my knowledge of the properties of light to show how it can be used in a creative way.

SCN 2-12b
I have explored the structure and function of sensory organs to develop my understanding of body actions in response to outside conditions.

Curriculum for Excellence:

Cross-curricular links to the arts, technologies and mathematics mean you have also targeted:

EXA 2-01a

I have experienced the energy and excitement of presenting/performing for audiences and being part of an audience for other peoples presentations/performances.

EXA 2-02a

I have the opportunity to choose and explore an extended range of media and technologies to create images and objects, comparing and combining them for specific tasks.

TCH 2-01a

When exploring technologies in the world around me, I can use what I learn to help to design or improve my ideas or products.

TCH 2-01b

I can investigate how an everyday product has changed over time to gain an awareness of the link between scientific and technological developments.

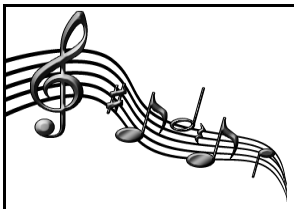
MNU 2-11a

I can use my knowledge of the sizes of familiar objects or places to assist me when making an estimate of measure.

A Slinky and a Tuning Fork

The movement of the slinky is similar to the way sound moves through the molecules that make up air.

Different types of waves will produce different sounds. Fill out the table below, describing what kind of sound you will hear when the types of wave are produced.

	Slow	Fast
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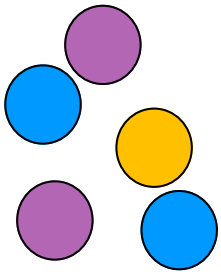


As sound waves travel through solids, liquids or gases, they behave differently, because the atoms that make up these things are arranged differently.

Draw how the atoms are arranged in a solid, a liquid and a gas in the spaces below.

Solid	Liquid	Gas

A Slinky and a Tuning Fork

What did you observe when sound waves travelled through water?

What is the effect of sound waves travelling through a hollow object?

What is the effect of sound waves travelling through a solid object? What should you do to 'hear' the sound?

As humans, we hear by detecting the vibrations of sound waves that are carried through the air. Name an animal that 'hears' through vibrations carried through the water. Can they hear sounds further away than us? Why might this be?

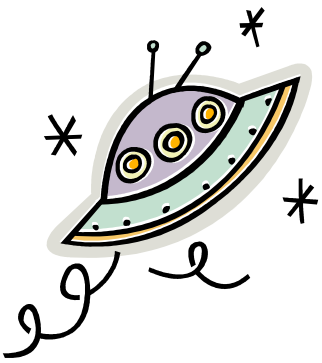
Name an animal that 'hears' by vibrations through the ground? Can they hear sounds further away than us? Why might this be an advantage?

Sound Research Project

By understanding more about the way sound works, musicians and technicians can create brand new sounds for films and TV effects. In the past, technicians searched far and wide for ways to create interesting new noises: for example, the laser gun sounds from the original Star Wars films were created by suspending a steel slinky from the roof and hitting it with a metal rod!

Nowadays, most sounds are created with computerised technology: the sounds of the Wargs in the Lord of the Rings films are made by blending the call of a cheetah and a backwards hyena laugh.

By experimenting with the things you have at home or at school try to find or blend sounds that could work in the following situations:



- First Contact: an alien language
- Jungle Exploration: a new species of bird is found with a unique call
- Rumble: an earthquake is heard under the city
- Dolphin Sense: what a boat sounds like from under the sea
- Space: the sound of a spacecraft flying by

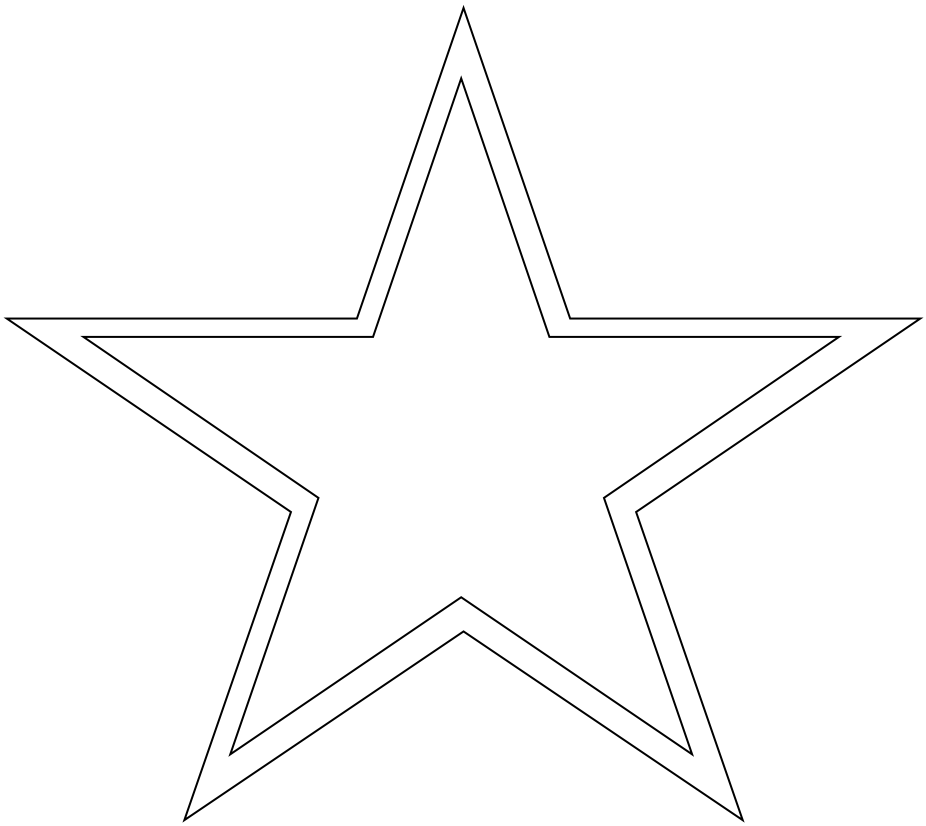
Write down exactly how you made the sounds and bring your favourite in to share with the class as a recording.

You can also look for inspiration from your favourite films - the DVD special features section sometimes contains short documentaries about how the sound effects were made. I recommend the special features documentary on WALL-E (Disney-Pixar) all about sound effects both old and new.

Mirror Mirror

Try to keep inside the lines!

You can practice a few times with the same star, just use a different colour each time to see if you get any better.



Now try to write your name using the mirror - and with your eyes shut?

Mirror Mirror Questions:

Take a look at your star. Did you get better with practice?

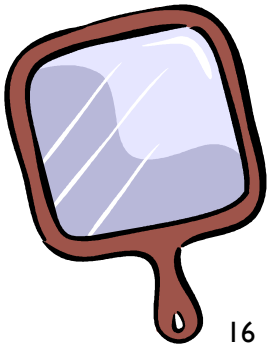
Is there any other time when the effect of a mirror can confuse your brain?

Can you think of any jobs where this might be a problem?

Was your name neater when written with the mirror, or with your eyes closed? Why do you think this was?

What do you think would happen if you bounced the light off two mirrors, or even three?

Get together with some other groups and test out your theories!



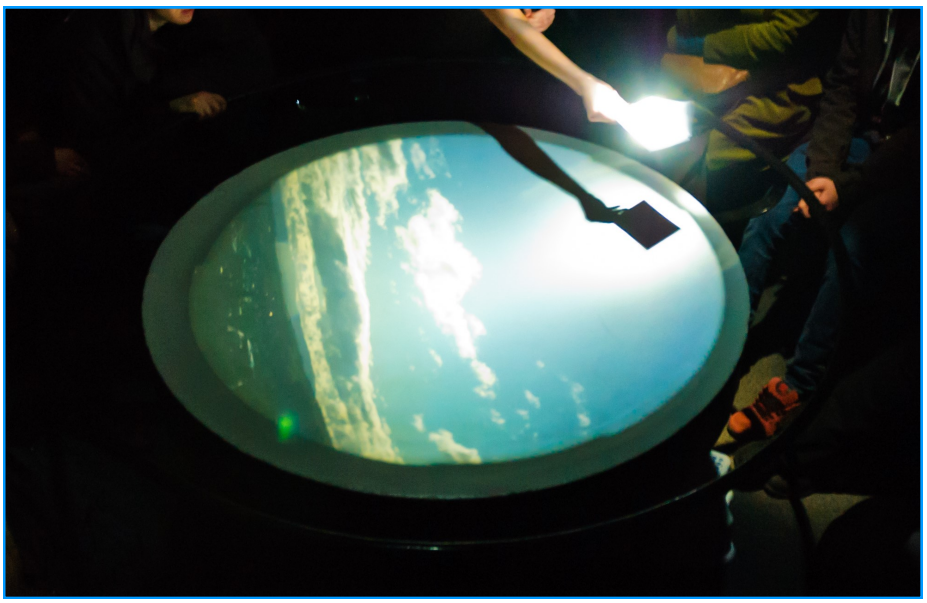
Visit Tracking Sheet

Camera Obscura Show

Fill this section out as soon as you arrive:

My show time is _____ .

The Camera Obscura is on the _____th floor.



Questions:

What year did the Camera Obscura open?

What can you see that people watching the very first show could not have? (*hint: think about inventions.*)

Two new things I learnt today?

Shake Hands

A concave mirror is one that curves inwards. Light bounces off this curved surface and creates a *focus point* somewhere in front of the mirror.

Try to shake you own hand. Is the reflection of your hand smaller or bigger? Does it change in size if you move closer or further away from the mirror?

Try it with an object. A pen joined to its reflection will give you the illusion of a giant pen.

Look into the mirror. What happens when you get really close to the back of the mirror?

With your head really close to the back of the mirror say hello to a friend, how do you sound?

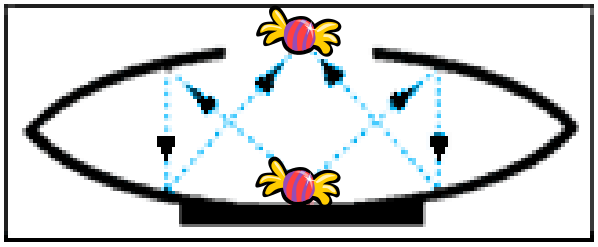
Help Yourself

This mirage is created by two concealed *parabolic* (or bent) mirrors which are set opposite each other in a space within the table.

The sweets are actually sitting at the centre of the bottom bowl-shaped mirror, but the image appears to hover on the table top.

By following the blue lines in the diagram below, you can see how light bounces from the sweets, up to the mirror, down to the bottom mirror again and then up to the table top where the image of the sweets appears.

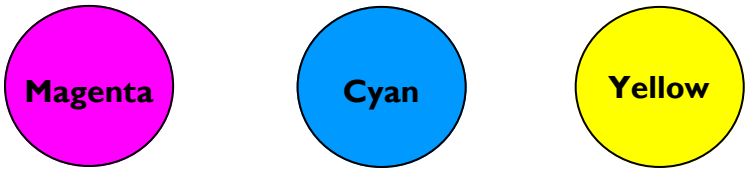
This illusion works because light always travels in a straight line.



What happens when you look directly above the opening?

How might this be used creatively, in art or theatre?

Coloured Shadows



Three different lights are shining onto the screen - magenta, cyan, and yellow.
Because the lights are all at the same level of brightness, the screen appears to be white instead of coloured. This is called additive colour mixing.

By walking in front of the screen, you block out some of the coloured lights. If you block one light, you will get a shadow that is a mixture of the other two.

Experiments:

How many colours can you make by standing in front of the wall and blocking the light? What are the colours?

Take the coloured shapes to the side of the area and look at them under normal light. What happens to their colour as they are moved in front of the magenta, cyan or yellow lights? Why?

Pinhole Camera Art Project

Pinhole cameras have been used by artists and scientists since at least the 5th century AD, and occurring naturally for much longer than that! In ancient China, pinhole cameras helped scientists to work out that light travels in straight lines. Pinhole cameras also helped astronomers to observe eclipses, and artists to make lifelike drawings by tracing the images that appeared on the screen. All that's needed to create a pinhole effect a dark space with a tiny hole to let in light - you can use anything from a shoebox to a Pringles tube to a wheelie bin!

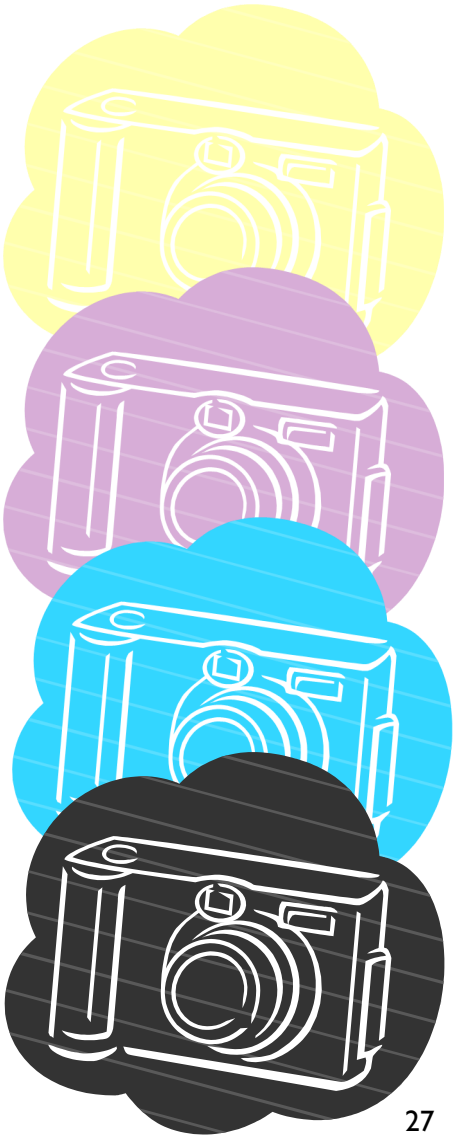
Now it is your turn to make something using pinhole camera technology.

Thinking about the way light travels and the difference colours, brightness and shadows have on the final image, try to create a unique piece of art with help from your pinhole camera.

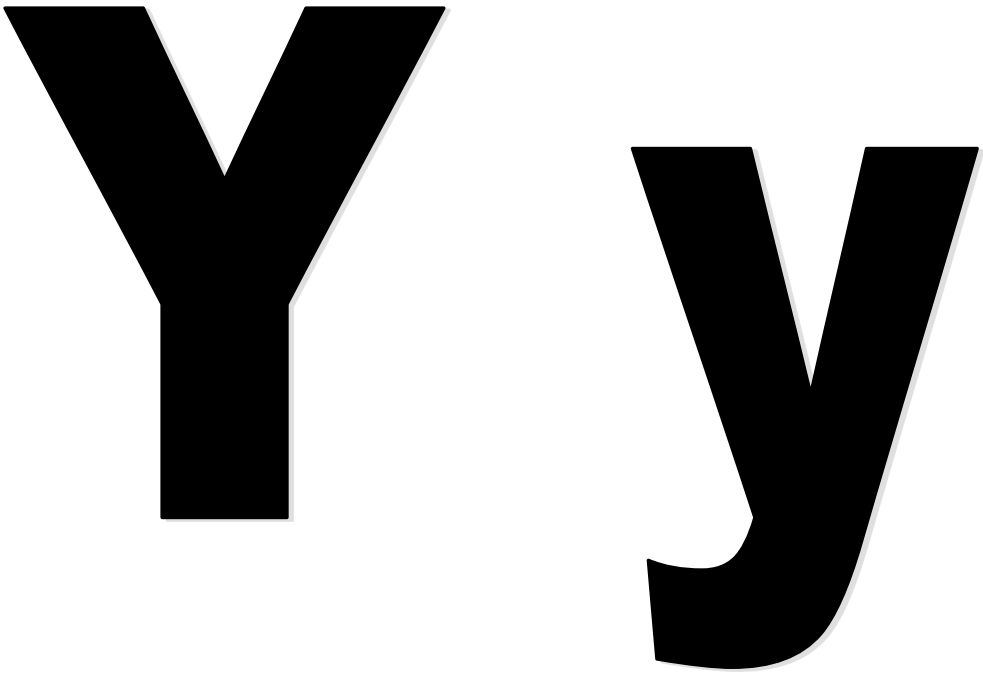
You may want to do some practice pieces first to test out the different effects you can make with your pinhole cameras, and then figure out what you will use for your final piece.

You can always tape over any holes that become too big you and then begin again, so you will only need one camera for all your testing.

Name your artwork and write a short blurb to go with it, explaining what you did and why you chose to do it.



Pinhole Camera Letter Templates:



Teacher Feedback Form

We always welcome feedback from our visitors, and would be grateful if you could spend a few moments filling out this form and then emailing or posting it back to us at:

alyce@camera.obscura.co.uk -or-

Camera Obscura
549 Castlehill
Edinburgh
EH1 2ND

CAMERA OBSCURA AND WORLD OF ILLUSIONS

School Name:

Teacher Name:

Contact Email:

Contact Phone:

1. Why did you chose Camera Obscura and World of Illusions as an excursion venue?

2. What school year/years did you bring?

Prep P1 P2 P3 P4 P5 P6 Secondary

3. Did you use the pre or post-visit resources?

Yes No

4. If yes, were the activities beneficial to your class, did you have to make any changes to them?

5. Did the resources link well to the visit?

Yes No

6. What should be improved to assist school groups visiting the centre?

7. What aspect of the visit was most beneficial to you as a teacher?

8. Would you consider returning next year?

Yes, please send me information about your programs for next year

Yes, I will find you when I need you

No

A Slinky and a Tuning Fork - Answers

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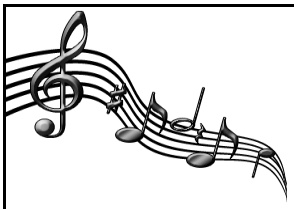	Slow	Fast
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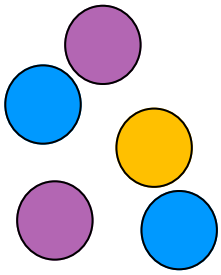

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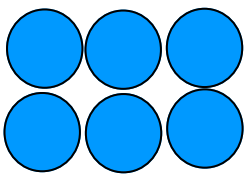	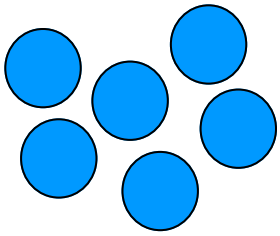	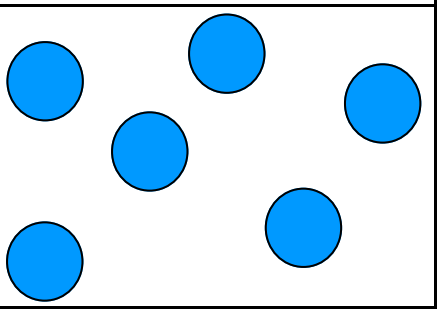

A Slinky and a Tuning Fork - Answers

What did you observe when sound waves travelled through water?

The water splashed out of the cup. You could see the waves.

What is the effect of sound waves travelling through a hollow object?

It is louder than when it travels through the air, or through a solid object. Amplified.

What is the effect of sound waves travelling through a solid object? What should you do to 'hear' the sound?

They sound louder (amplified) compared to when they travel through air.

If you press your ear to the solid object the sounds are really loud!

If the solid is soft, like a sponge, the sound will be absorbed and become quieter rather than louder.

As humans, we hear by detecting the vibrations of sound waves that are carried through the air. Name an animal that 'hears' through vibrations carried through the water. Can they hear sounds further away than us? Why might this be?

Animals like whales and dolphins communicate in the water. The sounds travel for miles, according to the Guinness Book of World Records the furthest away you can hear a whale song is 530 miles!

The sounds can be heard from further away because the atoms that make up water are closer together, so they can 'pass on' the sound faster and more easily than the atoms that make up the air.

Name an animal that 'hears' by vibrations through the ground? Can they hear sounds further away than us? Why might this be an advantage?

Snakes can 'hear' vibrations through the ground. This means that they can hear predators coming from further away which will help them escape.

Many animals that live underground hear through the ground as sound would have trouble traveling through their winding tunnels.

Some new studies have found that elephants hear through their front toes by pressing them to the ground so that they can communicate with other elephants that are too far away to call to using the air.

Mirror Mirror Questions:

Take a look at your star. Did you get better with practice?

This is a skill that can be learnt, therefore, those that practice should be able to do a perfect star using the mirror after about 10 tries. If they immediately try to do a normal star without the mirror after perfecting the new technique you might notice that it is much more difficult, as your brain has got used to a different set of signals!

Is there any other time when the effect of a mirror can confuse your brain?

Brushing your hair or teeth while looking in the mirror.

Can you think of any jobs where this might be a problem?

A dentist has to look into a mirror all the time to see the inside of your mouth—bet you hope he practices!

Hair dressers also look into the mirror a lot while cutting your hair.

Drivers use mirrors to see what is happening around them.

Was your name neater when written with the mirror, or with your eyes closed? Why do you think this was?

You can usually write you name quite neatly with your eyes closed—most people call this muscle memory. Your brain is only using your proprioception to know where your hand is.

You will probably be messier when writing your name with the mirror as you are getting confusing signals from your hand and eyes.

What do you think would happen if you bounced the light of two mirrors, or even three?

Get together with some other groups and test out your theories!

As each mirror flips the light upside down, an even number of mirrors will give you a correct image that should be easy to interpret and an odd number of mirrors will give you an upside-down image that confuses your brain.