UKRI Science and Technology Facilities Council
RAL Space

HISTORY OF SCIENCE MUSEUM

UNIVERSITY OF OXFORD

Light and Space

Explore at home

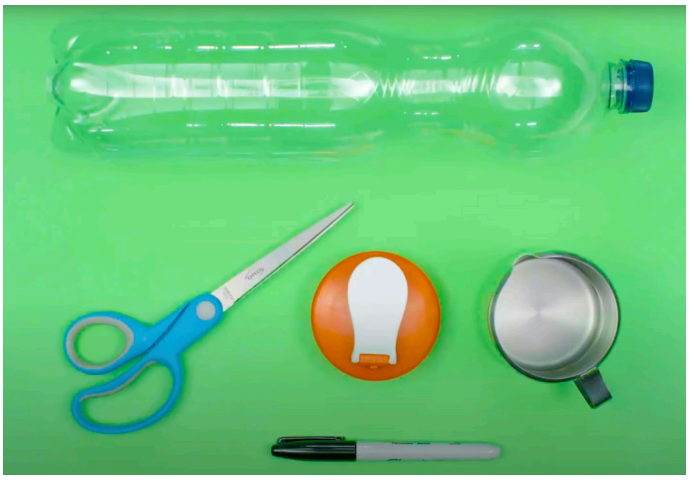
Magnification

Making things look bigger

Make a watery magnifying glass

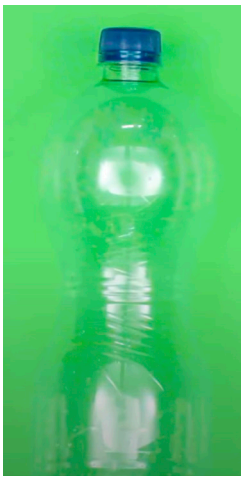
Time: 15 minutes

You need: Large plastic bottle, scissors, marker pen, circular lid from a jar

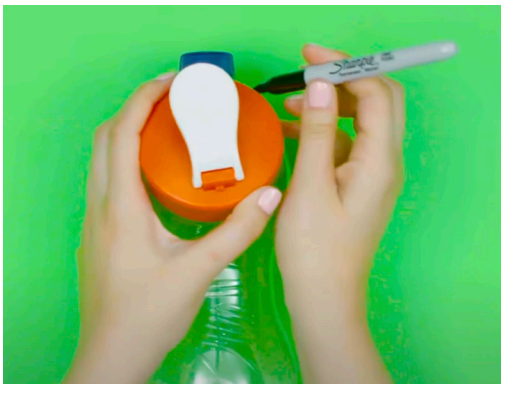


Instructions

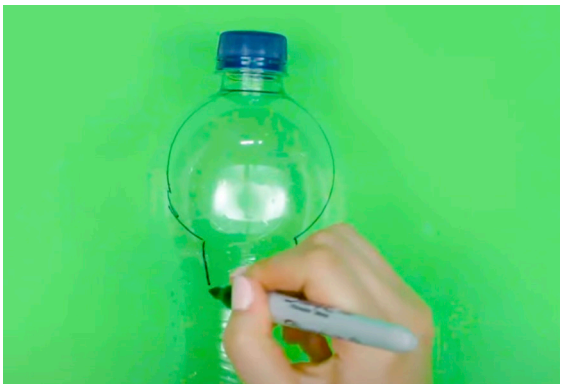
1. Look for a smooth curved part on your bottle



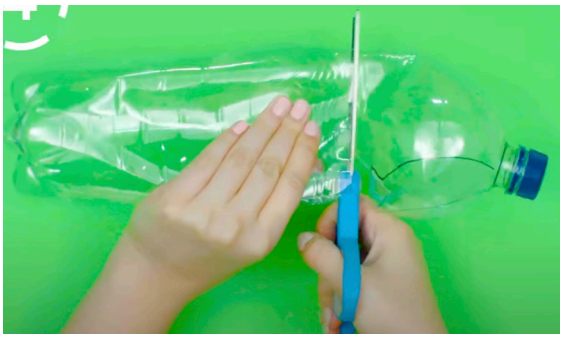
2. Draw around the lid to create a circle



3. Draw a small handle at the bottom of your circle

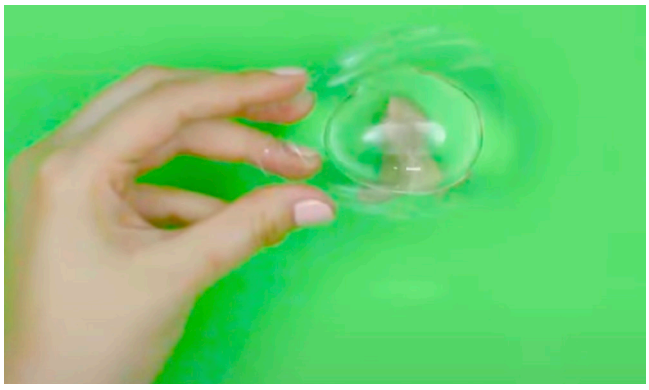


4. Carefully cut out your circle and handle shape with the scissors

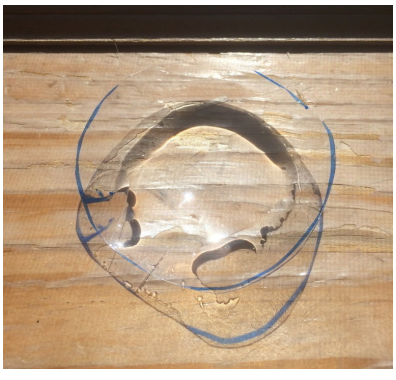


5. Hold the handle and add some drops of water to your magnifying glass

6. Find things to look at e.g. coins, leaves, clothing. Take care not to drop the water!



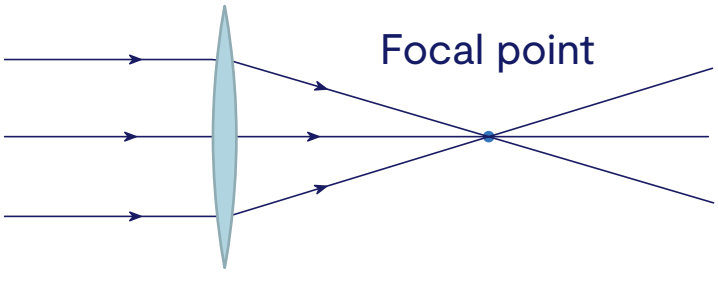
Final product



How does it work?

You have created your own **convex lens**.

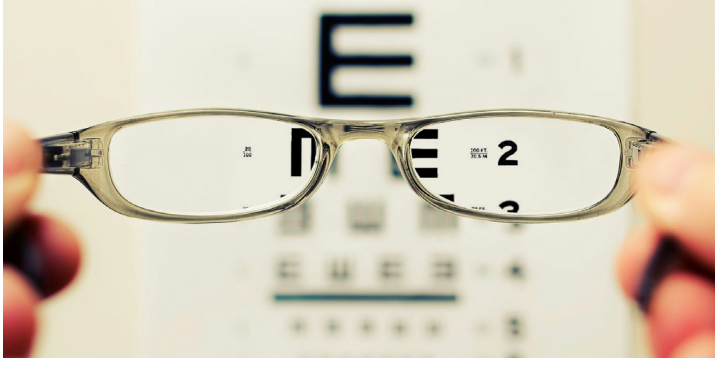
A convex lens is a surface that is curved outwards and is made from material that you can see through. When light hits the surface it bends, making things appear closer to your eye that they really are.



A convex lens

Science around us

Convex lenses are used in reading glasses. Glasses to help you see further away though are shaped curving inwards.



A pair of reading glasses with two convex lenses.

Space science

Lenses are used in telescopes to help make distant objects look bigger. They help scientists to better see stars, galaxies and planets in other solar systems.

RAL Space helped build the James Webb Space Telescope, which took this image of a rare, massive star with clouds of gas just before it exploded as a supernova.

Meet a scientist

My name is Daisy Shearer and I lead the education activities at the National Quantum Computing Centre. My job is to help people understand quantum computing topics.

Some days I work in the office writing about quantum computing and other days I attend events or give talks about the topic.

In school I enjoyed learning about quantum mechanics so I went to university to study Physics and become a researcher. Over time, I realised that what I enjoyed the most was teaching and helping other people understand science and technology.

During this job I realised that your career probably won't follow the path you expected, but that's okay. Take the time to understand your needs and find people who support you in a positive work environment where you can enjoy your passions.

For me, this job allows me to work with my neurotype, and it's a very fulfilling work life!

Daisy Shearer

Museum science Microscope

Microscopes use curved pieces of glass (lenses) that bend light rays passing through them. They allow you to see very small things that often you wouldn't be able to see just by looking at them. This beautiful silver microscope was made for King George the Third in 1763, over 260 years ago.

Photograph of a microscope made for King George the Third © History of Science Museum, University of Oxford, inv.35086

Portrait of King George the Third

Reflections and Curved Surfaces

Making the world look different

Arrow trick

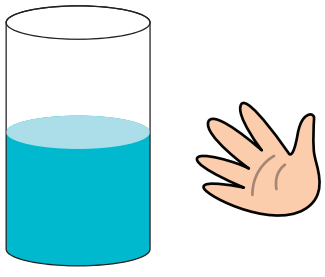
Time: 5 minutes

You need: A glass or jar with straight sides, water, small piece of paper, pen

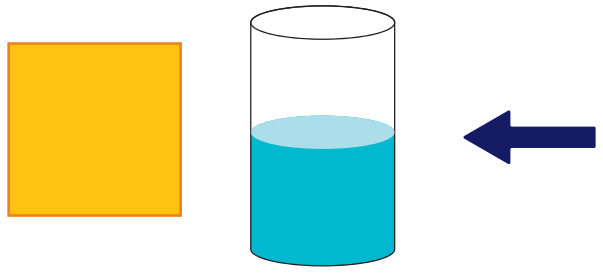
Instructions

1. Draw an arrow with a pen on a piece of paper

2. Put the glass of water in front of the arrow



3. See the arrow switch direction



How does it work?

Light travels in straight lines, but the light changes direction when it enters and leaves the glass of water.

This trick doesn't work with an empty glass because the curved surfaces of the glass and the water work together to makes the arrow appear to flip over.

Science around us

Have you noticed how your reflection looks upside down on the inside of the spoon?

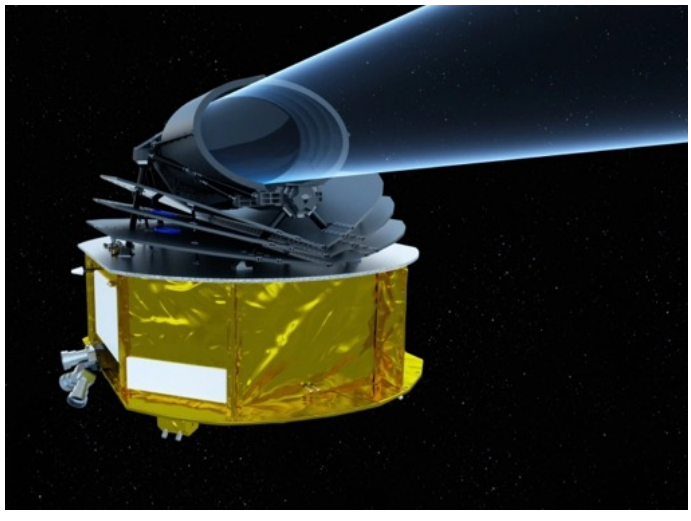
This is because the spoon acts like a **concave mirror** (a mirror that curves inwards). While a flat mirror sends the light rays straight back into your eyes, the rounded scoop of the spoon bounces your reflection back at different angles and turns your reflection upside down.

The back of spoons like this act like small concave mirrors.

Space science

Like lenses, mirrors are also used in telescopes. Mirrors reflect the light onto science instruments that are then used to conduct specific experiments.

The size of the mirror is related to how much light they can focus down. A bigger mirror, such as the Ariel Space Telescope, is about 1 metre. This means that it can take a lot of light and do very specific science.



Artist drawing of the Ariel telescope. Light from objects in space is collected on the mirror.

Meet a scientist

My Name is Richard Stamper and I lead on space assurance activities. I make sure we can show that we have done things the right way or, if we have got something wrong, that we have worked out how to fix the problem and what to do differently next time!

My days are very varied! Answering questions, thinking about and discussing problems, contributing to meetings, chairing meetings, writing documents, making decisions and communicating them to others.

I became a scientist because I think I always wanted to understand why things are as they are, and that leads to scientific thinking. If you've tried your best and still don't understand, don't be afraid to say so.

Richard Stamper

Museum science

Mirror

This mirror has two sides, one is **convex** and the other is **concave**. It curves outwards (**convex**) on one side and inwards (**concave**) on the other.

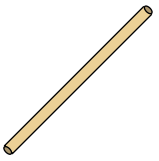
It is over 300 years old and was made for experiments and teaching about light. Curved glass was very expensive and difficult to make at that time.

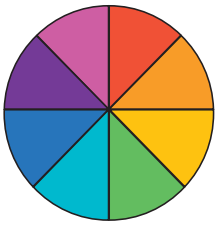
Light and Colour

Colouring mixing with a spinning top

Time: 15 minutes

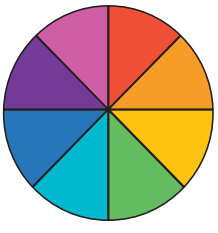
You need: a cocktail stick, spinning wheel cut-outs, colouring pens, a blob of play-dough or blue tack, a pair of scissors



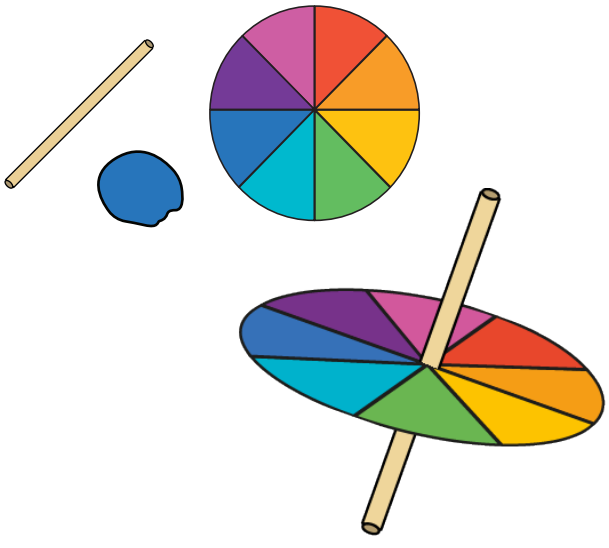


Instructions

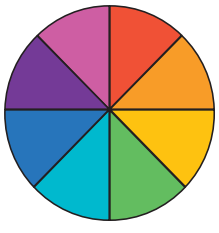
1. Cut out the multicoloured spinning wheel from the booklet



2. Put a cocktail stick through the middle of the coloured wheels (press down against blue tack/ playdough or ask an adult to help if needed)

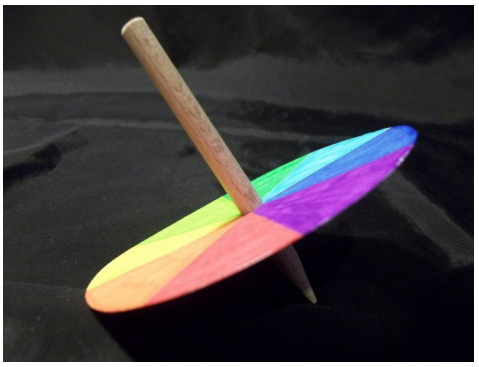


3. Spin the wheel. What happens to the colours?



4. Now colour in the blank wheels with two of your own colours. What happens to those colours when you spin them? Is it the same as when you mix paint?

Final product



How does it work?

Mixing coloured light is different from mixing coloured paint. White light is a mixture of all the colours of light, so when you add one coloured light to another you get closer to white.

When the spinner moves quickly you see light reflected from all the colours, but your brain cannot separate them. So you see a mixture of all 7 colours which is white.

Science around us

Have you noticed that sunglasses sometimes have different coloured lenses (the part you look through)? Because the brown lenses soak up all colour apart from brown, they help block out sunlight when it is too bright but also can help make things appear clearer and help you judge how far away something is by taking away blue light that comes from the sky.

A pair of glasses with coloured lenses.

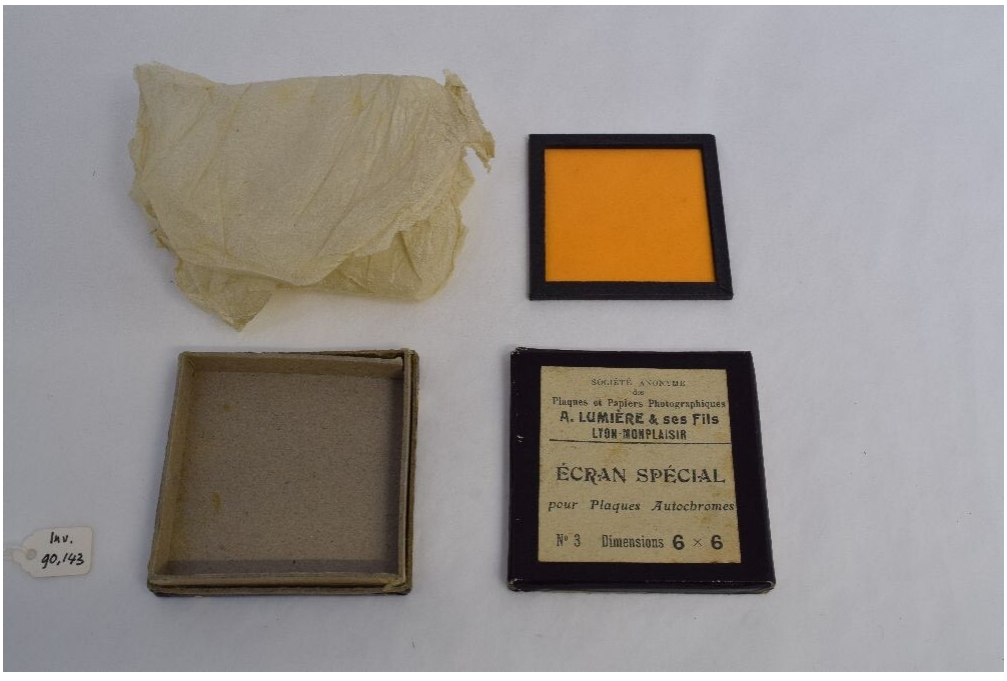
Space science

Why do we build telescopes in unusual places, for example in the desert or on a mountain? And why do we send them into space? Earth's atmosphere is made up of the air we breathe and other gases, such as carbon dioxide, water, and other bits of dust. If we go to drier places, such as the desert or higher up, such as a mountain or even into space, the amount of gas, water and dust gets less and less. In space there is very little, and it is very spread out, meaning the pictures we get will be much clearer.

This is a telescope. It is extremely large. It is being built in the Atacama desert in Chile, a country in South America.

Museum science

This yellow piece of glass (also called a filter) was used by people taking the first colour photographs over 100 years ago. The filter soaks up all colours apart from yellow. It shows a bigger difference between the dark and light parts of the picture, so you can see the things in it more clearly.

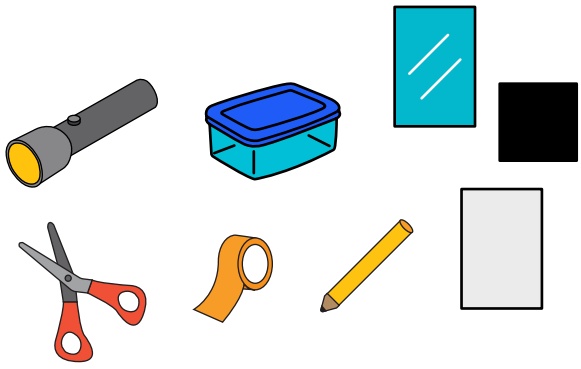


Yellow glass filter for photography and its box
© History of Science Museum, University of Oxford, inv.90143

Slicing up Light

Light splitting experiment

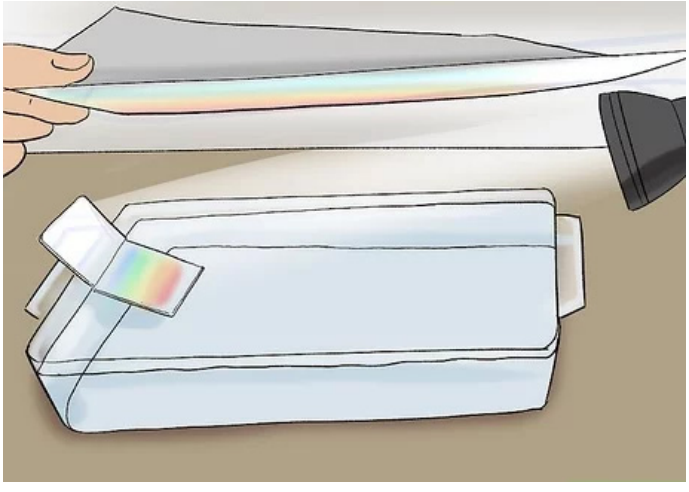
You need: a torch, a Tupperware or clear plastic box full of water, a small mirror, a small piece of black paper, a piece of white paper, scissors, pencil, sticky tape, water and a dark room.



Instructions

1. Give your torch a narrow beam by taping on a black paper cover with a small slit in it

2. Half fill the box with water. Stand the mirror in it so it leans against the end of the box



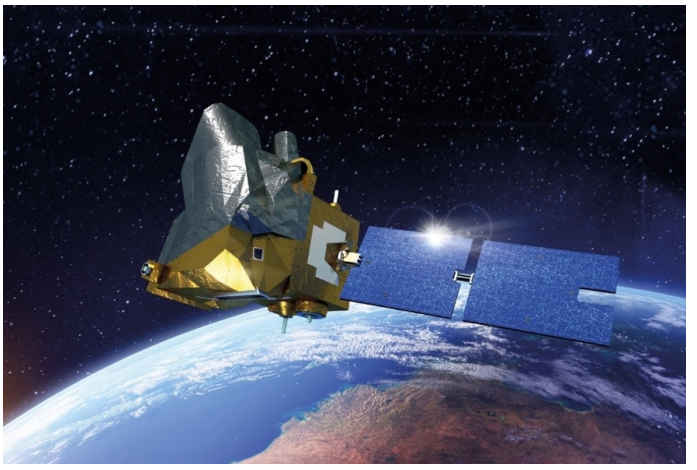
3. Point your torch so the light beam shines on the mirror under the water

4. In your other hand, hold up a white piece of paper so reflected light from the mirror shines on to it. Can you see a rainbow on the paper?

Space science

Different gases in the atmosphere, such as carbon dioxide and methane will absorb different colours of light. Space instruments can choose to look at the light that a specific gas will absorb.

One example is the MicroCarb satellite which will orbit Earth and send us information about the gases in our atmosphere which contribute to climate change.



An artist drawing of the MicroCarb satellite above Earth.

How does it work?

When light enters the water, it slows down and bends. All the colours that make up light travel at different speeds so they each bend at a slightly different angle. This makes the light separate into seven colours (red, orange, yellow, green, blue, indigo and violet).

The mirror reflects them so you see a rainbow.

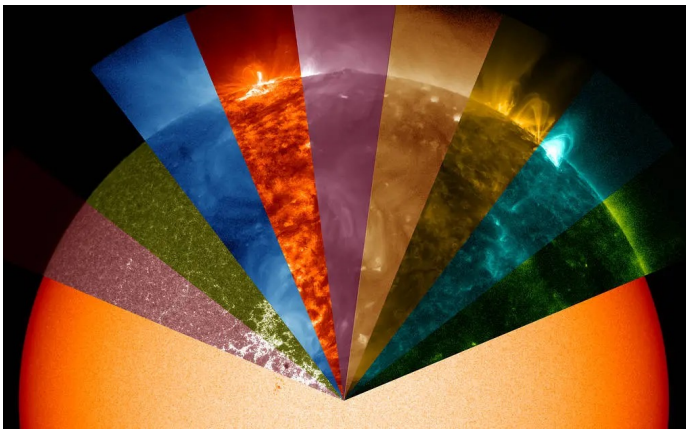
Science around us

Have you wondered why you see rainbows when the sun is out and it's raining? When sunlight enters a raindrop, the different colours are bent at different angles. These are reflected off the inside of the back of the raindrop. When the sun is behind you and rain is in front of you a rainbow of colours in reflected back from inside all the raindrops.

Space science

The Sun looks completely different when we take images in different colours of light. Scientists use this information to understand what the Sun is made of and how it creates solar flares that cause the northern lights.

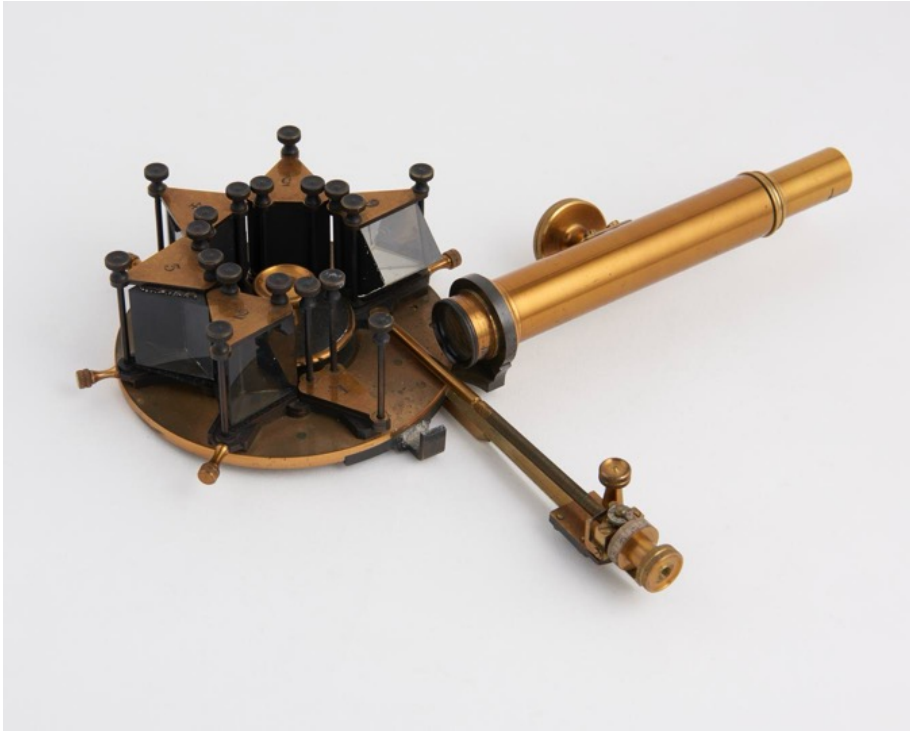
The Solar Dynamics Observatory is a spacecraft than can take photos of the Sun in different colours.



Photos of the Sun in different colours combined together in one image.

Museum science

This object uses glass **prisms** (a 3D shape with two triangle bases and three rectangle faces) to split light up. It is called a **spectroscope**. When you look down the tube on the right, you will see the light split up like a rainbow. You could use objects like this to understand what different types of gem stones are made from, for example, as each type of stone will show up different colours.
It was made over 200 years ago in 1880.



An object called a spectroscope. This one uses 6 prisms to split up light © History of Science Museum, University of Oxford, inv.18039

What does the word mean?
Science terms used in this booklet

Convex	outward curving mirror or lens
Concave	inward curving mirror or lens
Colour filter	a piece of coloured material that light passes through that changes how you see things
Lens	shaped glass made from glass or plastic
Spectroscope	a device that splits colours into its different wavelengths, which humans see as different colours
Triangular prisms	3D shape with two triangle bases and three rectangle faces

Who made this booklet

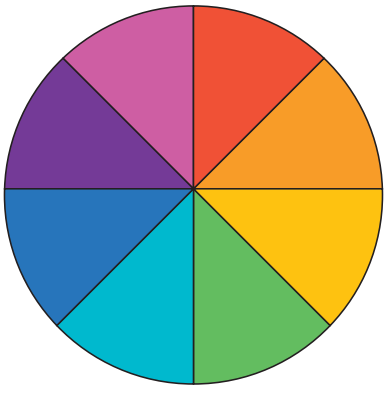
This booklet has been created by scientists from RAL Space and learning staff at the History of Science Museum in Oxford.

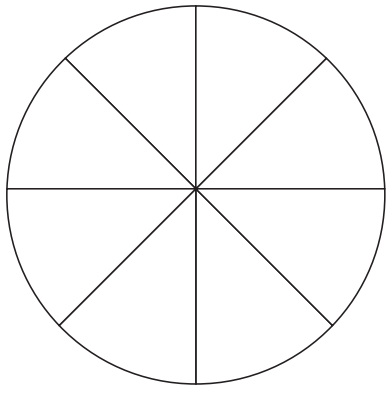
Thank you to the staff and young people at Iffley Academy for their support with this project.

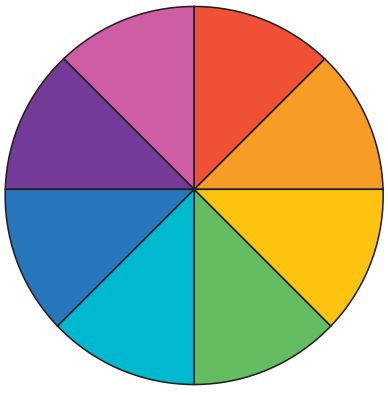
Thank you to the STFC Public Engagement Spark Awards for funding the project.

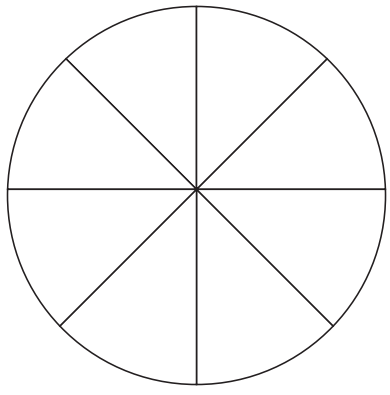
To learn more about jobs and opportunities at RAL Space go to **ralspace.stfc.ac.uk**

Cut outs for Light and Colour activity









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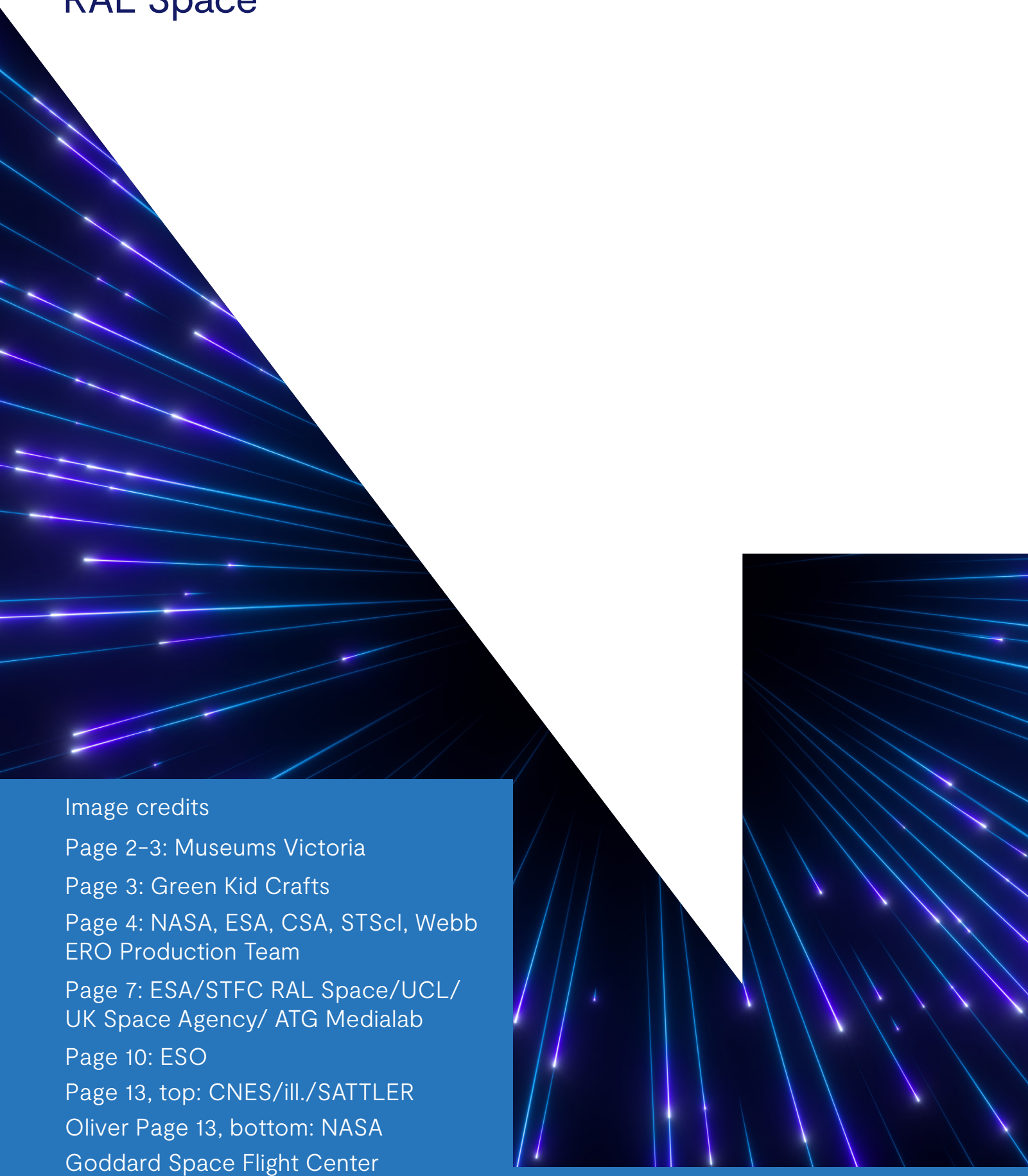

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