teach with space

→ THE MAGIC OF LIGHT

Using spectroscopes and colour wheels to study the properties of light

The Magic of Light

What is a light source?

In this task you will think about some of the light sources you see around you every day.

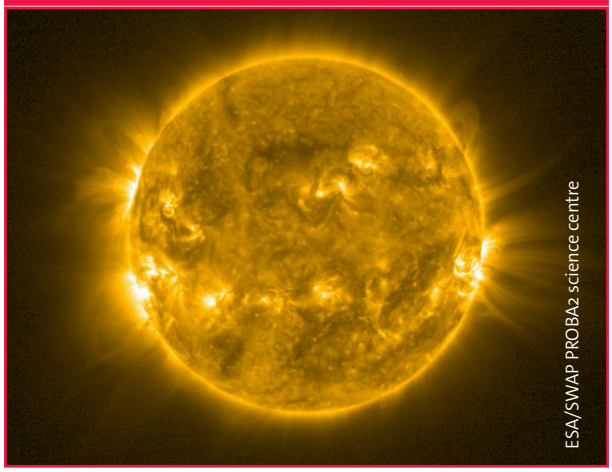
Name a few natural light sources

Name a few artificial light sources

Is the Sun a light source? Why / Why not?

Is the Moon a light source? Why / Why not?

Figure A1



↑ The SWAP instrument on board ESA's Proba-2 sees the Sun on 30 July 2013.

Figure A2

↑ The Moon as seen by Apollo 17.

Did you know?

We live in a galaxy called the Milky Way. The main light sources in galaxies are stars. The Milky Way contains at least 100 billion (100,000,000,000) stars!

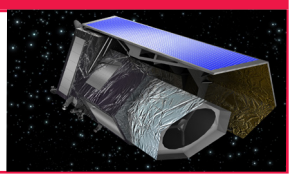
The Magic of Light

How can we study light?

In this activity you will assemble a spectroscope that will be used to study light.

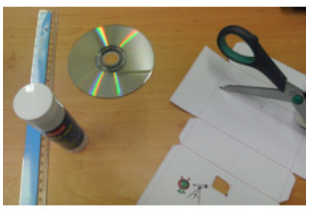
Did you know?

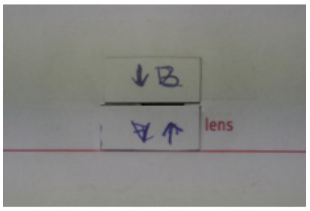
As of 2013, the European Space Agency has been building a satellite called Euclid, which will use a professional spectroscope to study why the universe is getting bigger.



Equipment

- Thick black A4 paper
- Printed A4 spectroscope design
- CD or DVD
- Glue stick
- Ruler
- Scissors
- Adhesive tape





Exercise

1. Glue the backside of the spectroscope design onto the thick black sheet of paper.
2. Cut out the model following the dashed lines.
3. Cut out a hole for the lens and the viewing window next to Paxi. Cut out either the CD or DVD hole, depending on which you are using.
4. Cut out the two pieces marked (A) and (B). Make sure to cut all the way to the edge of the paper.
5. Tape pieces (A) and (B) over the lens hole as shown in the photo. Make sure the two pieces are straight, parallel, and that the arrows point towards each other. The distance between pieces (A) and (B) should be about the thickness of your fingernail.
6. Use a ruler to help fold the model along the solid lines. The black card should be facing the inside of the box. Fold the tabs inwards to support the sides.
7. Put adhesive tape on every edge to seal the box.
8. Insert the CD (or DVD) with the blank side facing towards the lens.
9. Your spectroscope is assembled.

The Magic of Light

Is white light truly white?

In this activity you will use your spectroscope to study the colours of different light sources.

Equipment

- Spectroscope
- Phone Camera (Optional)

Exercise

Point the lens at the top of your spectroscope towards light sources around you. Look through the viewing window to see the different colours in each light source. You can take a photo of what you see using a phone camera.

Light source 1 is: .....

Write the colour(s) you see here:	Colour the colour(s) you see here

Light source 2 is: .....

Write the colour(s) you see here:	Colour the colour(s) you see here

Light source 3 is: .....

Write the colour(s) you see here:	Colour the colour(s) you see here

Did you know?

We see rainbows when it is sunny and rainy at the same time. Raindrops in the air split white light from the Sun into lots of colours, in a similar way that your spectroscope just did. What colours do you see when you look at a rainbow?

The Magic of Light

How does your screen produce colours?

In this activity you will use water to investigate how colours are produced on a computer screen.

Equipment

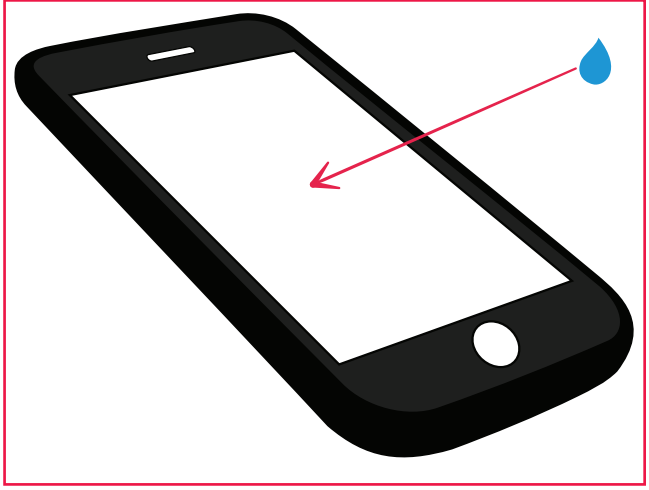
- Water or magnifying glass
- Screen (e.g. a mobile phone, a computer, a tablet)

Exercise

First, write or draw your ideas about how a screen might produce different colours.

Carefully place a small drop of water or a magnifying glass onto the middle of a white screen. Look closely inside the drop/magnifying glass and you will see the basic colours of the screen.

Figure A3

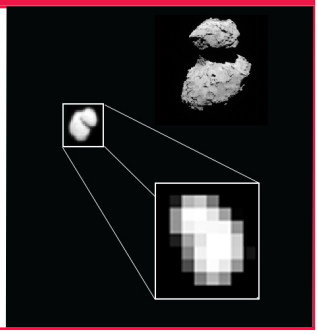


What colours do you see when performing this experiment?

Do you have any ideas about how your screen could produce colours other than red, green, blue and white?

Did you know?

The tiny squares you see on your screen are called pixels. A screen shows images by colouring each pixel with a different mix of red, green, and blue. Both of these images, taken by ESA's Rosetta probe, are of the same comet (a 'dirty snowball' in space). The first image is very fuzzy because the comet is far away so it is very small on the image and only covers a few pixels, as we can see when we zoom in. The second image is much clearer because the comet is closer and covers many pixels, so we are able to see it in more detail.



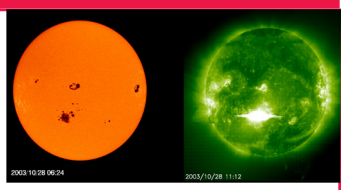
The Magic of Light

How can you break down a complex colour into basic colours? (I)

In this activity you will use the spectroscope to investigate how colours are produced on a screen.

Did you know?

We can look at the Sun in different colours and in different types of light, such as ultraviolet, to find out different information about it. Surprisingly, these photos are both of the Sun! They are just taken with different types of cameras. Can you see the difference between these photos?



Equipment

- Spectroscope
- Screen (e.g. a mobile phone, a computer, a tablet)

Exercise

Now we will investigate which of the basic pixel colours (red, green and blue) are used to generate more complex colours on a screen.

Two basic colours are combined to generate each of the complex colours you will look at in this activity. Point your spectroscope at each colour on the screen and look through the lens to determine which two basic colours are the most obvious inside the spectroscope. Make a cross in the boxes below to indicate which two basic colours you can identify in each complex colour.

Simple colours / Complex Colours	Red	Green	Blue
Yellow			
Cyan			
Magenta			

The Magic of Light

How can you break down a complex colour into basic colours? (II)

In this activity you will use the spectroscope to investigate how colours are produced on a screen.

Equipment

- Spectroscope
- Screen (e.g. a mobile phone, a computer, a tablet)

Exercise

The more complex colours that you will look at in this activity are produced using different amounts of two basic colours. You will look at these now.

Use your spectroscope to determine which two basic colours (red, green and blue) are used most obviously to generate each new colour below. Describe how much of each basic colour is used to produce the complex colours by writing 'none', 'low', 'medium' or 'high' under the red, green, and blue headings.

Simple colours / Complex Colours	Red	Green	Blue
Orange			
Turquoise			
Violet			
Raspberry			
Spring Green			
Ocean			

You can study any colour with your spectroscope. The most complex colours are made by combining different amounts of all three of the basic colours.

Did you know?

In space we can look at colours to work out what is happening very far away. For example, this image is called the Butterfly Nebula. Can you see why? It was produced by a dying star. The hot white/blue areas contain a lot of gases that are constantly crashing together, whereas the red areas are cooler and calmer.

The Magic of Light

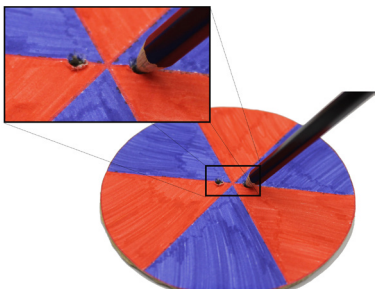
Can we make our own complex colours?

In this activity you will assemble a colour wheel. When the colour wheel is spinning really fast, the colours will mix into something new.

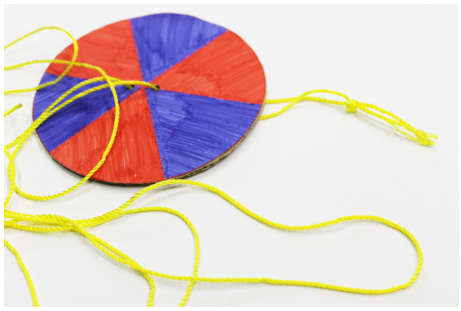
Equipment

- Colour wheel template
- Cardboard (at least the size of the colour wheel template)
- Colouring pens if using template 3 (choose two out of red, green, and blue)
- Pencil
- Ruler
- Scissors
- Glue stick
- String (the same length as your height!)
- Torch

Exercise



1. Cut out the colour wheel template.
2. Glue the template onto the cardboard and cut around it.
3. FOR TEMPLATE 4: Colour each of the six sections alternating between your two colours. You will end up with three sections of each colour. If using template 1 or 2, move straight to step 4.
4. Use a pencil to poke two small holes in the colour wheel. They should be made either side of the centre of the circle, about 1 cm apart from each other, as shown in the photo.
5. Pull a string through one hole then back through the other and tie the ends together to make a large loop.
6. Your colour wheel is assembled.



For this part you will need to work together in groups of at least three pupils.

The first pupil should hold the ends of the string loop and stretch her/his arms out, pulling the string firmly with the colour wheel at the centre. The second pupil should twist the colour wheel to wind it up tightly. The third pupil should kneel on the floor with a torch pointing towards the coloured face of the wheel.

Release the colour wheel and write your observations. Swap roles and repeat the experiment a few times.

Look at the spinning colour wheels of groups or students with different colour combinations. What do you observe?

The Magic of Light

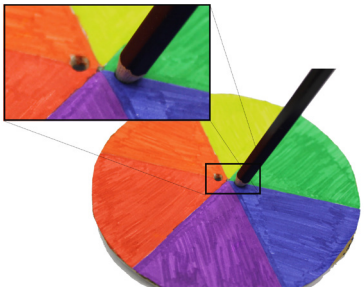
What happens when we mix all the colours of the rainbow?

In this experiment you will assemble a colour wheel. When the colour wheel is spinning really fast, all the colours will mix into something new.

Equipment

- Colour wheel template
- Cardboard (at least the size of the colour wheel template)
- Colouring pens (red, orange, yellow, green, blue, violet)
- Pencil
- Ruler
- Scissors
- Glue stick
- String (the same length as your height!)
- Torch

Exercise



1. Cut out the colour wheel template.
2. Glue the template onto the cardboard and cut it out.
3. FOR TEMPLATE 4: Colour each of the six sections in order; first red, then orange, yellow, green, blue and violet. If using template 1 or 2, move straight to step 4.
4. Use a pencil to poke two small holes in the colour wheel. They should be on either side of the centre of the circle, about 1 cm apart from each other.
5. Pull a string through one hole then back through the other and tie the ends together to make a large loop
6. Your colour wheel is assembled.

For this part you will need to work together with two other pupils.

The first pupil should hold the ends of the string loop and stretch her/his arms out, pulling the string firmly with the colour wheel at the centre. The second pupil should twist the colour wheel to wind it up tightly. The third pupil should kneel on the floor with a torch pointing towards the coloured face of the wheel.

Release the colour wheel and write what you observe. Swap roles and repeat the experiment a couple of times.

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