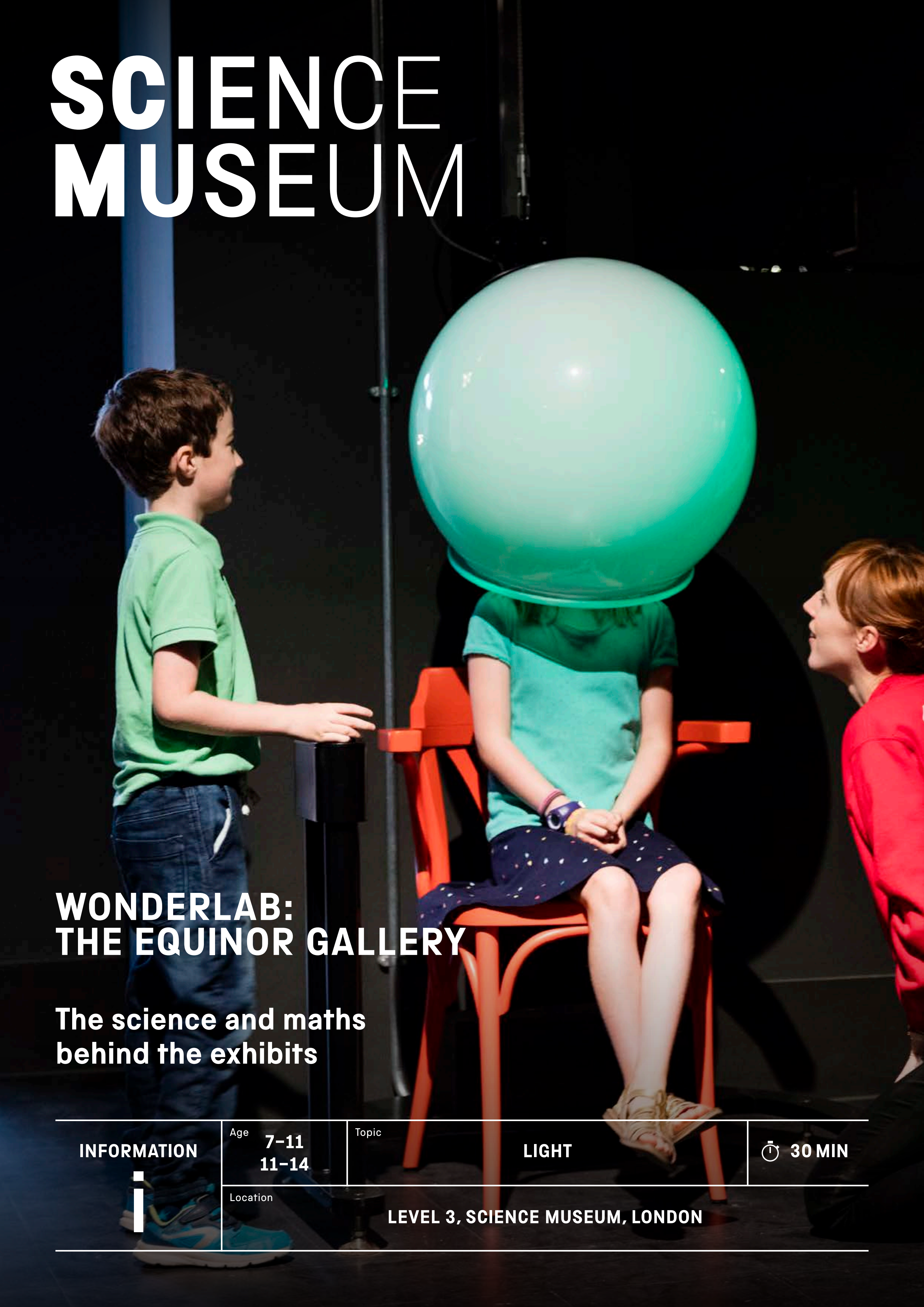

SCIENCE MUSEUM

WONDERLAB: THE EQUINOR GALLERY

The science and maths behind the exhibits

INFORMATION	Age	Topic	
	7–11 11–14	LIGHT	30 MIN
	Location	LEVEL 3, SCIENCE MUSEUM, LONDON	

What's the science?

What more will you wonder?
The science and maths behind the exhibits

Wonderlab: The Equinor Gallery is packed with over 50 hands-on experiments and experiences. You need to look closer, ask questions and get creative to discover what they're all about.

If you're still curious you can find out more about the science and maths behind each of the exhibits using these handy resource packs. Check out each of the seven zones that you'll find in the gallery.

Light

Light can be blocked, reflected, bent or blended. You can experience how your reflection changes in different mirrors or how the colours of light can be mixed together.

Find out more about the science behind the Light zone exhibits in this pack.

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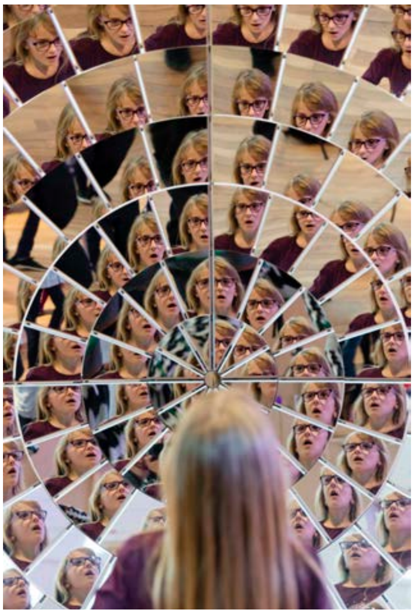
The science behind the exhibit



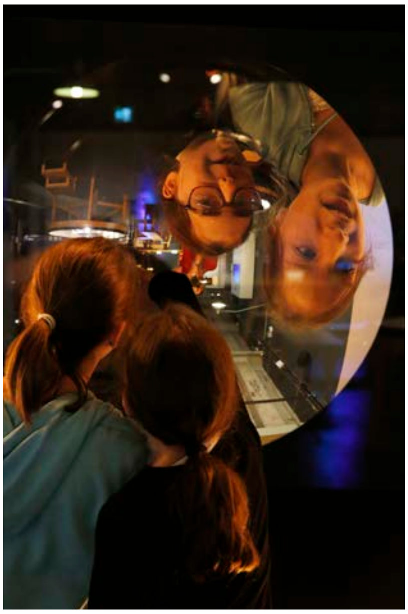
The Reflections mirror is made out of about 100 flat stainless-steel mirrors arranged in a curved shape. The mirrors are placed at angles so that they create an inwards curve similar to a concave mirror.

When a light ray from an object is reflected by a mirror and reaches your eye, your brain makes no allowances for the fact that this is a reflection. Instead your brain traces the light rays back in a straight line to where they seem to be coming from. So when you look into a flat mirror you perceive a virtual image of the object that seems to come from behind the mirror.

When many flat mirrors are placed into a curved shape light is reflected back at different angles. This means that an object can appear as a slightly different reflection in every mirror, creating the illusion of many repeated reflections. If you stand in front of the mirror with your eye level with the centre, then you'll see yourself reflected over and over again in the mirrors. But if you stand to one side then your repeated image will only be visible to someone standing on the opposite side.

Berenice Abbott used a mirror like this one to create her iconic photograph called 'A Thousand Eyes'. To take this photograph she actually took a photo of her own eye first and put it on a stand at a precise location in front of the mirror. She made a swing to help her move up and down and get to exactly the right spot – so that both the mirror and the stand would be in shot, and to capture the photo of her eye repeated in every individual mirror. Berenice did many experiments with photography to take scientific photographs like this one which demonstrate key principles in physics.

The science behind the exhibit



This exhibit is a concave mirror, which is a curved mirror with a reflective surface that curves inwards. Because of the curved surface light rays will reflect from various points on the mirror at different angles. This means that a concave mirror reflects light inwards towards a single focal point.

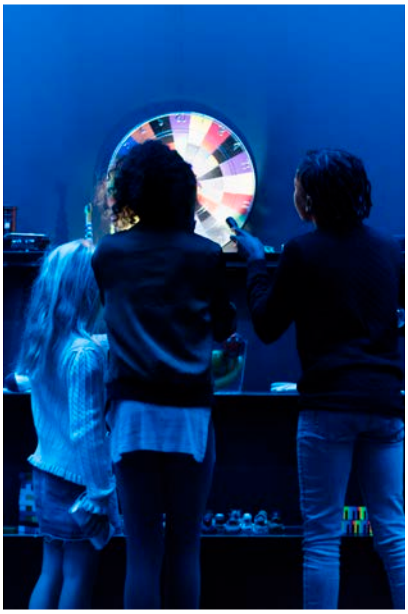
Concave mirrors can also cause unusual reflections to happen, depending on your position in relation to the focal point of the mirror.

When you are positioned close to the mirror, in front of the focal point, your reflection appears to be behind the mirror, as a virtual image. Your reflection is also magnified and upright. This is useful for making magnifying mirrors such as make-up mirrors.

When you stand at the focal point the reflected rays never meet and so no image forms. This makes it seem as though your reflection has disappeared or has become just a distorted blur.

When you move further away from the mirror and go beyond the focal point, your reflection will appear to be in front of the mirror. This is called a real image and gives the impression that your reflection is hovering in front of the mirror and that you could touch it. The reflection will also appear to be upside down. The further you move away from the mirror the smaller and smaller your reflection will become.

The science behind the exhibit



In the Colour Room the lights slowly change between red, green and blue light. This light is a single wavelength of light, called monochromatic light. Normally light sources are white light, which is a mix of every colour or wavelength of light.

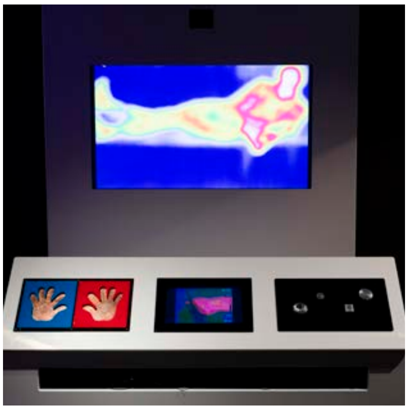
Usually when we look at an object under white light it appears to be a particular colour because it reflects that wavelength or colour of light into our eyes. For instance, a red object under white light appears red. This is because it absorbs all wavelengths of light except for red, which it reflects and we can see.

Under monochromatic light there is only one colour of light hitting the objects, which means this is the only light that can possibly be reflected. For instance a red object under monochromatic red light will appear red as it reflects this colour of light. But the same red object under green or blue light will appear darker or even black. This is because a red object will absorb both blue and green light and no light gets reflected. The object appears dark, even black, as no light is being reflected by it.

A white object reflects all colours of light and absorbs none. This means that under the changing monochromatic lights a white object will appear to change colour from red, to green and to blue. On the other hand, a black object reflects no colours of light and absorbs them all. This is why a black object will appear black under all three lights.

Some of the objects in this room are shades of red, green and blue or even different colours entirely. They all reflect the monochromatic lights differently so they appear to change as the lights do. The torches have white light, so they can be used to reveal what colour the objects usually appear.

The science behind the exhibit



There are more types of light than the visible light we see with our eyes.

Beyond visible light there is ultraviolet light, X-rays, microwaves, radio waves and infrared. All these types of light can be useful, such as using X-rays to look inside bodies for broken bones. Infrared radiation is a type of light that carries heat. We can't see infrared light, but we can feel it as this heat radiation. Hot objects give off more infrared light than colder ones.

A special camera can be used to detect this infrared light and show it on a screen. The infrared camera used in the exhibit shows hot objects as red/white and colder objects as green/blue. There are different experiments and activities on the table to explore.

Our bodies give off infrared light as heat radiation. Some parts of our bodies are warmer than others. For instance your eyes are warmer than your nose. Your image on the screen will appear strange, as the camera detects the hot and cold areas of your body. Using the activities can change your infrared appearance.

The hot hand pads show how heat can be transferred to your hands, which you can see on screen as your hands change colour. Or the cold pads and the hand tattoos can show how your body heat can be transferred to the metal, making your image get bluer and therefore colder.

You can also block infrared light with different materials, such as the masks. You can try out different ways to make heat, such as rubbing your hands together to see how friction generates heat and makes your hands appear brighter on the screen.

The science behind the exhibit

Step into the Light lets you experience what it's like to walk inside a light beam.

Light moves in straight lines and can be blocked to create shadows. On a sunny day you can cast a shadow by blocking the light rays from the Sun. In this room you can make shadows by blocking light from a projector. What's unusual is that inside this room you can see the path that the light takes. This is because the room is filled with mist.

The mist is made up of tiny water droplets. When the light from the projector hits these droplets the light rays are scattered in many directions, including into our eyes. This means we can now see the path of the light beam. If we block this path of light with our bodies we can also see the shadows we cast.

Light can also be reflected by shiny surfaces, such as mirrors. If a mirror is held in the path of light, the light will be reflected off the mirror in a different direction. In this room you can use mirrors to block the path of the light beam and also to see the path it takes when it's reflected. The angle that the light hits the mirror will be equal to the angle it's reflected away at.

The science behind the exhibit

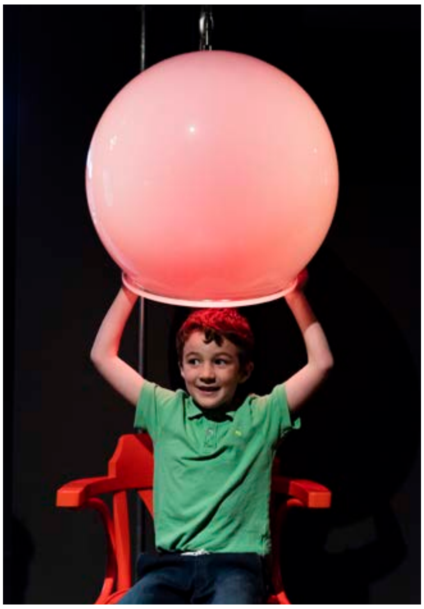
When a light ray from an object is reflected by a mirror and reaches your eye, your brain makes no allowances for the fact that this is a reflection. Instead your brain traces the light rays back in a straight line through the mirror to where they seem to be coming from. So when you look into a mirror you perceive a virtual image of the object that seems to come from behind the mirror.

When two mirrors are placed opposite each other with an object in the middle there is a strange effect. The reflection of the object in one mirror acts as an object for the second mirror, creating multiple reflections from the original object. These multiple reflections seem to appear further and further away from each other and stretch off into infinity.

The number of reflections will depend on the angle at which the mirrors are placed opposite each other. When the mirrors are parallel there are infinite reflections, as the light can keep bouncing between the two mirrors. The wider the angle between the two mirrors gets, the fewer repeated reflections they will make as the light will eventually bounce away from the mirrors.

The exhibit contains several mirrors placed at angles inside the box. When you put your head inside the box you see multiple reflections of yourself stretching off into infinity. Both boxes have more than one place to put your face. This means there are different reflections that you can see from each of the different viewpoints. You can see infinite reflections of other people when they put their heads into the box too.

The science behind the exhibit



Colour Mixing is all about mixing different coloured lights together. Light can be mixed together, just like paints are, to make other colours. However, mixing colours of light together works in a different way to how we mix coloured paints or crayons.

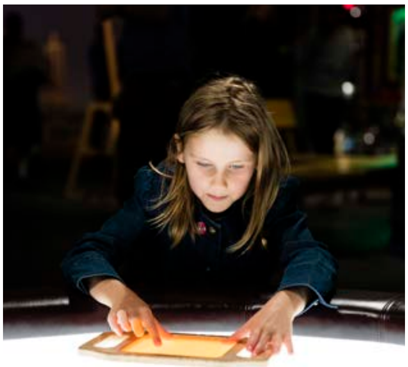
White light is actually a mixture of all other colours of light. White light can be split apart by a prism to show all the visible colours that white light is made from, which is a rainbow. If these colours of light are added back together again they will make white light.

White light can also be made by combining only three colours of light together. The three colours of light that produce white light when they are mixed together are red, green and blue. These are known as the primary colours of light.

Mixing a combination of these three colours together in varying brightness levels generates new colours. In fact every colour hue possible can be created by mixing these three colours together in different amounts. This is known as additive colour, because when more colours are added the result becomes lighter and heads towards white. Red, green and blue light is used to generate white light on computer and TV screens.

In the exhibit there are three dials, each representing either red, green or blue light. You can turn these dials to change the brightness of each colour of light. By doing this you can create countless different colours of light inside the hood. When all three dials are turned up to maximum this will mix the three colours together at the highest brightness and produce white light.

The science behind the exhibit



Light Lab lets you explore many of the key properties of light using tools such as mirrors, prisms, lenses and colour filters.

Light moves in straight lines. This means it can be blocked easily by any object that isn't see-through, such as your hands. The light cannot move around the object and so the absence of this light is seen as a shadow. If the object that blocks the light is highly reflective, such as a mirror, it will cause the light to bounce off the surface of the object. The light will bounce off at an angle equal to the angle it hit the mirror.

Certain colours of light can also be blocked using filters. Different coloured filters can be placed on the white light source, such as the lower light table or the lens tower. White light is a mix of all colours. A colour filter acts to block most colours of this white light and only lets a certain colour of light through. For instance a green filter will only let green light through and block all other colours – this is why it appears green, as only green light reaches your eye through it.

Light can also be bent. When white light travels through the air and then hits a glass lens or prism it will travel slower through the glass, causing it to bend, which is called refraction. The shape of a lens can cause the light to get bent at different angles. A concave lens will bend light inwards and a convex lens will bend light outwards. When white light hits a prism its shape means that the different colours of light are bent by different amounts, which splits them apart so we can see a visible rainbow spectrum. This shows that white light is made of many colours.