

Scientist Badge  
Pack Holiday 1997

**Topics**

Light

Movement and Mechanics

The Natural World

Electricity and Magnets

Floating and Sinking

**Light**

Materials needed for light.

Card.	Pencil.	2 Mirrors.
Bowl of water.	Cardboard tube.	Glass of water.
Comb.	Torch.	Magnifying glass.
Clear polythene bag or clear tape.		Coin.
Protractor.	Compass.	Long, thin box.
Sellotape.		

## Light and Shadows

Light can pass through some substances, such as glass or water. These are called *transparent* and we can see through them. Other substances, such as paper and metal, stop light passing through. They are called *opaque*. Shadows appear behind opaque substances when light shines on them. Shadows are produced because light travels in straight lines and cannot bend around corners.

### Shadow Clocks

**Equipment:** A long, thin box, pencils, tape, white paper.

**Method:** Cover one side of the box with white paper and hold it in place with sticky tape. Stick a pencil across the end of the box. On a sunny morning, take your shadow clock outside and place it on a pale-coloured, flat surface (such as a sheet of white paper). Point the box in the direction of the Sun. Notice where the shadow of the pencil falls and draw a line at the same point on the top of the box. Write the time next to the line. Do this at several different times during the day.

**Expected Result:** You should be able to make several different marks down the length of the box during the day.

**Explanation:** As the Sun changes position in the sky, it casts a different shadow at different times of the day.

### Make a Sundial

**Equipment:** Thin card, protractor, compass, piece of thick cardboard.

**Method:** On the thin card, draw a right angled triangle. Make the other two angles  $45^\circ$  (ideally the angle between the board and the slope should be the latitude of your town to make an accurate sundial). The two shorter sides should be about 15cm long. Make sure to cut an extra 'flap' at the bottom of the dial to hold it upright on the board. Draw a semi-circle on the cardboard. Stick the folded part of the triangle firmly to the cardboard. Place the sundial in a flat place outside so that the triangle points north-south. Mark the position of the shadow that falls on the base every hour.

**Expected Result:** You should find that the shadow travels the same distance along the semi-circle every hour. On a sunny day you will now be able to tell the time by looking at the position of the shadow on your sundial.

**Explanation:** As the Sun changes position in the sky, it casts a different shadow at different times of the day.

## Reflections

When rays of light hit a surface or an object they bounce off again. This is called *reflection*. Look for reflections in tin foil, cans, bottles and spoons. You will find that flat, shiny surfaces produce the best reflections. This is why most mirrors are made of flat sheets of highly polished glass with a shiny silver coating behind them.

### **Investigate Reflections**

**Equipment:** Comb, black paper, white paper, torch, mirror.

**Method:** Cut a small holes in a piece of card and tape a comb across the hole. In a darkened room, place the card in front of the torch, so that narrow beams of light come through the teeth of the comb. Hold a mirror in the beams of light so that it reflects the light. Move the mirror to a different angle, what happens to the beams of light?

**Expected Result:** The angle of the reflected rays will change.

**Explanation:** Light is reflected off the mirror at exactly the same angle as it hits the mirror.

### **More and More Reflections**

**Equipment:** Two mirrors.

**Method:** Stand two mirrors side by side and put a small object between them. How many reflections can you see? Move the mirrors closer together and then further apart. What happens to the number of reflections? Place two mirrors facing each other with an object between them. What can you see now?

**Expected Result:** As the mirrors move to face each other, you will see more and more reflections. When they are opposite each other, you should be able to see endless reflections.

**Explanation:** Less and less light is actually 'escaping' the two mirrors, so that when they are facing each other, all the light is 'trapped' in bouncing between the two mirrors.

## **Bending Light**

Light travels at different speeds through different substances. It travels more slowly through water or glass than it does through air. As the light slows down, it also changes direction a little. This is called *refraction* and it makes the light rays look as if they 'bend' at the point where two substances meet.

## **Magic Money**

**Equipment:** A coin, bowl, water.

**Method:** Put the bowl on a table and place the coin in the bottom. Keep looking at the coin and move slowly backwards until the coin disappears from view. Stay standing in the same place and ask a friend to pour water into the bowl. What can you see?

**Expected Result:** You will find that you can see the coin again!

**Explanation:** The light from the coin is 'bent' (refracted) by the water so you can see it again.

Swimming pools and ponds never look as deep as they really are because light from the bottom is refracted before it reaches our eyes.

On a very hot day, you can sometimes see what looks like a pool of water on the road although the road is really completely dry. Light from the sky is 'bent' (refracted) by the hot air near the road and the 'pool' you see is actually refracted sunlight. This is why people see mirages in a desert. The hot air bends the light so objects that are really a long way away appear to be close by.

If you hold a pencil behind a thick glass dish so that half the pencil is above the dish and half is below, you will find that the part of the pencil behind the glass seems to be separated from the part of the pencil in the air. This is because light travels more slowly in glass than in air. The light rays change direction at the edge of the glass and make a pencil look as if it 'bends' in the middle.

Glass can be made into different shapes so that it 'bends' the light in different directions. These are lenses.

## Lenses

Transparent materials (such as water or glass), which can bend light rays by refraction, can work as lenses. Lenses are curved on one or both sides and are useful for bending light in special ways. They make objects look larger or smaller, depending on the shape of the lens.

### **Making a Magnifying Glass**

**Equipment:** Stiff cardboard, pencil, clear polythene bag or clear tape, tape.

**Method:** Draw the shape of a magnifying glass on the cardboard. Cut around the outline and cut out a circle from the middle. Cut a piece of polythene to fit the hole in the middle. Carefully stretch the polythene tightly over the hole and secure it with sellotape. Put a drop of water on to the polythene and hold the lens over a page in a book.

**Expected Result:** You will see that you have made a magnifying glass.

**Explanation:** The drop of water is acting as a magnifier.

### **How Lenses Work**

**Equipment:** White paper, card, comb, convex lens (magnifying glass), concave lens (spectacles-short sighted), torch.

**Method:** Cut a hole in the card and tape the comb over it. In a darkened room shine a torch through the hole, so that the rays of light shine over the paper. Hold the magnifying glass against the edge of the paper and notice what happens to the rays of light. Repeat with a concave lens.

**Expected Result:** The magnifying glass will focus the rays to a point, and the concave lens will 'spread' the rays of light out like a fan.

**Explanation:** The lenses are created so that light is refracted in a certain direction.

## **Light and Sight**

When your eyes are open, the light reflected from objects around you enters your eyes through the *pupil* - the black hole in the middle. The pupil is an opening in the coloured part of the eye which is called the *iris*. A lens behind the iris focusses the light onto a light-sensitive layer called the *retina* at the back of the eye. Special optical nerves carry messages from the retina to the brain, which interprets the images so you can see.

Because you have two eyes you see two images of everything you look at. Each eye looks at the world around you from a slightly different position. This allows you to see things in three dimensions rather than just as a flat picture. It also helps you to judge distances and appreciate perspective.

### **How Many Pencils?**

**Equipment:** Pencil, glass of water.

**Method:** Place a glass of water on a table and stand a pencil about a foot behind it. Look through the jar and you will see the images of two pencils in it. Close your left eye and the right hand pencil will disappear. Close your right eye and the left hand pencil will disappear.

**Explanation:** The water is working as a lens to produce the images but because the water is held in a cylinder shape each eye looks through the water at a slightly different angle. So, with both eyes open, you see two pencils. With one eye open you see only one image.

### **Touch the Dot**

**Equipment:** Pencil, paper.

**Method:** Draw a dot on a piece of paper and put the paper about 75 cm in front of you on a table. Sit at the table put a hand in front of one eye and use your other hand to try and touch the dot with a pencil.

**Expected Result:** You will find it quite difficult to touch the dot accurately at the first attempt.

**Explanation:** You cannot judge distances easily with only one eye. You use both eyes to find the exact position of things.

### **Hole in the Hand**

**Equipment:** Cardboard tube.

**Method:** Using a cardboard tube (or rolled up piece of paper) look through the tube with your right eye and hold your left hand up next to the paper with the palm towards you.

**Expected Result:** You should see that there seems to be a hole through the middle of your palm.

**Explanation:** Your right eye sees inside the tube and your left eye sees your open hand. The brain is confused because it receives such different signals from each eye. So it combines the images and you appear to see a hole in your hand.

### **Fool Your Eyes**

Here are some tricks to fool your eyes so that objects appear to move when they are really still and you see objects that are not really there at all! You can also find out how a confusing background changes the shape of size of an object. (Optical illusion book)

If your eyes see two pictures very quickly, one after the other, they may not be able to tell that the picture has changed and the image will appear to move. You can only register 12 pictures a second as separate images. If the pictures appear more quickly than this, you see them as moving pictures. Films that you see at the cinema have 24 photographs (frames) every second.

### **Make Your Own Movie**

**Equipment:** Paper, pencil, small notebook.

**Method:** Using a notebook with small pages (or pages put together), on each page of the book draw one of the pictures in the sequence. It can be anything as long as each image is only slightly different from the one before. Make sure you draw on only one side of the page. When the book is complete flick the pages with your thumb.

**Expected Result:** You will see your story come to life.

**Explanation:** The pages are moving too fast for the eye to see them as separate images, so it makes them into a 'movie'.

## Rainbow Colours

Sunlight or the light from an electric light bulb appears colourless and is called 'white light'. But it is really made up of a mixture of different colours. We can only see these colours when light passes through a transparent substance (such as water or glass), which separates the colours into a rainbow pattern called a *spectrum*. A spectrum consists of seven colours - red, orange, yellow, green, blue, indigo and violet - as well as two other kinds of light (ultra-violet and infra-red), which we cannot see. You can see a spectrum in bubbles of water or in a rainbow.

## **Make a Rainbow**

**Equipment:** Mirror, bowl of water, white paper.

**Method:** On a sunny day, fill a bowl with water and rest a flat mirror against the inside. Stand the bowl so the Sunlight falls onto the mirror. Hold a sheet of white card in front of the mirror and move it around until a rainbow of colours appears on it. You may have to adjust the position of the mirror to get this just right. Once the mirror and card are in the correct position you can keep the mirror still with a little modelling clay.

**Explanation:** The 'wedge' of water between the mirror and the surface of the water acts as a prism and splits up the light so you can see the different colours. This happens because each of the colours in white light travels at a slightly different speed and is bent (refracted) inside the prism by a different amount. Violet light bends the most and red light bends the least.

If you put a magnify glass between the mirror and the card you should find that the lens bends the light so the colours come back together again and the rainbow disappears. This shows that the seven colours of the rainbow combine to make white light.

## **Colour Spinners**

**Equipment:** Card, pencil.

**Method:** Cut out a disc with a diameter of 10cm. Divide it into seven equal sections. Make each section about  $51^\circ$  wide. Colour each section with one of the colours of the spectrum. Make a small hole in the middle of the disc and push the sharp pencil through. Spin the disc quickly, what do you see?

**Expected Result:** You should see the colours disappear to make a white disc.

**Explanation:** When the circle spins quickly, your eyes cannot see each colour separately. You see only the result of mixing the different coloured light together. This is why the disc appears greyish white even though there are really seven colours on it.



