In this chapter, we will do experiments with electricity. However, we must never use mains electricity for these. Mains electricity comes at a high voltage (230 volts). It is very powerful and dangerous. Touching it can cause a severe electric shock. That is why they put danger signs near things like electric meters and transformers.

Cells and batteries

For our experiments, we will use the electric cell. It is a safe and portable source of electricity (power source). A cell gives a very small amount of electricity that is safe to handle. We usually use cells of 1.5 volts (1.5 V) for devices like remotes, clocks, toys and torches.

Look closely at an ordinary cell. The small metal cap on one side is the positive terminal (+) and is marked '+'. The flat metal disc at the other end is the negative terminal (–). It may be shown by a '–' sign. In a button (coin) cell, the larger side is positive, and is marked '+'.

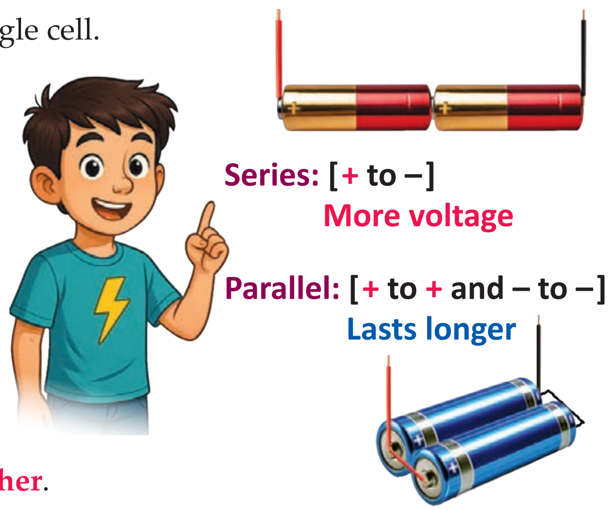
Types of cells Electric cells use chemicals that react and release electrical energy. The common cells we use are not chargeable. Once their chemicals are used up, they stop working and must be thrown away.

The cells in laptops, mobiles, vehicles, power backups, etc., are chargeable. These cells can be recharged by passing electricity through the cells. This restores the chemicals inside. These cells can be used many times.

Fig. 2.5 Different types of electric cells and batteries

Battery We often call a single cell a 'battery'. But in science, **a battery is a group of cells joined together to provide more electricity**. The 9-volt battery used in some devices is a true battery as it has small electric cells connected inside its case. Note that a mobile's power source may contain one or more cells. But it is always called a battery.

A battery of cells provides more electricity than a single cell. We can join cells in two ways: in series or in parallel.



When we connect cells **in series, we join the positive end of one cell to the negative end of the next**. This adds up the voltages of all the cells. But a common current flows through each cell. For example, two 1.5-volt cells in series give 3 volts. We use cells in series in remotes, toys, torches, portable music systems, radios, etc.

When we connect cells **in parallel, we join all the positive ends together and all the negative ends together**.

blue litmus paper and red litmus paper for testing. Blue litmus paper turns red in acidic solutions, while red litmus paper turns blue in basic solutions.

Info Flash

Lichens are plantlike organisms made up of a fungus and an alga living together in close partnership. The fungus collects water and provides protection, while the alga uses sunlight to make food. This teamwork helps them survive in places where other plants cannot.

Lichens can grow almost anywhere. They are often found on rocks, tree trunks, walls and rooftops, especially in regions with abundant rainfall and clean air. They can be of many different colours, depending on their type. Lichens are very sensitive to pollution, so if you see many lichens in an area, it is a sign that the air is clean.

Do & Discover

Let us do a simple activity and test samples using litmus paper.

- Collect samples of lemon juice, limewater, baking soda solution, amla juice, liquid detergent, soap solution, tamarind water, tap water, toothpaste, vinegar and sugar solution.
- Pour a small amount of each sample into separate test tubes and label them clearly.
- Dip one blue litmus paper and one red litmus paper into each sample. Observe any colour changes and record the results in a table.

Sample	Effect on blue litmus paper	Effect on red litmus paper
Lemon juice	Turns red	No change
Limewater	No change	Turns blue
Baking soda solution	No change	Turns blue
Amla juice	Turns red	No change
Liquid detergent	No change	Turns blue
Soap solution	No change	Turns blue
Tamarind water	Turns red	No change
Tap water	No change	No change
Toothpaste	No change	Turns blue
Vinegar	Turns red	No change
Sugar solution	No change	No change

Rainwater harvesting is a smart way to manage water. It helps us save water and protect nature, so everyone has enough water now and later. In many cities in India, all new buildings are required to harvest rainwater.

KNOWLEDGE BOOSTER

Ice stupas in Ladakh

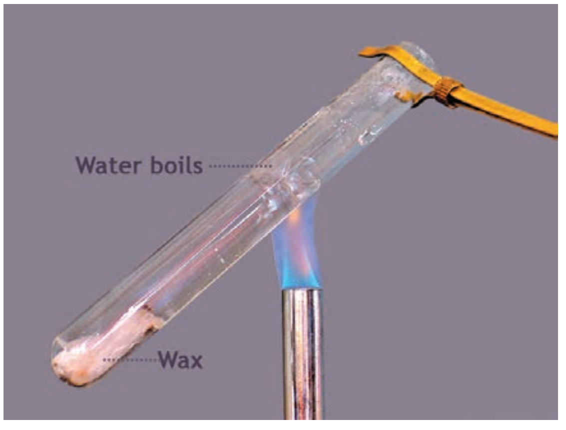
In the cold desert of Ladakh, people face severe water shortages in spring and early summer. Farmers need water to sow crops then. Most winter snow melts too early and glacier water is not available. To solve the problem of water scarcity, engineer Sonam Wangchuk introduced an artificial glacier.

The cone-shaped artificial glacier resembles a Buddhist stupa. Hence it is called an ice stupa. It is made by freezing water. In winter, water from streams flows down from higher ground through pipes. It is then made to flow up a vertical pipe. The water sprays through a nozzle into the very cold air and freezes into ice. Slowly a tall cone of ice forms around the pipe. This cone melts slowly in spring and early summer, providing water when farmers sow crops.

Left: An illustration of the set-up of an ice stupa. Right: Photograph of an ice stupa

DO & DISCOVER

1. Here is a well-known experiment to show that water is a poor conductor of heat. Put some wax or an ice cube weighed down with wire in a test tube of water. Heat the top end of the test tube. When the water at the top boils, the temperature near the bottom remains much lower. So, the wax/ice does not melt immediately.



2. Let us do an experiment during the day. Take two equal-sized plates—one made of metal and the other made of plastic or ceramic. Place same-sized ice cubes on each. Place the plates near a window. The ice cubes on the plates will start melting. The one on the metal plate will melt faster. Metal is a good conductor and gets heated faster from the surroundings than the other plate. So, heat transfer to the ice cube on it is faster.

Other examples of chemical changes

Besides combustion and rusting, many other everyday changes also involve chemical reactions that produce new substances.

Cooking food Cooking changes the texture, taste and structure of ingredients. Raw vegetables, grains and pulses become soft and flavourful after being cooked because heat causes a chemical change. For example, when you boil an egg, the heat changes its structure permanently. A cooked egg cannot be turned back into a raw one.

Curdling of milk When milk turns into curd or cottage cheese, it forms a new substance with a different taste and texture.

Charring of sugar When sugar is heated strongly, it melts, turns brown, and eventually becomes black. The black substance left behind is carbon, and the original sugar cannot be recovered.

Fig. 6.8 The boiling of eggs, charring of sugar and curdling of milk are all chemical changes.

Digestion When we eat food, our body breaks it down into simpler substances that can be absorbed and used for energy. This breakdown of food is brought about by digestive juices and the process is called digestion.

Photosynthesis It is the process by which plants prepare their own food. Using sunlight, they combine carbon dioxide and water to form the new substances glucose and oxygen.

In all these examples, the original substances are changed into entirely new substances and cannot be brought back. That is what makes them chemical changes.

Physical and Chemical Changes Can Happen Together

Sometimes, a single process can involve both physical and chemical changes. A good example of this is the burning of a candle.

C Look at the Assertion (A) and Reason (R). Say if the statements are true. If true, state if the reason correctly explains the assertion. Here are some examples.

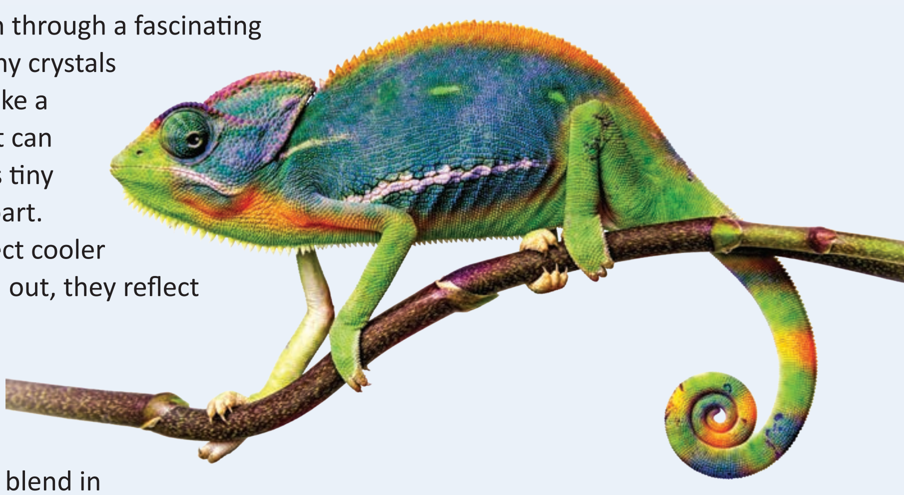
- Assertion (A) The burning of wax is a chemical change.
  Reason (R) Wax changes into vapour and burns to form new substances.
  Answer Both A and R are true, and R explains A correctly.
- Assertion (A) Iron tools left outside in the rain may get weaker over time.
  Reason (R) Rust is hard and protective.
  Answer A is true, but R is false.

1. Assertion (A) A fruit that ripens and is then cut into pieces has gone through both chemical and physical changes.
   Reason (R) Ripening is a chemical change, while cutting is a physical change.
2. Assertion (A) A substance only starts burning when it is heated to its ignition temperature.
   Reason (R) A substance can start burning even without a visible flame.
3. Assertion (A) A plant growing in a rock crack causes biological weathering.
   Reason (R) Growing roots can exert pressure and break the rock apart.
4. Assertion (A) Erosion during a landslide is an example of a chemical change.
   Reason (R) Sediments such as soil and rocks are carried from one place to another by natural forces.

GOING FURTHER

The colour-changing chameleon

Chameleons can change the colour of their skin through a fascinating combination of pigment-containing cells and tiny crystals located beneath the surface. Their skin works like a special coat lined with microscopic crystals that can shift position. You can imagine these crystals as tiny mirrors that move closer together or farther apart. When the crystals are close together, they reflect cooler colours like blue and purple. When they spread out, they reflect warmer colours such as red and yellow.



Chameleons use this colour-changing ability to express their mood, like when they are calm, excited or angry. They also change colour to match their surroundings, which helps them blend in and avoid predators. This colour-shifting skill serves both as a form of communication and a clever way to stay safe in the wild.

Because this ability is part of the chameleon's natural body function, the colour change is reversible. The skin returns to its normal state when the mood or environmental condition changes.

Nutrition in Plants

Photosynthesis is the process of making food using sunlight, water and carbon dioxide in the presence of chlorophyll. Sunlight provides the energy required to make food. Chlorophyll is the green pigment found inside leaf cells. It helps capture solar energy. Plants absorb water from the soil using their roots. This water is carried up to the leaves through special tubes. Plants also take in carbon dioxide from the air through the tiny pores called stomata (singular: stoma; it means 'mouth' in Greek) present on their leaves. During photosynthesis, plants make glucose, a simple carbohydrate. Oxygen is also produced during this process. Photosynthesis can be summarised as

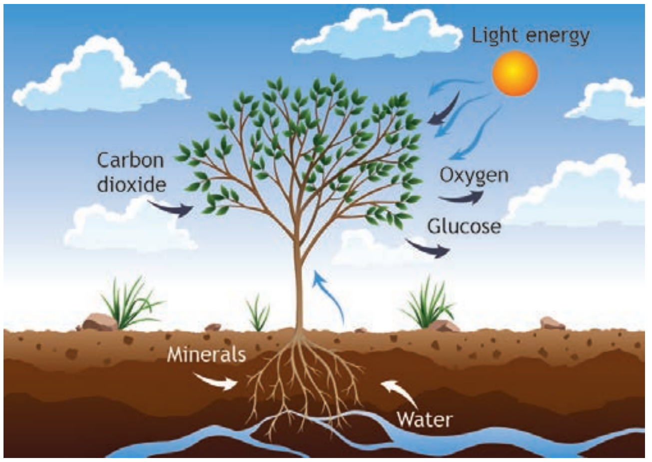


Fig. 7.2 How photosynthesis occurs

$$\text{Carbon dioxide} + \text{water} \xrightarrow[\text{chlorophyll}]{\text{sunlight}} \text{glucose} + \text{oxygen}$$

The glucose made by photosynthesis is transported from the leaves to all the other parts of the plant. Some of this glucose is immediately used by plants to produce energy. The rest is stored as starch (a complex carbohydrate) in leaves, stems, roots or seeds. When the plant needs energy later, this starch is converted back into glucose. Plants also use glucose to form important substances like proteins and fats for growth.

Usually, leaves are the main parts making food. Most leaves are broad and flat. This shape gives them a larger surface area to capture maximum sunlight. Other green parts of plants can perform photosynthesis too. For example, the green stems of cacti can carry out photosynthesis because they contain chlorophyll.

Structure of stomata

Stomata are mostly found on the underside of leaves. Green stems also have stomata. Each stoma is controlled by two guard cells. These guard cells are bean-shaped and border the opening. Stomata usually open during the day and close at night. This helps the plant control gas exchange.

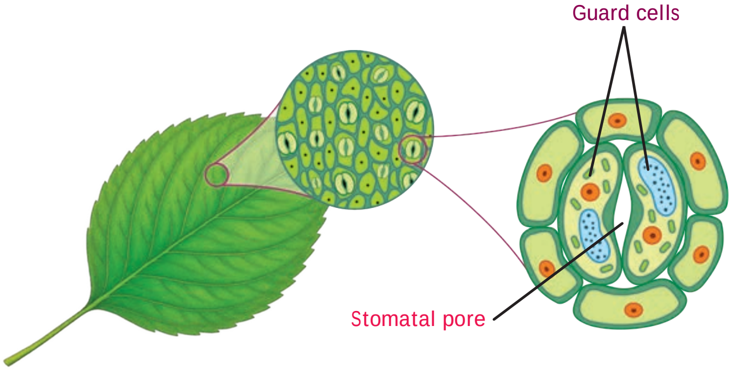


Fig. 7.3 Stomata are scattered throughout the surface of leaves. Guard cells control their opening and closing.

Info Flash

It is important to brush our teeth properly to stop harmful bacteria from growing. These bacteria grow on food stuck between the teeth. They make acids that damage the outer layer of the teeth, called enamel. This leads to cavities. We should brush gently twice a day using a soft toothbrush and toothpaste. We should also clean our tongue and rinse our mouth after meals. Drinking water after eating, and eating fewer sweets also helps keep bacteria away.

In ancient India, people used neem or babool twigs to clean their teeth. They chewed one end to make it soft, then used it like a brush. These twigs helped protect teeth and gums from germs. People also swished coconut or sesame oil in their mouths and spat it out. This made their teeth strong and healthy. Cleaning the tongue with copper, silver or wooden scrapers was common too. These old methods kept mouths healthy even before modern toothbrushes.

In the pharynx The pharynx is a short muscular tube at the back of the mouth. It connects the mouth to the oesophagus. It also connects the nose to the windpipe.

After chewing, the tongue rolls food into a ball and pushes it into the pharynx. But how does food not enter the windpipe and choke us? A small flaplike structure called the epiglottis prevents this. Every time we swallow, the epiglottis closes the windpipe. Sometimes, if the epiglottis does not close quickly enough, food or water enters the windpipe. This makes us cough and choke.

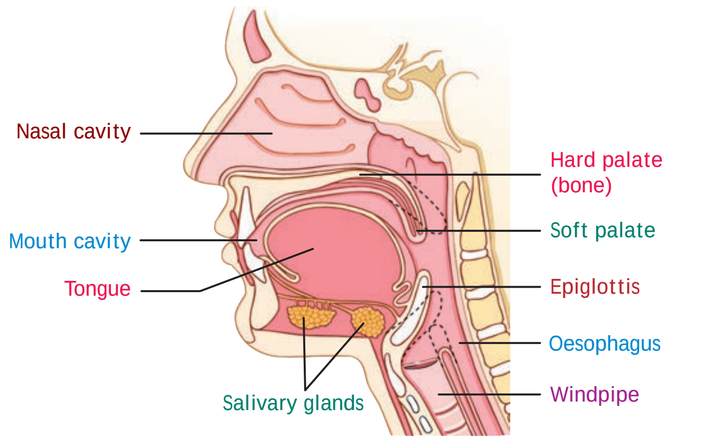


Fig. 8.3 The epiglottis closes the windpipe every time we swallow.

In the oesophagus The oesophagus is a long, muscular tube that carries food from the pharynx to the stomach. Food moves down the oesophagus by wavelike muscle movements called peristalsis. The muscles above the food ball contract and push it downwards. Then they relax, and the muscles below contract next. Peristalsis pushes the food all the way through the alimentary canal.

In the stomach The stomach is a large, J-shaped pouch. Food travels quickly from the mouth, down the pharynx and oesophagus, and into the stomach. No digestion happens in the pharynx or oesophagus.

The stomach has thick, muscular walls. Its inner lining has many tiny glands called gastric glands. These glands make gastric juice. It contains mucus, hydrochloric acid and enzymes like pepsin and

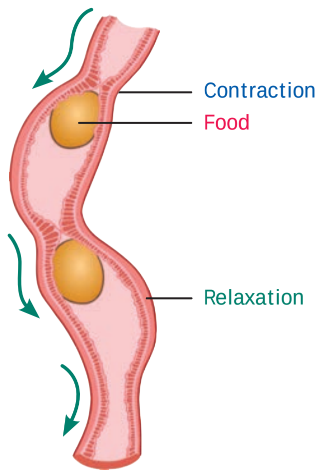


Fig. 8.4 Food is pushed down the alimentary canal by a series of contractions called peristalsis.

GOING FURTHER

You may have seen at home or at school that boys and girls are often expected to do different tasks. For example, boys may be pushed towards sports, while girls may be pushed towards creative work. A girl may be asked to help in the kitchen. A boy may be asked to repair a fuse or carry heavy bags. Parents may buy dolls for girls and toy cars for boys. These are examples of gender roles. Gender roles are the tasks that society expects men and women to do. These are not decided by nature but are taught from childhood.

Think about the different tasks in your home. Look at the table given below. Who does each task—your mother or your father? Then, ask the same questions in your class and see if the answers are the same for the boys and girls in different families.

Tasks	Performed by
Who plans and cooks the meals?	
Who takes care of younger children or the elderly?	
Who arranges for the maid?	
Who decides what groceries to buy and who goes shopping for them?	
Who calls the plumber or electrician and carries out minor repairs?	
Who books the tickets when the family goes for a holiday?	
Who decides which car, TV, smartphone or motorcycle to buy?	
Who decides what to do with the family's savings?	
Who decides the colour or type of curtains and other furnishings?	
Who manages online bill payments or banking at home?	
Who drives the car or rides the scooter most often?	
Who buys clothes for family members?	
Who teaches you how to use a phone, computer or other gadgets?	

Gender roles are also seen in jobs. Women are often linked with caring work, like nursing or teaching, while men are linked with tough jobs, like the army or police. These roles can change over time, but many families still follow them strictly.

Sometimes gender roles become linked with taboos. A taboo is a social or religious custom that says something should not be done. In the past, widow remarriage was seen as a taboo. Even today, in some places, higher education for girls or choosing a job outside the home is treated as wrong, while early marriage is treated as acceptable.

This thinking leads to child marriage. In India, the legal age for marriage is 18 for girls and 21 for boys. But many children are still married young. A girl's body is still growing and is not ready to have a baby. So, the baby may be born too small or too early and fall ill more easily. The mother may fall ill too. Early marriage often forces a girl to leave school and give up her education and career. Young couples may also not be ready mentally or have enough money to raise children.

By questioning unfair gender roles and harmful taboos and by ending child marriage, we can build a fairer society where boys and girls get equal chances to study, grow and succeed.

Of two cars moving at 36 km/h and 15 m/s, which is moving faster?

Speed of the first car = 36 km/h = $36 \times \frac{5}{18}$ m/s = 10 m/s.

Speed of the second car is 15 m/s.

The second car is moving faster.

In a long-distance race, a Kenyan runner runs at a speed of 21 km/h. He finishes the race in 2 hours. What is the distance of the race?

Distance = speed × time

Here, speed = 21 km/h and time = 2 h.

Distance = 21 km/h × 2 h = **42 km**.

The distance between two towns is 66 km. In what time will a motorcycle cover this distance at a speed of 44 km/h?

$$\text{Time} = \frac{\text{distance}}{\text{speed}} = \frac{66 \text{ km}}{44 \text{ km/h}} = \frac{3}{2} \text{ h}$$

$$= \mathbf{1\frac{1}{2} \text{ h} = 1.5 \text{ h}.}$$

A horse covers a distance of 9.8 km in 12 minutes. What was its speed in km/h?

$$\text{Distance travelled} = 9.8 \text{ km} = \frac{98}{10} \text{ km}.$$

$$\text{Time taken} = 12 \text{ min} = \frac{12}{60} \text{ h} = \frac{1}{5} \text{ h}.$$

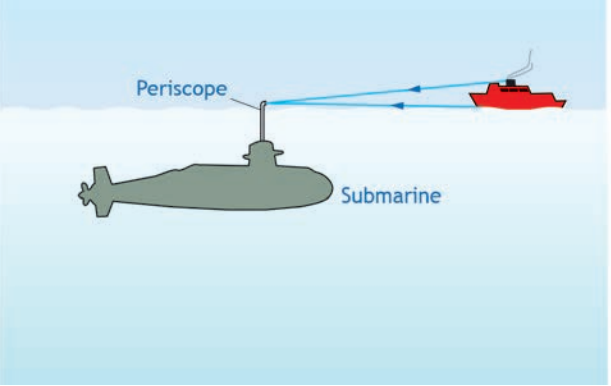
$$\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{\left(\frac{98}{10}\right) \text{km}}{\left(\frac{1}{5}\right) \text{h}} = \frac{98}{10} \times 5 \text{ km/h} = \mathbf{49 \text{ km/h}}.$$

Average speed

On a drive, watch the speedometer. The speed rises at first, then stays steady for some time, and finally drops to zero when you stop. In between, the speed may increase and decrease in traffic, and the car stops at red lights. Now, if the drive takes 30 minutes and covers 20 kilometres, what is the speed?

Fig. 10.11 Speeds at different instants of time on a speedometer

$$\text{Speed} = \frac{\text{distance}}{\text{time}} = \frac{20 \text{ km}}{\left(\frac{1}{2}\right) \text{h}} = 20 \times 2 \text{ km/h} = 40 \text{ km/h}.$$



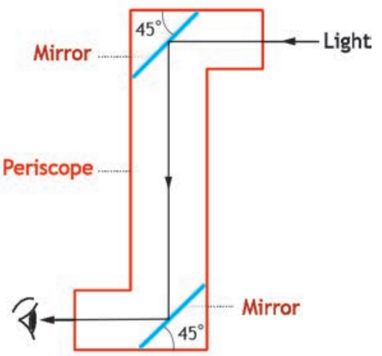


Fig. 11.26 Periscope

DO & DISCOVER

- Take a long narrow cardboard box and two small mirrors. Cut a rectangular window at the top of the box. Make another window at the bottom, on the side opposite the first window.
- On the sides next to each window, cut narrow slots at 45° facing the window. The top and bottom slots should face each other, as shown.
- Fix the mirrors in the slots. The mirrors will be parallel to each other.
- Look through a window. You will see objects in front of the other window, even those behind a wall or around a corner.

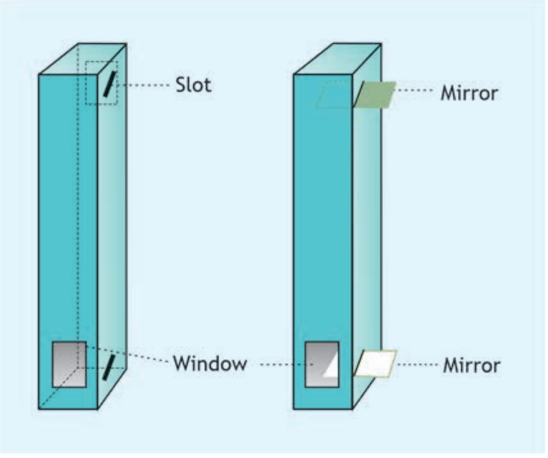


Fig. 11.27 Making a periscope

Kaleidoscope A kaleidoscope is a device based on multiple reflections. It shows endless beautiful, symmetrical patterns. It has three rectangular mirrors joined in the shape of a triangle. Small pieces of coloured transparent material are placed at one end. The mirrors reflect them many times. Each time you turn the kaleidoscope, the pieces fall into a new arrangement, and you see a fresh pattern. Designers use kaleidoscopes for ideas for fabrics, jewellery and wallpapers. Let us make one.

Kaleidoscope comes from Greek words.
kalos = beautiful
+
eidos = shape
+
skopein = to see

DO & DISCOVER

- Tape three mirrors into a triangle, with the reflecting sides facing inwards. You can use plastic mirrors.
- Make a small pouch from tracing paper or clear plastic to cover one end. Put in a few transparent or translucent beads, bits of bangles, short straws or coloured paper. Tape the pouch over one end.
- Look through the open end to see patterns that change as you rotate the mirrors.
- If you do not have transparent coloured pieces, point the taped mirrors at a colourful design on a phone or computer screen, or at a bunch of flowers. Look through the open end to see patterns created by multiple reflections.

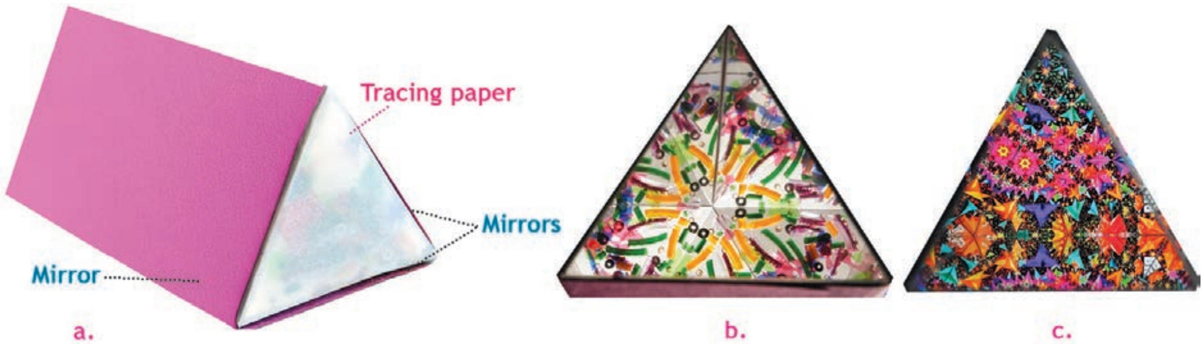


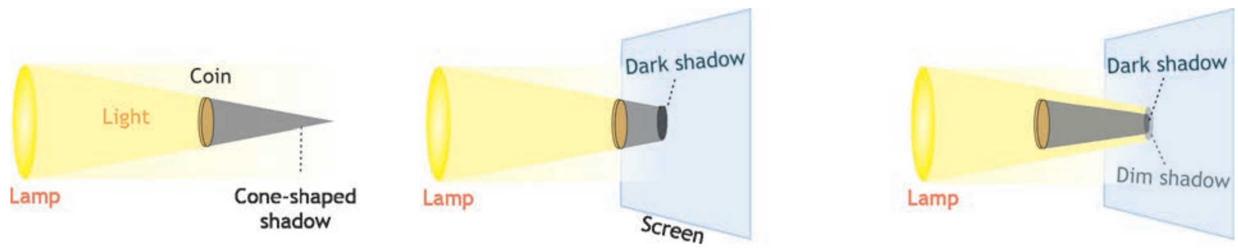
Fig. 11.28 **a.** Kaleidoscope **b.** A pattern formed by the kaleidoscope mirrors of the bits of coloured material inside **c.** A pattern formed by the three mirrors held against a design on a screen

KNOWLEDGE BOOSTER

DO & DISCOVER

- Hold a coin or bottle cap below a wall lamp. Start near the floor and slowly raise the coin. Note how the shadow dims as the coin is raised higher. Finally, the shadow on the floor disappears.

The shadow of the coin has a cone shape. When the coin is near the floor (screen), a large part of this dark cone falls on the floor, so you see a sharp dark shadow, called umbra. As the coin moves up, a smaller part of the dark cone reaches the floor. Light from the edges of the lamp also reaches the floor, so the outer part of the shadow becomes dim and fuzzy. The faint, fuzzy shadow is called penumbra. As the coin moves farther, the entire shadow becomes fuzzy and then vanishes. The same thing happens with birds and planes in flight. We see their shadow when they are near the ground. When they rise higher, the shadow on the ground becomes faint and finally disappears.



Since the fuzzy part of the shadow receives some light from the source, it will be a dark shade of the colour of the light.

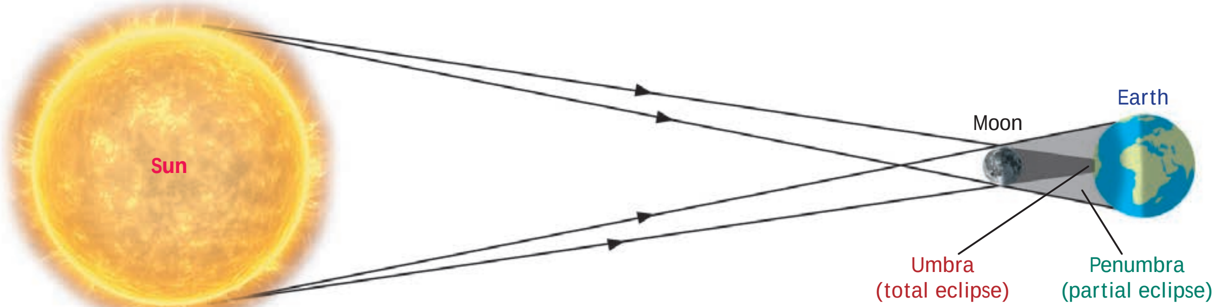


Fig. 12.15 Solar eclipse

The shadow of the moon is a cone. It has two distinct parts. The completely dark central region is called the umbra, while the lighter outer region is called the penumbra.

- In the regions of the earth where the umbra (the dark inner shadow) of the moon falls, the sun is hidden completely (totally eclipsed). People there see a total solar eclipse.
- In the regions of the earth where the penumbra (the lighter outer shadow) of the moon falls, the moon blocks only part of the sun. Some sunlight still reaches these regions. People there see a partial solar eclipse. The sun looks as if a bite has been taken out of it.

Because of the rotation of the earth and the motion of the moon, the shadow of the moon sweeps across the earth. So, any one place sees a total solar eclipse only for a few minutes.

Just before a total solar eclipse, and again as it ends, a single bright spot appears along the edge of the moon, surrounded by a faint ring of light from the sun's outer atmosphere. This phenomenon is known as the diamond ring effect. The 'diamond' is sunlight peeking through a valley between mountains on the edge of the moon.

Fig. 12.16 From left to right: total solar eclipse, diamond ring effect and partial solar eclipse

DO & DISCOVER

- Place a small ball (moon) in front of a globe (earth). Shine a torch (sun) on them from a distance.
- Watch the shadow of the ball fall on the globe. This is how the shadow of the moon falls on the earth during a solar eclipse.
- Move the ball closer, farther, or sideways; the shadow shifts and changes size, so eclipses look different from place to place and last only a short time at one place.
- What happens if the moon is raised just above the earth? Its shadow does not fall on the globe.

Fig. 12.17