# Nelson International Science

## Student Book 5

Anthony Russell

OXFORD

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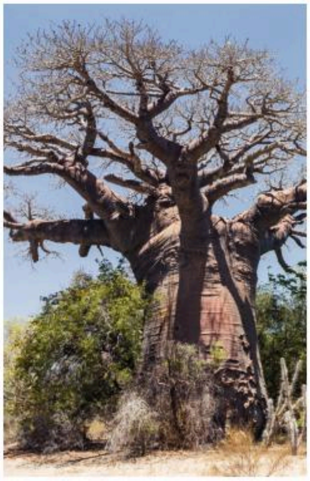
Observe Write Discuss

## Energy from light

Look at the pictures. All these plants can do something that you cannot do. In fact all the plants in the world can do it.










Plants can make their own food.

Animals cannot make their own food. Because of this, every human being and every animal depends on plants.

Without them we would die. We cannot make our own food in our bodies. We have to eat food – put it into our bodies from outside and then digest it.

In Stage 6 you will learn more about how plants support all other living things.

Plants make food for themselves by a process called **photosynthesis**.

This word is made of two parts: 'photo', which means light, and 'synthesis', which means building or putting together.

Plants 'capture' the **energy** in sunlight and store it in the sugars and **starch** that they make (build; put together). The green parts of a plant are where photosynthesis takes place.

A plant's roots, flowers, fruits and **seeds** cannot make food. They have different functions. Only the green parts have the chemical called **chlorophyll**. This is a green pigment found mostly in leaves.

Plants must have four things for photosynthesis:

light, chlorophyll, water and carbon dioxide.

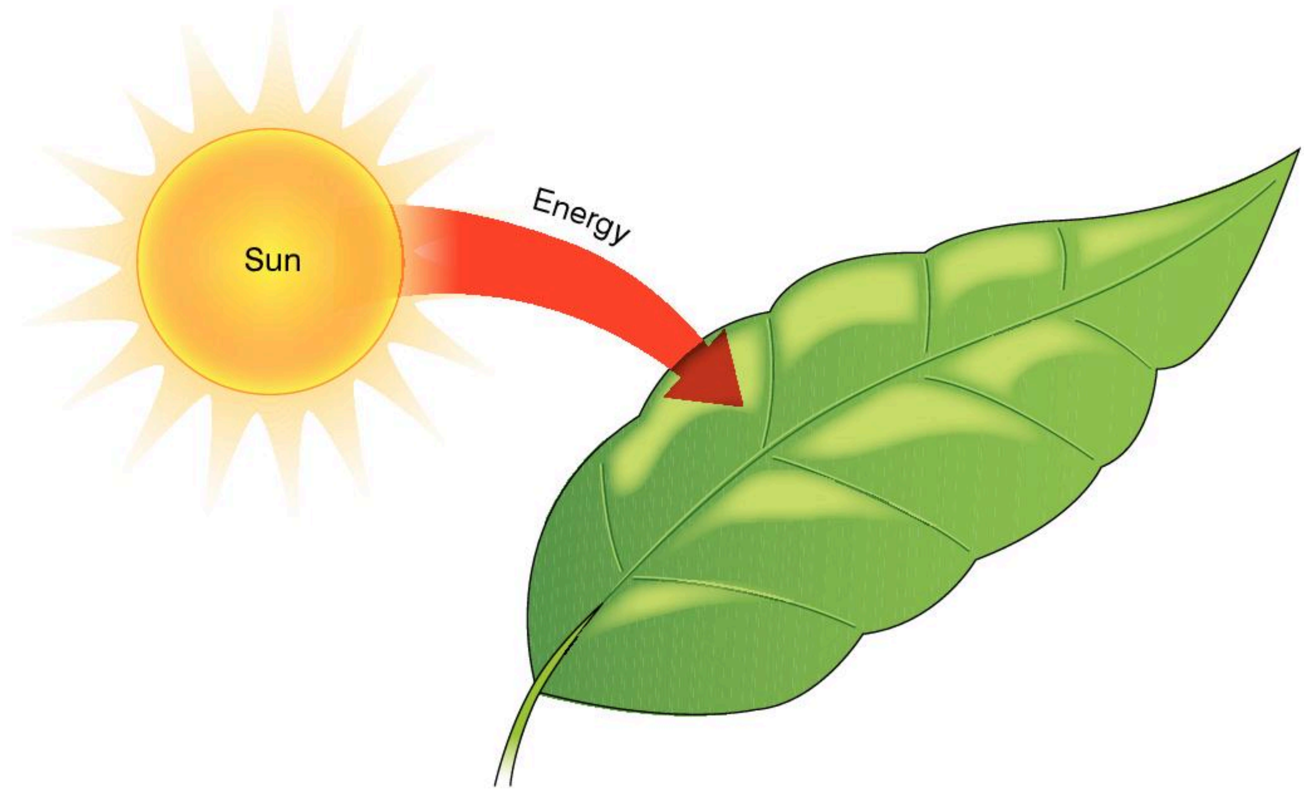
- Where do plants get water from?
- Where do plants get carbon dioxide from?
- Where do plants get light from?

Tell the class what you think.

So, plants need energy from light for their growth.

**water + carbon dioxide + light + chlorophyll → starch (food) + oxygen**

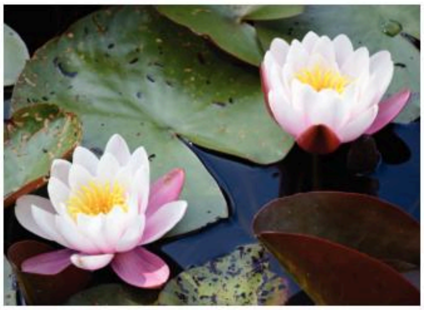
The energy that plants 'capture' is stored in the sugars and starch that they make. These are then used to feed the growing plant.



# Flowers – male and female parts

Look at the pictures of flowers and discuss their similarities and differences.

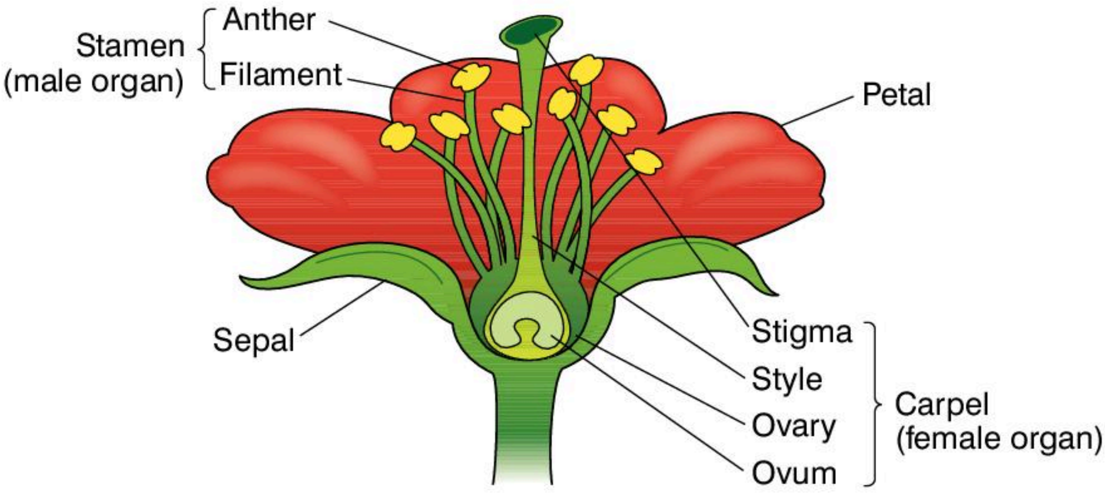
Try to answer the question: 'What are flowers for?'



***A variety of flowers***

We often think of flowers as colourful, sweet-smelling things that we can enjoy outside and in our homes. But flowers are not just for decoration – they have a very important function in the life of a flowering plant.

The pictures show that there is a huge variety of flowers, but all flowers have some basic parts. These are shown in the diagram below.



## Activity 1

**You will need:** some flowers, a hand lens, paper (or Workbook) and a pen or pencil.

1 Collect some flowers from outside.

2 In class, identify the **petals** and **sepals** of your flowers. What are the colours of the petals?

3 Use the hand lens to **observe** the small parts inside each flower.

a What parts can you see?

b Count the numbers of each part.

4 **Record** your observations in a table like this one. Include the names of the plants if you know them.

| Name of plant | Number and colour of sepals | Number and colour of petals | Number of stamens (male parts) | Number of carpels (female parts) |
|---|---|---|---|---|
| | | | | |
| | | | | |

Add a new row to the table for each plant.

**5 Choose one flower that has a large carpel or carpels.**

**a** Use a sharp blade to cut the flower in half lengthwise.

⚠ **WARNING:** Take care when using the knife.

**b** Use the hand lens to identify the **ova** inside the **ovary**.

**c** Count the ova.

**d** Make a drawing of the flower that you have cut in half. Label the following parts on your drawing:

**petal sepal stigma style ovary**
**ovum anther filament**

**6 Share your drawing and your observations with the class.**

**a** **Compare** the structure of the flowers that you looked at with the ones that other learners investigated. What is different? What is the same?

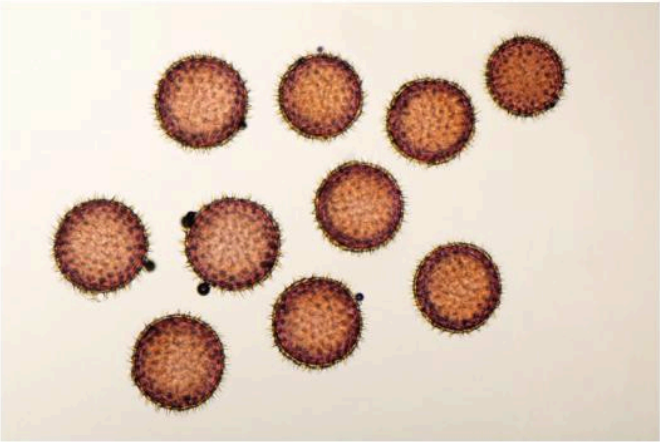
**b** Can you see any **patterns** in the observations?

**c** Share your ideas with the class.

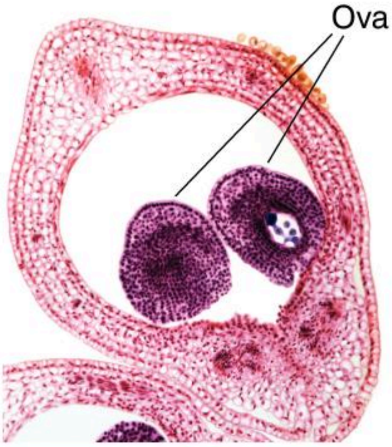
# Plant reproduction

Flowers are for **reproduction**. Plants reproduce sexually. That is why they contain the male and female organs. They produce two types of cells which must be combined to produce a new plant. These are the **sex cells**.

- The female sex cells are the ova.
- The male sex cells are the **pollen** grains.



*Pollen grains*




*Ova*

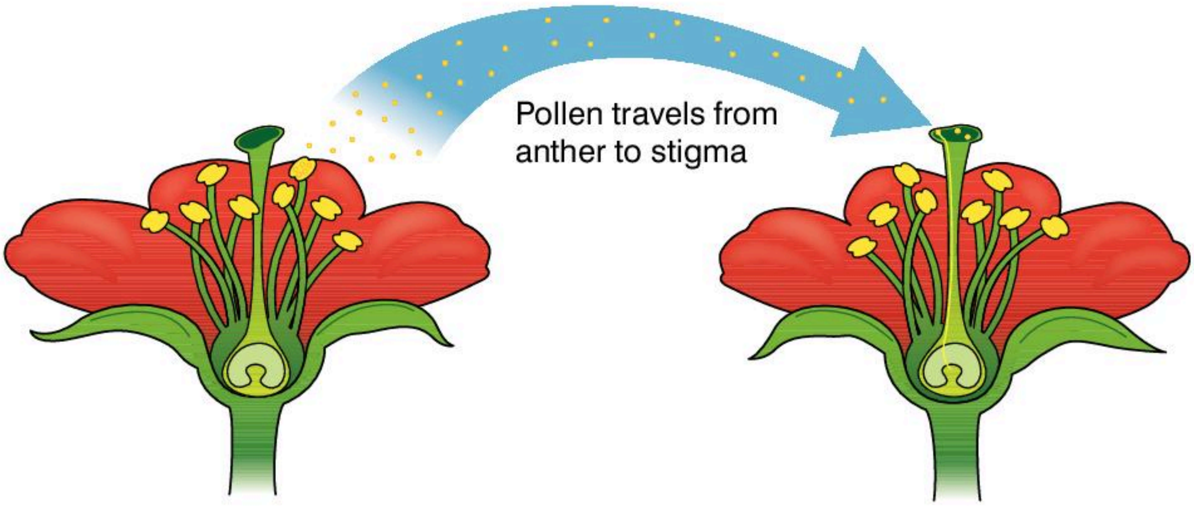
- The female sex cells are made and stored in the ovary.
- The male sex cells are made and released from the **anthers**.

Plant reproduction can happen only when the pollen and the ova are brought together and **fuse**. This fusion of the two sex cells is called **fertilisation**.

The result of the fusion is a seed. Each seed can then become a new plant, if it is given the things it needs to grow. This is how plants reproduce – make new plants.

The shape, colour, size and scent of the flowers are all designed to increase the chance of success in making seeds.

The process of moving the pollen from the anthers to the **stigma** is called **pollination**.




*The process of pollination*

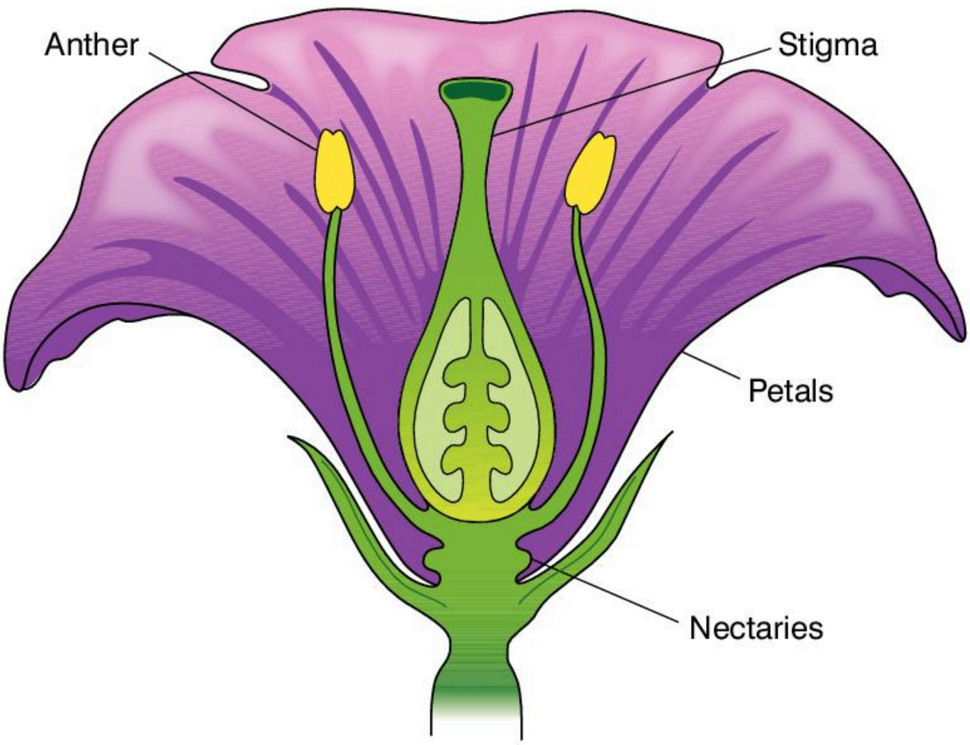
Flowers can be pollinated in different ways.

# Insect pollination

Some plants depend on insects to carry pollen from their anthers to their stigmas, or to the stigmas of other flowers. This is called **insect pollination**.

Their flowers are adapted to attract insects to them. Their flowers are often colourful, large and have attractive scents.

A **nectary** is found at the base of the petals in some flowers. This makes a sweet sugary **liquid** called **nectar** that some insects like to feed on.




The insects push their way into the flowers to reach the nectar. As they do this, they brush past the anthers and stigmas. This shakes pollen out of the anthers and some lands on the sticky surface of the stigmas.

Some pollen grains also stick to the hairs on the body and legs of the insects. When they fly off, they carry the pollen with them to the next flower, and so it is spread around.

Some insects, such as bees, also collect pollen for food. These insects pollinate the flowers by accident. They do not visit flowers to help the plants reproduce. They go to the flowers for food.

Examples of insect-pollinated flowers are:

- coffee
- cotton
- sunflowers
- beans
- hibiscus.

# Seed dispersal

When the flower is pollinated and the ova are fertilised, seeds develop inside the ovary.

When seeds are scattered or spread out away from the parent plants, this is called seed **dispersal**.

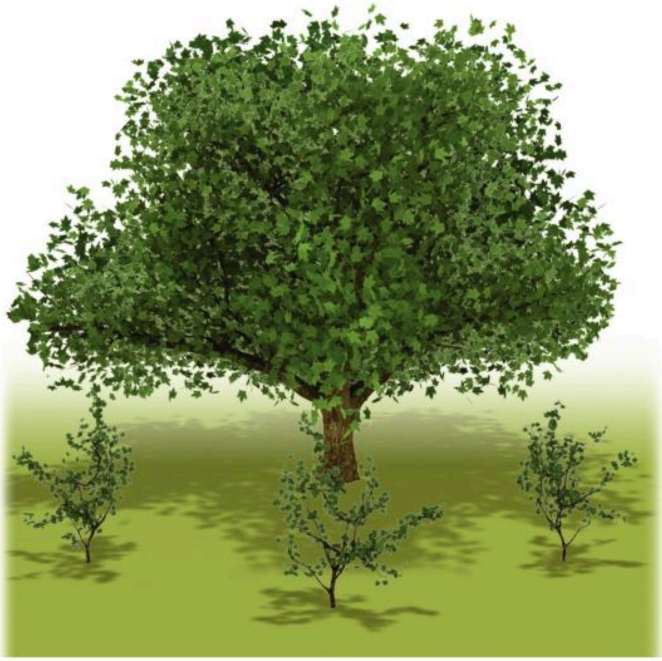
Plants, like all living things, compete for the things they need in order to grow and develop. Sort out the jumbled words below to identify the things that plants need:

**ria   thilg   slamreni   traew**

If a plant's seeds are not dispersed, they will all be competing with one another for these vital things, and with the parent plant. The parent plant has the advantage because it is already big and has a fully developed root system.

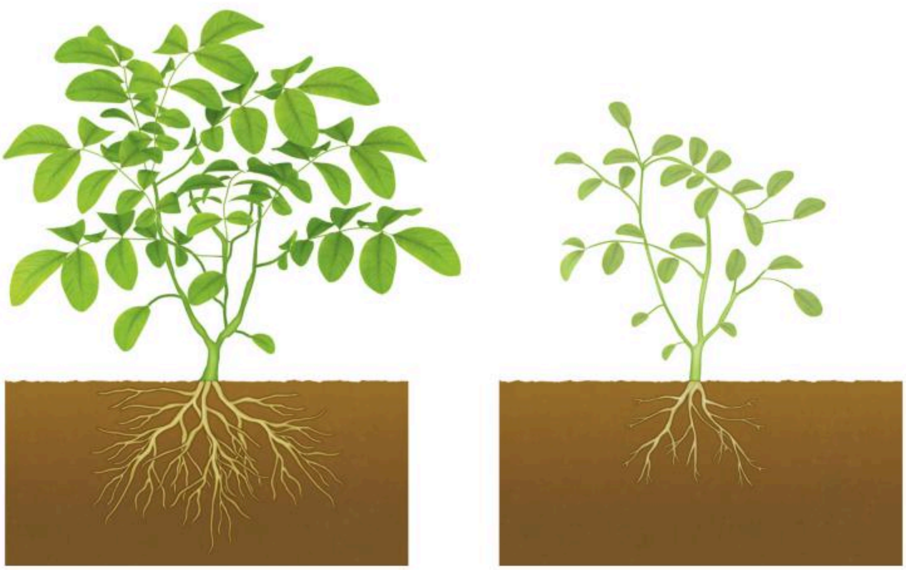
Dispersed seeds are much less likely to be overcrowded. So they stand a better chance of getting what they need in order to grow and develop into strong new plants.

Look at the two large plants shown in the picture at the top of page 13 and work out which one has dispersed its seeds. What are the disadvantages of *not* dispersing the seeds? Use the pictures to help you discuss your ideas.



*What are the advantages of seed dispersal?*

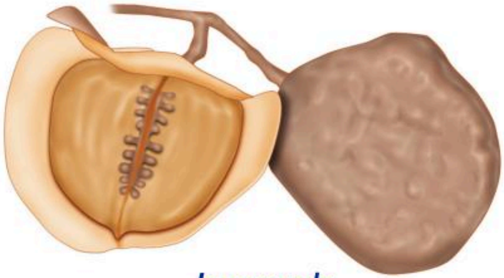
Look at the picture below. Which seedling was overcrowded during its growth? How can you tell?



*The forms of seed dispersal*

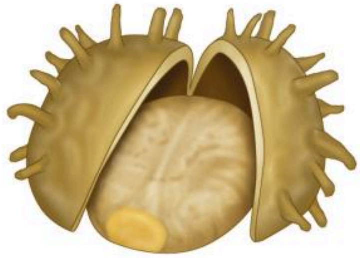
The fruits and seeds shown in the picture are all dispersed in different ways.

*Coconut*



*Jacaranda*

*Cowpea fruit*



*Castor oil fruit*

*Mango*

*Tree peony seeds*

*Orange*

*Seeds are dispersed in different ways*

Try to match the methods of dispersal listed here to the pictures:

**birds water wind hairy animals animals exploding fruit**

Copy and complete these sentences using these words:

**throws juicy hard cowpea droppings eat long seeds ground coconut mango jacaranda animals hooked eaten wind fur digestive**

a ________ fruits such as orange and ________ are dispersed by ___________, which ____ them.

b The ________ are either discarded or ________ with the fruit, which passes through the ______________ system unharmed. They fall to the _________ with the ______________ of the animal.

c The ______ fruit of the ______________ and other plants are carried away by the ______.

d _________ and sticky fruits become attached to the ____ of animals and are carried away from the parent plant.

e The fruit of the ___________ floats in water and can travel ______ distances.

f The wall of the _________ fruit splits open and _________ the seeds out, away from the plant.

## Activity 2

**You will need:** some fruits and seeds, a hand lens, paper (or Workbook) and a pen or pencil.

**1** **Go outside and look for fruits and seeds. Collect four different kinds and return to class.**

**2** **Use the hand lens to observe the fruits and seeds closely.**

**a** Look for clues about how the seeds are dispersed.

**b** Think about their shapes and textures. Are they spiked, hooked, juicy, winged, or feathery and light?

**3** **Make large drawings of the seeds and fruits.**

**a** Name them if you can.

**b** Label the features that you think are connected with seed dispersal.

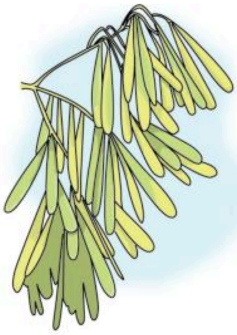
**4** **Display your drawings.**

**a** Look at those from other learners.

**b** Sort them into groups – one for each method of dispersal.

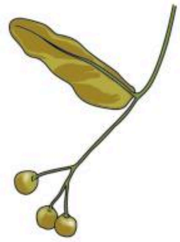
*Wind dispersal*

Wind is a very useful method of dispersal because it can lift and carry seeds far away from the parent plant. Of course, many seeds are blown away to places where they cannot **germinate** or survive, but some land in fertile places where they can get all the things they need in order to grow.

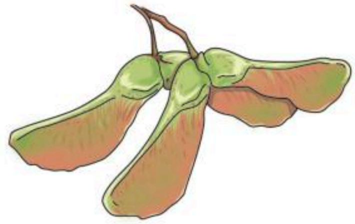


*Ash*

*Elm*



*Lime*

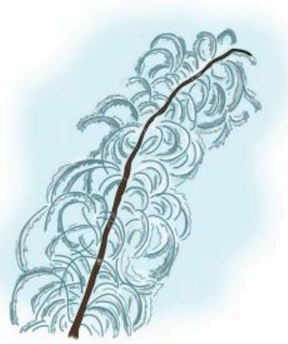


*Sycamore*

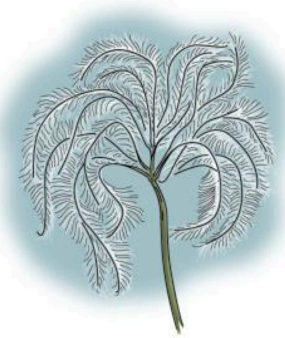
*Tecoma*

*Plane seeds*

*Silk cotton tree*



*Willowherb seeds*



*Clematis seeds*

*Dandelion seeds*

*Thistle seeds*

*Some seeds that are dispersed by wind*

*Dispersal by birds and other animals*

Birds, like the wind, can carry seeds over large distances.

Some seeds are sticky and birds rub their beaks against trees or rocks to remove them.

Others are embedded in juicy berries and other fruits that birds eat. The seeds are not digested. They pass through the bird and are left randomly in the bird's droppings.

Other animals, such as elephants, eat fruits and deposit the seeds from the fruit with their droppings.

In all these cases, the droppings are a good source of **nutrients** for the developing seedlings.

*Seedlings growing in elephant dung*

Hooked, spiky and sticky seeds can also stick to the hairy skins of many animals. As the animals move about from place to place, the seeds are rubbed off and land away from the parent plants.

*Exploding fruit*

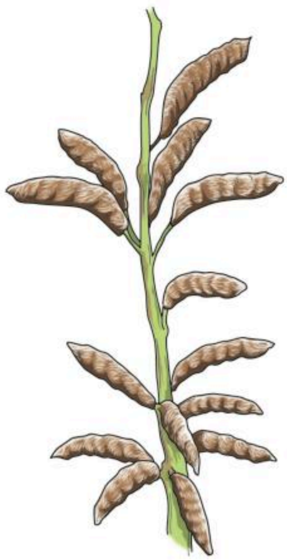
Some fruits explode by twisting or bursting as they dry out. This throws the seeds away from the parent plant, increasing their chances of survival.

***Cowpea***

***Gorse***

***Hura crepitans***

***Impatiens capensis***



***Lupin***

***Some seeds that are dispersed by exploding fruits***

## *Water dispersal*

***Box fruit***

***Mucuna***

***Coconut***

***Some seeds that are dispersed by water***

The sea and rivers have enormous potential to carry seeds away from parent plants.

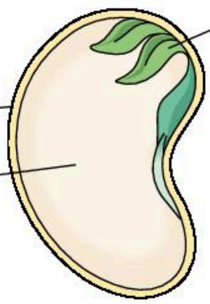
The fruits or seeds carried in this way must float, otherwise they would not be carried by the water. They often have large amounts of air-filled spaces inside to make them buoyant. The coconut is one example.

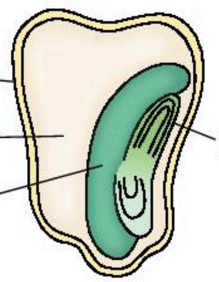
# Seed germination

**Germination** changes a seed into a seedling.

When a plant makes a seed it is **dormant**. This means that it is not growing. A germinating seed is active. The **embryo plant** is growing, using the stored food in the seed to expand its root, shoot and the first leaves, to form a seedling.

What do you think the seed needs to 'wake up' and germinate?




## Activity 3: Investigating the conditions necessary for seed germination

**You will need:** some seeds, paper (or Workbook) and a pen or pencil.

**1** **Discuss with your group what conditions you think are necessary for seeds to germinate.**

a Make a list of all the **factors** that you think are essential.

b Share the list with the class.

Continue over the page

**2** **Choose which factors your group will investigate.**

**a** Discuss how you can do a **fair test** to investigate the effect of the factors on seed germination.

**b** **Predict** what you think will happen, and write down your prediction.

**3** **Make a plan of how the investigation will be done. Show the plan to your teacher.**

**4** **Collect the equipment you need and set up the test carefully. Label any containers you use so that they do not get mixed up.**

**5** **Set up the test and put the containers with the seeds in a safe place where they will not be disturbed.**

**6** **Observe the seeds.**

**a** Keep a **record** of your observations each day for seven days.

**b** After seven days, share your **results** with the class.

**7** **Compare what has happened to the seeds in each container.**

**8 Continue with the test until no more seeds are germinating in your containers.**

a Discuss with your group what you think this experiment has shown.

b Draw your **conclusions** based on the data you have collected.

> **Remember** to use the knowledge you gained from your previous experience.

c Compare the outcomes with your predictions.

**9 Share your conclusions with the class.**

a Answer any questions that other learners want to ask.

b Listen to what other groups have found from their investigations. Ask them questions if their **explanations** are not clear.

**10 Write down your own list of conclusions about the conditions essential for germination.**

Here is the list of the conditions that are essential for germination, but they are mixed up with some non-essential conditions. Sort out these words and compare them with your own list:

**treaw liso ria tramwh glith odof**

Light is needed by plants to make food in their leaves.

Seeds do *not* need light to make food – they have food stored in them. This is enough for them to germinate.

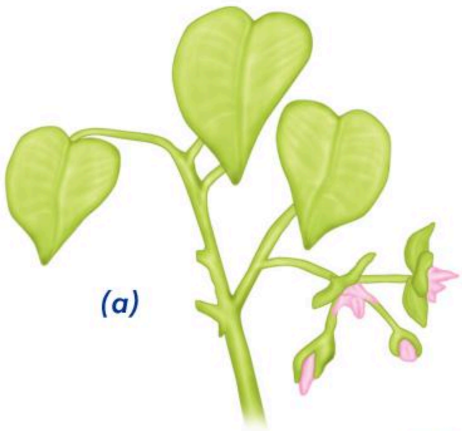
The food stored in the seed is very dry and it cannot move around the seed. Before it can be used by the seed to germinate it must dissolve. This is why seeds need water for germination.

The **solid** food in the seed dissolves in the water and becomes a **solution**, which can then travel to the dormant (not active) embryo plant.

Life processes, including growth, are affected by **temperature**. Low temperatures slow down growth. Warmth speeds up the processes of growth. That is why temperature is a factor in seed germination.

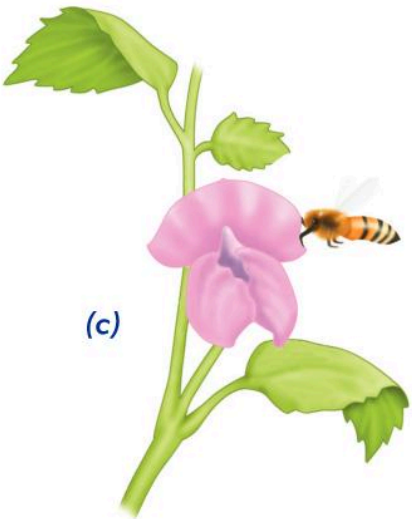
# Life cycle of flowering plants

Here are the stages of the **life cycle** of a bean plant. They are not in the right order and the pictures are not matched with the names of the stages.



*(a)*

*(b)*



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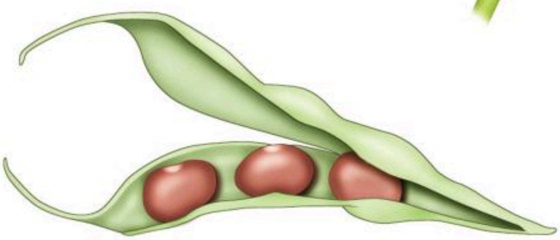

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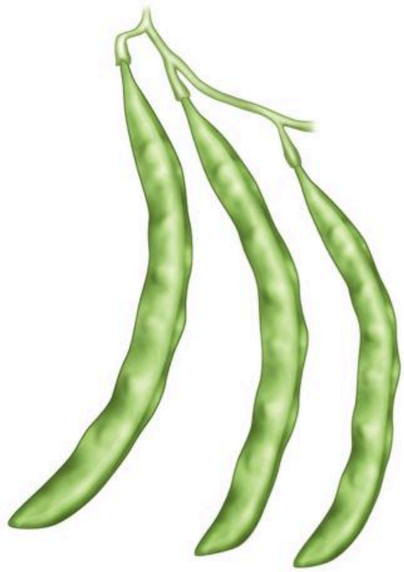


*(e)*

| | |
|---|---|
| Pollination | Seed production |
| Seed dispersal | Germination |

Flowering bean plant

## Activity 4

**You will need:** paper (or Workbook) and a pen or pencil.

1. Look at the pictures on page 25 and the stages. Match the stages to the pictures.

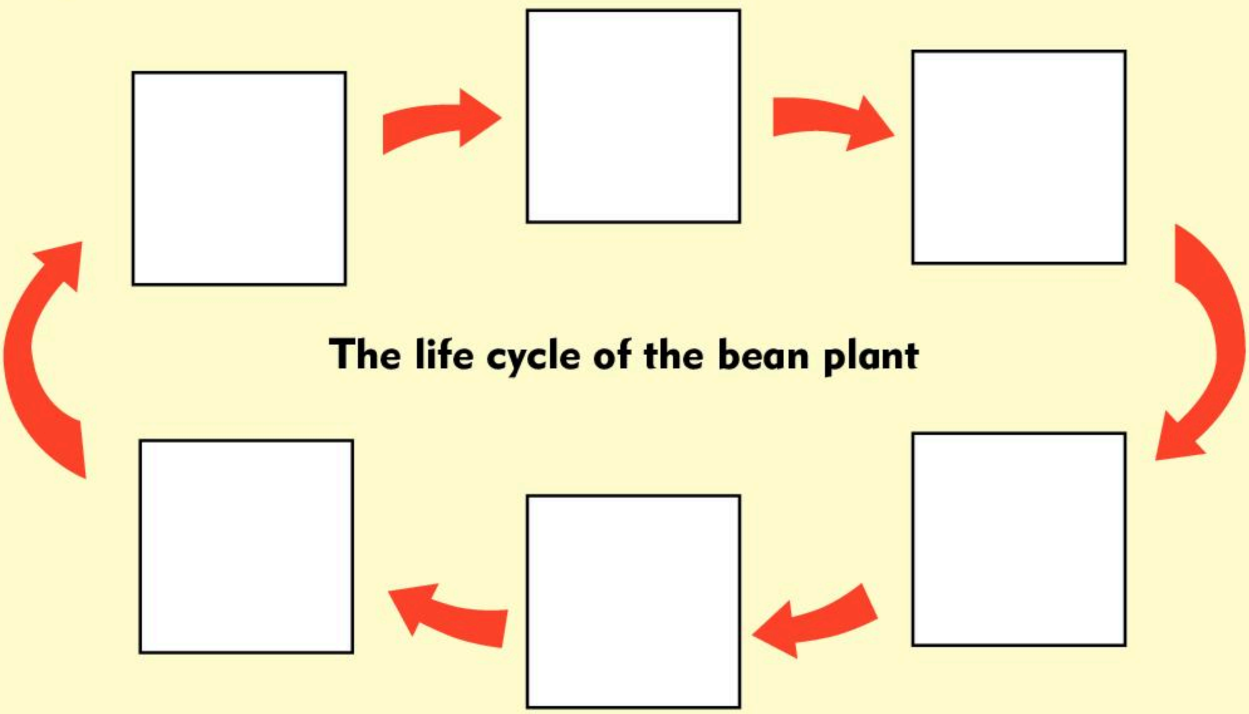
2. Now order the stages of the life cycle of the bean plant correctly.

_______________ _______________

_______________ _______________

_______________

3. Write your cycle in a diagram like this:




4. Share your diagram with the class.

The life cycle of a flowering plant depends on the parent plant's ability to reproduce itself by producing seeds. These seeds can then germinate, growing into new plants and starting the cycle all over again.

Copy and complete the sentences below using these words (you might need to use some words more than once):

**change pollen parents life cycle bean beginning order seeds same ovum stages end**

1 Plants grow and __________ as they get older. This is called development.
2 The plants go through different __________ in their development.
3 These __________ fit together, from the _______________ to the _____ of the life.
4 The stages go in an ________. All of them together form the ______ ________ of the plant.
5 New plants are made by ____________. This is called reproduction.
6 Two types of sex cells are needed. One is the __________ and the other is the ______.
7 New plants become like their ____________ but are never exactly the ______.
8 Male and female bean flower parts produce new ______ plants by making ________.

## Evaporation

Discuss with your group what you remember from Stage 4 about how matter can change from a solid into a liquid, and from a liquid into a gas. Evaporation occurs when a liquid turns into a gas.

### Activity 1: Investigating what affects the rate of evaporation

**You will need:** a small piece of fabric, a plastic bag, a spoon, some water, paper (or Workbook) and a pen or pencil.

**1** **Go outside into the sunshine. Do the following things.**

- **a** Soak a small piece of fabric in water and hang it up in the Sun.
- **b** Pour about a spoonful of water onto a plate, a plastic bag, or any other waterproof surface, and leave it out in the Sun.
- **c** Wet your hands with water. Keep one hand curled up in a fist. Open the other hand and spread your fingers. Stand in the Sun.

**2** **Observe what happens in the three situations. Note what you observe.**

**3** **When no more changes are happening, go back to the classroom and share your results with the class.**

**4** **Compare the three situations. Try to explain what you have observed.**

Look at the pictures. What is happening in all of these situations?

Discuss your ideas with other learners.

Water exists in three forms or states:

- water (a liquid)
- **water vapour** (a gas)
- ice (a solid)

It can be changed from one state to another quite easily. When wet things – for example, your skin, dishes, fabrics or puddles – become dry, the liquid water has changed into the gas called water vapour.

This process of changing from liquid to gas is called evaporation.

The water vapour is invisible, so the liquid seems to just 'disappear' into the air. Evaporation happens to all liquids, not only to water.

Copy and complete the sentences below using these words (you might need to use some words more than once):

**shade liquid Sun dry dries skin faster gas hot**

1 Puddles of water ____ up in the ____. They dry faster when the day is ____.
2 Washing _______ faster in the ____ than in the _______.
3 My _____ dries ________ when the ____ warms it.
4 If I put my bucket of water in the Sun, it _______ up.
5 You can change ________ water into ____ by heating it.

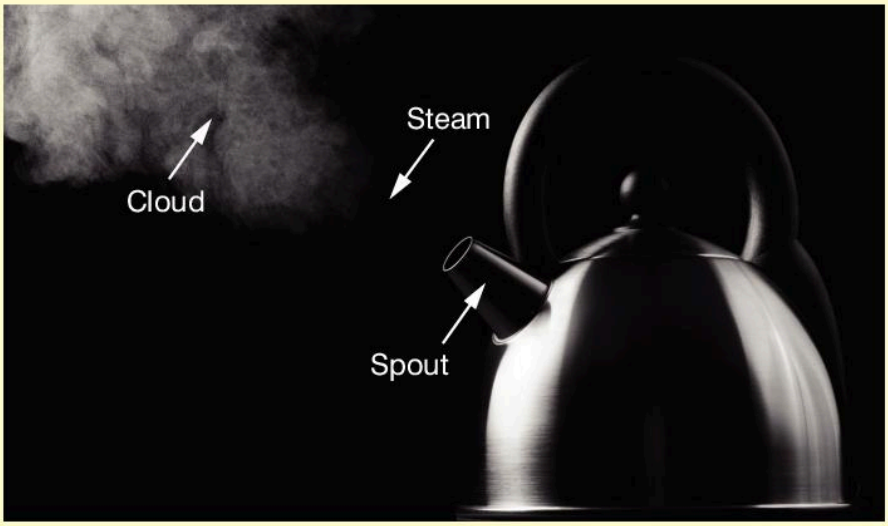
# Condensation

Discuss with your group what you remember from Stage 4 about the process of **condensation**. Can you remember when it happens?

## Activity 2: Observing water changing its state

**You will need:** a kettle, a cold plate, a cloth, a bowl, paper (or Workbook) and a pen or pencil.

Your teacher will use the kettle and plate to demonstrate another process.




**WARNING**: Take care when the water boils not to get too close, or to put your hand near.

**1** Look carefully at the spout of the kettle and see if you can observe the 'gap' between the cloud and the spout.

**Remember**, the 'gap' is the invisible **steam** – the product of **boiling** water.

Continue over the page

**2** **Now look at the cloud.**

**a** What do you think it is – gas or liquid?

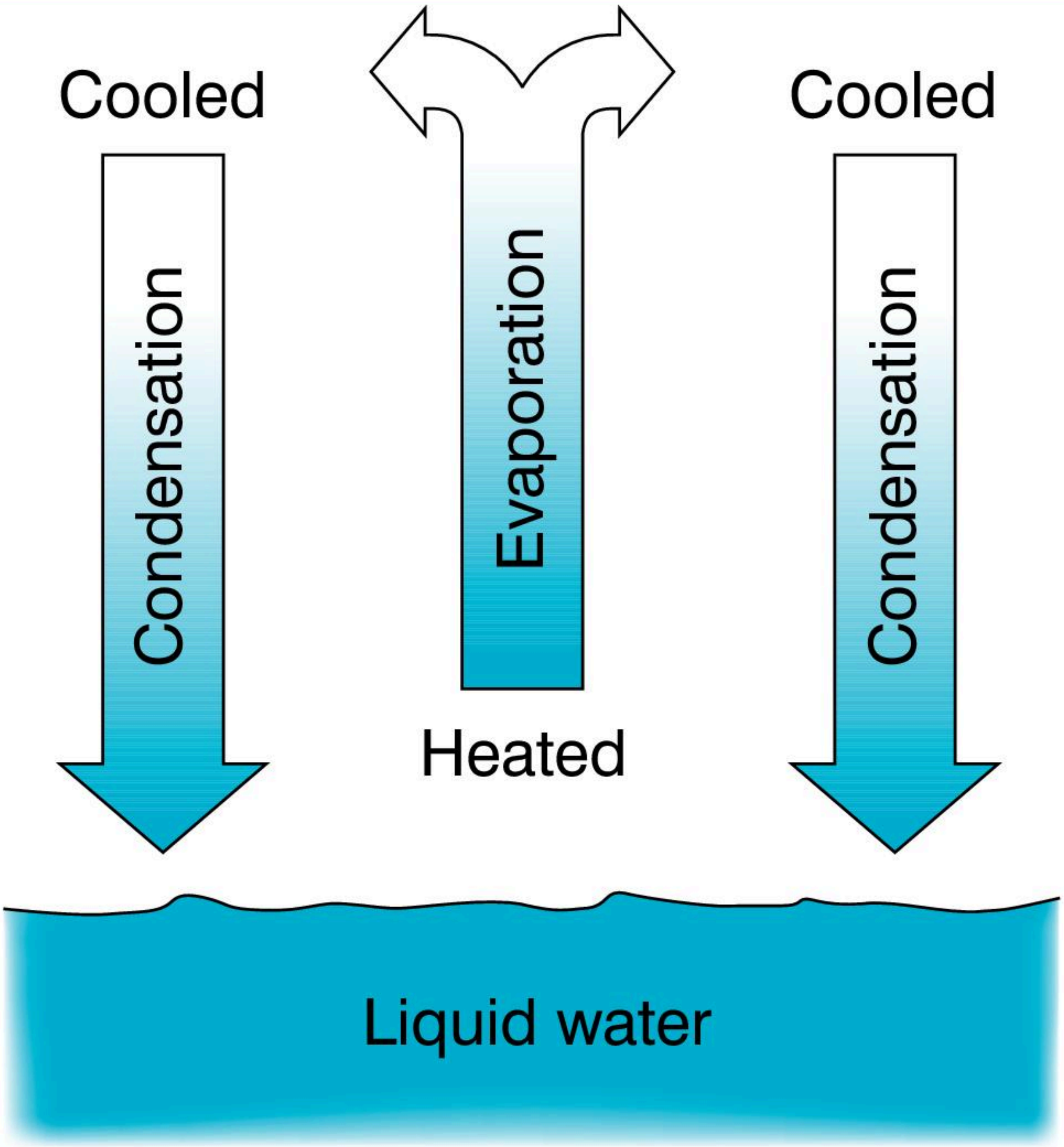
**b** Tell the class what you think.

**3** **Watch carefully as your teacher holds the cold plate with the cloth, and puts it into the invisible steam. The bowl is standing below the point where the plate is being held.**

**a** What do you observe on the plate?

**b** What do you observe in the bowl?

**4** **Try to explain your observations to the class.**

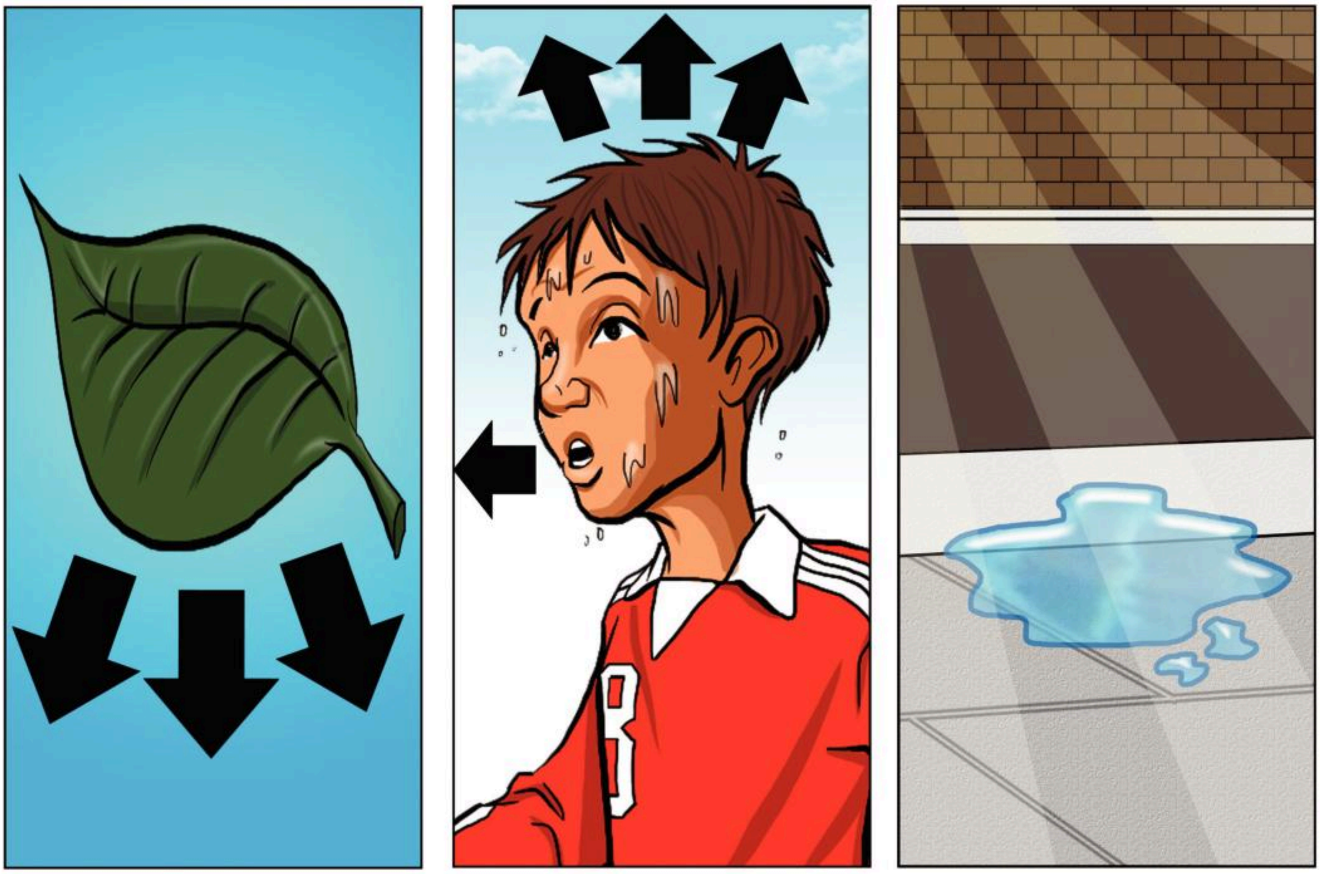



Look at the diagram. It shows the two processes that change liquid water into water vapour (evaporation) and water vapour back into liquid water (condensation).

Discuss with other learners what causes liquid water to evaporate and water vapour to condense.

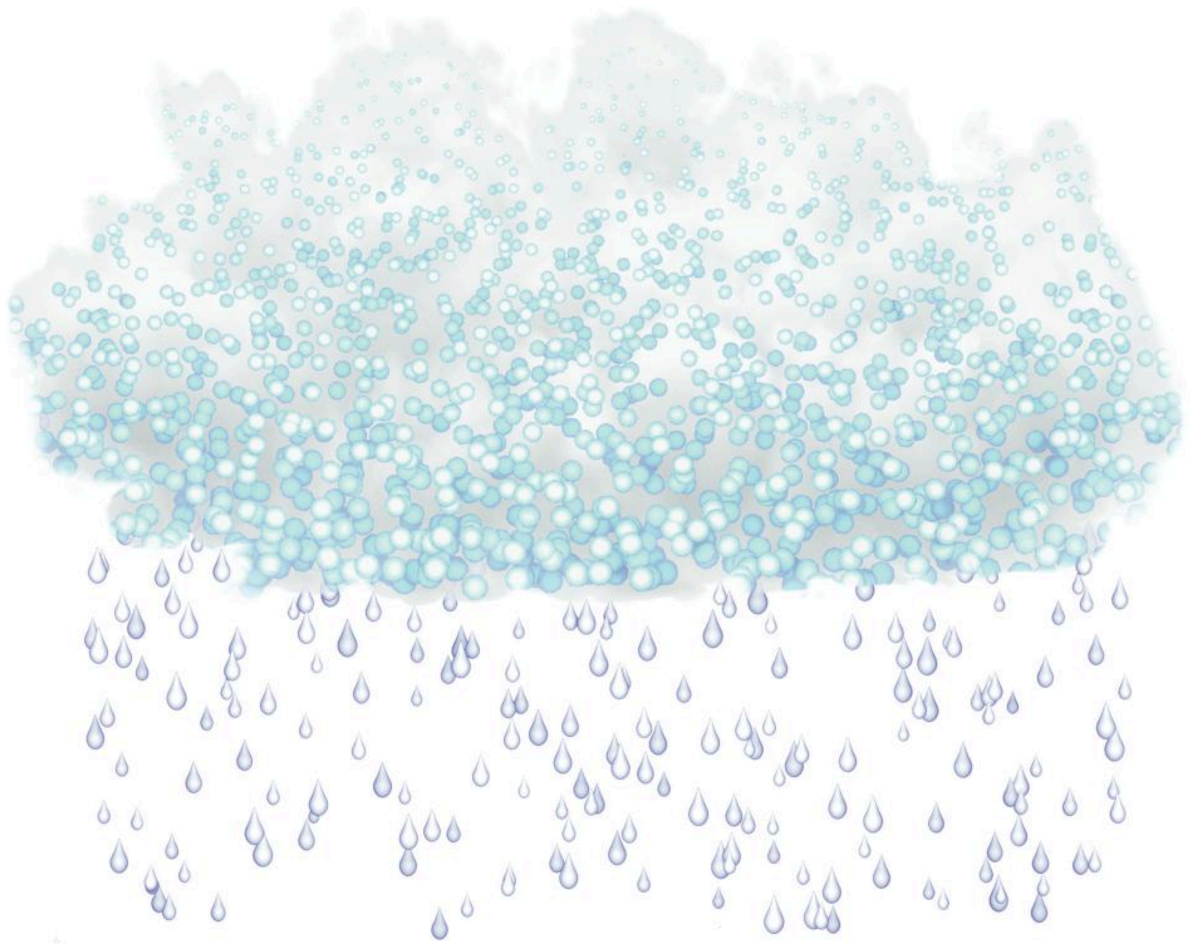
What did you conclude? Share your group's conclusions with the class.

# Water vapour in the air



Water on the Earth's surface – for example, in oceans, rivers, reservoirs or puddles – is heated by the Sun. This heating changes it into water vapour, which goes up into the air.

Plants, washing, your skin – in fact everything wet – loses water when it is heated. Invisible water vapour leaves our skin all the time as sweat, and it leaves our lungs as we breathe.



As air goes higher and higher above the Earth, it gets colder and colder. This is why the invisible water vapour condenses and forms visible clouds high up in the sky. These clouds are made of billions of tiny drops of liquid water.

Look at the pictures. Each one shows what happens when water vapour – an invisible gas – is cooled down.

In picture (a), the water vapour in the warm air touches the cold window. The water vapour is cooled and changes back into liquid water. It forms tiny drops of water on the glass as it condenses.

*(a)*

*(b)*

In picture (b), the water vapour in the warm air touches the cold can. The water vapour is cooled and changes back into liquid water as it condenses.

Now try to explain the clouds in picture (c). Tell the class what you think.



*(c)*

## Activity 3: Investigating the boiling point of water

**You will need:** a metal container, a heat source, a thermometer, some water, paper (or Workbook) and a pen or pencil.

⚠ **WARNING**: Take care when using the heat source and working with boiling water. Ask an adult to help you.

**1 Set up a container of water above a heat source.**

**a** Put a thermometer into the water.

**b** Read the temperature and record it in a table like this:

| Time | Temperature (°degrees Celsius) |
|---|---|
| 9.25 | 20 |
| 9.27 | |
| | |

Add a new row to the table each time you read the temperature of the water.

Continue over the page

2 Read the thermometer regularly and record the time and the temperature each time in the table.

3 When the water is boiling, read the thermometer VERY CAREFULLY and record the temperature.

4 Write down what the investigation has shown you about the **boiling point** of water.

5 Share your conclusion with the class.

## The melting point of ice

Investigating the **melting point** of ice can be difficult, as it depends on having a freezer in school, or some other source of ice. If this is not available at school, you might be able to do this activity at home.

### Activity 4: What temperature does ice begin to melt at?

**You will need:** a thermometer, some ice cubes, paper (or Workbook) and a pen or pencil.

1. **Measure the temperature of the ice cube with the thermometer before you start warming it. Record your reading.**
2. **Observe the process of melting.**
   - a Record the temperature when the melting begins.
   - b Repeat the temperature readings every minute and record them.
   - c When the cube has melted completely, stop the temperature **measurements**.
3. **Write down what this investigation has shown you about the melting point of ice.**
4. **Share the results of your investigation with the class.**

Water boils and turns to steam at 100 degrees Centigrade (Celsius) (100 °C).

Ice melts at 0 degrees Centigrade (Celsius) (0 °C).

# Evaporation of solutions

In Stage 2 you explored how some materials dissolved in water. The solid material 'disappeared' into the water and became a solution. This is the name given to this kind of liquid and solid mixture.

Will it be possible to separate the two parts of the solution?

Discuss this question and think of ways of doing it.

Share your ideas with the class.

## Activity 5: Investigating how you can get a solid back out of a solution

**You will need:** a solution, paper (or Workbook) and a pen or pencil.

**1** **Choose a solution to work with. Plan how to separate the solid from the solution:**

**a** in a slow way

**b** in a faster way.

**2** **Write down what your group will do. Plan your investigation in detail.**

**3** **When your plan is complete, show it to your teacher.**

**4** **Make a prediction of which method will be faster, and write it down.**

**5** Collect the things you need to make a solution and make enough for repeating your methods three times each.


**6** Carry out your plan for the fast method and observe what happens. Record your observations in drawings and text as you go along.

**WARNING**: Take care when using the heat source and working with boiling water. Ask an adult to help you.

Continue over the page

**7** **When you have a clear result, repeat the method another two times in exactly the same way. Observe and record what happens each time.**

**8** **Now carry out the slow method. It might be possible to do all three at the same time. Observe and record what happens each time, as you did for the first method.**

**9** **Look at your results.**

**a** Discuss your results with your group.

**b** Write down your group's conclusion and share it with the class.

**10** **Compare your methods with the methods used by other groups.**

**a** Which one was the fastest?

**b** Why? Try to explain your answer.

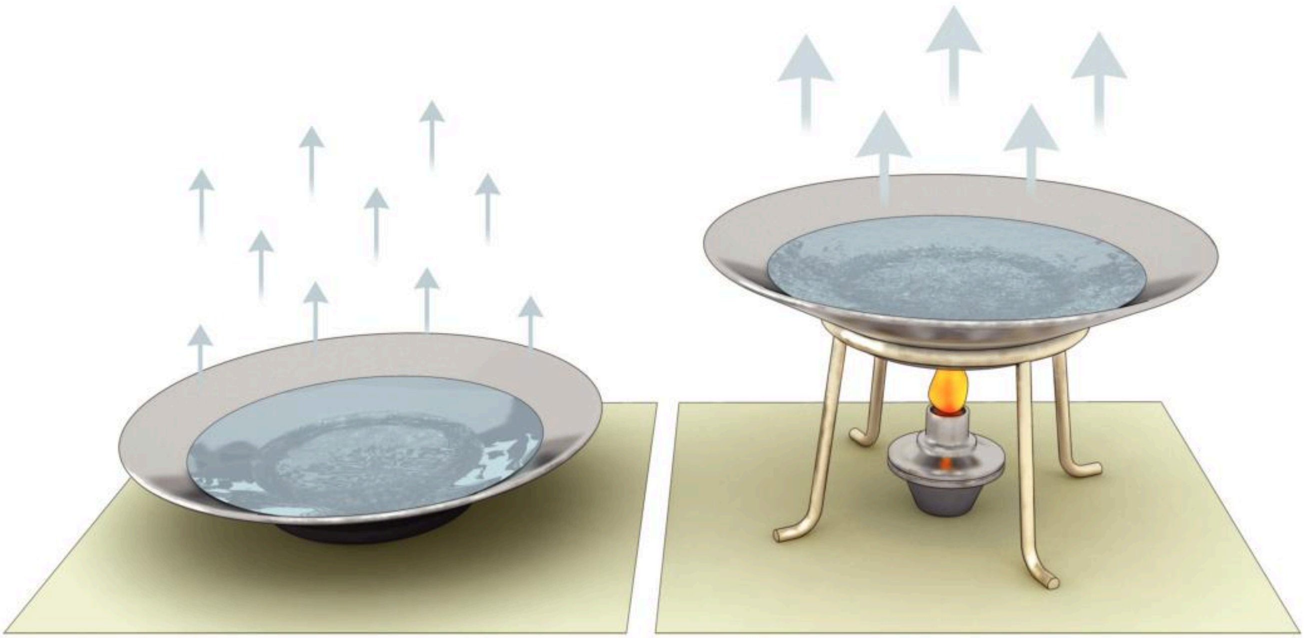
Evaporation of the liquid from the solution leaves the solid material behind.

This shows that the solid was 'hidden' inside the liquid and had not gone away. Removing the liquid by evaporation allowed you to get the solid back in its original form.

The **rate of evaporation** depends on temperature: the greater the heat, the faster the rate of evaporation.

One slow method of evaporation is to use just the heat of the Sun to remove the liquid. This works, but it might take a long time, especially if there is a large **volume** of solution.

Faster methods use some form of heater – for example, a candle, a spirit lamp, a gas burner or a stove. The liquid boils and evaporates much faster, leaving the solid material behind.



*(a) Slow evaporation from a shallow dish standing in the Sun*

*(b) Fast evaporation from a heated crucible*

## Shadow formation

Think back to Stage 2 and discuss in a group what you can remember about investigating **shadows**.

### Activity 1: Investigating shadows

**You will need:** a camera, a ruler, paper (or Workbook) and a pen or pencil.

1. Go outside on a sunny day and look at shadows. Notice their size and direction.
2. Look at your own shadow and change it to create different shapes. Make at least three different shadow shapes.
3. Share your shapes with the class and look at the shapes made by other learners.
4. Try to lose your shadow – make it disappear somehow. When you have done this, share your method with the class. Observe the methods used by others.

**5 Back in class, discuss with your group what you have observed outside.**

**a** Try to answer the question: how are shadows formed?

**b** Share your group's ideas with the class.

Continue over the page

**6** **Plan how you can test your ideas of shadow formation using a torch and a number of objects.**

**a** Make it a fair test. Think about what conditions of the test must be made the same for each object.

**b** Show your plan to your teacher.

**7** **Decide what observations you will make and how you will record them.**

**8** **Carry out your test and record what happens.**

**9** **Look at the results for the different objects.**

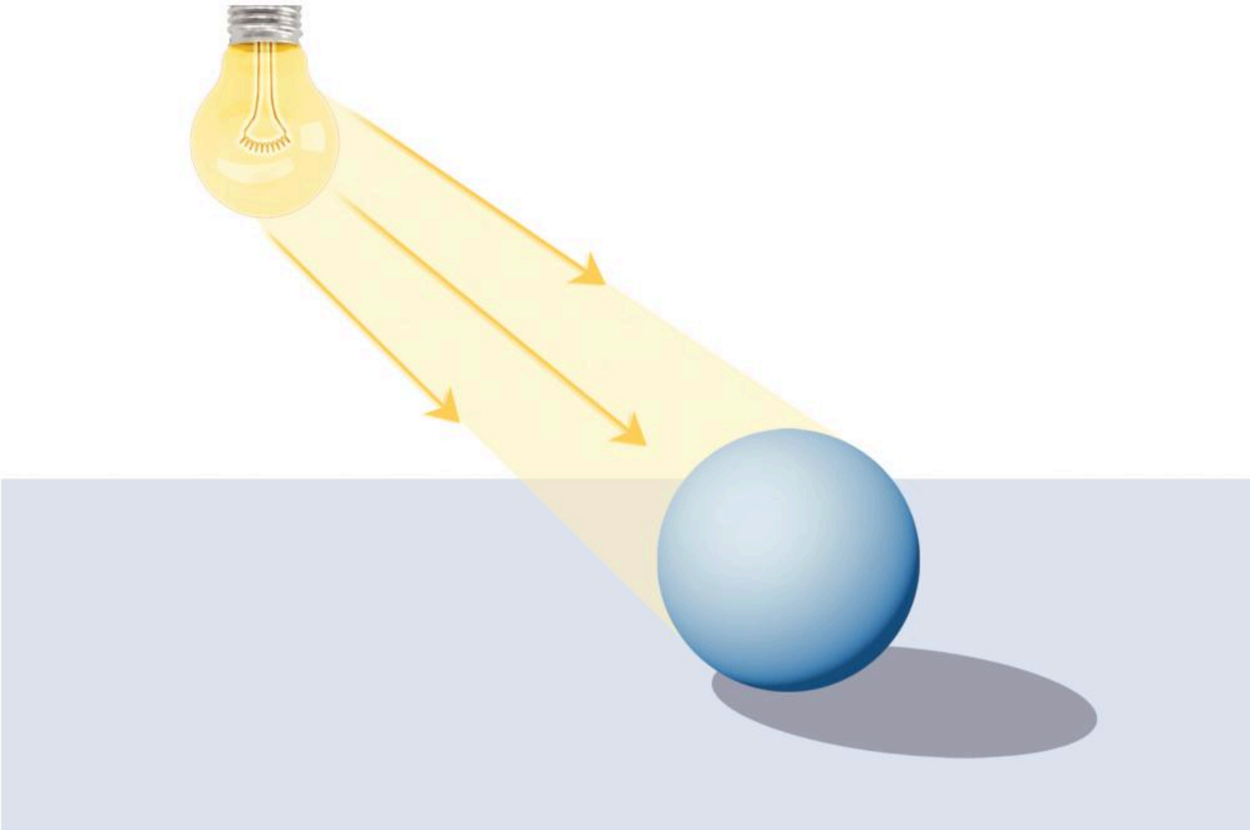
**a** Compare them to find any patterns.

**b** Try to make a **generalisation** based on the **evidence** you collected.

**10** **Share your results and conclusion with the class. Listen to others.**

You will have seen that there is a pattern in shadow formation.

- A source of light is needed.
- An object is needed that does not allow the light to pass through it completely (either **translucent** or **opaque**).
- The shadow of the object forms on the opposite side from the light source.





## Activity 2: Changing shadow size

**You will need:** a torch, some different-sized objects, paper (or Workbook) and a pen or pencil.

1. Using the torch, try to change the size of the shadow around one of the objects.

2. As you make a different-sized shadow, draw round it to record its size. You can use sheets of A3 or A2 paper to do this and stick sheets together if you need to.

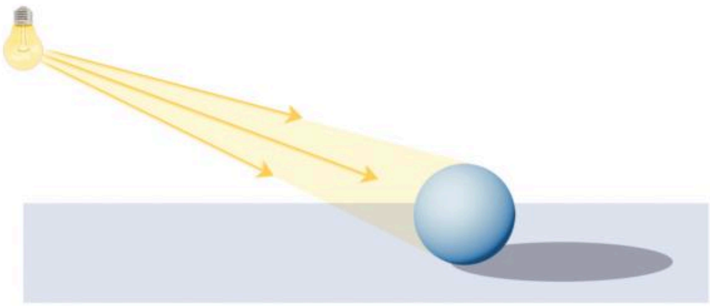
   Try to change the size at least three times: the biggest possible, the smallest possible and one in between.

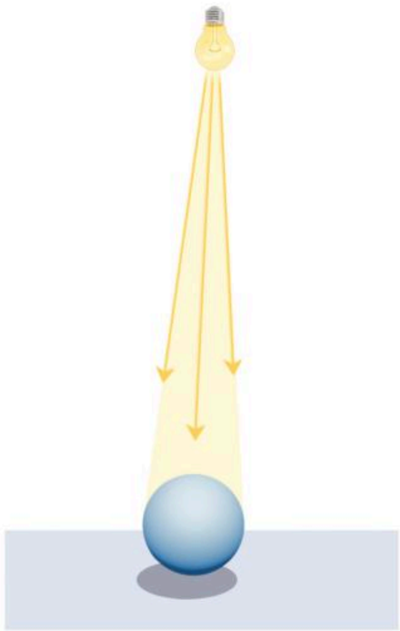
3. Repeat the process with at least two objects of different sizes and shapes.

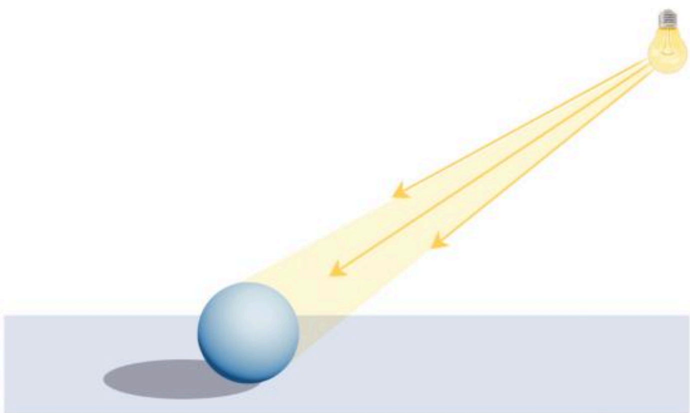
**4 Share your drawings with the class.**

a Discuss what you have all observed.

b Try to make a general statement about what controls shadow sizes.







Look at the drawings of light source and objects and shadows. The light source is the same distance from the object in each case, but the shadows are not the same length. Complete the sentences:

The lower the light source, the _________ the shadow.

The _________ the light source, the shorter the shadow.

## Activity 3: Changing shadow length

**You will need:** a torch, some different sized objects, paper (or Workbook) and a pen or pencil.

**1** **Play with the torch and one object against a sheet of paper to act as a screen where you can observe the shadow.**

**a** Predict what will happen to the shadow length as you change the distance of the object from the torch.

**b** Write down your predictions.

**2** **Observe what happens to the shadow on the screen when the light source (torch) and the screen stay in the same position, but the object is moved further and further from the light source.**

**3** **Draw the shadows on the screen when the object is in at least five different positions (five different distances from the torch).**

**a** Measure the distance each time.

**b** Measure the shadow size each time.

**c** Record the measurements in a table like this one.

| Observation | Distance from source (cm) | Length of shadow (cm) |
|---|---|---|
| 1 | | |
| 2 | | |
| 3 | | |
| 4 | | |
| 5 | | |

**4 Discuss your results with your group.**

a Compare your results with your predictions.

b Present your results as a **line graph**.

c Try to reach a conclusion and make a generalised statement about shadow length and distance from the light source.

**5 Share your group's ideas and graph with the class. Look at the graphs of other groups and listen to their ideas.**

Copy and complete these sentences using these words (you may need to use some more than once):

| | | | | |
|---|---|---|---|---|
| **shadow** | **object** | **shorter** | **light** | **longer** |
| **close** | **further** | **source** | | |

a When the _________ is ________ to the ________ source, the shadow is _________.

b The _________ is ___________ when the object is ___________ from the light _________.

c The closer the _________ is to the light source, the _________ the _________.

## Activity 4: Investigating the changes in shadows throughout a day

**You will need:** a ruler, some graph paper; paper (or Workbook) and a pen or pencil.

**1 Plan the investigation.**

a Write down your group's ideas, including any measurements you will make and how you will record them.

b Think about how to make it a fair test. Think about what conditions of the test must be made the same for each object.

c Show your plan to your teacher.

**2 Collect the items you need and start the investigation as early in the day as you can. Make the first measurement and record it in a table. Use the table headings listed here:**

| Time of day | Object | Shadow 1 | Shadow 2 |
|---|---|---|---|

**3 Repeat the measurements throughout the day for as long as possible.**

**Remember** to record the measurements as you collect them.

a What must you be careful to keep the same?

b What two features of the shadows should you be recording?

**4** **When all the measurements are finished, look at the results.**

a Discuss with your group what they tell you about changes in shadows over the day.

b Copy and complete these sentences:

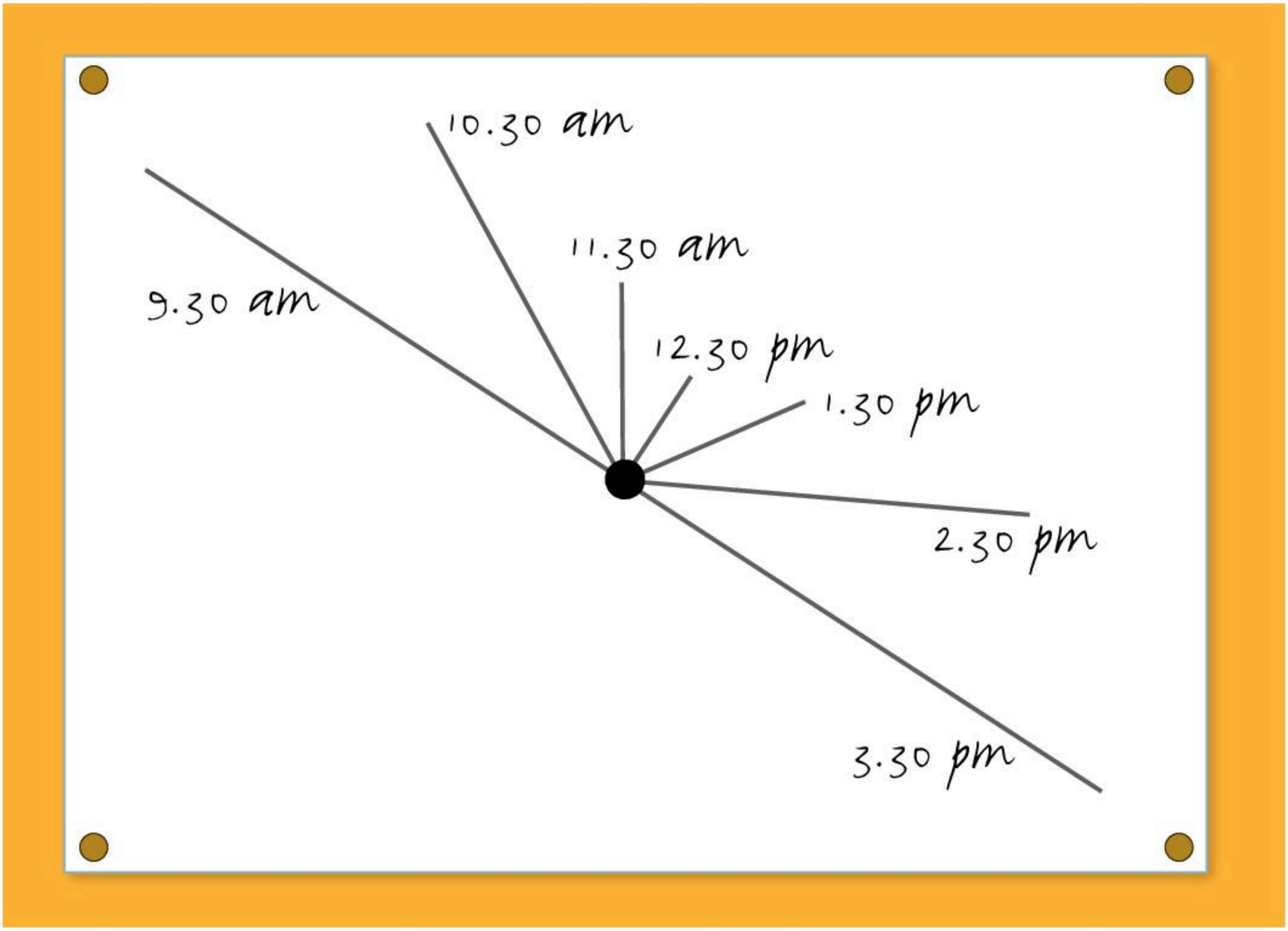
i *As the day goes by, the length of the shadow ________________.*

ii *The other change is the ________________.*

c Share your answers with the class.

**5** **Use the length measurements to draw a bar chart on graph paper, showing the changes over the time you made your observations.**

**6** **Display your chart and the record you made of the directions/positions of the shadows over the day.**




*One group's record of their shadow observations*

The shadow is long early in the day and it points in the direction of one edge of the record sheet – away from the Sun. As the day goes by, the shadow gets shorter and shorter, and its direction changes.

After noon, the shadow begins to get longer again and it points more and more away from its first position.

At the end of the observation, the shadow length matches what it was at the start and it is pointing to the opposite edge of the record sheet.

*A scene at different times of the day.*

# Measuring light intensity




*Light meters*

Look at the photographs of **light meters**.

A light meter can be inside a machine such as a camera, or it can be a separate item. A photographer uses one to check on the **intensity** of light before taking a photograph. The meter has a cell inside that reacts to light and produces an electric current. This current produces the movement of the pointer on the dial, or the appearance of the numerals on the screen.

## Activity 5

**You will need:** a light meter, paper (or Workbook) and a pen or pencil.

**1** **Handle the light meter and become familiar with how to use it and to read it.**

**2** **Draw a table like this one to record your readings of light intensity in different places.**

| **Place** | **Prediction** | **Meter readings** | | | | | **Average readings** |
|---|---|---|---|---|---|---|---|
| Under a tree | | | | | | | |
| In the classroom | | | | | | | |
| | | | | | | | |
| | | | | | | | |
| | | | | | | | |

**a** Write down the places in the first column of the table. Try to choose places where you predict the light intensity will be very different.

**b** Write down your predictions of where you expect the light intensity to be *highest* and *lowest* in the second column.

Continue over the page

**3 Take the light readings. Take several in each place.**

a Think about why you need to take several readings in the same place.

b Record the readings in your table.

**4 When you have finished taking the readings, work out the average for each place. Write the averages in your table.**

a Compare your averages with your predictions.

b Come to a conclusion about the readings you made.

**5 Share your results and conclusions with the class.**

a Discuss what you have all learned about light intensity readings.

b Try to make a generalised statement about light intensity and meter readings.

Sort out this jumbled sentence:

**reading greater higher the the the the**
**the the light of on meter intensity**

Share your answer with the class.

# Opaque and transparent materials

Some materials allow a lot of light to pass through them, so that we can see objects clearly on the other side. These materials are called **transparent**.

Other materials allow some light to pass through. They change the light so that objects on the other side are not clear. These materials are called translucent.

Materials that do not allow any light to pass through them are called opaque.

## Activity 6: Exploring opaque and transparent materials

**You will need:** some different materials, paper (or Workbook) and a pen or pencil.

**1** Plan an investigation with your group, to explore transparent and opaque materials.

Continue over the page

**2 Choose a variety of materials for your investigation.**

a Write down the names of the materials you have chosen.

b Now write down your predictions about how the materials will behave when you try to pass light through them.

**3 Plan what you will do. Make sure it is a fair test, by doing the same to each material. Show your plan to your teacher.**

**4 Test each material one by one.**

a Record your results in a table like this one.

| Material | Transparent | Opaque | Translucent |
|---|---|---|---|
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |
| | | | |

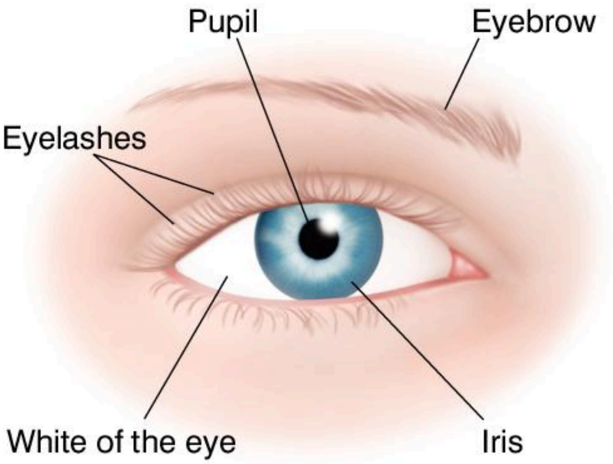
b Identify each material as transparent or opaque (or translucent).

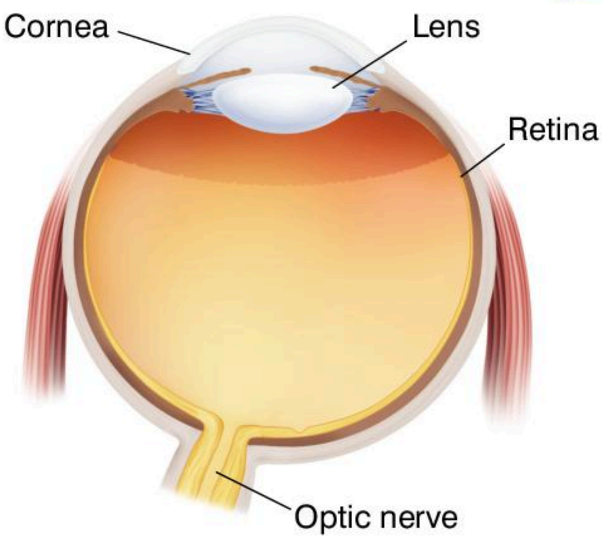
c Write these words in your table and compare the results of your test with your predictions.

**5 Share your results with the class.**

Glass, some plastics, some fabrics, some liquids and some papers are transparent. Most materials are opaque.

# Light and the eyes




The front of the eye is covered with a transparent **cornea**, which bulges out slightly.

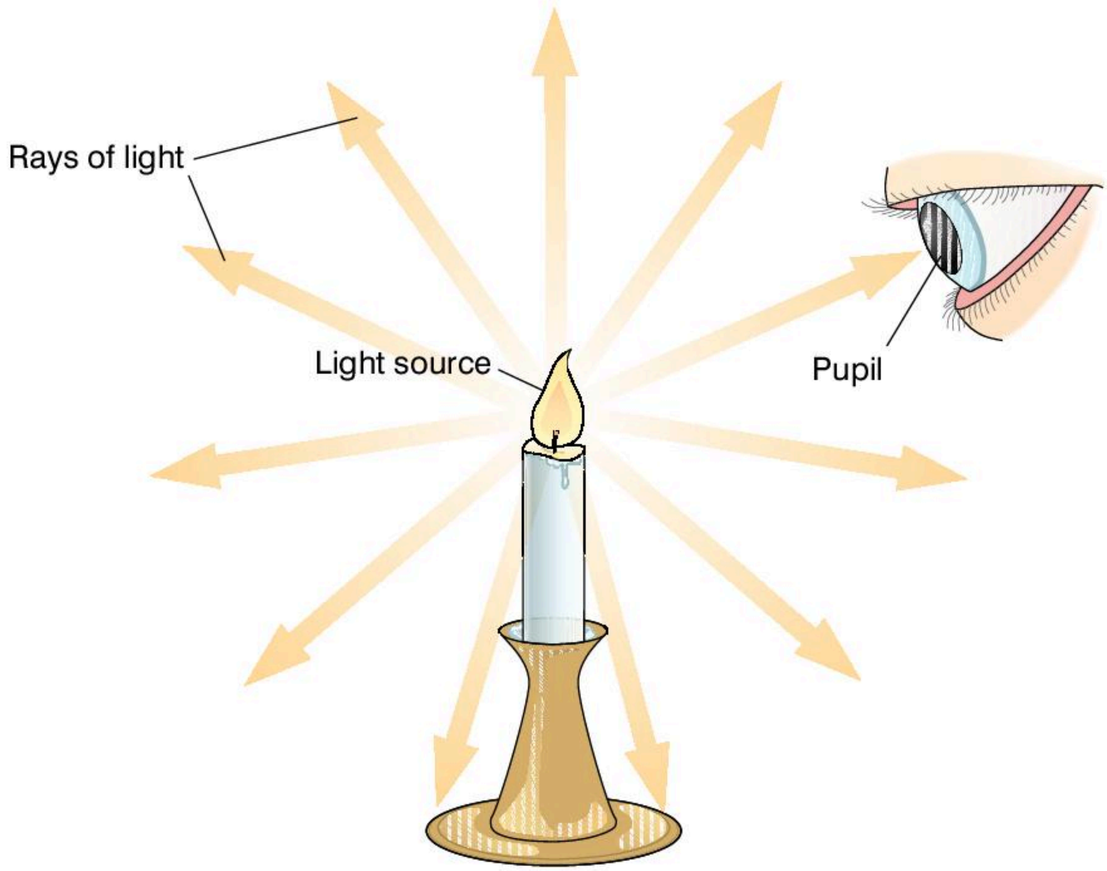
The cornea protects the more delicate parts of the eye, which are behind it. Light passes through the cornea and enters the eye through the **pupil**.

The pupil is a hole at the front of the eyeball. It appears as the black, circular centre of the eye. The size of this hole changes, depending on the amount (intensity) of light arriving at the eye.

The **iris** is the coloured ring of tissue that surrounds the pupil. The size of the pupil is changed by the contraction or relaxation of the iris. This is brought about by tiny muscles in the iris.

- When the light intensity is high, the iris automatically relaxes. This closes down the size of the pupil to a minimum.
- When the level of light intensity is low, such as at night, the iris automatically contracts and opens the pupil to its maximum size. This is *16 times bigger* than its minimum size.

We do not have to think about the size of our pupils. Our eyes react automatically to the intensity of light and the size of our pupils is adjusted accordingly.




*We see the light source when the light enters the eye*

All light sources send out **rays/beams of light**.

Think of sun beams and moon beams. Think of the beam of light from a torch or a car headlight. Light from some sources travels in all directions – for example, a candle, the moon, or the ceiling light in a room. Light from other sources is directed into a beam that points in a particular direction – for example, a torch, a television, or a computer screen.

We will see the source of the rays when we look at it, because when light rays pass through the transparent cornea they enter our eye. That is how we see the light source.


## Activity 7

**You will need:** paper (or Workbook) and a pen or pencil.

**1** **Look at the pictures above. Some show sources of light and some show non-sources of light.**

**2** **Sort them into two groups:**

**a** The light sources *and* the non-sources of light.

**b** Write the letters (a–o) in the groups.

Continue over the page

**3** **Now sort the light sources into two sub-groups:**

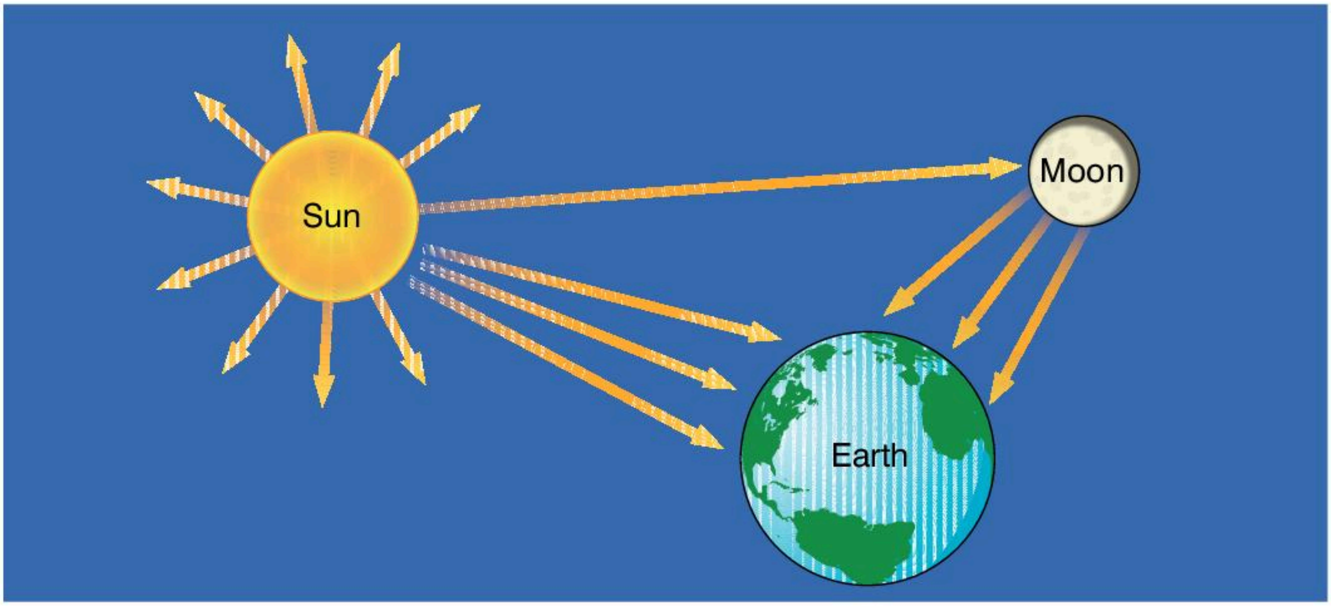
**a** artificial light sources

**b** natural light sources.

**4** **Share your groups with the class.**

**Luminous** objects produce or **reflect** light. Name five luminous objects and give their names to your teacher.

The moon is a luminous object, but it is not a source of light. It reflects light that comes from the Sun.




The moon is like a giant mirror in space. Light rays from the Sun bounce off the moon and travel to the Earth.

## Activity 8: How is light reflected?

**You will need:** mirrors, foil, water, a plate or bowl, paper (or Workbook) and a pen or pencil.

**1** **Discuss the reflection of light with your group.**

**a** Try to name three other examples of natural reflection.

**b** Try to name three examples of artificial reflection.

**2** **Share your examples with the class.**

**3** **Play with the mirrors and explore how they reflect.**

**4** **Compare a mirror with a smooth sheet of foil.**

**a** Can you see **images** in both of them?

**b** Record what you observe.

**5** **Crumple the foil and look again. Make a note of what you observe.**

**6** **Put some water into a plate or bowl and let it stand still on the desk.**

**a** Look down into it.

**b** Make a note of what you see.

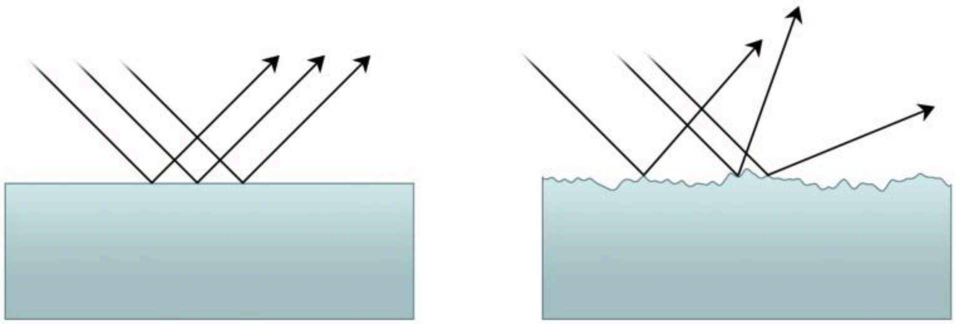
**7** **Gently shake the desk and look down into the water again. Record what you see this time.**

The surfaces of all objects reflect light. If they did not, we would not be able to see them. When light is reflected from their surfaces, the light enters our eyes and we see the objects.

Most objects are not *shiny*. They are not good reflectors, because much of the light falling on them is **absorbed**. It does not land on the surface and bounce off. The light energy is taken in by the object.

Smooth surfaces – such as mirrors, windows, polished wood and metal, and still water – reflect light very well. A smooth surface means that the rays of light are not scattered in all directions. We can 'see our faces' when we look into such smooth surfaces; we see our reflection; we see an image of ourselves.

When the surface is shiny but rough (like the crumpled foil and the shaken water), we cannot see a clear image of our faces. Light is still reflected very well, but the light is scattered in all directions.



Look at the diagrams of the two surfaces. Explain which one is producing a clear image. Why is the other one not producing a clear image? Tell other learners what you think.

## Activity 9: Investigating reflected light

**You will need:** two shiny objects, a mirror, a torch, a wall, paper (or Workbook) and a pen or pencil.

1. Use the mirror to create as many different effects as you can.

2. Switch on the torch. Using a mirror, can you make the light from your torch beam shine on a wall.

3. When you have succeeded, draw a diagram of how you did it. Use arrows to show the direction and path of the light from its source to the mirror, and from the mirror to the wall.

Continue over the page

**4** **Collect two shiny objects and take them outside into the sunlight.**

**5** **Try using the shiny objects to re-direct the sunlight onto a wall or other shaded surface. How did you do it?**

**6** **Back in class, draw a diagram of what you did with the shiny objects.**

**7** **Discuss your results with your group.**

- **a** Try to explain how the light was re-directed by the mirror and the shiny objects.
- **b** Compare the three surfaces. What is similar about all of them?

**8** **Share your results and explanations with the class.**

Shiny objects, including mirrors, reflect light. The light hits the surface and 'bounces off'. The plane mirror is designed to produce perfect reflection. Like all good reflectors, mirrors are smooth – many are metal; some are plastic. Most plane mirrors are glass with a thin layer of aluminium on the back, which reflects light very well.

## Activity 10: Investigating reflections

**You will need:** a mirror, paper (or Workbook) and a pen or pencil.

**1** **Write out the alphabet in capital letters on a sheet of paper. Make each one at least 2 cm tall.**

**2** **Hold up the paper in front of the mirror. If the mirror is large enough, you will see all the letters at once. If it is small, look at each letter one at a time.**

**a** What do you notice about the letters when you look at their images in the mirror?

**b** Write down what you see.

**c** What do you notice about the images of these letters?

**A H I M O T U V W X Y**

**d** Write down what you see.

**3** **Try to make a word that looks exactly the same on the paper and in the mirror.**

**4** **Look at yourself in the mirror and touch your left ear with your right hand.**

**What do you see in the mirror?**

**5** **Discuss the results of all these investigations with your group.**

**a** Try to come to a conclusion about how plane mirrors make reflections.

**b** Share your words from question 3 and your conclusion with the class.

## Apparent movement of the Sun

Look at the picture and explain the differences you see. Think about the position of the Sun in your explanations.

*A village scene at different times of day*

### Activity 1: Does the Sun move?

**You will need:** a large ball, a torch or lamp, paper (or Workbook) and a pen or pencil.

1. Write a mark on a ball to represent your home.
2. Make the room dark or go into the darkest corner of the room.

**3** **Hold the ball at the top and bottom so that you can turn it slowly.**

**4** **Get another group member to shine the torch or lamp onto one side of the ball.**

**5** **Slowly spin the ball as the light shines on it from one side. Watch your mark on the ball as it goes into and out of the light.**

**6** **Discuss with your group what you have done and seen.**

- **a** Try to explain what the ball and the torch represent, as well as the movement of the mark into and out of the light.
- **b** Connect your ideas to the pictures of the village.

**7** **Record what this activity shows.**

- **a** Make drawings of what you have done.
- **b** Write an explanation of what this activity shows.

**8** **Share your drawings and your explanation with the class.**

The Earth is almost **spherical** in shape. A **sphere** is a solid, three-dimensional shape. Examples of spheres include a ball or an orange. A model of the Earth, called a globe, is also spherical. A globe shows all the land and the sea covering the Earth's surface.

As the pictures on page 70 show, the Sun appears to travel across the sky each day and then disappear at night. As the position of the Sun in the sky changes, the shadows on the Earth also change their size and direction.

Since long ago, people have observed this and used it as a way of telling the time, for example, with sundials.


Throughout human history, most people thought that the Sun was travelling up and then down, and across the sky each day. This is why we say 'sunrise' and 'sunset'.

## Activity 2

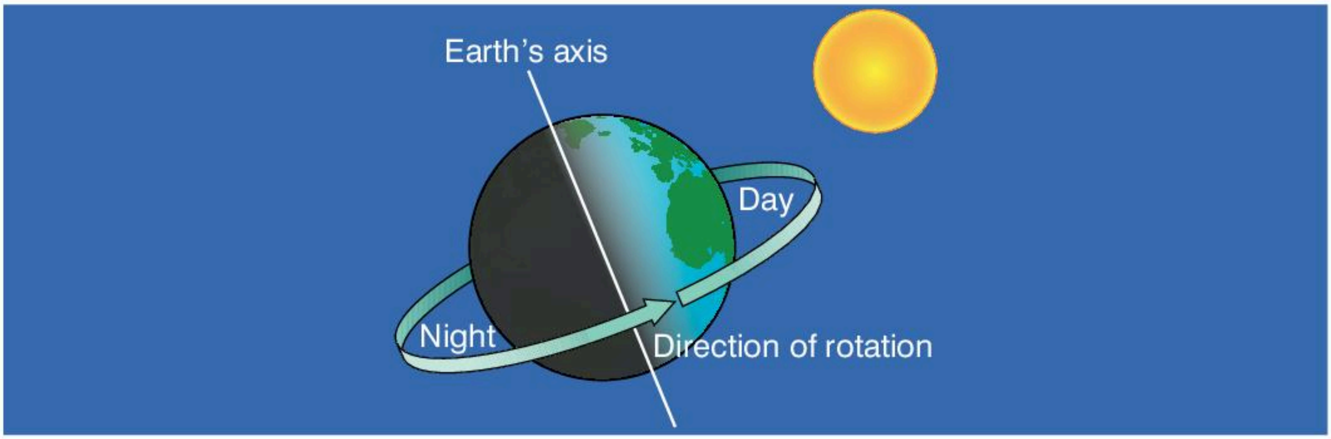
**You will need:** paper (or Workbook) and a pen or pencil.

**1** Discuss these questions with your group:

- Does the Sun travel around the Earth?
- What actually happens?
- What causes night and day?

**2** Share your group's answers with the class.

Look at the picture.




*Night and day*

Compare with other learners your ideas about what the picture shows. Change your explanation of what causes night and day if you think you need to.

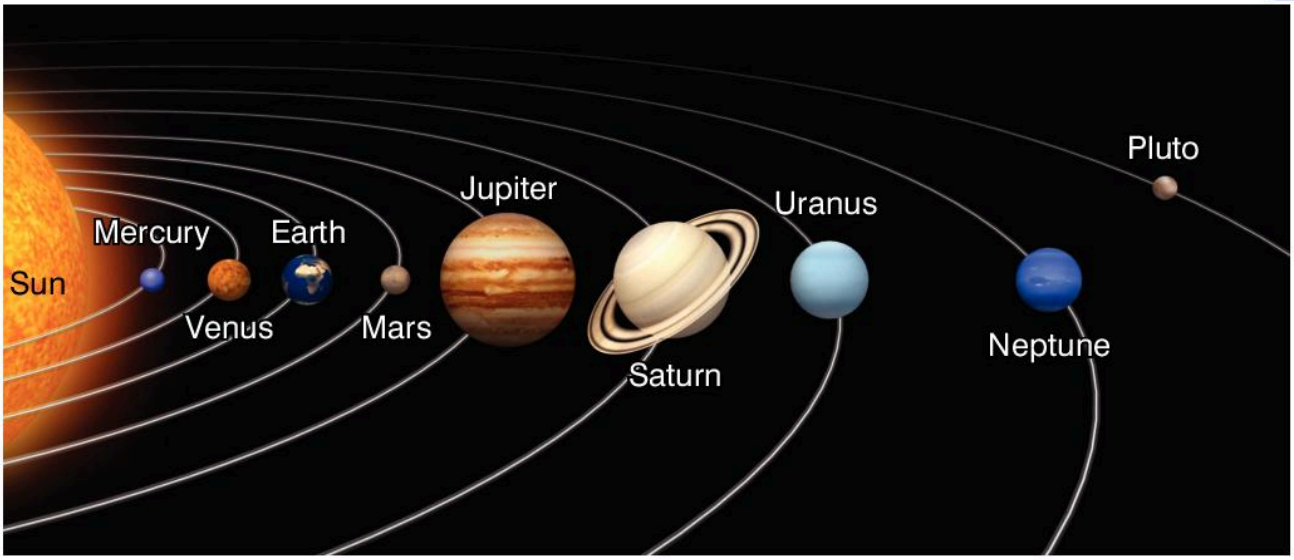
Scientists in many parts of the world – some in Africa long ago – observed the changes in the sky each day and tried to explain what they saw. Eventually, after a long time of study, scientists agreed that what the Sun *appears* to be doing is caused by the movement of the Earth, *not* the movement of the Sun. The Earth spins round and round on its **axis** (it rotates). This **rotation** makes it *appear* that the Sun is travelling across the sky each day, but this not what really happens.

Think of your activity with the ball and the light.

- Which was moving: the torch (the Sun) or the ball (the Earth)?
- Did you still get 'night' and 'day' coming and going for your 'home' (the mark on the ball)?

This rotation of the Earth takes 24 hours. It means that your home, and every other place on the Earth, is facing the Sun for part of that 24 hours. This is when there is daylight. For the rest of the 24 hours, your home faces away from the Sun. This is night time. Other parts of the Earth have daylight and night time at different times.

# The Earth's orbit




*The solar system*

The Sun is at the centre of a group of planets, and this whole system is called the **solar system**. The Earth is not the largest planet and it is not the closest to or furthest from the Sun. The planets shown in the picture are not drawn to scale, but the picture does show that some are much bigger and some are much smaller than the Earth.

Each planet travels around the Sun in a pathway called an **orbit**. Planets are said to revolve around the Sun, and each journey in a roughly circular orbit is called one **revolution**.

So, the Earth is moving in two ways at the same time – it is rotating and it is revolving:

- The Earth rotates once each day on its axis.
- In one year the Earth does 365.25 of these rotations.
- The Earth does only one revolution around the Sun each year.

The Earth's journey around the Sun is very long and it takes one year from start to finish. That is why there are 365 days in a year, with an extra day each leap year (every four years) to combine the four 0.25 days.

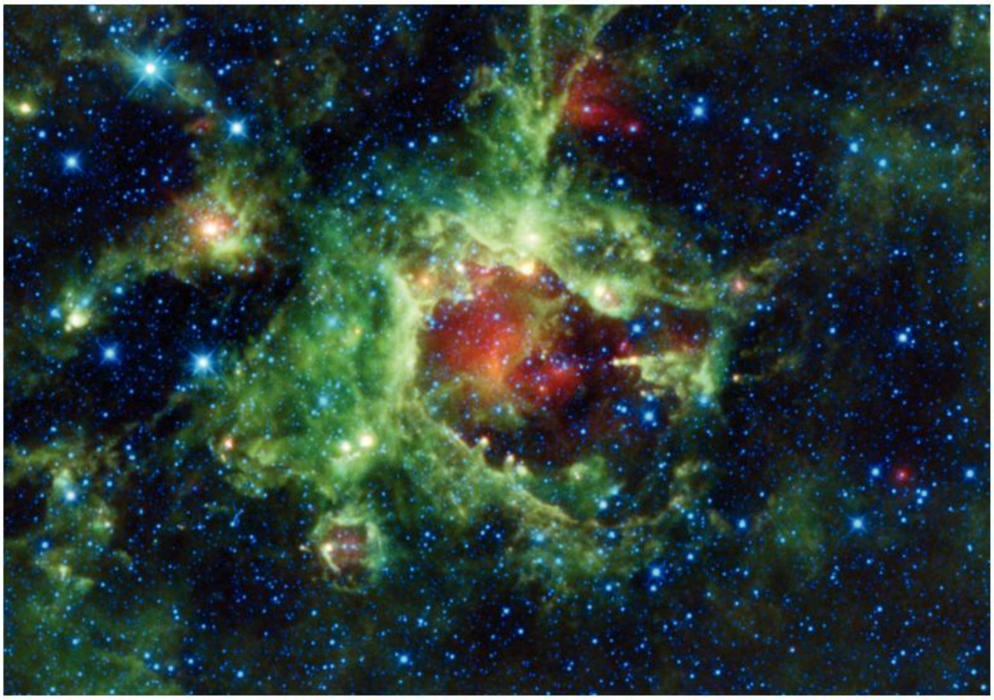
The axis of the Earth is tilted. So, as it revolves around the Sun, either the northern or the southern **hemisphere** is tilted towards the Sun.

The hemisphere tilted towards the Sun has more hours of sunlight and higher temperatures: this is the season of summer.

As one hemisphere is in summer, the other one is in winter because its half of the Earth is tilted away from the Sun. For example, Australia has its summer from November to February, whereas France has its summer from June to September.

# Famous astronomers

People all over the world have always been curious about what they see in the sky. The many changes they could see each day, especially each night, were mysterious and very interesting.



We do not know the names of most of the people from long ago who observed and explored and worked out patterns and relationships between things in the sky.

These people were living all over the world and were not called scientists or **astronomers**. They were often important in the religion of their tribes and cultures. The mystery of sun, moon, **stars**, comets, eclipses and meteors was a central part of many religions around the world.

The ideas of these early people were all worked out separately. They did not have any way of knowing what other people far away were observing and thinking. So these ideas about the universe developed separately in many places, for a long time.

A lot of the early information and ideas have been lost. We have only fragments preserved in carvings, paintings, objects and, later, in writings from some of these places.

*Eratosthenes of Cyrene, a Greek scholar and astronomer (276–194 BC)*

*Pythagoras, a Greek philosopher and mathematician (580–500 BC)*

*Ptolemy of Alexandria, a Greek astronomer and geographer (85–165 AD)*

These pictures show some of the earliest-known scientists from Europe and North Africa, whose ideas have been passed down to us over the centuries.

Others were also making observations and creating explanations in far off Asia. The names of some of these early Chinese and Indian observers of the universe have survived. For example, Gan De, Yi Xing, and Shi Shen from China, and Aryabhata from India. Their work was not known around the world at the time. Human beings have lived in isolated societies for most of history. The modern age is very new. Now we can know immediately what is happening anywhere on Earth, so the ideas of scientists can be shared quickly and our knowledge grows faster than it could in times past.

*Aryabhata*

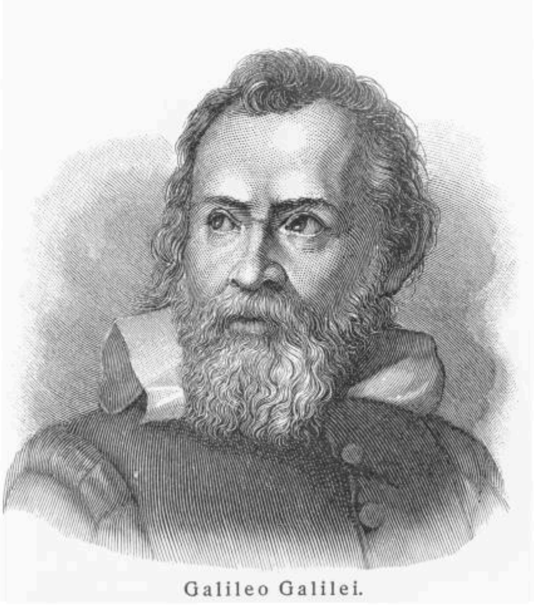
*A modern astronomical observatory in France*

Cultures in what we now call South and Central America – such as the Mayan, Inca and Aztec cultures – made great use of their observations of the sky. Their calendars and religious rituals were well developed and strongly connected. We have no record of who their greatest observers and thinkers were: only some of their work survives in buildings, paintings and inscriptions.

*Aztec calendar, Mexico*

Modern astronomy is seen as being built in Europe on the foundation of ancient observations and ideas from Egypt, Greece, Persia and other places. Many world-famous astronomers are from the period of European history starting in the 14th century. Names such as Copernicus, Galileo, Kepler and Newton are known around the world. They are the fathers of modern astronomy, and their discoveries and theories have shaped our understanding of the universe.


*Copernicus (1473–1543)*




*Galileo (1564–1642)*


*Kepler (1571–1630)*


*Isaac Newton (1642–1727)*

In the last century, astronomers, mathematicians and physicists, such as Albert Einstein (1879–1955), continued to gather data and extend our knowledge of the physical universe. Perhaps the greatest living astronomer is Stephen Hawking, a British professor who has made major changes to our understanding of the mysterious 'black holes' in space.

## Activity 3

**You will need:** reference sources (such as encyclopedias or the Internet), paper (or Workbook) and a pen or pencil.

**1 Find out more about astronomy.**

a Choose a time or place that you want to explore.

b Carry out research into the work of scientists from that time or place who have investigated the solar system or other parts of the universe.

**2 Use books, CD-ROMs, your school library database and the Internet to gather information on the lives and the discoveries of the people of your chosen time or place.**

**3 Make notes and drawings as you find useful and interesting information.**

**4 When you have completed your research, produce a display of what you have found.**

a Share your work with others in the class.

b Be prepared to answer questions about your research findings.

**5 Look at what others have displayed and ask questions if anything is not clear, or if you want more details.**

The work of exploration and developing theories goes on. We have not yet found the answers to all our questions about the mysterious universe in which we live.

# Glossary

## A

**absorbed** – taken in.

**anther** – male part of a flower where pollen is made and stored.

**apparent** – what seems to be correct, but actually might not be correct.

**astronomer** – a scientist who studies space and the objects found there, e.g. stars, planets, moons, comets and asteroids.

**axis** – the imaginary line around which the Earth spins or rotates.

## B

**bar chart** – a way of showing data in bars or blocks, sometimes on a grid of lines.

**boiling point** – the temperature at which a liquid begins to boil and turn into a gas.

## C

**carpel** – female part of flower, consisting of the stigma, style and ovary.

**chlorophyll** – the green pigment in plants that makes food by photosynthesis.

**compare** – to look for differences and similarities in two or more things or events.

**conclusion** – an opinion based on evidence; a decision.

**condensation** – the process of changing from a gas into a liquid, e.g. water vapour into liquid water.

**cornea** – the transparent 'window' that covers the front of the eye.

## D

**dispersal** – spreading seeds over a wide area.

**dormant** – sleeping; not active.

## E

**embryo plant** – the tiny plant inside the seed, which grows when the seed germinates.

**energy** – the ability to do work; it is needed to make things happen.

**evaporation** – the process of changing from a liquid state into a gas, e.g. water into water vapour.

**evidence** – facts, information, proof, clues or data that helps us to work something out.

**explanation** – telling why something is like it is; giving a reason for something.

**F**

**factor** – something that has an influence or a part to play.

**fair test** – a test of an idea in which everything is kept the same except the one thing you are testing.

**female** – part of plants that makes sex cells called ova (eggs).

**fertilisation** – the process of combining a pollen cell with an ovum in a flower.

**fuse** – two things joining to become one, e.g. ovum and pollen.

**G**

**gas** – the state of matter that is not solid or liquid.

**generalisation** – a statement or idea about all cases based on evidence from a few examples.

**germinate** – (used of seeds) begin to grow.

**H**

**hemisphere** – half the Earth, either northern or southern.

**I**

**image** – the reflection of an object in a mirror, or a picture of an object seen on a screen.

**insect pollination** – the transfer of pollen from anthers to stigmas by insects.

**intensity** – strength or amount of energy being transferred.

**investigate/investigation** – a search for evidence to answer a question.

**iris** – the coloured part of the eye that can expand and contract to control the amount of light entering the eye.

**L**

**life cycle** – the stages of a plant's life that take place in a particular order.

**light meter** – an instrument that measures the level of light.

**line graph** – a picture that uses a line to show the relationship between two things (variables), e.g. time and distance.

**liquid** – the state of matter that is not gas or solid.

**luminous** – producing or reflecting light.

## M

**male** – the part of plants that makes sex cells called pollen.

**measurement** – a quantity of something, e.g. time, mass, size or temperature.

**melting point** – the temperature at which a material changes its state from solid into liquid.

## N

**nectar** – sweet liquid produced by flowers to attract insects.

**nectary** – the part of the flower, at the base of the petals, that makes nectar.

**nutrients** – minerals that plants take in through their roots. They are needed for many living processes in the plant.

## O

**observe/observation** – notice when paying careful attention, e.g. when seeing, smelling, hearing, touching or tasting.

**opaque** – light does not pass through and it is not possible to see any image at all through such a material, e.g. stone.

**orbit** – the path of a planet moving around the Sun, or a moon moving around a planet.

**ovary** – the part of the flower where ova are made and stored.

**ovum (plural: ova)** – the egg cell of a plant; the female sex cell made in the ovary.

## P

**pattern** – a regular feature, e.g. a repeated shape, relationship or measurement.

**petals** – flower parts surrounding the reproductive organs. They are often colourful, large and attractive to insects.

**photosynthesis** – the process whereby plants make food by capturing energy from light.

**pollen** – male sex cell of plants, made in the anthers.

**pollination** – transfer of pollen from the anther to the stigma.

**predict/prediction** – telling what will happen before doing something.

**pupil** – the hole at the front of the eyeball through which light enters the eye.

## R

**rate of evaporation** – a measure of the volume of liquid water that turns to vapour in a given time, e.g. in a minute.

**ray/beam of light** – a narrow line or column of light travelling from a source or reflected from a surface.

**record** – writing, photos or drawings of what was done or what happened.

**reflect** – bounce back. Light hitting a surface is more or less returned (reflected) or absorbed.

**reproduce/reproduction** – to produce new individuals.

**results** – observations of all kinds, including measurements, collected during an investigation.

**revolution** – one complete turn or orbit of the Earth around the Sun, which is called a year.

**rotation** – turning or spinning, e.g. the Earth on its axis.

## S

**seed** – a fertilised ovule that can germinate and grow into a new plant.

**sepals** – the outer parts of flower, often green in colour and covering the petals when the flower is closed in the bud.

**sex cells** – the special cells (male and female) made for reproduction, e.g. pollen and ova in plants.

**shadow** – darkness or shade, where light is blocked by something.

**solar system** – the Sun and the planets that orbit it, e.g. Earth, Mars, Neptune.

**solid** – the state of matter that is not liquid or gas.

**solution** – a mixture of a liquid solvent and a solid solute. The solute dissolves into the solvent, to form the solution.

**sphere/spherical** – a solid, three-dimensional shape.

**stamen** – male part of a flower consisting of a filament (stalk) and anther.

**star** – a huge mass of burning gases. The Sun is a star.

**starch** – a foodstuff made and stored in plants, e.g. rice, maize or potatoes; used by plants and animals to give them energy.

**stigma** – female part of a flower that is sticky and traps pollen grains.

## T

**temperature** – a measure of how hot a substance is.

**test** – something done to find out if an idea is true or not.

**translucent** – some light passes through but it is not possible to see a clear image through such a material, e.g. a sheet of paper.

**transparent** – light passes through and it is possible to see through such material, e.g. a window.

## V

**volume** – how much space something fills, measured in units such as cc (cubic centimeters).

## W

**water vapour** – water in the gas state.

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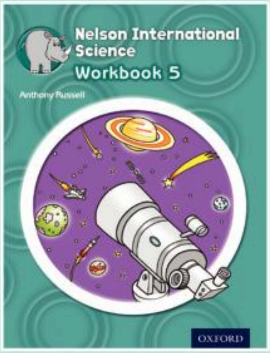


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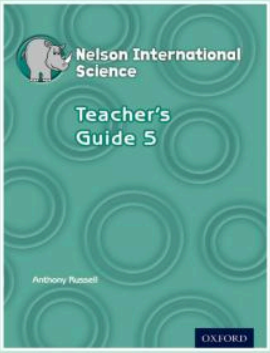


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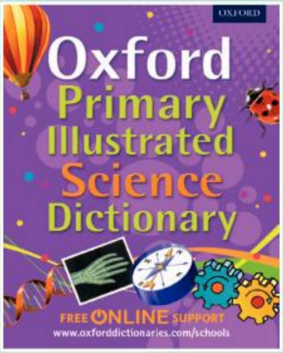


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