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Learner's Book 6

Fiona Baxter & Liz Dilley

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Introduction

Welcome to Stage 6 of Cambridge Primary Science. We hope you will enjoy using this book and find out how interesting and exciting Science can be.

People have always asked questions about things they observed and looked for answers to their questions. For example, in Stage 6 you will find the answers to these questions:

- Why does our heart beat?
- How does our body protect us against diseases?
- How can people harm food chains?
- How can we tell if a chemical reaction has taken place?
- How do rocks and fossils form?
- How does the Moon stay in orbit around the Earth?
- How do huge ships manage to float on the ocean?
- What is the difference between a series circuit and a parallel circuit?
- What causes rainbows?
- Why does the Moon look different at different times of the month?

You will work like a scientist to find the answers to these questions. You will also ask your own questions to investigate.

We have included a variety of different activities and exercises for you to try. Sometimes you will work with a partner or work in a group. You will be able to practise new skills such as drawing and interpreting circuit diagrams, presenting results on a scatter graph and interpreting food webs.

As you practise these new skills, you can check how you are doing and also challenge yourself to do better. You will be able to reflect on how well you have worked and what you could do differently next time.

We use science in our lives every day. You will see how science knowledge is important when we discuss issues such as pollution and the spread of diseases. You will learn about some of the things that scientists in the past discovered and invented and how scientists today are still improving on these designs. You will also see how people use science to divide the year up into months.

We hope you enjoy thinking and working like a scientist.

Fiona Baxter and Liz Dilley

Contents

How to use this book

In this book you will find lots of different features to help your learning.

What you will learn in the unit.

We are going to...

- draw food chains
- explain a food web and identify food chains in a food web
- explain how a food web shows feeding relationships in nature
- identify the source of energy in food chains and food webs
- describe how energy is transferred in food chains and food webs

Questions to find out what you know already.

Getting started

The parts inside your body are called organs. The body organs do different jobs to keep you alive and healthy. Discuss these questions with a partner. Be prepared to share your ideas with the class.

1 Which organ is found in the head?
2 Which organs are found in the chest?
3 Which organ pumps blood around the body?
4 Name two organs in the digestive system.

Important words and their meanings.

function	support
protect	muscles
organs	length

An investigation to carry out with a partner or in groups.

Think like a scientist

How people use rocks in my area

Work in pairs.

Look for ways people use rocks in your area.

For example: for building walls and roofs of houses, making pots, statues, gravestones, furniture, ornaments, roads, polished walls of bank and government buildings.

Safety: Take care not to wander around alone.
Don't climb onto roofs to get a closer look at building materials.

Make a list of what you find. Use references to identify the rocks used.

Take photographs if you can. Draw pictures of what you see.

These questions help you track your progress.

How am I doing?

How well did you work in your group? Did you contribute well?
Did you help to answer the questions?

Rate yourself ☺ or 😐 or ☹

A fun activity about the science you are learning.

Activity 1

Types of soil

1 Go back to the soil sample you studied earlier.
Test it to see how well it holds water.
Can you roll it into a ball or does the ball break up?
Does it contain organic matter?
What type of soil do you think this is?
Give reasons for your answer.

Questions to help you think about how you learn.

How can you use what you have found out in this topic to look after soil in the future?

This is what you have learnt in the unit.

Look what I can do!

- [ ] I can find out that there are different types of soils and they can be classified based on their clay, sand and organic content.
- [ ] I can find out that the composition of soil can change making it better or worse for plants to grow in it.
- [ ] I can make a prediction and see whether observation supports my prediction.
- [ ] I can observe and sort different materials in soil.
- [ ] I can record observations in a table.

At the end of the unit, there is a project for you to carry out, using what you have learnt. You might make something or solve a problem.

Project: How people use soil

In this project you will identify a person who uses soil in your area and ask them questions about how they use the soil.

You can do this project on your own or with a partner.

Speak to a person in your area who uses soil.
You could speak to a farmer or someone with a garden or an allotment.

Make an appointment to speak to the person. Introduce yourself and say why you want to speak to them.

Prepare a list of questions and leave space to write in your answers when you speak to the person.

Ask questions such as:

- What sort of soil do you have? What are its colour and texture? Is there any organic matter?
- Is it sandy, clay or loam?
- What do you grow in the soil?
- What do you need to add to the soil to make your plants grow well?
- How do you look after the soil?

If possible, take some photographs.

Remember to thank the person when you have finished.

Present the information you have collected as a poster.

Questions that cover what you have learnt in the unit. If you can answer these, you are ready to move on to the next unit.

Check your progress

1 The table shows the melting points of some substances.

Substance	Melting point/°C
gold	1064
candle wax	60
silver	962
copper	1083
ice	0
aluminium	660

a What is a melting point?

b List the substances in the order of highest to lowest melting point.

c Describe a pattern you can see in the melting points.

d Does the melting point of a substance change? Say why or why not.

2 a Why does food cook faster in the oven in a metal dish than in a glass dish?

b If you used a dish made of a different metal, would the cooking time change? Explain why.

3 a Sort the following processes into two groups: reversible processes and irreversible processes

rusting | boiling | freezing | dissolving | burning | evaporating

b Add another process that you know of to each of the groups.

Working like a scientist

We can work like scientists and use the five different types of scientific enquiry to find answers to different kinds of science questions.

Research

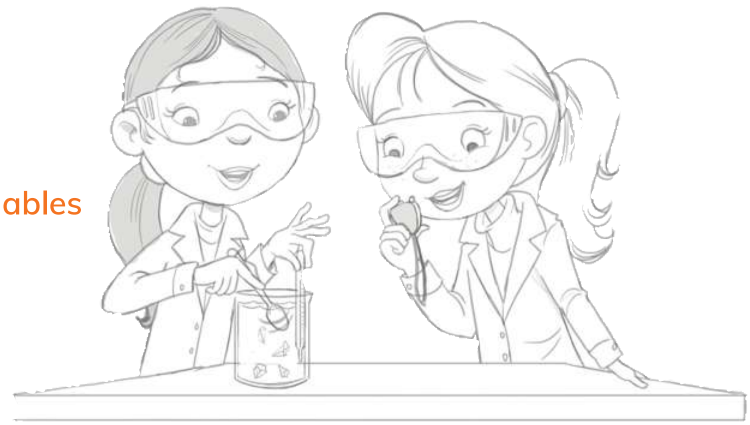
Sometimes we cannot find the answer to a scientific question in a direct way, such as by doing an investigation. This might be because it is impossible or unsafe to do. Instead, we can do research to find the information we are looking for. We can use books, use the internet or watch videos. These are called secondary sources of information. We can use this type of scientific enquiry to:

- find out about new scientific discoveries, such as how the coronavirus virus is spread, or discoveries made in the past, for example how scientists first invented batteries
- build on our knowledge of a topic, such as finding out about the respiratory systems of different vertebrates
- compare information from different sources and decide which answer is best, for example finding out how different factors can affect pulse rate, or the effects of harmful substances in food chains
- help us realise that sometimes there are questions that scientists don't yet know the answers to. For example, why does the force of gravity only pull and not push?

Fair testing

In a fair test we change one factor or variable and keep all the others the same, to try to answer a scientific question. By changing only one variable, we know that no other variable will affect the results of the test. For example, if we investigate the question in Unit 2, 'does water temperature affect the rate of dissolving?' then:

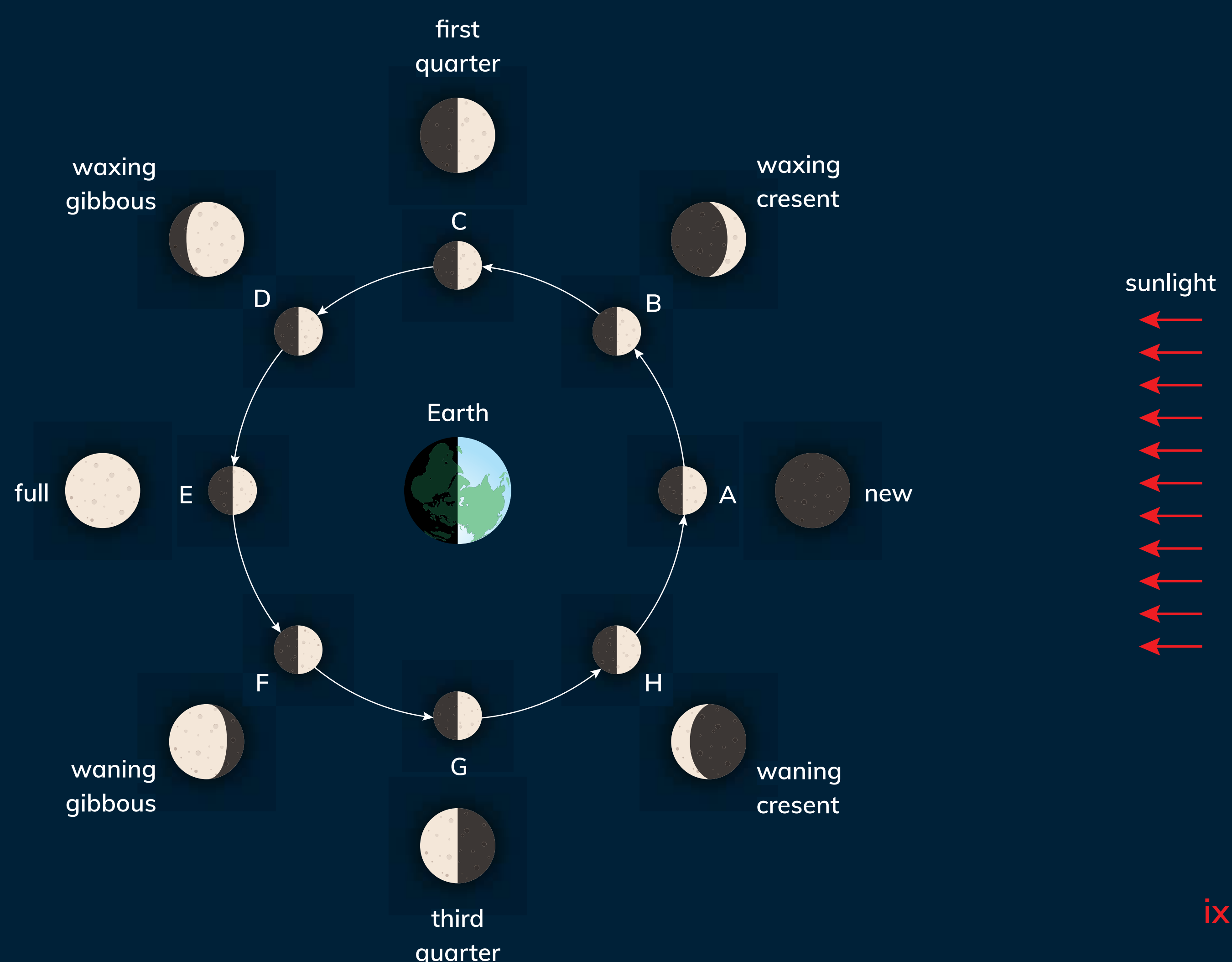
- the water temperature is the independent variable that we change



- the time it takes the solute to dissolve is the dependent variable that we measure
- the amounts of water and solute and number of times we stir the solution are the control variables that we keep the same.

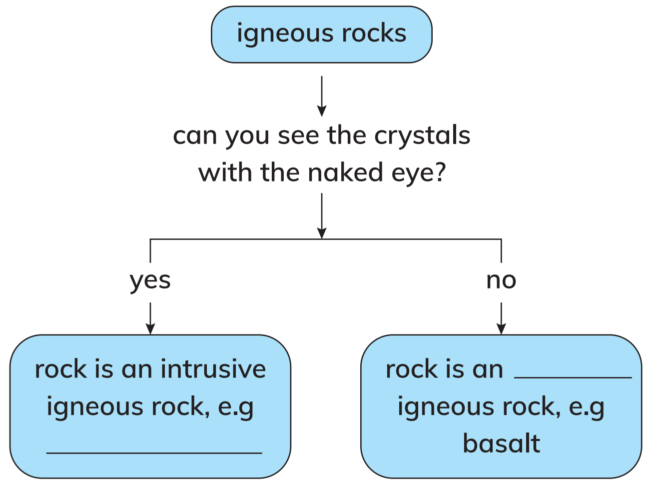
Observing over time

In investigations we often need to observe changes caused by things we do. How often we need to observe depends on the changes we are looking at. We can see some changes straight away, such as the formation of a gas when we mix vinegar and baking soda. If we observe what happens to our breathing rate when we exercise, we can see the change in a few minutes. Observing changes in nature can often take longer. We will need a month to observe the changes in the Moon's appearance as it orbits the Earth.



Identifying and classifying

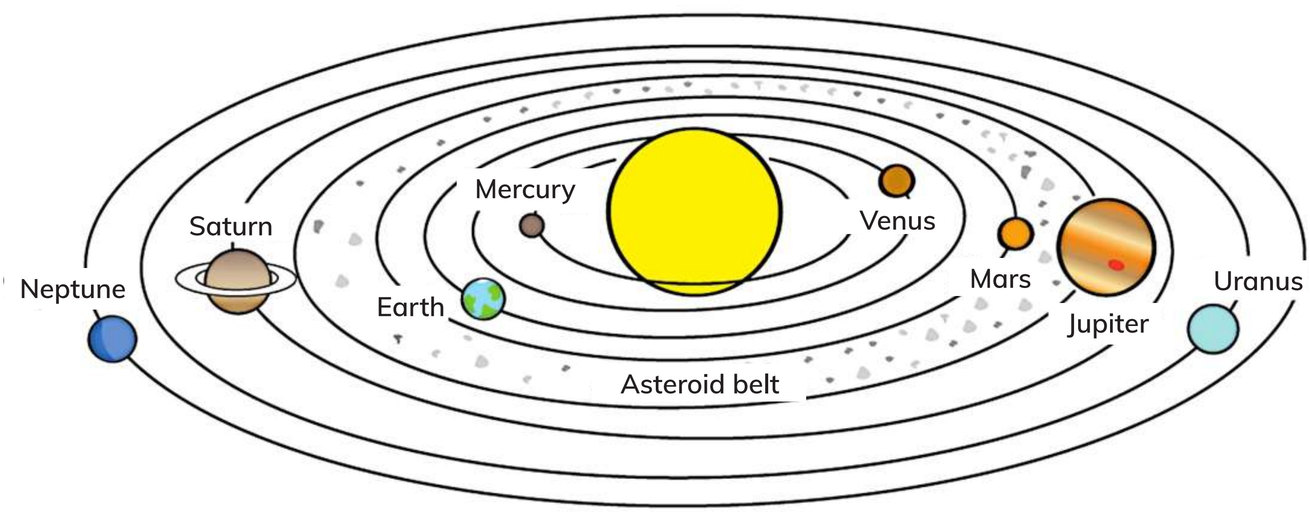
Identifying is the process of naming something, for example the different types of blood vessels in the human body. We can name them because they have features we recognise, such as the thickness of the blood vessel wall. We classify objects, materials and living things in groups by observing the ways in which they are different. We can usually classify these things by asking a series of 'yes or no' questions. For example, we can use a key to find out the type of igneous rock in a sample we have found.



Pattern seeking

Pattern seeking involves observing, recording and analysing data. The patterns we observe can help us to identify a trend or relationships between one or more things. We often find patterns in nature where we cannot easily control the variables. For example:

- a pattern linking mass of an object with its weight
- a pattern between the time a planet takes to travel around the Sun and its distance from the Sun.



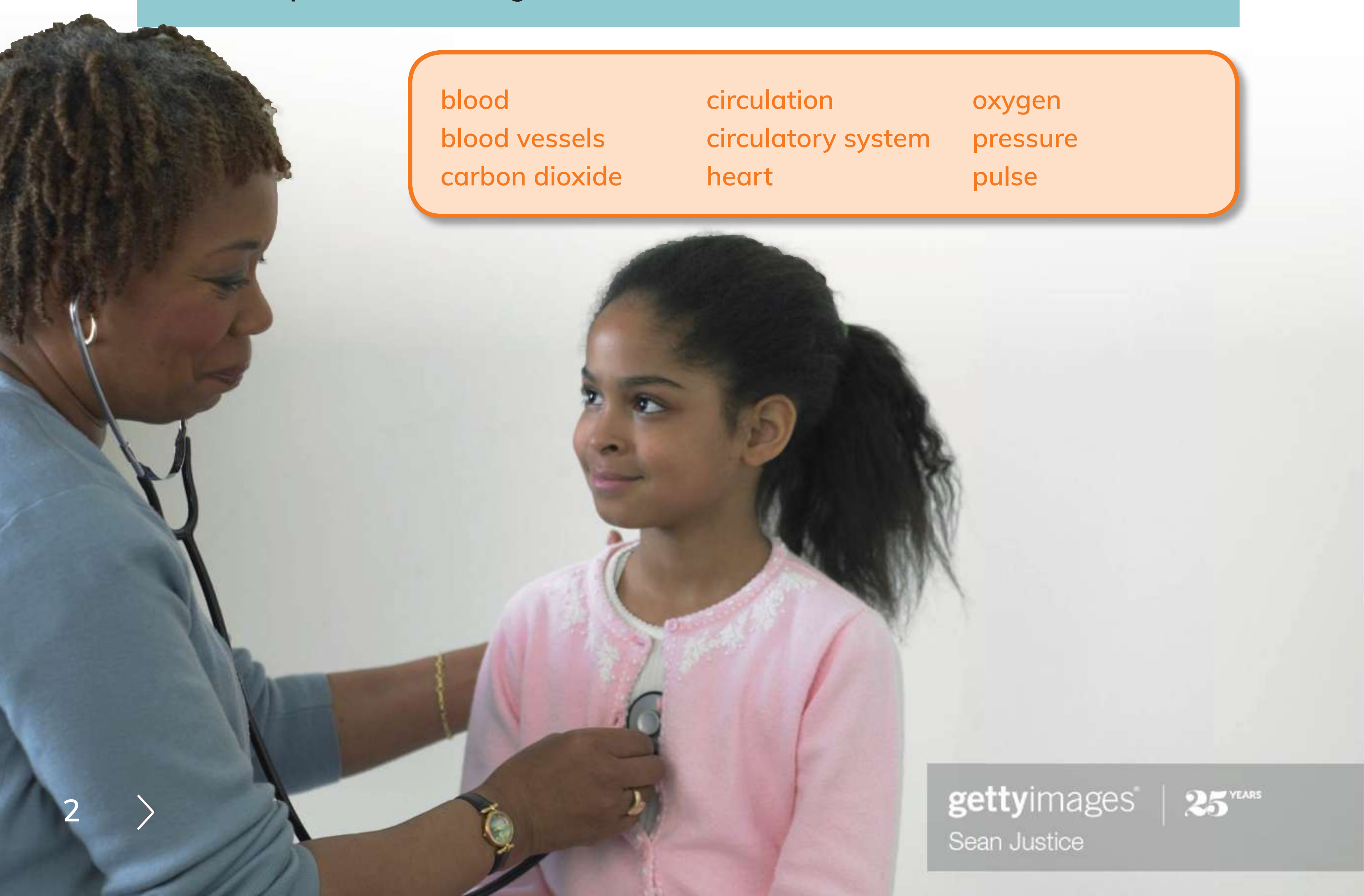
1 The human body

1.1 The circulatory system

We are going to...

- describe the parts of the circulatory system and their functions
- learn that the circulatory systems of other animals are similar to ours
- measure pulse rates and record results in tables
- make a prediction and plan a fair test on the effect of exercise on pulse rate
- use results to say if the prediction was accurate
- describe any patterns in results and use results to make a conclusion
- find information to answer a scientific question
- ask a question to investigate and find the answer.

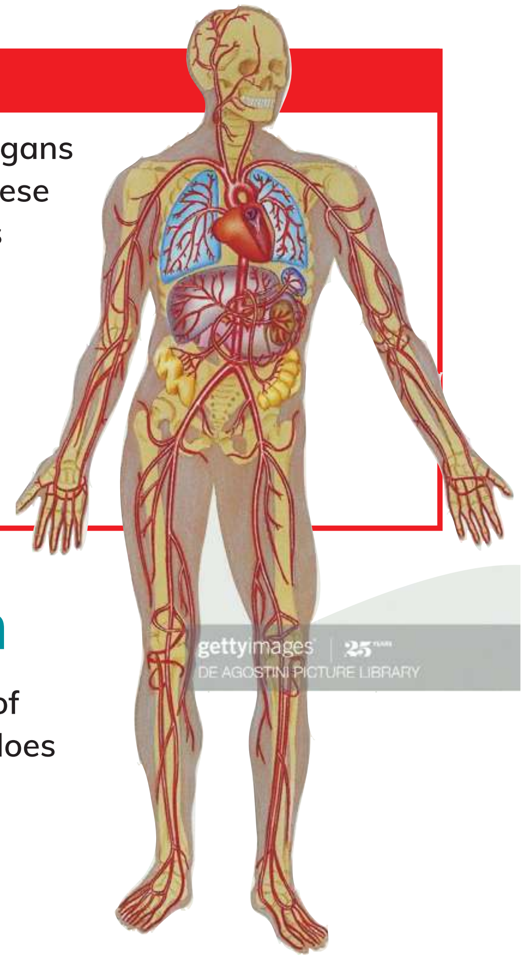
blood	circulation	oxygen
blood vessels	circulatory system	pressure
carbon dioxide	heart	pulse



Getting started

The parts inside your body are called organs. The body organs do different jobs to keep you alive and healthy. Discuss these questions with a partner. Be prepared to share your ideas with the class.

1 Which organ is found in the head?
2 Which organs are found in the chest?
3 Which organ pumps blood around the body?
4 Name two organs in the digestive system.



Parts of the circulatory system

The circulatory system carries food and oxygen to all parts of your body. It also carries waste substances that your body does not need. The circulatory system has three main parts:

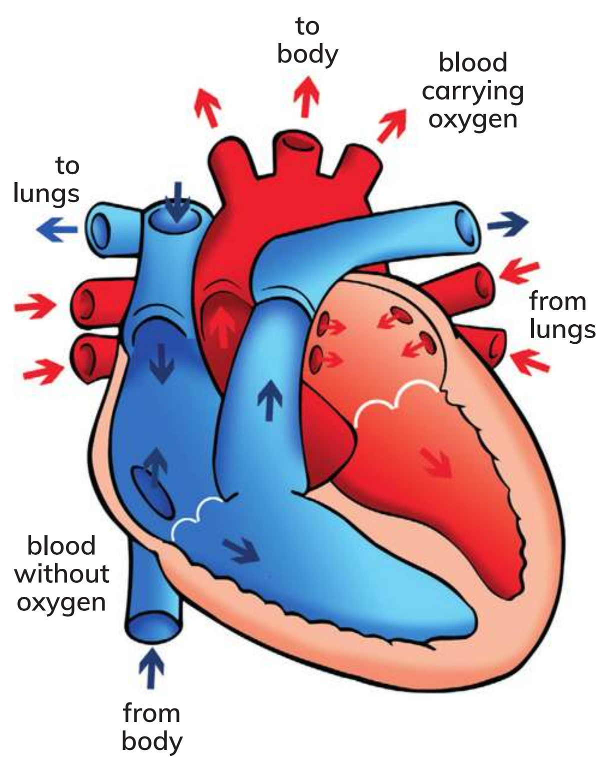
- the heart
- blood vessels
- blood.

The heart

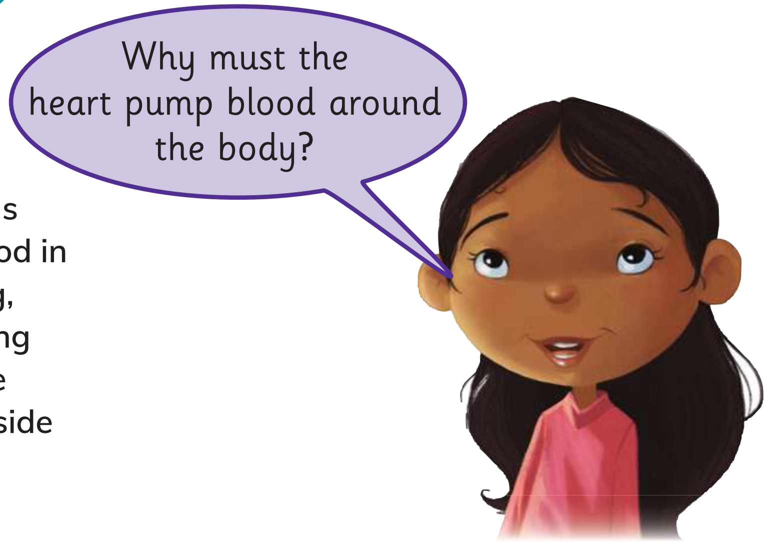
Put your hand on your chest. Can you feel your heart beating? Why does your heart beat?

Make a fist with your hand. That's how big your heart is. Your heart is found inside your chest, slightly to the left. It is protected by the ribs.

Your heart is a special muscle. Its job is to pump blood through your body. This process is called circulation. Every time the heart muscle contracts to pump blood, you can feel a heartbeat. It takes less than a minute to pump blood to every part of your body. The heart does this all the time and never stops.



The heart has two sides. The left side pumps blood that contains oxygen all around the body. The right side pumps blood without oxygen to the lungs only. The drawing shows the flow of blood in the heart. When you look at the drawing, remember that the left side of the drawing shows the right side of the heart and the right side of the drawing shows the left side of the heart.



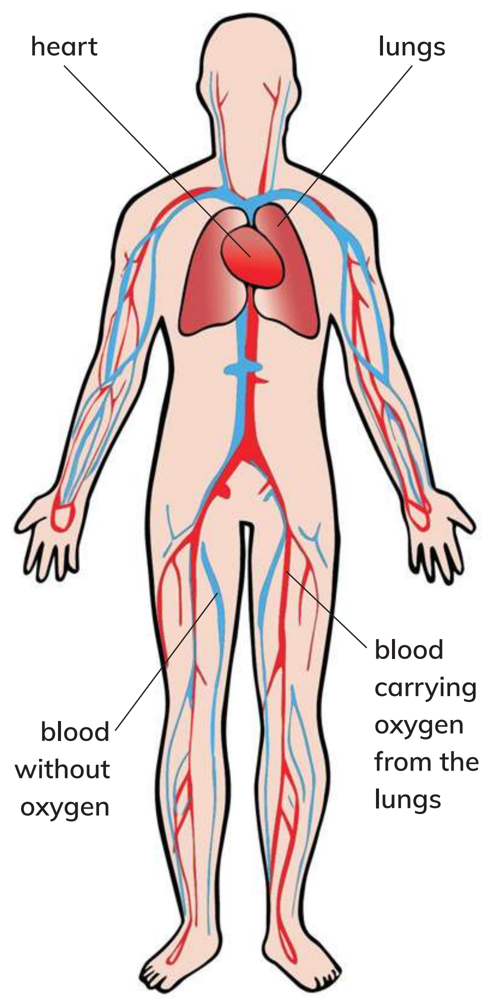
Blood vessels and blood

Blood is a red liquid that flows around the body. The blood carries food particles and oxygen to all parts of the body. It also picks up waste products, such as carbon dioxide, from the body and carries them to organs which can get rid of them. Carbon dioxide is a waste gas that the body must get rid of. The kidneys and lungs are body organs that help the body get rid of waste products.

Blood moves through the body in the blood vessels. Look at the inside of your wrist. Sometimes you can see the blood vessels through your skin.

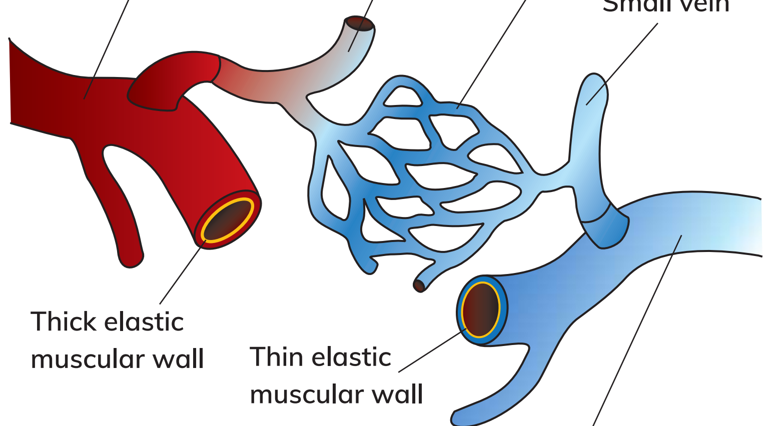
There are three kinds of blood vessels:

- arteries
- veins
- capillaries.



Each kind of blood vessel has a different structure and function in the body.

The blood vessels run from the heart to the lungs, around the body and back to the heart. Blood always moves along the same pathway in the blood vessels.



- The heart pumps blood in arteries to the lungs to pick up oxygen.
- The oxygen-rich blood travels back in veins from the lungs to the heart. These are the only veins that carry blood with oxygen.
- The heart pumps the oxygen-rich blood in other arteries to the rest of the body.
- The blood from the rest of the body, which is now low in oxygen, travels back to the heart in veins.

Questions

1 a What does the heart do?
  b Why does it do this?

2 What is a heartbeat?

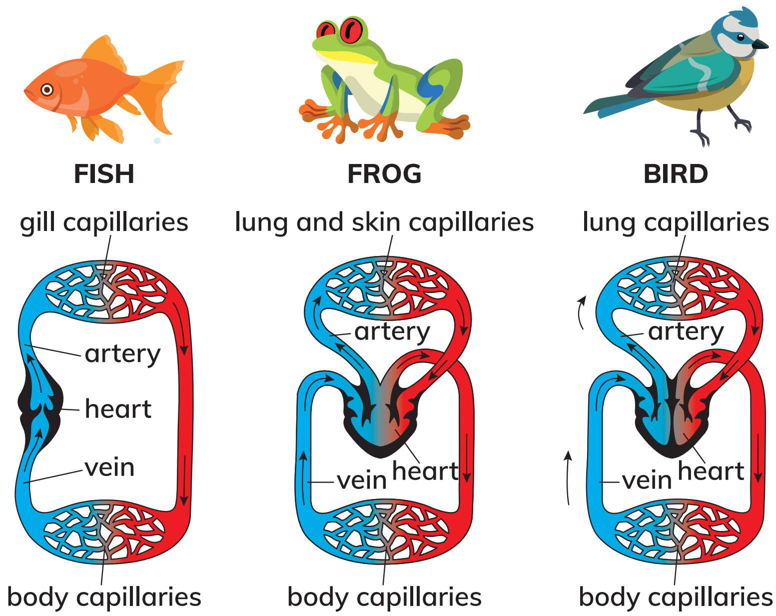
3 Why does the heart pump blood to the lungs before it pumps blood to the rest of the body?

4 Why do we need three different types of blood vessels?

5 Describe to your partner the pathway of blood around the body. Make a cycle diagram to show this pathway.

Circulatory systems of other animals

Many vertebrates have a similar circulatory system to ours.
The pictures show the circulatory systems of a fish, a frog and bird.



Activity 1

Compare circulatory systems of some vertebrates

Work with a partner. Look at the drawings of the circulatory systems of different vertebrate animals, then discuss the questions.

1. Which parts of the animal circulatory systems are the same as the human circulatory system?
2. How are the animal circulatory systems are different to the human circulatory system? Explain this to a partner.

How am I doing?

Answer 'well', 'okay' or 'I need help' to each of the questions below.

How well can I:

- identify the parts of the circulatory system in humans and other vertebrates?
- explain how the animal circulatory systems are different to the human circulatory system?

Heartbeat and pulse

Your heart beats about 90 times a minute. When you are grown up it will beat about 70 times a minute. When you run around, your body needs a lot more food and oxygen. The more active you are, the more often your heart needs to beat to supply enough food particles and oxygen from the blood.

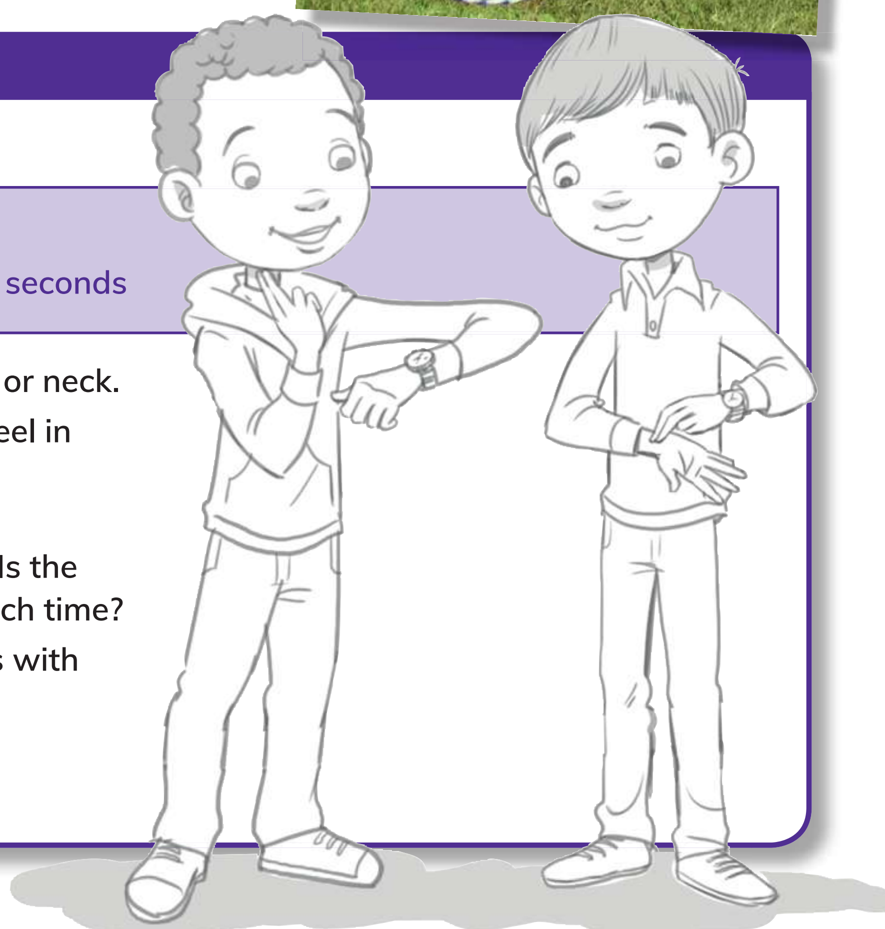
You can count your heartbeats by feeling your pulse. Your pulse is caused by the pressure of the blood as the heart pumps it to the rest of the body.

Two good places to find your pulse are on the side of your neck and the inside of your wrist. When you find your pulse you will feel a small beat under your skin. Each beat is caused by the contraction of your heart muscle.

Think like a scientist 1

Measuring pulse rate

You will need:
a watch or timer that can time seconds



1 Find your pulse on your wrist or neck.
2 Count how many beats you feel in one minute.
Repeat this three times.
3 Record the results in a table. Is the number of beats the same each time?
4 Compare your measurements with others in your class.

Continued

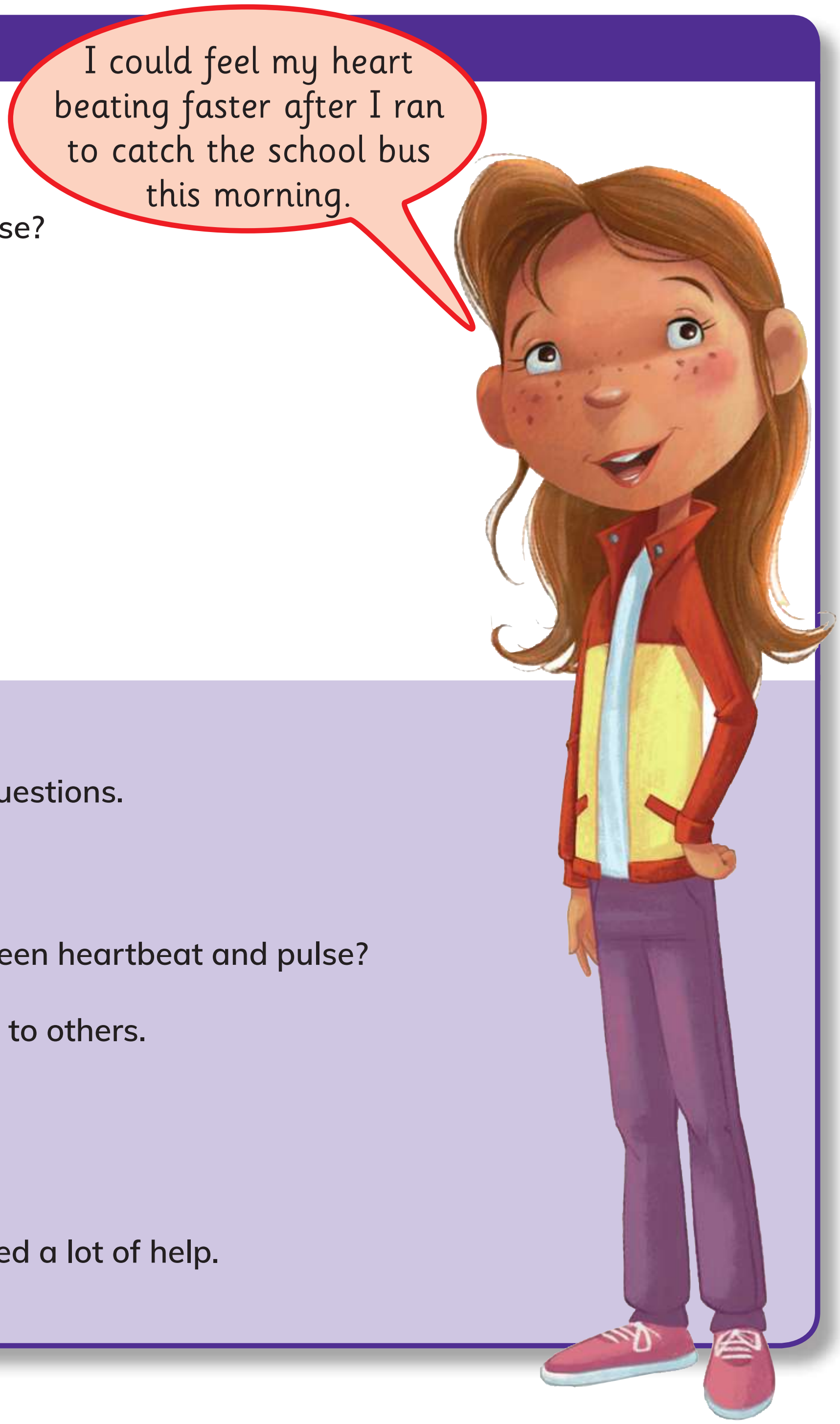
Questions

1 What is the difference between heartbeat and pulse?

2 Did everyone in your group have the same pulse rate? Why do you think this is?

3 Work out your average pulse rate from the measurements you made.

4 Which type of scientific enquiry did you use in the investigation?



How am I doing?

Choose a card to answer the questions.

How well can I:

- measure pulse rate?
- explain the difference between heartbeat and pulse?

(green card) I get it! I can even explain to others.

(yellow card) I need a little more help.

(red card) I don't understand it. I need a lot of help.

Think like a scientist 2

How does exercise affect pulse rate?

Plan a fair test investigation to find out how doing exercise affects our pulse rate.

1 a Make a prediction to answer the question you are going to investigate. Say why you made this prediction.
  b How will you test your prediction?
2 Identify the variables in your investigation that you will:
  - measure
  - change
  - keep the same.
3 Identify the equipment you will need.
4 Decide how you will record and present your results.
5 Carry out your investigation and present your results.

Questions

1 Was your prediction correct?
2 Describe any pattern you could see in the results.
3 What conclusion could you make from your results?
4 Which two types of scientific enquiry did you use in the investigation? Explain your answer.

How are we doing?

As a group, choose one the faces as your answer to each of the questions. ☺ or 😐 or ☹

Could we make a prediction with reasons?

- Could we identify the different variables in the investigation?
- Could we choose suitable materials and equipment to use?
- Could we say how to record and present our results?
- Did we work together to plan and carry out the investigation?

Activity 2

Identify other factors that affect pulse rate

You have found out that exercise affects pulse rate.
What other factors can affect pulse rate?
How do these factors affect pulse rates?

Do some research to find the answer.

Report back to the class on your findings.

Think like a scientist 3

Ask and investigate a question

You have investigated how exercise affects pulse rate. With a partner, think of another question about heartbeats and pulse rates that you would like to find the answer to. Decide on the type of investigation you will use to answer your questions; for example, a fair test, doing research or observing over time.

Find out the answer to your question.
Make a presentation to share with the class about your findings.

What did I do to help my group in the practical tasks?
Why did I choose to help them in this way?

Look what I can do!

- [ ] I can describe the parts of the circulatory system and their functions.
- [ ] I can say how the circulatory systems of other animals are similar to ours.
- [ ] I can measure pulse rates.
- [ ] I can record results in tables.
- [ ] I can plan a fair test on the effect of exercise on pulse rate.
- [ ] I can make a prediction about how exercise affects pulse rate.
- [ ] I can use results to say if the prediction was accurate.
- [ ] I can describe any patterns in results.
- [ ] I can draw a graph of results.
- [ ] I can use results to make a conclusion.
- [ ] I can find information to answer a scientific question.
- [ ] I can ask a question to investigate and find the answer.

1.2 The respiratory system

We are going to…

- describe how the respiratory system works
- make and explain a model of breathing
- show that breathing involves two different stages, breathing in and breathing out
- measure breathing rate
- do practical work safely
- record results in a table
- draw a line graph of results
- use results to make a conclusion
- find information to answer a scientific question.

Getting started

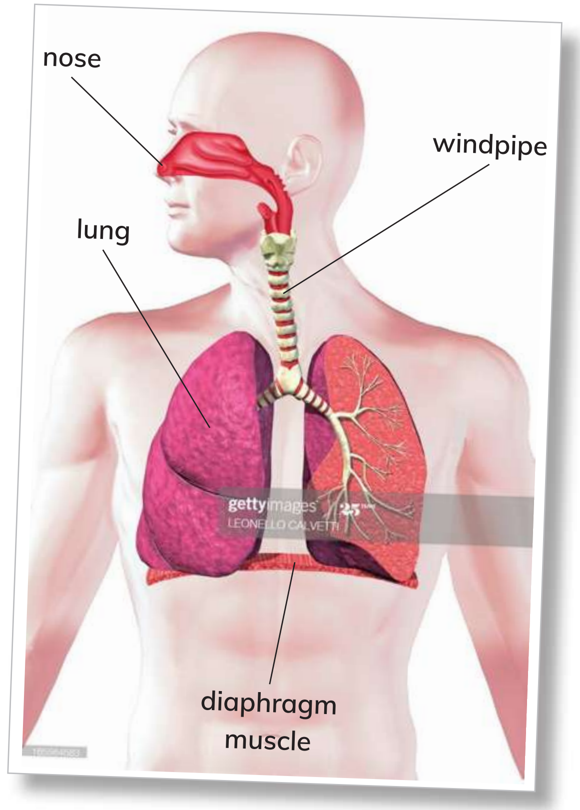
1 Draw a picture of the lungs.

2 Tell a partner the following:

- why you drew the lungs that way
- what happens to the lungs when we breathe in and out.

breathing
breathing rate
diaphragm
lungs
windpipe

Parts of the respiratory system



The human respiratory system contains these parts:

- two lungs
- air tubes leading from the mouth and nose to the lungs
- muscles in the chest that allow air to move in and out of the lungs.

The lungs and breathing

We use our lungs for breathing. We need to breathe to stay alive. We breathe in and breathe out.

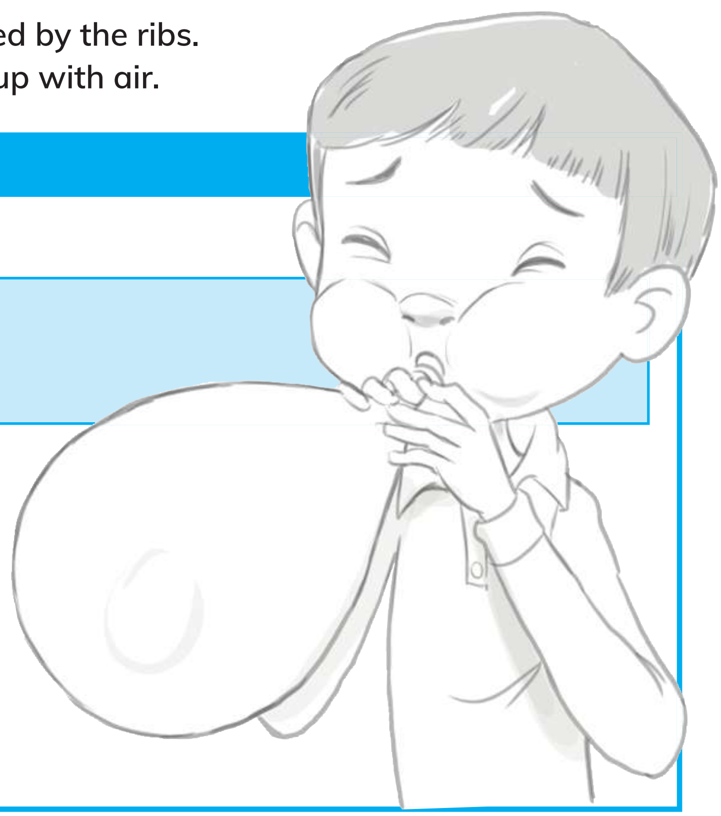
The lungs are in the chest. They are protected by the ribs. The lungs are like stretchy sponges that fill up with air.

Activity 1

Investigate breathing

You will need:

- a balloon



1. Put your hands on your rib cage.
2. Breathe in. What do you feel?
3. Now breathe out. What do you feel?
4. Breathe in again. Hold the balloon to your mouth and breathe out. What happens to the balloon?

   What does this show you?

Continued

Questions

1 When you breathe in, does your chest get bigger or smaller? Why do you think this is so?

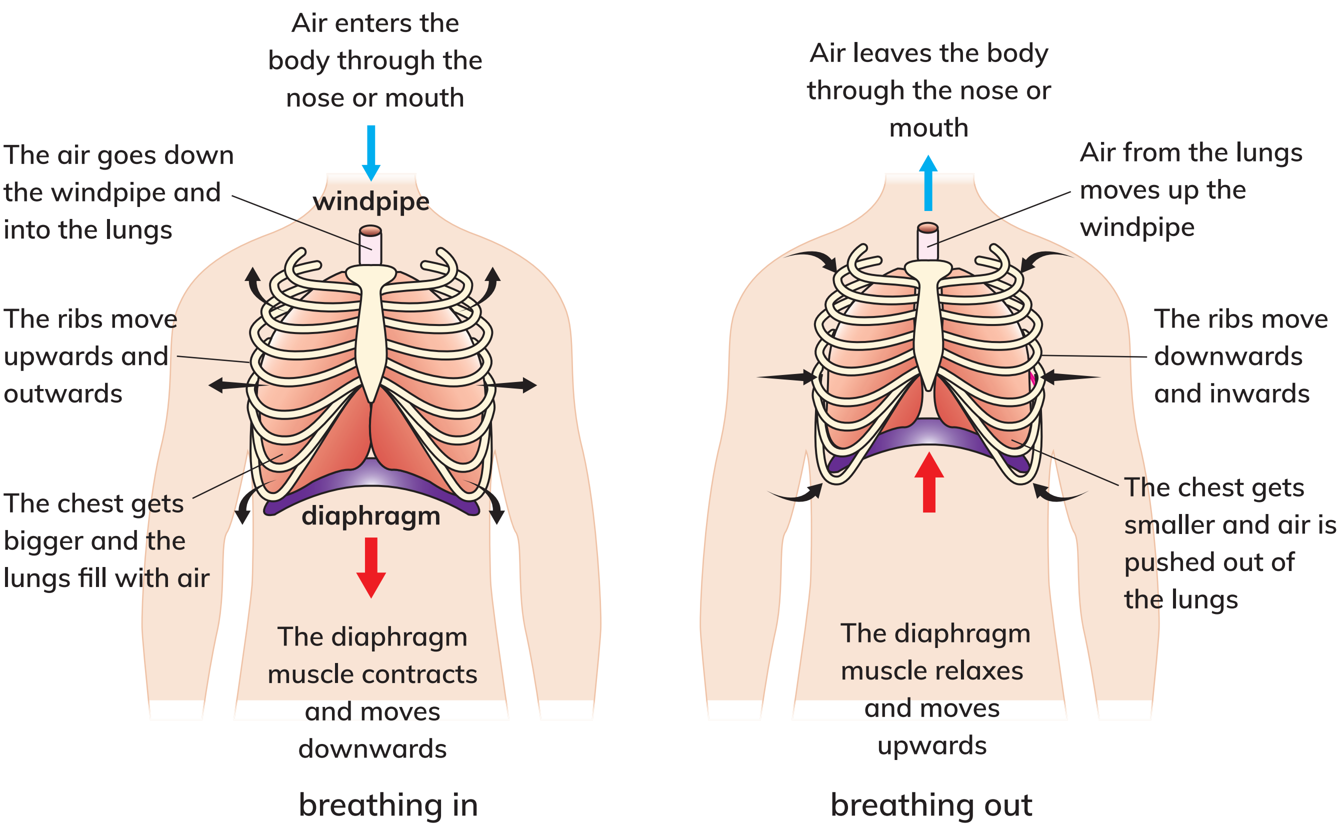
2 When you breathe out, does your chest get bigger or smaller? Why do you think this is so?

3 Explain how we are able to blow up a balloon.

Breathing

We need oxygen to live. When we breathe in, oxygen gas from the air moves into the blood vessels in the lungs. Blood carries the oxygen to the heart and then to the other parts of the body.

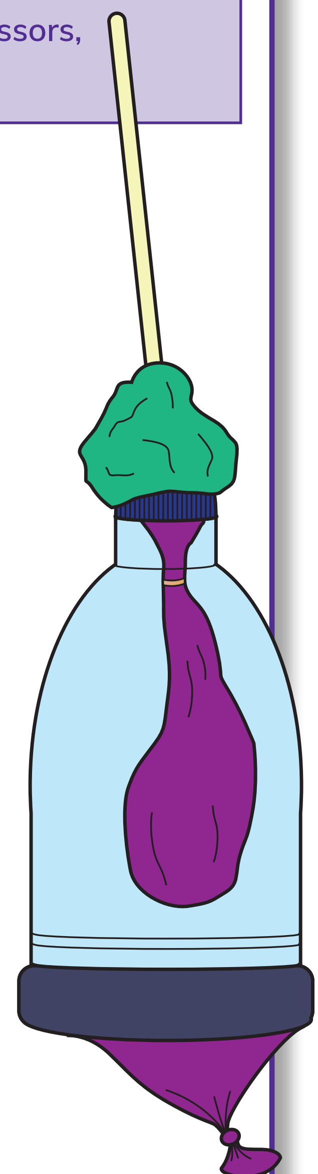
As your body uses up oxygen, it makes carbon dioxide. The blood carries the carbon dioxide back to the lungs. We get rid of carbon dioxide in the air we breathe out.



Think like a scientist 1

Make a model to explain breathing

You will need:
a plastic bottle, a narrow plastic tube or straw, an elastic band, scissors, two balloons, electrical tape, sticky putty or plasticine play dough®



1 Cut the bottom off the plastic bottle.

Safety: Take care not to cut yourself with the scissors or sharp edge of the cut bottle.

2 Tie a knot in the narrow end of one balloon and cut off the other end.

3 Stretch the newly cut end of the balloon around the bottom of your plastic bottle. Use the electrical tape to fix the balloon in place.

4 Put a plastic tube or straw in the neck of the other balloon and fix it in place with the elastic band. Be sure not to make the elastic band so tight that it crushes the straw. The air must flow through, so blow gently through the straw to see if the balloon inflates.

5 Put the straw and the balloon into the neck of the bottle. Put the play dough around the neck of the bottle to seal the bottle. Again, make sure that you don't crush the straw.

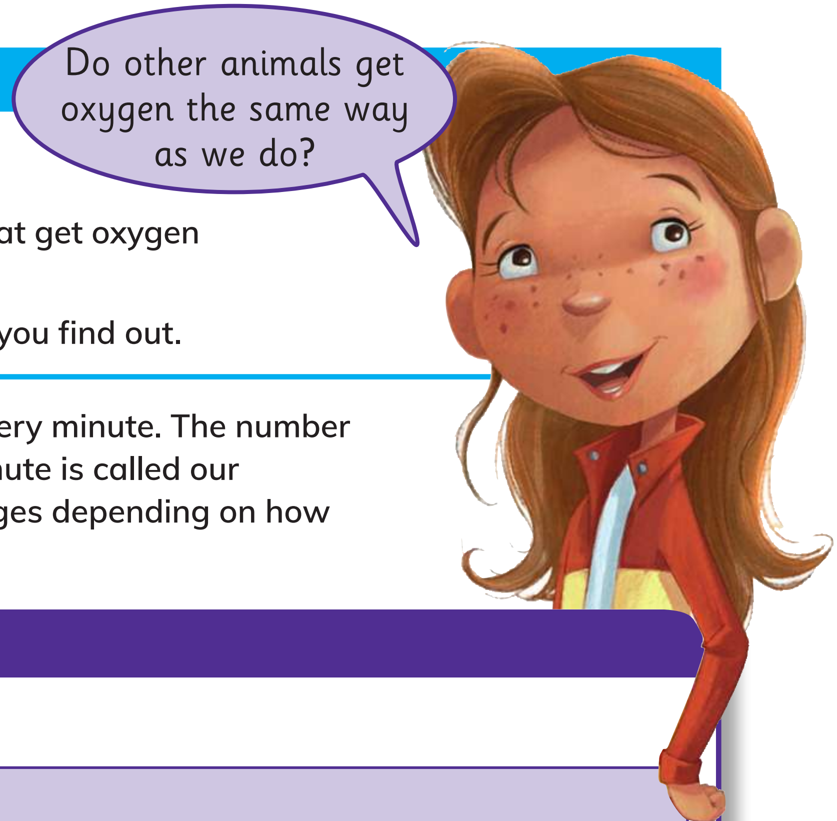
6 a Pull on the bottom balloon and observe what happens.
  b Let go of the balloon. What happens?

Questions

1 Which part of model represents the following parts of the human respiratory system:
  a lungs?
  b the chest cavity?
  c the windpipe?
  d the diaphragm muscle?

2 Which parts of the chest that are also involved in breathing are not shown by the model?

3 Explain how your model shows the breathing process.



Activity 2

Use books and the internet to find out the answer to Sofia's question.
Find information about two animals that get oxygen in a different way to humans.

Make a poster to show the class what you find out.

We breathe in and out about 16 times every minute. The number of times we breathe in and out in one minute is called our **breathing rate**. Our breathing rates changes depending on how much oxygen our body needs.

Think like a scientist 2

Investigate breathing rate

You will need:
a timer or watch with a second hand

1. Count the number of breaths you take per minute, while at rest. Record the measurement in a table.
2. Run on the spot for two minutes and then stop. Count and record the number of breaths per minute.
3. Run on the spot for another two minutes and then stop. Count and record the number of breaths per minute.
4. Wait two minutes and measure and record your breathing rate again. Do this again after another two minutes.
5. Draw a line graph of your breathing rate.
6. a When was your breathing rate lowest?
   b How did exercise affect your breathing rate? Suggest a reason for this.
   c Use your graph to work out how long it would take for your breathing rate to get back to normal after you stopped exercising.

Continued

7 Use your results to write a conclusion for the investigation.

8 Suggest another factor that could affect a person's breathing rate. Think about athletes and sports players.

9 Which type of scientific enquiry did you use in the investigation?

10 Name another body system you have learnt about that is also affected by exercise.

How am I doing?

Was I able to measure my breathing rate accurately?

- Was I able to draw line graph of my results?
- Was I able to use my results to make a conclusion for the investigation?
- Do I know how exercise affects breathing rate?

How have the practical activities helped me to learn about the respiratory system?

Look what I can do!

- [ ] I can describe how the respiratory system works.
- [ ] I can make and explain a model of breathing.
- [ ] I can show that breathing involves two different stages, breathing in and breathing out.
- [ ] I can measure breathing rate.
- [ ] I can do practical work safely.
- [ ] I can record results in a table.
- [ ] I can draw a line graph of results.
- [ ] I can use results to make a conclusion.
- [ ] I can find information to answer a scientific question.

1.3 The reproductive system

We are going to...

- describe body changes that happen during puberty
- name the parts of the reproductive system.

Getting started

Think about what you already know about reproduction and write down your answers to these questions.

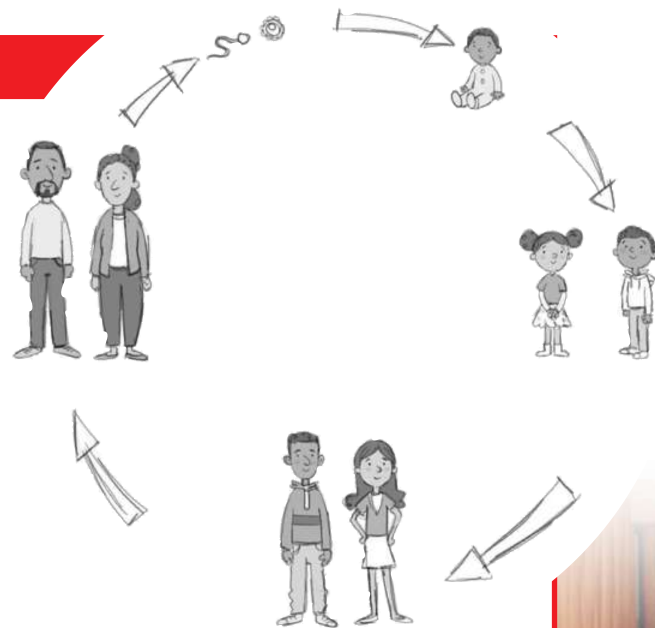
1 What is reproduction?

2 Why do living things need to reproduce?

3 Reproduction is part of the life cycle of all living things.
Look at the picture of the human life cycle.

a Which stage of the life cycle are you in now?

b Which stage or stages are your family members in?



fertilisation
hormones
menstruation
ova
puberty
reproductive system
sperm

Growing and developing

When you were born you were very small. You couldn't walk or talk or do anything for yourself. Now you are much bigger and can do many things for yourself.

Throughout your childhood you continue to grow and develop. You not only grow taller and heavier, but your body changes in other ways too. Some of the changes mean that you are becoming an adult and will be able to reproduce. This stage in your life is called puberty.

Puberty starts at different ages in boys and girls. In boys, puberty usually starts when they are about 13 years old. In girls, puberty often happens from the age of 11. The changes that happen during puberty don't happen all at once, but in stages. These changes are caused by chemicals in your body called hormones.

The first change you will notice is that you grow very fast. Boys can easily grow 10 cm in a year. Girls can grow up to 12 cm in a year as puberty starts.

One of the other changes you will notice is that your body grows more hair. In boys, hair begins to grow on the face, armpits and other parts of the body. In girls, hair begins to grow in the armpits and other parts of the body.

Your skin can also get oily. Many boys and girls get pimples during puberty.

A boy's shoulders and chest will get broader as his body muscles develop. His voice will change and become deeper.

A girl's hips will get wider and she will start to develop breasts. Her voice will also become a little deeper.

Activity

What do you know or want to know about puberty?

1. Write one or two sentences to explain in your own words what puberty is.
2. Make a table to compare your body before puberty with the changes you can expect in your body during puberty.
3. Write down a question you have about puberty on a piece of paper. Fold up the paper and give your question to your teacher. In the next lesson, your teacher will discuss answers to the questions your class has asked.

How am I doing?

Answer 'Very well', 'Quite well' or 'I need help' to these questions:

- How well can I explain what puberty is?
- How well can I identify the body changes that happen during puberty?

Changes in the reproductive system

There are also important changes that take place inside the bodies of boys and girls during puberty. These changes happen in the reproductive system and make it possible for a boy to become a father and for a girl to become a mother when they are older.

The main job of the reproductive system is to make special cells called sex cells that are needed for reproduction. In males, the sex cells are called sperm. In females, the sex cells are called eggs or ova (one egg is called an ovum). During reproduction, a sperm and an egg join together to form a new living being that will grow into baby. This process is called fertilisation.

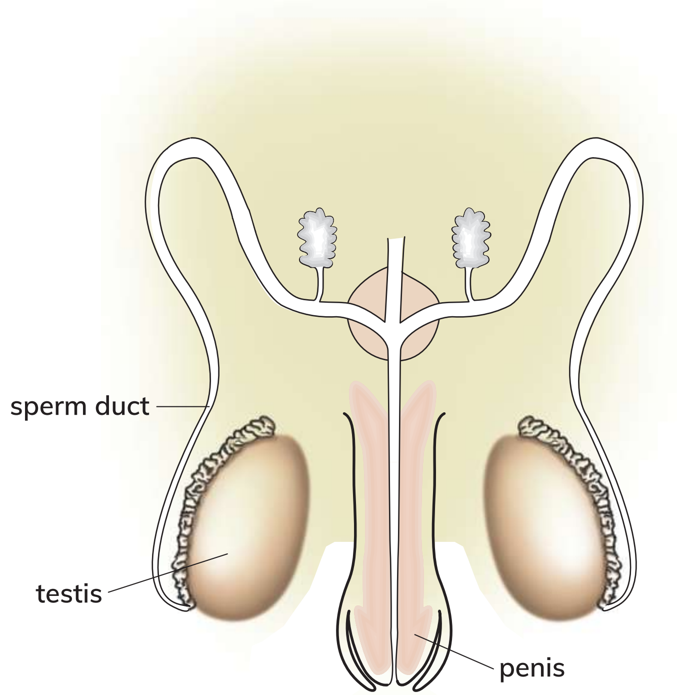
A boy's body starts to make sperm during puberty. In girls, ova start to develop. Menstruation in girls starts about a year after puberty begins. This is when an unfertilised egg is released from the body together with the lining of the uterus, which causes some bleeding. Menstruation happens about once a month but is often not regular until a girl is older.

The male reproductive system

The male reproductive organs include:

- two testes, which produce the sperm (one is called a testis)
- the sperm duct, which carries the sperm to the penis
- the penis, which transfers the sperm into the female's body.

The diagram shows the parts of the male reproductive system.

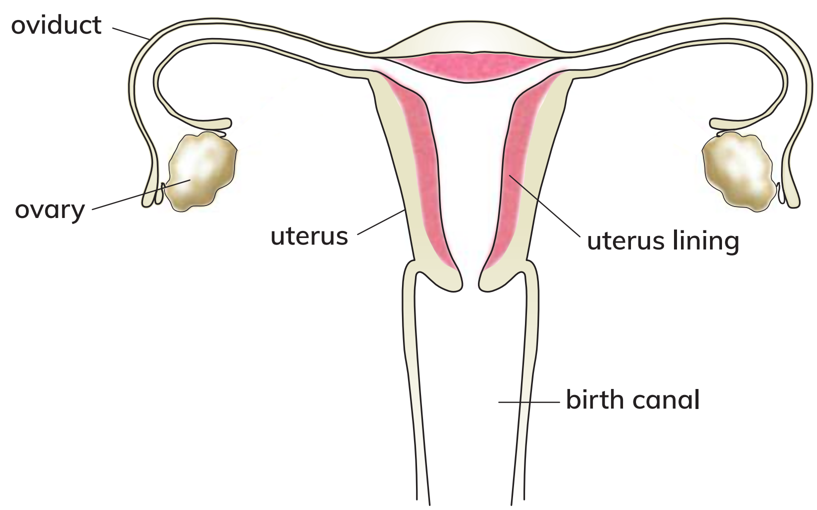


The female reproductive system

The female reproductive organs include:

- ovaries, which produce the ova or egg cells
- the uterus or womb, where the baby develops
- oviducts, where fertilisation takes place
- the birth canal, which receives the sperm from the male and through which the baby is born.

The diagram shows the parts of the female reproductive system.



Questions

1 What is the main job of the reproductive system?

2 a What are the male sex cells called?

  b What are the female sex cells called?

3 Which part of the male reproductive system has the following functions?

  a makes sex cells

  b carries sex cells to the penis

  c where the sperm leave the body

4 Which part of the female reproductive system has these functions?

  a makes sex cells

  b where fertilisation takes place

  c where the baby develops

  d where the sperm enters the body

What did I learn about myself in the different activities?

Have I changed any ideas I used to have about puberty and the reproductive system?

Look what I can do!

- [ ] I can describe body changes that happen during puberty.
- [ ] I can name the parts of the reproductive system.

1.4 Diseases

We are going to...

- find out about types of living things that cause diseases
- find information about diseases
- find out how our body stops us from getting infectious diseases
- find out about things we can do to prevent diseases from spreading
- group methods to prevent diseases
- draw a dot plot of results
- learn how to avoid being bitten by insects.

Getting started

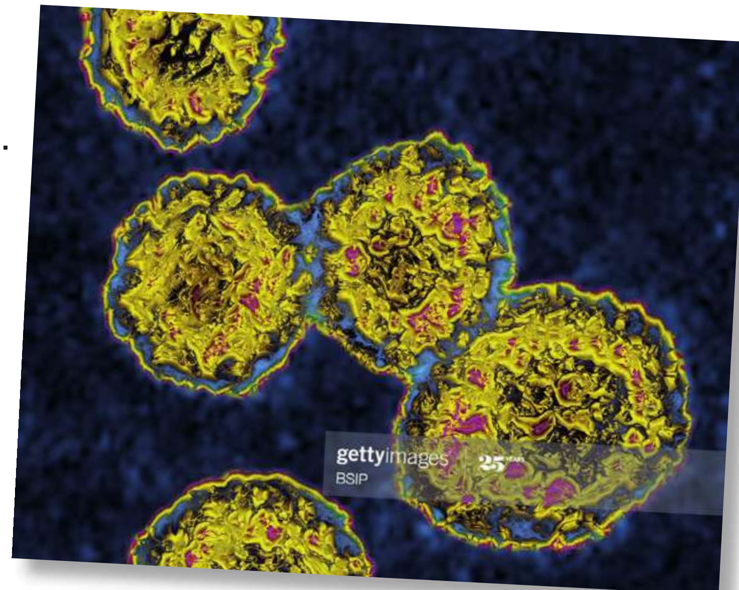
Write down the answers to the questions, then discuss your ideas with a partner before sharing them with the class.

1 The boy in the picture has chicken pox. Have you ever had chicken pox or any other similar disease?
2 What were the signs that you were ill?
3 Chicken pox is an infectious disease. What does this mean?

barrier	defence
host	hygiene
mucus	parasite
repellent	vector

Living things that cause disease

Diseases stop our bodies from working properly. There are different kinds of living things that cause disease. They infect other living things and grow and reproduce on or in the body of the living thing that they infect. Any living thing that lives on or in the body of another living thing is called a parasite. The living thing that a parasite infects is called the host.



Bacteria are very small living things that we can only see using a microscope. Bacteria cause diseases such as cholera and pneumonia. Not all bacteria are harmful.

Viruses are even smaller than bacteria. All viruses are harmful and cause diseases in humans, animals and plants. Some viruses even infect bacteria! Humans get flu, chicken pox and measles from viruses.

The yeast that we use to make bread rise is a fungus. Mushrooms that we eat are also fungi. But some fungi are parasites that cause diseases. Ringworm in humans and animals, athlete's foot in humans and rusts in plants are caused by fungi.

There are other kinds of parasites that also cause infectious diseases. Malaria and dysentery are two diseases caused by these parasites.

Questions

1 a What is a parasite?

  b Why are viruses and some bacteria and fungi parasites?

2 Make a table of the different kinds of living things that cause diseases and name two examples of a disease that each one causes.

Activity 1

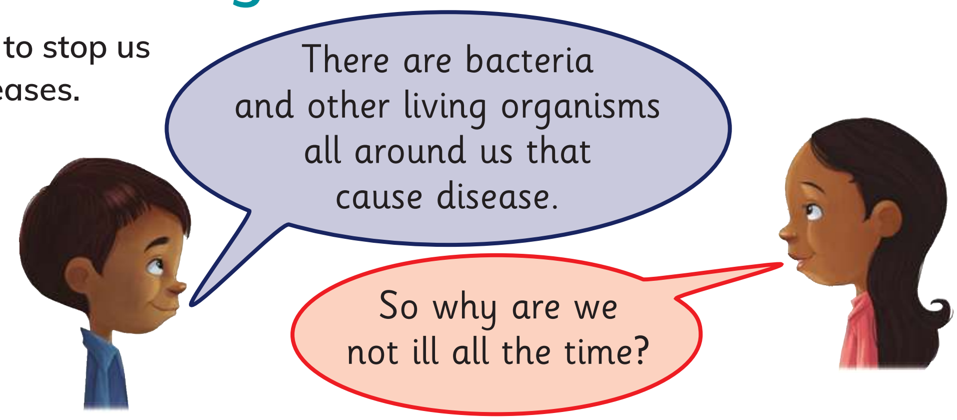
Find information about diseases

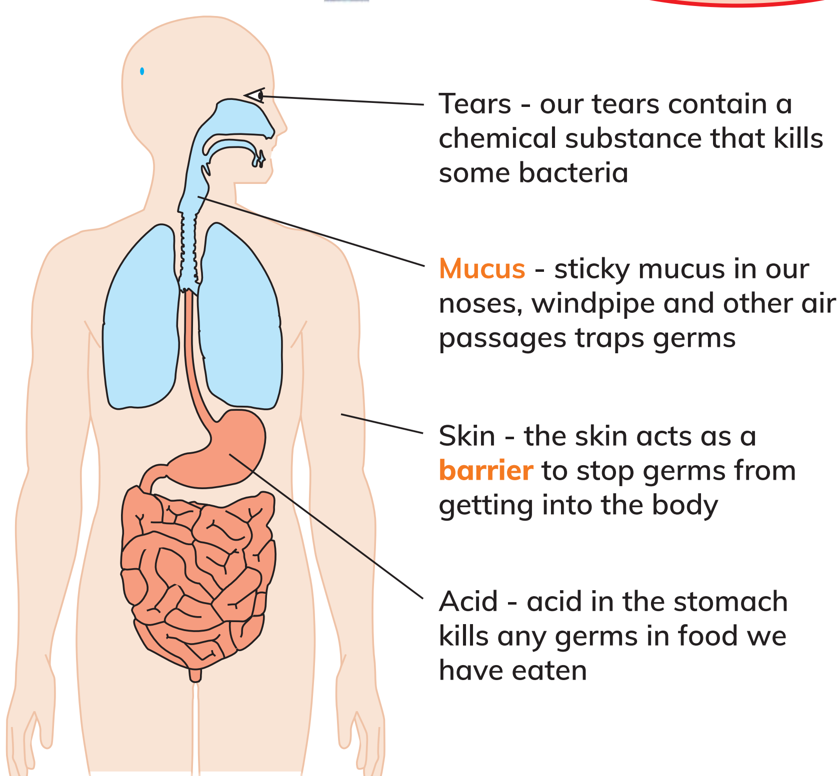
Do some research to find out the following:

- the word we use to describe any living thing that causes a disease
- the names of the parasites that cause malaria and dysentery
- how the parasites that cause malaria and dysentery are spread.

The body's defences against diseases

Our body has different ways to stop us from being infected with diseases. We call these the body's **defences** against diseases.





Controlling the spread of diseases

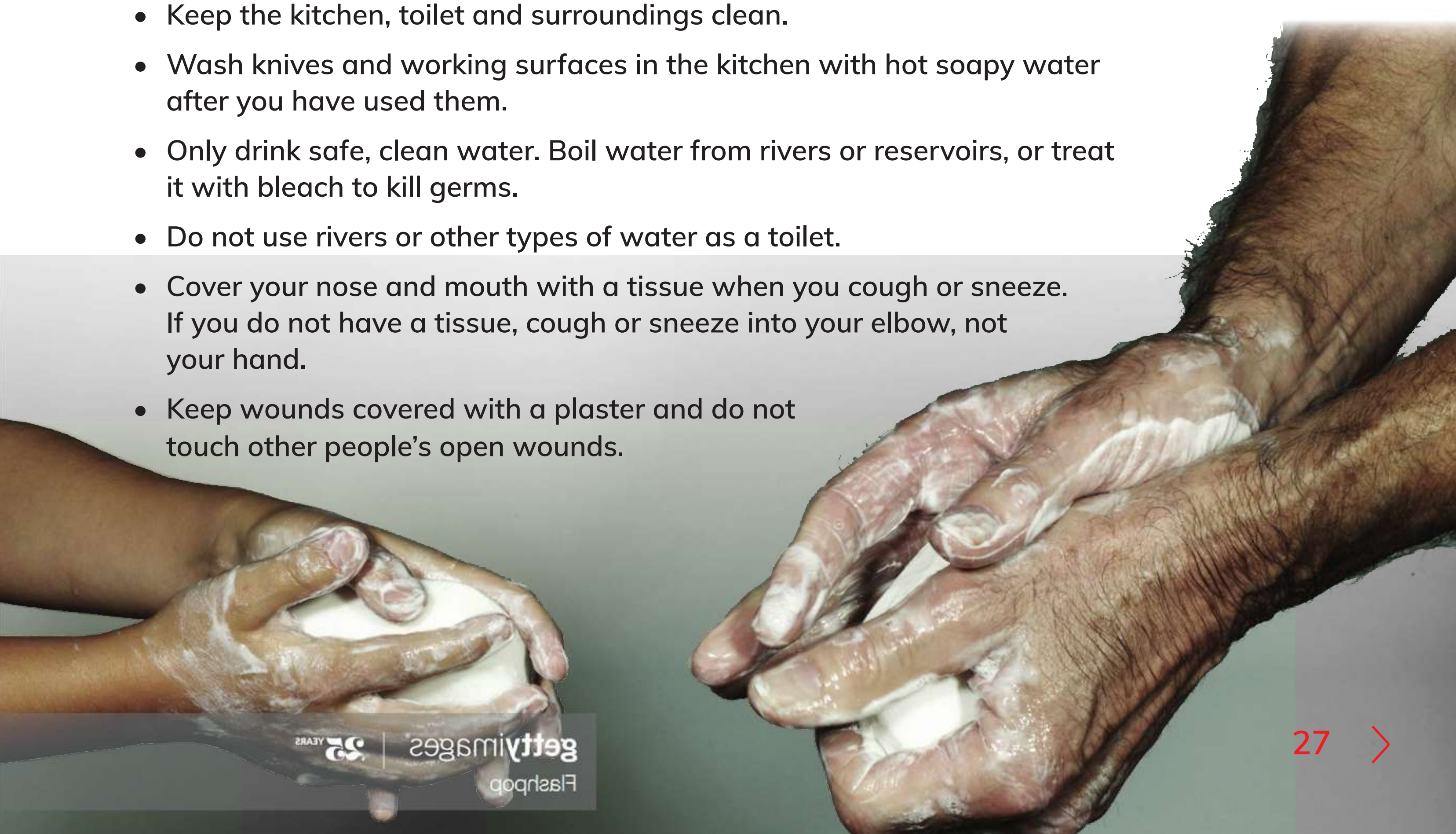
Diseases can be spread by body contact and in food, in water and in the air. There are different ways we can help to control the spread of diseases.

Good hygiene

Many diseases are spread in food, water and body fluids. We can help prevent the diseases from spreading by good hygiene. This means keeping yourself and the things around you clean.

These are some of the things we can do:

- Wash your hands with soap and water before eating or working with food and after going to the toilet. Also dry your hands well on a clean towel.
- Wash your hands after handling animals, cleaning up animal wastes or gardening,
- Wash raw unpeeled fruits and vegetables before eating them.
- Keep food covered.
- Do not leave food at room temperature, especially when the weather is hot, as bacteria and fungi grow faster when it is warm.
- Keep the kitchen, toilet and surroundings clean.
- Wash knives and working surfaces in the kitchen with hot soapy water after you have used them.
- Only drink safe, clean water. Boil water from rivers or reservoirs, or treat it with bleach to kill germs.
- Do not use rivers or other types of water as a toilet.
- Cover your nose and mouth with a tissue when you cough or sneeze. If you do not have a tissue, cough or sneeze into your elbow, not your hand.
- Keep wounds covered with a plaster and do not touch other people's open wounds.



Activity 2

Group methods to prevent diseases

We use different methods to prevent the spread of different types of diseases.

Sort and group the hygiene methods you have learnt about into these groups:

- Ways to prevent diseases spread in food.
- Ways to prevent diseases spread in water
- Ways to prevent diseases spread in body fluids

Present your answer in the form of a table.

Think like a scientist

Analyse hygiene methods that people use

Class 5 did a survey of people in their local community to find out which hygiene methods people used. These are their results.

Method to prevent infectious diseases	Number of people who use the method
wash hands after going to toilet	10
wash hands before working with food	5
wash hands after working with food	4
keep the kitchen, toilet and surroundings clean	12
cover nose and mouth when coughing or sneezing	7

1 Draw a dot plot of the results.

2 a Which hygiene method do most people use?

  b Which hygiene method do fewest people use?

3 Why do you think people should wash their hands with soap and water and not just water?

4 Why should people wash their hands before and after working with food?

5 Why should we cover our nose and mouth when we cough or sneeze?

6 Why do you think it is important to dry our hands well with a clean towel?

Continued

How are we doing?

Ask your partner these questions:

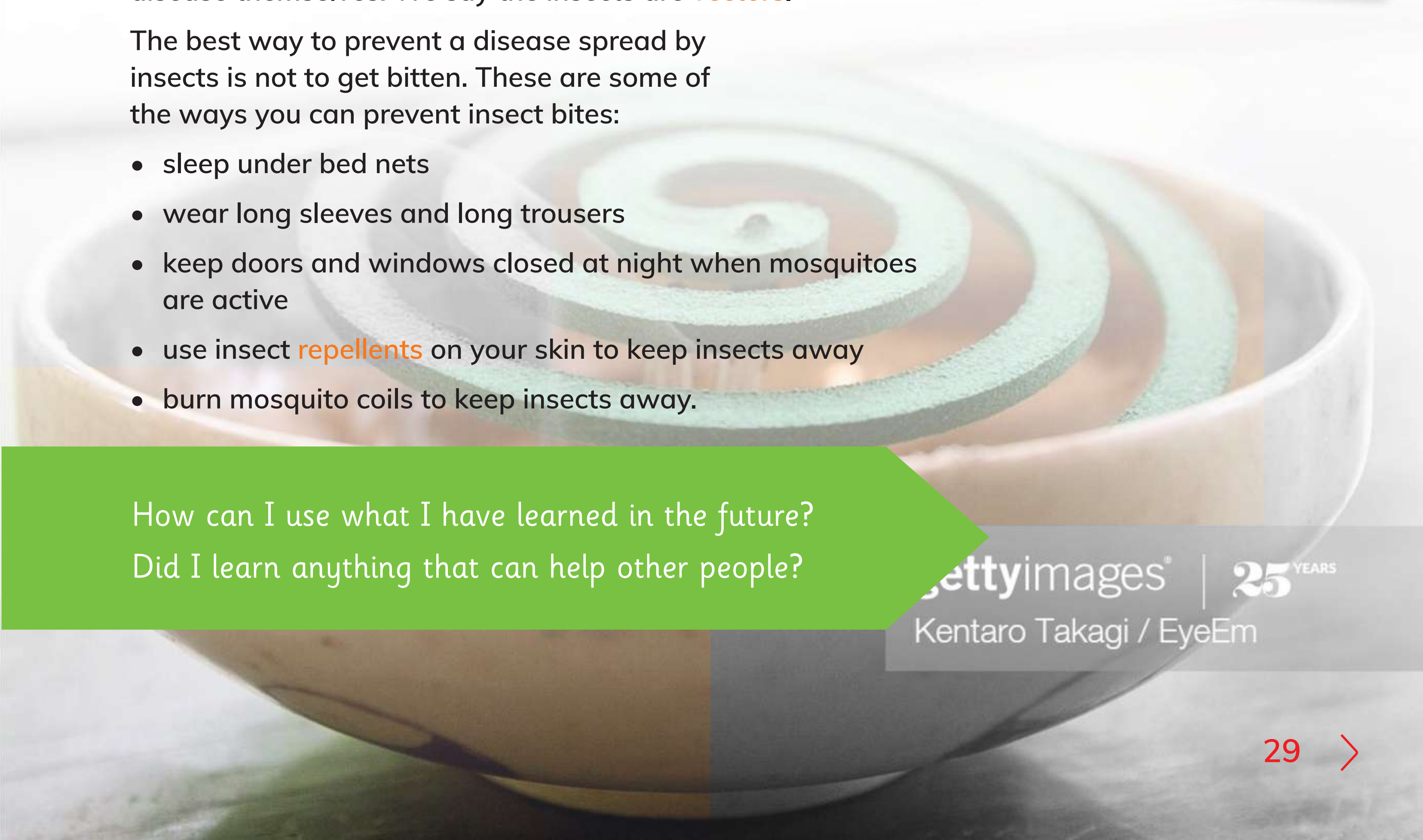
- Can you draw a dot plot of results?
- Can you say why we should use the different hygiene methods to prevent diseases spreading?

Preventing insect bites

Some serious diseases, such as malaria, yellow fever and sleeping sickness, are spread by insects. Malaria and yellow fever are spread by mosquitoes. Sleeping sickness is spread by the tsetse fly. The insects don't cause the disease, but they spread the disease parasite when they bite you. The insects also do not get the disease themselves. We say the insects are vectors.

The best way to prevent a disease spread by insects is not to get bitten. These are some of the ways you can prevent insect bites:

- sleep under bed nets
- wear long sleeves and long trousers
- keep doors and windows closed at night when mosquitoes are active
- use insect repellents on your skin to keep insects away
- burn mosquito coils to keep insects away.



How can I use what I have learned in the future?
Did I learn anything that can help other people?

Look what I can do!

- [ ] I can name types of living things that cause diseases.
- [ ] I can find information about diseases.
- [ ] I can say how our body stops us from getting infectious diseases.
- [ ] I can describe things we can do to prevent diseases from spreading.
- [ ] I can group methods to prevent diseases.
- [ ] I can draw a dot plot of results.
- [ ] I can say how to avoid being bitten by insects.

Project: The circulatory system

Part 1: Discovery of how the circulatory system works

People have tried to explain how the circulatory system works for more than two thousand years. One of the main books of Chinese medicine, written 2600 years ago, stated that 'all of the blood in the body is pumped by the heart, completes a circle and never stops moving'.

Galen was a surgeon and doctor who lived in what is now modern-day Turkey about 1900 years ago. At that time, scientists already knew that there two types of vessels in the body – arteries and veins. Galen thought that the liver produced blood that was then carried to the rest of the body in the veins. The body then used up the blood for energy as it flowed to the different organs. Galen also stated that the arteries contained blood, not air, which was what earlier scientists had thought. He understood that blood went from one side of the heart to the other side of the heart, but he didn't know how that happened. He thought there were tiny holes in a wall between two sides of the heart.

Continued

Ibn al-Nafis was an Arab physician from Syria who lived 800 years ago. In about the year 1240 he discovered that blood moves from the right side of the heart to the lungs and back to the left side of the heart. He was the first person to challenge Galen's idea that blood could pass directly from the right side of the heart to the left side of the heart.

William Harvey was an English doctor who lived 400 years ago. At that time doctors and scientists thought that the lungs moved the blood around the body. They also thought the heart's job was to control our feelings. Harvey observed water pumps in London which gave him the idea that the heart pumped blood around the body. He studied the heart and blood vessels and carried out experiments. He was very thorough in his work and spent many hours repeating experiments and going over every detail. He also read the work of early doctors to help him build up his own ideas.

Harvey's results showed him that the heart works by muscle contraction to pump blood to body organs and that blood is carried away from heart by arteries and returns to heart through veins. He observed that in one hour the heart pumps more than the body's weight in blood. This showed him that the body did not use up the blood that flowed to body organs. In 1628 Harvey explained how blood flows in one direction throughout the body and that gases enter and leave the blood in the lungs.

Just over 30 years later, in 1661, an Italian scientist called Marcello Malpighi used a microscope to observe capillaries for the first time. He suggested that capillaries connected the arteries and veins which allowed the blood to flow back through the body in a continuous pathway. We now know that he was correct.

Questions

1 a What incorrect ideas did doctors and scientists have about circulation up to 400 years ago?

  b What correct ideas did doctors and scientists have about circulation before William Harvey's discoveries?

2 Compare the ideas from the ancient Chinese medical book with Malpighi's findings two thousand years later. How are they the same? How are they different?

Continued

3 What observation made William Harvey start to think about how the heart works?

4 a How did Harvey obtain evidence about how the circulatory system works?

b Why did he repeat his experiments?

5 a How did Harvey show that the body does not use up the blood that flows to the organs?

b Name three other discoveries that William Harvey made about the circulatory system.

Part 2 Draw a timeline of discoveries about the circulatory system

1 Draw a timeline to show the discoveries made by different people about the circulatory system. You should include the date and a description of the discovery or event. Think of ways to decorate your timeline to make it look attractive and interesting.

2 Find out who was the first person to do each of the following and when:

- transplanted the first human heart
- discovered that humans can have different blood types
- invented the first stethoscope to listen to the heart beating
- discovered that a substance in the blood called haemoglobin carries oxygen.

Add this information to your timeline.

Check your progress

1 State whether each of the following statements is true or false. Correct the false statements.

a The heart pumps air around the body.

b Your heat beats faster when you exercise.

c Your pulse rate tells you how fast you are exercising.

d Blood moves around the body in special tubes called blood vessels.

e The veins carry blood to all parts of the body.

2 Marcus and Arun measured the pulse rate of some of their friends before and after exercising for three minutes. These are their results.

Name	Pulse rate before exercise	Pulse rate directly after exercise
Marcus	91	120
Arun	88	122
Jamal	90	128
Kai	89	125

a What equipment did they need to measure the pulse rates?

b Draw and label a bar graph of the pulse rates measured.

c Use the results to make a conclusion.

d Predict what would happen to the pulse rates if they were measured 10 minutes after exercise. Give reason for your prediction.

3 Name each of the following:

a the body organs used for breathing

b the gas we need to breathe in

c the gas our bodies must get rid of

d the substance that carries the gases around the body

e the muscle that helps us breathe

f the part of the skeleton that protects the breathing organs

Continued

4 a What is puberty?

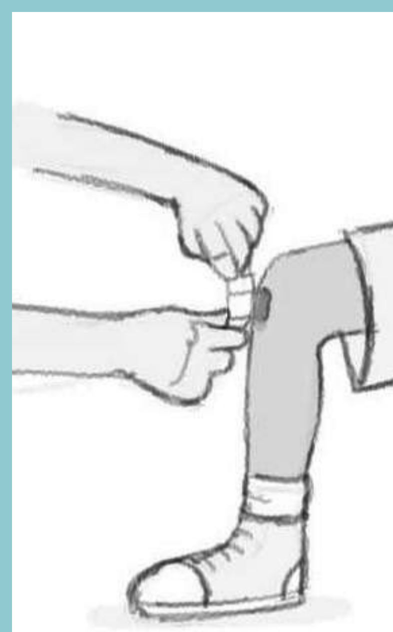
b Describe two body changes that happen in both boys and girls during puberty.

5 a Match each of the body's defences with the way it helps to protect the body from disease.

Body defence
tears
mucus
stomach acid
skin

How it protects the body from disease
traps germs
stops bacteria entering the body
contain a chemical substance that kills some bacteria
kills bacteria in food we have eaten

b Explain why we should clean cuts and wounds and cover them with a plaster.



2 Materials: properties and changes

2.1 Properties of substances

We are going to...

- learn that the temperature at which a substance changes state is a property of the substance
- learn about the difference between boiling and evaporation
- measure temperature
- collect and record observations and measurements in tables
- work safely in practical investigations
- draw graphs of results and measurements and make conclusions
- plan a fair test and choose materials and equipment to use
- identify risks and how to work safely when planning a practical investigation
- find out about the properties of gases
- use scientific knowledge to make a prediction and use results to say if a prediction was accurate.

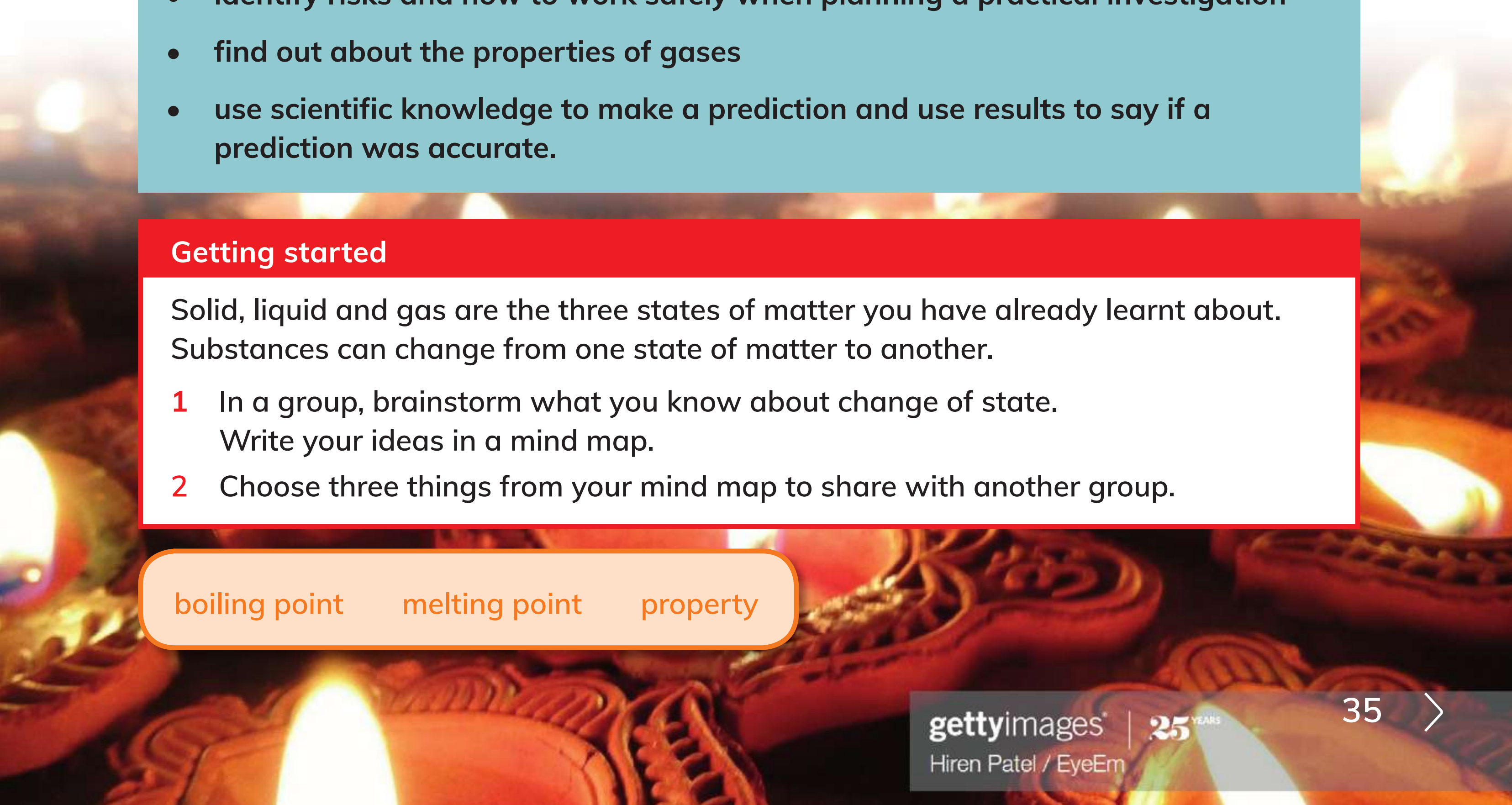
Getting started

Solid, liquid and gas are the three states of matter you have already learnt about. Substances can change from one state of matter to another.

1 In a group, brainstorm what you know about change of state. Write your ideas in a mind map.

2 Choose three things from your mind map to share with another group.

boiling point melting point property



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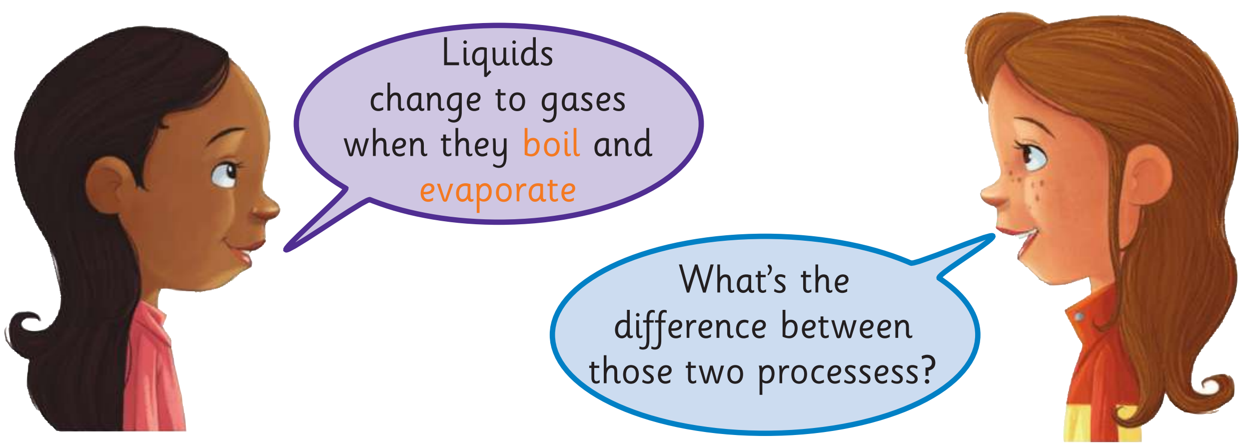
Change of state

You should already know that substances change state when they are heated or cooled enough. For example, when we heat ice it melts and becomes liquid water. Ice melts at a temperature of 0 °C. The temperature at which a solid becomes a liquid is the melting point. Gold is also a solid. The melting point of gold is 1064 °C.

Melting point is a property of a substance. A property is something about substance that allows us to tell it apart from other substances. This means that each substance has its own melting point.

Boiling point is also a property of a substance. Boiling point is the temperature at which particles throughout a liquid have enough energy to change to a gas. Each substance boils at a certain temperature. For example, pure water boils at 100 °C, vinegar boils at 118 °C and liquid gold boils at 2856 °C.

Boiling and evaporation



When a liquid boils, all the particles in the liquid have enough energy to become a gas. This is different to evaporation, which happens when particles on the surface of a liquid change into a gas. Most liquids boil only when they are heated. Evaporation can occur at any temperature.

Activity 1

Compare boiling and evaporation

1 Talk about these questions with a partner:
   a How do you know a liquid is boiling without measuring the temperature?
   b How can you tell if a liquid is evaporating?
   c Which process is faster, boiling or evaporation? Why do you think this?
2 Make labelled drawings to show the difference between boiling and evaporation. Think about what happens to the particle of the liquid in both processes.

Think like a scientist 1

Measure and compare melting points

You will need: three different solids, three pans, a hotplate, a thermometer, a stopwatch or digital watch

This activity is a teacher demonstration.

Safety: Do not touch the hot plate or pan: it can burn you.

You teacher will do the following:

1 Place a solid in a pan.
2 Heat the solid substance until it melts. Remove the pan from the hot plate as soon as the substance melts.
3 Measure the temperature of the melted substance. You should record the reading in a table.
4 Repeat steps 1–3 with the two other solids.

Questions

1 Which substance had:
   a the highest melting point?
   b the lowest melting point?

Continued

2 Draw a bar chart of the results.

3 Write a conclusion for the investigation.
Remember a conclusion is what you found out in the investigation.

4 Would the melting points change if you heated more of the substance in each pan? Explain your answer.

5 Why is the melting point of a substance always lower than its boiling point?

Think like a scientist 2

Plan a test to compare boiling points of substances

Work in a group to plan a fair test to compare the boiling points of different substances.

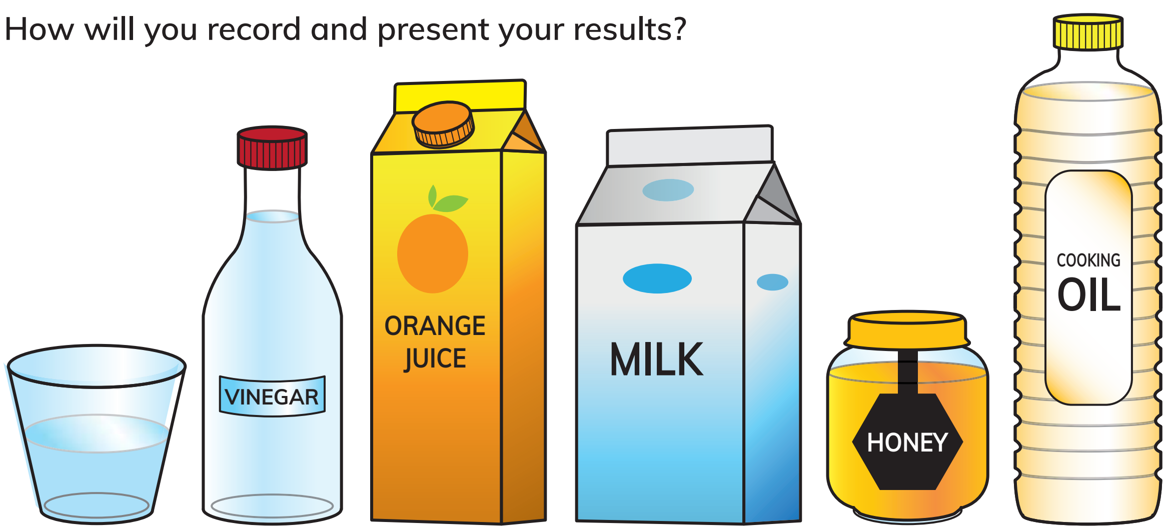
1 In your test, which variables will you:
- change?
- keep the same?
- measure?

2 What materials and equipment will you need?

3 What will you do to compare the boiling points of the different substances?

4 Are there any dangers or risks in your investigation?
How will you work safely?

5 How will you record and present your results?



Continued

How am I doing?

Answer 'Very well', 'Quite well' or 'I need help' to each of the questions.

How well can I:

- identify different variables in a fair test investigation?
- choose equipment and materials to use in an investigation?
- identify risks and dangers in an investigation and plan how to work safely?
- identify the best way to record and present results in an investigation?

Properties of gases

Air is a mixture of gases. Gas is one of the states of matter.
All matter has these properties:

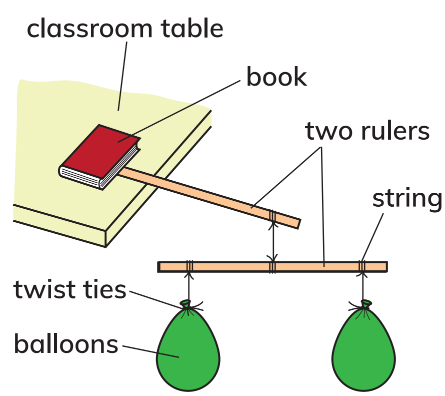
- It takes up space.
- It has mass.

Think like a scientist 3

Investigate the properties of gases

You will need:
two balloons of the same size, two rulers, string, a heavy book, twist ties, scissors, sticky tape, safety goggles

Safety: Take care when handling heavy books



1 Blow up the balloons to the same size and tie them off tightly with twist ties.
2 Measure and cut three pieces of string 15 cm long.
3 Use two pieces of string to tie the balloons onto one of the rulers as shown in the picture. Keep the balloons the same distance from the end of the ruler.
4 Put the second ruler near the edge of a table and hold down one end with a heavy book. The other end should stick out over the edge of the table.
5 Use the third piece of string to hang the ruler and balloons from the second ruler.
6 Carefully move the balloons so that they are balanced on the hanging ruler. Tape the strings in place so that they cannot move.
7 a You are going to loosen the twist tie on one balloon. Predict what will happen when you do this. Say why.
  b Loosen the tie and observe what happens. Was your prediction correct?
  c Make a drawing of your observation.

Questions

1 How does the investigation show that gases take up space?
2 How does the investigation show that gases have mass?
3 How did you work safely in the investigation?

How did the practical work help me learn about properties of substances?
Has the practical work made me change any of my ideas about gases?

Look what I can do!

- [ ] I can understand that the temperature at which a substance changes state is a property of the substance.
- [ ] I can describe the difference between boiling and evaporation.
- [ ] I can measure temperature.
- [ ] I can collect and record observations and measurements in tables.
- [ ] I can work safely in practical investigations.
- [ ] I can draw graphs of results and measurements and make conclusions.
- [ ] I can plan a fair test and choose materials and equipment to use.
- [ ] I can identify risks and how to work safely when planning a practical investigation.
- [ ] I can find out about the properties of gases.
- [ ] I can use scientific knowledge to make a prediction and use results to say if a prediction was accurate.

2.2 Thermal and electrical conductors

We are going to...

- learn that conducting heat and electricity are properties of a substance
- collect and record observations and measurements in tables
- work safely in practical investigations
- suggest how to improve an investigation
- draw graphs of results and measurements and make conclusions
- group substances according to their properties
- identify the type of scientific enquiry used in an investigation
- use scientific knowledge to make a prediction
- use results to say if a prediction was accurate
- identify and describe patterns in results.

Getting started

Have you noticed that when you put a cold, metal teaspoon into a hot cup of tea, the teaspoon handle feels warm after a while?

1 Talk about why this happens.

2 Draw an energy chain to help explain your answer.

conduction
electrical conductors
thermal conductors

Substances can conduct heat

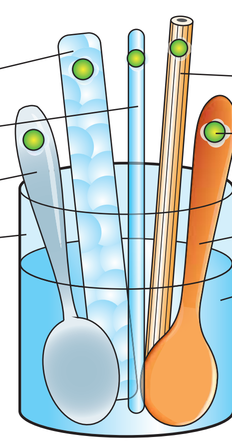
You should already know that heat can be transferred from one object to another. This type of energy transfer is called conduction. Substances and materials that conduct heat well are called thermal conductors.

Think like a scientist 1

Investigate how well different materials conduct heat

You will need:
a beaker of hot water, a metal teaspoon, a plastic teaspoon, a glass rod, a pencil, a long, thin piece of polystyrene foam, five beads, petroleum jelly

1. Put a small bit of petroleum jelly of the same size onto one end of each of the materials. Push a bead into the petroleum jelly.
2. Your teacher will pour hot water into a beaker. Put each of the different materials into the beaker.



Safety: Don't touch the hot water. Be careful not knock over the beaker of hot water.

Continued

3 Which bead do you think will fall off first? Say why.

4 Draw a table to record the order in which the beads fall off the materials.

5 a Which bead fell off first?

b Was your prediction correct?

6 a Which bead fell off last?

b What did this show you about that material?

7 Write a conclusion for the investigation from your observations.

8 Suggest a way to improve the investigation so that you can draw a graph of your results.

9 Which types of scientific enquiry did you use in the investigation? Explain your answer.

How am I doing?

Answer 'Very well', 'Quite well' or I need help' to each of the questions.

How well can I:

- make a prediction with reasons?
- record observations in a table?
- use observations to write a conclusion?
- suggest how to improve an investigation?

Some materials and substances conduct heat better than others. How well a substance can conduct heat is a property of the substance. Metals are good conductors of heat. Silver is the best conductor of heat. Non-metals, such as glass and plastic, are not good conductors of heat.

Questions

1 Explain in your own words what a thermal conductor is.
2 Why do you think pots and pans are made from metal?
3 Why do you think the handles of pots and pans are made from plastic?
4 In which cup will your tea stay warm longest: a stainless steel cup, a glass cup or a polystyrene foam cup? Explain why.
5 Find out the name for materials and substances that are not good conductors of heat.

Substances can conduct electricity

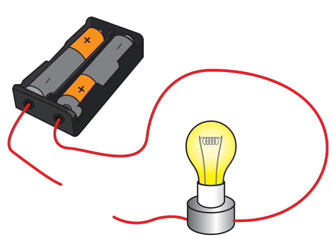
Some materials and substances are able to conduct electricity. They are called electrical conductors. The ability to conduct electricity is a property of materials and substances. You should already know that metals are substances that conduct of electricity. Do other substances also conduct electricity?

Think like a scientist 2

Investigate how well different substances conduct electricity

You will need:
two cells; a cell holder, a 1.5 V lamp, three 15 cm pieces of copper connecting wire, steel paper clip, aluminium foil, tap water, sugar, pencil graphite

1 Set up your circuit as shown in the diagram



Continued

2 Predict how well each of the substances you are going to test will conduct electricity. Write your predictions in a table. Use ticks to show your prediction and results:

0 ticks lamp doesn't shine

1 tick ✓ lamp is dim

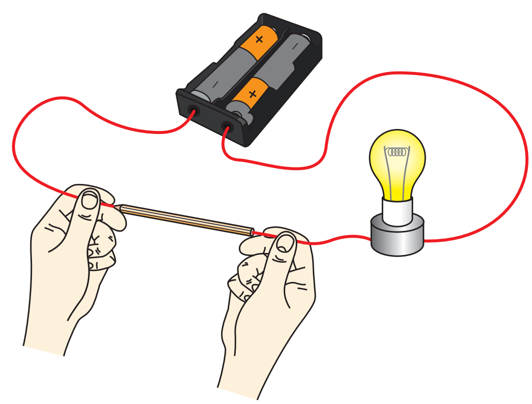
2 ticks ✓✓ lamp is bright

3 a What substance is the conducting wire made of?

 b Touch the free ends of the conducting wire together. How brightly does the lamp shine?

4 a Touch the free ends of the wire to the steel paper clip. How brightly does the lamp shine?

 b If the lamp does not light up, test the substance again to be sure of your result.



5 Repeat Step 4 with all the other substances you are going to test. For each substance, observe the brightness of the lamp.

6 a Record your observations in the table.

 b Are your results reliable? How can you find out?

Questions

1 How well did your results match your predictions?

2 Which of the substances you tested were metals?

3 a Which substance that you tested conducted electricity best?

 b Which substance that you tested conducted electricity worst or not at all?

4 What can you conclude from your investigation?

5 Group the substances you tested into substances that conduct electricity and substances that do not conduct electricity.

6 Which type of scientific enquiry did you use in the investigation?

Activity 1

Compare thermal and electrical conductors

The table shows measurements of how well some substances conduct heat and electricity.

	How well the substance conducts...	
Substance	Heat (W/m^{-K})	Electricity (W/m^{-K})
aluminium	237	37
copper	386	59
graphite	168	1
brass	150	16
steel	80	10

1 Draw a scatter graph of the measurements.
Label each data point you plot with the name of the substance.

2 Which substance is:

a the best conductor of heat?

b the best conductor of electricity?

c the worst conductor of heat?

d the worst conductor of electricity?

3 Describe the pattern you observe.

4 Identify and describe any measurements that do not fit the pattern.

5 Use the graph to predict the measurement for conducting heat for a substance with a value of 14 for conducting electricity.
Plot the value on the graph in a different colour.

6 Suggest a conclusion you can make from the data and your graph.

How well did I work in a group?
What did I find easy to do?
What do I need more help with?

Look what I can do!

- ☐ I can understand that conducting heat and electricity are properties of a substance.
- ☐ I can collect and record observations and measurements in tables.
- ☐ I can work safely in practical investigations.
- ☐ I can suggest how to improve an investigation.
- ☐ I can draw graphs of results and measurements.
- ☐ I can make conclusions from results and measurements.
- ☐ I can identify the type of scientific enquiry used in an investigation.
- ☐ I can group substances according to their properties.
- ☐ I can use results to say if a prediction was accurate.
- ☐ I can identify and describe patterns in results.

2.3 Reversible changes

We are going to…

- find out about and describe changes to substances that are reversible
- choose materials and equipment to use
- identify risks and work safely when doing practical work
- use the particle model to explain how temperature affects dissolving
- use scientific knowledge to make a prediction and use results to say if a prediction was accurate
- collect and record observations and measurements in tables
- decide if a test is fair
- make a conclusion from results and measurements
- ask a question to investigate and choose a type of scientific enquiry to find the answer

Getting started

You will need:
ice cubes, saucer, watch

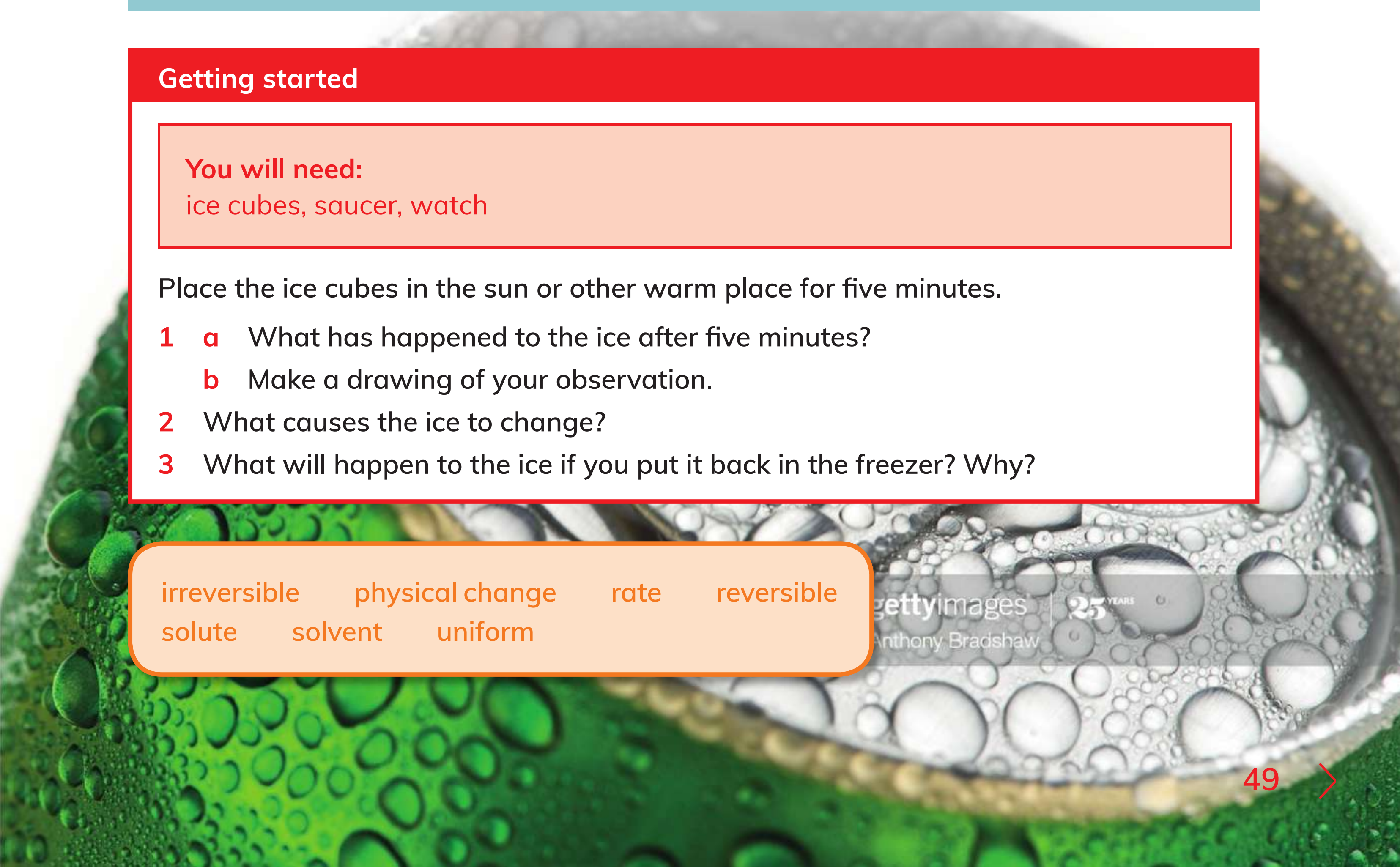
Place the ice cubes in the sun or other warm place for five minutes.

1 a What has happened to the ice after five minutes?
  b Make a drawing of your observation.

2 What causes the ice to change?

3 What will happen to the ice if you put it back in the freezer? Why?

irreversible   physical change   rate   reversible
solute   solvent   uniform

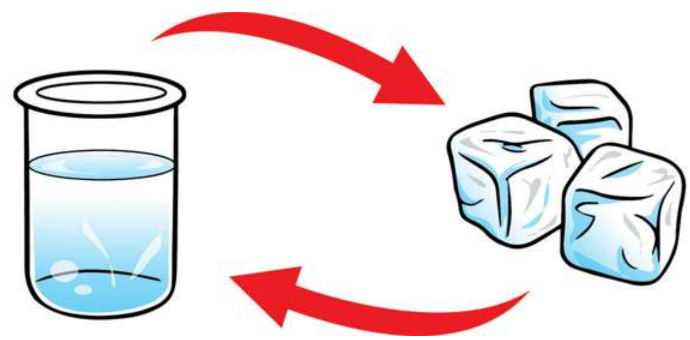


Changes to substances

In a warm place, solid ice melts to become liquid water. This is a change of state. A change of state is a physical change.
A physical change alters the how a substance looks or feels.
The substance does not change into a new substance.

When you put the water back in the freezer it becomes a solid again. We say that the change is reversible. This is because we can change solid ice to liquid water and also change liquid water back to solid ice.

Heating causes ice to melt into liquid water. When the water loses heat and cools it becomes solid again. The diagram shows the change of state between ice and water.



We can show the change of state in writing like this:

Liquid water $\underset{\text{Cooling}}{\overset{\text{Heating}}{\rightleftharpoons}}$ solid ice

What happens when we burn a match? Can the match change back to the way it was? Sometimes the changes to substances cannot be reversed. We call these irreversible changes. Some irreversible changes turn one substance into another substance. This means that there is chemical change. For example, when we burn a match the wood changes into a black substance called carbon.

Questions

1 When you mix boiling water with jelly powder it becomes a liquid. In the fridge it becomes solid. Can we make jelly change back to a liquid? Draw a simple flow diagram to explain your answer.

2 Does boiling an egg cause a reversible or irreversible change? Explain why.

Think like a scientist 1

Demonstrate a reversible change

1 Think of a reversible change to a substance. Describe the change.

2 a Decide how you could demonstrate this reversible change.

b How will you work safely?

3 Your teacher will put out some materials and equipment. Choose and collect the materials and equipment you will need.

4 a Demonstrate the reversible change you chose to another group. Ask the group to describe the change that takes place.

b Explain how to change the substance back to the way it was before you changed it.

How are we doing?

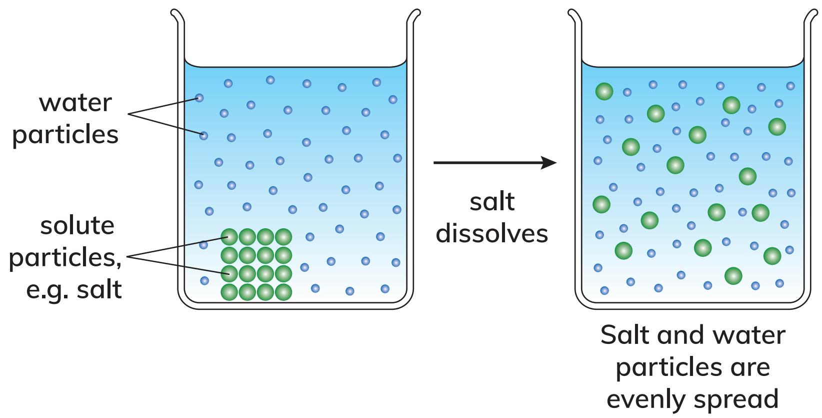
As a group, point to one of the faces to answer the questions. ☺ or 😐 or ☹

- Could we think of reversible change to demonstrate?
- Could we choose and use suitable materials and equipment?
- Could we demonstrate that the change is reversible?

Dissolving

Some substances can dissolve in water or other liquids. For example, sea water is salty because there is dissolved salt in the water. You should remember that the substance that dissolves is called the solute. The substance in which the solute dissolves is called the solvent. Together, the solute and solvent form a solution.

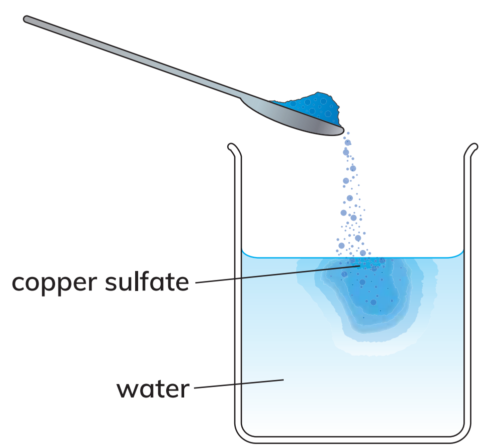
When a solute dissolves, the particles of the solute move between the solvent particles. The solute particles spread evenly in the solvent. Because of this you cannot see the solute in a solution after it has dissolved. We say that a solution has a uniform appearance. This means that it looks the same throughout. The picture shows how the solute particles spread when they dissolve in water.



Activity

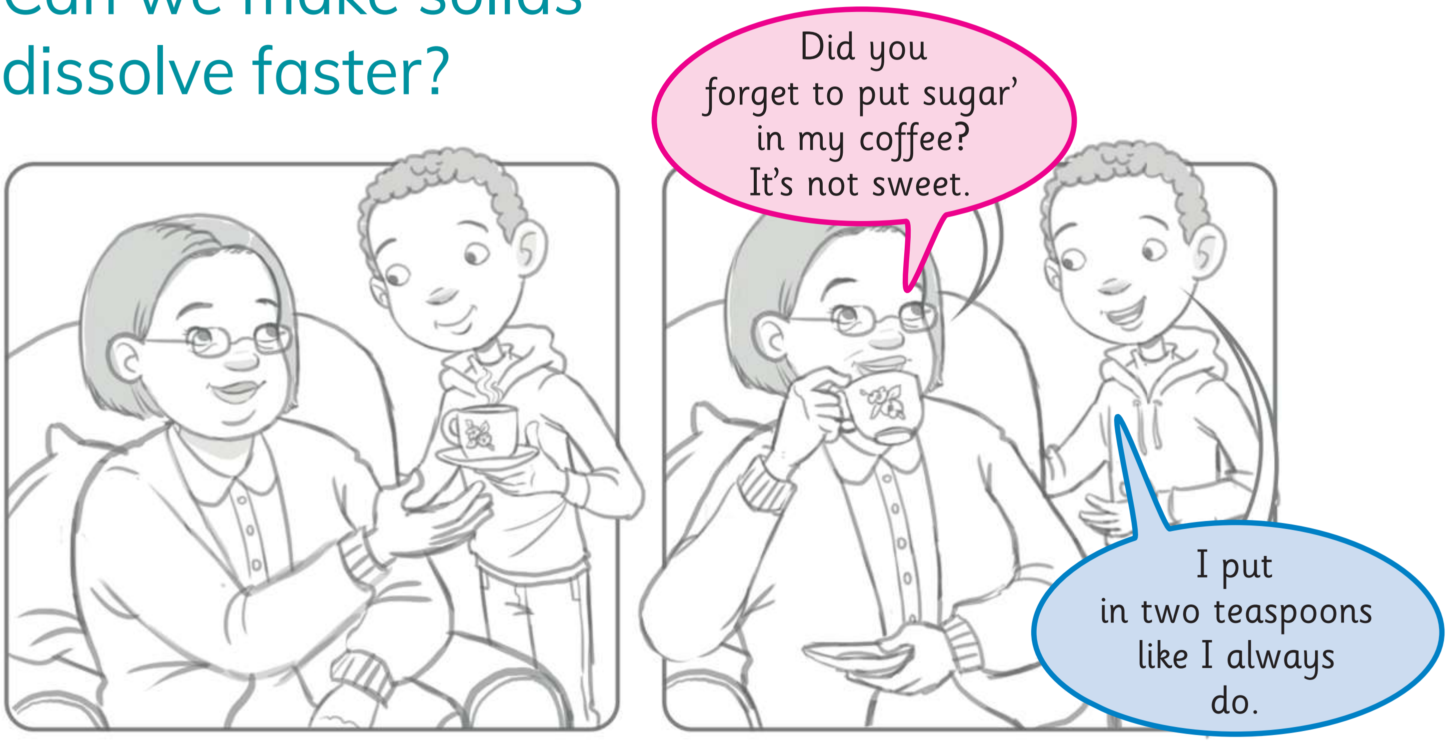
Describe dissolving

The picture shows dissolving.



1 Which substance is the solute? How do you know this?
2 Which substance is the solvent?
3 Draw a picture of the solution after all the solute has dissolved.
4 Describe to a partner what happens when a substance dissolves.
5 Is dissolving a reversible change? Say why or why not.

Can we make solids dissolve faster?



Why do you think the coffee tasted bitter? How could Marcus make the coffee taste sweeter without adding any more sugar?

The coffee and sugar form a solution. The sugar will dissolve faster if Marcus stirs the solution. Stirring is one way to make solid solutes dissolve faster. Stirring causes the particles of the solute to spread out into the spaces between the particles of the solvent more quickly. We say that stirring increases the rate at which a solute dissolves. The rate is how fast something happens.

There are other factors that make solids dissolve faster. Have you ever tried to make coffee with water from the fridge? Why do we use hot water?

Think like a scientist 2

Does water temperature affect the rate of dissolving?

You will need:
sugar, glass jars, cold water, hot water, teaspoon, a measuring cylinder, a stopwatch or timer

Safety: Don't touch the hot water. Be careful not knock over the jar of hot water.

1. Does sugar dissolve more quickly in hot or cold water? Make a prediction and say why you think this.
2. Stir a teaspoon of sugar into a 100 ml of cold water in a glass jar.
3. Stir a teaspoon of sugar into a 100 ml of hot water in a glass jar.
4. Time how long it takes for the sugar to dissolve in both jars.
5. Record your results in a table.
6. a In which jar did the sugar dissolve quickest? Suggest a reason for this.
   b Was your prediction correct?
7. How did you make sure your test was fair?
8. Write down what you conclude about the effect of temperature on dissolving a solute.

The particles in matter are always moving. When we increase the temperature of a substance, the heat adds energy to the particles of the substance. This energy causes them to move faster and spread out more.

In a heated solvent, the particles of the solute also gain energy and move faster than in a cooler solvent. This allows the particles of the solute to spread through the solution more easily, so the solute dissolves faster.

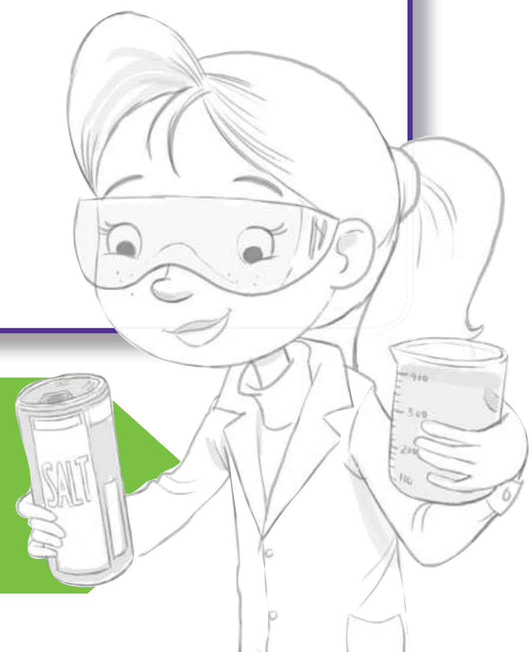
Questions

1. What does the rate of dissolving mean?
2. Name two factors that affect the rate of dissolving.
3. a How does heating affect the particles in a solution?
   b Explain how this affects dissolving.
4. Explain why sugar will dissolve on its own in a cup of cold water if we leave it long enough.

Think like a scientist 3

Ask and investigate a question about dissolving

1. With a partner, think of a question about dissolving that you would like to find the answer to.
2. Decide on the type of scientific enquiry you will use to answer your questions, for example, a fair test, doing research or observing over time.
3. Find out the answer to your question.
4. Make a presentation to share with the class about your findings.



Am I happy with the way I worked in this topic?
What could I do better?

Look what I can do!

- [ ] I can understand and describe changes to substances that are reversible.
- [ ] I can choose materials and equipment to use.
- [ ] I can identify risks and work safely in practical work.
- [ ] I can use the particle model to explain how temperature affects dissolving.
- [ ] I can use scientific knowledge to make a prediction and use results to say if a prediction was accurate.
- [ ] I can collect and record observations and measurements in tables.
- [ ] I can decide if a test is fair.
- [ ] I can make a conclusion from results and measurements.
- [ ] I can ask a question to investigate and choose a type of scientific enquiry to find the answer.

2.4 Chemical reactions

We are going to...

- find out that in a chemical reaction, substances react together to form new substances
- identify reactants and products in chemical reactions
- observe and describe evidence for chemical reactions
- record observations in drawings
- write a conclusion for an investigation
- measure temperature.

Getting started

You will need:
a candle, a candle holder, matches, a teaspoon

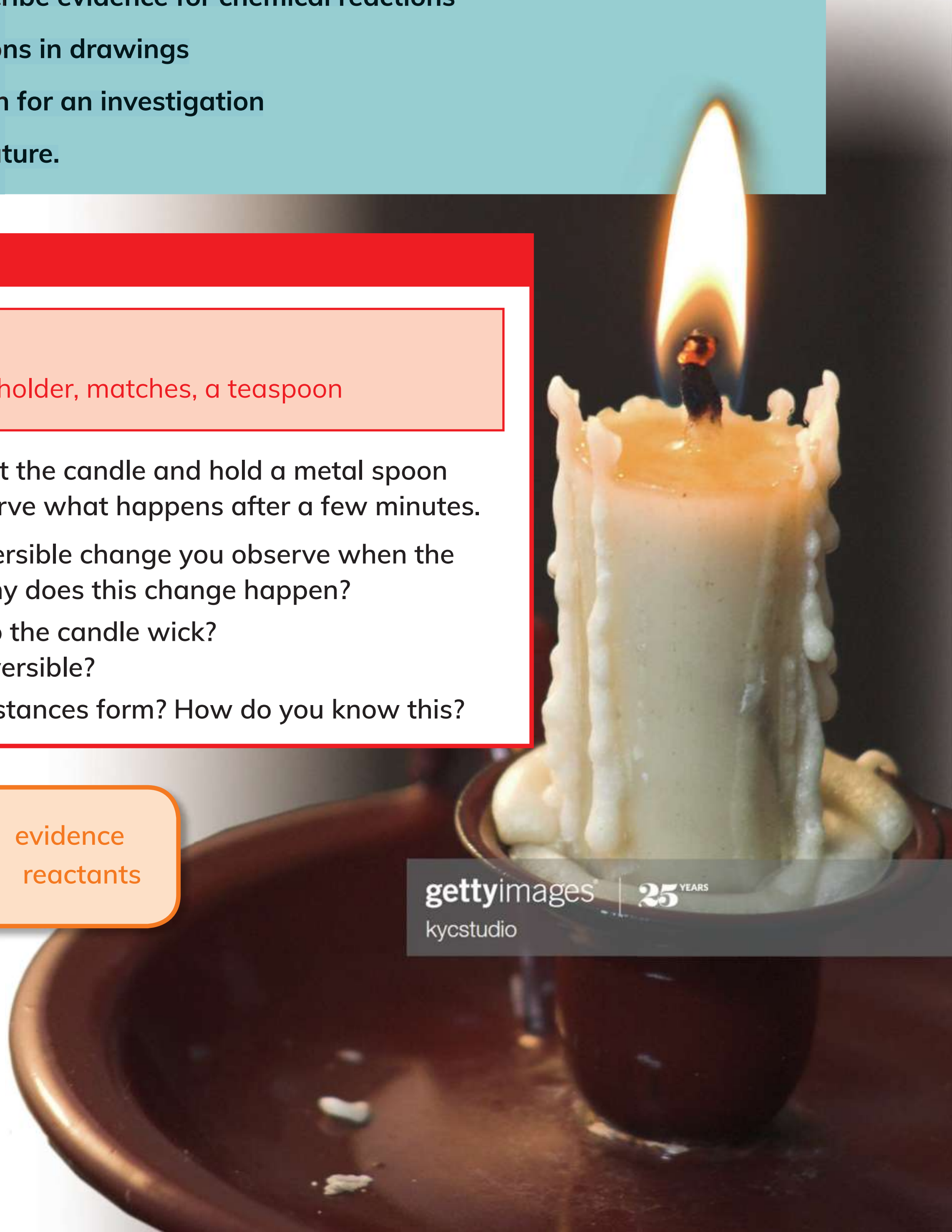
Your teacher will light the candle and hold a metal spoon over the flame. Observe what happens after a few minutes.

1 Describe one reversible change you observe when the candle burns. Why does this change happen?

2 What happens to the candle wick?
Is this change reversible?

3 Did any new substances form? How do you know this?

chemical reaction evidence
products react reactants



Reactants and products

When some substances are mixed together, they change and form a new substance. This is called a chemical reaction. We say that the substances react together. The substances that react together are called reactants. The new substances that form are called the products.

Think like a scientist 1

Identify reactants and products

You will need:
vinegar, bicarbonate of soda, a jar with a wide mouth, a spoon

1 Pour some vinegar into the jar.
2 a Put a teaspoon of bicarbonate of soda into the jar. Observe what happens.
  b Make a drawing of your observations.
3 Try to explain what you observed.
4 Which substances were the reactants?
5 Which substance was the product?
6 a Wait about five minutes. Can you observe any other product?
  b Describe what you observe.

How am I doing?

- Could I make a drawing of my observations?
- Could I explain my observations?
- Could I identify the reactants in the chemical reaction?
- Could I identify any products formed in the reaction?

Evidence for chemical reactions

Sometimes we can see that a product has formed in a chemical reaction. For example, when vinegar and bicarbonate of soda react, we can see that a gas is produced. The gas is evidence of the reaction. There are also other ways we can tell if a chemical reaction has taken place.

Think like a scientist 2

Investigate evidence for chemical reactions A

You will need:
water, cornstarch, iodine solution, a dropper, a spoon, limewater, a drinking straw, beakers

1 a Pour some water into a beaker. Add three full droppers of iodine solution.
  b Make a drawing of your observations.
  c Add a spoon of cornstarch to the beaker and stir.
  d Make a drawing of your observations.

2 a Pour some limewater into a beaker.
  b Breathe air into the limewater with a straw. Which gas is in the air you breathe out?
  c Write one or two sentences to describe your observations.

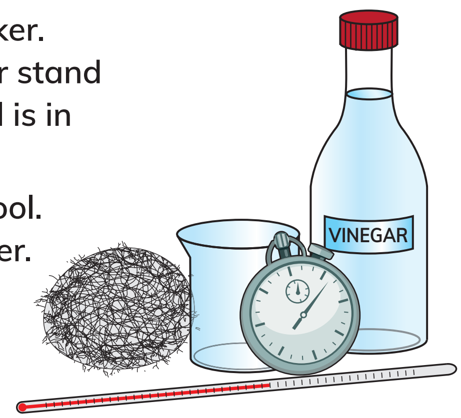
3 How do you know that a chemical reaction has taken place in this investigation?

Safety: Take care not to suck up the limewater into your mouth. It can also irritate your eyes and skin.

Continued

Investigate evidence for chemical reactions B

You will need:
wire wool, vinegar, a beaker, a thermometer, a timer



1 Loosen up a ball of wire wool and place it in a beaker. Pour vinegar on to the wire wool and let the beaker stand for one to two minutes. Make sure all the wire wool is in contact with the vinegar.
2 Place a thermometer into the middle of the wire wool. Record the temperature reading on the thermometer.
3 Wait five minutes and record the temperature reading on the thermometer again. What do you observe?
4 How do you know that a chemical reaction has taken place in this investigation?
5 Write a conclusion for the investigation.

Questions

1 Describe three ways that we can tell that a chemical reaction has taken place and give an example of each.
2 When clear limewater is mixed with carbon dioxide, the reaction forms a substance called calcium carbonate.
   a Name the reactants in the reaction.
   b Name the product in the reaction.
   c How can we tell that the reaction has taken place?
3 Zara drops a fizzy tablet into glass of water. What evidence will she have that a chemical reaction is taking place?

How did the practical work help me learn about different evidence for chemical reactions?

What did I do best in this topic?

What do I need to practise more?

Look what I can do!

- [ ] I can explain that in a chemical reaction, substances react together to form new substances.
- [ ] I can identify reactants and products in chemical reactions.
- [ ] I can observe and describe evidence for chemical reactions.
- [ ] I can record observations in drawings.
- [ ] I can write a conclusion for an investigation.
- [ ] I can measure temperature.

Project: Electrical insulators

We are going to:

- find out how an electrician uses electrical insulators
- find out how electrical insulators are used in our homes and local area
- do research to find other examples of how we use electrical insulators.

Materials and substances that are not good conductors of electricity are called insulators. Plastic, rubber, glass and most non-metal substances are electrical insulators.

1 Speak to an electrician in your area. Find out how he or she uses electrical insulators in their work.

2 a Identify places in your home and local area where electrical insulators are used. Take photos or make drawings of the insulators.

  b Identify the substance or material that each insulator is made of.

3 Do some research to find out about other examples of how we use electrical insulators.

4 Prepare a short presentation on your findings. Include photos or drawings. In your presentation also explain why we need to use electrical insulators.

Check your progress

1 The table shows the melting points of some substances.

Substance	Melting point/°C
gold	1064
candle wax	60
silver	962
copper	1083
ice	0
aluminium	660

- a What is a melting point?
- b List the substances in the order of highest to lowest melting point.
- c Describe a pattern you can see in the melting points.
- d Does the melting point of a substance change? Say why or why not.

2 a Why does food cook faster in the oven in a metal dish than in a glass dish?

- b If you used a dish made of a different metal, would the cooking time change? Explain why.

3 a Sort the following processes into two groups: reversible processes and irreversible processes

rusting | boiling | freezing | dissolving | burning | evaporating

- b Add another process that you know of to each of the groups.

4 a Will a solid usually dissolve faster in cold water, warm water or hot water?

- b Explain your answer to **4a** by describing how temperature affects the movement of particles in a solution.

5 Class 6 put an iron nail in a saucer of water. A few days later they observed that the nail had rusted.

- a What evidence for a chemical reaction did class 6 observe?
- b Name the reactants in the reaction.
- c Name the product that formed in the reaction.

3 Rocks, the rock cycle and soil

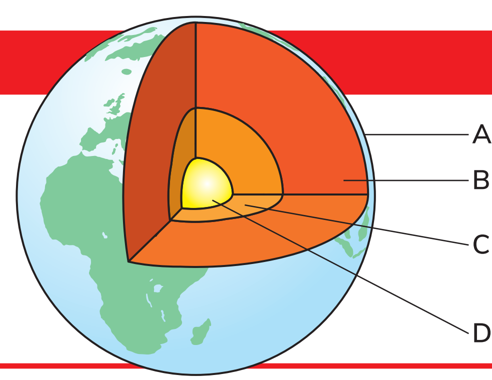
3.1 Igneous rocks

We are going to...

- find out that rocks can be classified into different types and describe the features of each
- use diagrams and photographs to describe igneous rocks
- describe the formation of igneous rocks in terms of magma and solidification
- make predictions, based on what we know about how igneous rocks form
- describe the accuracy of predictions, based on results
- make a conclusion from results using science understanding
- describe risks when planning practical work and carry out practical work safely
- sort and group rocks by observing differences
- complete a key to igneous rocks based on easily observed differences.

Getting started

1. Name the layers A, B ,C and D.
2. What does layer B consist of?
3. What happens when the material in layer B is ejected through the Earth's surface?



crystal crystalline extrusive igneous rock geologist igneous rock
intrusive igneous rock mineral naked eye sedimentary rock solidification

Rocks are different

Rocks differ from one another because they were formed in different ways. Geologists are scientists who study rocks. In the next few topics you are going to be a geologist.

Think like a scientist 1

Collect and sort rocks

1 Find some samples of rock. Make sure you don't choose 'manufactured' materials like concrete and brick. Good places to look are rock cuttings where a road passes through and the rocks are exposed, or a quarry where rock is being cut out to use for building materials. Ask an older sibling or adult to help you.

Safety: Be careful not to fall or climb any steep rock faces!

2 Put a label on each rock with your name and the place where you found the rock. Bring your rock samples to class.

3 Work in groups and use a hand lens to study your rocks.

4 Investigate your rocks by answering these questions about each rock:

   a Does the rock have only one colour or different colours?

   b Does the rock consist of grains stuck together?

   c Can you see shiny crystals in the rock?

5 Divide your rocks into two groups:

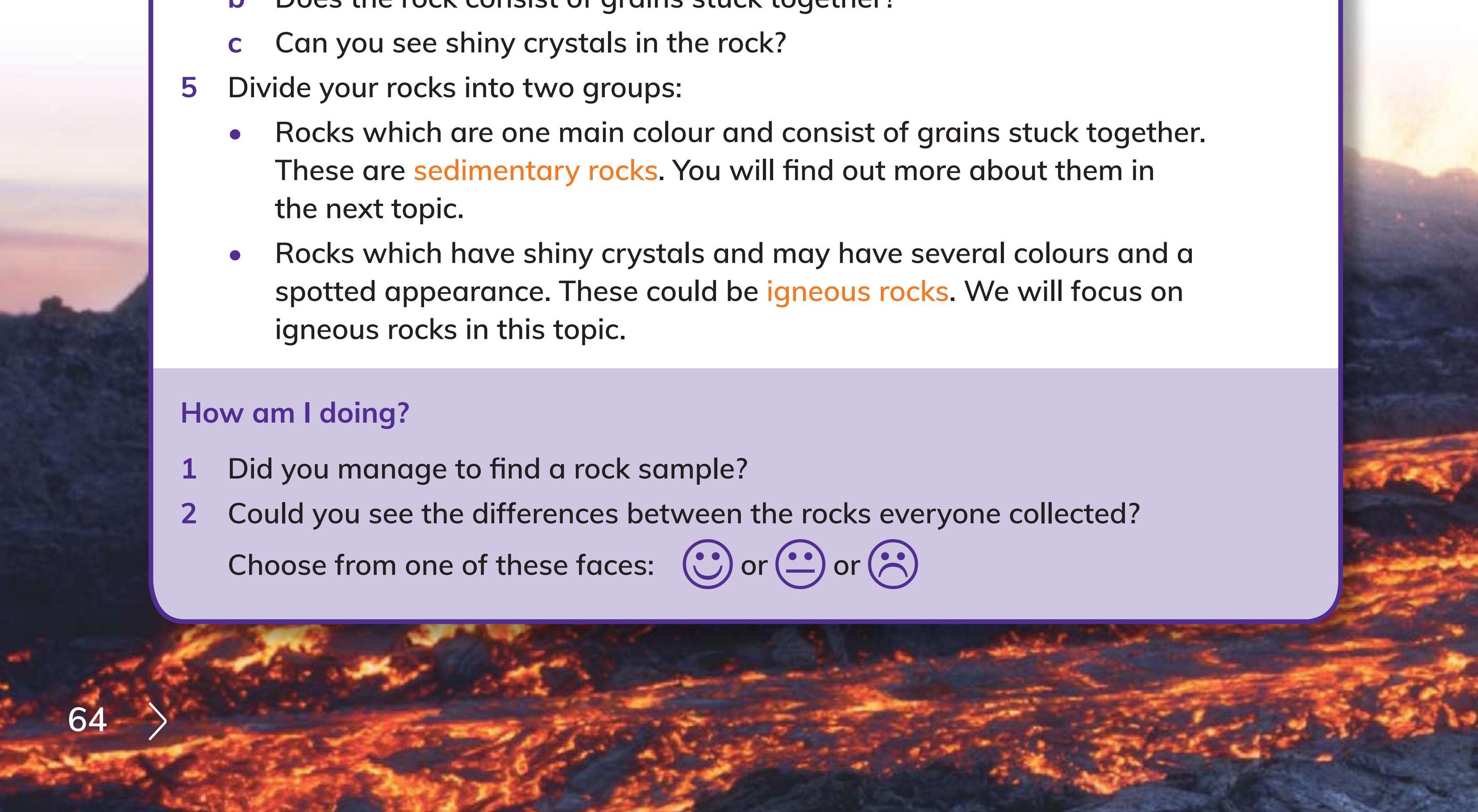
- Rocks which are one main colour and consist of grains stuck together. These are sedimentary rocks. You will find out more about them in the next topic.
- Rocks which have shiny crystals and may have several colours and a spotted appearance. These could be igneous rocks. We will focus on igneous rocks in this topic.

How am I doing?

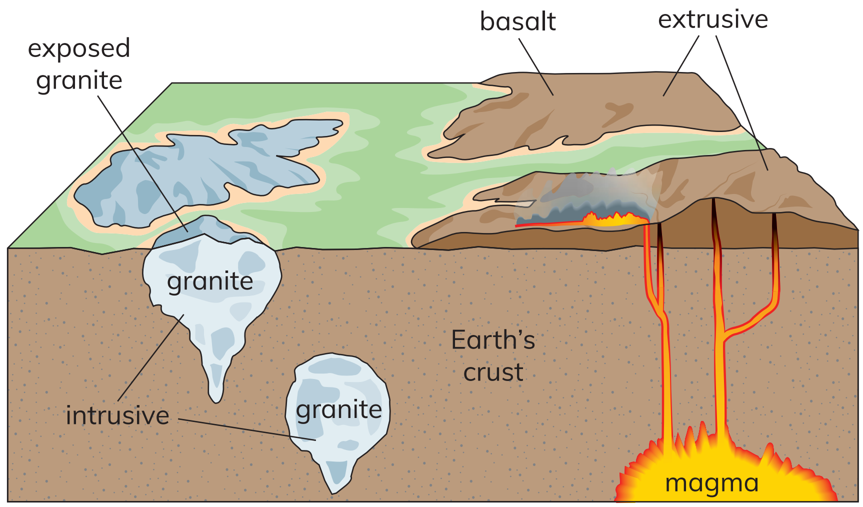
1 Did you manage to find a rock sample?

2 Could you see the differences between the rocks everyone collected?

Choose from one of these faces: ☺ or 😐 or ☹



What are igneous rocks?



The word 'igneous' means fire. Igneous rocks come from magma that has cooled into solid rock. Magma is hot, like a fire.

Look at the diagram. Notice that magma is coming from the mantle, deep below the Earth's surface. When magma cools it turns into a solid. This process is called solidification.

Some of the magma comes out at the surface as lava. When the lava cools, it solidifies into an extrusive igneous rock. 'Extrusive' means outside the Earth's crust on the surface. The photograph on the opening page of this unit shows this happening. The rock is a black rock called basalt.

Some of the magma stays inside the Earth's crust. It cools down more slowly than the lava and solidifies into an intrusive igneous rock. 'Intrusive' means inside the Earth's crust. An example of an intrusive igneous rock is granite. On the diagram you can see that when the rocks above the intrusive igneous rock wear away, the granite appears at the surface.

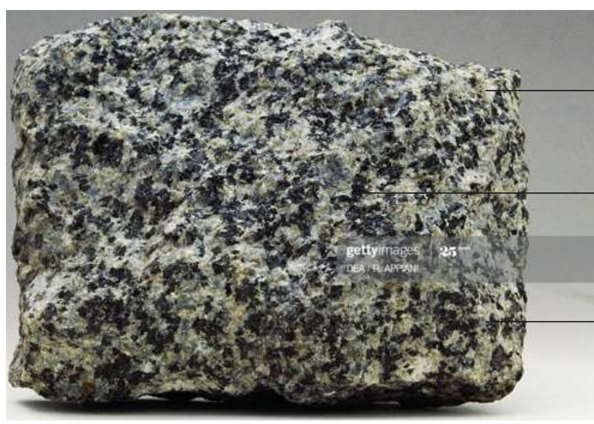
What are igneous rocks made of?

All igneous rocks are made of minerals. Each mineral consists of a different group of substances. The most common substances in the Earth's crust are silica, oxygen, aluminium, magnesium and iron. These substances join in different combinations to form minerals.

The most important characteristic of all igneous rocks is that they are crystalline. Crystals are formed when the minerals cool dow
Look at the photograph of quartz crystals. Quartz is a mineral made up of silica and oxygen.

When the magma is deep below the surface of the Earth it cools slowly. This causes the crystals to form slowly. The crystals are large enough for us to see with the naked eye. But because the crystals are so close, they do not form shapes like the crystals on their own in the photograph of quartz crystals.

Look at the photograph of a piece of granite. Notice that the rock has different colours because of the different crystals. The minerals in granite are quartz, feldspar and mica.

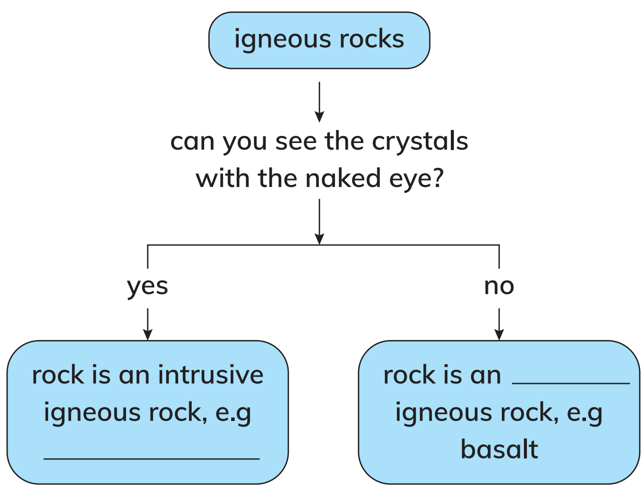


The lava cools quickly to form an extrusive igneous rock. The crystals in the rock are too small to see with the naked eye. An example is basalt.

Activity

Describe igneous rocks and complete a key

1. Name the process where magma cools down and becomes a rock.
2. Do you think the magma that made granite rock cooled down slowly or quickly? Explain your answer.
3. Is granite an extrusive igneous rock or an intrusive igneous rock?
4. Do you think the liquid basalt rock cooled down slowly or quickly? Explain your answer.
5. Is basalt an extrusive igneous rock or an intrusive igneous rock?
6. In the granite in the photograph:
   - a Which mineral appears as glassy crystals?
   - b Describe the crystals of feldspar.
   - c Name the mineral which forms black, shiny crystals.
7. Copy and complete this key for igneous rocks:



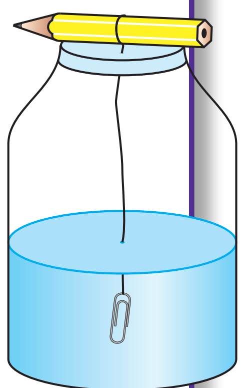
In the next activity you are going to make salt crystals in a warm and a cool environment. This is modelling making crystals for an intrusive and an extrusive igneous rock.

Think like a scientist 2

Make your own crystals

You will need:
2 glass jars, 2 paper clips, 2 pencils, 2 × 10 cm pieces of string, a cup of coarse salt, hot water, a teaspoon

1 Before we begin, this activity involves handling very hot water. How can we make sure we take care when using hot water?
2 Tie a paperclip to the end of each piece of string.
3 Half fill each jar with hot water. Be careful not to burn yourself.
4 Add coarse salt to each jar. Stir until the salt dissolves. Continue to add more salt until no more dissolves. Leave jar 1 to cool.
5 Lower a paperclip into jar 2 Wind the other end of the string round the pencil and place the pencil over the top of the jar as shown in the picture.
6 Leave jar 2 in a warm place for a week. Check and observe every day. Unwind the string so that the crystal is always in the salt solution. Crystals of salt will form on the paper clip.
7 When the jar 1 has cooled down, lower the paperclip into the jar as you did for jar 2. Keep jar 1 in the fridge for a week. Check and observe every day. Unwind the string so that the crystal is always in the salt solution.



Questions

1 a Describe the safety risk when doing this activity.
  b How can you minimise this risk?
2 Predict which jar, 1 or 2, will begin to make crystals first.
3 Predict which jar, 1 or 2, will make the bigger crystals.
4 After a few days check whether your prediction was correct.
5 Make a conclusion about the size of crystal and the temperature of the environment.
6 Make a conclusion about the size of crystal and the time taken for crystals to form.
7 Which jar represents crystals for an intrusive igneous rock?

What was the most interesting thing you have learnt about rocks so far?

Look what I can do!

- [ ] I can find out that rocks can be classified into different types and describe the features of each.
- [ ] I can use diagrams and photographs to describe igneous rocks.
- [ ] I can describe the formation of igneous rocks.
- [ ] I can make predictions, based on what we know about how igneous rocks form.
- [ ] I can describe the accuracy of predictions, based on results.
- [ ] I can describe risks when planning practical work and carry out practical work safely.
- [ ] I can make a conclusion from results using science understanding.
- [ ] I can sort and group rocks by observing differences.
- [ ] I can complete a key to igneous rocks based on easily observed differences.

3.2 Sedimentary rocks and fossils

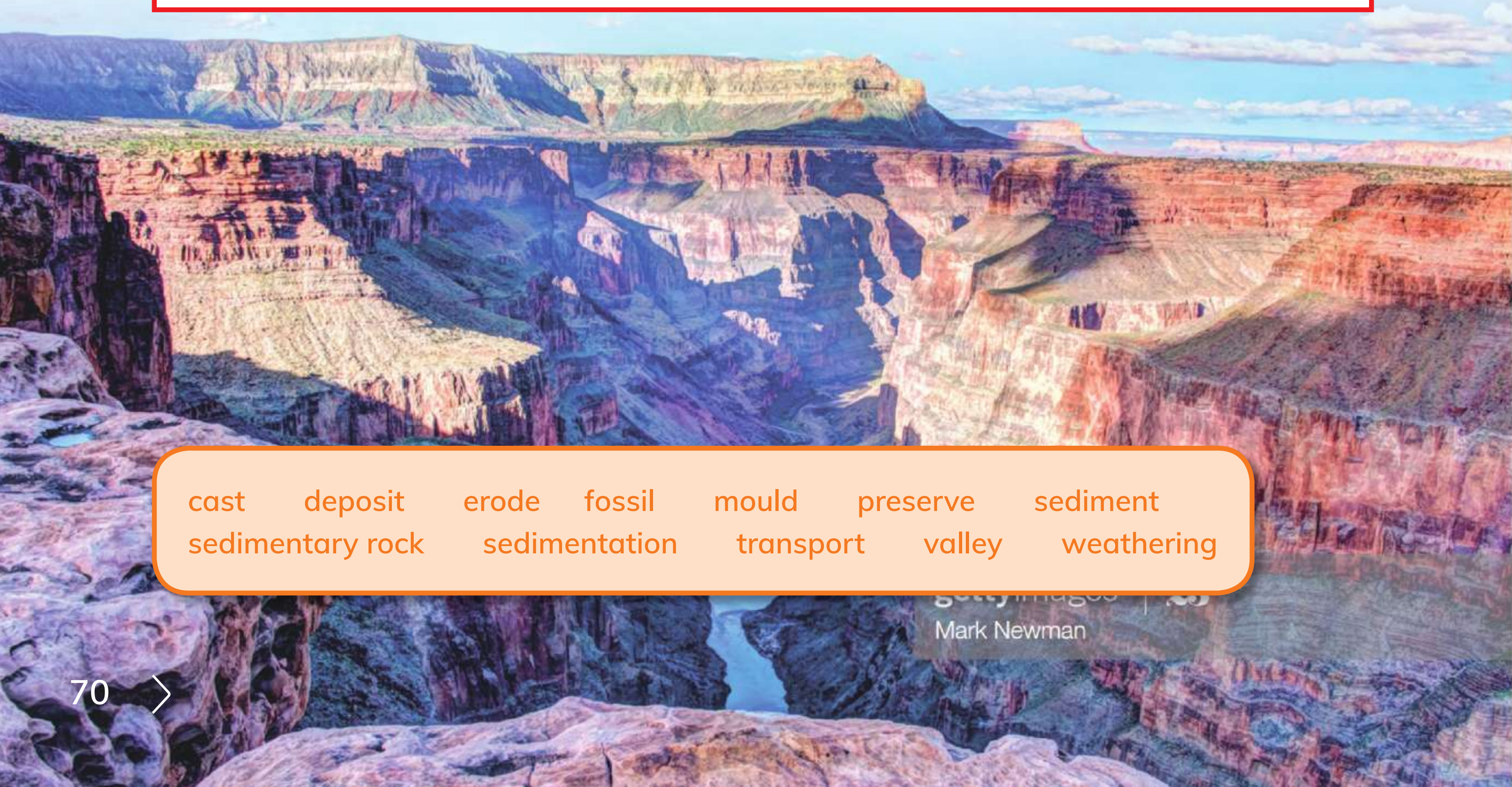
We are going to...

- find out that rocks can be classified into different types and describe the features of each
- use diagrams and photographs to describe sedimentary rocks
- explain the formation of sedimentary rocks, in terms of weathering, erosion and sedimentation
- describe the way fossils can form in sedimentary rocks
- sort and group rocks by observing differences
- complete a key to sedimentary rocks based on easily observed differences.

Getting started

Look at the photograph.

Describe the rocks. How are they different to igneous rocks?



cast deposit erode fossil mould preserve sediment
sedimentary rock sedimentation transport valley weathering

What are sedimentary rocks?

Sedimentary rocks are made from small pieces of other rocks stuck together. Very small pieces of rock are called sediments.

Where do the sediments come from?

Rocks are continuously being broken up by a process called weathering. For example:

- High and low temperature cracks rocks and breaks up the surface layer.
- Rainwater dissolves some rocks.
- Plants break up the surface of rocks with their roots.

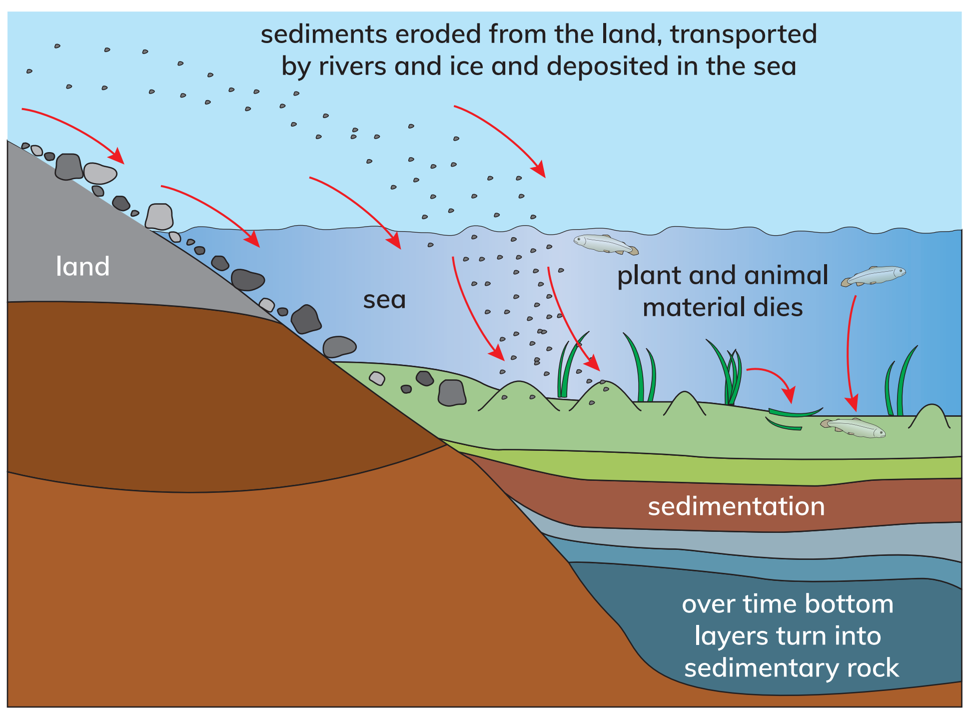
Once the rocks are weakened by weathering, they become eroded by rivers. The broken-up rocks wear away or erode the sides and bottom of river valleys. The broken rocks are eroded into sediments. Ice and wind can also erode rocks into sediments.

All the sediments are carried or transported by rivers. When the water in a river reaches the sea or a lake, it flows slowly. It drops or deposits the sediments. This process is called sedimentation.

Over millions of years the layers at the bottom get more and more squashed by the layers on top of them. These sediments are stuck together by minerals in the water to form sedimentary rock.

The diagram shows how sedimentation takes place on the sea floor.

Sedimentary rocks always form in layers, like the layers in the canyon in the photograph on the opening page of this topic. This is an important characteristic of sedimentary rocks.



Activity 1

Use text, a photograph and a diagram to describe how sedimentary rocks form

1. Give an example of weathering.
2. Describe how a river uses weathered rocks to erode.
3. Where are layers of sediments deposited?
4. How do you know that the rocks in the photograph on the opening page of the Unit are sedimentary rock?
5. Put these five stages of the formation of sedimentary rocks into the correct order:

   sedimentation   transporting   depositing   eroding   weathering

Types of sedimentary rock

Three of the most common types of sedimentary rock are sandstone, shale and limestone.

Sandstone is a sedimentary rock which consists of sand grains stuck together. Most sand is made of quartz because this is a very hard mineral. Sand is the most resistant to weathering processes at the Earth's surface. Sandstone can be red, orange, yellow or grey in colour.

The photograph at the beginning of this topic is sandstone. Notice the layers.

Shale is formed of very fine-grained sediments. The sediments are softer than sand grains. Shale is usually grey in colour. If you scratch shale it leaves a mark. Shale is often soft enough to break with your hands. Look at the photograph of shale opposite. Notice the layers.

Limestone is made from layers of shells. The shells were covering sea animals that died and sank to the bottom of the sea. Limestone is usually white or grey in colour. Chalk is a pure type of limestone.

Look at the photograph of chalk cliffs opposite/alongside. Notice the layers.

Activity 2

Identify and describe sedimentary rocks

1 Go back to the rocks the class collected. Set aside the igneous rocks. Which of the rocks you have left do you think are sedimentary rocks?

Look for rocks that you can see are made of sediments cemented together. Look for rocks that are one colour rather than different colours like granite.

2 Describe each sedimentary rock:

- What colour is the rock?
- Is it coarse-grained or fine-grained?
- Is it soft enough to break up or scratch or is it very hard?

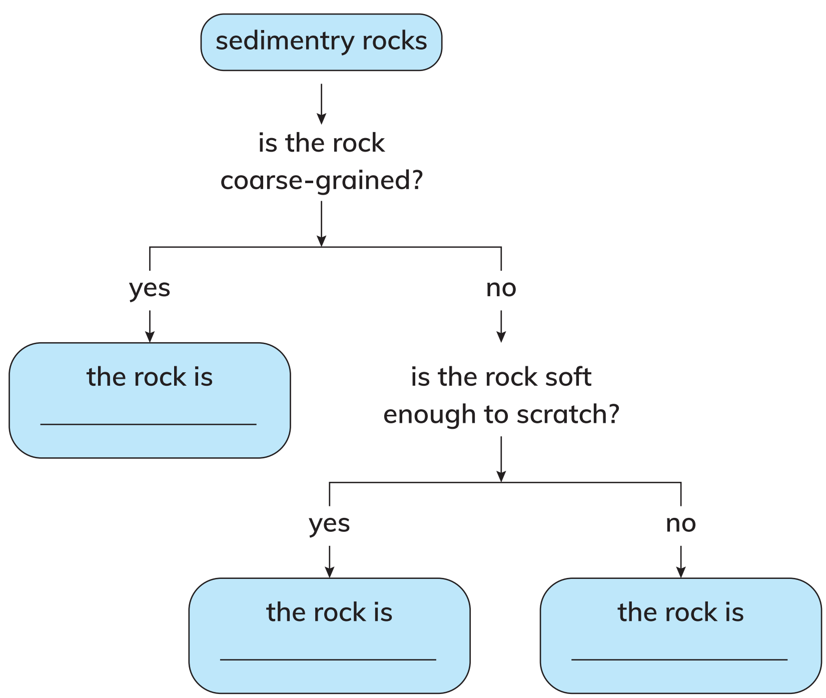
3 Identify the rocks as sandstone, limestone or shale.

4 Copy and complete these sentences which give two important characteristics of sedimentary rocks:

Sedimentary rocks are formed of sediments ________________ together

Sedimentary rocks form in ________________ .

5 Copy and complete this key for sedimentary rocks:



Continued

How am I doing?

Are you confident in using a key to classify rocks?

Choose one of these answers:

- Yes, I like using a key.
- I think I need more practice.
- No, I don't understand how a key works.

Fossils

Another characteristic of sedimentary rocks is that they sometimes contain fossils.

Fossils are the preserved remains of animals and plants which we find in sedimentary rocks.

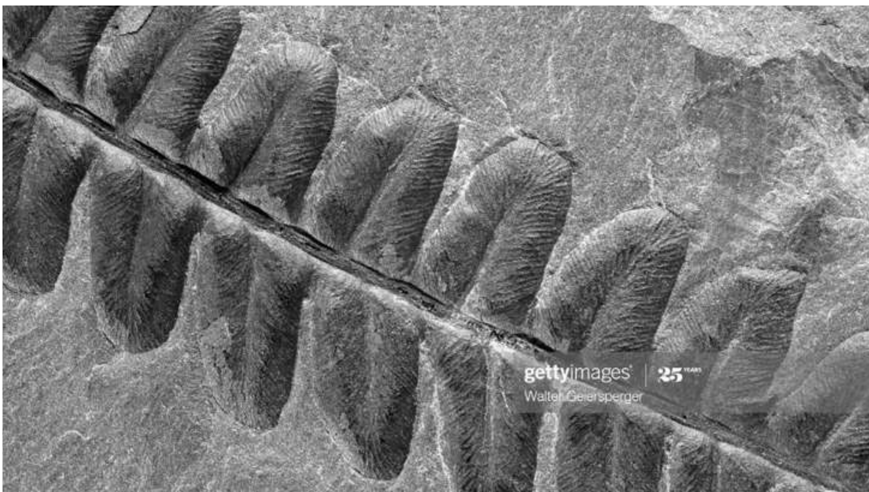
How do fossils form?

A fossil can only form if the animal or plant is buried quickly in a place where there is very little air. This is why we only find fossils in sedimentary rocks which form in water on the sea bed or a lake bed.

When animals that live in or near the sea die, their bodies are washed into the sea. The soft parts of the animals rot away. Over a long period of time, minerals in the water gradually replace the bones of the animal. Eventually the minerals harden into rock so we have a copy of the original animal as a fossil, like the dinosaur in the photograph. This fossil is in limestone and it was formed about 150 million years ago.

Sometimes only the imprint of the animal in the sediments is left behind. This kind of fossil is called a mould. Look at the mould of a dinosaur's footprint in sandstone in Namibia – this footprint is also about 150 million years old!

Below is a fossil mould of a leaf in shale that is 350 million years old!



Sometimes a mould fills with minerals that harden to a solid. This makes a cast of the animal. The photograph below shows two fossils of ammonites in limestone. The moulds filled with minerals which hardened to form the shape of the original animal. Ammonites do not exist on Earth any more. They lived 240 million years ago so that is how old this fossil is!

In the next activity you are going to make a mould and cast of a leaf.

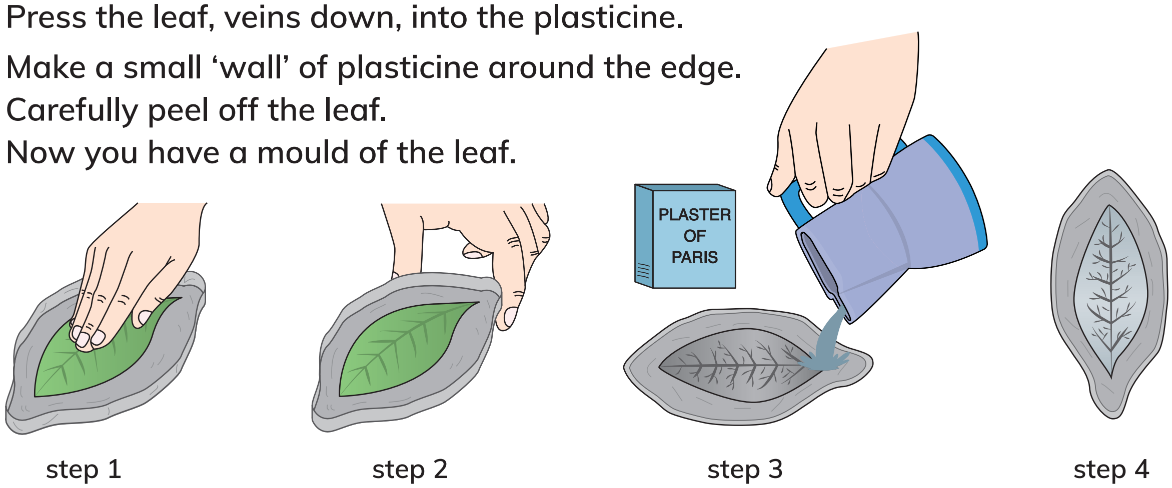
Think like a scientist

Make your own plant fossil

You will need:
some plasticine, a packet of plaster of Paris, a leaf with veins which stick out

1 Press or roll the plasticine out into a shape slightly bigger than the leaf. Press the leaf, veins down, into the plasticine.

2 Make a small 'wall' of plasticine around the edge. Carefully peel off the leaf. Now you have a mould of the leaf.



3 Mix up the plaster of Paris according to the instructions on the packet. Pour the mixture on top of the plasticine and leave to set. This will take 30–45 minutes.

4 When the plaster of Paris has set, peel off the plasticine. You have a cast of a plant.

Paint your fossils and display them in the classroom.

Questions

1 In a real fossil what replaces:
   a the plasticine?
   b the plaster of Paris?

2 Why can fossils only form in sedimentary rocks?

Did you enjoy making a 'fossil'? Did it help you to understand how fossils form in sedimentary rock?

Look what I can do!

- [ ] I can find out that rocks can be classified into different types and describe the features of each.
- [ ] I can use diagrams and photographs to describe sedimentary rocks.
- [ ] I can explain the formation of sedimentary rocks, in terms of weathering, erosion and sedimentation.
- [ ] I can describe the way fossils can form in sedimentary rocks.
- [ ] I can sort and group rocks by observing differences.
- [ ] I can complete a key based on easily observed differences.

3.3 Metamorphic rocks and the rock cycle

We are going to...

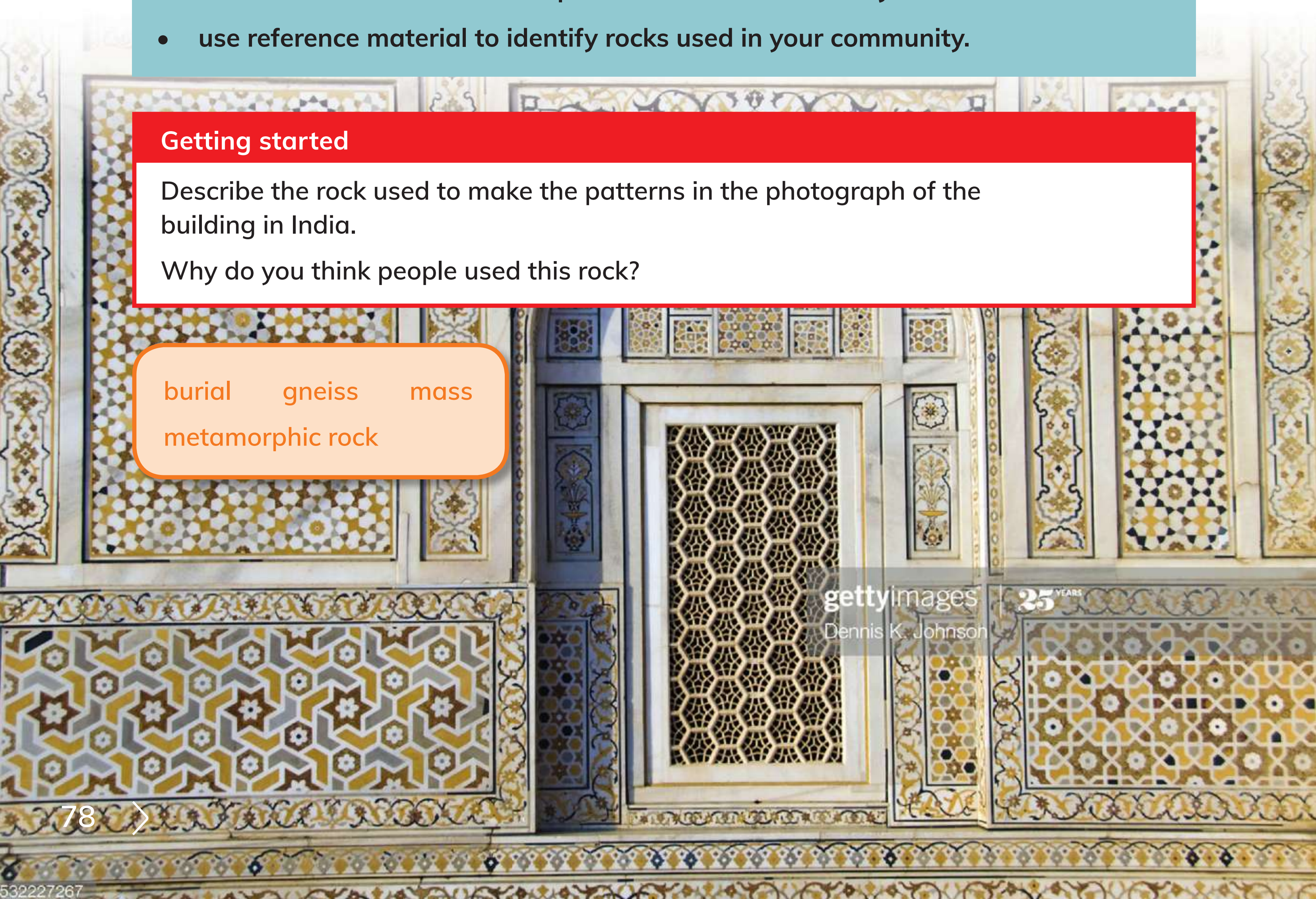
- describe the features of metamorphic rocks and how they form
- use diagrams and photographs to describe metamorphic rocks
- sort and group rocks by observing differences
- complete a key to metamorphic rocks based on easily observed differences
- describe the rock cycle, and the formation of metamorphic, igneous and sedimentary rocks, in terms of magma, solidification, erosion, sedimentation, burial, metamorphism and melting
- describe how a model can help us understand the rock cycle
- use reference material to identify rocks used in your community.

Getting started

Describe the rock used to make the patterns in the photograph of the building in India.

Why do you think people used this rock?

burial gneiss mass
metamorphic rock



What are metamorphic rocks?

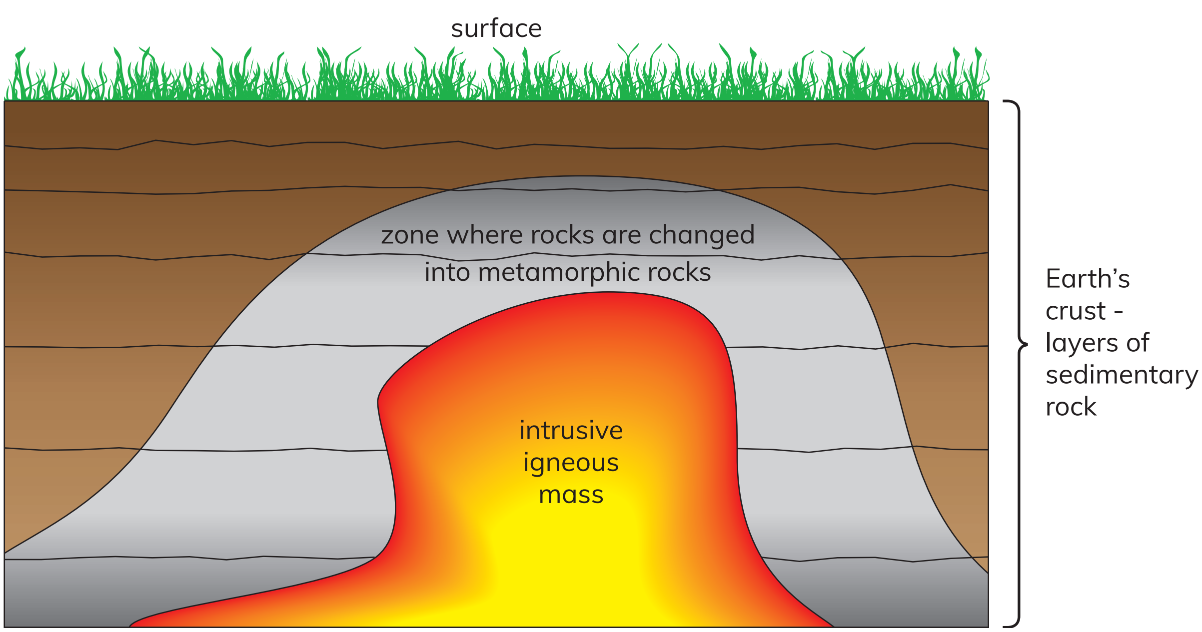
The word 'metamorphosis' means 'change'. Metamorphic rocks are existing rocks which have been changed. The rocks may be changed by heat. When this happens all the minerals in the rock melt and then form new crystals.

Sometimes rocks are changed by huge pressure. The pressure squeezes the rocks so much that the new rock has lots of thin layers.

Sometimes rocks are changed by heat and pressure together. Then the new rock has different minerals and lots of layers.

What causes the heat and pressure?

Look at the diagram below. It shows layers of sedimentary rocks buried beneath the Earth's surface. Magma rises up from the mantle and forms an intrusive igneous rock mass. Just imagine this happening! A huge mass of extremely hot liquid rock pushes solid rocks aside. This causes all the surrounding rocks to be affected by the heat and the pressure. These rocks are changed into metamorphic rocks.



Types of metamorphic rock

Let's see which metamorphic rocks form when sandstone, limestone, shale and granite are heated until they melt and are squashed by pressure.

Quartzite

When sandstone is heated, all the sand grains melt and make new quartz crystals. This forms the metamorphic rock called quartzite. It looks similar to sandstone but the crystals shine and the rock is much harder than sandstone.

This rock is so hard that it is sometimes used to make sculptures. The photograph shows a quartzite statue of Ankhrekhu which was made in 1850 BCE – almost 4000 years ago.

Marble

When limestone is heated, it changes into a metamorphic rock called marble. All the minerals melt and form new crystals. Marble is extremely hard and very shiny. It can be white, red, blue or green depending on which substances were in the original limestone.

Marble is a very beautiful rock and it lasts for a very long time. People use marble to carve statues and gravestones and decorate public buildings and places of worship. Look at the photograph on the opening page of this topic. The picture shows how different coloured marble has been used to decorate a building in India.

The white marble in the photograph has been cut into blocks to use for carving statues and making furniture.

Slate

When shale is put under intense pressure it forms thin layers – this is the metamorphic rock called slate.

Remember that layers of sediments build up on the sea bed. The bottom layers are buried by the top layers. If there are many layers, the bottom layer is put under huge pressure from the layers above. Burial changes the rock into a metamorphic rock with many layers like slate.

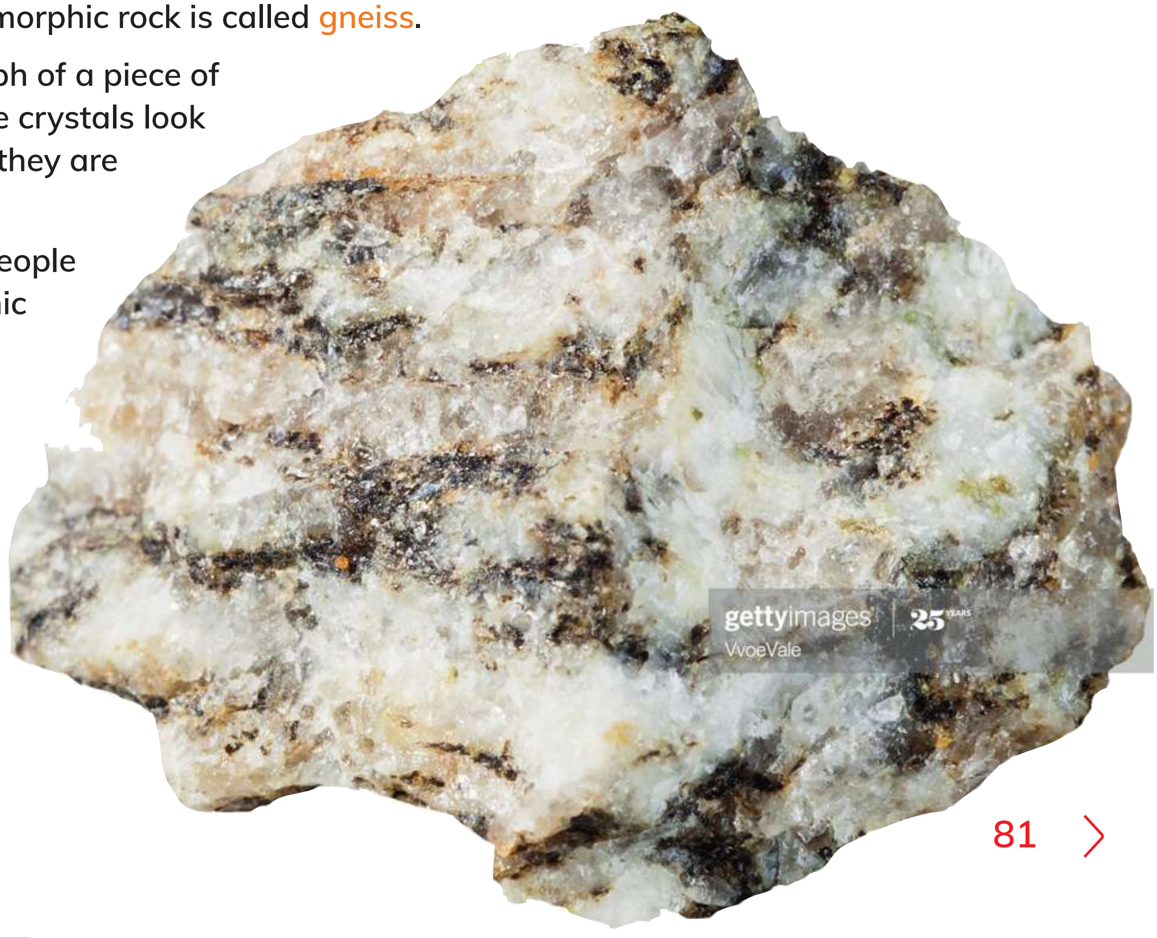
People use slate for making roof tiles and floor tiles because it is hard and long-lasting. The photograph shows slate roof tiles.

Gneiss

When granite is heated all the minerals melt and make new crystals. Pressure causes the new rock to have stripes or bands of crystals. The metamorphic rock is called gneiss.

Look at the photograph of a piece of gneiss. Notice that the crystals look similar to granite but they are in bands.

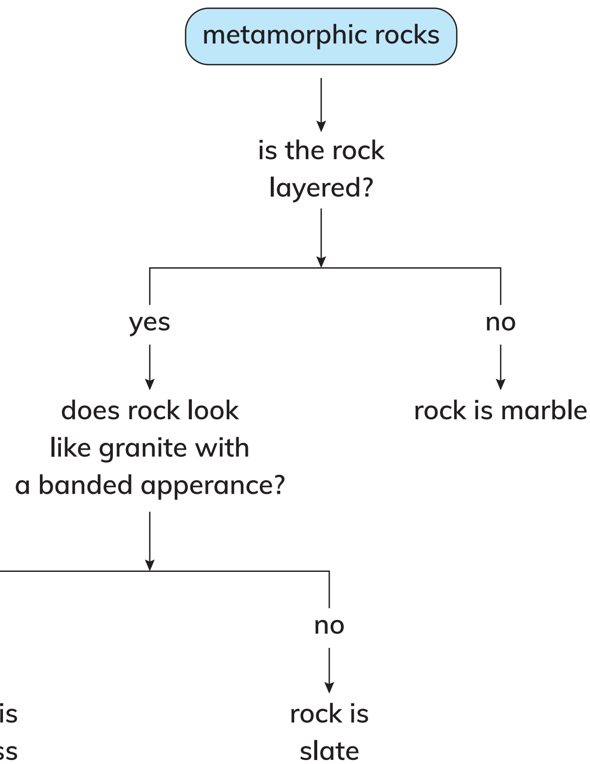
Gneiss is very hard. People crush this metamorphic rock to make roads.



Activity 1

Identify and describe metamorphic rocks

1. Which metamorphic rock forms when limestone is heated?
2. Name the sedimentary rock which quartzite formed from.
3. What happens to shale when it is heated and put under pressure?
4. What is gneiss?
5. Go back to the rocks the class collected.
   Set aside the igneous and sedimentary rocks.
   Which of the rocks you have left do you think are metamorphic rocks?
   Use this key to help you to identify the rocks.



6. Copy and complete these sentences which give two important characteristics of metamorphic rocks:
   Metamorphic rocks are shiny because they are ______________ .
   Metamorphic rocks sometimes have many ______________ because of pressure.
   Metamorphic rocks sometimes have ______________ of crystals because of pressure.

Think like a scientist

How people use rocks in my area

Work in pairs.

Look for ways people use rocks in your area.

For example: for building walls and roofs of houses, making pots, statues, gravestones, furniture, ornaments, roads, polished walls of bank and government buildings.

Safety: Take care not to wander around alone.
Don't climb onto roofs to get a closer look at building materials.

Make a list of what you find. Use references to identify the rocks used.

Take photographs if you can. Draw pictures of what you see.

Share your findings with the class.

The rock cycle

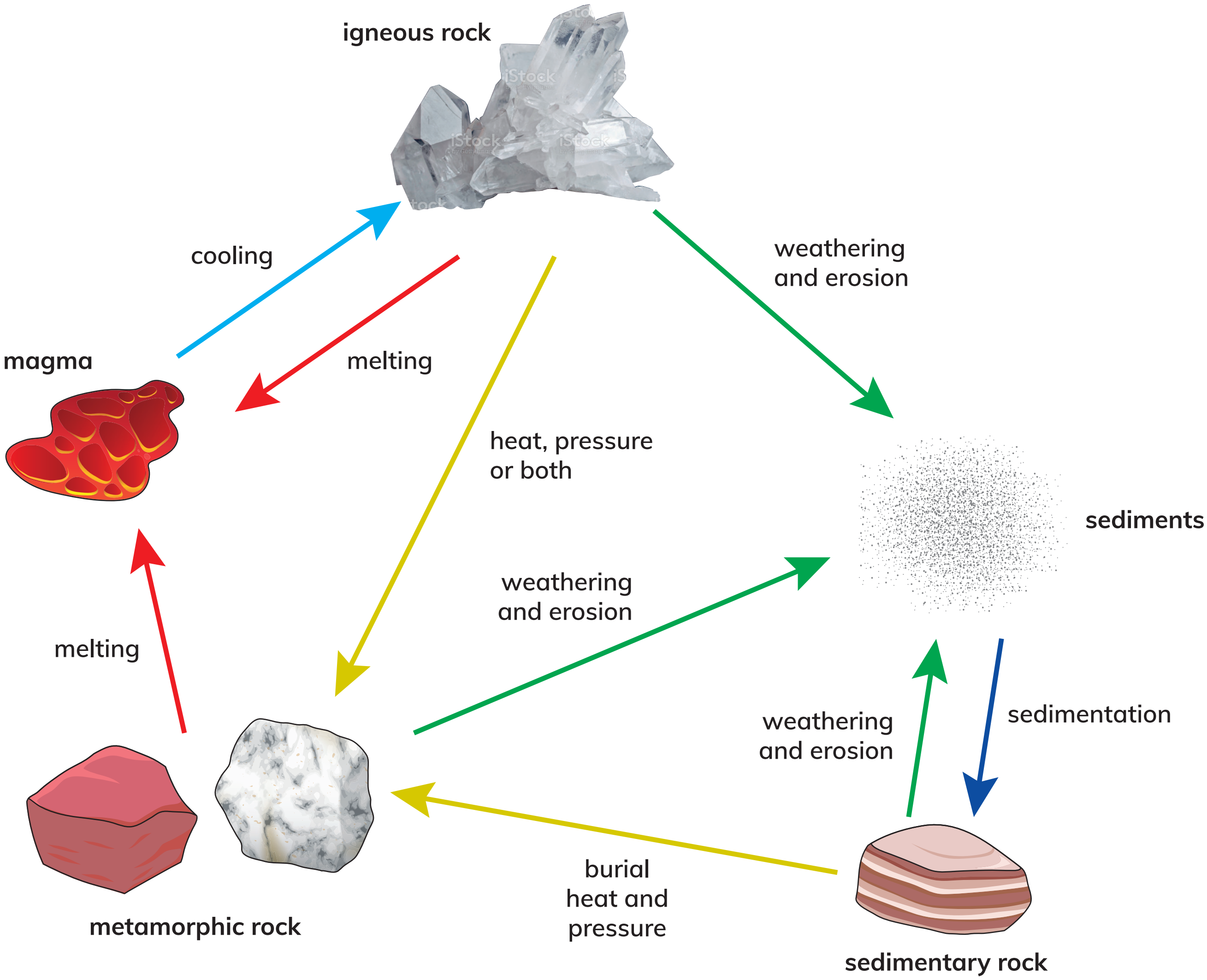
At Stage 5 you studied the water cycle. You saw how water is re-used over and over again on the Earth's surface.

The rock cycle shows us how the rocks of the Earth are used over and over again. One rock can be changed into another type of rock. These processes take a very long time – hundreds of millions of years!

Look at the diagram on the next page of the rock cycle. This diagram is a model of what is happening in the rock cycle. It is not showing scale or time. But it is showing possible orders of events in the cycle.

Look at the arrows:

- The orange arrows show melting.
- The blue arrow shows cooling.
- The green arrows show the breaking-down processes: weathering and erosion.
- The purple arrow shows sedimentation.
- The yellow arrows show burial, heat and pressure.



Now follow the cycle with your finger. Begin at magma.
The bold words refer to the labels on the rock cycle diagram.

- Magma cools (blue arrow) to form igneous rock.
- There are three arrows coming out of igneous rock:
  - Either (green arrow): Weathering breaks up the igneous rock. Erosion wears down the rock pieces to form sediments.
  - Or (yellow arrow): If it is an intrusive igneous rock it in the Earth's crust. Heat and pressure from magma can change the igneous rock into metamorphic rock.
  - Or (orange arrow): Igneous rocks are melted back into magma.

Look at the arrow between sedimentary rock and metamorphic rock. This arrow says burial, heat and pressure. Remember that layers of sediments build up on the sea bed. The bottom layers are buried below the Earth's surface by the top layers. If there are many layers, the bottom layer is put under huge pressure from the layers above. It is much hotter below the Earth's surface. Heat and pressure changes the rock into a metamorphic rock.

Activity 2

Describe how a model can help us understand the rock cycle

1. Why do we call this a rock cycle?
2. How does the model show actions, such as melting?
3. Name the actions that break rock up into sediments.
4. Name the action that happens when magma changes into igneous rock.
5. Name the action that changes rock back into magma.
6. Name the actions that change sedimentary and igneous rock into metamorphic rock.
7. Describe the two changes that can happen to sedimentary rock.
8. We can show parts of the rock cycle as chain diagrams. Here is an example:

Draw a chain diagram to show how:

a. Sedimentary rock changes into metamorphic rock
b. Granite changes into gneiss
c. Magma changes into granite

How am I doing?

Answer 'Yes', 'Partly' or 'Not yet ' to each of these questions:

- Can I identify the different types of metamorphic rock?
- Can I describe what happens in the rock cycle?

How does the diagram of the rock cycle help you to understand how rocks are re-used and changed over and over again?

Look what I can do!

- [ ] I can describe the features of metamorphic rocks and how they form.
- [ ] I can use diagrams and photographs to describe metamorphic rocks.
- [ ] I can complete a key to metamorphic rocks based on easily observed differences.
- [ ] I can identify rocks used in my community.
- [ ] I can describe the rock cycle, in terms of magma, solidification, erosion, sedimentation, burial, metamorphism and melting.
- [ ] I can describe how a model can help us understand the rock cycle.

3.4 Soil

We are going to...

- find out that there are different types of soils and they can be classified based on their clay, sand and organic content.
- find out that the composition of soil can change, making it better or worse for plants to grow in it.
- make a prediction and see whether observation supports your prediction.
- observe and sort different materials in soil.
- record observations in a table.

Getting started

Look at the photograph on the opening page of this topic. The woman is working in a vegetable garden in Vietnam.

1. What do the vegetables grow in?
2. What do you think is below this layer?
3. What is weathering?

artificial fertiliser composition
compost loam organic matter
nutrient pesticide soil
texture waterlogged

What does soil consist of?

In Topic 3.2 you found out that rocks were broken up by weathering. The broken-up rocks help to make soil.
A layer of soil covers most of the rocks on the Earth's surface.

Let's find out what soil consists of.

Think like a scientist

Investigate a soil sample

1 Collect some soil in a tin or a jar and bring it to the classroom.
2 Predict what you think the soil is made of.
3 Spread the soil on to a sheet of newspaper.
4 Observe the soil. Discuss these questions in your group to help you to decide what the soil is made of.

Questions

1 What colour is the soil?
2 Are there any stones in the soil?
3 Are the particles of soil the same size?
4 Rub some of the soil between your fingers. Describe how it feels. Choose from these words: rough, smooth, sticky, crumbly, damp, dry. These words describe the soil's texture.
5 What do you think the particles of soil are made from?
6 Is there any organic matter in the soil? Organic matter is living things or things which were alive such as dead leaves, bits of root and twigs.
7 Animals are also organic matter.
Are there any animals such as ants or worms in your soil sample?
8 What do you think is between the particles of soil?
9 Does the soil contain any water?

Continued

10 Did the soil contain what you predicted?

Record your observations in a table like the one below.

Colour	
Texture	
Organic matter – plant	
Organic matter – animal	
Air	
Water	

How am I doing?

How well did you work in your group? Did you contribute well? Did you help to answer the questions?

Rate yourself 🙂 or 😐 or ☹️

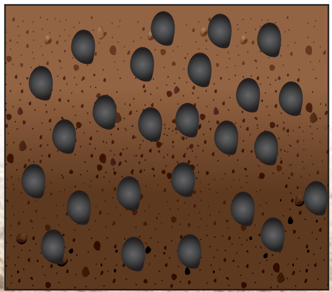
Types of soil

Different types of rock make different soil. For example, sandstone and quartzite weather into sandy soil. Shale weathers into clay soil. Igneous and metamorphic rocks weather into a sandy, clay soil.

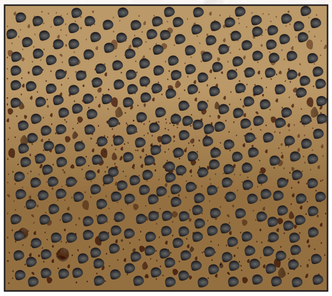
The amount of organic matter in the soil varies. A dark colour shows that the soil contains lots of organic matter. This type of soil is called loam.

Sandy soil

Sandy soils have large particles. The texture is rough and crumbly. Look at the diagram of sandy soil. There are large spaces between the particles. There is air and water in the spaces. This means that sandy soils contain lots of water and air. The water can drain through the sand easily.



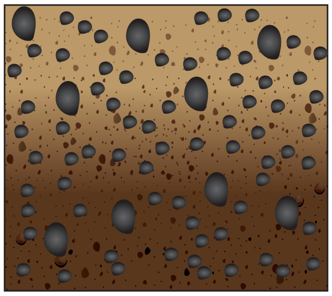
Clay soil



Clay soils have very small particles which are packed together tightly. The texture is smooth and sticky. Look at the diagram of clay soil. The spaces between the soil particles are very small. Because of this, there is not much air in clay soils. Clay soil dries out and cracks in hot, dry weather.

Clay soil absorbs and holds water easily. The water does not drain through so clay soils can become waterlogged.

Loam



Loam soils consist of a mixture of sand and clay, so they are made of particles of different sizes. Look at the diagram of loam soil. The particles are not very tightly or very loosely packed together. There is enough air in the spaces between the soil particles. The organic matter in loam soils helps the soil hold water and gives the soil lots of nutrients. This is why loam soils have the best composition for growing plants.

Activity 1

Types of soil

1 Go back to the soil sample you studied earlier.
Test it to see how well it holds water.
Can you roll it into a ball or does the ball break up?
Does it contain organic matter?
What type of soil do you think this is?
Give reasons for your answer.

Continued

2 Copy and complete the following table, which summarises the differences between the three types of soil. Choose your answers from the words in brackets.

	Sandy soil	Clay soil	Loam
Size of particles (small, medium, large)			
Amount of water soil holds (a lot, medium amount, a little)			
Size of air spaces (small, medium, large)			
Amount of organic matter (small, medium, large)			

3 Look at the photograph of rice growing.

Rice is planted when the soil is covered in water.

What type of soil do you think this is? Give a reason for your answer.

Changing the composition of soil

People choose to grow certain plants in different types of soil. Loam is the best type of soil for growing plants because of its composition. But if a plant needs a very well-drained soil, the farmer or gardener might add sand to it to make a sandy loam soil.

Some plants need a lot of lime in the soil to grow well. Then the farmer or gardener adds lime to the soil.

Soil needs air in it to keep the composition the same. This is one of the reasons why farmers and gardeners dig or plough the soil. These actions mix air into the soil.

Soil needs water. If it doesn't rain, a farmer or gardener must water it.

Compost

All plants need organic matter to grow well. But plants use up the nutrients in the organic matter. This is why it is important that farmers and gardeners regularly add compost or artificial fertilisers to the soil.

Compost is made from dead organic matter. It is good for the soil because it provides nutrients and improves the texture of the soil.

You can make your own compost with food scraps like vegetable peels, egg shells, over-ripe fruits and bones. Add garden waste like grass cuttings, leaves and weeds. Keep the mixture moist in a warm place. In a few weeks you will have compost!

Artificial fertilisers provide the same nutrients as organic matter. But they do not improve the texture of the soil like compost does.

Damaging soil

For plants to grow well, it is important to look after the soil by maintaining the composition of the soil. Sometimes farmers or gardeners do not look after the soil and the composition changes. Here are some examples:

- Farmers plant the same crop year after year. The crop uses up the nutrients in the soil. The soil dries out easily and is no longer good for growing plants.
- Farmers use pesticides to kill weeds and insects. The chemicals in pesticides can also kill the organic matter in the soil.
- Farmers use artificial fertilisers. These can damage the soil texture and dry out the soil.
- Farmers do not dig and turn the soil over often enough. Air and organic matter needs to be mixed through the soil.

Activity 2

Changing the composition of soil

1 What must a farmer or gardener do to make sure that:
   a the soil has enough water?
   b the soil has enough nutrients?
   c the soil drains well?
2 Look again at the vegetable garden in the photograph at the beginning of the topic.
   a What type of soil is this? Explain how you know.
   b List ways the woman maintains the composition of the soil.
3 Draw a table with two columns headed Action and Change in the composition of the soil. In the first column list actions that damage the soil . In the second column write down how the action changes the composition of the soil.

How can you use what you have found out in this topic to look after soil in the future?

Look what I can do!

- [ ] I can find out that there are different types of soils and they can be classified based on their clay, sand and organic content.
- [ ] I can find out that the composition of soil can change making it better or worse for plants to grow in it.
- [ ] I can make a prediction and see whether observation supports my prediction.
- [ ] I can observe and sort different materials in soil.
- [ ] I can record observations in a table.

Project: How people use soil

In this project you will identify a person who uses soil in your area and ask them questions about how they use the soil.

You can do this project on your own or with a partner.

Speak to a person in your area who uses soil.
You could speak to a farmer or someone with a garden or an allotment.

Make an appointment to speak to the person. Introduce yourself and say why you want to speak to them.

Prepare a list of questions and leave space to write in your answers when you speak to the person.

Ask questions such as:

- What sort of soil do you have? What are its colour and texture? Is there any organic matter?
- Is it sandy, clay or loam?
- What do you grow in the soil?
- What do you need to add to the soil to make your plants grow well?
- How do you look after the soil?

If possible, take some photographs.

Remember to thank the person when you have finished.

Present the information you have collected as a poster.

Check your progress

1 Match the words 1–5 in Column A with their meanings A–E in Column B

A	B
1 Fossil	A: Process where liquid magma or lava cools down and becomes solid rock.
2 Solidification	B: A whole animal preserved in minerals.
3 Pesticide	C: A factory-made product that kills unwanted insects but also kills the organic matter in the soil.
4 Cast	D: Sinking of rocks below the Earth's surface.
5 Metamorphic rock	E: The preserved remains of animals and plants in sedimentary rocks.
6 Burial	F: A rock that has been changed by heat or pressure or both heat and pressure.

2 Give an example of:

a An extrusive igneous rock

b A sedimentary rock formed of crushed shells.

c A well-balanced soil.

3 a Is this an igneous, a sedimentary or a metamorphic rock?

b Explain your answer.

c What is this rock made up of?

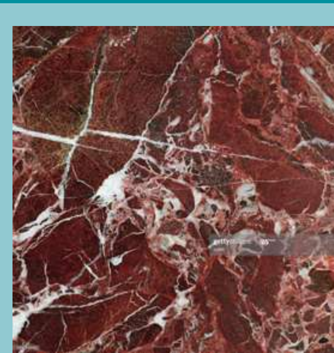
d How did this rock form?

4 a Is this an igneous, a sedimentary or a metamorphic rock?

b Explain your answer.

c Where did this rock form?

Continued



5 This is a photograph of a piece of cut, polished metamorphic rock.

a Identify the type of metamorphic rock.

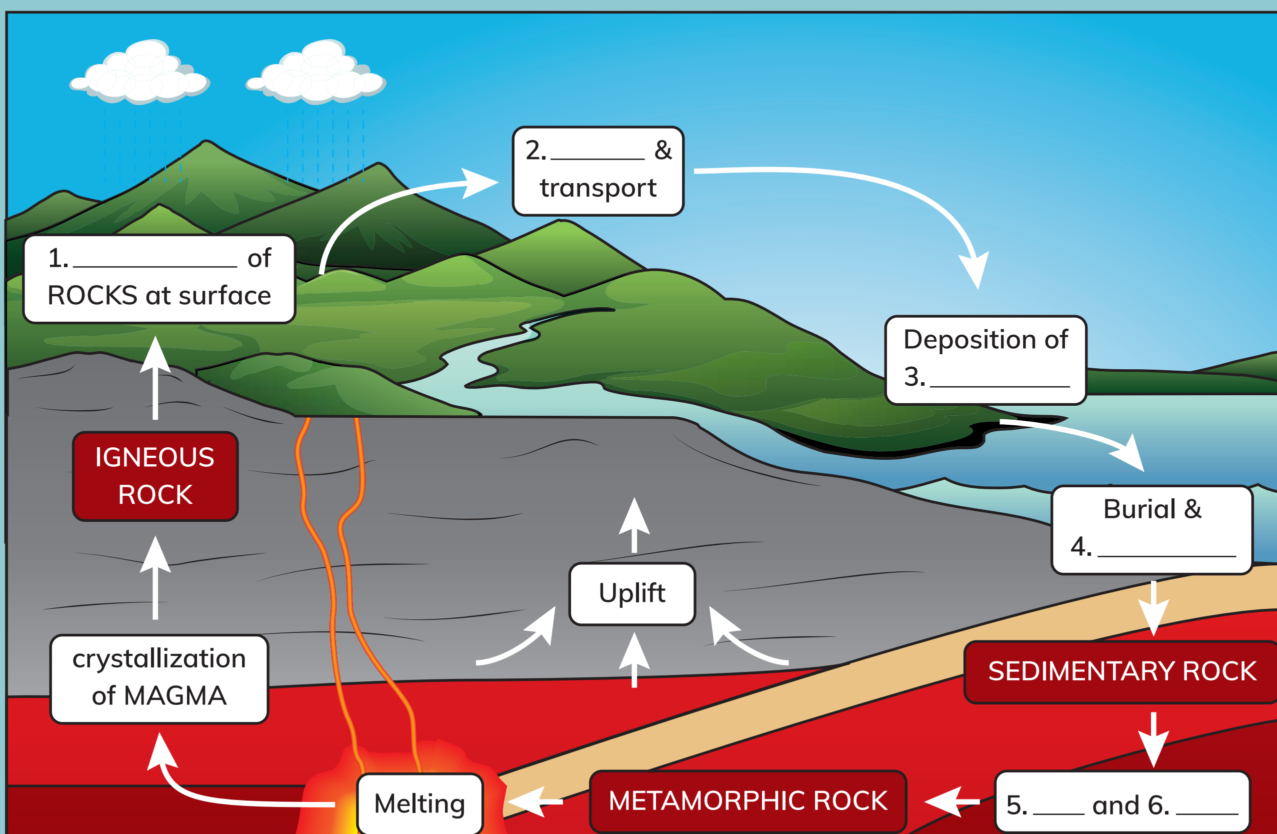
b Which sedimentary rock changed into this metamorphic rock?

c Describe the change that took place.

6 a Complete the labels at 1–6 Choose from:

sedimentation, erosion, heat, sediments, pressure, weathering.

b Suggest a title for this diagram.



4 Food chains and food webs

4.1 Food chains, food webs and energy transfers

We are going to...

- draw food chains
- explain a food web and identify food chains in a food web
- explain how a food web shows feeding relationships in nature
- identify the source of energy in food chains and food webs
- describe how energy is transferred in food chains and food webs

accurate food chain food web represent

Getting started

We can sort and group living things according to how they obtain the energy they need to live. The pictures show some producers and consumers.

1 **a** What is a producer?

b Make a list of the producers shown in the pictures.

2 **a** What is a consumer?

b Draw a Venn diagram to sort the consumers shown in the pictures into:

- herbivores
- carnivores
- omnivores

Food chains

A food chain is a diagram that shows the order in which animals eat plants and other animals to get energy. A food chain is made up of pictures and/or words to show or represent the plants and animals, with arrows linking them. The arrows show the direction in which the food moves. Food contains energy, so the arrows also show the direction in which the energy is transferred.

Food chains always contain a producer and at least one consumer. The order of living things in a food chain is always:

producer → consumer

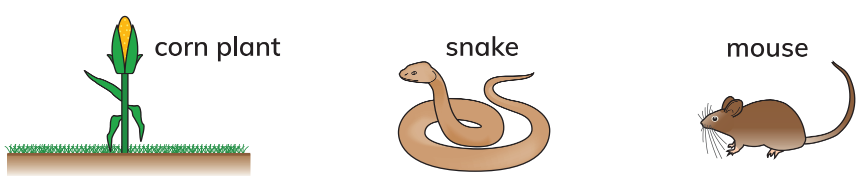
Energy is always transferred from the producer to the consumer because the consumer eats the producer. Most food chains have more than one consumer.

Activity

Draw food chains

Put the living things in the pictures in the right order to make food chains. Draw the food chains.

1



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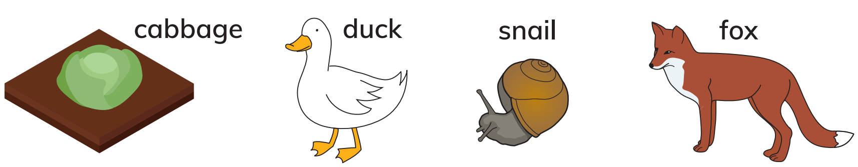

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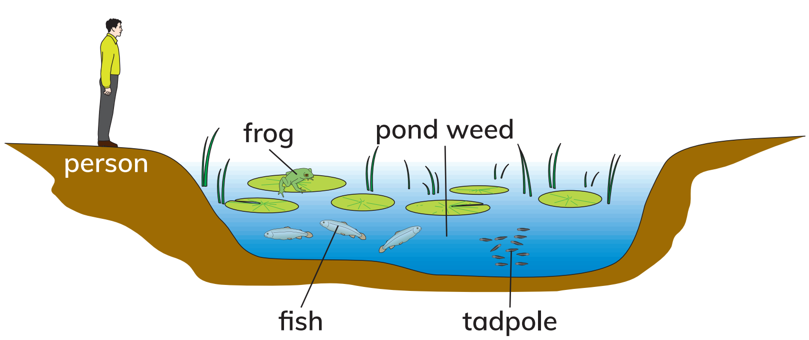
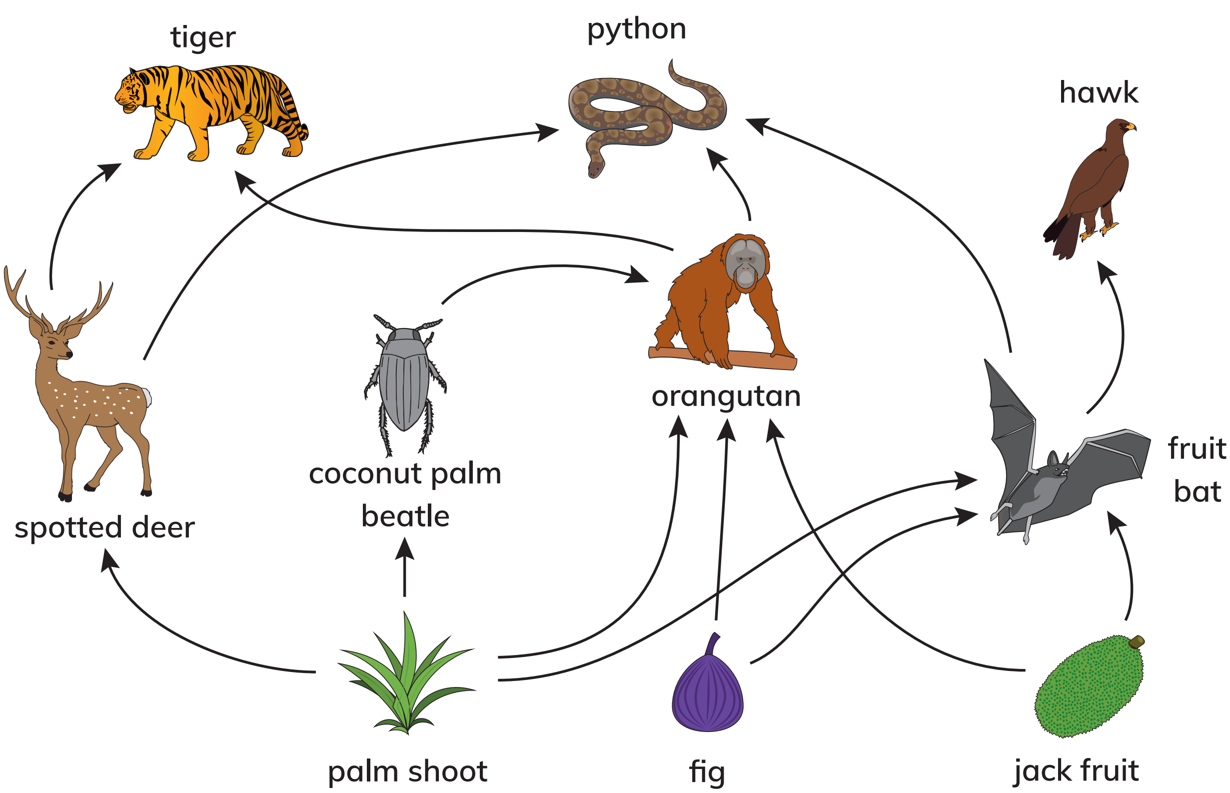


Food webs

Do you eat only one kind of food?
Most living things don't eat just one food.

For example, a frog will eat worms, flies, beetles and other insects. Some large frogs will eat small snakes, mice, baby turtles and even other smaller frogs. This means that most animals are part of more than one food chain.

These different food chains link together to form a food web. Food webs are a more realistic or accurate way to show how energy is transferred between living things. A food web shows the different food chains a living thing can be part of in its habitat. Look at the picture of a food web from the rainforests in Indonesia.



Think like a scientist

Explain a food web and draw food chains

Look at the food web and answer these questions.

1 a Name the producers in the food web.
  b Name the herbivores in the food web.
  c Name the carnivores in the food web.
  d Name an omnivore in the food web.

2 Name the foods the orangutan eats.

3 a Which animals eat the orangutan?
  b Which other animals do they eat?

4 a Identify and draw three food chains in the food web that have three links.
  b Identify and draw one food chain in the food web with four links.

5 How does a food web help us to understand feeding relationships in nature?

How am I doing?

Answer 'Very well', 'Quite well' or 'I need help' to these questions:

- How well can I identify producers and different consumers in a food web?
- How well can identify and draw the food chains in a food web?
- How well can I explain the way a food chain or food web helps us to understand feeding relationships in nature?

Energy transfers in food chains and food webs

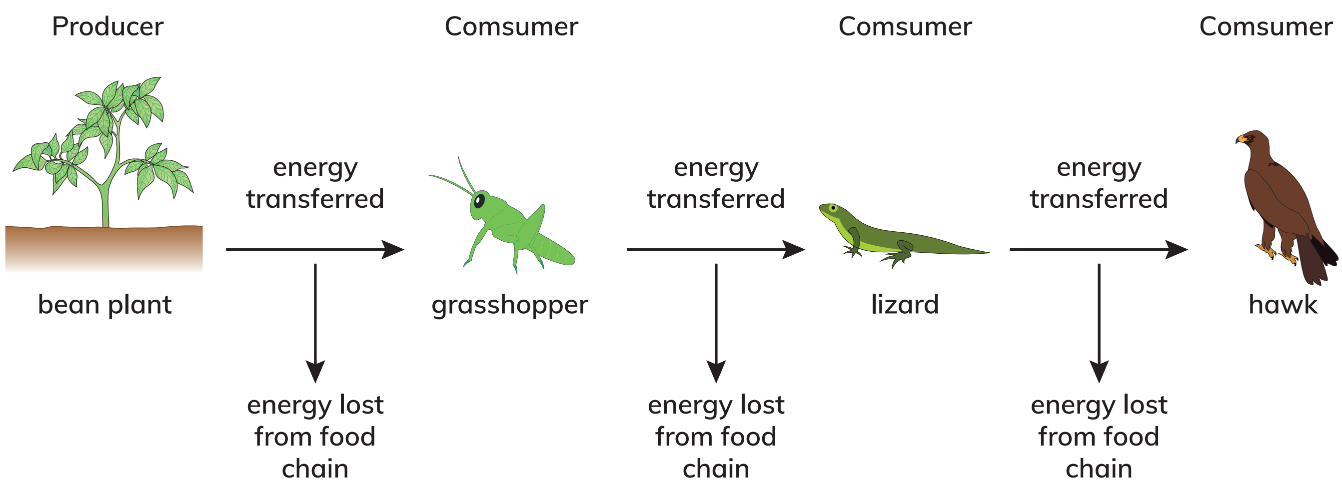
Energy is transferred from one living thing to another in a food chain. Producers get their energy from the Sun. They use the Sun's energy to make food. The food the producers make becomes the source of energy for the herbivores that eat the plants. The herbivores in turn become the source of energy for the carnivores that eat them.

Not all the energy in the food a consumer eats is passed on to the next link in the food chain. For example, this is what happens to the energy a herbivore gets from the plants it eats:

- some of the energy is used by the herbivore to stay alive
- some energy will be stored in the herbivore's body
- some energy will be transferred to the surroundings as heat.

So, when a carnivore eats the herbivore, it only gets the energy that is stored in the herbivore's body. The rest of the energy is lost from the food chain.

Because energy is lost at each link in a food chain or food web, the amount of energy that is transferred to the next link gets less and less.



Questions

1 Where does the energy in a food chain or food web come from?

2 How do producers use this energy?

3 How is the energy in a producer transferred to a consumer?

4 How does a consumer, such as a hawk, depend on producers?

5 a What happens to the amount of energy as it is transferred through a food chain?

b Say why this happens.

What did I find difficult?

What can I do to understand food webs better?

Look what I can do!

- [ ] I can draw food chains.
- [ ] I can explain a food web and identify food chains in a food web.
- [ ] I can explain how a food web shows feeding relationships in nature.
- [ ] I can identify the source of energy in food chains and food webs.
- [ ] I can describe how energy is transferred in food chains and food webs.

4.2 Harm to food chains and food webs

We are going to…

- learn that some substances can harm living things, and that these substances can move through a food chain or food web.
- play a game to show how harmful substances can move through a food chain or food web.
- explain how a game can show the way harmful substances can move through a food chain or food web.
- record results in a table, draw a graph and describe a pattern in results.
- research information to answer questions about a harmful substance in food chains.

Getting started

In a group, brainstorm ideas about things you think can harm the plants and animals in a food chain or food web.

accumulate environment microplastics pesticides toxic

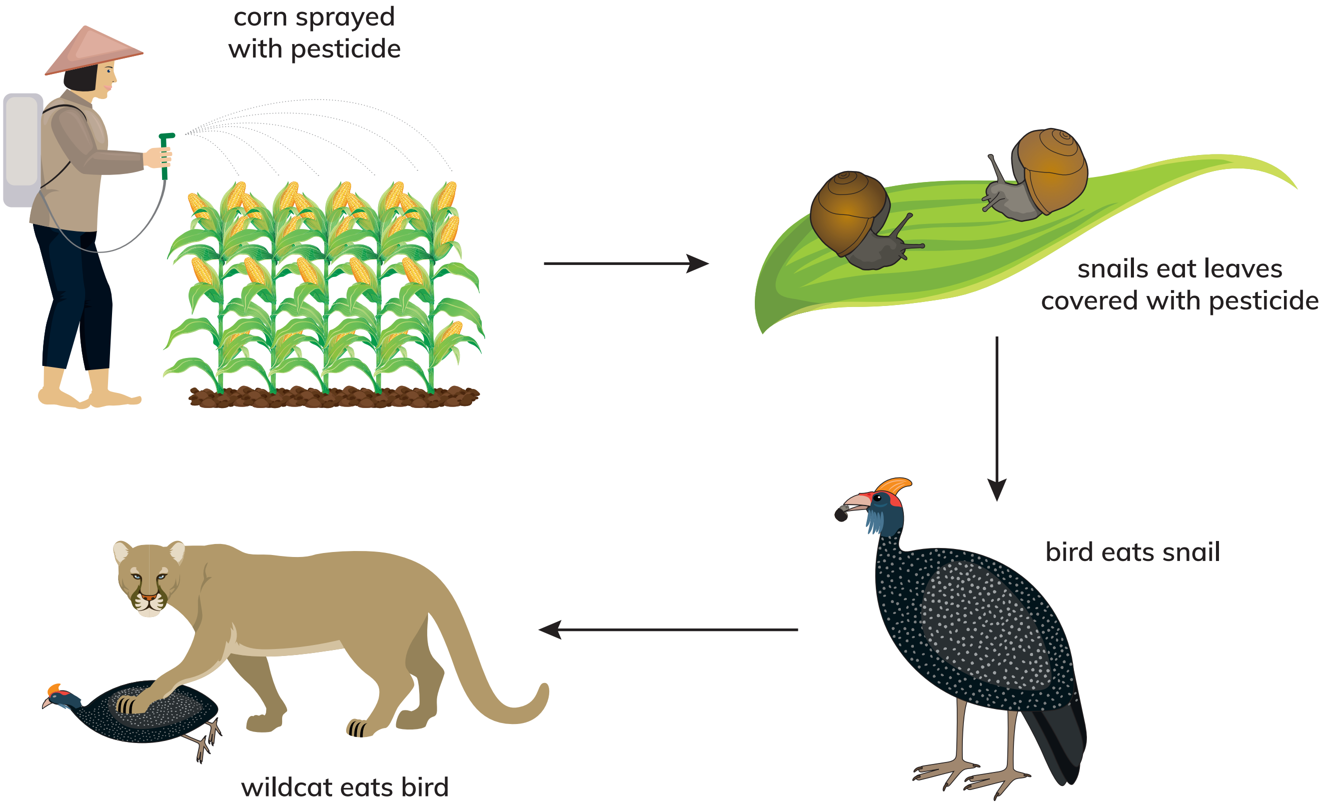
Harmful substances in food chains and food webs

The environment is everything around us. It includes air, water, soil and other living things. Some substances in the environment can be harmful or toxic to living things. These substances include certain metals, such as mercury and cadmium.
Very small particles of plastic called microplastics can also be toxic, especially in ocean food chains and food webs.

People put harmful substances into the environment, sometimes by accident and sometimes on purpose. For example, farmers and gardeners don't like insects, snails, worms and other pests that eat their plants. They often use chemicals called pesticides to get rid of the pests. Pesticides are another type of harmful substance that can affect food chains.

If a farmer sprays a pesticide on his or her crops, the pest that eats the crop will die. Pesticides can also kill consumers in a food web that are not pests. For example, butterflies can die if they drink nectar from a flower sprayed with a pesticide.

Other living things in a food chain or food web can also be affected by pesticides. For example, a bird may eat a snail that was killed by a pesticide. The pesticide enters the bird's body. The bird may not die, but the pesticide could affect it in other ways. For example, the bird's bones may get weaker. A predator that eats the bird will also take in any pesticide still in the bird's body.



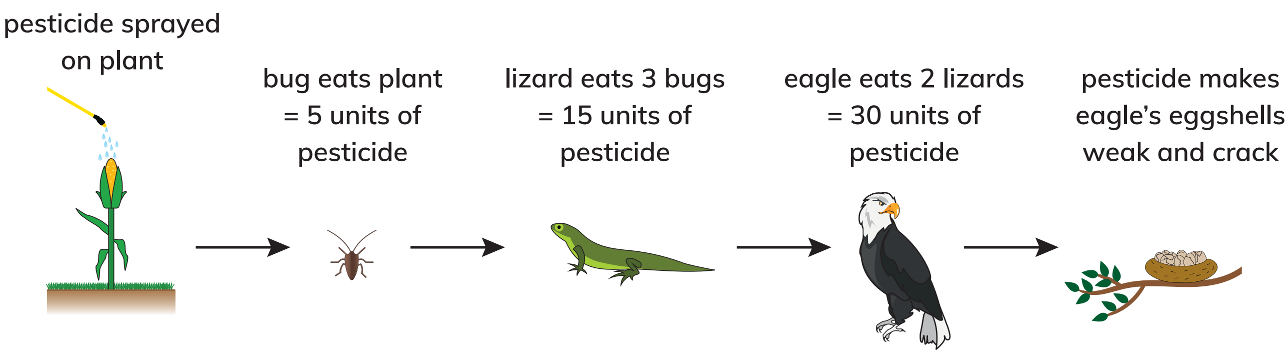
Questions

1 How does the pesticide get into the food chain in the picture?

2 How does the pesticide move through the food chain?

3 Redraw the food chain to how the pesticide could be passed to people.

Some toxic substances will break down into other harmless substances in the soil or water in the environment. Others stay in the environment and do not break down. These substances build up or accumulate in food chains. They can harm the organisms in the food chain, especially the predators at the end of the chain.



Think like a scientist

Play a food chain game

In this game you will pretend to be producers and consumers in a food chain. The aim of the game is to show how toxic substances, like pesticides, can move through food chains and food webs.

You will need:
paper cups marked with different colours, paper pesticide 'particles', sticky notes

Your teacher will group you into 'rice plants', 'caterpillars', 'frogs' and 'kingfishers', and give each learner in a group a paper cup marked with the group's colour. Your teacher will also spread paper pesticide 'particles' into the game area

1 'Rice plants' start the game by collecting the pesticide 'particles' into their cups.

Continued

2 Play the game by tagging other learners with sticky notes and collecting pesticide particles from them in your cup. When you tag a player, they must empty their particles into your cup and sit down. Count and record the number of particles you collect. Your teacher will explain more about how to play the game

3 Draw a table of the average number of pesticide 'particles' collected by each type of living thing in the food chain.

4 a Draw a bar graph of the results to show the average number of particles found in each type of living thing in the game food chain.

  b Which living thing in the game food chain received the biggest amount of 'pesticide'? Why?

5 Describe the pattern you can see in the results.

Questions

1 In the food chain game, which living thing represents the:

  a producer?

  b first consumer?

  c second consumer?

  d third consumer?

2 What does the tagging of another player represent in the game?

3 Draw the food chain represented in the game.

4 Explain to a partner how the game shows the way toxic substances, like pesticides, can move through a food chain.

How are we doing?

Answer these questions with a partner: ☺ or 😐 or ☹

- Could we follow the instructions to play the game?
- Could we record results in a table and draw a graph?
- Could we explain how the game shows the way toxic substances move through a food chain?

Activity

Research information about mercury in food chains

Almost all substances that contain mercury are toxic and can be dangerous, even at very low levels, in food chains.

Do some research to find out the answers to these questions:

- How does mercury get into the environment?
- How does mercury get into food chains?
- How does mercury move through food chains?
- Why is mercury harmful to living things?

Present your findings in a slide show, poster or information sheet. Include a food chain in your presentation to help explain your findings.

What did I do well in this topic?

What could I do better next time?

Look what I can do!

- [ ] I can understand that some substances can harm living things, and that these substances can move through a food chain or food web.
- [ ] I can play a game to show how harmful substances can move through a food chain or food web.
- [ ] I can explain how a game can show the way harmful substances can move through a food chain or food web.
- [ ] I can record results in a table.
- [ ] I can draw a graph of results.
- [ ] I can describe a pattern in results.
- [ ] I can research information to answer questions about a harmful substance in food chains.

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Project: Reducing plastics in food chains

Part 1 The ecobrick project

A lot of the plastics we throw away end up in the oceans, where they start to break down into smaller bits. Sea animals such as turtles, penguins and fish often mistake the plastic for food. They swallow the plastic which often gets stuck in the animals' digestive systems. Many sea animals die because of this.

Very tiny pieces of plastic are also a problem. Microplastics are tiny particles less than 5 mm across that form from the breakdown of larger plastic items by sunlight and the action of waves in the ocean. There are more than 51 trillion pieces of microplastic in our oceans – that's more than 500 times the number of stars in our galaxy. These plastic particles affect every part of our oceans and their food chains. One way to reduce the number of microplastic particles in the oceans is to reduce the amount of larger plastics that we throw away.

Some waste plastics can be recycled. This means they can be changed into other products. Other plastics cannot be recycled. A project in South Africa is making ecobricks from plastic waste. Ecobricks are made from plastic bottles filled with waste that cannot be recycled, such as plastic straws and chocolate wrappers. The ecobricks are used to build day care centres and pre-primary schools for children in poor communities.

In a group discuss these questions:

1 How do plastics cause problems in ocean food chains? (Also think about what you learnt in Topic 4.2.)

2 How do microplastics form?

3 Why are there so many microplastic particles in the oceans?

4 How does the ecobrick project help to reduce plastic waste in the oceans?

5 How else does the ecobrick project have a good effect?

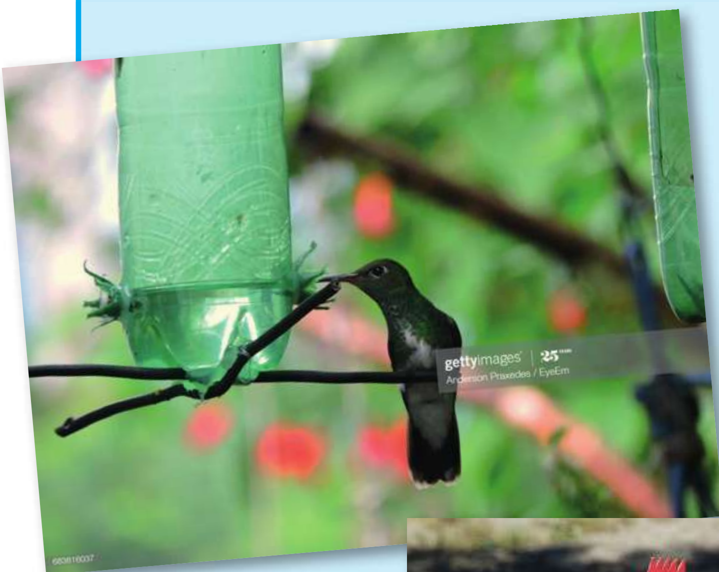
6 a In what other ways can we reduce plastic waste?

  b Why should we try to reduce plastic waste?

Continued

Part 2 Design and make a product from waste plastic

People have come up with many creative ideas to make other products from waste plastics.



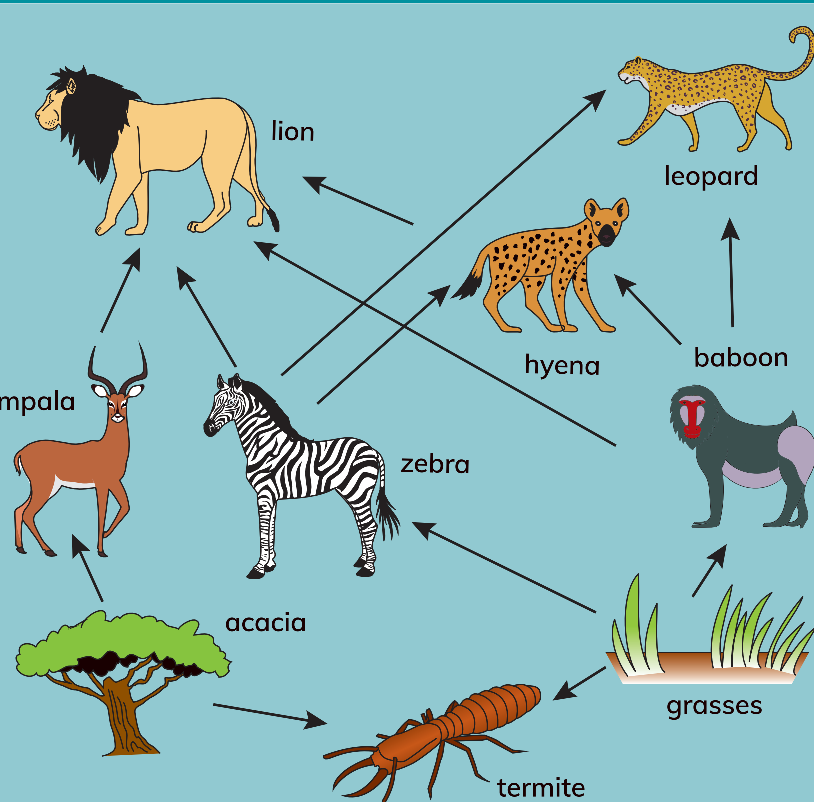
Work with a partner to design and make a product from waste plastic.

Display your product with an information sheet that tells people:

- what the product is and what it is used for
- which plastics you used to make it
- how you made it
- how your product helps the environment.

Check your progress

1 Look at the food web from an African grassland. Use the drawing to answer the questions.



a Name two producers in the food web.

b Name three herbivores in the food web.

c Name any omnivores in the food web.

d How many carnivores are shown? Name them.

e Identify and draw three food chains in the food web with three links.

f Identify and draw two food chains in the food web with four links.

g Identify and draw a food chain in the food web with five links.

2 Class 6 played a game to see how toxic substances can accumulate in living things in a food chain. Here are their results.

Living thing in food chain	number of toxic particles taken in
green algae	2
shrimp	8
small fish	24

a Draw a dot plot of the results.

b How many algae did the shrimp eat?

c How many shrimps did the small fish eat?

d A big fish ate five small fish. How many harmful particles did it take in?

e Name two toxic substances in food chains that you have learned about.

5 Forces and electricity

5.1 Mass and weight

We are going to...

- describe the difference between mass measured in kilograms (kg) and weight measured in newtons (N)
- describe the effect of gravity and know that when gravity changes, the weight of an object changes but the mass does not
- measure the mass and weight of objects and practise pattern seeking
- decide when it is necessary to repeat measurements to give more reliable data
- describe a pattern in results and identify if results do not fit the pattern
- make a conclusion from results using science knowledge
- record measurements in a table.

Getting started

The picture shows an astronaut standing on the Moon.
Discuss these questions with a partner.

1. What is a satellite?
2. Why is the Moon a natural satellite rather than an artificial satellite?
3. How does the Moon stay in orbit around the Earth?
4. Do you think the astronaut weighs the same on the Moon as he does on Earth? What unit will his weight be measured in?

astronaut forcemeter mass newton
rehabilitation weight weightlessness

What is the difference between mass and weight?

Mass is the amount of matter in an object. We measure mass in kilograms (kg). In the picture, the baby's mass is 3.6 kg. In everyday English we use the words *weigh* and *weight* to mean an amount in kilograms. So it is confusing to hear that this is in fact mass.

Scientifically, mass and weight are not the same. The weight of an object depends on the force of gravity.

Remember that all objects on Earth are pulled or attracted towards the centre of Earth by gravity. Weight is the amount of attraction on an object caused by gravity. Our weight is the force on us due to the pull of the Earth on our mass.

Scientists measure weight using a unit called the newton (N). Newtons are named after Sir Isaac Newton, a scientist who lived in England about 400 years ago. He was the first person to explain what forces are.

How does gravity affect weight?

Objects have the same mass wherever they are. You will have the same mass if you go to the Moon or planet Jupiter. But your weight will not be the same because it depends on gravity. The smaller the amount of gravity, the lower your weight will be. The amount of gravity depends on the mass of the object. For example, the Moon's gravitational force is less than the Earth's because the Moon has a smaller mass than the Earth. This means that if you went to the Moon you would weigh less, even though your mass stays the same!

Activity 1

What is the difference between mass and weight?

1 Was the nurse scientifically correct to say that the baby weighs 3.6 kg? If not, what should she have said?

2 Complete the following sentence using the words weight and mass:

An object's ______________ remains the same wherever it is.

An object's ______________ depends on the amount of gravity.

3 a Will the astronaut in the picture have the same mass as he does on Earth?

b How will the astronaut's weight change on the Moon?

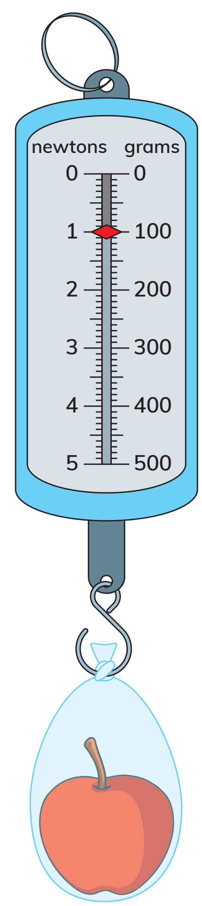
c Explain why his weight changes.

4 With a partner, discuss why you think astronauts who walk on the Moon have to wear very heavy suits and boots.
Do you think they can drink a glass of water on the Moon?

Measuring mass and weight

We measure mass in grams and kilograms with a measuring scale. For example, when you make a cake you measure the mass of the flour, the sugar and the butter in grams on a measuring scale.

We measure weight in Newtons on a forcemeter. The forcemeter hangs by a hook and has a hook at the other end to hang what you are measuring.



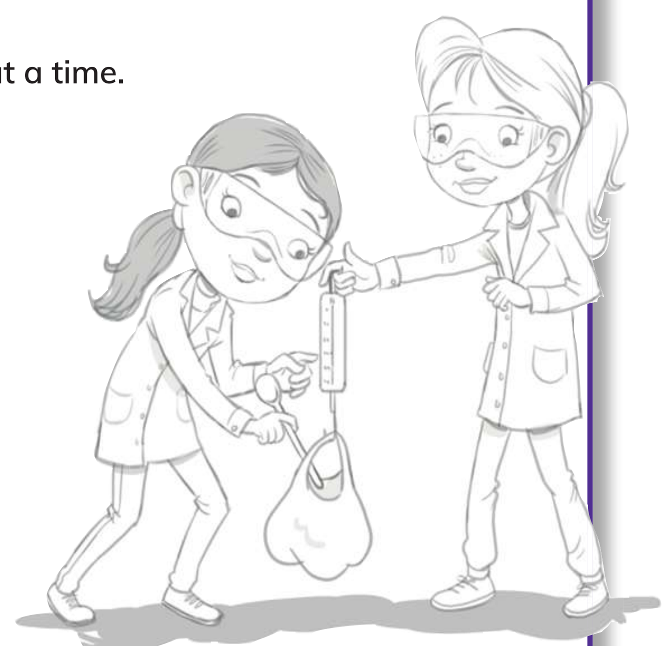
Think like a scientist

Measure the mass and weight of objects

Work in groups of two or four.

You will need:
a scale to measure mass and a forcemeter to measure weight (or a device that measures both mass in g and weight in N), a plastic carrier bag, objects of different masses to measure

1. Draw a table to record your measurements. You will need a column for the objects, a column for the mass of the objects in grams and a column for the weight of the objects in newtons.
2. Place each of the objects on the scale, one at a time. Record your measurements on your table.
3. Hold the forcemeter by the top hook. Put each of the objects in the plastic bag, one at a time. Hang the bag on the bottom hook of the forcemeter. Record your measurements on your table.



Questions

1. Compare the readings on the measuring scale with the readings on the forcemeter. What pattern do you see?
2. Did any of your measurements not fit this pattern? If so repeat these measurements.
3. Complete this sentence to make a conclusion about the mass and weight of an object measured on Earth:

   One kilogram of ______________ has a weight of ______________ on Earth.
4. Imagine you had done this activity on the Moon.
   - a Would the mass of the objects be the same or different to those measured on Earth? Explain why.
   - b Would the weight of the objects be the same or different to those measured on Earth? Explain why.

Continued

How are we doing?

Did your group work well as a team?
Did you take it in turns to use the equipment?
Did everyone help to clear up afterwards?

For each question, choose from one of these faces: ☺ or 😐 or ☹

Weightlessness

When you are in space, the main thing to get used to is zero gravity.

The International Space Station is permanently in orbit around the Earth. Scientists from many countries visit the Space Station to carry out research in space. The Space Station is attracted by gravity to the Earth. Its forward motion just about equals the speed of its 'fall' toward the Earth. This means that the people who go into space – the astronauts – inside the Space Station are not pulled in any particular direction. So they float, meaning that they have a feeling of weightlessness.

Floating might sound relaxing. But it is not good for your bones and muscles to float for a long time! Weightlessness causes several systems of the body to relax, because it is no longer fighting the pull of gravity. For example, the astronaut's sense of 'up and down' gets confused. Astronauts find it difficult to tell where arms, legs and other parts of the body are. One astronaut said in an interview, 'The first night in space when I was drifting off to sleep I suddenly realised that I had lost track of my arms and legs. For all my mind could tell, my limbs were not there.'

Look at this astronaut – he is doing research outside the spacecraft. Scientists design spacecraft to take lack of gravity into account. During spacewalks, astronauts need extra handholds and footholds on the exterior of their spacecraft so that they do not float away.

Astronauts in space for weeks to months can get more health problems. Calcium in their bones is lost through their urine. This causes their bones to weaken. They are more likely to break their bones if they slip and fall.

The astronauts' muscles become weak. They have to exercise for two hours a day in space to try to overcome these effects. Exercising is quite difficult to do in such a small space. In spite of this exercise, after a typical six-month space mission, astronauts need several months of **rehabilitation** when they return to Earth. During this period of rehabilitation, they re-train their bodies to live on Earth and re-build their strength.

Activity 2

How gravity affects weight in space

1 What causes weightlessness?
2 Which force causes the International Space station to fall to Earth?
3 List three ways that weightlessness affects astronauts.
4 How do astronauts manage to work outside the spacecraft?
5 Why do astronauts have to exercise every day?
6 Why do you think spacecraft have all the writing on the walls pointing in the same direction?
7 What do you think an astronaut's weight will be in the International Space Station?
8 What will an astronaut's mass be in the International Space Station?
9 Talk to a partner about how astronauts can eat and drink in space.

How did this activity help you to understand how gravity affects weight?

Look what I can do!

- [ ] I can describe the difference between mass measured in kilograms (kg) and weight measured in newtons (N).
- [ ] I can measure the mass and weight of objects and practise pattern seeking.
- [ ] I can understand how gravity affects weight.
- [ ] I can know that when gravity changes, weight changes but mass does not.
- [ ] I can record measurements in a table.
- [ ] I can describe a pattern in results and identify if results do not fit the pattern and repeat these measurements.
- [ ] I can make a conclusion from results using science knowledge.

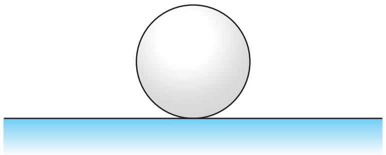
5.2 The effects of forces

We are going to...

- describe the effect of different forces on an object at rest and in motion
- use force diagrams to show the name, size and direction of forces acting on an object
- practise observing over time.

Getting started

1. Is the ping pong ball at rest or moving?
2. Are there any forces acting on the ball?
3. Copy the picture and draw and label force arrows to show which forces are acting on the ping pong ball.



4. What applied force is the person in the photograph showing?

What are the effects of forces on an object?

A force acting on an object can cause the object to change its shape or size, to start moving, to stop moving, or to go faster or slower. Do the investigation described next to see these forces in action.

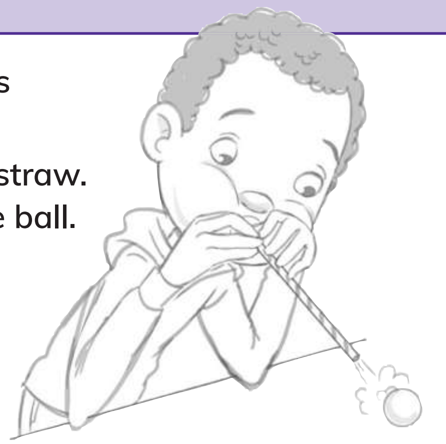
Think like a scientist

Investigate and discuss the effects of forces on an object

You will need:
a ping pong ball, a straw, a table, a book, a table cloth or towel

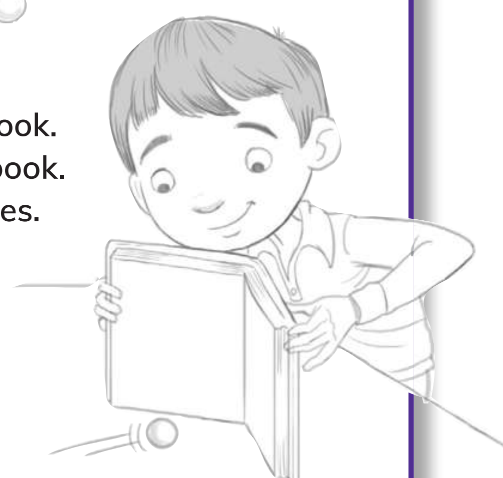
1 Put the ball on the table. Does the ball move?

2 Blow on the ball through the straw. Observe what happens to the ball.



3 Hold up a book across one end of the table. Roll the ball gently towards the book. Allow the ball to roll into the book. Observe what happens to the ball when it reaches the book. Discuss the effects in your group to see if everyone agrees.

4 Cover the table with a table cloth. Roll the ball towards the book again. Observe and discuss how fast the ball rolls compared to how fast the ball rolled when there was no cloth on the table.



Continued

5 Remove the table cloth. Flick the ball with your fingers towards someone else in your group. Get that person to flick the ball to someone else.

Observe and discuss what happens to the direction of the ball each time you flick it.

6 Place the ball on the table. The ball is at rest. Press down on the ball gently. Observe what happens to the shape of the ball.

How are we doing?

How well did the members of your group work together? Did they take turns? Did they finish in time?

Answer each question with ★★★ or ★★ or ★

The effects of forces

You have found out that forces can:

1 make an object move

2 slow down a moving object

3 stop a moving object

4 change the direction an object is moving

5 change the shape of an object.

Activity 1

The effects of forces

1. Give an example from your investigation with the ping pong ball of each of the five effects of forces listed above. For each example, identify the force and the effect of the force.
2. Draw a force diagram to show the forces involved in rolling the ball to the book. Label the forces.
3. Draw a force diagram to show the forces involved in rolling the ball across the table cloth to the book. Label the forces.
4. What effect does force have when the table tennis player in the photograph hits the ball?

Activity 2

Identify the effects of forces in ball games

Look at the pictures of children playing ball games.

1. a In Picture A, what will the boy do to the ball?
   b How will this force affect the ball?
2. a In Picture B, what is the boy doing to the ball?
   b How does this force affect the ball?
3. a In Picture D, the girl is watching the ball carefully. What will she do to the ball when it reaches her?
   b How does this force affect the ball?

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Continued

4 In picture C, the boys have set up a snooker game in the street. The aim of this game is to hit different coloured balls so that they hit other balls and make them go down the pockets along the sides of the board.

   a What forces are working on the balls when they are at rest?

   b When the boys play the game, list the effects the forces have on the balls.

5 Play a ball game during your next break or after school. What forces do you apply to the ball? What effects do the forces have on the ball?

How did the practical work help you to think about the effects of forces?

Look what I can do!

- [ ] I can investigate the effect of different forces on an object at rest and in motion.
- [ ] I can use force diagrams to describe effects of forces.
- [ ] I can observe and discuss the effects of forces on a ball at rest and moving.

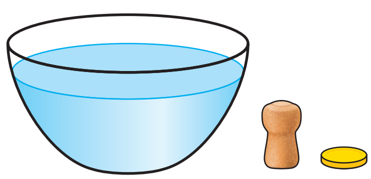
5.3 Floating and sinking

We are going to...

- find out that the mass and shape of an object can affect if it floats or sinks
- use force diagrams to describe effects of forces
- make predictions and find out whether our predictions were correct
- plan a fair test and identify the independent, dependent and control variables
- practise fair testing and pattern seeking
- take accurate measurements
- collect and record observations and measurements in tables
- describe patterns in results and identify any results that do not fit the pattern
- make a conclusion from results using knowledge about floating and sinking
- suggest changes which could improve a boat design
- present results in a scatter graph.

Getting started

1 If you place the cork on the surface of the water in the bowl, will it float or sink?



2 Why do you think the cork does this?

3 If you place the coin on the surface of the water in the bowl, will it float or sink?

4 Why do you think the coin does this?

5 Look at the photograph of the container ship. This ship has a mass of thousands of tons. How do you think the container ship can float?

displaced
upthrust

Forces acting on objects when they float or sink

When an object is on water there are two forces acting on it:

- weight due to force of gravity
- upthrust.

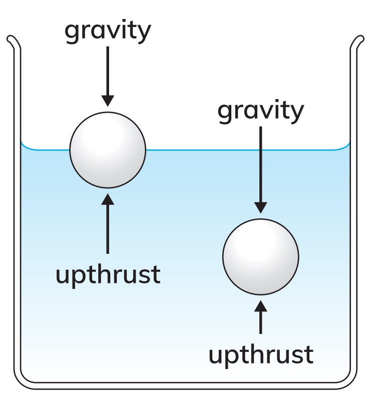
Try pushing a ball down on to the surface of water – you can feel the water pushing up underneath the ball. This is the upthrust force. The upthrust force causes water to be displaced or pushed out of the way.

This idea of displacement was discovered by a man called Archimedes who lived in Ancient Greece. He was sitting in his bath one day and he noticed that all the water displaced as he sat in the bath. He was so excited that he ran into the street shouting 'Eureka!', which is Greek for 'I have solved it!'

How do we know whether an object will float or sink?

We can measure the mass in kilograms of an object so we can compare its mass with the mass of the water it will displace. This will show us whether the object will float or sink.

If the mass of the object is less than, or equal to, the mass of water displaced by upthrust, the object will float. If the mass of the object is greater than the mass of water displaced by upthrust, the object will sink.



How does the force diagram show why one ball floats and the other sinks?

Notice that the force arrows for the floating ball are equal in length. The ball would also float if the gravity arrow was shorter than the upthrust arrow.

With the sinking ball, the gravity force arrow is longer than the upthrust arrow so the ball sinks below the surface.

The container ship has a huge mass but it displaces an even greater mass of water. This is why the container ship can float.

Think like a scientist 1

How does mass affect floating and sinking?

You will need:
a large container half-full of water, a measuring scale, a small plastic container, sand (or rice), a spoon

1 Draw a table with three columns to record your predictions and results. Write these headings for your columns: Amount of sand; Prediction (float or sink) and Result (float or sink).
2 From what you know about floating and sinking, predict whether the plastic container will float or sink. Write your prediction on the table.
3 Test your prediction. Record your result in your table.
4 Measure 10 g of sand. Put the sand into the small container. Predict whether the container will float or sink. Write your prediction on your table.
5 Test your prediction. Record your result in your table.
6 Continue adding another 10 g of sand to the small container and repeat steps 4 and 5 until the container sinks.

Activity

Fair testing, force diagrams and writing a conclusion

Answer these questions about the practical activity you have just done on how mass affects whether an object floats or sinks.

1 Identify the control, dependent and independent variables.
2 How did you make this a fair test?
3 a Draw and label a force diagram to show the small container floating.
  b Draw and label a force diagram to show the small container sinking.
4 Write a conclusion.

Continued

How am I doing?

Am I getting better at identifying the control, dependent and independent variables?

Am I getting better at drawing force diagrams?

For each question, choose from one of these faces: ☺ or 😐 or ☹

How the shape of an object affects floating and sinking

Mass is not the only thing that affects floating and sinking. In the next practical activity you are going to see what effect the shape of the object has.

Think like a scientist 2

How does shape affect floating and sinking?

You will need:
a large container half-full of water, ten marbles, an aluminium foil dish, some aluminium foil

1. From what you know about floating and sinking, predict whether a marble will float or sink in the water.
   Test your prediction.
2. Put a marble in the aluminium foil dish. Predict whether the marble will float or sink in the water now. Test your prediction.
3. Place more marbles, one at a time, on to the aluminium foil dish. Continue until the dish sinks.
4. In your group, make different shaped 'boats' out of the aluminium foil. See how many marbles each boat will hold before it sinks.

Continued

Questions

1 Draw the shape of aluminium boat which held the most marbles before it sank.

2 How could you change the shape of your boat to make it hold even more marbles?

3 Identify a pattern in how the shape of the container affects whether an object floats or sinks.

4 Write a conclusion about how the shape of an object affects whether the object floats or sinks.

5 Look at the container ship in the photograph at the beginning of this topic Scientists have used their knowledge of floating and sinking to design the most economical shape to carry heavy loads of containers without sinking.

a Use what you have learnt to explain how this ship can float.

b What will happen when the ship carries empty containers?

6 Marcus and Arun did a similar investigation using different shaped foil containers and coins instead of marbles. They used the same sized coins each time. They recorded their results on a table:

Area of base of container /cm^2	2	4	5	7	9	11	14	16
Number of coins before container sank	1	2	2	3	4	6	7	9

Present the data in the table in a scatter graph. Refer to the Skills at the end of this book to remind yourself of how to draw a scatter graph.

Identify the trend as a positive trend, a negative trend or no trend.

Explain how the activities helped you get better at predicting whether an object would float or sink.

Look what I can do!

- [ ] I can find out that the mass and shape of an object can affect whether it floats or sinks.
- [ ] I can use force diagrams to describe effects of forces.
- [ ] I can make predictions and find out whether our predictions were correct.
- [ ] I can do scientific enquiries involving fair testing and pattern seeking.
- [ ] I can plan a fair test and identify the independent, dependent and control variables.
- [ ] I can take accurate measurements.
- [ ] I can collect and record observations and measurements in tables.
- [ ] I can describe patterns in results and identify any results that do not fit the pattern.
- [ ] I can make a conclusion from results using knowledge about floating and sinking.
- [ ] I can suggest how to change the shape of a boat to carry more mass and still float.
- [ ] I can present results in a scatter graph.

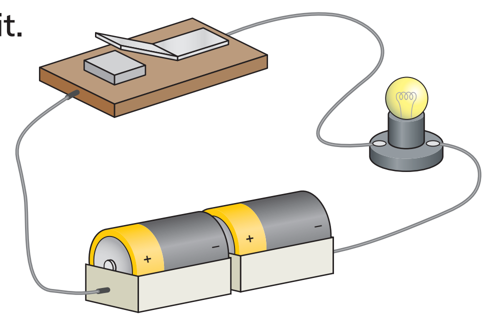
5.4 Different circuits and circuit diagrams

We are going to...

- use conventional symbols to draw circuit diagrams
- choose components to make circuits and compare circuits that include batteries, switches and buzzers
- compare the brightness of lamps in series and parallel circuits
- make predictions, referring to what you know about electricity and test to see if your predictions are correct
- describe risks when planning practical work and consider how to minimise them and carry out practical work safely
- decide when observations need to be repeated to give more reliable results
- present and interpret results in tables
- make a conclusion from results using your understanding of electricity
- identify and classify circuits as series or parallel.

Getting started

Look at the picture of a circuit.



1 List the components of this circuit.

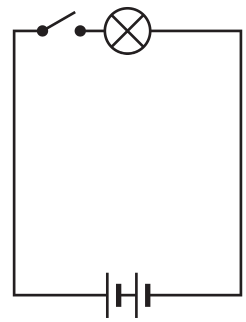
2 If you made a circuit to look like this, without touching the circuit, would the lamp light up?

3 Explain why or why not.

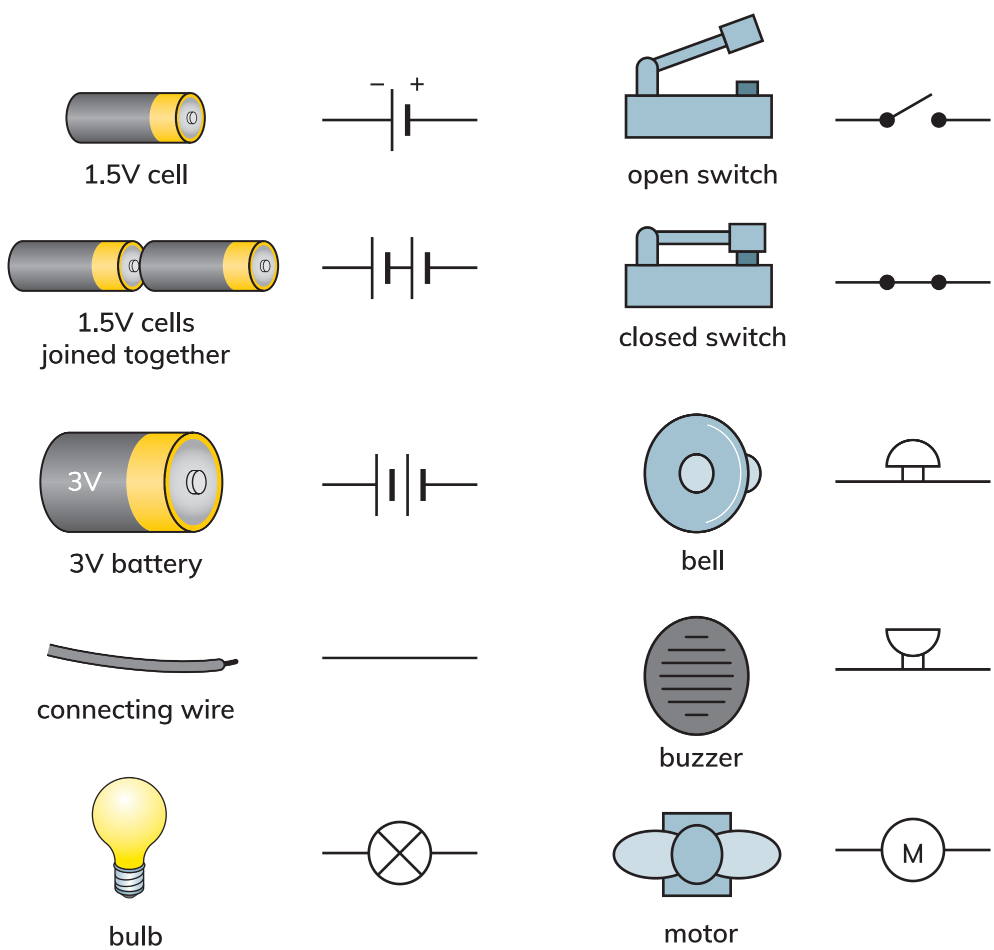
circuit diagram
conventional symbol
parallel circuit
series circuit
symbol
volt
voltage

Circuit diagrams

It takes a long time to draw a circuit like the one in the picture of cells, lamps and switch. It is much quicker to replace the pictures of components with signs. This is called a circuit diagram. People all over the world can understand circuit diagrams because everyone uses the same signs or symbols. We call them conventional symbols because they are used by everybody. Look at the picture at the start of this topic – this is a very complicated circuit diagram. But imagine having to draw all the components instead of using symbols! Here is a circuit diagram of the simple circuit in the picture above:



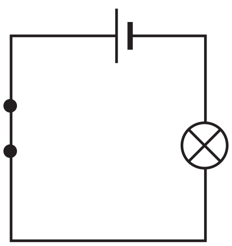
Here is a list of circuit components and their symbols. In the cells and batteries, the long lines represent the negative ends and the short thick lines represent the positive ends.

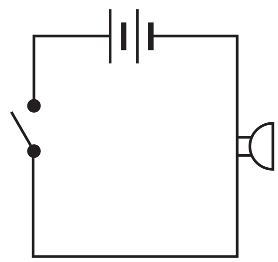


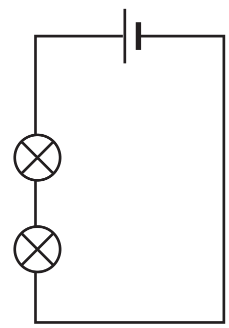
Activity

Use circuit symbols to read and draw circuit diagrams

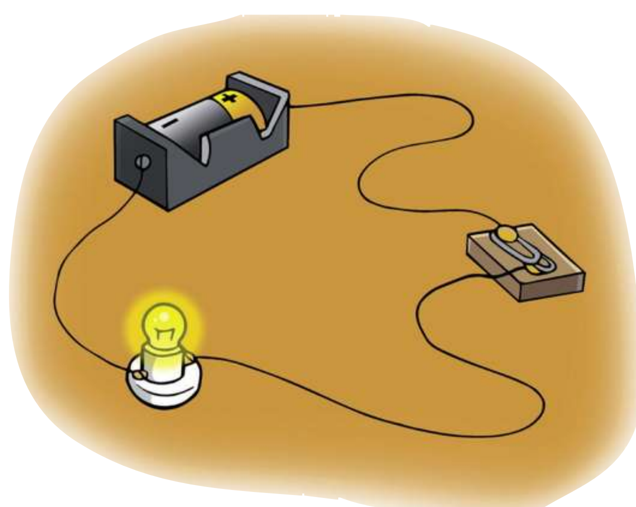
Look at circuit diagrams A, B and C.


Circuit A


Circuit B


Circuit C

1 Identify the circuit that shows:
   a a battery, a buzzer and a switch
   b a cell, a lamp and a switch
   c a cell and two lamps.
2 Which circuit shows the switch open?
3 Which circuit has the biggest energy source? How do you know?
4 Draw a circuit diagram to represent the circuit in the picture:
5 Draw a circuit diagram to represent a circuit with a 3 V battery, two lamps and a closed switch.



How am I doing?

Can I draw circuit diagrams? Answer with one of these:

Easily Getting there I still need some help

Adding different components to a circuit

Different components need different strengths of electricity. You can put a buzzer in a circuit instead of a lamp. But a buzzer needs a stronger supply of electricity than a lamp.

The strength of electricity is measured in units called volts (V). The strength of electricity that a component needs for it to work is called the voltage.

For example, if you put a 3 V buzzer into a circuit, you need a 3 V battery to make the buzzer work. You can make a 3 V battery by joining two 1.5 V cells.

Think like a scientist 1

Build circuits with different components

You will need:
one 1.5 V cell, a 3 V battery, a switch, a lamp, a buzzer, connecting wires

You are going to make:

- a circuit with a cell, a lamp and a switch
- a circuit with a 3 V battery, a switch and a buzzer.

1 In your group, discuss how you will make these circuits. Choose what components you need.
2 What are the risks when making circuits? How will you minimise these risks?
3 Predict what will happen before you make each circuit. Make the circuit. Does the evidence support your predictions?
4 Test whether adding another cell will make the buzzer sound louder.
5 Repeat any observations you are not sure of.

Continued

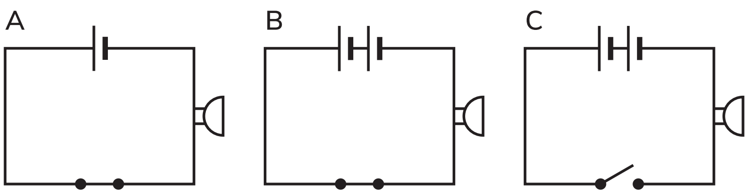
Questions

1 Draw a circuit diagram for each of the circuits you made.

2 Think about when you added a cell to your buzzer circuit. What was your conclusion about the effect of this?

3 How could you make the lamp shine brighter?

4 Look at circuits A, B and C.

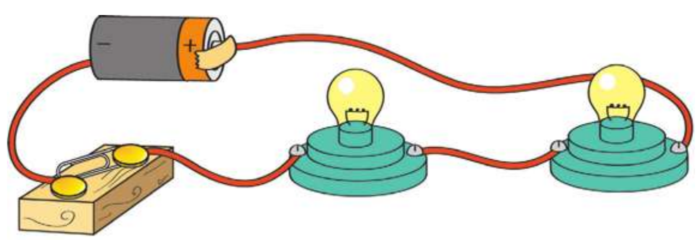


a Predict which circuit will work.

b Explain why the other two circuits will not work.

Series circuits

So far you have made circuits where the electric current has only one path. A circuit like this is called a series circuit. Here is an example:



People often use strings of coloured lamps connected in series to decorate trees, buildings or rooms for festivals or parties. If one lamp does not work, none of the lamps will light up. You have to check every single lamp to find the faulty one.

Parallel circuits

Is it possible to light up several lamps so that if one lamp burns out the rest of the lamps will stay alight?

You can to do this if you connect the lamps so that each lamp has its own circuit with the battery. This is called a parallel circuit. Each pathway in a parallel circuit receives the full circuit voltage. Find out more about parallel circuits by making one yourself in the next investigation.

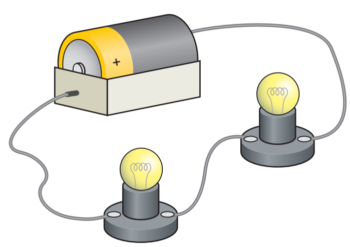
Think like a scientist 5.4.2

Make and compare a series circuit and a parallel circuit

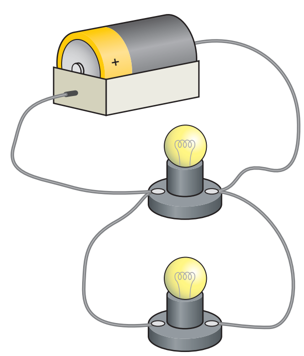
You will need:

- plastic coated wire
- 4 lamps in lamp holders
- two 3 V batteries

Connect the components as shown in the drawings.



Series circuit



Parallel circuit

For each circuit:

1 Predict whether both lamps will shine. Predict whether one lamp will shine more brightly than the other or whether they will both shine the same amount.

2 Test your prediction.

3 If you unscrew one of the lamps, predict whether the remaining lamp will shine or not. Will it shine more brightly, the same amount or less brightly than before?

Safety: Make sure you don't unscrew a lamp if it has been on for a while because it will be hot and it could burn your fingers.

Continued

4 Test your prediction.
5 Record your results in a table like this one.

	Brightness of lamps (* or ** or ***)	Does the remaining lamp shine when one lamp is removed?	Does the remaining lamp burn with same brightness as before?
Series circuit			
Parallel circuit			

Questions

1 When both lamps were shining, did they shine more brightly or less brightly in the parallel circuit than they did in the series circuit?

Explain your answer using what you know about how the current flows in a series circuit and a parallel circuit.

2 When you unscrewed one lamp from the series circuit, did the other lamp light up? Explain why this happened.

3 When you unscrewed one lamp from the parallel circuit, did the other lamp light up? Did the remaining lamp shine the same as before, more brightly or less brightly? Explain why this happened.

4 Draw a circuit diagram for each circuit you made.

5 Write a conclusion. Copy and complete these sentences:

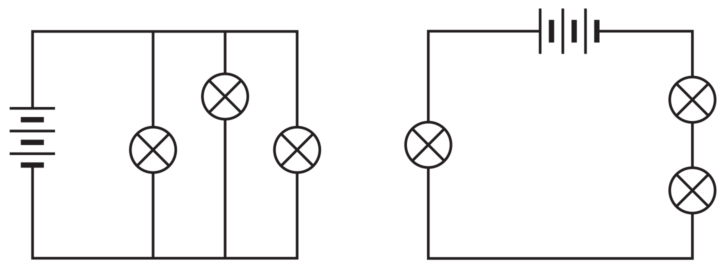
In a series circuit with two lamps and one battery, the lamps will burn _________ brightly than in a parallel circuit with two lamps and one battery .

In a series circuit there is only _________ path for the electric current. If one lamp is removed from a series circuit, the other lamp will _________ light up because the circuit is _________ .

In a parallel circuit, each lamp has its own _________ . If one lamp is removed from a parallel circuit, the other lamp will remain lit. The remaining lamp will shine with the _________ brightness as before.

Continued

6



Circuit A Circuit B

a Identify which circuit is the series circuit and which is the parallel circuit.

b In which circuit will the lamps shine more brightly? Explain your answer.

How did the practical activities help you to understand the differences between series and parallel circuits?

Look what I can do!

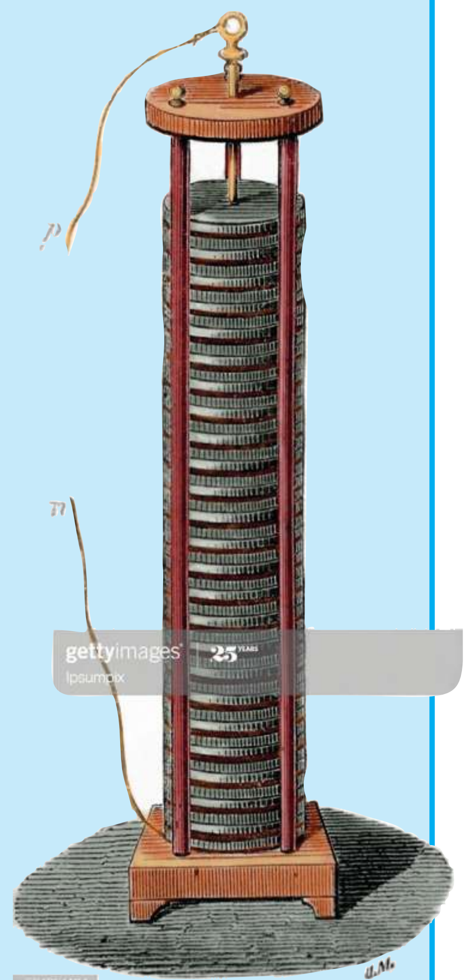
- I can use conventional symbols to draw circuit diagrams.
- I can choose components to make circuits and compare circuits that include batteries, switches and buzzers.
- I can compare the brightness of lamps in series and parallel circuits.
- I can make predictions, referring to what I know about electricity and test to see if my predictions are correct.
- I can describe risks when planning practical work and consider how to minimise them and carry out practical work safely.
- I can decide when observations need to be repeated to give more reliable results.
- I can present and interpret results in tables.
- I can make a conclusion from results using my understanding of electricity.
- I can identify and classify circuits as series or parallel.

Project: Rechargeable batteries

In this project you will describe how scientific knowledge and understanding changes over time through the use of evidence gained by enquiry.

An Italian scientist called Alessandro Volta invented one of the first batteries in 1800. The battery was named after Volta – the voltaic pile – because it consisted of a pile of copper and zinc discs. This was an amazing discovery but not something you could fit into a torch or a mobile phone!

Here is Volta demonstrating his battery to Napoleon, the emperor of France.



Today there are many types of batteries – long life, small size, high current or light in weight. Scientists have had to think creatively to invent new batteries for different needs.

Alkaline batteries are used in devices such as torches and toys. You have been using these for your science experiments. Alkaline batteries are cheap and come in different sizes to fit different devices. But they are not rechargeable. This means when they run out of power or become 'flat' you have to throw them away and buy new ones.

Continued

Scientists have now invented rechargeable batteries.
Do some research to find out about:

- nickel metal hybrid batteries
- nickel cadmium batteries
- lithium ion batteries.

For each battery describe:

- the advantages of the battery compared to batteries that were invented earlier.
- the disadvantages of the battery
- what the batteries are used for.

Present your project on one A4 page.
Include pictures of the batteries and how they are used.

Check your progress

1 a What units are used to measure mass?

b What unit is used to measure weight?

2 When an astronaut stands on weighing scales on Earth, the scales read 70 kg. The astronaut travels to planet X which has half the gravitational force of the Earth.

a What is the astronaut's mass on Earth?

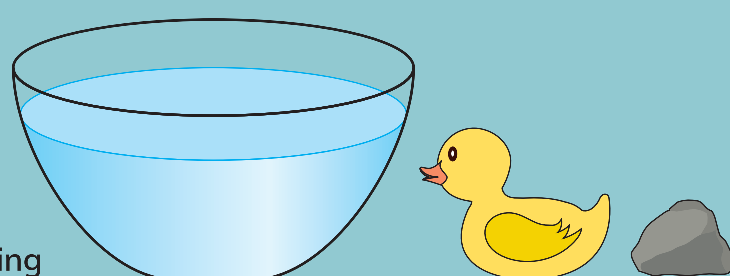
b What is the astronaut's weight on Earth?

c What is the astronaut's mass on Planet X?

d What is the astronaut's weight on Planet X?

3 Describe FOUR ways in which the photograph shows the effects of forces on the car

4 Arun and Marcus are investigating floating and sinking. Here are the things they used.



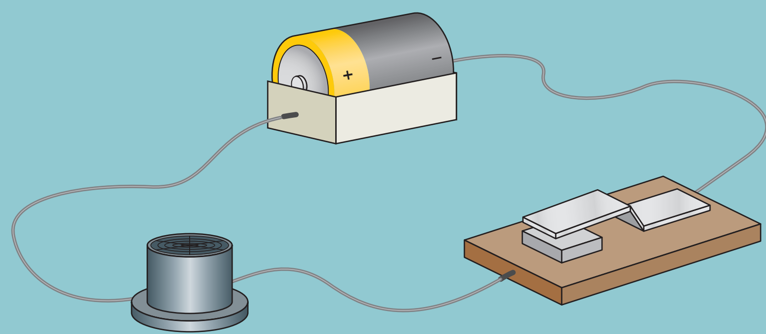
a Draw a force diagram to show a plastic toy duck floating on water. Label the forces.

b Draw a force diagram to show a stone sinking in water. Label the forces.

c Explain why the toy duck floats and the stone sinks.

Continued

5 Sofia and Zara made the circuit in the picture below:



a Draw a circuit diagram of the circuit that Sofia and Zara made.

b Identify whether this a series or a parallel circuit. Explain why.

c When they added a second buzzer to the circuit the buzzers did not work. What could they add to the circuit to make the buzzers work?

d How could they change their circuit, without adding components, to make the buzzers work? Draw a circuit diagram of your answer.

6 Light and the Solar system

6.1 Reflection

We are going to...

- describe how a ray of light changes direction when it is reflected from a plane mirror
- use diagrams to show how light reflects from a plane mirror
- decide when observations need to be repeated to give more reliable data
- describe a pattern in results
- make a conclusion from results using knowledge of reflection
- suggest improvements to the design of a periscope.

Getting started

1 What is the source of light in this picture?
2 How does Sofia see the tree?
3 Draw a ray diagram to show how Sofia sees the tree.
4 Which type of surface reflects light well?
5 Do all surfaces reflect some light?

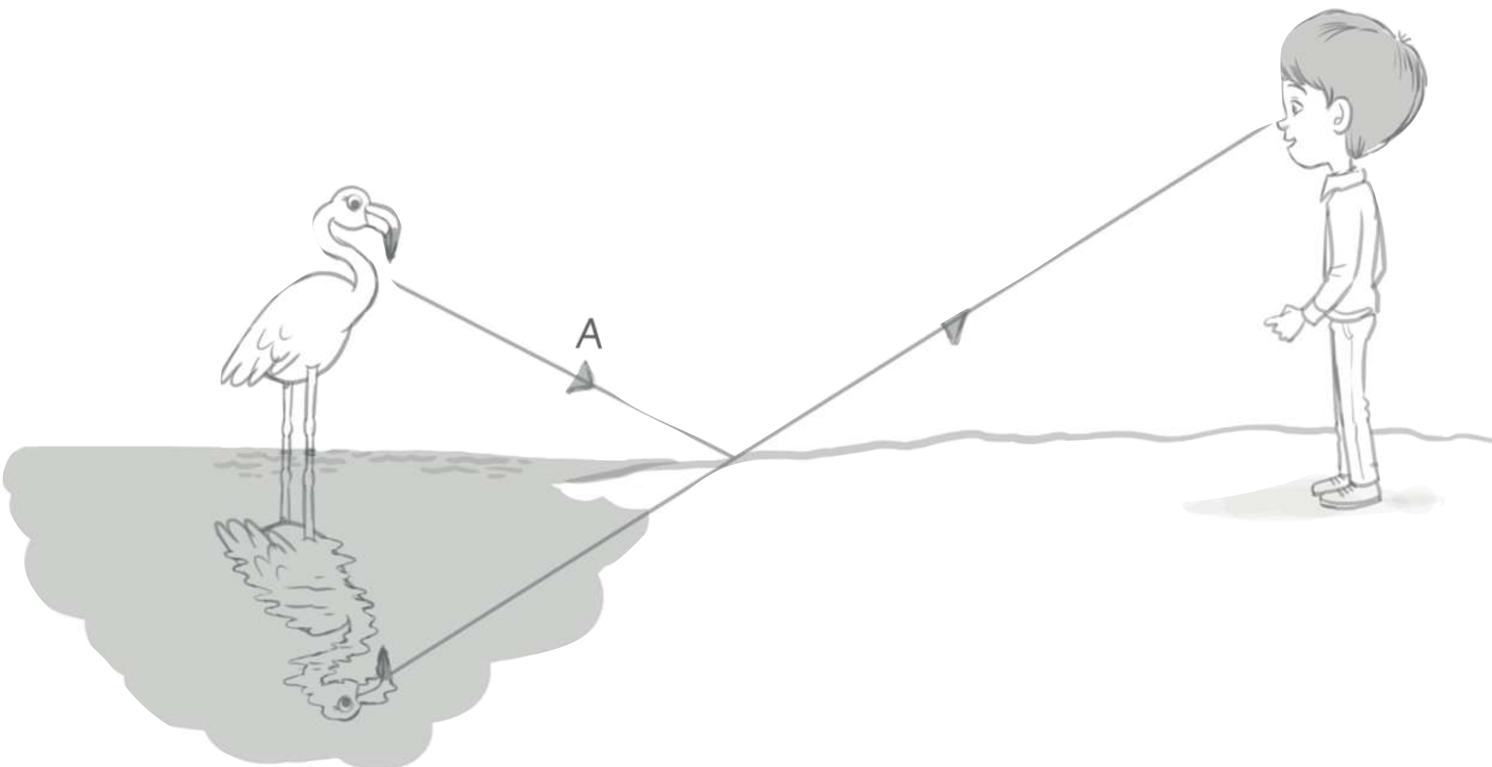
angle incident ray mirror image normal periscope plane mirror reflected ray

Reflected light

Smooth, polished surfaces, like mirrors, are very good at reflecting light. Plane mirrors are flat mirrors. When you see your face in a plane mirror, you are seeing light from your face reflecting off the mirror. We call the reflection of your face in the mirror your mirror image.

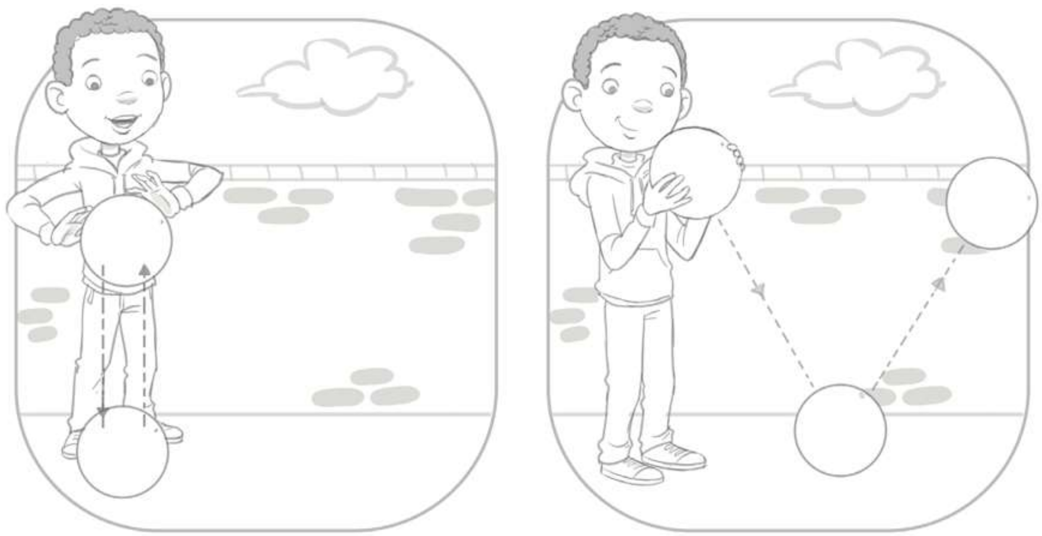
When light reaches our eyes from an object, we assume it has travelled in a straight line from the object. This is what usually happens. Reflected light creates a second version – the mirror image – of the original image.

Clear, still water like a lake, is also good at reflecting light. Look at the picture of the flamingo reflected in the lake in the photograph at the beginning of this unit. You can see the real flamingo and the reflection of the flamingo. When you look at the reflection you see the mirror image of the flamingo. Look at the second version of the picture, which shows how you see the mirror image.



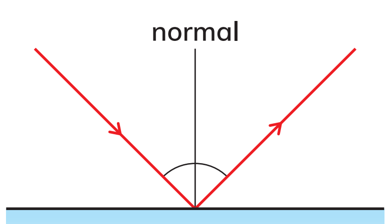
How does light travel when it reflects?

The way light reflects off mirrors is very much like the way a ball bounces against a hard surface.



When Marcus throws a ball straight down, it bounces straight back at him. In the second picture, Marcus bounces a ball away from him at an angle, which is the number of degrees between the arriving red arrow and the ground. The ball bounces off the floor at the same angle away from him.

Light reflects off a mirror in a similar way. In other words, light reflects from a mirror at the same angle as it arrives. The diagram shows how light travels when it reflects with lines and arrows. The arriving ray of light is called the incident ray. The ray of light that reflects off the mirror is called the reflected ray. The normal is a line drawn at right angles (90°) to the surface of the mirror. The angles that each ray makes with the normal are the same.



Activity

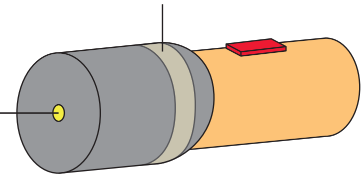
How we see reflected light

1. Give two examples of a smooth, shiny surface that reflects light well.
2. Name the type of image you see from reflected light.
3. In the picture of Arun looking at the reflection of the flamingos, name the rays labelled A and B.
4. Copy the diagram of the light ray being reflected off the mirror. Label the reflected ray and the incident ray.

Think like a scientist 1

Demonstrate how light travels when it reflects

You will need:
a darkened room, a powerful flashlight, a plane mirror, a sheet of white paper, a piece of black plastic or black paper, a pin, masking tape



1. Make a small hole with a pin in the middle of the black plastic. Cover the flashlight glass with the black plastic so that the pin hole is in the middle of the flashlight glass. Secure with masking tape.
2. One person should hold the mirror (or you can fix the mirror to the wall).
3. Hold the white paper in front of the mirror, about 50 cm away from the mirror. The mirror must be upright.
4. Shine your flashlight at the mirror. You will get a thin ray of light as the light passes through the pin hole.
5. Observe the angle at which the ray of light from the flashlight reaches the mirror.
6. Observe the angle the light reflects off the mirror.
7. Observe the point at which the reflected light falls on the white paper.
8. Shine your flashlight at different angles from the mirror. Observe the rays of light that arrive at the mirror and reflect off the mirror on to the paper.

Continued

Questions

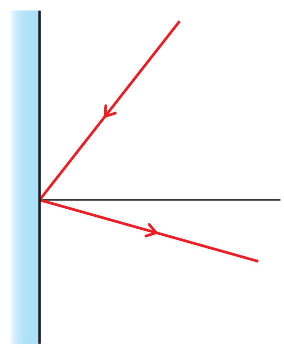
1 Draw the path of the ray of light you observed. Show the directions the light rays travelled with lines and arrows. Label the incident ray and the reflected ray.

2 What pattern did you notice about the angle the incident ray arrived at the mirror and the angle the reflected ray left the mirror?

3 Why do you think it was a good idea to repeat the activity several times?

4 Write a conclusion about how light changes direction when it is reflected from a plane mirror.

5 The diagram below is incorrect. Re-draw the diagram correctly.



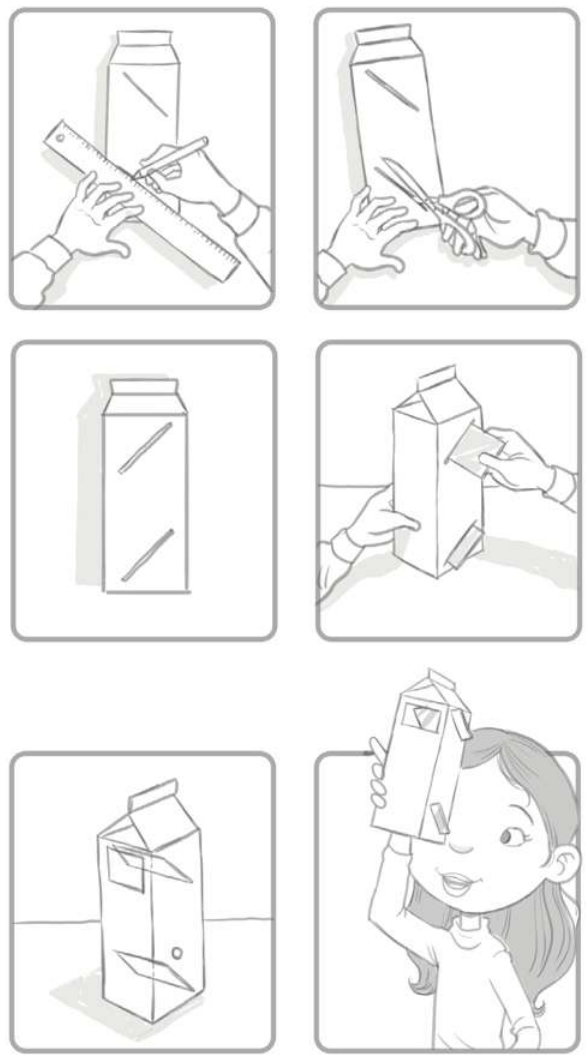
Periscopes

These people are watching a golf championship. The people at the back of the crowd can't see the golf players. This is because they can't see over the tops of the heads of the people in front of them. Many of the people are holding periscopes to help them to see over the heads of the people standing in front of them. People use the science of reflection to design a periscope. Let's find out how a periscope uses plane mirrors and reflection to work.

Think like a scientist 2

Make and test a periscope

You will need:
tall box or carton, two small square plane mirrors, a pencil, a ruler, a protractor to measure the angles, scissors, tape



1 Draw a line across the top half of the box at 45° to the horizontal. Draw another line in the bottom half of the box at the same angle. Make the lines the same length as the mirrors.
2 Cut along the top line and the bottom line. Make each cut wide enough and long enough for the mirror to slide in.
3 Draw and cut slits on the opposite side of the box in line with the cuts you have already made.
4 Push a mirror through each pair of slits. The top mirror must have its reflecting surface facing down. The bottom mirror must have its reflecting surface facing up.
5 Cut a square window in front of the top mirror. This is so that light can enter and reach the top mirror.
6 On the other side of the carton cut a square hole in front of the bottom mirror. This one is your viewing window.
7 Test your periscope.

Questions

1 What is a periscope?
2 Describe how you tested your periscope.
3 Draw a diagram to show the mirrors in your periscope and how light travels through it to your eyes. Label the incident and reflected rays.

Continued

4 Why did you have to angle the mirrors at 45°?

5 Using your science knowledge, explain how you could use a periscope to see a person standing on the other side of a wall. Copy and complete these sentences:

Light travels from the Sun to the person on the other side of the wall. Light reflects off the _________ to the _________ mirror of the periscope. Light reflects off the _________ mirror and travels _________ the periscope to the _________ mirror. Light reflects off the _________ mirror into your _________ .

6 How could you have changed the design of the periscope to allow you to see over a higher wall?

7 Discuss other ways in which a periscope could be useful.

How are we doing?

Did your group follow the instructions carefully?

How well did your group's periscope work?

Answer ★★★ or ★★ or ★ for each question.

Did you have fun with the periscope?
How did it help you to understand reflection?

Look what I can do!

- ☐ I can describe how a ray of light changes direction when it is reflected from a plane mirror.
- ☐ I can use diagrams to show how light reflects from a plane mirror.
- ☐ I can decide when observations need to be repeated to give more reliable data.
- ☐ I can describe a pattern in results.
- ☐ I can make a conclusion from results using knowledge of reflection.
- ☐ I can suggest improvements to the design of a periscope.

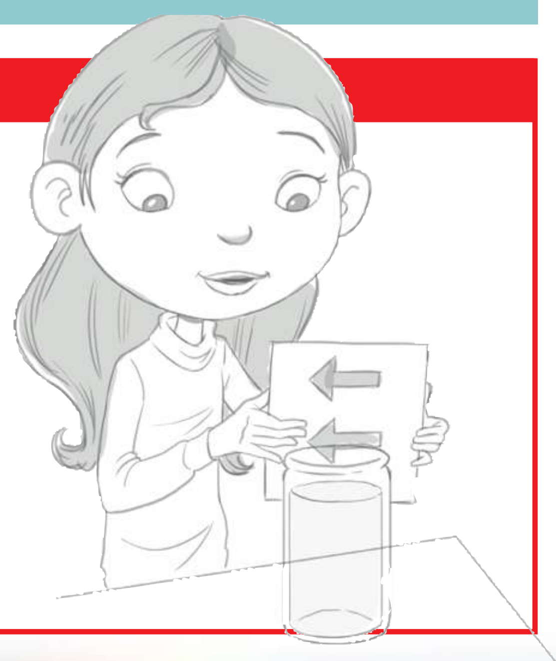
6.2 Refraction

We are going to…

- describe how a ray of light changes direction when it travels through different mediums and know that this is called refraction.
- use diagrams to show how light refracts.
- ask scientific questions and select appropriate scientific enquiries to use.
- make predictions and see if predictions were correct.
- use secondary information sources to find answers to questions.
- make a conclusion from results using knowledge of refraction.

Getting started

You will need:
a glass with curved sides, some water,
a white card with two arrows drawn on it like this:



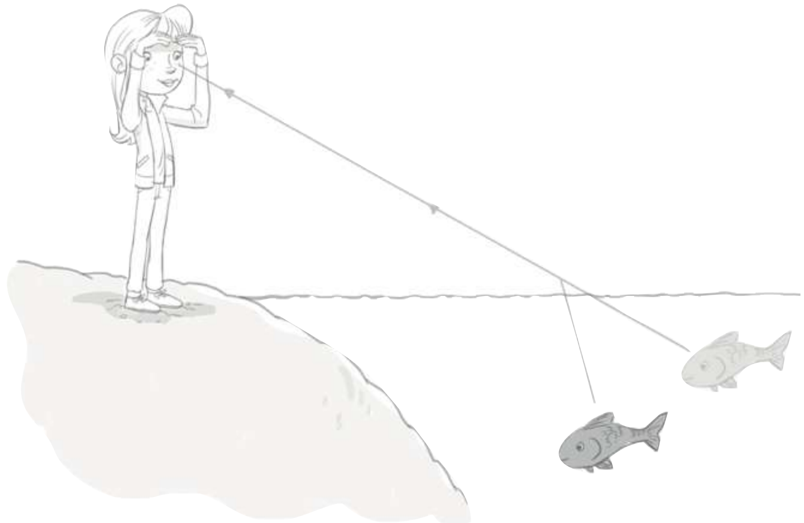
Look carefully at the front of the glass.

Lower the card with the arrows on it so that it is behind the glass. What do you notice?

How do you think this could happen?

converge convex lens focal point lens medium optical illusion
prism rainbow refraction refracts

What is refraction?



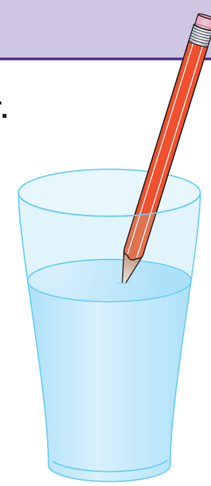
Refraction is the bending of light. Refraction occurs because light travels at different speeds through different mediums. A medium is a material such as water, glass or air.

Look at the picture of Sofia. She is looking at the fish in the water. She thinks the fish is in a direct line from her eyes. This is called an optical illusion. An optical illusion is something our eyes see but which is not real. Look at the real position of the fish. The ray of light from the fish bends or refracts as it goes from the water to the air.

Think like a scientist 1

Demonstrate how light travels when it refracts

You will need:
a glass of water and a pencil



1 Predict what you will see when you put the pencil into the water.

Put the pencil in the glass of water.

2 Observe the pencil in the glass from the side.

3 Observe the pencil in the glass from the top.

4 Take out the pencil. Is it changed in any way?

Questions

1 Did what you saw match your prediction?

2 Draw a picture of the pencil in the glass from the side.

3 Draw a picture of the pencil in the glass from the top.

4 Why is what you saw an optical illusion?

5 Which mediums does the light pass through between the pencil and your eyes?

Continued

6 Describe what you saw. Complete these sentences.

Light from the pencil travels through the _________ in the glass and then _________ when it passes through the glass to the _________ .

7 Write a conclusion to explain why the pencil appeared to bend, using your scientific knowledge of refraction.

8 Think back to the paper with the arrows on it behind the glass of water. Repeat the demonstration. Try to explain what happened using what you know about refraction.

How are we doing?

How well have you and your group done the demonstrations?

How well can you explain what happened using your scientific knowledge of refraction?

Choose from:

'We can explain refraction well' or 'We are learning how to explain refraction' or 'We need some help'

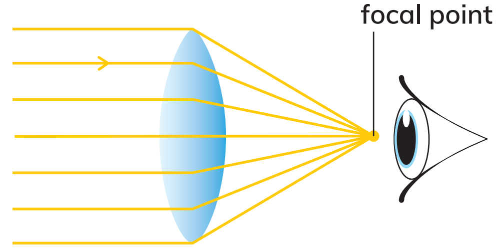
Lenses

A lens is a transparent substance with at least one curved surface. Lenses refract light in useful ways. Our eyes have lenses in them! Other lenses that we use may be made of glass or transparent plastic.

People have used the science of refraction to make many useful things. Here are some examples.

The lens bends light rays as they pass through it, so the rays change direction. This means the rays seem to come from a point that is closer or further away than they actually do. This is what makes objects seen through a lens appear either bigger or smaller than they really are.

A convex lens makes things look bigger. All the things in the pictures above use convex lenses. Light rays pass through the lens and bend inward and meet or converge at a point just beyond the lens. This point where the rays converge is called the focal point.



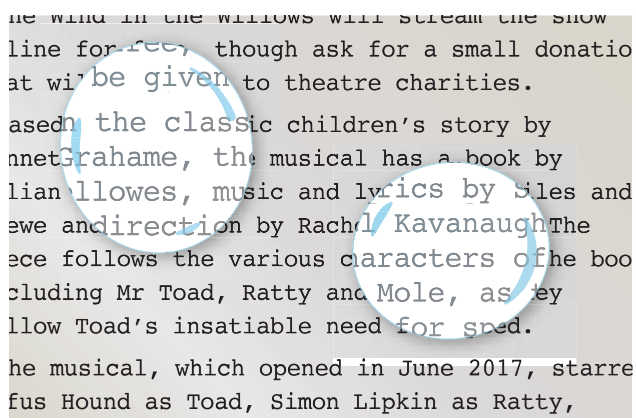
Convex lenses are used to make eyeglasses, projectors, microscopes, binoculars and telescopes. The lens brings distant light rays to a focus in our eyes. Some telescopes have such strong lenses that we can see distant planets and moons in the solar system.

Think like a scientist 2

Make and test a convex lens

You will need:
a sheet of newspaper or an old magazine, a piece of plastic wrap, an eye dropper or very small spoon, a cup of water

1. Cut a square of plastic wrap about 10 × 10 cm.
2. Place the plastic wrap over some printed words on the newspaper.
3. Very carefully, use the dropper or spoon to place a drop of water on the plastic.
4. Look at the print and you should be able to see that the water drop magnifies the words. You have made a lens!



Continued

Questions

1 In what way is the shape of the water drop like a convex lens?

2 Why is the print bigger when you read it through the water drop?

3 Ask scientific questions like these:
- What happens if you make the water drop bigger or smaller?
- What happens if you lift the plastic away from the paper?

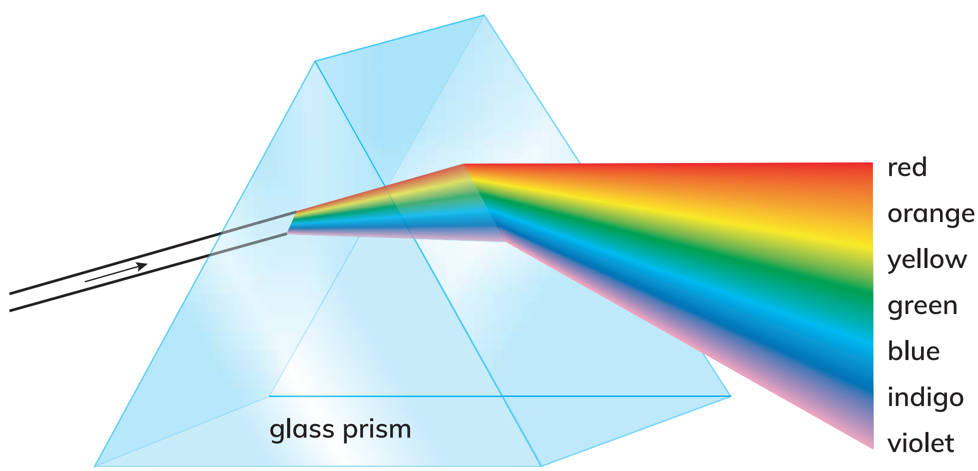
Test your ideas out.

Try to explain what has happened using your science knowledge.

Prisms and rainbows

A prism is a triangular block of glass or clear plastic.

We usually see light as having no particular colour. We call this 'white light'. But white light actually consists of different colours. When a narrow ray of white light passes through a prism, the ray refracts and splits into different colours. Each colour refracts at a different angle.



Look at the photograph at the beginning of this topic. Have you ever seen a coloured arc in the sky like this? It is called a rainbow. If you have seen one, you will know that it has to be sunny and raining at the same time. The Sun has to be shining behind you and the rain has to be falling in front of you.

A rainbow is another optical illusion. It happens when sunlight is refracted as it passes from the air to a raindrop. The raindrops act like tiny prisms. When this happens, our eyes see the seven colours which make up white light.

Activity

Prisms and rainbows

1. Shine a flashlight through a small hole in a sheet of card so that you get a ray of light passing through. Shine the ray of light on to one side of a prism. Watch the coloured light come out the other side. Identify the seven colours.
2. What causes the light to split into different colours?
3. Why does it have to be raining and sunny at the same time to see a rainbow?
4. Find out the name of the scientist who was the first person to discover that white light was made up of different colours.
5. Find out how the scientist made this discovery.
6. How did people think we got colours before this discovery?

Show a person at home the demonstration with the pencil in the glass of water. Explain to them in simple terms what happens.

Look what I can do!

- [ ] I can describe how a ray of light changes direction when it travels through different mediums and know that this is called refraction.
- [ ] I can use diagrams to show how light refracts.
- [ ] I can ask scientific questions and select appropriate scientific enquiries to use.
- [ ] I can make predictions and see if predictions were correct.
- [ ] I can use secondary information sources to do research.
- [ ] I can make a conclusion from results using knowledge of refraction.

6.3 The Solar System

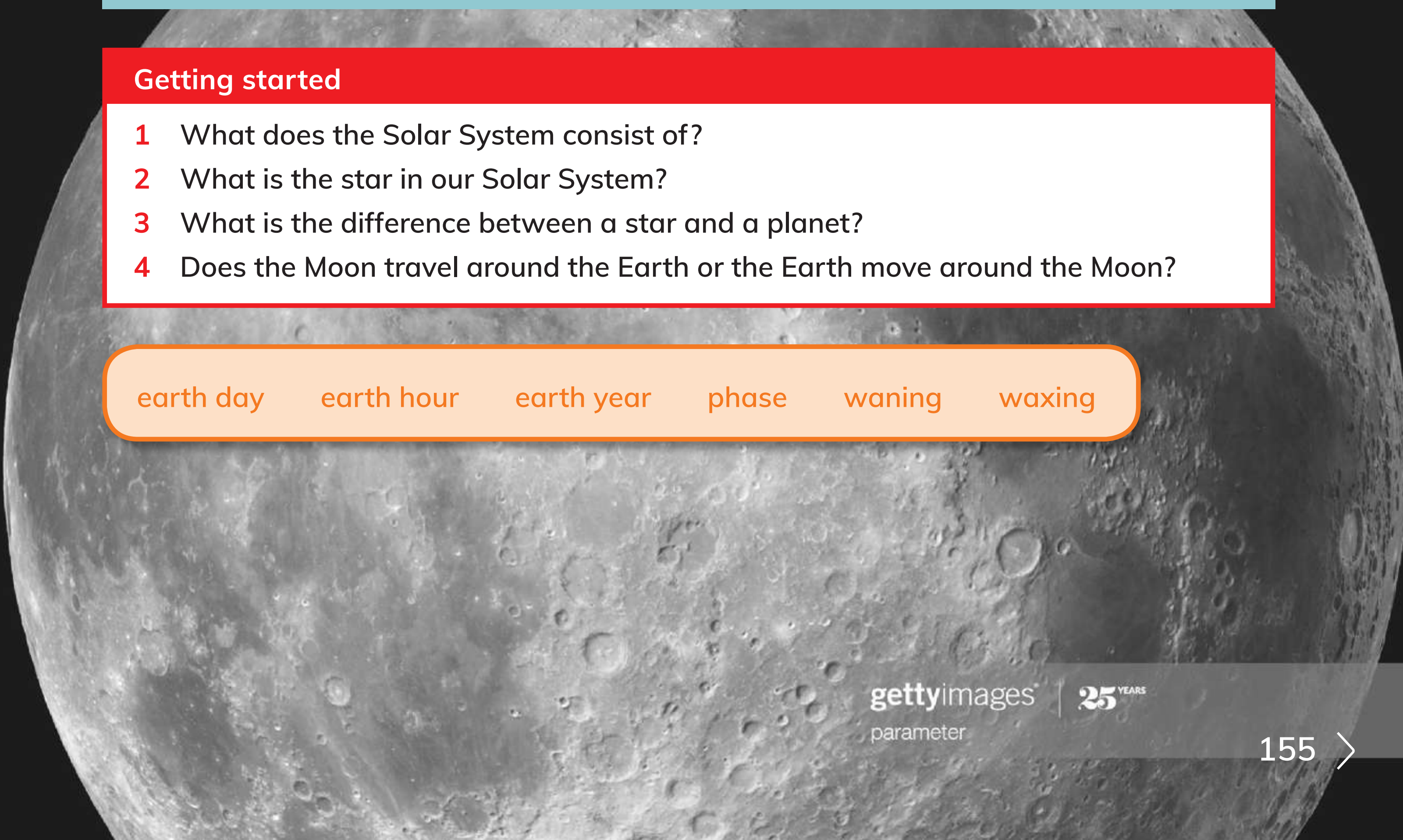
We are going to...

- describe the relative position and movement of the planets, the Moon and the Sun in the Solar System
- observe and describe the changes in the appearance of the Moon over its monthly cycle
- use models, including diagrams, to represent and describe the Solar System
- take appropriately accurate measurements
- practise the science enquiry skills of research, observation over time and pattern seeking
- describe patterns in results, including identifying any results that do not fit the pattern
- use a range of secondary information sources to research and answer questions
- collect and record observations in a table.

Getting started

1 What does the Solar System consist of?
2 What is the star in our Solar System?
3 What is the difference between a star and a planet?
4 Does the Moon travel around the Earth or the Earth move around the Moon?

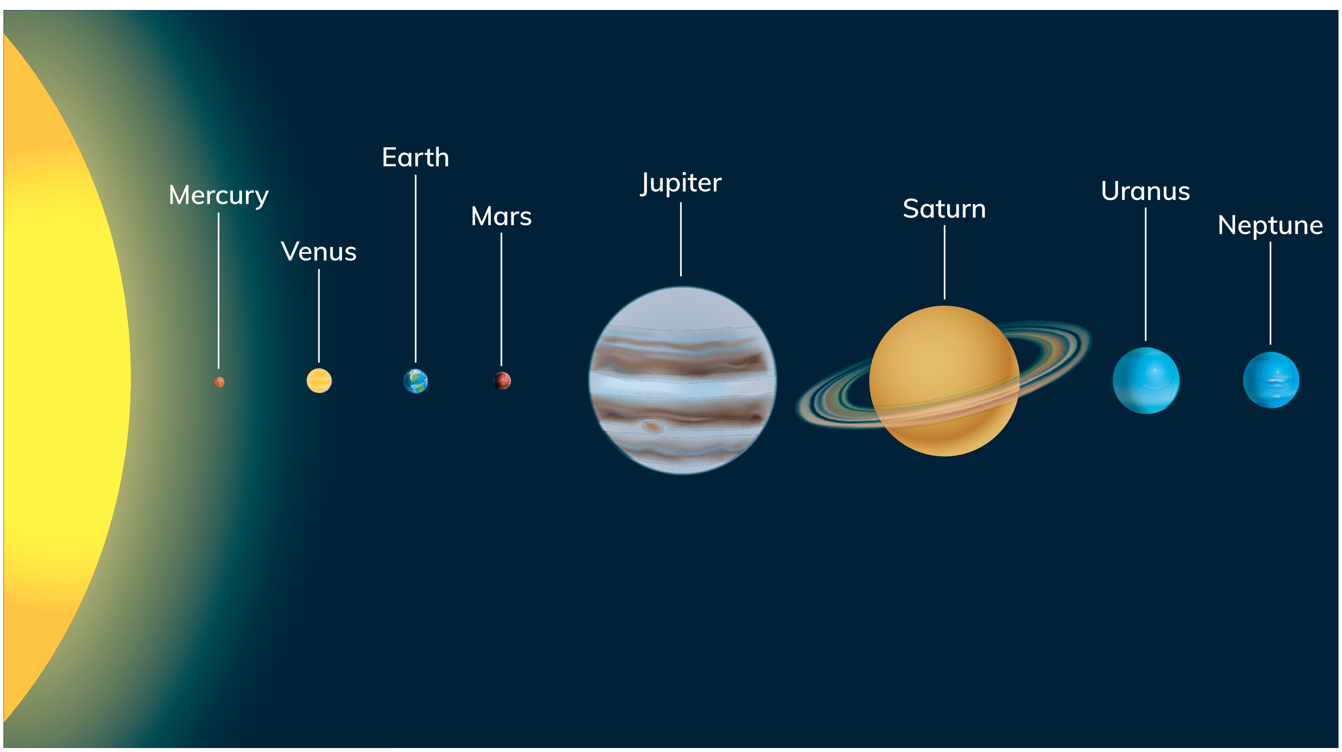
earth day | earth hour | earth year | phase | waning | waxing



Positions of the Sun and planets in the Solar System

Positions and distances in space are very difficult to imagine. For example, the Moon and the Sun look about the same size to us. But, in reality the Sun is about 500 times larger than the Moon. They look about the same size because the Sun is much further away from us – the Sun is about 150 million km away and the Moon is only 390 000 km away.

Look at the diagram of the Solar System. You can see that there are four small planets close to the Sun and then four much bigger planets further away from the Sun. Mercury is 60 million km away from the Sun. Neptune is 4500 million km away from the Sun! So if we drew this diagram to scale we would need a huge piece of paper and Neptune would be a kilometre away from the Sun!



Think like a scientist 1

Make a scale model of the Solar System

You will need to set up this model in a large space about 250 m long, such as a field.

You will need:
a tennis or cricket ball, grains of sugar, two peas, two lentils, a long tape measure, nine sticks or poles to push into the ground, paper and a marker pen to make signs, sticky tape, measuring tape

Use the information in this table to see which objects represent which planets and how far from the Sun each planet must be.

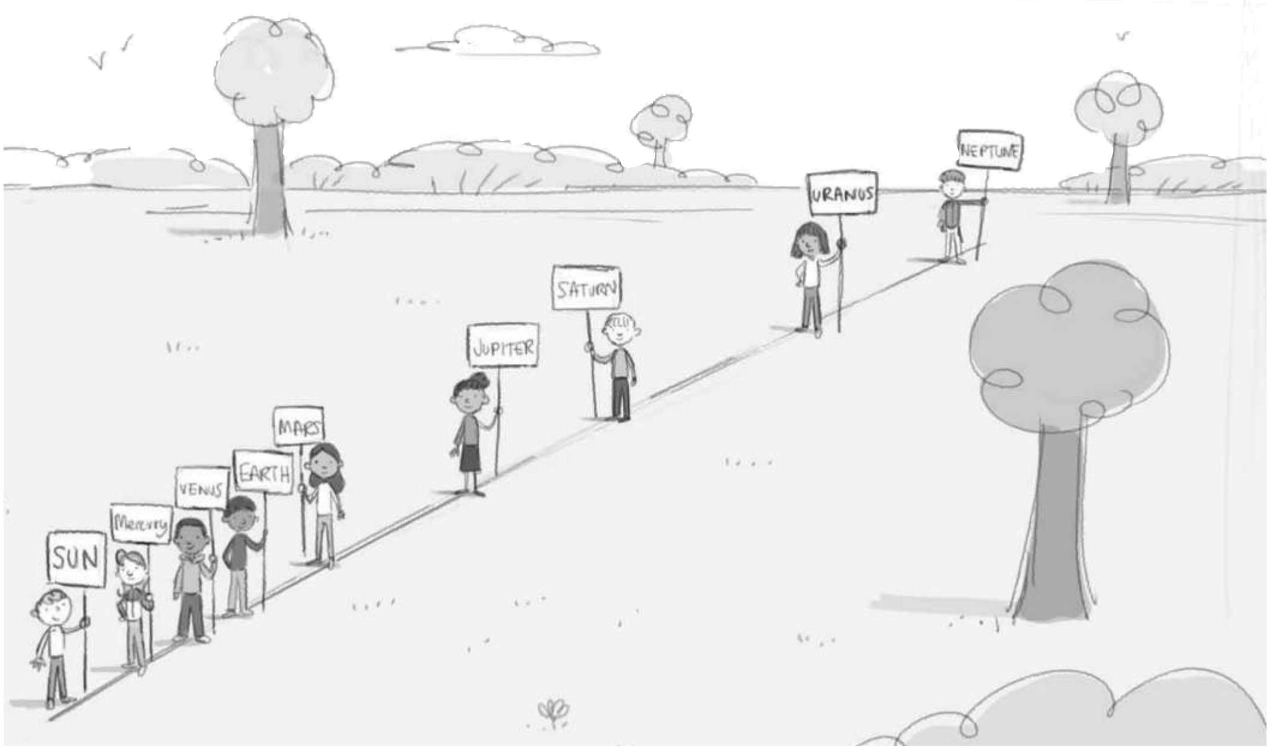
Sun or planet	Diameter in mm	Use this object	Distance from the Sun/m
Sun	70	Tennis ball or cricket ball	
Mercury	0.3	Grain of sugar	3
Venus	0.6	Grain of sugar	5.5
Earth	0.7	Grain of sugar	7.5
Mars	0.4	Grain of sugar	11.5
Jupiter	7.2	Pea	39
Saturn	6	Pea	72
Uranus	2.5	Lentil	144
Neptune	2.5	Lentil	250

1 Make a sign saying ‘Sun’ and tape this to the ball.
Make signs for each planet and stick a sugar grain, pea or lentil on the sign.
Attach signs to sticks.

2 Put the Sun at one end of your space. Measure the distances from the Sun for the planets and put in your signs on sticks.

3 Leave your model in place for other classes to look at.

Continued



Questions

1 How does this model represent the Sun and the planets?
2 In what way is this model more accurate than the diagram on the previous page?
3 If you used a football to represent the Sun, how far away do you think Neptune would be?

In what way does this model help you to understand the relative sizes of the Sun and the planets?

In what way does this model help you to understand the distances between the Sun and the planets?

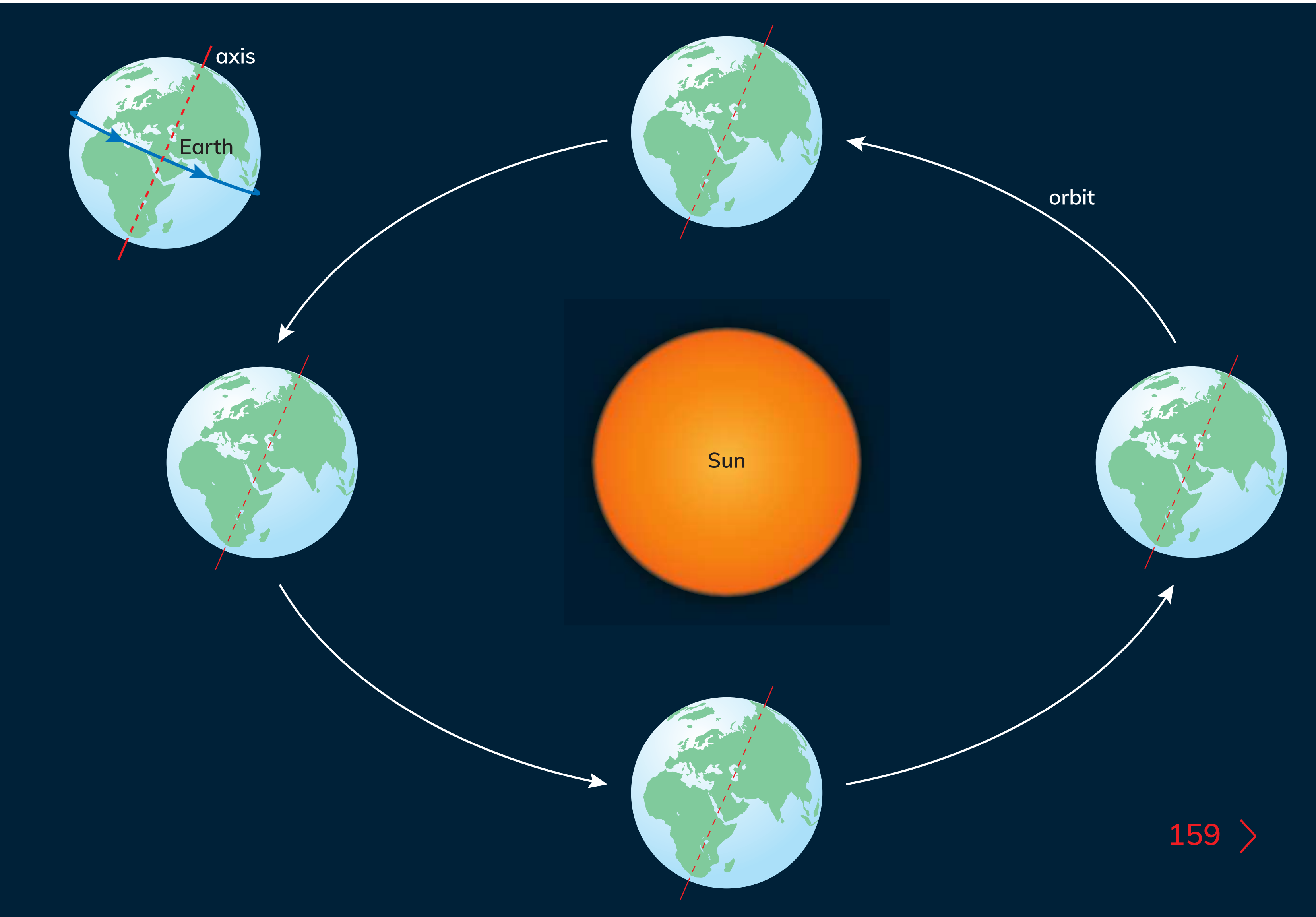
Movements of the planets in the Solar System

In earlier stages you learnt that the Earth makes two movements:

- It turns on its axis once every 24 hours or day.
- It completes an orbit around the Sun once every year or $365\frac{1}{4}$ days.

It isn't only Earth that makes these movements. Every body in the Solar System makes regular motions like this. Other bodies in the Solar System take different amounts of time to turn on their axes. We measure these time periods in terms of 'Earth days' or 'Earth hours'. One earth day is 24 hours and one Earth hour is 60 minutes.

The other bodies in the Solar System also take different amounts of time to complete their orbits around the Sun. We measure their orbiting times in earth days or 'Earth years'. An Earth year is $365\frac{1}{4}$ days.



Look at the diagram below to find out about these regular movements.

Earth: One turn on axis: 24 hours or 1 Earth day. Orbit around Sun: 365¼ days or 1 Earth year. 1 Moon

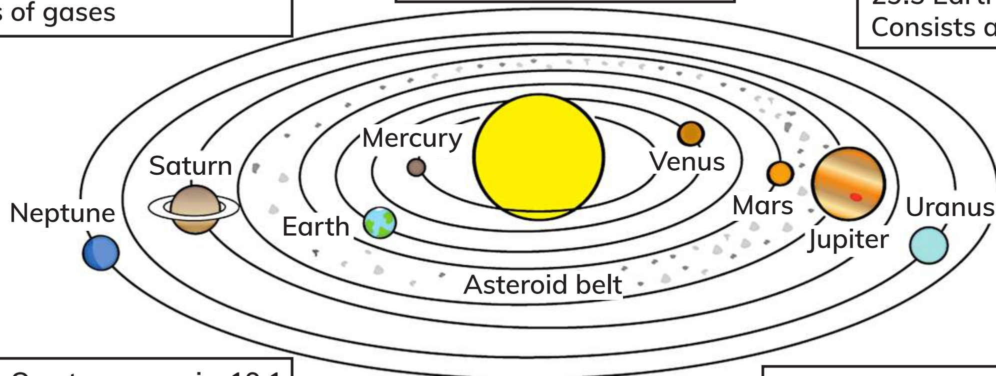
Mercury: One turn on axis: 58.7 Earth days. Orbit around Sun: 88 Earth days. No Moons

Venus: One turn on axis: 243 Earth days (in the opposite direction to most other planets). Orbit around Sun: 225 Earth days. No Moons

Saturn: One turn on axis: 10.2 Earth hours. Orbit around Sun: 29.5 Earth years. 18 Moons. Consists of gases

Sun: Turns at Equator once every 25 Earth days

Uranus: One turn on axis: 10.2 Earth hours. Orbit around Sun: 29.5 Earth years. 15 Moons. Consists almost entirely of ice



Neptune: One turn on axis: 19.1 Earth hours. Orbit around Sun: 164.8 Earth years. 8 Moons. Consists almost entirely of ice

Mars: One turn on axis: 24.62 Earth hours. Orbit around Sun: 687 Earth days. 2 small Moons called Phobos and Deimos

Jupiter: One turn on axis: 9.8 Earth hours. Orbit around Sun: 11.9 Earth years. At least 16 Moons. The biggest Moon is Ganymede which is larger than planet Mercury. Consists of gases

Activity 1

The planets

Here is a quiz on the planets. You can find the answers on the diagrams. Divide the class into teams and see which team is first to find all the correct answers.

Which planet:

1 Is the biggest?
2 Is the smallest?
3 Is the closest to the Sun?
4 Is the furthest from the Sun?
5 Has the longest days?
6 Has the shortest days?
7 Takes the longest time to orbit the Sun?
8 Takes the shortest time to orbit the Sun?
9 Is the hottest?
10 Is the coldest?
11 Has the most moons?
12 Has a moon that is bigger than Mercury?
13 Has life on it?
14 Are formed of gas (two planets)?
15 Are formed of ice (two planets)?

Earth's Moon

Earth has one moon. It takes 29.5 days for the Moon to complete its orbit around the Earth. We call this a month.

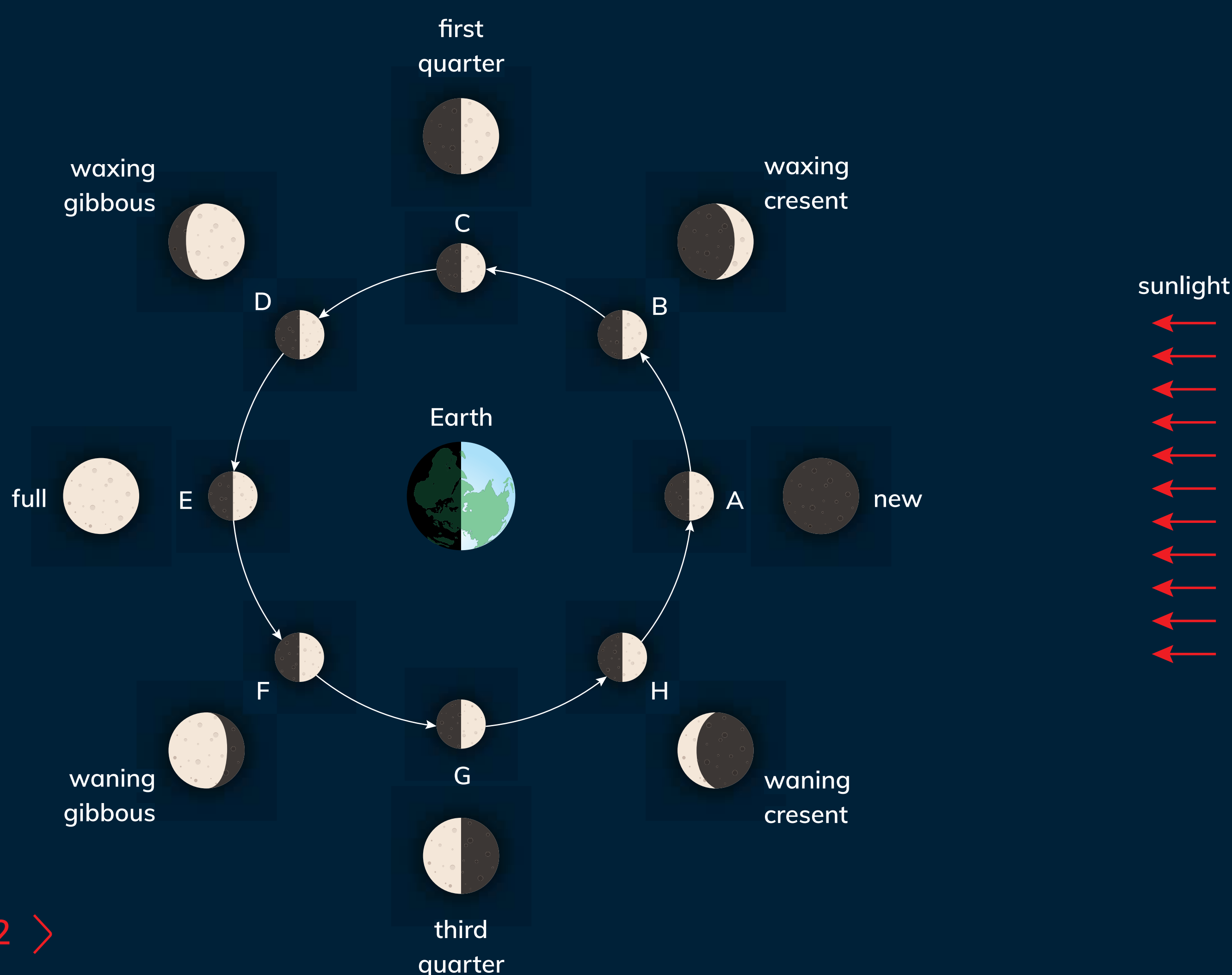
During the month we can sometimes see half the Moon, sometimes a whole circle of Moon and sometimes no Moon at all. This is because, like Earth, only half the Moon can be lit up by the Sun at any one time. The part of the lit half of the Moon which we can see from the Earth is called the phase of the Moon. We see all the phases of the Moon in 29.5 days or one month. Look at the photograph of the Moon completely lit up below. This is called a full Moon. We only see this once a month.

Phases of the Moon

Look at the diagram. The diagram shows the Moon in eight positions A–H in its orbit around the Earth. The Sun is far away on the right-hand side of the diagram. So the right half of the Earth and the right half of the Moon in all its positions is lit by the Sun. The halves shaded black on the diagram are in darkness.

The phases of the Moon are shown around the edges of the orbit. Look at the Moon in its different phases on the diagram:

- New Moon (position A). The part of the Moon facing the Earth is in darkness so we can see no Moon at all. The night after new Moon we can see a very thin slice of lit-up Moon. A few days later the Moon is in position B.
- Crescent (positions B and H). About a quarter of the Moon is lit up.



- First quarter (C) and Third quarter (G).
  The Moon has a semi-circular shape since half of it is lit up.
- Gibbous phase (positions D and F).
  About three-quarters of the Moon is lit up.
- Full Moon (position E).
  The whole of the Moon facing us is lit up so we see a circle.

As the Moon's phases go from new Moon in position A to full Moon in position E, the Moon is appearing larger every night. We say the Moon is waxing.

As the Moon's phases go from full Moon in position E to new Moon in position A, the Moon is appearing smaller every night. We say the Moon is waning.

Think like a scientist 2

Observe and describe the phases of the Moon

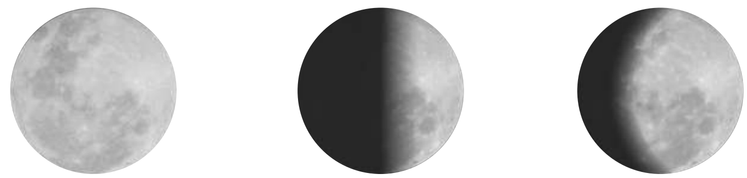
1. Plan an investigation to identify the phases of the Moon over a period of one month. Include the following:
   - When and where will you conduct the investigation?
   - How will you record data?
   - What factors could make your investigation difficult?
2. Conduct the investigation over a period of one month.
3. Collect data.
4. Record your data in a table.
5. Identify and label the phases you observed.
6. Identify a pattern in your results.
7. Which of the five types of scientific enquiry have you practised in this activity?

Was your investigation as complete as you would like it to be?
Think about reasons for this.

Activity 2

Identify phases of the Moon

Look at the photographs of the Moon numbered 1–3. The photographs were taken at different times of the month.



1 2 3

1 Identify the phase of the Moon in each of the photographs.
2 Is the Moon waxing or waning?
3 Which phase will the Moon be in a few days after the phase shown in 3?
4 Draw what the Moon would have looked like a few days before position 1.
5 How long does it take for the Moon to complete all its phases?
6 Which movement causes the phases of the Moon?

How am I doing?

How well can I plan and carry out an investigation to describe the changes in the Moon over a month?

Choose from one of these faces: or or

Look what I can do!

- [ ] I can describe the relative position and movement of the planets, the Moon and the Sun in the Solar System.
- [ ] I can observe and describe the changes in the appearance of the Moon over its monthly cycle.
- [ ] I can use models, including diagrams, to represent and describe the Solar System.
- [ ] I can take appropriately accurate measurements.
- [ ] I can practise the science enquiry skills of research, observation over time and pattern seeking.
- [ ] I can describe patterns in results, including identifying any results that do not fit the pattern.
- [ ] I can use a range of secondary information sources to research and answer questions.
- [ ] I can collect and record observations in a table.

Project: Using the Moon's cycle to make a calendar

Different groups of people in the world have used calendars to divide the year into months, weeks and days. Many of them use the Moon to make their calendar. A calendar that uses the Moon is called a lunar calendar.

For example, Muslims use a lunar calendar. For Muslims all over the world, the crescent Moon is an important symbol. Several Muslim countries, such as Malaysia, have the crescent Moon on their national flag.

The Hindu religion uses a lunar month and Full Moon day is very important.

In Buddhism, some months of the calendar are based on lunar months.

Christians and Jews also use the Moon in their calendars.

Work on your own or with a partner. Choose a religion that interests you. Find information on the internet. Speak to a religious leader. Find out how the Moon's cycle is used in their calendar and special times of the year.

Arrange your information on to an A4 page. Include pictures and photographs.

Check your progress

1 Choose the correct alternative for each of the following:

a The bending of light is reflection/refraction.

b A piece of glass with a curved surface is a lens/mirror.

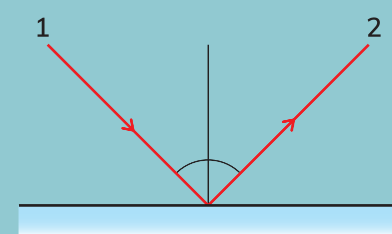
c A periscope uses mirrors set at 90°/45° angles.

d When the lit up part of the Moon becomes bigger over a period of days, the Moon is waxing/waning.

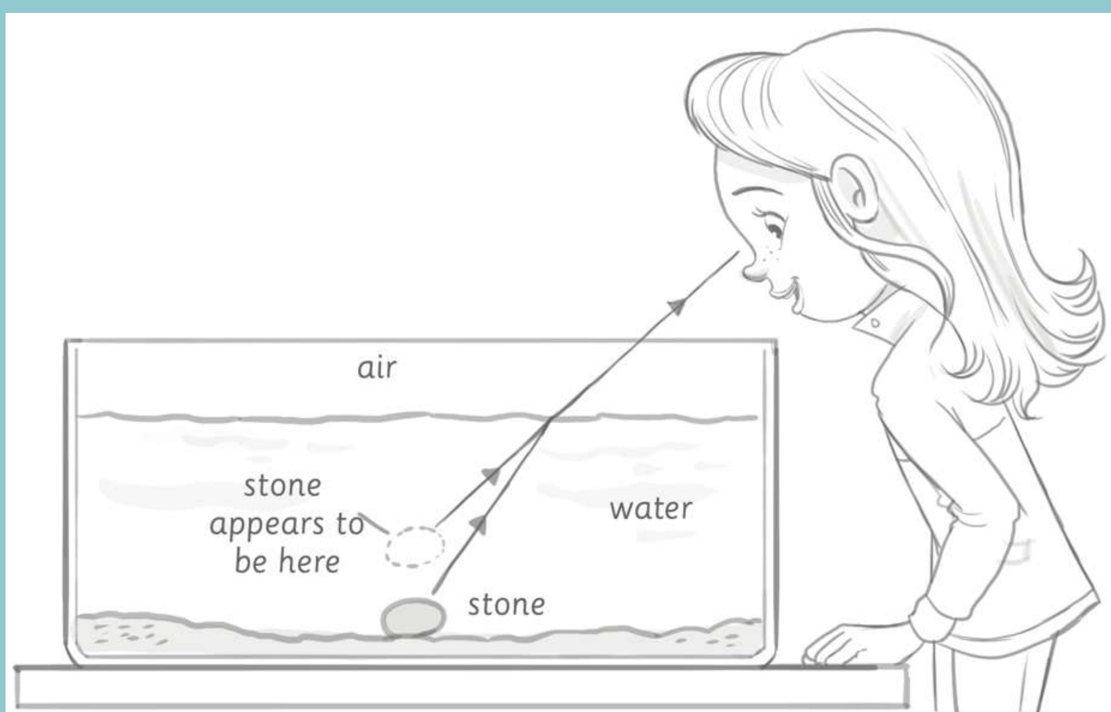
e A rainbow is a trick of the light/optical illusion.

2 a Name the rays 1 and 2.

b What angles do the rays make with the plane mirror?



3 Sofia is looking at a stone in a container of water. The stone appears to be nearer the surface than it really is. Explain this using the information on the diagram.



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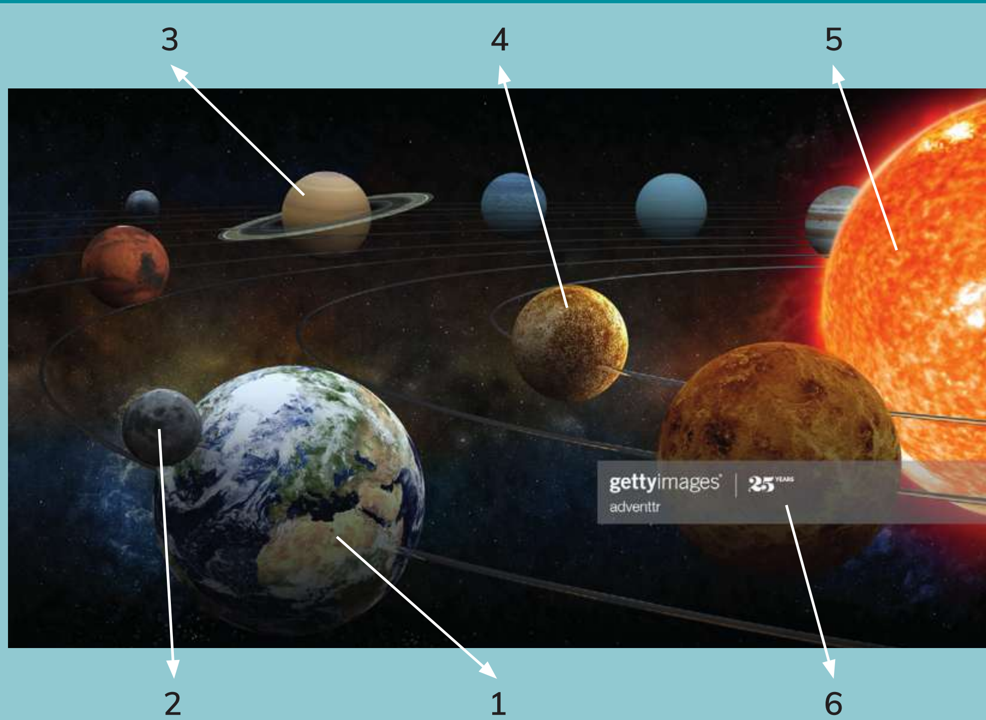


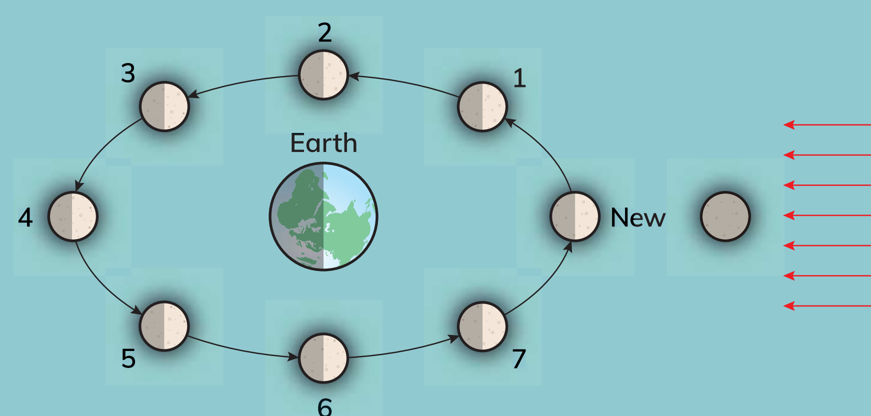
a Name the bodies in the Solar System numbered 1–6.

b How long does body 1 take to complete an orbit around body 5?

c How long does body 2 take to complete an orbit around body 1?

d Which body, 3 or 4, takes longer to orbit body 5?

5



a What do the arrows on the right-hand side of the diagram represent?

b Is the Moon waxing or waning from position 1 to position 4?

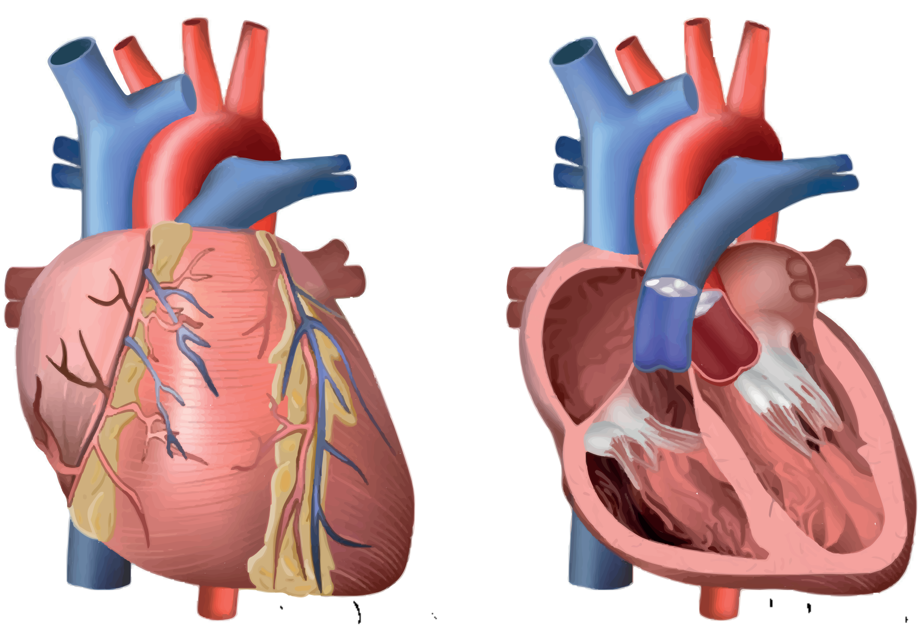
c Draw and name the phases of the Moon at positions 2, 4 and 7.

New science skills

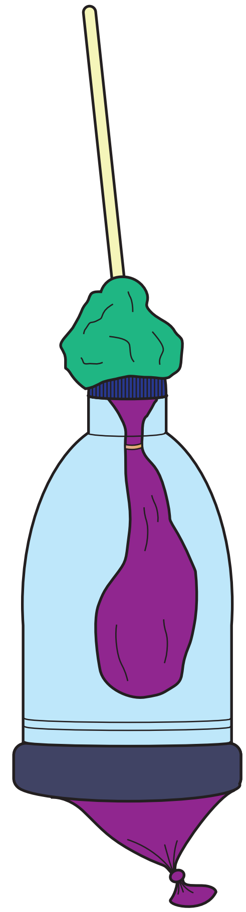
Using models to help understand and describe a scientific idea

Scientists use models to help them to describe and understand things they cannot see. For example, in Stage 6 you describe what our respiratory system and our circulatory system look like and how they work. Unless you become a surgeon you will never actually see these parts of our bodies. Diagrams are models. We use diagrams a lot to help us to describe what these systems look like and understand how they work.

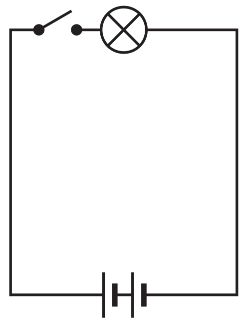
A three-dimensional (3D) model is also a helpful way to describe and understand systems in our body. A 3D model gives you a good understanding of the size of our body systems and what they look like inside. Here is an example of a 3D model of the heart and the heart cut open to see the inside.



You will make your own model of the respiratory system to help you to understand how it works.



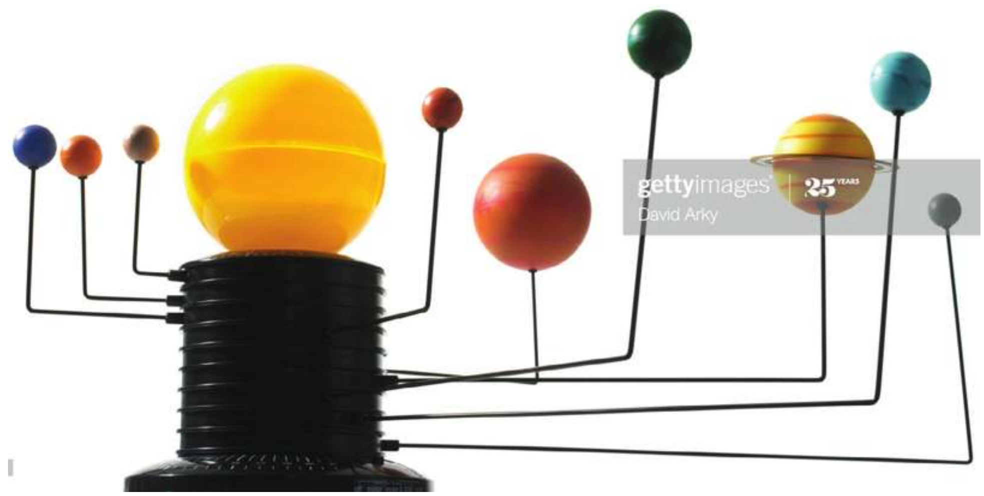
This year you will also be learning more about electric circuits. You will find out how to represent circuits with circuit diagrams. They will help you to describe a circuit and understand how it works.



When we learn about the solar system we also have to rely on models to describe and understand things. We can't see the whole Earth unless we are in a space station in orbit, and we cannot see the Solar System except through a powerful telescope. Even then, we can only see a tiny part of it at any one time.

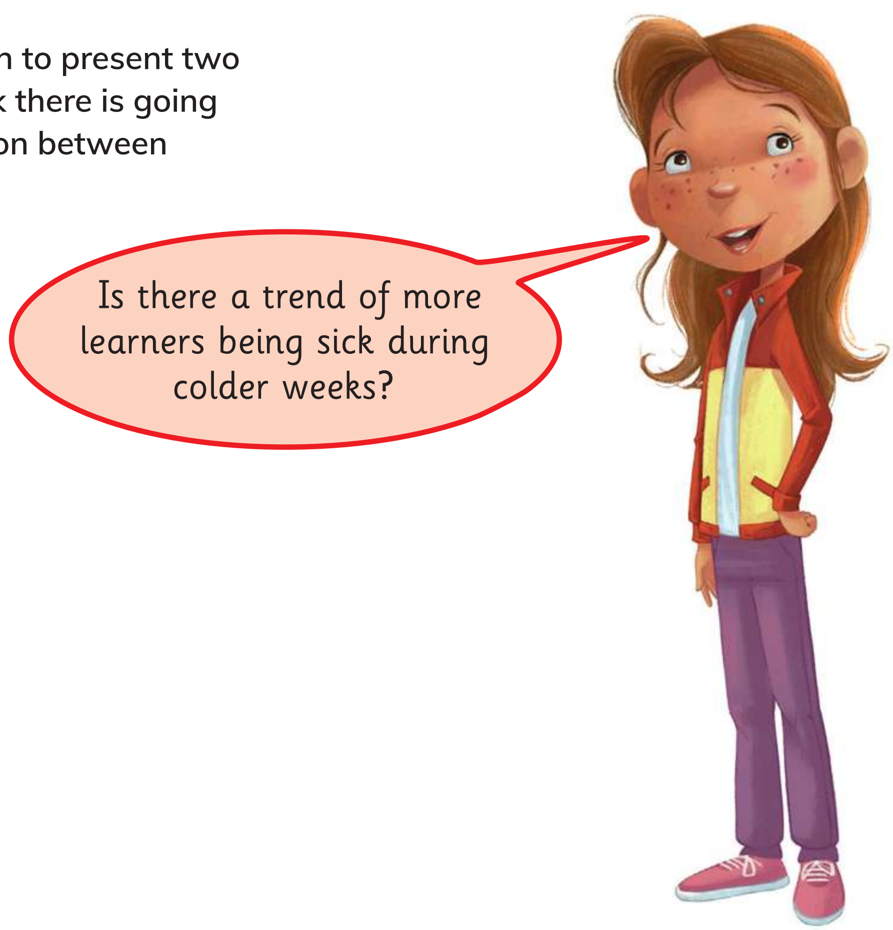
A globe is a very good model of the Earth. It is the correct shape, it is tilted at the correct angle on its axis and you can turn it to explain how night and day occur.

In this Stage you will make a scale model of the Solar System. It will help you to understand how enormous the Sun is compared to the planets and how far apart the planets are. But to understand how everything in the Solar System moves in orbits, it is much easier if you have a moving model. For example, the models shown here have a yellow lamp to represent the Sun. The model on the left shows the Earth orbiting the Sun. The model on the right shows all the planets orbiting the Sun at the same time.



Scatter graphs

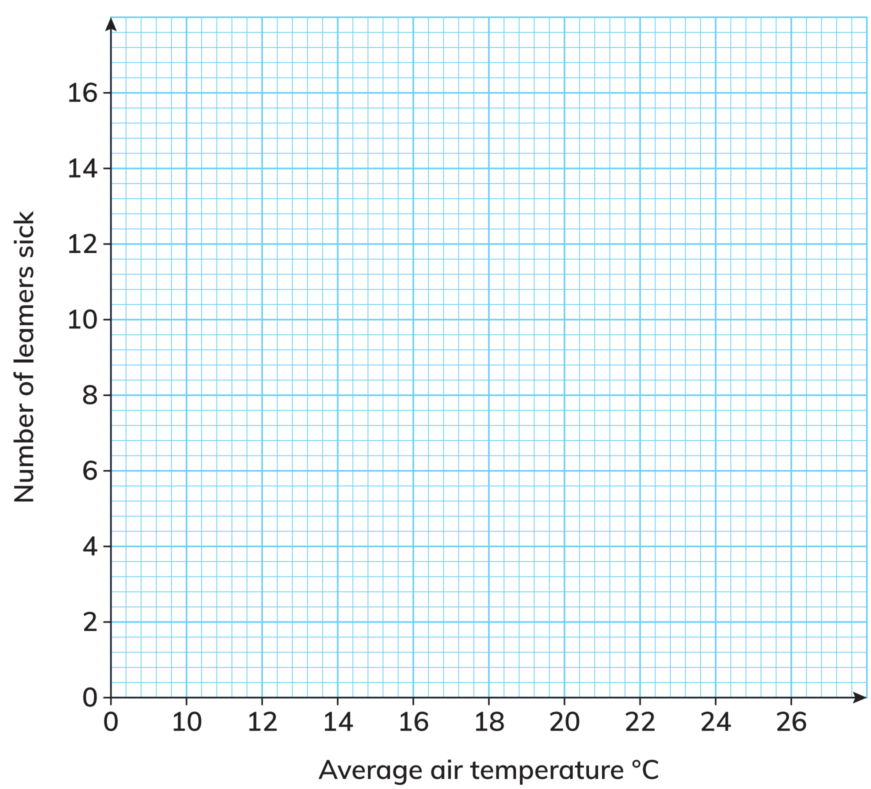
We can use a scatter graph to present two sets of data when we think there is going to be a trend in one direction between the two sets.



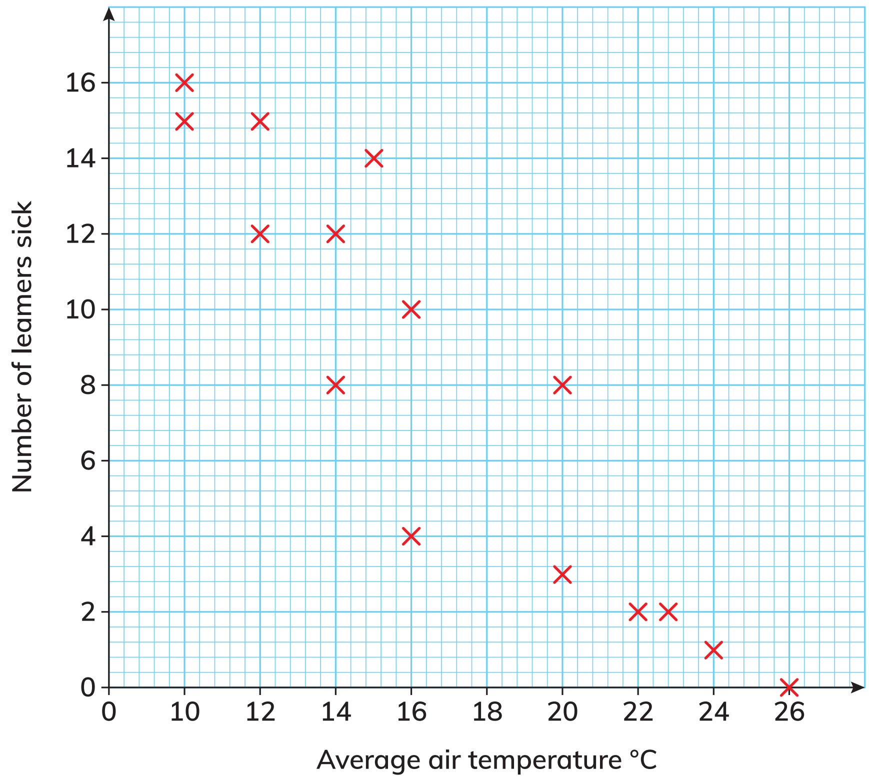
Sofia collects data on the number of learners who are absent from school with sickness over a period of 15 weeks. She also records the average air temperature for each week. She records the data in a table.

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Temperature (°C)	26	22	24	20	22	14	16	20	16	14	15	12	12	10	10
Number of learners off school with sickness	0	2	1	3	2	8	4	8	10	12	14	12	15	16	15

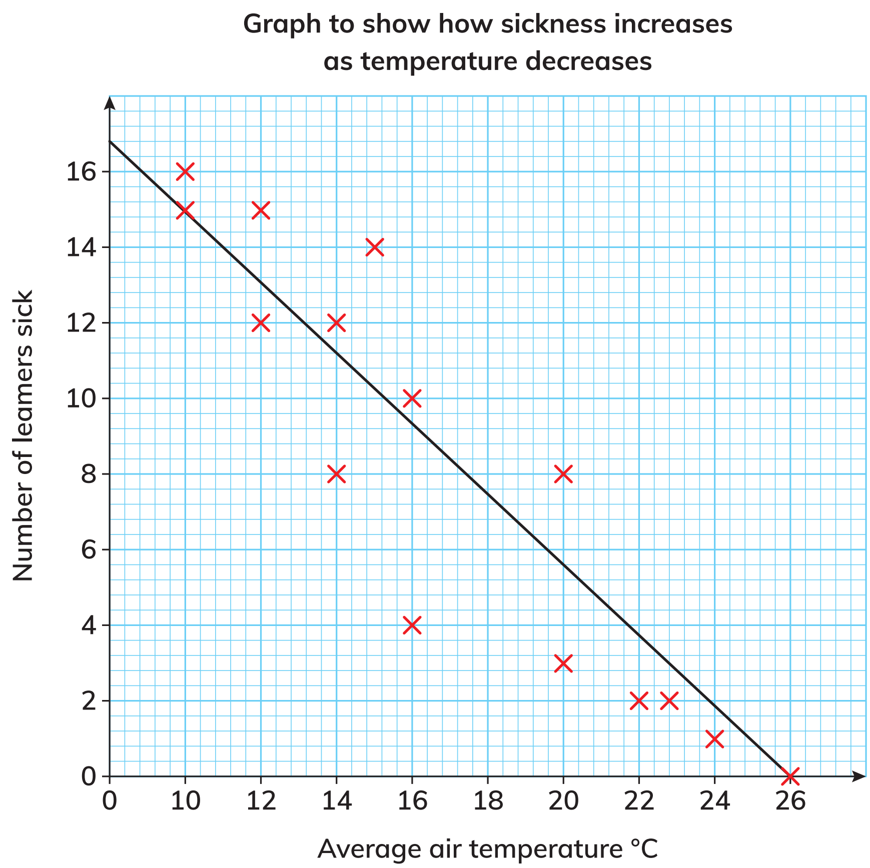
She decides to present the data on a scatter graph because she is expecting that there will be a trend. She draws the axes for her graph like this:



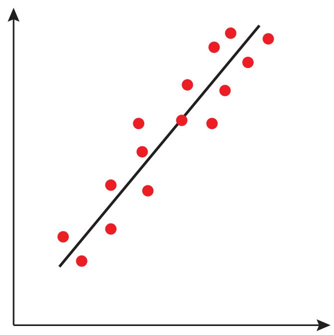
Then she draws a dot for each week using the data in her table. She draws the dots in the same way as she draws dots on a line graph.



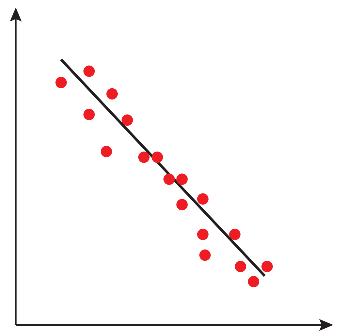
She can see that the dots are making the trend she expected, that more learners are sick when the temperature is low. To make this trend more obvious, she draws a **line of best fit.** This line passes through the dots. She gives her graph a heading.



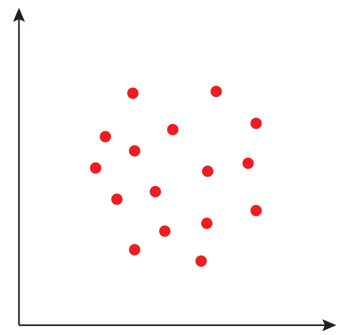
Sofia's graph shows a negative trend. That is, as one value increases the other value decreases. Sometimes a scatter graph shows a positive trend, so that when one value goes up the other value also goes up. Sometimes a scatter graph shows no trend: the dots are scattered and it is not possible to draw a line of best fit.



positive trend



negative trend



no trend

Glossary

accurate	correct and true, more real, without mistakes	00
angle	the space between two lines that meet at a surface, measured in degrees	00
artificial fertiliser	a fertiliser is a mixture of organic matter and minerals that help plants to grow. An artificial fertiliser is a factory-made fertiliser made from chemicals	00
astronaut	a person who goes into space	00
barrier	an object that stops things getting through or past it	00
blood	a red liquid that carries food and oxygen to all parts of the body	00
blood vessels	special tubes that carry the blood around the body	00
boiling point	the temperature at which particles throughout a liquid become a gas	00
breathing	the way we take air into our lungs and let it out again	00
breathing rate	the number of times we breathe in and out in one minute	00
burial	burying of sediments with many layers of sediments above	00
carbon dioxide	a waste gas that the body must get rid of	00
cast	a fossil where the whole animal is preserved in minerals	00
circuit diagram	a diagram of a circuit using conventional symbols for all the components	00
circulation	the pumping of blood all around the body	00
circulatory system	the system formed by the heart, blood vessels and blood to carry food and oxygen around the body	00
composition	what something is composed or consists of	00
compost	a natural fertiliser made of dead organic matter such as dead leaves and insects	00

conduction	the transfer of heat energy from one object to another	00
conventional symbol	a symbol that is recognised all over the world	00
converge	to meet or come together	00
convex	a bulging shape	00
crystal	the particular shaped structure of a mineral	00
crystalline	the adjective for crystal	00
defence	protection against something	00
deposit	to put down or drop	00
diaphragm	a muscle in the chest that helps us to breathe in and out	00
displaced	the moving aside of water as a result of upthrust	00
earth day	a time period of 24 hours	00
earth hour	a time period of 60 minutes	00
earth year	a time period of 365¼ days	00
electrical conductors	materials and substances that conduct electricity well	00
environment	the air, water, land and living things around us	00
erode	to wear down weathered rocks into sediments	00
evidence	the way we know that something has happened or changed	00
extrusive igneous rock	an igneous rock that has formed from lava cooling down on the surface of the Earth	00
fertilisation	the joining of a male sex cell and a female sex cell	00
focal point	the point where rays of light converge	00
food chain	a drawing that shows the order in which animals eat plants and other animals to get energy	00
food web	a number of linked food chains	00
forcemeter	a device to weigh objects in newtons (N)	00
fossil	the preserved remains of animals and plants in sedimentary rocks	00
geologist	a scientist who studies rocks	00

gneiss	metamorphic rock made from granite. This word is pronounced the same as ‘nice’	00
heart	the special muscle that pumps blood around the body	00
hormones	chemicals in the body that cause the body changes that happen during puberty	00
host	the living thing that a parasite infects	00
hygiene	keeping yourself and the things around you clean	00
igneous rock	a rock which comes from magma that has cooled down into solid rock	00
incident ray	the ray of light that arrives at the mirror	00
intrusive igneous rock	an igneous rock that has formed when magma cools down inside the Earth’s crust	00
irreversible	cannot be changed back to the way it was before	00
lens	a transparent material such as glass, Perspex or plastic with at least one curved surface	00
loam	a soil with a balance of sand, clay and organic matter	00
lungs	the organs we use for breathing	00
mass	a large intrusion of igneous rock	00
mass	the amount of matter in an object. Mass is measured in kilograms (kg)	00
medium	a material such as air, water or glass	00
melting point	the temperature at which a solid becomes a liquid	00
menstruation	the release of an unfertilised egg with the lining of the uterus	00
metamorphic rock	a rock that has been changed by heat or pressure or both heat and pressure	00
microplastics	very small particles of plastic that make their way into the environment, especially rivers and seas	00
mineral	part of a rock made of different substances with a crystal structure	00
mirror image	reflection in a mirror	00

mould	an impression or exact shape and size	00
mucus	a sticky substance found in our noses, windpipe and other air passages	00
naked eye	we can see something with our eyes without the help of a magnifying glass or hand lens	00
newton	the unit of measure for weight, named after Isaac Newton who explained the force of gravity	00
normal	a line drawn at right angles (90°) to the surface of the mirror	00
nutrients	food in the form of organic matter and minerals such as iron and phosphates	00
optical illusion	something our eyes see but it is not real	00
organic matter	living things or things which were alive, such as dead leaves, bits of root and twigs	00
ova	female sex cells	00
oxygen	a gas in the air that the body uses	00
parallel circuit	a circuit where there is more than one pathway and each pathway receives the full circuit voltage	00
parasite	any living thing that lives on or in the body of another living thing	00
periscope	a device that uses mirrors for you to see things otherwise out of sight	00
pesticide	a factory-made product that kills unwanted insects but also kills the organic matter in the soil	00
phase	the changing shapes of the Moon in its monthly cycle	00
physical change	any change that does not change a substance into a different substance	00
plane mirror	a flat mirror, rather than a mirror with a curved surface such as a concave or convex mirror	00
preserved	means kept forever	00
pressure	the force that is exerted on or against an object by something in contact with it	00

prism	a triangular block of glass or clear plastic	00
products	the new substances that form in a chemical reaction	00
property	something about a substance that allows us to tell it apart from other substances	00
puberty	the age at which a person becomes able to reproduce	00
pulse	a small beat felt under the skin due to the pressure of blood as the heart pumps it around the body	00
rainbow	an arch of colours formed when sunlight is refracted as it passes from the air to a raindrop	00
rate	how fast something happens	00
react	to interact and change to make a new substance; also to respond to something	00
reactants	the substances that react together in a chemical reaction	00
reflected ray	the ray of light that reflects off the mirror	00
refract/refraction	the bending of light	00
rehabilitation	to restore your body to health	00
repellent	a substance that keeps insects away	00
represent	to show or stand for; for example, the colour red usually represents danger	00
reproductive system	the parts of the body that make the sex cells	00
reversible	can be changed back to the way it was before	00
sediment	very small pieces of rock	00
sedimentary rock	a rock made from small pieces of other rock stuck together	00
sedimentation	the process where sediments build up in layers on the sea bed or lake bed	00
series circuit	a circuit where the electric current only has one pathway	00
soil	a mixture of broken up rocks, organic matter, water and air	00
solidification	the process where liquid magma or lava cools down and becomes solid rock	00

solute	the solid in a solution	00
solvent	the liquid in a solution	00
sperm	male sex cells	00
symbol	a small sign used on a diagram to represent a real thing; for example, the symbol ✓ means 'correct' and the symbol ✗ means 'wrong'	00
texture	the feel of a material; for example, rough or smooth	00
thermal conductors	materials and substances that conduct heat well	00
toxic	harmful or poisonous; for example, the factory produced toxic gases	00
transport	to carry	00
uniform	the same throughout	00
upthrust	a force that pushes up to an object in water or air	00
valley	the landform that a river erodes in the rocks. The river flows in the valley	00
vectors	living things that spread diseases but do not get the diseases themselves	00
volt (V)	the unit for measuring strength of electricity	00
voltage	the strength of electricity needed for an electrical component or appliance to work	00
waning	the decreasing in size of the lit-up part of the Moon in its monthly cycle	00
waterlogged	full of water that will not drain through	00
waxing	the increasing in size of the lit-up part of the Moon in its monthly cycle	00
weathering	a process where heat, ice, rain or plant roots break up rocks	00
weight	the amount of attraction on an object caused by gravity. Weight is measured in newtons (N)	00
weightlessness	a state of having no weight because there is no gravity	00
windpipe	the air tube that carries air from the nose and mouth to the lungs and back again	00

Acknowledgements

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