Natural Sciences and Technology

Grade 5-B

(CAPS)

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Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

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TECHNOLOGY-POWERED LEARNING

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Natural Sciences and Technology

Grade 5-B
Teacher's Guide

CAPS

Revised for 2014

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AUTHORS LIST

This book was written by Siyavula and volunteer educators, academics and students. Siyavula believes in the power of community and collaboration. By training volunteers, helping them network across the country, encouraging them to work together and using the technology available, the vision is to create and use open educational resources to transform the way we teach and learn, especially in South Africa. For more information on how to get involved in the community and volunteer, visit *www.siyavula.com*

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THIS IS MORE THAN JUST A WORKBOOK!

In many places you will see there are "Visit" boxes in the margins. These boxes contain links to videos online, interesting websites which pertain to the content, or else games or activities for learners to complete.

To access these websites or videos, simply type the link provided into your address bar in your internet browser. The links look like this for example, *goo.gl/vWKnF*

You can use these links in your lessons or else explain to your learners that they can watch them at home on a PC, laptop or on their mobile phones.

To download these workbooks or learn more about the project, visit the Sasol Inzalo Foundation website at *http://sasolinzalofoundation.org.za*

THE NATURAL SCIENCES AND TECHNOLOGY CURRICULUM

Science as we know it today has roots in African, Arabic, Asian, European and American cultures. It has been shaped by the search to understand the natural world through observation, testing and proving of ideas, and has evolved to become part of the cultural heritage of all nations. In all cultures and in all times people have wanted to understand how the physical world works and have needed explanations that satisfy them.

Natural Sciences and Technology complement each other

This is the first year that Natural Sciences and Technology have been combined into one subject, which is compulsory for all learners in Grades 4 to 6. Natural Sciences and Technology are also both compulsory subjects for all learners in Grades 7 to 9. These two subjects have been integrated into one subject as they complement each other.

	Natural Sciences	Technology
Goal	Pursuit of new knowledge and understanding of the world around us and of natural phenomena.	The creation of structures, systems and processes to meet peoples' needs and improving the quality of life.
Focus	Focus is on understanding the natural world.	Focus is on understanding the need for human-made objects and environments to solve problems.
Developmental methods	Discovery through carrying out investigations.	Making products through design, invention and production.
Major processes	Investigative and logical processes • planning investigations • conducting investigations and collecting data • evaluating data and communicating findings	Practical solution-orientated processes • identifying a need • planning and designing • making (constructing) • evaluating and improving products • communicating
Evaluation methods	Analysis , generalisation and creation of theories.	Analysis and application of design ideas.

ORGANISATION OF THE CURRICULUM

In this curriculum, the knowledge strands below are used as a tool for organising the content of the subject Natural Sciences and Technology.

Natural Sciences Strands	Technology Strands
Life and Living Matter and Materials Energy and Change Earth and Beyond	Structures Processing Systems and Control

Allocation of teaching time

Time for Natural Sciences and Technology has been allocated in the following way:

- 10 weeks per term, with 3.5 hours per week
- Grades 4, 5 and 6 have been designed to be completed within 38 weeks
- 7 hours have been included for assessment in terms 1, 2 & 3
- Term 4 work will cover 8 weeks plus 2 weeks for revision and examinations

Below is a summary of the time allocations per topic. The time allocations provide an indication of the weighting of each topic. However, this is a guideline and should be applied flexibly according to circumstances in the classroom and to accommodate the interests of the learners.

Life and Living and Structures

Chapter	Time Allocation
1. Plants and animals on Earth	2.5 weeks (8.75 hours)
2. Animal skeletons	1.5 weeks (5.25 hours)
3. Skeletons as structures	2.5 weeks (8.75 hours)
4. Food chains	1.5 weeks (5.25 hours)
5. Life cycles	2 weeks (7 hours)

Matter and Materials and Structures

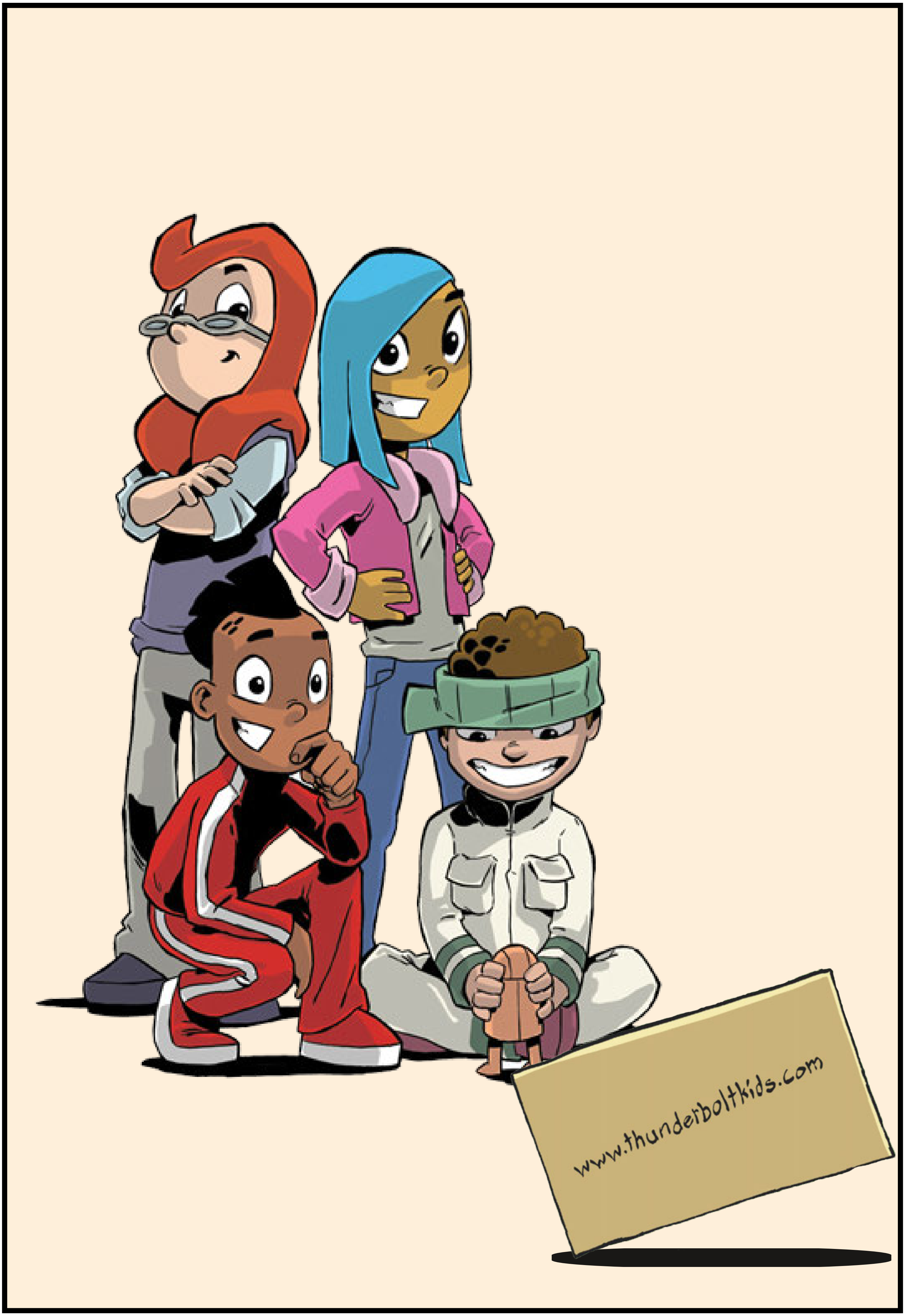
Chapter	Time Allocation
1. Metals and non-metals	2 weeks (7 hours)
2. Uses of metals	2.5 weeks (8.75 hours)
3. Processing materials	3.5 weeks (12.25 hours)
4. Processed materials	2 weeks (7 hours)

Energy and Change and Systems and Control

Chapter	Time Allocation
1. Stored energy in fuels	3 weeks (10.5 hours)
2. Energy and electricity	3 weeks (10.5 hours)
3. Energy and movement	1 week (3.5 hours)
4. Systems for moving things	3 weeks (10.5 hours)

Earth and Beyond and Systems and Control

Chapter	Time Allocation
1. Planet Earth	1 week (3.5 hours)
2. Surface of the Earth	2.5 weeks (8.75 hours)
3. Sedimentary rocks	2 weeks (7 hours)
4. Fossils	2.5 weeks (8.75 hours)


www.thunderboltkids.com

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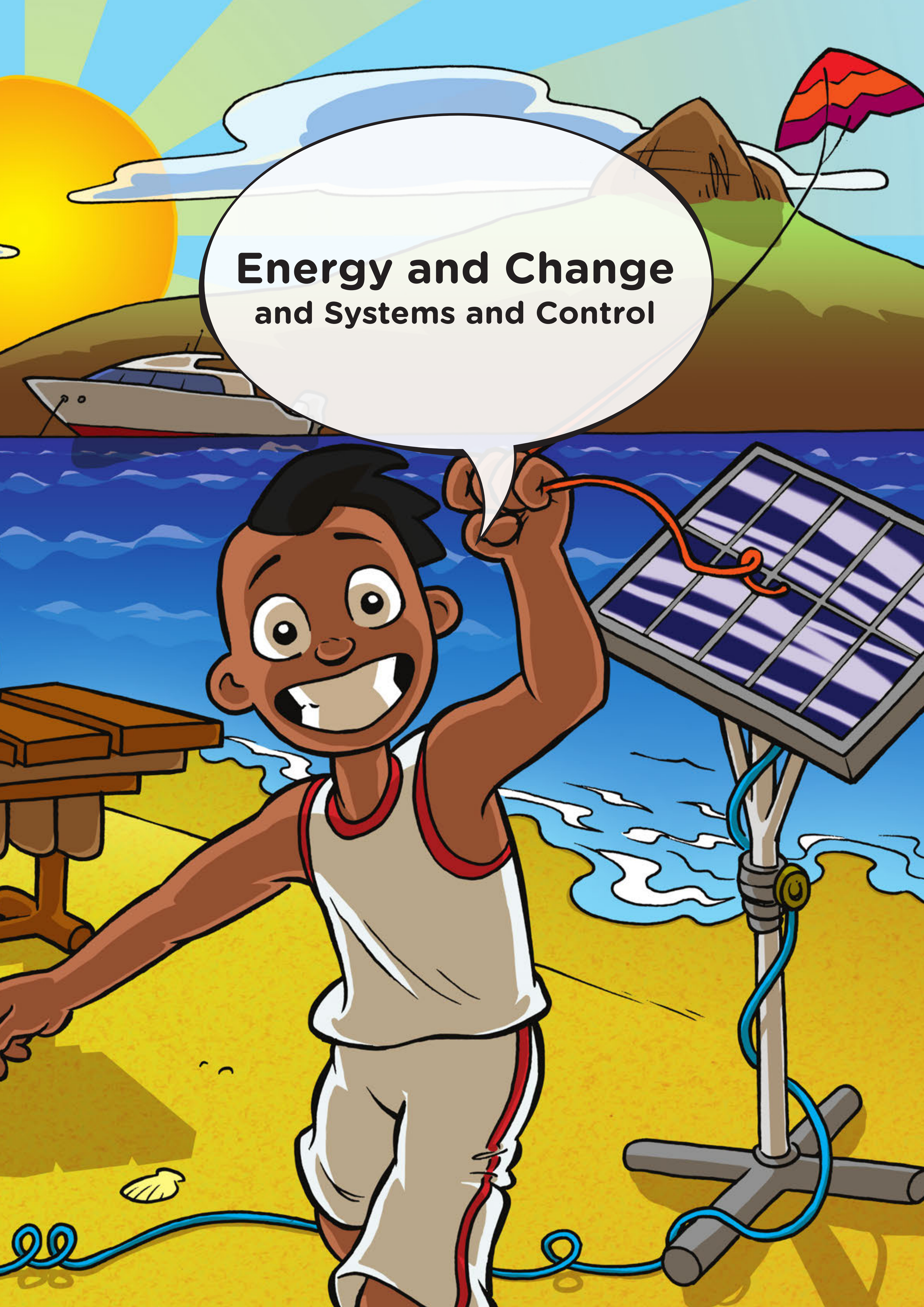

Energy and Change
and Systems and Control

1 Stored energy in fuels

KEY QUESTIONS

- What are fuels?
- What is required to burn fuels?
- How can we safely burn fuels?
- How can we prevent fires and what must we do if there is a fire?

1.1 What are fuels?

In Gr. 4, we learnt that there are many different types of energy. This year we are going to learn about stored energy and how we can use the stored energy to do something useful.

New Words

- fuel

QUESTIONS

What do you understand about the term fuel? Discuss this word with your partner and write down your own definition below.

Learner dependent answer (a material such as coal, gas, or oil that is burned to produce energy)

There are a few different definitions for fuel. There are three main categories that you can use to investigate fuels.

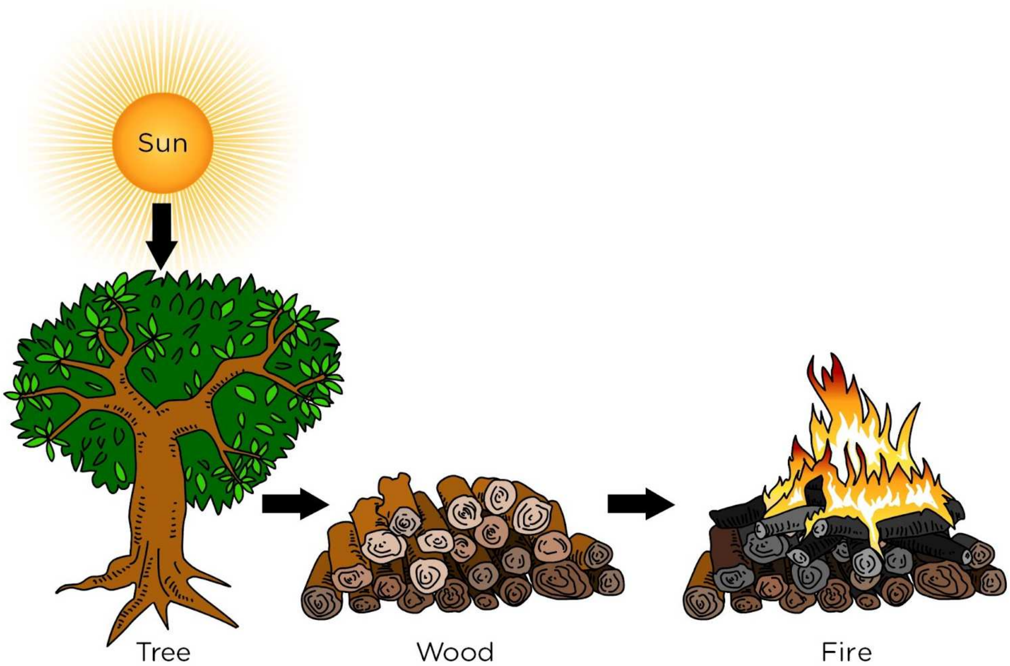
Some fuels can be burnt to create heat and light

Wood is often collected and burnt to give us heat and light. On a cold evening, it is wonderful to sit around a fire to tell stories and warm yourself with friends.

This man has made a fire to provide heat and light. [1]

Cooking meat on a fire made from wood in Khayelitsha. [2]

Wood comes from plants, specifically trees. Plants use light energy from the Sun, as well as carbon dioxide and water to grow. Plants take the energy and store it in their leaves, roots and all parts of the plant. Wood also contains this energy stored by plants. Burning wood allows us to change this stored energy into light and heat which is useful to us.



Energy from the Sun is stored in the tree's wood which is released as light and heat when we burn the wood.

VISIT

Formation of fossil fuels (video)

goo.gl/y041H

Coal is a type of fossil fuel that is also burnt to provide us with heat that we can use. The heat from coal can be used to cook our food and warm our houses.

Hot coals burning

VISIT

How fossil fuels are made

goo.gl/rxiVG

Fossil fuels like coal were made from prehistoric plants. The plants took up energy from the Sun and stored it in their bodies. Millions of years ago, the Earth was mostly covered by water. The plants that died sank to the bottom of the water. Over millions of years, the layers of plants were covered by layers of sand and compressed by the weight of the sand. The plant material was buried deeper and deeper under the ground where it is much hotter than on the surface of the Earth. Over millions of years, the plant remains changed into fossil fuels.

These fuels get their name, "fossil fuels", because they are made from plants and animals that lived a very long time ago.

Natural gas and oil are also examples of fossil fuels. Scientists have realised that tiny sea organisms also died, sank to the the bottom of the ocean, and were buried under the sand. Over millions of years, many layers of dead sea animals got buried like this. Over millions of years, the dead sea animals changed into oil and natural gas.

Wax in a candle is burnt to provide light. By burning the candle, the stored energy in the wax is released as light and heat energy.

Candle wax is an everyday fuel that we use to give us light.

A paraffin lamp [3]

Paraffin is also a fuel that contains stored energy. Paraffin is burnt in paraffin lamps and paraffin stoves to provide us with useful energy in the form of light and heat.

Gas is another fuel that can be burnt to release stored energy in the form of heat and light. We can use gas heaters to keep warm, and gas stoves to cook food and boil water. Natural gas is odourless and colourless, and it is also known as 'clean gas' because, unlike other fossil fuels, it doesn't produce harmful byproducts when it burns.

Food is fuel for the body

Humans and animals need energy to live. We get our energy from the food that we eat. Do you remember learning about food chains in the beginning of the year in Life and Living?

QUESTIONS

Choose one of the foods that you will eat for lunch today and draw a food chain including this food and ending with you.

Any food chain starting with the Sun and ending with a person (the learner). Perhaps it is a piece of fruit, then it will just be a 3 link food chain. If it is a meat product, then it would be a four link food chain.

Remind learners about food chains and how the direction of the arrows shows the transfer of energy from the Sun and then from one organism to the next.

Food contains stored energy that our bodies can change into useful energy that we need when we run, jump, breathe, learn and do everything else that we do.

So we can say that food is the fuel for our bodies! I must need a lot of fuel for my body as I love being active!

The energy value of food is often shown on the packaging of foods that we buy. The energy of food is measured either in calories (Cal) or in joules (J). A snack such as a packet of chips gives you thousands of joules of energy. Therefore, we rather talk about kilojoules (kJ) of energy when talking about the energy in food.

Spend a moment going over the link between units of measurements and the use of "kilo" as this is often a huge problem with learners in the higher grades. For example, write some of these on the board, 1000 grams (g) = 1 kilogram (kg), 1000 metres (m) = 1 kilometre (km), and then write 1000 joules (j) = ... and ask learners for the answer.

Have a look at the photo of the side of a mealie meal packet below. The side of the packet contains a lot of information about what the mealie meal contains. The very top line tells us that 100 g of mealie meal will supply your body with 1368 kJ of energy.

The nutritional information on a mealie meal packet

The energy value of a food tells us how much energy that food is worth to our bodies as fuel. An average adult man needs about 2500 kcal or 10 000 kJ per day. Children and adults that are not very active need less energy. People that are very active need more energy. These numbers are just to give us an idea of the amount of energy your body needs as fuel everyday.

It is important to eat a balanced diet. In the next activity we are going to look at how much energy different food gives us. In Gr. 6 we will learn a lot more about nutrition and what you should eat to be healthy!

ACTIVITY: Energy from food

About two weeks before you get to this activity, ask the learners to start bringing in packages from food that they eat, e.g. cereal boxes, butter wrappers, egg boxes, sweet wrappers, biscuit boxes, chip packets, rice packets, bread packets etc. The bigger the variety of packages the better. Make sure the learners understand that you need to be able to read the information in the table on the packet. Have a couple of examples with you to show the learners what they are looking for. NB: Not all foods will give kJ per 100 g. Ask learners to attempt to do some of the conversions themselves.

MATERIALS:

- various packaging for foods collected from home

INSTRUCTIONS:

1. Work in pairs.
2. There is a collection of packages from different types of foods in your classroom.
3. Look carefully at the energy information given on the packets and use this information to complete the table.
4. It is important to record the number and the unit in your table.

Food item	**Energy per 100g**

QUESTIONS:

1. Which food item contains the most amount of energy per 100g?
2. Which food item contains the least amount of energy per 100g?

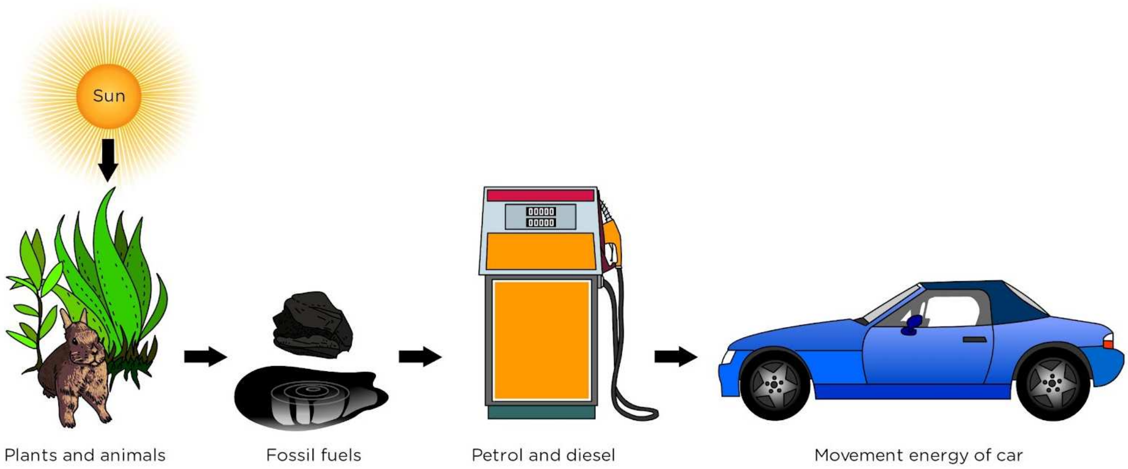
Some fuels are energy sources for engines and power station

Fuels can also be used to give us other forms of useful energy.

Petrol or **diesel** is used in cars and trucks to make them go. The stored energy in the fuel is changed into movement energy of the car or truck.

Putting petrol into a car at a petrol station

Petrol and diesel are made from fossil fuels. Can you see that even energy for cars and generating electricity comes from the Sun?



Energy from the Sun is stored in the plants and animals which eat the plants. Their remains turned into fossil fuels over millions of years which are then mined and used to make petrol and diesel to fuel cars.

Coal is not only burnt in our homes for cooking and keeping us warm. It can also be used to make electricity. A power station is a large factory where the coal is burnt in large amounts to produce electricity.

A power station [4]

We can also carry out an investigation to find out how much energy is stored in fuels.

INVESTIGATION: How much energy can we get from different fuels?

The teacher must make the apparatus as per the instructions in the method. This investigation must be performed by the teacher or under very careful teacher supervision due to the fire hazard. If possible, watch the video in the Visit box to get an idea of the experiment. If you cannot perform the experiment in your class, then possibly play the video for learners. This investigations makes use of simple equipment such as tin cans and corks. But, if you have access to a science laboratory, then you can use a metal retort stand, test tube and bunsen burner instead. The idea of this investigation is to show that you do not need fancy science apparatus to perform an experiment.

AIM: To determine which fuel contains the most energy

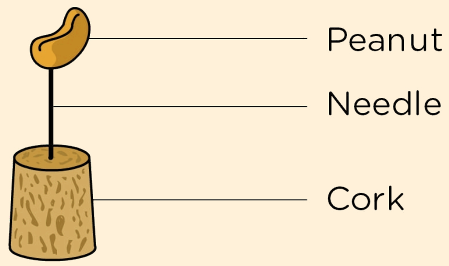
MATERIALS AND APPARATUS:

- a cork
- a needle
- peanuts (other fuels such as a piece of wood, candle wax or piece of biscuit)
- a large metal can (e.g. coffee tin)
- a small metal can (e.g. soup can) with paper label removed
- a can opener
- a hammer
- a large nail
- a metal spike longer than the diameter of large can
- 150 ml of water
- a thermometer
- a lighter

The idea of this investigation is to examine the amount of energy given off by a peanut. **NB:** Learners might struggle with linking a burning object, with energy given off, which then heats water, which then gives a reading on a thermometer. Take time to explain how a burning peanut can result in a different reading on a thermometer, and that we are actually looking at the energy given off and not the reading on the thermometer. The thermometer reading is an indicator that more energy is released.The experiment can be taken further to compare different fuels. You can also use a piece of wood, piece of candle wax, piece of biscuit (approximately the same weight of each fuel). It is important to burn the same weight of each fuel so that you can directly compare the amount of energy given off per gram of weight.

Method:

1. Carefully push the eye of the needle into the smaller end of the cork. The gently push the pointed end of the needle into a peanut. If the peanut breaks use another peanut.



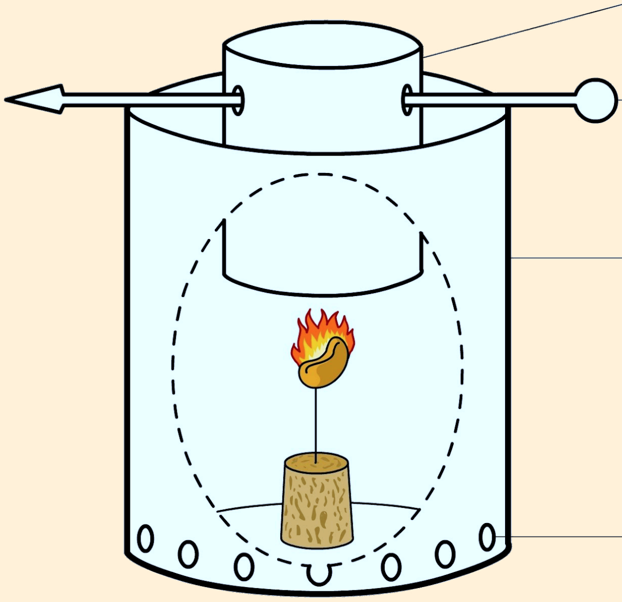
Set up your peanut and cork like this.

2. Carefully remove both ends of the large can. Watch out for sharp edges.
3. Use the hammer and nail to make holes all around the bottom of the large can. These are air holes.
4. Use the small can and punch two holes near the top of the can exactly opposite each other.
5. Slide the metal spike through the two holes in the small can.
6. Pour 150 ml of water into the small can.
7. Use the thermometer to measure the temperature of the water and record it in the results table.
8. Put the cork and peanut on a surface that cannot burn. Use the lighter to light the peanut. The peanut can be difficult to light so keep trying. It will eventually start burning.
9. As soon as the peanut is burning, carefully place the large can over the peanut. Balance the small can inside the big can as shown in the diagram. The small can must be a short distance above the peanut.

VISIT

Burning a peanut (video)

goo.gl/JoXw6



Set up your apparatus like this.

10. Let the peanut heat the small can with the water until the peanut stops burning. Stir the water and measure the temperature of the water and record it in the results table.
11. Repeat the experiment with two different fuels. Your teacher will decide which fuels to test. Fill in the results table for the other fuels tested. Remember to use quantities of the other fuels which are similar in size to the peanut, and always to start with a can of cold water.

RESULTS:

	Fuel 1: Peanut	**Fuel 2: ________**	**Fuel 3: ________**
Temperature of water before heating (°C)			
Temperature of water after heating (°C)			
Change in temperature (°C)			

CONCLUSION:

Write a conclusion for your investigation.

The energy stored in the peanut was changed into heat energy which we used to warm the water.

At this point, ask questions like if the peanut had stored a greater amount of energy would the final temperature of the water be greater or smaller. Lead the class to discuss which substance contained the most amount of energy. Also ensure the learners understand that to make a fair comparison about the amount of stored energy in each substance, that you would have had to have the same mass of fuel for each experiment. In addition, you could use a metal bottle top and fill with paraffin or other liquid fuel to compare stored energy.

QUESTIONS:

1. Which fuel contained the largest amount of energy, and how did you determine this?
   The fuel containing the most amount of energy would have burnt for the longest and therefore caused the greatest change in the temperature of the water.
2. Where did the energy in the peanut originally come from?
   The energy comes from the Sun.

3. Discuss what happened to the energy stored in the nut, or other fuels you used.
   As the nut was set on fire, the stored energy was released as heat and light.
4. What was the input energy needed to make the peanut (and other fuels) burn?
   heat energy
5. What was the output energy obtained from the fuel?
   heat and light energy
6. Discuss how you could compare the amount of energy stored in peanuts to the amount of energy stored in a cashew nut.
   The experiment (peanut or cashew nut) that produces the biggest increase in temperature has used the fuel with the most stored energy.
   Repeat the experiment with a peanut and then a cashew nut of the same mass. Learners can go into the details of how to set up and perform the experiment. Unless they have done it, they won't be able to predict which one has the most stored energy, but the following conclusion could be made:

In order to light the fuel, you had to put in a small amount of energy. The fuel however gave out a lot more energy than what was put in. The difference between the energy you put in and the energy the fuel gave out is how much energy was stored in the fuel.

The OUTPUT ENERGY obtained from a fuel is GREATER THAN the INPUT ENERGY needed to make the fuel burn.

1.2 Burning fuels

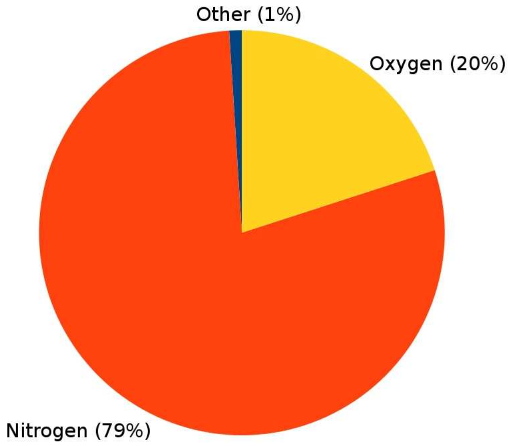
We have learnt that burning fuels provides us with energy that we can use. What does a fuel need to be able to burn?

It requires some energy to start burning fuel. Fuel needs oxygen to burn. Fuel usually gets oxygen from the air around it. There are other gases present in air as well, but they do not burn.

The following pie chart illustrates how much of each type of gas is found in the air around us.

New Words

- oxygen
- combustion



Pie chart of showing the percentage of gases in the air around us.

VISIT

The science of fireworks (video)

goo.gl/d4HJj

When something burns we say it is combusting. Another word for burning is combustion.

QUESTIONS

How much of the air around us consists of oxygen?

Oxygen makes up 21% of the air around us.

What happens to a flame when we take one of these things away, such as oxygen? When we take something away, we say we deprive it. Let's find out what happens when a flame is deprived of oxygen!

INVESTIGATION: What happens when a flame is deprived of oxygen?

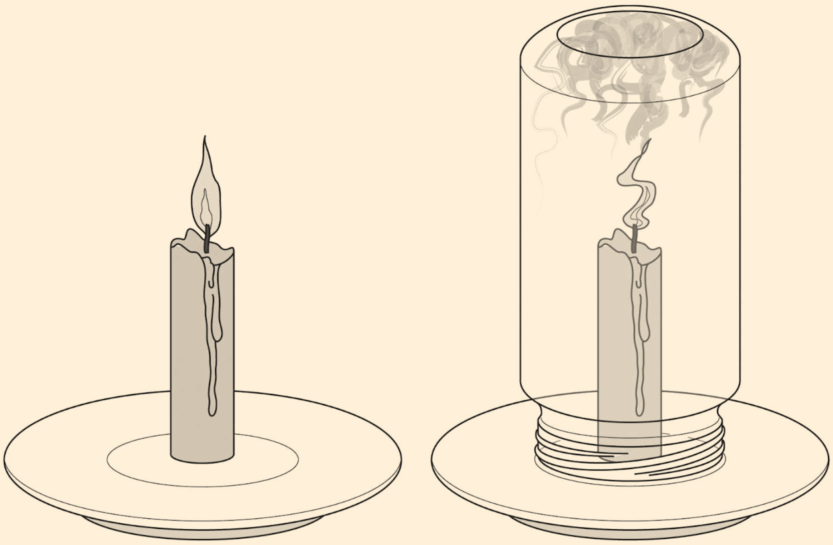
AIM: To find out how long a candle will burn for when given different amounts of oxygen.

MATERIALS AND APPARATUS:

- 1 candle
- 4 glass bottles (small, medium, large and extra large)
- matches
- 1 flat bottomed bowl

METHOD:

1. Light the candle.
2. Drip some wax in the middle of the bowl and 'mount' a candle in the wax.
3. Pour a small amount of water in the bowl around the candle for the glass jars to stand in.
4. When the candle is securely standing upright, light the candle with the matches.
5. Place the small bottle over the candle and time how long it takes until the candle goes out. Record the time taken in the results table.
6. Repeat the experiment with each of the different sized glass containers and record the time taken for the candle to go out.



Cover the candle as shown with each of the different sized bottles.

RESULTS AND OBSERVATIONS:

Size of glass jar	Time taken for candle to go out (s)
Small	
Medium	
Large	
Extra Large	

1. In which glass jar did the candle burn the longest?
   the extra large jar
2. In which glass jar did the candle burn out the fastest?
   the small jar

CONCLUSION:

Write a conclusion for the investigation.

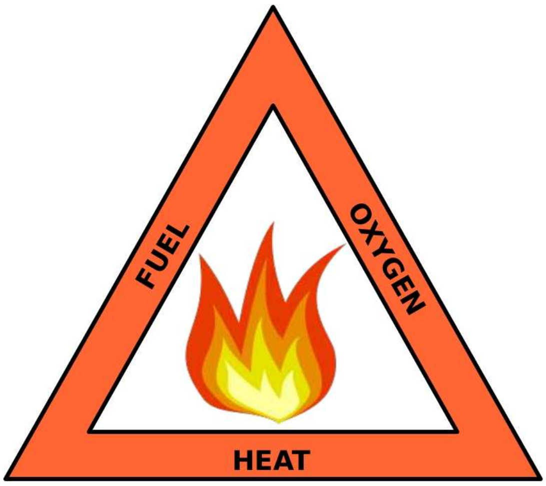
The more air the candle has available, the longer the candle can burn for.

QUESTIONS:

1. When lighting a candle, identify the heat source that provides the starting energy and the fuel supply.
   heat source is lit match, fuel is the wax
2. Why did the candle go out once you put the glass jar over the candle?
   The candle used up all the oxygen in the air. Burning cannot happen without oxygen so the candle went out.
3. Why do you think there is a difference in the time it took for the candle to go out?
   The small jar has less air and hence less oxygen than the bigger jars. The smaller the amount of oxygen, the quicker it gets used up and the quicker the candle goes out.
4. A candle that is allowed to burn freely in air will eventually burn down and go out. Why does the candle stop burning in this situation?
   The fuel has run out.

In this experiment we learnt that if you take away the fuel or the oxygen, the flame will stop burning.

For combustion to be possible, three things are required; a heat source, fuel, and oxygen. Without one of the three, combustion will not happen. You can remember this using the Fire Triangle (in the following picture). All three sides of the triangle are required for combustion.



The combustion triangle

1.3 Fire safety

Invite someone from the local fire department to come and talk to the children in your school. Ask them to bring their equipment and talk to them about fire safety. The fire department is normally very willing to visit schools and they are the experts. If the fire department is not available, a community member can also be asked to talk to the learners.

We have spoken a lot about fire and burning in this chapter so far. Fire is a major source of heat energy for many people whether it for keeping warm, cooking food or for some other purpose. Although fire is very useful it is also very dangerous! Great care is needed when using fire. Fire is a threat in our communities.

VISIT

Burning substances in air and pure oxygen (video)

goo.gl/sEV5g

New Words

- threat
- extinguish

DID YOU KNOW?

Some plants even need fire to survive! An example is Fynbos. This is a group of plant species found only in South Africa. The seeds of Fynbos plants need smoke and heat to germinate.

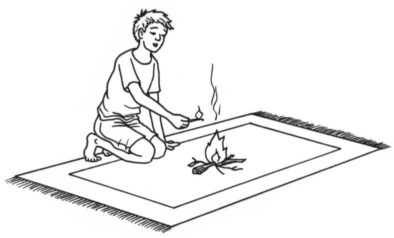
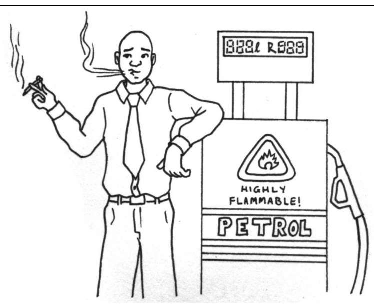
There are a few safety rules that everybody should know:

1. Never play with matches and lighters. Make sure that matches and lighters are kept out of reach of young children who do not know how to use them properly.
2. In case of fire - stay away. If there is a fire in your home, do not hide, rather go outside as soon as possible.
3. Know the number of the local fire department and phone in case of emergency.
4. Have an escape plan for your home and practice it with your family. Have a meeting place outside so that you will know everyone is safe in the event of a fire.

ACTIVITY: Dangerous situations involving fire.

INSTRUCTIONS:

1. Below are four different scenes.
2. Each one involves fire and is potentially dangerous.
3. Write a description next to each picture about why it is dangerous.

Situation	Why is it dangerous?
	
	

Fire alarms are extremely important to warn people in buildings that a fire has started.

You should have some fire extinguishers in your school. See if you can locate them.

A great additional activity is to demonstrate the use of a fire extinguisher and then ask the learners to explain why it puts out the fire. Does the fire extinguisher blow out the fire? Does it remove oxygen from the burning material? Does it remove heat from the fire? Does it prevent oxygen from getting to the fire? Lots of interesting questions can arise here that could lead to a valuable discussion. No mention need/should be made of carbon dioxide unless the idea has already been raised before this.

ACTIVITY: Talking about fire in our communities

1. Work in groups of four.
2. Talk about your experience of fire in your neighbourhood. List some good and some bad experiences in the table below.

Good experiences of fire	Bad experiences of fire

3. What causes of fire can you identify in your community?
4. How could you prevent each of the causes of fire you have been discussing?

The answers to these questions are unique to the community in which you live. Discuss the answers each group has come up with with the class. Suggest that each group makes a poster about fire safety after the class discussion.

Sometimes fires break out and it is important for us to know what to do in the event of a fire.

ACTIVITY: Acting out what to do in case of a fire!

INSTRUCTIONS:

1. In groups of 5, plan and act out a play for your class to teach them what to do in case of a fire.
2. Make sure that your play provides important information about:
   a) how to escape from a burning building;
   b) not to open a door in a building that is burning;
   c) what to do if your clothes are on fire; and
   d) what to do if your friend is stuck in a burning building.

The following actions should be shown in the plays:

- To escape from a building, fall and crawl.
- When clothes are on fire, stop, drop and roll, or cover in a blanket or carpet.
- If a friend is in a building, learners should show that they NEVER go into the building themselves, but rather call for help.

Assess the learners' plays as a group according to how clearly the learners speak and demonstrate the actions to do with their bodies and by acting out.

Have you ever seen any fire posters in your school telling you what to do in case of a fire? Did this poster catch your attention and make you aware of the dangers that fire can hold in your school? Maybe your school does not have any fire posters. Let's create our own fire posters to put up in the school.

ACTIVITY: Creating a fire poster

MATERIALS:

- Pieces of paper and cardboard.
- Coloured pens and pencils.
- Old magazines
- Scissors
- Glue

INSTRUCTIONS:

1. Design a poster telling everyone in your school what to do if

there is a fire.
2. Include some pictures to show the steps to follow. You can draw these pictures or cut some out of old magazines or newspapers.
3. Some points to think about when making your poster:
    - Does your school have an alarm bell?
    - If so, what is the signal?
    - Is there a safe place that a large amount of people can gather?
    - How will you make sure no one is left inside the buildings?
    - Is it safer to use the lift or the stairs when there is a fire?
    - What extra measures can you take to stop the fire? (Clue: Remember fire needs oxygen to burn so what can you do to your classrooms to help stop the fire and reduce the supply of oxygen?)

DID YOU KNOW?

Smoke inhalation (breathing in the harmful smoke) from a fire kills more people in household or domestic fires than the actual fire does.

Extra precautions are to close windows and doors.

KEY CONCEPTS

- Energy is stored in fuels.
- Fuels are sources of useful energy.
- Fuels are burnt to be able to use their energy as heat and light.
- Fire can be dangerous.

REVISION:

1. List three types of fuel that you use in your community.
   food, coal, any fuel that the learners have experienced
2. What is needed for combustion to take place?
   heat, fuel and oxygen
3. Your dad is cooking with hot oil on the stove. The oil catches fire. Suggest a way to put out the fire and explain why it will work.
   Put the lid on the pot. This will cut off the oxygen needed to burn and the fire will go out. Do not use water to put out an oil fire.
4. An enthusiastic science learner decides to perform an experiment to find out how long different quantities of firelighters will last. Each firelighter was cut into equal size blocks. The experiment was performed under adult supervision, and the following results were obtained:

Number of firelighters	Time of burn (min)
2	6,0
4	11,5
6	18,6
8	23,8
12	37,0
16	48,0

   a) Plot a graph of number of firelighters on the horizontal (x) axis and the time of burn on the vertical (y) axis.
   b) Draw a line of best fit on your graph.

   Line must NOT join the points. Must be a line drawn with a ruler that is as close to the data points as possible. There should be as many data points above the line as below.

5. Describe the relationship between the time of burn and the number of firelighters.
   The greater the number of firelighters, the greater the burn time.

6. Use your graph to find out how long ten firelighters would burn for.
   30 min

7. Your mom leaves the iron on and it is next to a window with a curtain blowing in the wind. Explain to her why this is dangerous and what she should rather do.
   The curtain could blow against the hot iron and catch fire and burn the house down. The wind blowing in from the window would also help to spread the fire. She should rather turn the iron off when not using it and close the window so the curtain does not blow against the iron.

I really enjoyed learning about fuels! Let's find out more about energy and electricity.

KEY QUESTIONS

- What do cells and batteries do?
- What is an electric circuit?
- Where does energy come from in a power station?
- How does electricity get from a power station to where it is needed?
- How can we use electricity safely?

2.1 Cells and batteries

Batteries come in all shapes and sizes. Batteries are needed for many different purposes. Most torches, radios, calculators, cell phones, some toys and even cars, pacemakers and hearing aids need batteries to work.

Typical batteries

New Words

- cell
- battery
- circuit
- pacemaker

Batteries are useful because they store chemical energy. When the battery is connected in an electrical appliance and the appliance is switched on, the stored energy in the battery is transferred to the appliance in the form of electrical energy to make it work.

ACTIVITY: Investigating the source of electricity in a torch.

MATERIALS :

- a working torch
- an old, broken torch

INSTRUCTIONS:

1. Turn your torch on and off. Can you see the bulb light up?
2. Turn your torch off. Open it up and take the batteries out.
3. Now turn it back on.

QUESTIONS:

1. Does the bulb light up when there are no batteries in the torch?
   No
2. What does this tell you about the need for batteries to make your torch work?
   You need batteries for the light bulb to light up. This is because the batteries are the source of electrical energy.
3. Do you remember learning about transfer of energy in Gr 4? When the torch lights up, what is the chemical energy in the battery transferred to?
   Chemical energy in the batteries is transferred to electrical energy. Electrical energy is then converted to light energy in the bulb.
4. Bring an old torch to school that can be taken apart. Look carefully at all the parts that make up a torch and make a list of what you find. Each part of the torch is needed for the torch to work properly.
   batteries, light globe, wires, switch, casing, glass or plastic front

An electric circuit is a system that consists of different parts. We call these parts the components of the circuit. For example, batteries, light bulbs and connecting wires are components that can make up a circuit. When these components are connected the right way, electricity will be transferred from one component to another. In this example, the electricity would be transferred from the batteries through the connecting wire to the bulb and back through the wire to the batteries to complete the circuit.

The chemical energy from the battery is transferred to electrical energy in the wires, then electrical energy is transferred into heat and light energy in the bulb.

ACTIVITY: Making a simple circuit

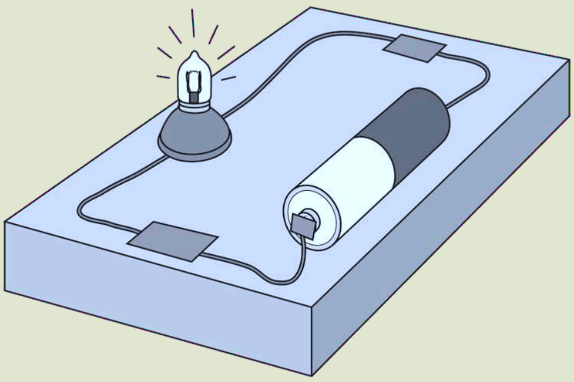
MATERIALS:

- 2 torch batteries
- 1 light bulb
- connecting wires

INSTRUCTIONS:

Part 1

1. Set up the circuit as shown in the following diagram.
2. Make sure all the wires are connected to form a closed loop.



A simple circuit

QUESTIONS:

1. What do you observe?
   The globe lights up.
2. What happens when you disconnect one end of one of the wires?
   The light goes out.
3. The one end of the battery is labelled positive and the other end is negative. Draw a diagram of the battery and label the ends as positive or negative.

Part 2

1. Set up a new circuit with 2 batteries and 1 globe.
2. Explain how you connected the batteries so the globe still light up.
   Batteries had to be connected end to end, with the positive side of one battery touching the negative side of the other battery.
3. Did the globe glow brighter or dimmer than in experiment 1, or did it glow the same?
   brighter
4. Explain your answer to question 2.
   Two batteries contain more stored energy than 1 battery, more stored energy changes to more light energy
5. Describe an electric circuit.
   An electric circuit is a pathway that allows electricity to flow or a system that allows electrical energy to move.

If you have access to the internet, there is a wonderful site that allows you to build circuits and do experiments. Go to `goo.gl/jrGJ3` and see if you can build some circuits. Experiment to see how to make the globes burn brighter and dimmer.

Batteries are actually made up of smaller parts, known as cells, that store chemical energy. Two or more cells connected end to end are called a battery. We will mostly refer to them as batteries, but keep in mind that 'cell' is the scientific term for what most people call a battery in everyday life. One cell stores a small amount of energy. If we need to store a lot of energy we use a battery.

A car needs a lot of energy to start its engine. One cell does not have enough stored energy. Therefore, a car battery has six cells that are connected end to end inside the battery case. In this case, there is six times more energy stored in the battery than in a single cell. This gives the car enough energy to start the engine.

A car battery contains 6 cells.

Mmm... so a torch needs two batteries to light up. I wonder how many batteries are needed to light up our house?!

Good question Jojo! Let's find out in the next section.

2.2 Mains electricity

New Words

- transmission lines
- pylons

A battery has stored energy which can provide electrical energy. However, our homes, schools, shops, and factories cannot run on batteries. We use electricity for many different things every day. The main source of electrical energy is from power stations. We call this 'mains electricity'.

A power station

Power stations need a source of energy

Power stations use different ways to generate electricity. A power station needs a source of energy. In South Africa, most of our power stations burn coal to use the energy stored in coal to generate electricity.

VISIT

Electricity generation (video)

goo.gl/32irY

QUESTIONS

Coal is not the only source of energy for power stations, there are also other types of power stations. Find out what these are and write down what source of energy they each use.

Types of power stations include hydroelectric (water), geothermal (steam), and nuclear power stations (nuclear).

Electricity is transferred in a huge circuit to our homes

From a power station, electricity is transferred through transmission lines held up by pylons. The transmission lines are part of the circuit that connects the power stations to where we need to use the electricity.

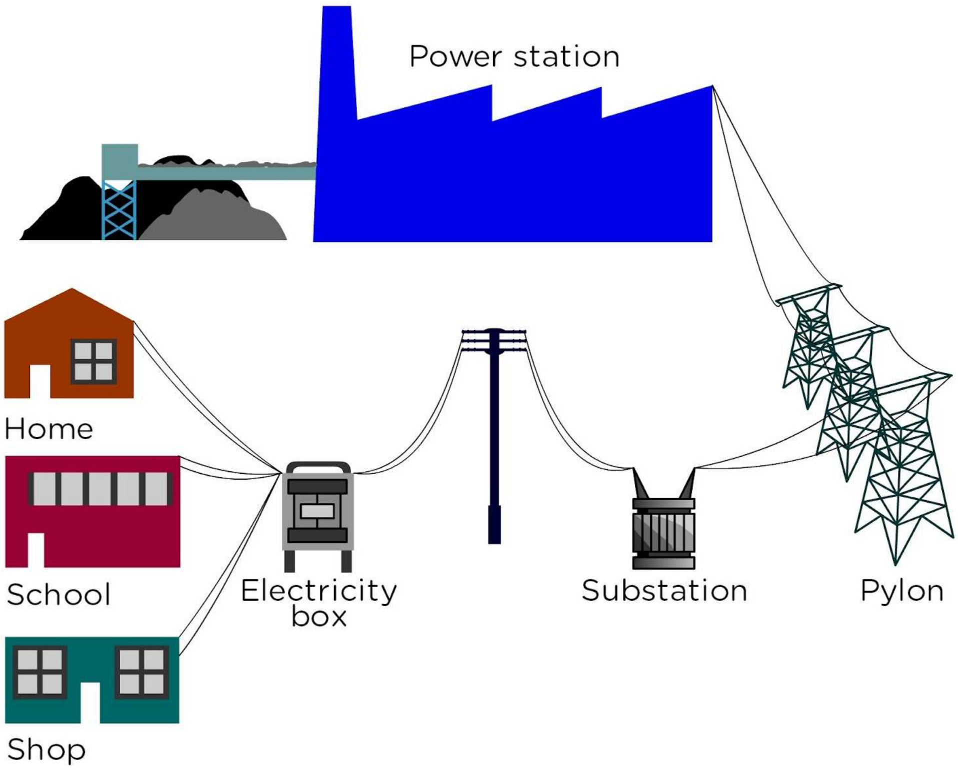
Do you remember learning about the structures of pylons in Gr. 4 in Matter and Materials? Remember they are made from triangular shapes and struts to make them strong and stable!

Huge pylons carrying the transmission lines across the country

Making electricity from coal (video) goo.gl/Hzu5V and goo.gl/scUhI

The transmission lines carry large amounts of electricity to substations in cities and towns.

From a substation, electricity is carried in smaller amounts to an electricity box for our home. From the electricity box, electricity travels through wires to the plug points and light fittings in our homes.



Transfer of energy from power stations to our homes, schools and shops

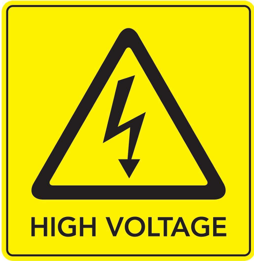
QUESTIONS

The above diagram shows how electricity is transferred from the power station to your home. Continue the diagram (use the space below) to draw the path of electricity once it is in your home and goes through the wires, wall socket and plugs to get to an appliance, such as the TV.

This is to assess the learner's ability to draw a flow diagram and translate words into pictures and text.

2.3 Safety and electricity

We use electricity every day. Electricity can be dangerous, so it is important that we use it safely. Electricity can give you an electric shock. An electric shock can hurt you badly or even kill you.



High voltage is very dangerous. Look out for warning signs like these!

VISIT

Interactive site about electricity

goo.gl/mrFiy

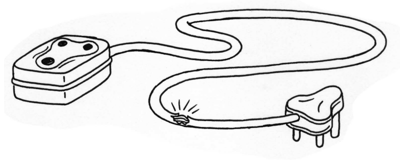
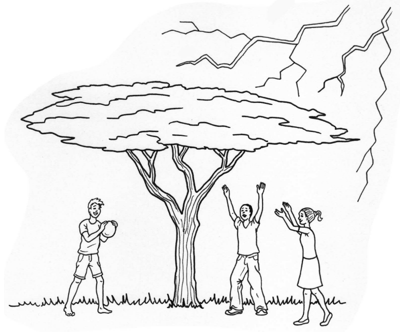
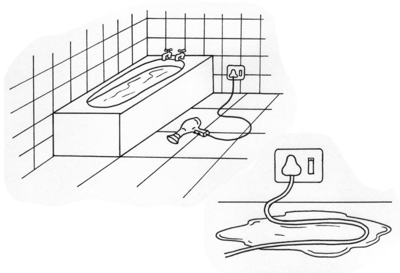
Electricity can cause fires and injuries, even death. Here are some rules for using electricity safely:

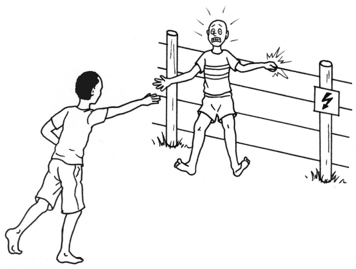
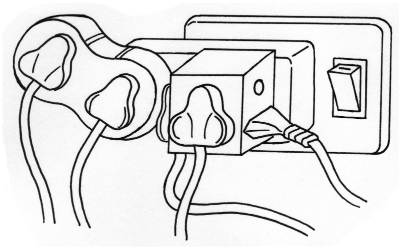
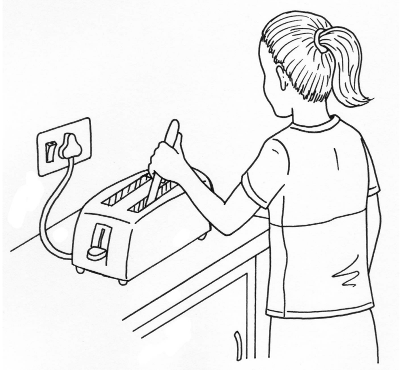
1. Do not put anything into an outlet except a plug.
2. Do not pull on the cord to unplug an appliance, hold the plug and pull.
3. Dry your hands before you plug in or unplug a cord.
4. If a plug is broken or a cord is cut or worn, do not use it.
5. Do not plug too many cords into one outlet.
6. Keep appliances away from water. Do not use a hair dryer if there is water nearby.
7. If there is an electrical storm (with lightning), turn off and disconnect electrical appliances, like the TV and computer.
8. Never touch any power lines.
9. Some power lines are buried underground. If you are digging and find a wire, do not touch it.
10. Do not fly a kite or climb a tree near a power line.

ACTIVITY: 10 Safety tips for electricity

INSTRUCTIONS:

1. Look at the pictures.
2. Each picture shows an INCORRECT use of electricity or electrical appliance.
3. Study the pictures and write a "Safety tip" for the situation in each picture.
4. The first example has been done for you.

Picture	Safety tip
	Never use an appliance that has a broken cord or has some of the metal wire showing through the cord casing.
	Do not play outside when there is thunder and lightning. If this powerful natural electricity strikes close to you, it will try to get to the ground through you!
	Never play near to or on electric fences or power lines. These have live electricity running through them so you can get a shock without even touching them!
	Never use electrical appliances outdoors in wet weather or if you are wet. Water conducts electricity well, so you WILL get a shock if you are touching an appliance and water drips into the socket, cord or motor. Wear closed shoes with rubber soles when using electrical appliances. Never use electrical appliances barefoot.
	Never use electrical appliances in the bathroom. Remember, electricity can flow through water.

	Electricity can flow from one person to the next. NEVER try to pull someone who is being shocked away from the appliance. you will get shocked too! Use a non plastic/non metal object to separate them from the electrical source.
	Never put lots of appliances into one socket. Too much electricity flowing to one plug is dangerous. One multi-plug adapter is safe, but do not put adapters into each other. Rather use 2 different plug points.
	Never stick a metal knife into a toaster while it is on. First turn the toaster off and unplug it and use a wooden or plastic knife. Beware, electricity can flow through metals.

KEY CONCEPTS

- Energy can be stored in cells and batteries.
- The cells or batteries are a source of electrical energy for an electric circuit.
- An electric circuit is a system that transfers electrical energy to where it is needed.
- A power station needs a source of energy.
- Electricity from the power station is transferred in a circuit to our homes.
- Electricity can be dangerous and needs to be used safely.

REVISION:

1. Why do torches need cells (batteries) to operate?
   Cells (battery) are a source of energy for the torch. Chemical energy is stored in the battery which is changed into electrical energy and then light energy as the light glows.
2. What is an electric circuit?
   An electric circuit is a pathway that allows electricity to flow or a system that allows electrical energy to move.
3. How is a battery different to a cell?
   a battery is two or more cells connected end to end
4. Draw a diagram of a simple circuit containing one cell and one bulb so that the globe will glow.
   diagram as in workbook
5. How is it possible that electricity that is generated at a power station, reaches a TV in a home that is far away from the power station? Describe how the energy is transferred from a power station to your home.
   Power station through transmission lines supported by pylons to substation. From substation through distribution lines to electricity box in your home. From electricity box through wires in our homes to plug points and lights and appliances.
6. When should you NOT handle electricity or electrical appliances?
   When you are barefoot, have wet hands or in the bathroom.
7. Choose the correct answer: If someone is being shocked by an electricity source, I should:
   a) Try to pull them away from the source of the electricity.
   b) Throw water on them to cool down the shock.
   c) Turn off the power source as quickly as possible then attend to them.
   d) Attend to them then turn off the power source as quickly as possible once they are safe.
   Answer: C
8. Give a reason for the following statement: 'Do not play under or near power lines or electric fences'.
   If the electricity fields are live, I can get shocked even if just standing close to the electrical source.

3 Energy and movement

KEY QUESTIONS

- How can stored energy be changed into movement energy?
- How can we make things move using stored energy?

This chapter is an introduction to stored (potential) energy and movement (kinetic energy). Although the proper terms are not used here, you could introduce them in class so that learners start to become familiar with these words for the later grades.

Do you remember in Gr. 4 when we looked at energy and movement in a system? We were mostly looking at musical instruments and how they use movement energy (the input) such as plucking or blowing to make them work.

In this chapter we are going to look some other ways of using stored energy to produce movement energy.

3.1 Elastics and springs

New Words

- catapult
- stretch
- compress
- store
- potential

Stretching an elastic band

QUESTIONS

Have you ever stretched an elastic band? When you pull it apart and then release it, what happens?

When you release the elastic band, it shoots back into position.

Wow, I wonder how far I could shoot this elastic!

When we stretch an elastic band, we store energy in it. This is because when the band is stretched, it can do work when you release it. We are going to look at some other ways of using stretched elastic bands to do work and produce movement.

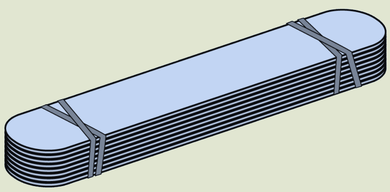
ACTIVITY: Making your own catapult

MATERIALS:

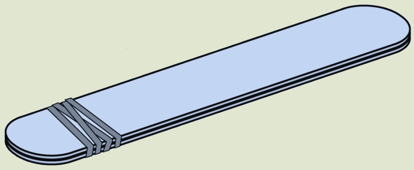
- 10 ice lolly sticks or craft sticks
- 4 to 6 rubber bands
- 1 plastic spoon
- bag of marshmallows

INSTRUCTIONS:

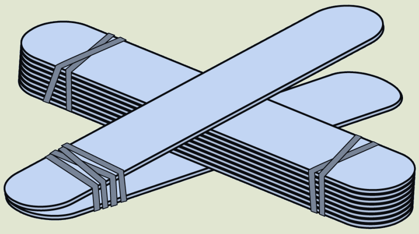
1. Place 8 of the sticks together and tie a rubber band tightly around one end.
2. Tie another elastic band around the other end so that the sticks are bound tightly.



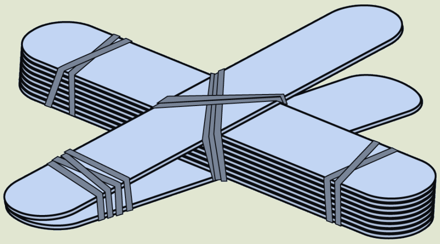
3. Tie a rubber band around the remaining 2 sticks, close to the one end.



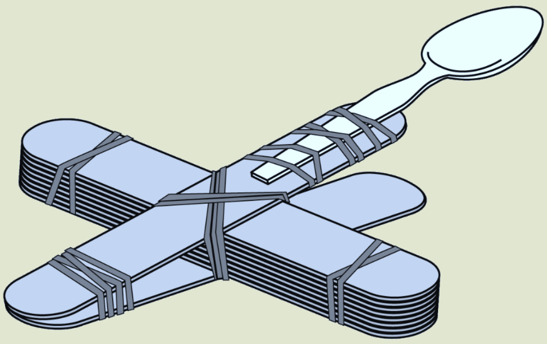
4. Insert the bundle of 8 sticks bound together through the 2 stick bundle. Look at the image below to see how to do this.



5. Tie another rubber band in a cross so that the two bundles are held in place, as shown below.



6. Use a rubber band to secure the plastic spoon on the end. You now have a simple catapult.



7. Shoot the marshmallows by placing one on the spoon, pulling down, and then releasing it.
8. Have a competition to see who can shoot marshmallows the furthest and the most accurate - can you hit a target?!

QUESTIONS:

1. How are you able to shoot a marshmallow closer or further away?
   Pulling the spoon down further will make the marshmallow shoot further.
2. When the marshmallow goes as far as possible, how much did the elastic band stretch compared to when the marshmallow didn't go far?
   The greater the stretch of the elastic band, the further the marshmallow went
3. Where did the movement energy of the marshmallow come from?
   Stored energy in stretched elastic

We saw in this activity that if you stretch an elastic band, you can produce movement. The stored energy in the band - when it is stretched - has the potential to do work. We call the stored energy in the elastic band potential energy because it has the potential to do something for us later. But what does the word potential mean?

QUESTIONS

Look up a definition for 'potential' in your dictionary.

Having the capacity to do or develop into something in the future. Synonyms are possibility/feasible.

A stretched elastic band can also produce movement and do work in the future when it is released.

Let's look at another way of using an elastic band to produce movement energy. Instead of stretching it, we can twist the elastic band.

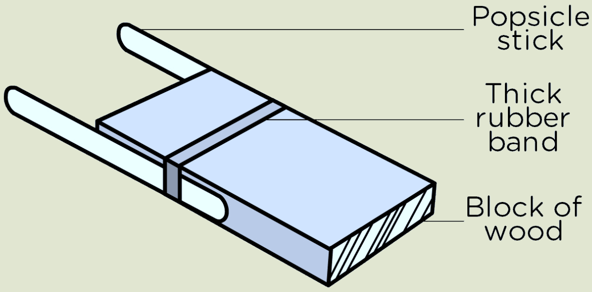
ACTIVITY: Build an elastic band powered boat

MATERIALS:

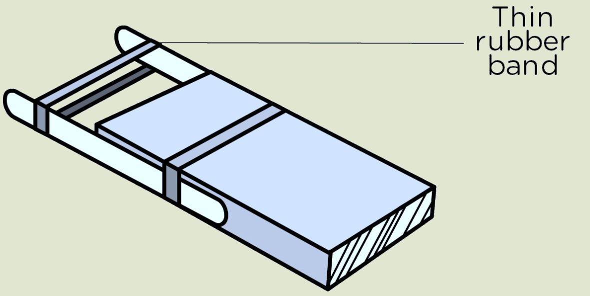
- rectangular wooden block (about 5 cm by 8 cm by 2 cm)
- 2 ice cream sticks
- 1 piece of plastic (6 cm by 2,5 cm cut from a plastic coffee tin lid)
- 1 large rubber band
- 1 small rubber band
- a tub of water to test your boat in

INSTRUCTIONS:

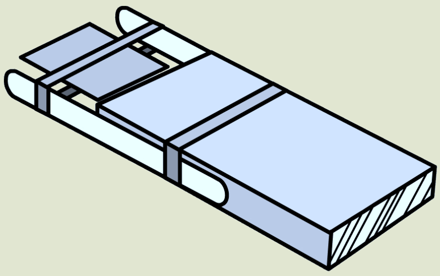
1. Secure the ice cream sticks flat against the sides of the wooden block with a thick rubber band, so that about $\frac{1}{4}$ to $\frac{1}{2}$ of each stick is extending out beyond the end of the block.



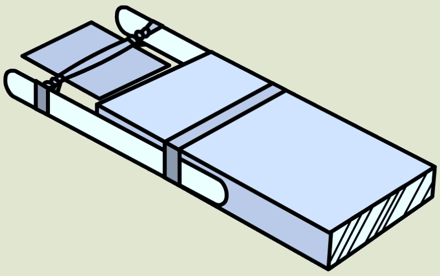
2. Place a thinner rubber band across the ends of the sticks.



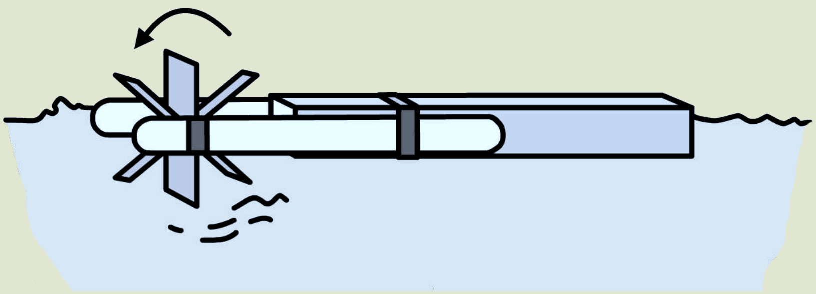
3. Slip the piece of plastic through the thin rubber band.



4. Turn the plastic to twist the rubber band.



5. Place it in the water, and let it go.



6. Challenge: Can you get your boat to move backwards and forwards?

QUESTIONS:

1. What is the purpose of twisting the elastic band?
   The purpose of twisting the elastic band is to store energy in it.
2. Why does the boat move? Use what you have learnt about potential energy and energy transfer to answer this question.

   Stored/potential energy in the elastic band is released in the form of movement energy and transferred to the piece of plastic, which in turn drives the boat.

3. How could you make the boat move in different directions (backwards and forwards)?
   Twist the piece of plastic in different directions. Twisting it towards the boat will make the boat move forwards, twisting it away from the boat will make it move backwards in the water.
4. Write down what you have learnt about energy from the last two activities that you have completed. Use words like movement energy and potential energy or stored energy.
   Elastic bands that are stretched or twisted store energy. The stored energy can be released as movement energy when the elastic band is released and returns to its normal shape.

VISIT

Slow motion slinky spring (video)

goo.gl/FwlFL

We have been looking at elastic bands and how they can be stretched or twisted to store energy to do work (to produce a movement). Springs can also be compressed or stretched to store energy.

A slinky is a metal coiled spring. When you stretch a slinky spring it stores energy. When the spring is released, the stored energy is changed into movement energy as it springs back into place.

A slinky is a spring. [1]

Springs can also be compressed to do work. To compress something means that you squash it! Look at the photo below of a child jumping on a pogo stick. This pogo stick works using a compressed spring.

This spring was stretched and when released it moved back. [2]

Jumping on a pogo stick [3]

QUESTIONS

Use your knowledge of springs to explain how a pogo stick works. Your answer must include the words 'compress', 'stored energy' and 'movement'.

When a child jumps on a pogo stick he compresses the spring (squashes it). The spring then has stored energy and releases back up and pushes the child up again. The stored energy from the compression is released and turned into a movement.

REVISION:

1. A jack-in-the-box is a fun toy. An object jumps out of a box when the lid is opened. Explain how it works.
   A compressed spring is under the object. When the lid is opened, the spring is released and the stored energy is changed into movement energy of the object.
2. Is a stretched elastic band an example of stored or released energy?
   stored energy
3. What else, besides stretching, can you do to an elastic band to give it stored energy?
   Twist it.
4. Think of some examples which you have experienced that use springs to store energy and write them down below.

KEY CONCEPTS

- Stored energy can be changed into movement energy.
- Energy can be stored in a stretched or twisted elastic band.
- Energy can be stored in compressed or stretched springs.

4 Systems for moving things

KEY QUESTIONS

- What is a wheel and axle system?
- What is the purpose of using wheels and axles?
- How can I make my own wheel and axle system?

Have you ever looked underneath a car? It looks very complicated and there are all sorts of pieces and parts, each with their own job to do. We are going to focus on two of the main parts in a vehicle which allow it to move.

There is no specified Technology Design Process in this chapter, but the focus is on Technology and systems. In Gr. 6 in Earth and Beyond, learners will follow a Design Process and design and make a car to move on the Moon or Mars. They will revise some of the concepts that they learnt here about wheels and axles.

4.1 Wheels and axles

New Words

- axle
- machine

All vehicles have wheels. Most cars have 4 wheels, while some have only 3 wheels, and yet others have many more. Trucks and buses have many wheels while some trailers or bicycles only have 2 wheels.

QUESTIONS

Why do you think wheels are round? Why will a square or a triangular wheel not work?

Wheels need to be round in order to roll. A square or triangle wheel will not roll.

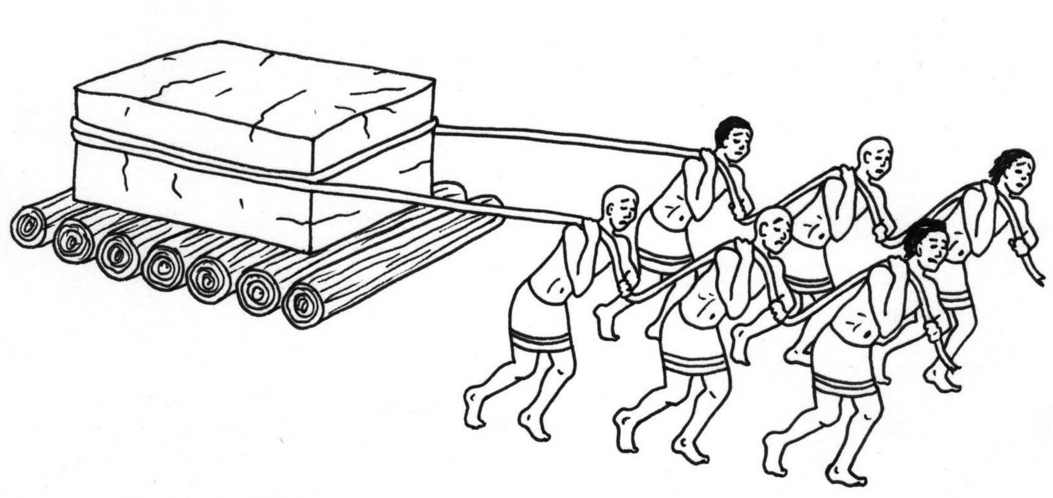
How did wheels and axles develop?

In the past, before the wheel was invented, it was very difficult to move things around. People would try to drag heaving objects along the ground using ropes, or else they had to carry things, but this was very inefficient! As a result, people started to experiment with ways of making it easier to transport goods and heavy objects.

The pyramids in Egypt were built long before modern transport (including trucks) was invented.

The pyramids are very high structures made of stone. [1]

The Egyptians were very clever in finding ways to move very heavy objects. They used logs that were laid down like in the picture. The heavy objects were placed on them, rolling them creating movement like in the picture.



Egyptians pulling heavy stone blocks along logs

You can demonstrate this by using pencils and placing a bunch of pencils next to each other. Then put a heavy object on top of the pencils and push it along. As the object moves the pencils underneath it move too.

The Egyptians used this method to move the massive blocks of stone to build their pyramids. But, there were still many problems with using logs cut from trees.

QUESTIONS

Can you think of any problems of using logs to try move very heavy objects? Discuss with your friends around you and write your answers below.

Logs not of the same size or length. Needed a lot of logs and then had to move logs as well.

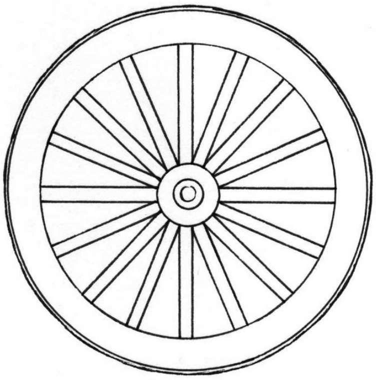
This can be demonstrated by using different shapes and sizes of pencils and pens.

Later on, people started to cut the logs into short pieces so that they were the same size. Each piece was like a wooden disc. The wooden disc could not stand up by itself so people attached a wooden pole between two of the wooden discs. The wooden pole was the first axle, and we still use axles to this day. That is how the first wheel and axle was developed!

DID YOU KNOW?

The first inflatable tyre was made of leather. Today they are made from rubber.

People could then balance goods on the axle and use this simple machine to pull or push objects along. However, this wooden disc wheel was still very heavy! To make it lighter, the wheel was changed to a round frame with spokes, like a wagon wheel. This made it much lighter and easier to move. Since then, the wheel has advanced a lot. Think of the shiny metal and rubber wheels you see on cars today!



A wagon wheel (left) and the modern rubber and metal rimmed wheel we have today (right)

How do wheels and axles help us?

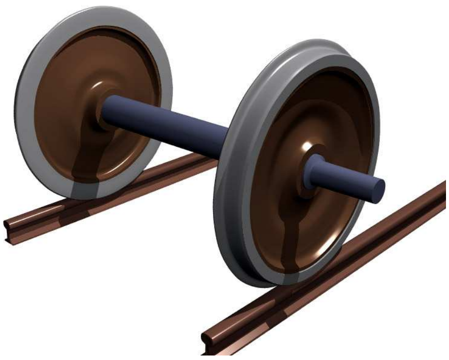
Humans have built many machines to help make their tasks easier. A wheel and axle is a simple machine. It makes it easier to move a load; to transport things and people.

It is much easier to move a heavy bag on a wheelbarrow rather than carry it by hand.

A wheel and axle is made up of a wheel (large cylinder) joined onto an axle (which is a small cylinder).

QUESTIONS

Label the two wheels and the axle in the following diagram.



Wheels and axle [2]

When we think of wheels and axles, we think of cars and other vehicles that we see all around us that have wheels.

VISIT

Wheels and axles (video)

goo.gl/LAvza

DID YOU KNOW?

The earliest record of a wheelbarrow comes from China in the Three Kingdoms period (AD 184-280).

A wagon wheel and axle [3]

However, there are many examples of objects and machines that use wheels and axles:

1. rolling pin,
2. windmill,
3. fan,
4. egg beater,
5. door knob, and
6. bicycle wheels.

ACTIVITY: Identifying vehicles with wheels

1. Find pictures of three of the above examples. Look in old magazines and newspapers at home, or on the internet for pictures. Paste the pictures in below and label the axle and the wheel in each picture.

2. Explain carefully how a door knob is a wheel and axle machine.

A door knob has a large cylinder on the outside, attached to a small cylinder on the inside. It is easier to turn the large cylinder than the small cylinder with your hands.

Let's make a simple wheel and axle mechanism to understand how it works.

ACTIVITY: A simple wheel and axle machine

MATERIALS:

- 2 chairs
- broom handle
- string
- bucket with handle
- masking tape
- scissors
- ruler

INSTRUCTIONS:

1. Place the chairs back to back, about 30 cm apart. Rest the broom handle across the back of the chairs.
2. Tie a 50 cm length of string to the bucket handle.
3. Tape the free end of the string to the middle of the broom handle.
4. Place a few marbles or some other light objects in the bucket.
5. Turn the broom handle with your hands to raise the bucket into the air. Turn it back the other way to return the bucket to the ground.
6. Tape the ruler straight up and down the broom handle near one end.
7. Use the ruler, which acts as a wheel, to turn the broom handle and lift the pail.

QUESTIONS:

1. Could you lift the bucket by turning the broom handle with your hands?
   Yes
2. Was it easier to lift the bucket when you turned the broom handle using the ruler?
   Yes
3. Replace the ruler with a stick that is longer than the ruler and use the stick to turn the broom. Was it easier to lift the bucket using the long stick?
   Yes, the longer the ruler or stick the easier it was to lift the bucket.
4. Identify the axle in the setup.
   The broom handle is the axle.
5. Identify the wheel in the setup.
   The ruler or long stick is the wheel.
6. Write a conclusion to summarise what you learnt in this activity.
   We could lift the bucket by turning the broom handle. It was much easier to lift the bucket when we used the ruler. Our hand had to move further when we used the ruler, but it was easier and the bucket felt lighter. We made a simple wheel and axle machine to make it easier to lift the bucket.

Now, let's put two axles and four wheels together to make a simple tractor!

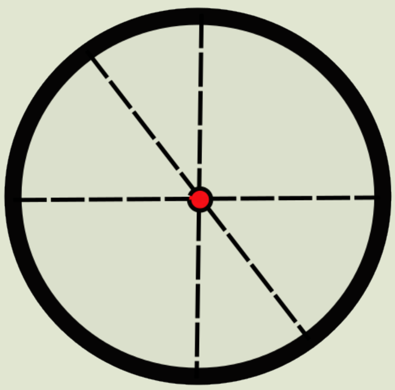
ACTIVITY: Making a trailer with wheels and axles

MATERIALS:

- cardboard
- two pencils
- a small box
- scissors

INSTRUCTIONS:

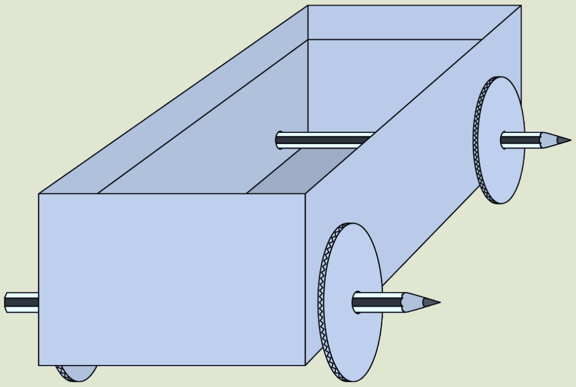
1. Cut out four circles of the same size from the cardboard. You can use a lid from a bottle or a cup to trace around to get circles which are all the same.
2. Make a hole in the centre of each circle and in the bottom 4 corners of your box.
   a) To find the centre of the wheel, use a ruler to draw diameter lines across the middle.
   b) A diameter line is the longest straight line you can draw across a circle. Where diameters cross, that is the centre.



A wheel is a circle. Find the centre by drawing some diameters. In this example the centre is the red dot.

3. Push a pencil through the middle of one circle and through a corner of the box.
4. Push the pencil through to the other hole on the other side of the box.

5. Then attach another circle on the end of the pencil poking out of the side of the box.
6. Repeat this for the other 2 wheels.
7. You know have a simple tractor like in the picture below.
8. Put an object in the box and push your vehicle along the floor.



QUESTIONS:

1. Can you see the wheels turning on the axle and how the axles connect the wheels?
   Yes
2. Which part of the vehicle that you made is the axle?
   The pencils are the axles.

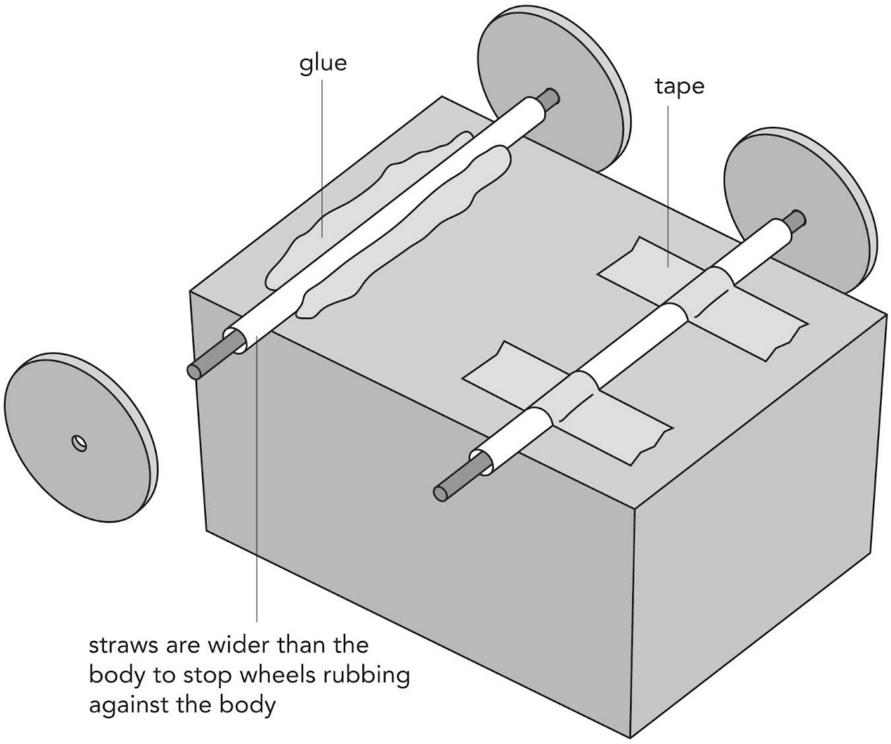
Different ways to make wheels and axles

This section shows different ways of making wheels and axles using materials which are easily obtainable. First go through some of the ways to make wheels and axles, and finally the last activity is to experiment with different materials and evaluate which set ups work best.

We are now going to experiment with different ways of making wheels and axles and finding out the best materials to use.

There are two ways to let wheels turn on an axle. One way is to have the axle fixed to the body, and the wheels are free to turn on the axle. The other way is to have the wheels fixed to the axle and the axle turns in a bigger tube called the bearing. The bearing is the hollow tube that the axle goes through. The bearing must be bigger than the axle so that the axle can turn easily.

You can use plastic straws or the barrel of an old ball-point pen to make a bearing for an axle. The picture shows you two ways to fix the bearings onto the body.

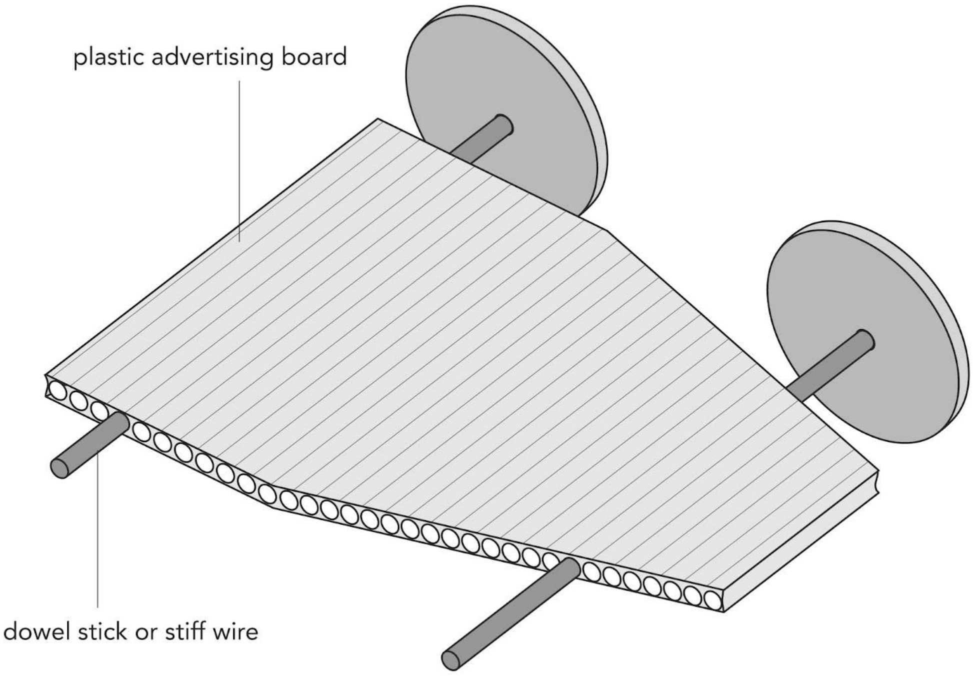


Two ways to fix the bearing onto the body

QUESTIONS

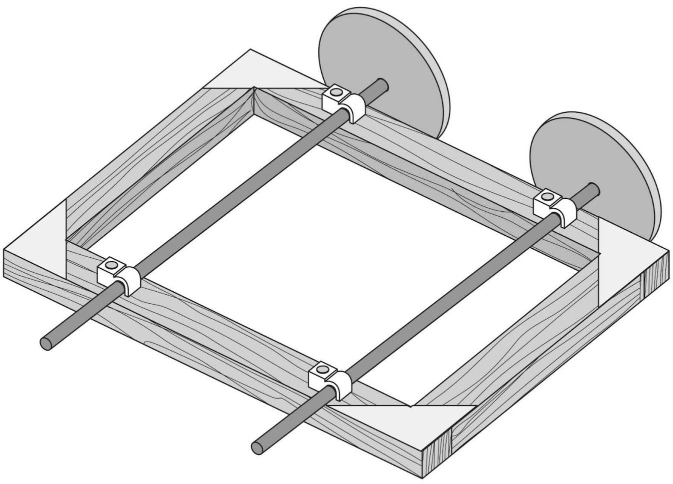
1. What are the two ways used in the picture to fix the bearing onto the body.
   tape and glue
2. What are some materials that you could use to make the axle in the above picture?
   Smaller straws, dowel sticks, sosatie sticks, etc.

You can also use plastic sign-board or strong corrugated cardboard to make a body with wheels. Can you see how the axle goes through the holes in the cardboard?

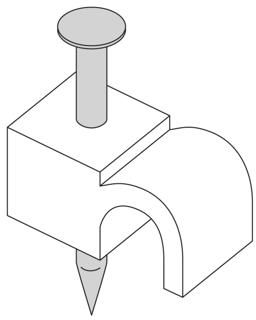


The board makes bearings for the axles which are fixed to the wheels. The axles turn in the holes.

The next picture shows you the other way to let the wheels turn. This time the axle remains fixed and the wheels turn on the axle. The axle is fastened to a wooden body with cable clips. Cable clips fasten telephone cables to walls. Can you see the blown up version of a cable clip? The clips may hold the axle tightly, so the wheels must be free to rotate.



How the cable clips can hold an axle



A clip to hold telephone cables to the wall

ACTIVITY: Making and evaluating different wheels and axles.

This activity does not follow a Technology Design process with all the steps, but does involve investigating, making and evaluating different objects to make wheels and axles and then using their best option to make an improved tractor from what they first made in the beginning of this chapter.. Ask learners to collect the materials for wheels and axles from home beforehand - tell them to also use their imaginations when looking for different materials to use. You will also need to supply some of the materials below.

MATERIALS:

Things you can use for wheels and axles.

- things to collect for wheels: shoe-polish tins, the lids of bottles, cut out cardboard circles.
- things to collect for axles: sosatie sticks, stiff plastic straws, wooden dowel sticks, aluminium rods, nails or wire, or the school may have plastic rods from a supplier.

- scissors
- glue
- tape
- pencils and crayons
- a small box

INSTRUCTIONS:

1. Bring the different materials that you have collected to make wheels and axles to class.
2. You must now experiment with the different materials that you have to make wheels and axles. Attach the setup to the small box to test the wheels and axles.
3. Remember what you learnt about how to attach axles to the box and experiment with these different methods as well (Hint: Bearings!)
4. Experiment with different sized wheels and find the best option.
5. Once you have tested and evaluated the different setups you have made to see whether they move easily, select the best option and make an improved tractor from the simple tractor you made at the beginning of this chapter with the pencils.
6. Evaluate how far your improved tractor can go if you give it a push with an object in the small box.

Set up a mini competition to see whose tractor can go the furthest after giving it one push and it is carrying an object (such as the board duster, or some other small, fairly light object). Use a tape measure to record how far each learner's tractor went.

QUESTIONS:

1. Make a drawing of your final design for your improved tractor in the space provided on the next page. Remember to label the different materials that you used.
2. Which material did you decide was the best to use for the wheels and why?
   Learner dependent answer. Make sure they provide a reason for the chosen material.
3. What did you decide to use for the axles and why?
   Learner dependent answer. Make sure they provide a reason for the chosen material.
4. How did you attach the wheels to the axle in your final design?
   Learner dependent answer
5. How far could your tractor travel (while carrying an object) after you gave it a push?

Learner dependent answer

6. How would you improve your design if you had to do it again?

This is a learner dependent answer but the teacher needs to check that learners evaluate their designs.

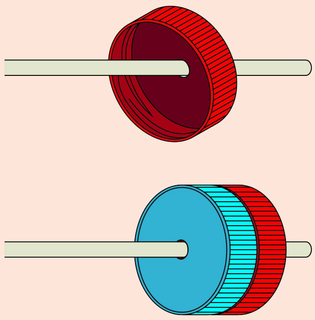
KEY CONCEPTS

- Many vehicles are machines that use wheels and axles.
- Wheels and axles are used to help vehicles move more easily.

REVISION:

1. Name four different vehicles that make use of wheels and axles in order to move.
   Car, truck, bicycle, pram, motor bike, trolley, etc.

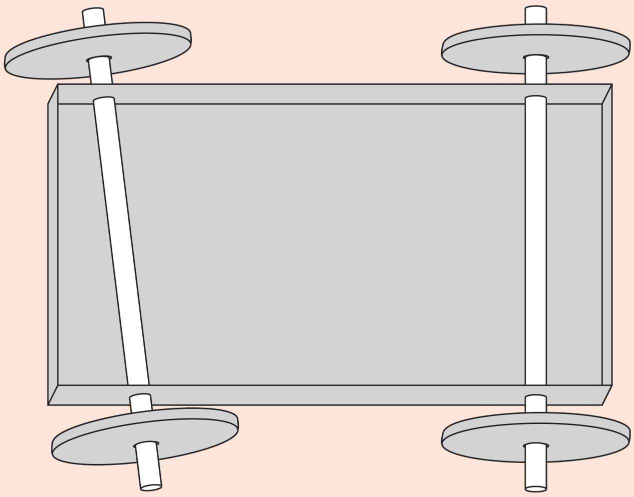
2. When Jojo was experimenting with making wheels, he decided to use bottle lids. Look at the picture below. He decided that glueing two lids together was better than one lid. Explain why you think Jojo did this.

   Jojo glued two lids together.

   Jojo did this because one lid was probably unstable and wobbled, whereas two lids are more stable and do not wobble.

3. When Jojo made the axles for his tractor, it looked like this underneath:

   The axles under Jojo's tractor

   What is wrong with these axles and how do you think the tractor will move? What should Jojo do to improve his design?

The one axle is skew which will make the tractor move in a curve to the one side. He should improve the design by making the axles parallel to each other and perpendicular to the side of the tractor. (Perhaps explain the words parallel and perpendicular to your class by drawing pictures on the board)

4. When looking to buy a pram, there are many different ones available. Some have big wheels and some have small wheels. Look at the pictures below.

This pram has small wheels. [4]

This pram has big wheels. [5]

When do you think it would be best to use a pram with small wheels and when would a pram with big wheels be used?
Small wheels - over smooth ground, in homes, shops, etc. Big wheels - over rougher ground, to move more easily, go faster

That's all for Energy and Change! I hope you enjoyed it. I sure did!


Earth and Beyond
and Systems and Control

1 Planet Earth

KEY QUESTIONS

- Why does the Sun appear to move across the sky?
- How long does it take the Earth to move around the Sun?
- How long does it take Earth to spin around once on its axis?

How to introduce this topic

Remind them of the lessons in the last term of Gr. 4, when they learnt about the Earth, Sun, Moon and planets. Use Figure 1 to start them thinking about what is on the surface of the Earth and under the surface of the Earth.

Start "**Activity: Begin to make soil"** (making compost), in the first week of the term, because the compost needs time to break down You need compost out of the column by week 3 or week 4.

You will need a globe in the classroom and atlases that show South Africa in large enough scale to find names of towns. The cognitive development issue is that children need the ability to move mentally from the physical place where they are to another place on the planet, and that means being able to handle models of those places in the form of globes and maps. Also read through all the "What you will need" sections today, because some of the things take time to collect. The learners can help with collecting many of the items you will need.

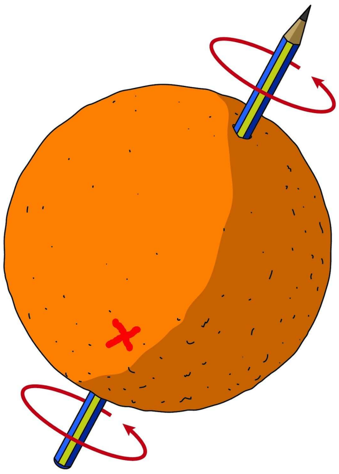
1.1 The Earth moves

In Gr. 4 we learnt that the Earth moves in two different ways. The Earth orbits the Sun and the Earth also spins on its own axis. Let's revise these concepts again.

The Earth spins on its axis, and so we have day and night

You learnt that the Earth spins on its axis. But what does this mean? Imagine an orange with a pencil stuck through it. Look at the following picture. If you hold the pencil in your fingers, you can spin the orange around. The pencil is the axis of the orange.

The Earth does not really have a pencil through it, but it does spin around. We can imagine a big pencil through the middle of the Earth.



The Earth is like the orange and the pencil is like the axis.
The curved arrows show which way the Earth spins.

New Words

- orbit
- axis
- Space
- planet
- circle
- path
- plane
- diameter
- kilometre (km)

We are on the Earth. Let us imagine we are at the point where you see the red "X" on the orange:

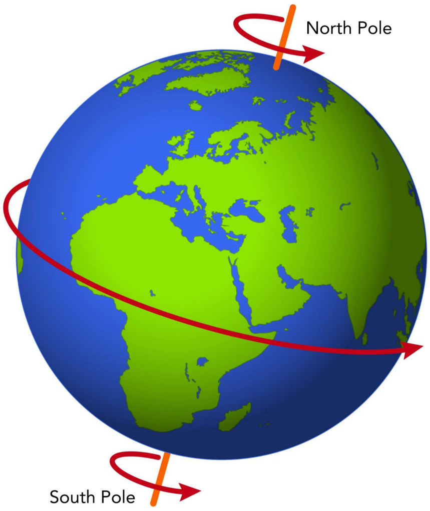
Use an orange and do this as a demonstration. You can set up a mirror or a big sheet of white paper, outside, to shine the Sun into the classroom.

- The Sun shines on the Earth and so we, at **X**, see the Sun. We call that daytime.
- But the Earth never stops spinning. So we, at **X**, move around into the shaded part of the Earth. Then we cannot see the Sun any longer and it is nighttime for us at **X**.
- The Earth spins right around in 24 hours, so it will take 24 hours for us to come around to the same position you see in the picture.
- We call the 24 hours a day. When we say "a day" we really mean a day and night; together they last 24 hours.

VISIT

Planet Earth (video)
goo.gl/aqaDr

If we are at position **X**, we move past the Sun. But to us, it looks as if the Sun is moving. The Sun seems to move from the East to the West. The Sun seems to come up (rise) in the East, move across the sky during the day and go down (set) in the West. The Sun does not actually move.



The Earth has an axis from the North to the South pole.

ACTIVITY: Who is having daytime?

What you need:

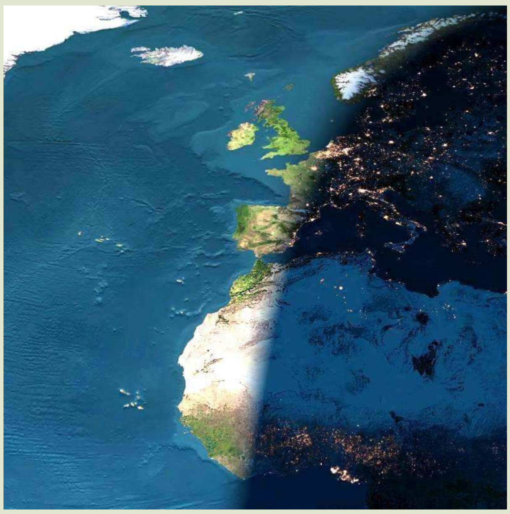
- a globe of the Earth
- the photographs of the Earth labelled Picture A and Picture B

A globe is a model of the Earth.

INSTRUCTIONS:

1. There are two images of the Earth.
2. Look carefully at these pictures and use them and the globe to answer the questions.

Picture A



Picture B

QUESTIONS:

Picture A

1. You are in South Africa. Find South Africa on the globe.
2. Find South Africa in **Picture A.**
3. Was it daytime in South Africa, when the spacecraft took the photo?
   Yes, the Sun is shining on South Africa.
4. Was is daytime in Saudi Arabia? Hint: Use your globe to find Saudi Arabia and then find it in **Picture A** to see if it is day or night.
   Yes, there is sunshine on Saudi Arabia.
5. Was it day time in Argentina when this photograph was taken? Use the globe to help you locate Argentina. Explain your answer.
   No, it was night time in Argentina; in the photo, Argentina is on the darkened side of the Earth, and there are lights showing.
6. Now use the globe to locate Brazil. In Picture A, the tip of Brazil is in the sunlight. Is it morning or afternoon in Brazil? Why?
   It is morning, because Argentina is moving towards the east and into the part of the Earth that is in the light.

Picture B

1. Look at Picture B. What part of the Earth is this picture showing?
   Europe and the top of Africa is shown.
2. Can you see the lights on in Italy? When it is dark in Italy, is it still light in Spain?
   Yes
3. Is it late afternoon or morning in Spain in Picture B?
   It is late afternoon.

Now that we have looked at some photographs of the Earth as it changes from day into night as the Earth rotates, let's make a model of Earth using our heads to explain this.

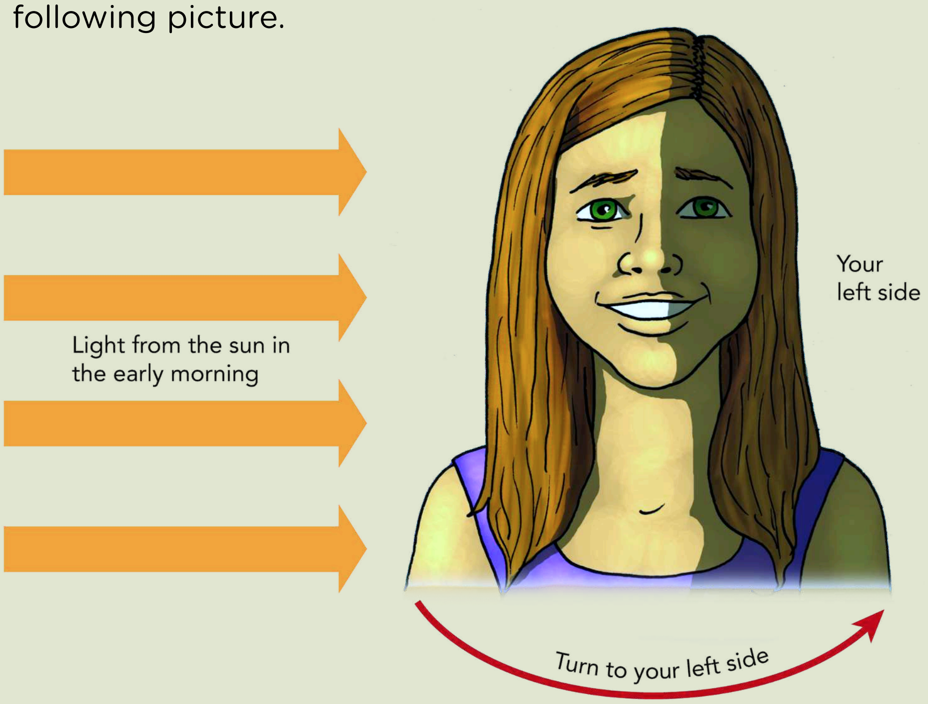
ACTIVITY: Your head can be a model of the Earth

MATERIALS:

- yourself
- sunlight coming from one side

INSTRUCTIONS:

1. This model will help you to understand why we see the Sun move across the sky. Do this in the early morning when the Sun is still low.
2. Let's say that your nose represents Africa. Have a look at the following picture.



Using your head as a model of the Earth

3. Stand so that bright light from the Sun shines across your right cheek.
4. Turn slowly to your **left**. Turn your eyes towards the bright place where the Sun is. You will see the Sun move to your right while you move to the left.
5. Move your feet and turn further; you will see the Sun "go down" over your right cheek.
6. When you have turned your back to the Sun, you cannot see the bright light any more. That is like nighttime in Africa.
7. Turn further to your left and you will see the Sun 'rise' over your left cheek. That is like sunrise in Africa.

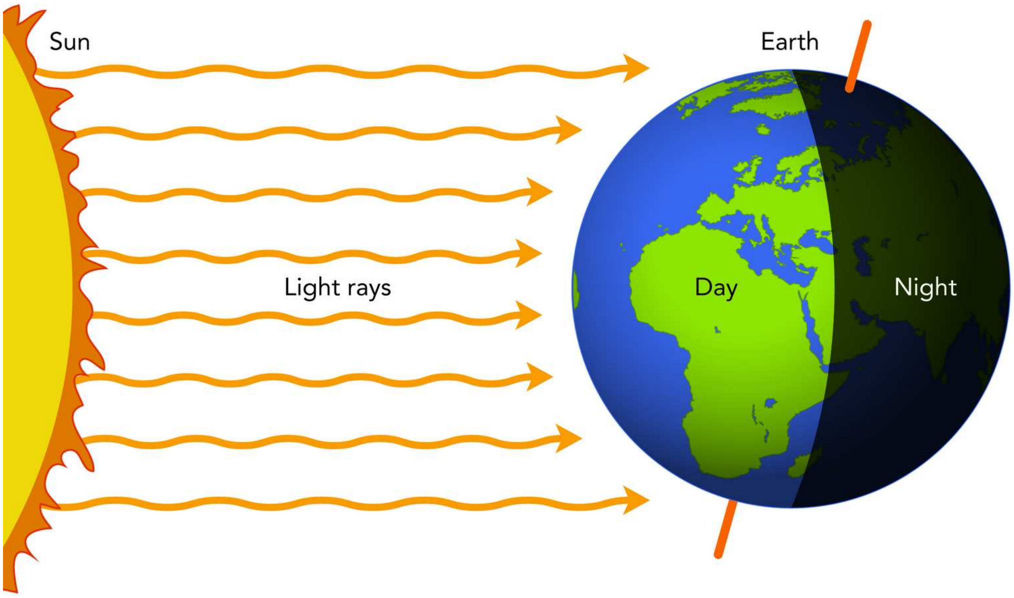
Teacher note: They must move their whole bodies round, not just their heads!

QUESTIONS:

1. Which of your cheeks (left or right) represents west? That is where the Sun appears to go down.
The learner's right cheek; that is where she saw the Sun disappear.

2. Which cheek represents east, where the Sun comes up?
   Their left cheeks are like the east. You can chalk an "E" on their left cheeks to remind them.

We see the Sun rise and move across the sky every day, but the Sun does not really move. It only seems that way to us. Actually, Earth is spinning around and around, and we are moving around with the Earth. The Earth takes 24 hours to complete one full rotation.



Can you see how the light from the Sun only reaches one half of the Earth as it rotates?

The Earth moves in an orbit around the Sun

The Earth moves around the Sun. While the Earth orbits the Sun, it is also spinning on its own axis. It spins round 365 times while it completes one orbit of the Sun. That means 365 days pass and we call that a year.

VISIT

Short video showing the Sun, Earth and Moon system

goo.gl/cXeog

The Earth is a planet. There are 7 other planets also moving around the Sun. You can see one of the other planets on most evenings, or early in the morning. This planet is called Venus or *iKhwezi* or *Naledi ya Masa*. It is not a star.

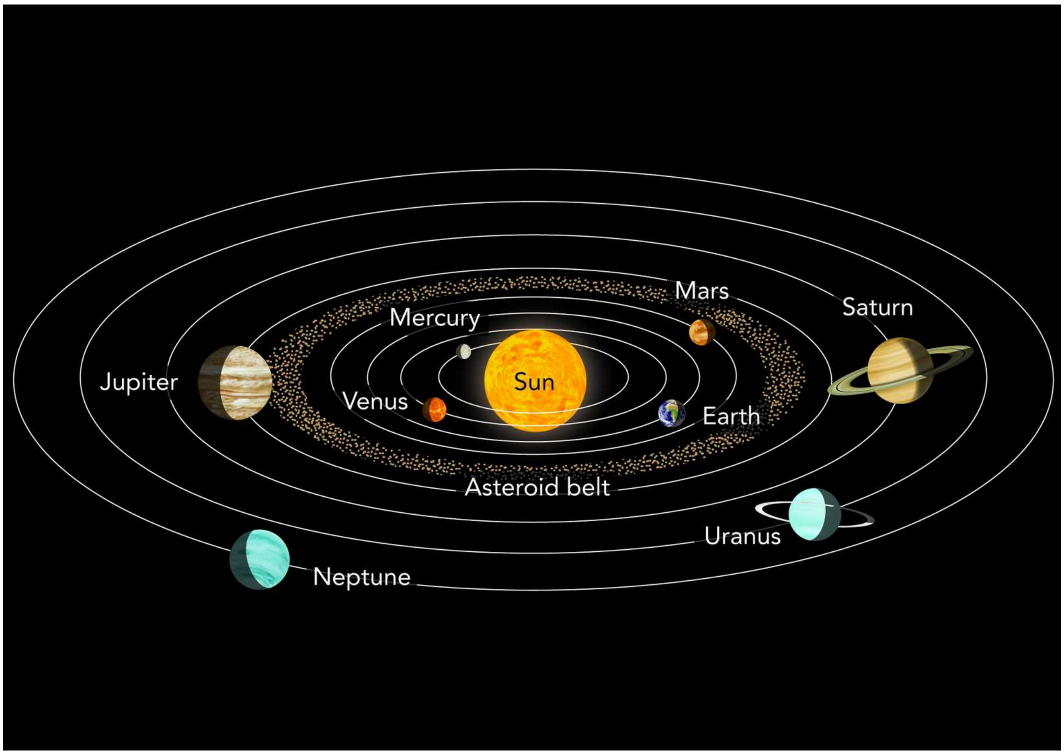
Venus also moves around the Sun but its orbit is a smaller circle than Earth's orbit. Venus takes 225 Earth days to go once around the Sun.

You can see the planet Venus just after sunset or just before sunrise below the Moon.

The days referred to here are Earth days; Venus has its own day-length but it's very much longer than an Earth day.

Mars is another planet you can see on some nights. Mars appears as a small, orange dot in the sky. Mars takes 687 Earth days to go once around the Sun.

You can also see Mercury, Jupiter and Saturn in the sky, but they are harder to see than Venus and Mars. All the planets seem to move along the same path that the Sun and Moon seem to move.



The planets move in orbits around the Sun. The orbits lie on the same plane, as if they were on a big, flat plate.

Explain to learners using the picture above that all the planets lie on the same plane - as if they were all lying on a plate. The "plane" does not mean an aeroplane; it means a flat surface like the top of your table or a big flat plate. Also, make sure they understand the next concept of this diagram not being drawn to scale - the orbits of the outer 4 planets are much larger than shown here. But, this is difficult to represent using an image in a book as if it were to be drawn to scale, the outer rings would not fit on the page.

The orbits of the outer planets are actually much bigger than what is shown in this image. But, if we tried to draw the orbits to scale, they definitely would not fit on this page!

Let's make a scale model of the solar system using our bodies to understand what it means to orbit the Sun!

My model of the solar system is not to scale. If we want to make one to scale, we will need a really big area!

In the image of Sophie, her model of the solar system should have all planets on the same plane to be correct. Perhaps ask your learners what Sophie should do to make the model correct if they compare it to the previous diagram of the solar system? She can rotate the rings so that they all lie in the same plane.

ACTIVITY: A scale model of the solar system

This activity is useful to help learners understand the structure and scale of the solar system, especially how far apart the planets are from the Sun. The activity requires a large open space, such as a school field. The model only uses 9 learners at once, so swap the learners so that each one gets a chance to be one of the celestial bodies. The teacher can be the Sun in the middle and the learners can be divided into 8 groups, each group assigned to a planet. The teacher should note that as each learner/planet revolves around the Sun, he/she also rotates! This is even trickier to get right, but let the learners attempt to do so.

MATERIALS:

- 100 m heavy string
- 9 pieces of heavy cardboard
- scissors
- permanent marker

INSTRUCTIONS:

1. Learners are divided up into 8 groups and each group is assigned a planet.
2. Each group must cut a piece of string to represent the distance of their planet from the Sun, using the lengths indicated in the table below. The actual distance of the planets from the Sun is given in millions of kilometres and the length of the string is in metres (m). 1 million kilometres is known as 1 gigametre (Gm). 1 kilometre is 1000 metres. Therefore, 1 gigametre is 1 000 000 000 metres.

Planet	Distance from Sun (millions of km)	Length of string (m)
Mercury	58	0.4
Venus	108	0.7
Earth	150	1.0
Mars	228	1.5
Jupiter	779	5.2
Saturn	1 434	9.6
Uranus	2 873	19.2
Neptune	4 495	30.0

3. Each group must cut a circle out of cardboard and write the name of their planet and the actual distance from the Sun on it.
4. Make a hole at one edge of the cardboard and tie the length of string to it.
5. Now it is time to go outside to a big open space, like the school field!
6. Your teacher will be the Sun in the centre. She does not move because the Sun does not move.
7. One member from each group must hand the 'Sun' the end of their length of string and then stretch out their length of string.

8. Do this one at a time starting from Mercury and going out to Neptune. you do not all need to be in a straight line but can be in different positions around the 'Sun'.
9. Place the strings on the ground, all stretched out in different directions.
10. Walk around so that you can all see the scale model of the solar system.

Explain to learners that on this scale, the nearest star (other than the Sun), would still be 2748 km away!

11. Now comes the tricky part - making the planets orbit the Sun.
12. Select one learner from each group to be the planet.
13. He/she must pick up the planet and walk in a circle around your teacher, all going in the same direction. Try and walk at the same speed.

Hold all the ends of the strings in one hand above your head so that you are like a maypole and the learners will revolve around you.

14. Swap with other learners in your group so that you each have a turn to be a planet orbiting the Sun.

Make sure to point out to learners about the length of time it takes each learner to orbit the Sun. When Neptune has completed one revolution, Mercury will have completed many more as it is closer to the Sun. Point out the big gap between Mars and Jupiter - the space between the inner and outer planets. Mention to learners that there is actually a ring of asteroids (giant rocks) that also orbit the Sun in this space.

KEY CONCEPTS

- The Earth spins on its axis. This is the reason we have day and night.
- The Earth also moves through Space, around the Sun.
- The Earth's path through Space around the Sun is called its orbit.

REVISION:

1. How many hours are there in a day?
   24 hours
2. How many hours pass from sunrise until the next sunrise?
   24 hours
3. How many days pass between your 10th birthday and your 11th birthday?
   365 days
   Teacher note: The answer is actually $365\frac{1}{4}$ days. When a day is defined in terms of the spinning of the Earth learners will be able to appreciate the quarter of a day as well, and thus an 'extra' day during leap year. '365 days' makes things manageable only for short term.
4. How many times must the Earth spin around between your birthdays?
   365 times
5. Which planets have smaller orbits than Earth?
   Mercury and Venus.
6. Write out the whole paragraph and complete it using some of the words/phrases in the word box. You do not need all the words/phrases.

   Word box:
   - the orbit of Mars
   - the orbit of the Earth
   - 687 Earth days
   - 365 days
   - Sun
   - Earth

   If I lived on Mars, I would have to wait much longer for my birthday. The reason is that __________ is much bigger than __________, and Mars takes __________ to go around the __________ once.
   *If I lived on Mars, I would have to wait much longer for my birthday. The reason is that **the orbit of Mars** is much bigger than **the orbit of the Earth**, and Mars takes **687 days** to go around the **Sun** once.*

Let's find out more about our planet Earth!

2 Surface of the Earth

KEY QUESTIONS

- What would you find if you could dig a very deep hole?
- Where does soil come from?
- If you were going to buy a farm, what kind of soil would you look for?

Chapter 2 deals with the rocky crust of the Earth; we aim to teach the children where soil comes from: soil is broken-down rock plus organic matter from plants and animals. However, we can't just teach about the crust because that would leave a hanging question - the crust of what? So we spend a little time looking at what the crust is covering, and so we look at the structure of the Earth.

2.1 Rocks

QUESTIONS

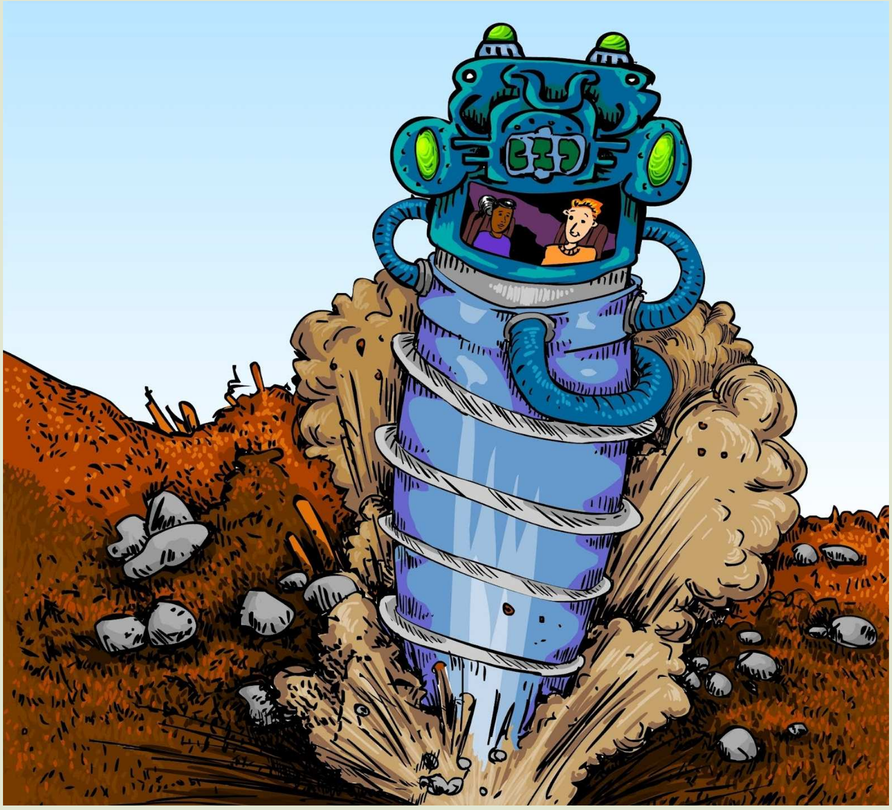
1. You saw the photo of the Earth in at the beginning of Chapter 1. What is on the surface of the Earth? Name all the features (parts) you can think of.
   Answers may include land, sea, forests, rivers, deserts, air, clouds. Learners may correctly include animals and people although they cannot see them in the picture.
2. What do you think is under the surface?
   Answers may include soil, rocks, mines, bones, roots, drainpipes, and many more. Encourage them to think of as many ideas as they can.

New Words

- crust
- mantle
- core
- model

ACTIVITY: What will you find if you dig a hole, as deep as it can go?

Look at the picture of a digging machine and imagine you are driving it.



Imagine that you have a powerful digging machine.

The purpose of this drawing task is to make learners grapple with the idea that they are on a ball-shaped Earth. Most learners have no problem with saying that the Earth is shaped like a ball and most have seen pictures of the ball-shaped Earth like **Figure 1**. However, this concept is not easy to think about when you are actually standing on the ball. So the question, "what would you find if you could dig a hole right through the ball?", makes them move mentally between the ground they can see and the view of the ball-shaped Earth as seen from Space.

DID YOU KNOW?

Geomorphology is the study of the Earth's surface features. If you break the word up it is easier to understand: geo- (earth), -morph- (shape), -ology (study of).

QUESTIONS:

1. What is under the floor of your classroom?
   This question is for discussion.
2. Imagine that you use the machine to dig as deep as you want. You drive it down into the Earth. What do you find as you go down?
   Let the learners discuss this before they write. If they cannot write, let them draw pictures of what they think they will find under the Earth.
3. Make a drawing of yourself, the digging machine and the hole. In your drawing, show (a) the Earth (b) the digging machine with you inside (c) the hole (d) what you find at the deepest part of the hole.

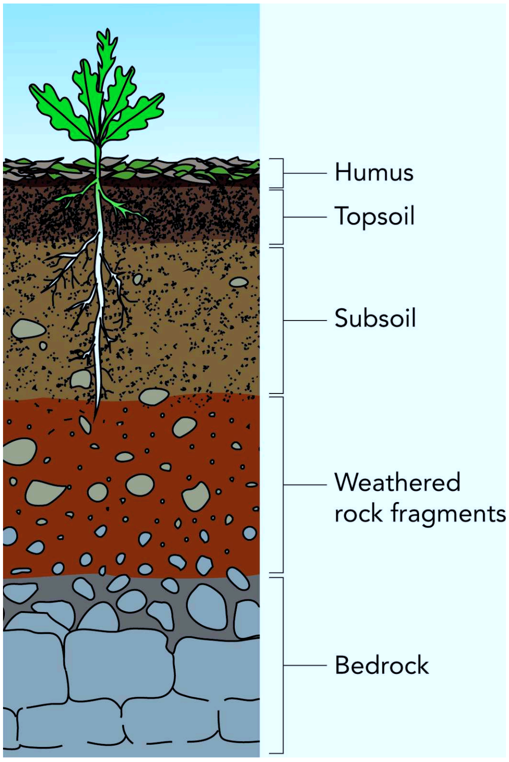
Give the learners enough time to think while they make their drawings.
Look at the learners' drawings but do not correct them. If you give them the right answer, you will stop them thinking about the problem. At the end of the chapter they will get a chance to change their ideas - see Activity: So what is under our feet?
Some learners' drawings might show the hole going down through soil and rocks and underground water and volcanoes. Other learners' drawings might not show any of these things; it depends on how much general knowledge they have by Gr. 5. Correctness does not matter at this stage: we are raising their curiosity by asking the question "what is deep down under our feet?"
If they are thinking about that question, then the next section will make more sense to them.

DID YOU KNOW?

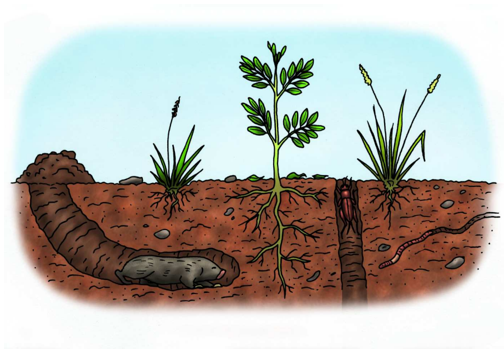
The deepest mines in the world are in South Africa, in Gauteng. Those mines are 4 kilometres deep and the miners are digging deeper every month.

So what do we find as we dig deeper?

When we begin to dig, we first dig though topsoil. Good topsoil is usually a dark colour.



Topsoil is usually darker than the soil underneath.



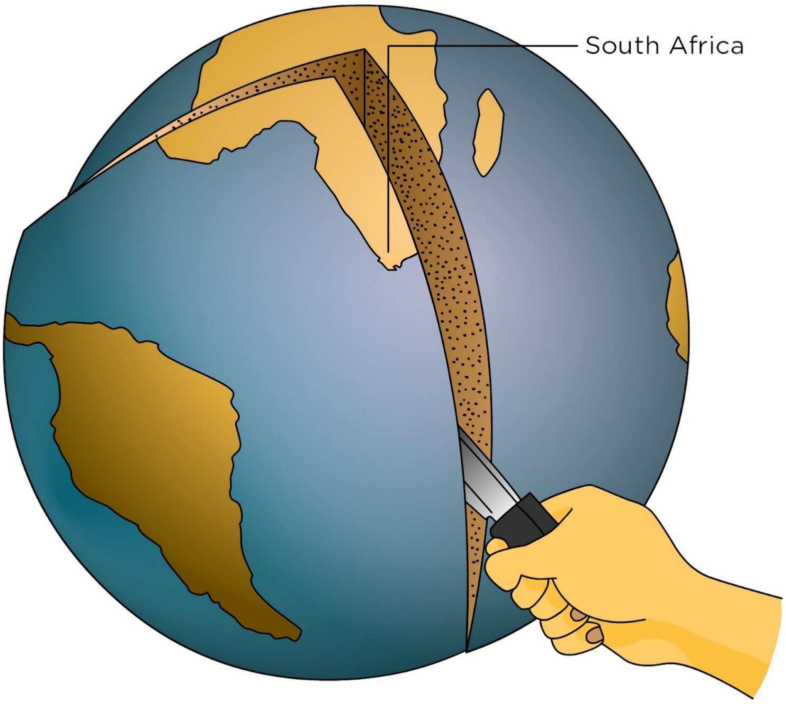
Plants and animals depend on topsoil.

Topsoil is very important for life. As you can see in the picture, plants and animals depend on topsoil.

If we dig deeper, we find subsoil. This layer is often sandy and orange in colour. When we dig even deeper, we come to rock. this layer of rock underneath the soil is called bedrock. Look at the illustration and find the topsoil. Find the subsoil underneath the topsoil and the bedrock at the bottom.

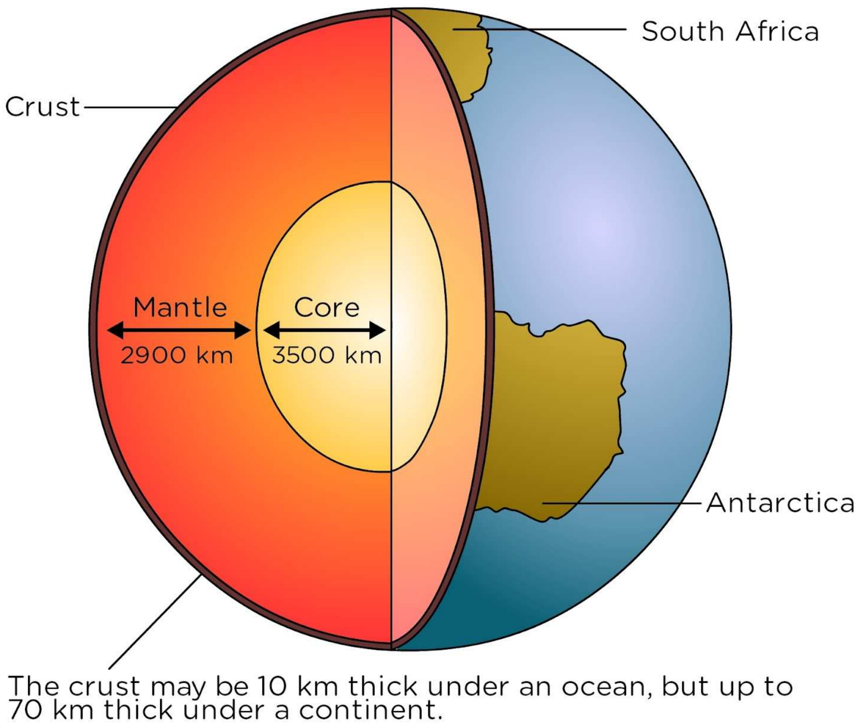
When we dig through the rock, a few hundred metres deep, we may find different layers of rock. We may even find water in cracks in the rock in some places. We may find coal in a few places.

Deeper down, about a kilometre deep, we may find oil and gas. Still deeper, we will find very hard rock which will feel hot to touch. In very few places in Gauteng and the Free State, we will find rock that has gold in it. Look at the following picture. Can you see a hand cutting a slice out of the Earth?



Imagine we could cut a slice out of the Earth.

In the next picture you see what the Earth is like inside.



If we cut the slice out of the Earth, the Earth could look like this inside.

VISIT

Video showing the structure of the Earth

goo.gl/YXUFE

The surface of the Earth is the crust

People have not really explored deep into the Earth. We live on the rock that is called the crust of the Earth. The crust is the outer layer of the Earth's surface. Find the crust in the previous diagram. The crust consists of rock and soil.

The Earth's crust is about 70 km thick. Humans have only dug as far as 5 kilometres deep, which is not very far at all! If you look at the diagram of the Earth, you cannot even see the hole in the crust because it is so small.

Miners in the deep gold mines work under very hot conditions. The deeper they go, the hotter the rocks around them are.[1]

Does the crust also extend beneath the sea? Look at the rocks and sea in the following picture.

This is where the ocean meets the land. Does the land go under the ocean? [2]

QUESTIONS

1. If you dig a hole in the beach sand, what will you find if you dig very deep?
   You will find rocks, if you dig deep enough. Children who have dug holes in sand will also tell you that sea water flows through the sand and flows into the hole.
2. If you went down under the sea water, to the bottom of the sea, what would you find down there? Explain what surface you expect to find. Will it be sandy, or rocky, or could you find mud down there? Do you expect to find different layers?
   Sand near the beach, but further out to sea you find fine mud and under it you find rock.

Far out to sea, far from the beach, the water is very deep. The sea may be many kilometres deep.

It must be such an interesting world in the depths of the oceans. I wonder what it is like?!

The deepest part of the sea is called the Marianas Trench. It is near the Marianas Islands, south of Japan. You can find this place on the classroom globe or a map. The deepest part of all the oceans is here. It is a trench (like a valley with steep sides) that is 11 kilometres deep. In fact, the trench is so deep that the light from the Sun cannot reach the bottom, leaving it pitch-dark. The water presses down with a pressure that is like the weight of three buses pressing on your thumbnail!

Three scientists have gone down there in small submarines, and taken pictures and collected rocks. The submarines had bright lights, and the scientists were amazed when they saw animals that live down there. You can see an animal called an anemone in the next picture.

The people in the submarines saw anemones like this in the deepest part of the ocean. [3]

They found rocks that look like those in photograph. That means the Earth's crust rock lies under the oceans as well as under our feet. The crust is a layer of rock all around the Earth, like the shell of a hard-boiled egg.

The mantle and the core lie even deeper under the crust.

If we go deeper than the crust, we go into rock called the **mantle**. The mantle is the layer that lies underneath the crust. Mantle rock is much hotter than the rock that is found in the crust. The rocks are so hot that they are soft in some places, like toothpaste. The hot rock pushes upwards against the crust. Where there is a weak spot in the crust, the hot rock might burst through. This is how volcanoes erupt. The mantle is 2 900 km thick, so it is still a long way to go down to get to the core.

QUESTIONS

Find the mantle in the diagram of the Earth cut open. Mark it with your pencil. How could you get to the mantle? Which way do you have to go?

You would have to dig a very deep hole down into the centre of the Earth.

The core is still deeper than the mantle. It is very hot, as hot as the surface of the Sun, and made mostly of iron.

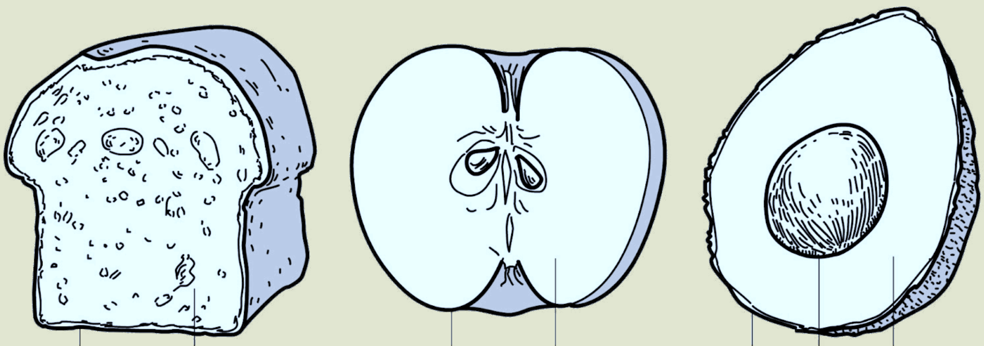
Iron melts at those temperatures, but the iron is being pressed so tightly by the mantle all around it that it cannot melt.

ACTIVITY: Thinking about the layers of the Earth

QUESTIONS:

1. What is the diameter of the Earth?
   Think of the Earth as a circle; then the diameter means the distance across the middle of the Earth. The diameter is 12 900 km. They can read this off the diagram.
2. The Earth is really a ball, so how deep can the hole be?
   Only 12 900 km, because after that the hole will come out of the other side of the Earth!
3. If the digging machine went as far as it can go, what is the last layer of the Earth that it would dig through?
   It will dig through the crust, but from underneath and then it will come out into the air.

4. Which is the best **model** of the Earth - a loaf of bread, an apple or an avocado? Look at the three pictures below. Which of those is most like the Earth? Explain your answer. Remember that the Earth has a **hard crust**, a **hot sticky mantle** and a **hot core**.



Three different possible models of the layers of Earth

The bread has a crust, but no core. The apple has a peel or skin and a core, but the core is not one solid thing. The avocado has a tough skin or peel, and a solid core, so it is quite a good model of the Earth.

5. Although the model you chose is most like the Earth, it is not exactly the same. In what way is this model not like the Earth?

One example is that the avocado pip is not hot, but the core of the Earth is very hot.

Soil, air, water and sunlight support life on Earth

Life on Earth exists on the very thin layer around the planet - the crust. The soil is a thin layer that forms the top part of the crust. Plants need soil to grow in. The plants also use energy from the Sun to grow, and they make the oxygen we and all the animals need to breathe. You already learnt about this in Life and Living.

ACTIVITY: So what is under our feet?

INSTRUCTIONS:

1. In the first activity at the beginning of this Chapter you drew pictures of yourself digging a hole into the Earth. You had to imagine you were making the hole as deep as possible.
2. Perhaps you feel your picture is correct, or perhaps you want to change your idea about the Earth.
3. Look at those pictures now, and do the activity again.

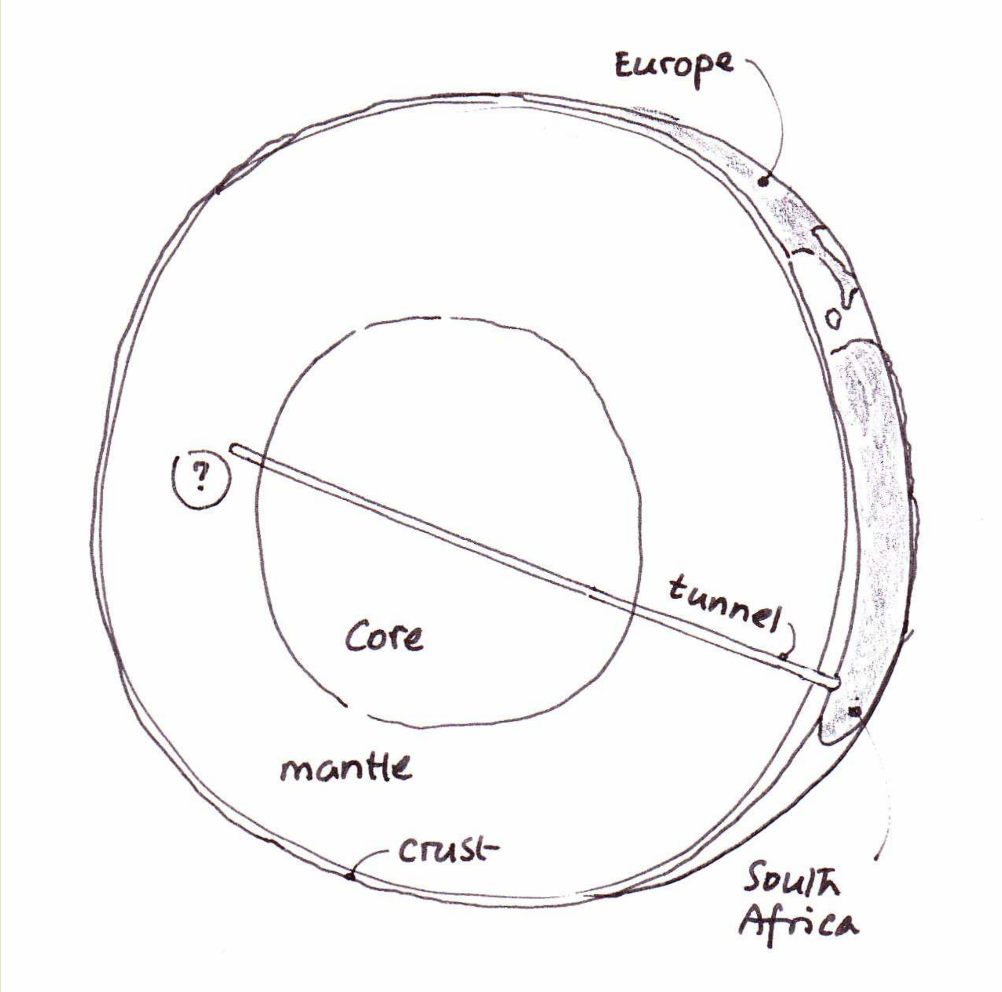
QUESTIONS:

1. If you could make a hole into the Earth, through the floor of your classroom, what would you find down in the Earth?
2. Imagine you have that machine that can dig as deep as you want. You drive this digging machine as far as it can go. What do you find?
3. Do a new drawing of yourself and the digging machine and the hole. Your drawing must show the hole that the machine makes if you let it go on until it cannot go further.

The hole will come to of the other side of the Earth.

4. Do you think about the Earth the same way you did when you started this chapter? Have you changed your ideas about the Earth?
5. Use the classroom globe to answer this question: If you dug a hole straight down into the Earth from South Africa, and went through the core of the Earth, where would the hole come out? Draw a picture in the space provided.

Answer: The hole would come out in the Pacific Ocean, near Hawaii, about 26 degrees north of the equator, and about 150 degrees west of the Greenwich meridian. Check this for yourself on your globe. Let the learners work with the globe until they solve this for themselves. However, they are not allowed to poke a pencil into the globe!



An example of the drawing learners should draw

This is what the hole would look like. Let the learners draw their own ideas before you draw this on the board

2.2 Soil comes from rocks

Rocks do not last for ever! They seem very hard and indestructible, but are they? Let's have a look.

ACTIVITY: Can hard things like rock and stone wear away?

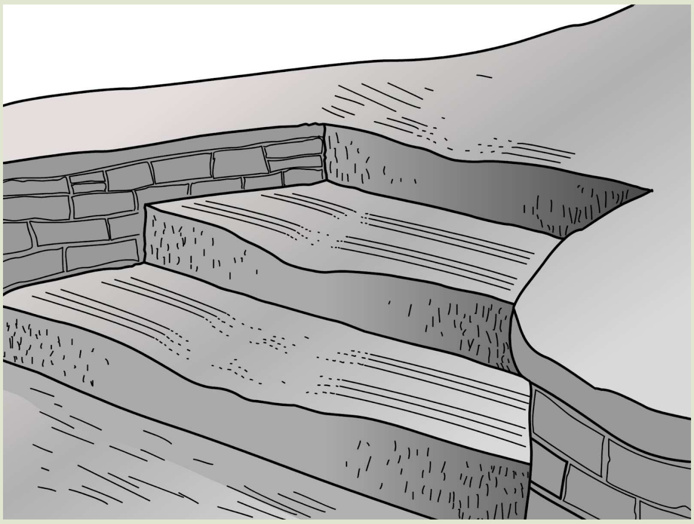
Stones are hard. People say that a thing that is made of stone will last for ever. But is this true?

MATERIALS:

- two stones or pieces of rocks
- a sheet of paper

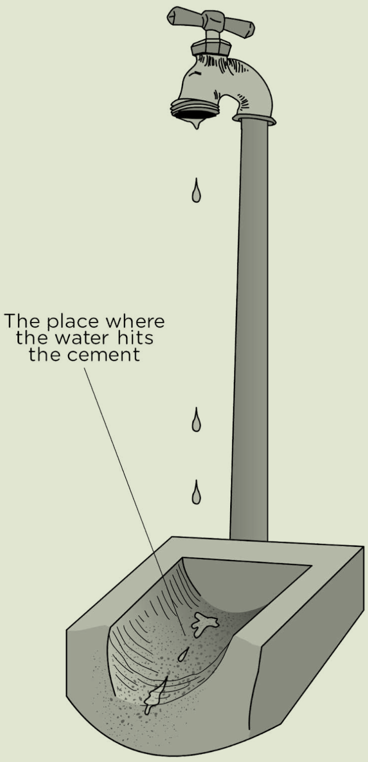
INSTRUCTIONS

1. Find a cement step that everyone at the school walks on. Sweep the step clean and then look carefully at the step.



Why are these steps wearing away?

2. Can you see where people put their feet? What has happened there?



3. Find a piece of cement under an outside tap. Look carefully at the cement, where the water falls on it. You might see that the cement is rougher just where the water hits it. The cement has lost little pieces.

New Words

- expand
- contract
- weathering
- surface
- microorganism

4. Find out how long the cement has been there. Perhaps it was put in when the school was built. So how many years did it take to wear away the cement?
   The learners have to find out when the school was built.
5. Find another object that is being worn away. Tomorrow, tell the class what you have found and write what it is below..
   The learners could report that they found a door edge; corner of building; pencil point; piece of board chalk; bottom of spoon; sole of shoe.
6. What do you think is wearing away the object?
   Many shoes wear away the step, or many shoulders that rub against the object. Or paper that the pencil rubs on wears away the pencil.
7. When a small bit breaks off the object, where do you think it goes?
   Learners may not have the idea that small bits break off. Find out whether they really think this.
8. Are the small bits still lying somewhere, do you think?
   If they do think of small pieces breaking off, learners may believe the pieces no longer exist. Here we are dealing with conservation of matter, which is a mental operation the learners must develop.
9. Now rub the two rocks together for three minutes. Let all the little pieces fall onto the paper. *Make a pile of the pieces and look carefully at them. They look like a pile of sand. You are changing the two rocks into sand!*

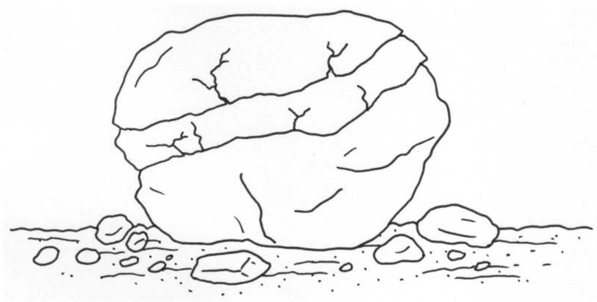
Rubbing rocks together to make sand

In nature, rocks turn into sand. But how does it happen?

Big rocks break up into smaller rocks

We know that we can break big stones into smaller stones. But when we see small stones lying on the ground, it is hard to think how they were broken up.

In nature, rocks break up in many ways. We will look at just three of those ways.



Can you see the cracks forming in this rock to make smaller and smaller pieces of rock?

DID YOU KNOW?

The volcanic rock known as pumice is the only rock that can float in water.

1. Bigger rocks break up into smaller rocks

Over time, rocks can get cracks in their surface. Water gets into the cracks and causes these cracks to get bigger. Pieces of rock then break off when the cracks get bigger. Smaller and smaller pieces of rock form as the rocks breakup more and more.

VISIT

Rocks erode to form soil (video).

goo.gl/6Rd6D

2. Water breaks up the surface of rocks

Soil contains a little water. The roots of plants can change this water so that the water becomes an acid. Vinegar is an example of an acid that we use in our everyday lives.

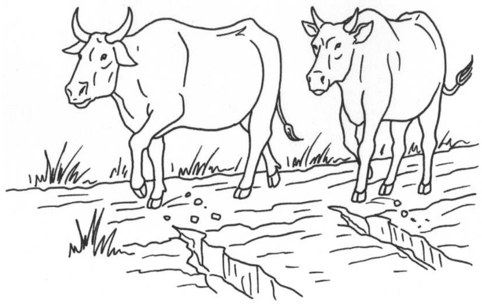
Acid can work on stones to break them up. The acidic water breaks the surface of the stone and then the stone can break more easily.

Rain water can also break up and wear down the surface of stones causing small pieces to break off. We saw an example of this with the water from the tap breaking up the cement.

Rain wears down rocks and causes smaller pieces to break off.

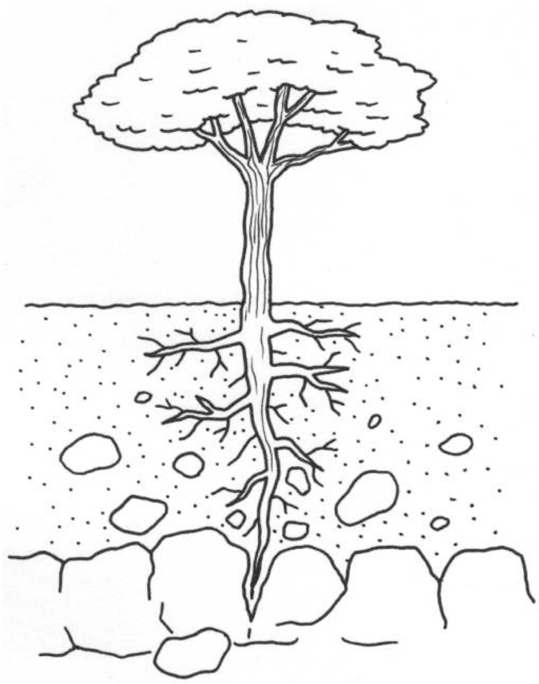
3. Stones rub together, and their surfaces break up

Stones rub together when water moves them, or when wind blows them against bigger stones. People and animals walking on a path kick stones and break off little pieces. Small stones become even smaller, and eventually the very small pieces become sand.



People and animals break stones into smaller stones when they walk over them.

The constant impact from heavy tractors driving through will break larger rocks up into smaller pieces. [4]



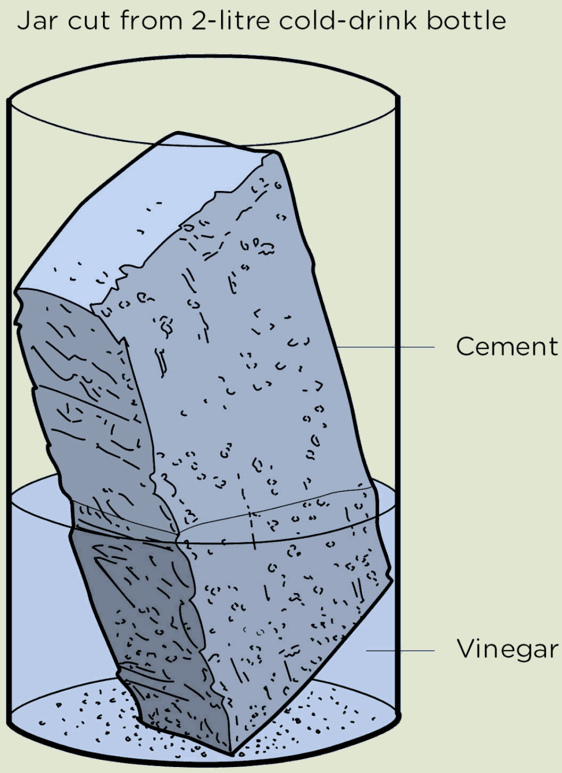
The roots of plants also cause stones in the soil to rub together and break up into smaller pieces.

ACTIVITY: Make a model of acid water breaking up rocks

In real soil this change takes many years. We can make it happen in the classroom in a week. We will use vinegar to represent the acid water in the soil. Look at the picture below.

MATERIALS:

- a cement brick (not the shiny dark red or orange bricks)
- a large plastic container (like the bottom half of a plastic cool drink bottle)
- a bottle of white vinegar



Vinegar acid is working on the surface of the cement brick. Parts of the brick are falling off.

INSTRUCTIONS:

1. Put the cement brick into the container.

2. Pour enough of the vinegar into the plastic container to cover half of the brick.
3. Put the container in a place where everyone can see it every day for two weeks.
4. Cover the container and make sure the mixture does not evaporate and leave the brick dry.

QUESTIONS:

1. Draw the brick as it looks on Day 1.
2. Draw the brick as it looks on Day 14.
3. How has the brick changed?
4. Has the part of the brick that is above the vinegar changed in the same way as the part that is under the vinegar?
   The vinegar moves up the brick and reacts with substances in the brick. you may find white whiskers of a new substance that has formed from the reaction between the brick and the vinegar.
5. Have any parts of the brick fallen off to the bottom of the container?
6. Write out the whole sentence in your book and complete it with words from the word box:

Word box:
- represents
- represents the real
- is not

This equipment is a model of rock, not the real rock. The brick __________ a real rock and the vinegar __________ water around the roots of plants.
represents ... represents the real

Making soil

Rocks break down and slowly change into sand. This change needs thousands of years to take place because soil, wind and water do it very slowly. Sand is not soil. More changes must happen to sand before it is soil.

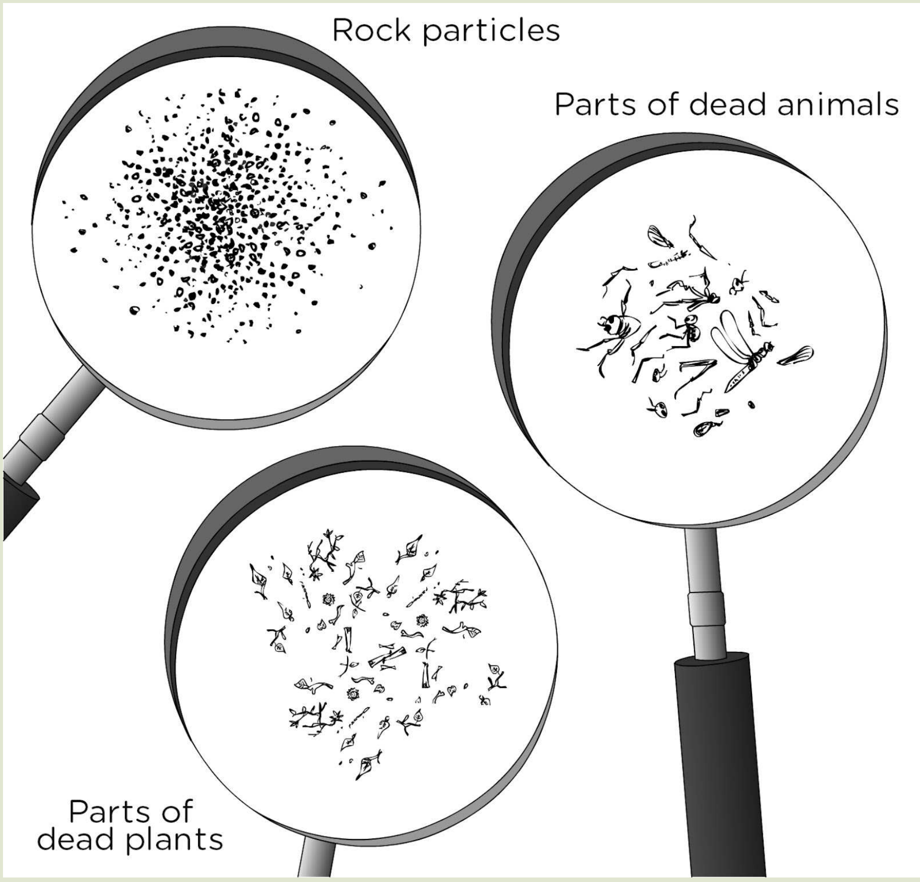
ACTIVITY: Look at different kinds of soil

MATERIALS:

- a tin-can half full of moist topsoil (moist means it is not dry)
- a hand lens or some other kind of magnifier
- a sheet of white paper
- toothpicks, matches or pieces of dried grass that you use for moving the little pieces of soil.

INSTRUCTIONS

1. Smell the soil in the tin. Does it have a smell?
2. Put a teaspoonful of the topsoil on the white paper and spread it out.
3. Use your stick to move the small bits of soil that you find there. Look at the soil with the magnifier. Make piles of bits that look the same.



Look closely at the soil. What pieces do you find there?

- One pile will be rock grains. You will find very small pieces of rock and some pieces that are not so small. There will also be some grains that are almost too small to see.
- Another pile will be small bits of plants. You will find very small pieces of sticks, leaves and roots.
- Another pile will be small bits of animals. You will find very small pieces of beetle shell, or legs, or wings of flies.
- You may even find a small live animal! If you do find one, do a drawing of it on your paper and then let it go on the soil outside.

QUESTIONS:

1. What colour is your soil? Use words like "dark brown", "grey" "orange" or "yellow".

2. Draw some of the grains of rock (sand) that you find. Draw any small bits of plants or bits of dead animals that you see in the soil. Draw any small living animals that you find in the soil. Then let them go, outside.

3. Complete the sentence: Soil has sand but it also has...
   ...rock particles, organic matter such as pieces of plants and dead animals, etc.

We can make soil in a few weeks, but only a small amount of soil.

ACTIVITY: Begin to make soil

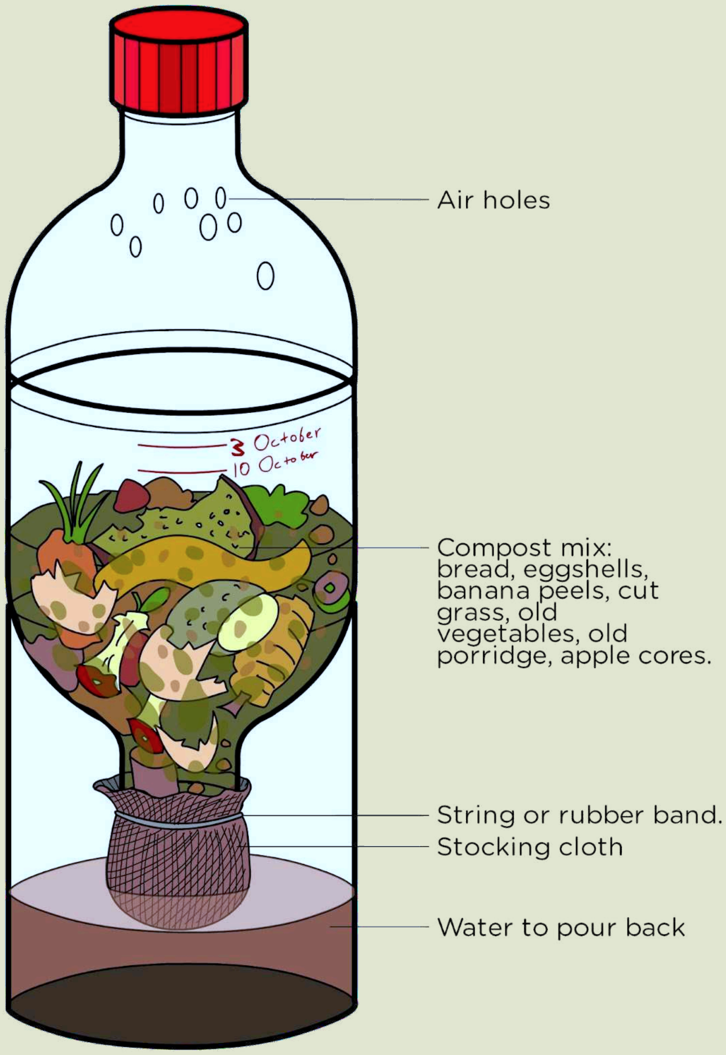
The class should begin this activity on the first day of the 4th term, because it needs about 3 weeks to be complete.

In this activity you begin the slow process of making soil. Your class perhaps started your compost column in the first week of the term.

MATERIALS:

- 3 big cool drink bottles like the ones in the picture
- an old stocking
- a strong rubber band
- felt-tip pens that will write on plastic
- a big needle

- a pair of scissors
- scraps of vegetables and fruit, leftover porridge, cut grass, enough to fill a big bottle to the top
- a cup of water



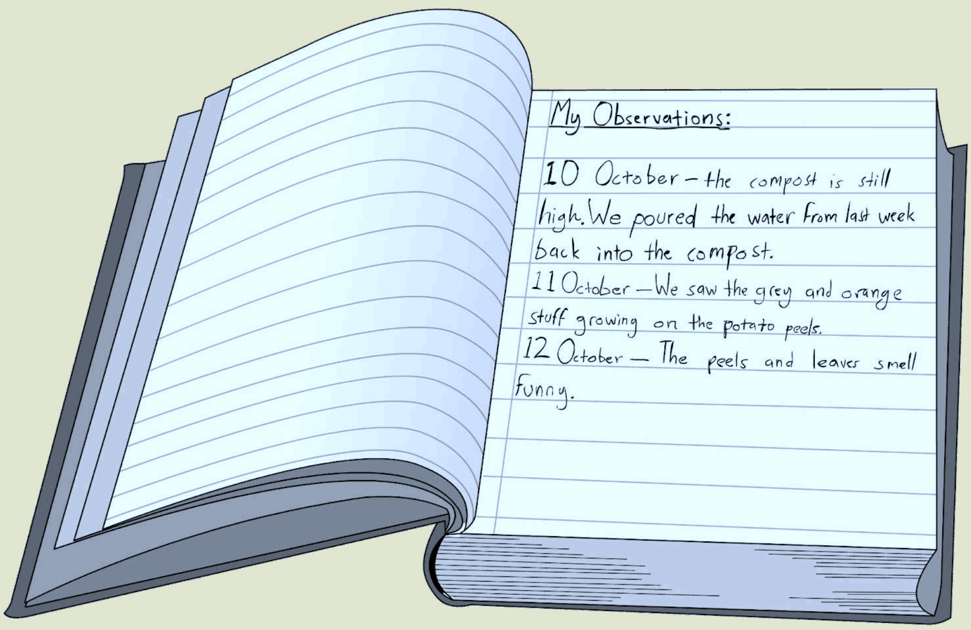
Cut and join 3 the cold drink bottles like this.

INSTRUCTIONS:

1. You need the plastic bottles you collected. Cut and join them together as you see in the picture.
2. Cut a piece of stocking to fit over the neck of the bottle that is upside down. The stocking will stop the vegetable peels falling through the hole, but it will let water go through.
3. Add the vegetable peels, old bread, and leaves.
4. Now slowly pour in the cup of water. Let the water go down through the stocking, into the bottom container.
5. Now use the needle to make air holes in the top bottle, as you see in the picture.

6. Mark the height of the compost column on the plastic. Write the date next to the mark.
7. Each Friday, mark the height of the compost column again, and write the date on the bottle.
8. Then take out the bottom container with the water in it, and pour the water into a tin.
9. Then use the tin to pour all the water slowly back into the compost. This will stop the compost drying out.
10. Begin a class logbook. A logbook is a book in which you write down what happens on a day. Look at the example below which shows Sophie's log book from when the Thunderbolt Kids did the experiment in their class.

In the beginning, you might think the compost looks ugly, and is just a lot of rotting food and leaves. It might have a smell. As the weeks go by, you may notice changes in the colour of the compost, and also in the colour and size of the small pieces. You can also see some things begin to grow in the compost. The smell will change. You may also see insects appear from the compost.



This is a page in Sophie's logbook.

QUESTIONS:

1. Did you notice any changes in the compost? Did you see anything begin to grow in the compost?
   This is dependent on the activity - possibly fungi.
2. What happens to the colour of the water that you pour back in every week?
   It should get darker and more "muddy" in colour.

3. What do you think is in the water?
   Possibly fine bits of broken down organic material from the plants and other matter.
4. Why must you use the same water each week and not take fresh water?
   This is so that you do not lose the nutrients from that water, because if you use fresh water, then you are washing out and losing the fine bits that have been broken up and beginning to form in the compost.
5. Why does the compost column become lower as the days go by?
   As the days go by, the organic matter is broken down into smaller particles which can pack closer together and take up less space. So the compost column decreases in height.
6. Where do you think the insects come from?
   Possibly from eggs/larvae that were present on the organic matter before putting it into the compost column.

The grey hairy things that you see growing in the vegetable peels are fungi, and they help to break down the peels. There are many kinds of fungi and they can have different colours.

When you see insects in the compost column, they could come from two places. They may be fruit flies that can get in through the air holes, but they may also be hatching from eggs that insects laid in the peels and leaves before you put them into the plastic bottles. Do you remember in the first term when we did Life and Living, we observed the life cycle of fruit flies?

After about 4 weeks, your compost will be a dark colour and the big pieces will have broken down into small pieces. You can pour out the compost and mix an equal amount of sand with the compost. Now you have made a little soil.

Real soil is more complex than this mixture, and the living things in the soil make substances that bind the grains of sand together, or break down the grains into smaller pieces. But for Gr. 5, it is enough to help the learners understand that soil is not just sand.

Microorganisms in the soil

When introducing microorganisms, start off with a discussion about them and ask learners whether they think microorganisms are living or not.

When you looked at soil, you found sand grains, small bits of plants and small bits of animals. But there was another group of things you could not see, because they are too small. They are microorganisms. They are living things that, in the soil, change dead plant and animal material into substances that plants can use and absorb through their roots.

If we work hard, we can make a small amount of good topsoil in a term. But a farmer needs good topsoil all over the farm. Nature works all over the Earth but it works very slowly. Nature needs about 1 000 years to make topsoil just 10 cm deep. If rain washes away the topsoil the farmer cannot grow good crops on that land. When the topsoil has been lost due to wind or rain, we say **erosion** has taken place. Look at the following picture.

The topsoil has gone from this land, and the farmer can never grow food here again. [5]

Even if the farmer stops the erosion, it will be about 1 000 years before nature can make new topsoil to replace the soil that has been lost.

If there is too little topsoil, then there will be too few plants for animals to eat. This means that all animals depend on the topsoil, even animals like lions that only eat meat.

QUESTIONS

We can say that lions depend on topsoil for their food, although they do not eat topsoil. Why do lions depend on the topsoil for their food? Explain your answer. Hint: Think back to what you learnt in the first term in Life and Living about food chains.

Lions eat other animals, such as impala, zebra, giraffe, etc. These animals are herbivores which eat grass and other plants. The plants that these animals eat need topsoil to grow in. So the lions are indirectly dependent on topsoil by their feeding relationships.

2.3 Soil types

Have you ever noticed how many different colours and textures soil can have? Even if you are just walking around your school grounds, you may come across many different types of soil.

This is because soil is made up of different particles. These particles can vary in amounts and therefore make up different types of soils.

Some particles are bigger, others are smaller whereas some are in between. A soil sample normally has a lot of particles either bigger, smaller or in between, and has a smaller portion of the other sizes.

New Words

- clay
- loam
- humus
- sample
- silt
- compare

Soil particles - Sand, silt and clay

There are 3 main types of particles which make up soil.

1. Clay
2. Silt
3. Sand

If the soil was formed from a very hard rock, then it has bigger particles, if it was formed from a soft rock then the particles will be smaller.

INVESTIGATION: Different amounts of sand, silt and clay

AIM:

To find out how much sand, silt and clay there is in soil from two different places.

PREDICTION (what you think you will find out):

The soil from ______________ will have more ______________, and the soil from ______________ will have more ______________.

MATERIALS AND APPARATUS:

- two types of soil that look different from one another and are from two different places, such as:
  - near the top of a slope/hill and near the bottom, or
  - soil from under a tree and soil from an area with wild grass

- sheets of newspaper to keep the desks clean
- two large see-through jars that are **the same size**

INSTRUCTIONS:

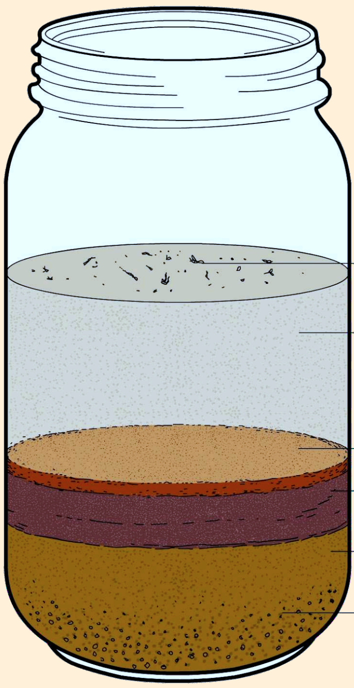
1. Collect two tins of soil from places you choose. These are samples of each kind of soil (a sample is a little bit to study).
2. Feel the two samples in your hand. How do they feel different? Do they smell different?

Ask for oral answers, no written answers.

3. Spread a teaspoonful on the white paper and look at each - in what ways do they look different?

Ask learners for oral answers. Make sure you get answers from different learners and it is not just the same learners each time.

4. Put your soil samples into the glass jars. Pour in water to make the jar almost full, cover the top and shake each jar to mix the soil and water.
5. Leave the two jars to stand until tomorrow. The jars must be kept very still because the water must not move.
6. In the morning you will see something like in the picture below. In each jar, the water has let the large grains settle at the bottom, the very small grains are on top, and the clay grains are so small they are still mixed with the water. You may see some plant parts floating on the water.



You will have two jars like this. The parts of your soil settle in layers.

7. Your two jars will show different layers. In one jar, you might see a lot of sand, and in the other jar you might see less sand.

OBSERVATIONS:

Draw the two jars showing the layers in your two sand samples. Give your drawings labels and a heading.

How could you improve this investigation?

CONCLUSION (what you learnt):

The difference between our two soil samples is:

You will see that your soil contains grains of different sizes. Some are grains of sand, some are grains that are smaller than sand, and some that are so small you can't even see them.

- **Sand** - you know how it feels between your fingers.
- **Silt** has much smaller grains than sand but you can still feel that it is a bit rough.
- **Clay** has such small grains that when you rub it between your fingers it feels like paint. In fact, you can paint with it. When clay dries, it becomes hard.

QUESTIONS

1. Can you make pots with sand?
2. What kind of soil is good for making pots?

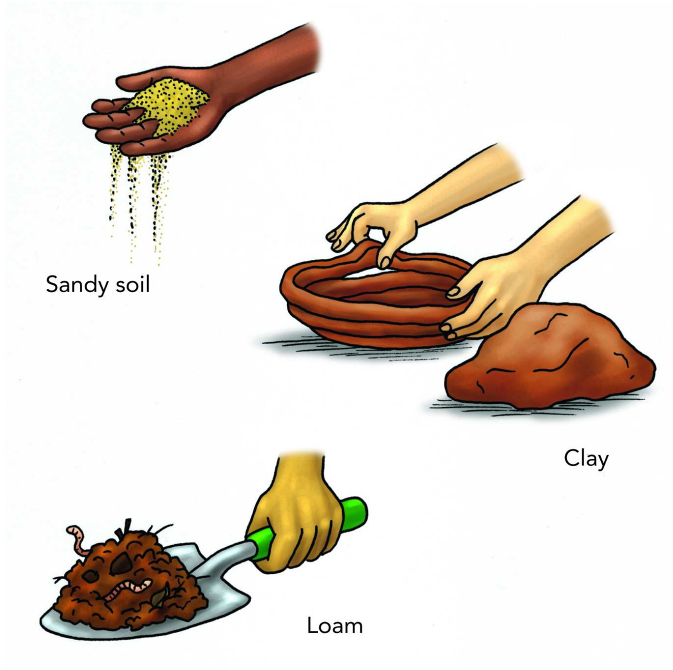
Soil types - Sand, clay and loam

As we saw previously, different soil samples collected from different places have different size particles. Imagine running along the beach and feeling the sand beneath your feet. Now imagine running through a forest over the soil. Can you see there are big differences in these types of soil?

The mixture of particles and the size of particles determines the soil type. There are 3 different types of soils:

1. Clay
2. Loam
3. Sand

Let's look at the characteristics of the soil types.



The types of soil

Sandy soil is the soil you find at the beach. It consists of large gritty particles and very tiny bits of rock which we call grains of sand. The grains of sand are coarse and the soil is loose.

Can you see how, in the picture of sandy soil, the grains can fall though your hand? It does not retain fertilisers. It is easily washed or blown away. On sunny days sandy soil warms up quickly. Most plants do not grow well in sandy soil.

Sandy soil has lots of coarse grains of sand. [6]

QUESTIONS

Why do you think plants do not grow well in sandy soil?

Sandy soil does not have any nutrients. It is easily blown away so plants can not form roots or roots become exposed. Sandy soil does not retain water.

Have you ever made a pot out of **clay**? If you are lucky enough to have done this or seen someone do it, you will know a bit about the properties of clay.

Clay can be moulded. This is because it consists mainly of very fine particles which cling together. Clay becomes sticky when wet. It retains fertilisers for a very long time. Clay is not easily blown or washed away. It does not become as warm as sandy soil.

Clay soil consists of lots of very fine grains of clay and can be moulded into pots.

QUESTIONS

Do you think plants will be able to grow in clay?

No, not if the soil only consists of clay. This is because the clay can become waterlogged and it could pack too tightly around the roots.

Loam is a very funny word! But this is also a type of soil. Loam is actually a mixture of clay, sand and humus. Humus is organic material from plants and animals which is decomposing.

Loam is fairly loose and fertile. It retains fertilisers longer than sandy soil. It is not easily blown or washed away. It is much cooler than either sand or clayey soil. Loam soil is the best type of soil for plants to grow in!

Loam soil is rich with humus. [7]

VISIT

Interesting website about soil types

goo.gl/QMnsG

QUESTIONS

What are the differences between loam and sand soil? Name three things that you find in loam but you do not find in sand.

Plant material, animal material, living organisms (microorganisms).

Each soil type also contains air and water, and sometimes the remains of dead organisms and very small living organisms.

How do some plants live when no rain falls?

We do know that many plants can live through the dry season, even though no rain falls for eight months. How do they do it?

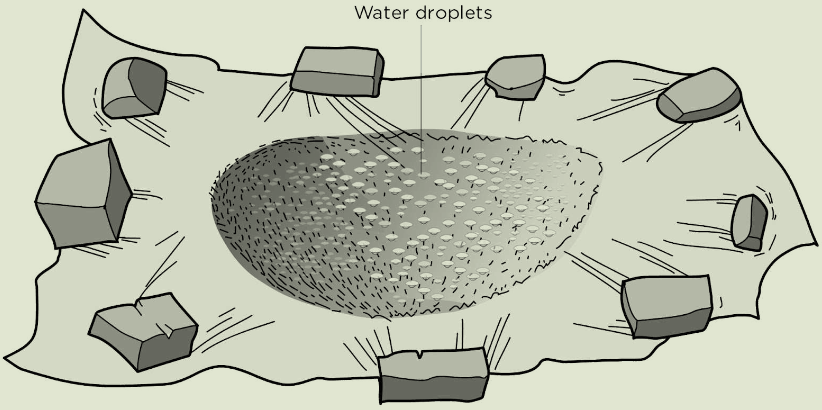
ACTIVITY: Soil holds water

MATERIALS:

- a spade
- a large sheet of clear plastic
- a few bricks

INSTRUCTIONS:

1. Look at the picture below.
2. Dig a hole in the soil outside, like this.
3. Cover the hole with a sheet of clear plastic and hold it down with some bricks.
4. After a short time, you can see drops of water on the plastic.



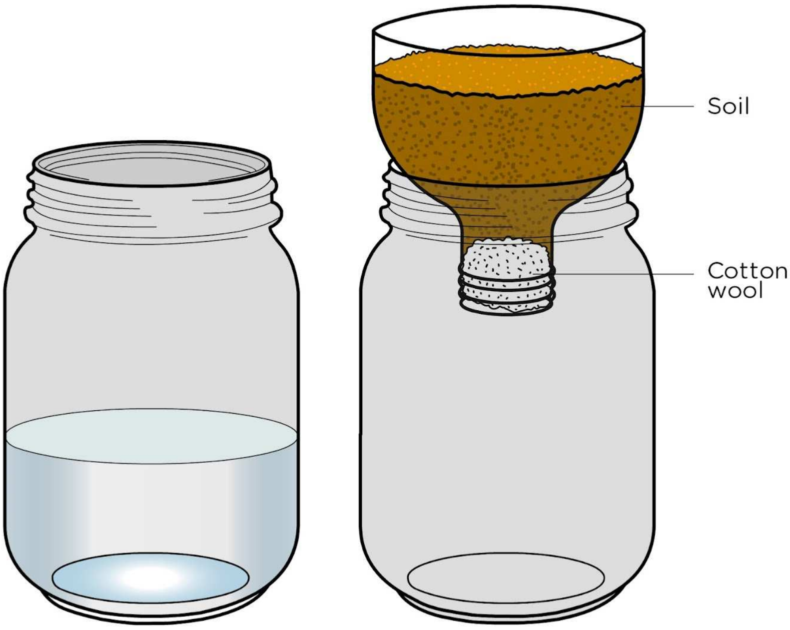
Dig a hole in the soil, and cover it with a clear plastic sheet.

QUESTIONS:

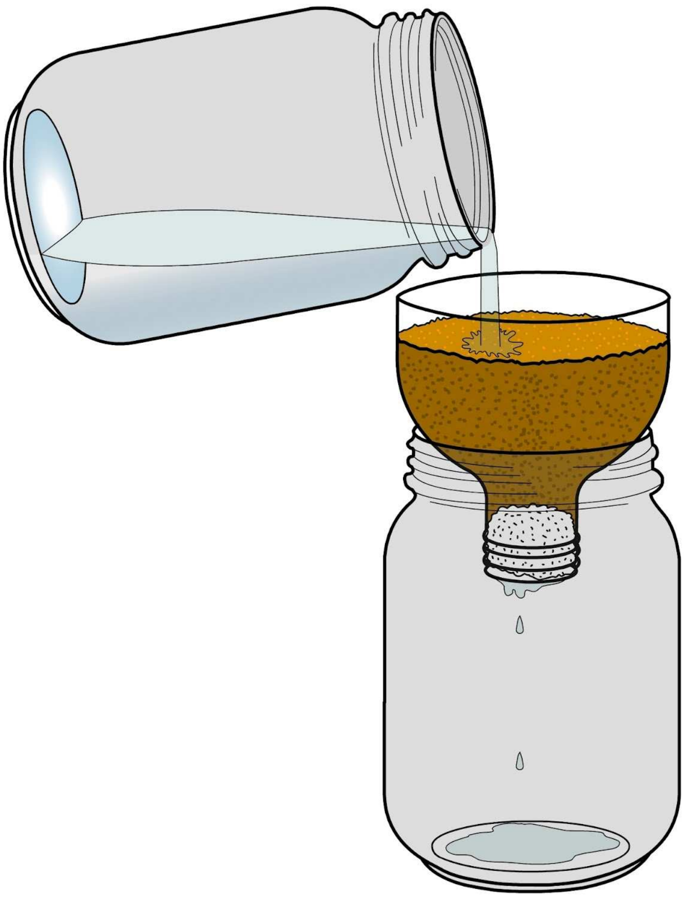
1. Are the drops on the top or the bottom of the plastic?
   The drops are on the bottom, nearest the soil.
2. Where is the water coming from?
   The water is coming from the soil.
3. How did the water get into the soil?
   from the rain
4. Some plants can live even when no rain falls. How do they live?
   Their roots can absorb water in the soil. Some plants have roots that do this very well, so they can live in dry places.

Farmers know that soils are not all the same. They know that some soils hold water well, and other soils do not hold water well.

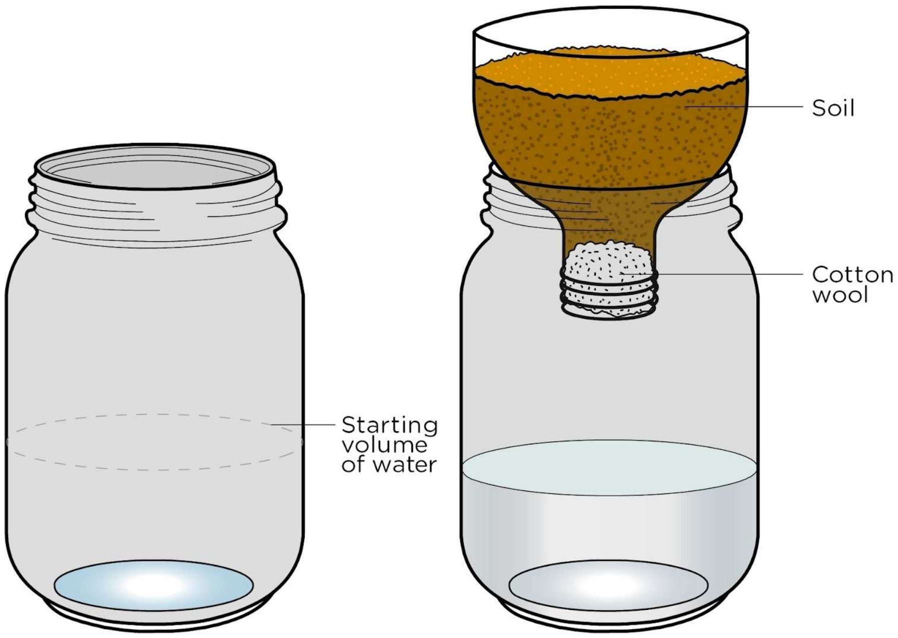
An easy way to see how well soil holds water is to pour some water into soil and let it run through into a bottle. Look at the first picture below. These two bottles are the same size. In the next picture, the water is poured into the jar with the soil in it. Look at the last picture - has all the water run through the soil?



Put the soil in a funnel, like this. Use two jars the same size.



Slowly pour the water onto the soil, and wait 5 minutes.



Has all the water run through the soil?

Let's do an investigation to see how much water the different soil types can hold. For this investigation activity you need two different kinds of soil, from two different places. Let us call them Soil A and Soil B.

Try and get samples of different soil types - i.e. sand, clay and loam soil. For the following investigation, the learners will have to plan some of it themselves and will not be told step-by-step what to do. If you want to, you can make the investigation include all three different soil types if you manage to get samples from each, and then you will have Soil A, B and C.

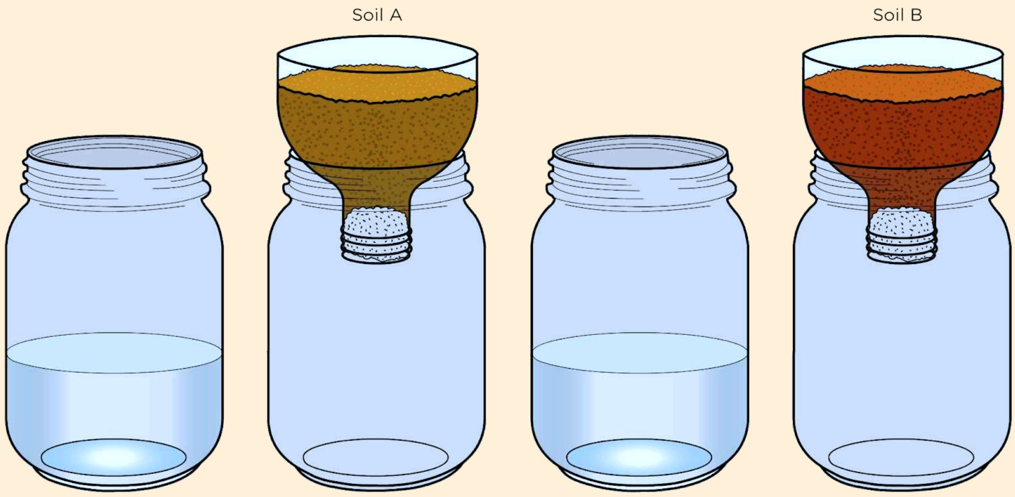
Plan an investigation to compare Soil A, Soil B, and then do the investigation. The main question you must answer is: **which soil holds more water**?

INVESTIGATION: Which soil holds more water,

Soil A or Soil B?

When you compare things, you must be fair. For example, if we want to compare runners in Gr. 5 athletics, we must let them run on the same track. It is not fair if we let some of them run through bushes but the others can run on a smooth track! To be able to compare them all fairly, we must treat all the runners in the same way.

Set up the soils as you see in the next picture; in funnel A, the soil will hold some of the water you pour in. In funnel B, the other soil will also hold some of the water you pour in. But will they hold the same amounts?



Setup the soils in two funnels like this.

How will you ensure that you are being fair?

Teacher note: The learners should realise that the amount of water and the amount of soil in each case should be the same to make it a fair test.

AIM (What you want to find out):

PREDICTION/HYPOTHESIS (What you think will happen):

MATERIALS AND APPARATUS (what you will need):

Look at the pictures above to help you write a list in the space provided.

METHOD (What you must do):

Write out the instructions for how to carry out this investigation below. Remember to number the steps.

RESULTS AND OBSERVATIONS:

What did you observe when doing this experiment?

Use the space below to draw a bar graph to show your results from this experiment. Remember to label the axes of your graph and give it a heading.

A bar graph is used as we are comparing two different things (soil A and B) and they are not related to each other. The "Soil type" will go on the x-axis and the "Amount of water held by soil" will go on the y-axis, probably measured in millilitres.

How you could do this investigation better?

CONCLUSION (What you learnt):

Write a sentence where you give a conclusion about what you learnt from this investigation. see if you can identify what types of soil Soil A and B were.

For example, I learnt that the soil from the bottom of the hill holds more water than the soil from the top of the hill. Also ask learners to identify what types of soil they think Soil A and B are.

Sandy soil does not hold much water. Clay soil holds too much water. Clay holds water because it has very small grains. The grains fit together tightly. Loam soil has a mixture of sand and clay, along with composted plant and animal substances. So, loam soil holds water well, but does not become waterlogged like clay soil.

QUESTIONS

Why does sand let the water run through quickly?

You are asking the children to make a hypothesis based on the information about the size of the grains. Sand grains are much larger than clay grains, and so they don't fit together so tightly and so there is more space for the water to run through.

Which soil type do plants grow best in?

Now that we have looked at how different soil types hold different amounts of water, let's compare how well plants grow in the different soil types. You might have grown seedlings before, in Life and Living, but let's do it again. This time we will focus on the type of soil.

INVESTIGATION: Compare how well plants grow in different kinds of soil

AIM (What you want to find out):

PREDICTION/HYPOTHESIS (What you think will happen):

MATERIALS AND APPARATUS:

- 3 large jam tins
- packet of radish seeds
- some sand, enough to fill one tin
- some loam soil, enough to fill a tin. You can find loam soil in a vegetable garden
- some clay soil, enough to fill the last tin (if you have access to clay soil)
- a ruler
- a measuring cup
- a table spoon

We use radish seeds because they germinate very quickly. Also, they are so small that they soon need substances from the soil to continue growing. In the tin with sand, they will not get those substances and they will soon begin to die. In the loam soil, your learners may get several good radishes. A radish is a root vegetable that has a sharp hot taste. If you cannot find clay soil, then just do the investigation using sand and loam soil which are easier to obtain.

METHOD:

1. Make five small holes in the bottom of each tin, so that water can drain out if there is too much water in the tin.
2. Fill one tin with sand, one tin with the loam soil, and the last tin with clay soil.
3. Plant 10 radish seeds in each tin. Cover the seeds by sprinkling a little of the sand or soil over them.
4. Pour a cup of water into each tin. Remember to keep the amount of water constant to make it a fair test.

5. Now let the seeds begin to grow, perhaps on the windowsill in the classroom to make sure that they have a light source.
6. Each day, give each tin a tablespoon of water.
7. Observe the radish seeds growing for a week, and compare them.
8. Measure the height of the radish plants growing in each type of soil. Calculate the average seedling height for each soil type.
9. Record your results in a table.

To calculate the average height, learners must measure the height of each seedling for a soil type, add all the heights together and then divide by the number of seedlings that have grown for that soil type. They must do this for each soil type.

RESULTS AND OBSERVATIONS:

Use the space provided to draw a table to record your results from measuring the height of the seedlings each day. Give your table a heading.

Learners may need help with this. Perhaps draw a table on the board like the one given below:

Average height grown by seedlings in different soil types.

Date	Loam soil (mm)	Sandy soil (mm)	Clay soil (mm)

Now draw graphs to compare your results. A table is one way of presenting results, but a graph gives a visual representation which is sometimes easier to quickly understand and compare the results from an experiment.

First draw a line graph to show the change in average height of the seedlings grown in loam soil over time.

A line graph is used as we are showing the change over time of one thing. The input, independent variable is the day and this goes on the x-axis. The output, dependent variable is the average height grown and this goes on the y-axis.

Next, draw a bar graph to compare the average height of the seedlings on the last day of your investigation for each soil type used.

As with the previous bar graph, a bar graph must be drawn as there are 3 different things being tested which are not related to each other (the different soil types). Soil type goes on the x-axis and Height grown goes on the y-axis, in centimetres or millimetres.

How could you improve this investigation?

CONCLUSION:

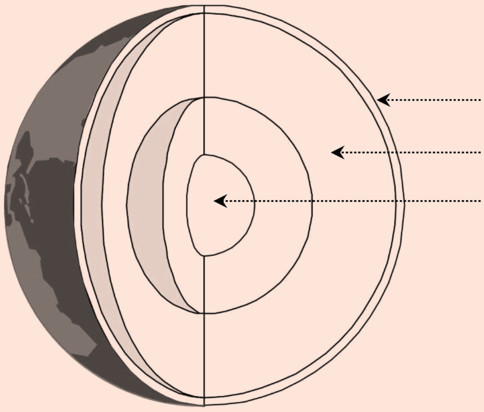
Write a conclusion for this investigation. Remember, in a conclusion you must answer the question which you set out to investigate at the start.

KEY CONCEPTS

- The rocks on the surface of the Earth form a crust that covers the whole planet.
- The continents are part of the crust, and the bottom of the oceans are part of the crust too.
- Rocks break up into small grains.
- The remains of living things mix with the grains and together they form soil.
- Three types of soil are sandy soil, clay soil and loam soil.

REVISION:

1. Label the layers of Earth on following diagram:



Labels: crust, mantle, core

2. What is the crust of the Earth made of?
Use some words from the word box to complete the sentences in questions 3 to 6. Write out the whole sentence each time.

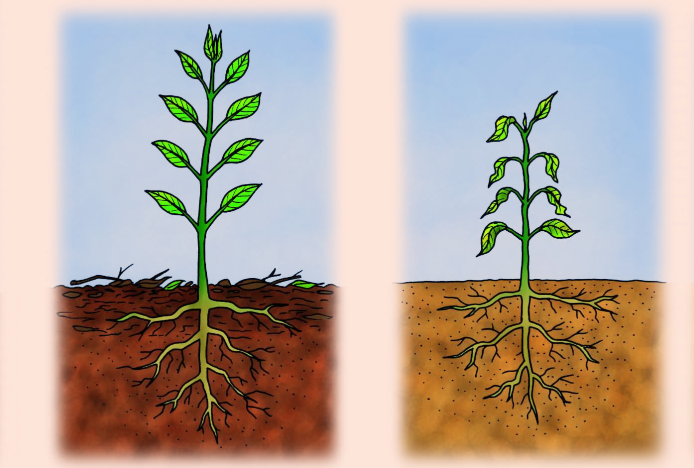
Word box:

- sand
- clay
- silt
- photosynthesis
- animals
- topsoil
- subsoil
- food
- loam

rocks and soil

3. The weathered rock becomes part of the soil. The big and small grains of rock mix with parts of dead plants and __________. This mixture is called topsoil. __________ can hold water that plants need.
animals, Topsoil
4. Loam soil is topsoil. It has a good mixture of __________ soil. __________ holds enough water for most plants, not too much and not too little.
sand, silt and clay, Loam

5. Plants need the nutrients in topsoil to make food by the process of __________. Plants are food for most animals. Some of these animals are food for meat-eating animals. So without __________ there will be no plants and no animals.
photosynthesis, topsoil
6. We have to stop topsoil washing away when it rains because we need __________ to grow __________ .
topsoil, food
7. What is humus and where would you find it?
Humus is the remains of dead organisms (plants and animals) that have started to decay. It is found in the topsoil, particularly in loam soil.
8. Look at the picture below of two different plants growing. Why do you think the one plant is healthier than the other plant? Explain your answer.



The difference has to do with the type of soil that each plant is growing in. The plant on the left is growing in rich loam soil. It can therefore get nutrients from the soil and also water as loam soil has a high water holding capacity. The plant on the right is growing in poor sandy soil which does not have many nutrients. Sandy soil also cannot hold water well as it has coarse particles so the water just runs through. The plant therefore is not getting enough water and is wilting.

Now that we have learnt about the core and the surface of Earth, let's find out about rock formations!

3 Sedimentary rocks

KEY QUESTIONS

- Why does the Earth have mountains and valleys?
- Have mountains always looked like they look now?
- How come you can sometimes see "layers" in rock which are different colours? How did these layers form?

Chapter 3 deals with one kind of rock - sedimentary rock. This does leave one wondering what other types of rock there are. The main other type of rock is igneous rock. That is rock that has been hot and molten, and pushed up from deep in the mantle. Mostly it hardens under the ground and we see it only millions of years later when erosion has removed the ground over it. Sometimes it breaks through the crust as molten lava, and we have a volcano. The top of the Drakensberg is the remains of a huge outpouring of lava long ago. Nature is always breaking down rock and eroding it, so mountains are always changing. They change so slowly that we cannot notice it in a person's lifetime, but the changes are happening all the time.

We saw in Chapter 2 that the surface of the Earth is made up of rocks and soil. There are different soil types, but did you know that there are also different types of rock? We classify rocks depending on how they were formed. We are going to look at sedimentary rock in this chapter and find out how it is formed and used.

3.1 Formation of sedimentary rock

VISIT
Different rock types (video)
goo.gl/YXUFE

In Chapter 2, we saw how rocks break up into smaller and smaller pieces, until we have grains of sand. Now we will find out what happens to the sand.

First, rocks break up into smaller pieces, until the pieces are grains of sand. Next, wind and moving water carry the sand and mud away. Then the wind or the water may drop the sand and mud in one place. Finally, the sand grains might get stuck together again over time and make new rock. This new rock is called sedimentary rock.

New Words

- weathering
- grains
- sediment
- sedimentary
- erosion
- deposition

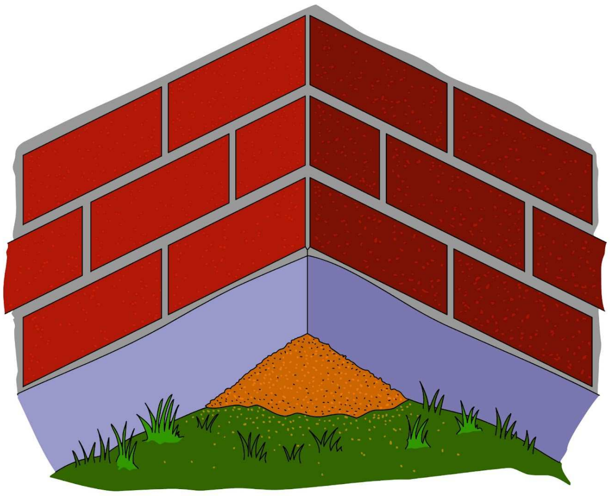
Erosion and deposition

A large valley is forming due to soil erosion. [1]

Soil erosion due to water [2]

When wind or water move the pieces away from the rock, we call this erosion. The wind and water erode the rock as they carry away the sand.

When the wind and water put the sand grains down, we call this **deposition**. The wind and water **deposit** the sand.



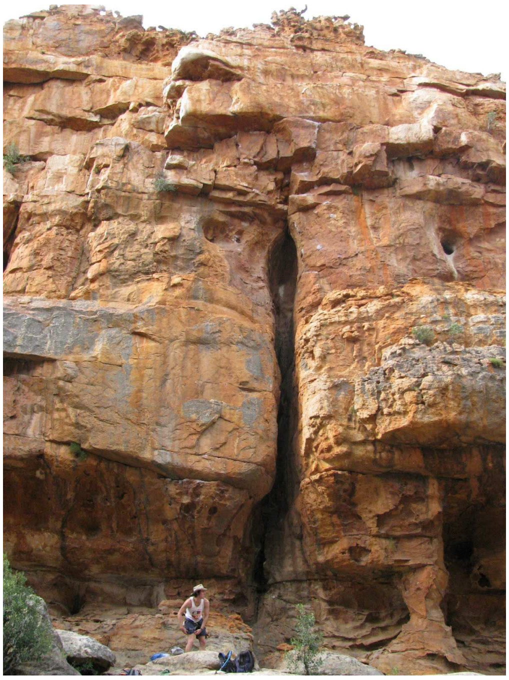
The wind is depositing sand in this corner of the school. Deposition is happening here.

Sediments

When the sand grains collect on top of each other, they form a sediment. Over time, new layers of mud and sand are deposited on the previous layers. Over a very long time, these sediments become compacted and hardened and become a sedimentary rock. This happens because the grains of sand become glued together, and other heavy sediments press down on the grains of sand. Sediments lie on top of each other. We can actually see these layers in sedimentary rock and they are sometimes different colours. Find the sediments in the pictures below.

Can you see the different coloured layers in this sedimentary rock? [3]

Look at these layers in this sedimentary rock known as shale. [4]



Sandstone rock in the Cederberg in the Western Cape

Layers of limestone sedimentary rock [5]

Let's have a look at how sediments are deposited over time. Except, we do not have thousands of years so we are going to pretend each day of the week is actually about 1000 years!

ACTIVITY: Depositing sediments

MATERIALS:

- a large see-through jar (you can make this from a 2-litre cold-drink bottle)
- different places for groups to collect sand and soil

For this activity, divide the class up into 5 groups - one for each day of the school week (Monday to Friday). Each group must collect sand or soil from a different place so that the different layers are evident by the end of the week. At the beginning of each lesson for the week, you can ask the group for that day to pour their sediment in and then carry on with the rest of the lesson. By the end of the week you can look at the layers of sediment that each group added. Explain to the learners that you are speeding up the process.

INSTRUCTIONS:

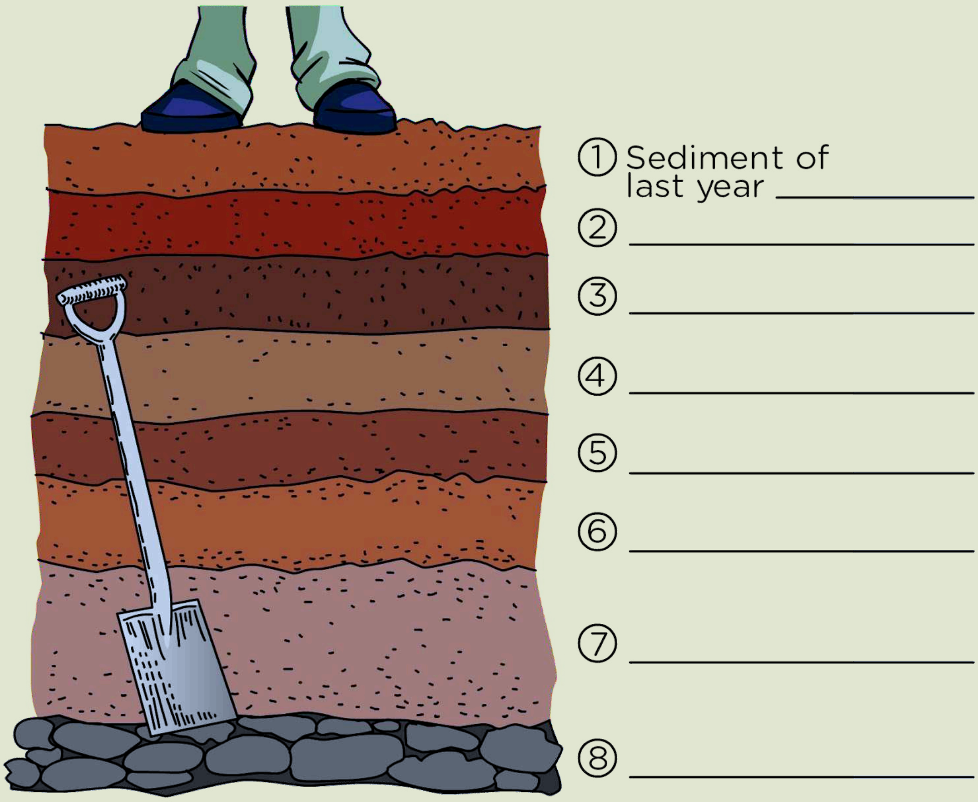
1. Put the jar in a place where everyone can see it.
2. Group 1 must collect a large jam-tin full of sand and on Monday they pour their sand into the jar.
3. Group 2 must collect sand or soil from a different place. On Tuesday, someone from Group 2 pours that sand into the jar.
4. On Wednesday, group 3 pours in sand or soil from a different place.
5. By Friday, the jar will have different layers.

QUESTIONS:

1. Which sand sediment was put in on Tuesday?
   The sediment second from the bottom was added on Tuesday.
2. Which is the oldest sediment?
   The bottom sediment is the oldest.

ACTIVITY: Which sediment is the oldest?

People who dig holes in the river to get to water sometimes see the sand sediments. The Thunderbolt Kids decided to dig a hole down in the river bed just outside their school. Look at the picture where you can see Sophie's feet standing on the top and the layers of sediment going down below.



This is what you might see if you dig down in a river-bed.

The river is dry now, but last year the river deposited a sediment. This river deposits a sediment every year when the rains come.

INSTRUCTIONS:

1. Find the sediment of sand that washed down **last** year. Read the number next to it.
2. Find the sediment that washed down **the year before last year.** Read the number next to it.

3. On the picture, complete the label, **Sediment of last year (20____).**
4. On the picture, where must you write **Sediment of the year before last (20____)**? Write it there.
5. On the drawing, next to sediment 5, write **I was ____ years old when the river brought this sediment**.

Sediment 5 was deposited in 2009. Let the learners count backward to 2009 and work out how old they were.

6. In sediment 4, we find the bones of a bird. How could a bird get into this sediment? Write or tell a short story about the bird. Explain why we find its bones under four sediments of sand. Work out in what year the bird fell into the mud.
   Teacher's note: For example, "The bird died and fell into the water. Then it sank in the water and the mud covered it. This happened five years ago. The next year more sand came down the river and covered it deeper." If Sophie is standing on the 2013 sediment, then the bird fell into the 2010 sediment. We use the example of yearly floods that bring down sand in a river, because the numbers of years is small. Remind the learners that erosion and deposition has been going on not just these few years, but for millions of years. From the time the first rocks formed from volcanoes on the Earth, weathering, erosion and deposition began to happen. That is why we can find sedimentary rocks that are thousands of millions of years old.
7. What will you find if you dig deeper than sediment **8**?
   You will find rock. The deep layer of rock is called the bedrock.

DID YOU KNOW?

Scientists think the Earth is between 4 and 5 billion years old.

Look at the picture of the Grand Canyon - can you see old sedimentary rock? Look at the sediments of rock. The rock is very hard now. It has been pressed down for millions of years.

Look at the layers in the sedimentary rock in the Grand Canyon.[6] [7]

DID YOU KNOW?

The oldest layers of sedimentary rock visible in the Grand Canyon are believed to be nearly 2 billion years old.

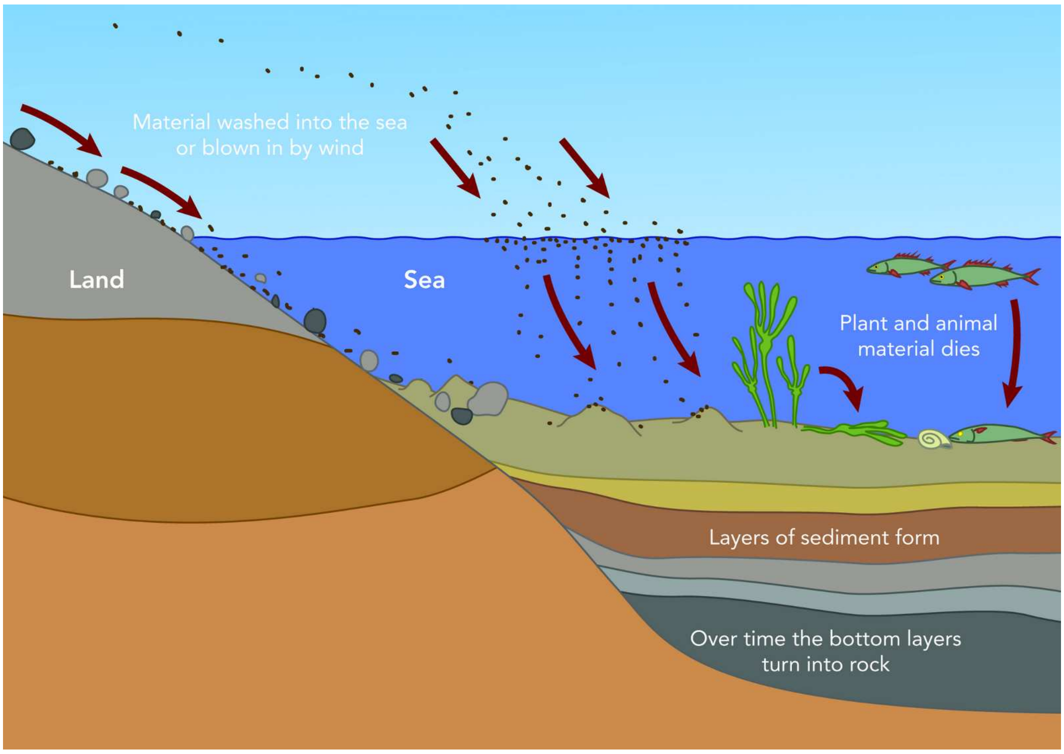
QUESTIONS

1. Show with your finger which sediment of rock is the oldest.
   The lowest sediment/layer of rock they can see in the photo is the oldest.
2. Show where you can find soil, in the picture.
   Soil can be found above the top most sediment, where the plants grow.

Sedimentary rocks are also eroded and broken down into grains of sand again.

The sedimentary rock in the Grand Canyon formed a very long time ago. The layers of sediment were once deposited in warm shallow seas and over millions of years they compacted to form rock. The wind and rain have eroded it until it looks like this.

Look at the diagram below which summarises how sedimentary rock is formed, mostly under the sea or lakes and rivers.



The formation of sedimentary rock

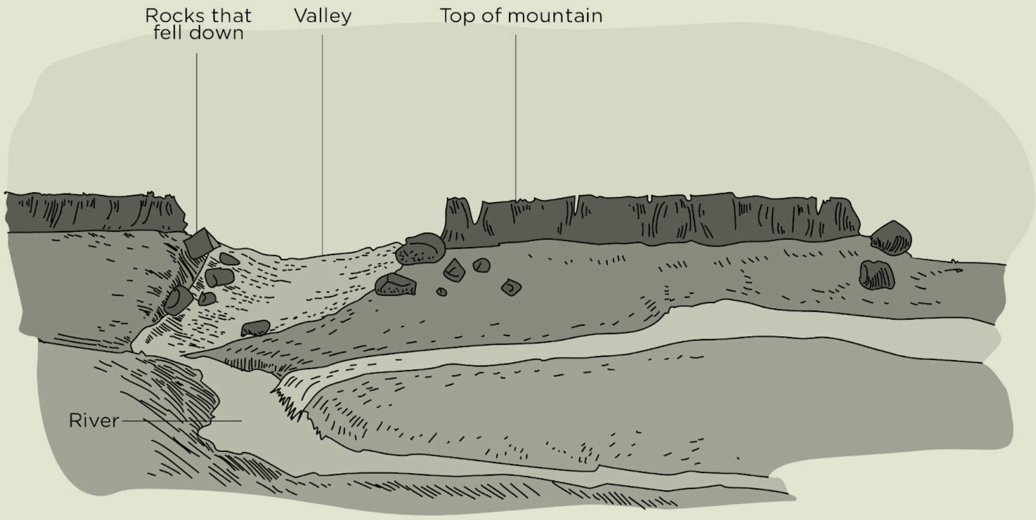
QUESTIONS

Use the diagram above to write a summary paragraph explaining how sedimentary rock is formed.

ACTIVITY: Rebuild the mountain the way it was

INSTRUCTIONS:

1. Look at the diagram below; it shows mountains that are being eroded.
2. The mountains did not always look like this.
3. Answer the questions below.



This is what mountains look like now. Draw on this picture to show what the mountains looked like millions of years ago.

QUESTIONS:

1. The rock and sand are being removed from the mountains. How does this happen?
This is due to erosion (rain water and the wind) over many millions of years.
2. Where does the rock and sand go?
It is washed down the mountain in the river and deposited on the banks lower down or in the sea.

3. Draw on the diagram to show how the mountain might have looked many years ago, **before** the rock and sand were eroded.
Learners should draw a higher mountain without valleys and rocks crumbling away and falling down.

Different kinds of sedimentary rock

There are many kinds of sedimentary rock. Here are three kinds:

1. **Sandstone** is made from grains of sand that are cemented together.
2. **Shale** is made from grains of clay that are cemented together. Shale is quite soft and you can use it to write with, like a piece of chalk.
3. **Limestone** is made of layers of shells of sea-animals that died and sank to the bottom of the sea. Other kinds of limestone are made from sea-water evaporating.

DID YOU KNOW?

Chalk is a soft, white form of limestone.

New Words

- cement
- limestone
- sandstone
- shale

3.2 Uses of sedimentary rock

You just saw that there are different types of sedimentary rocks. These rock types are used in different ways.

Limestone

Limestone is a very common sedimentary rock and it has many uses, mostly as building materials.

Limestone is cut into blocks and used in buildings. Look at these pictures below of different buildings made from limestone.

Can you see the blocks of limestone in this building? [8]

This old building is made from limestone blocks and looks like it can withstand anything. [9]

Limestone is crushed and used to make cement. Limestone is often used in sculptures as it can be carved easily.

A sculpture made from limestone [10]

Glass is made from molten sand, and limestone is mixed with the sand to make the glass stronger. Farmers use limestone to improve their soil, if the soil is too acidic.

Limestone is even used in some medicines and cosmetics and as a white pigment in toothpaste, paints and plastics!

Sandstone

Sandstone has been a popular building material since ancient times, especially in houses and cathedrals around the world. This is because it is quite soft and easy to carve. Houses in Lesotho and the Free State were built from sandstone blocks.

A cathedral in England made from sandstone [11]

Sandstone comes in many different colours and so it is often used in decoratively, such as in decorative stones, in fireplaces, in decorative columns and pillars in buildings and cathedrals and to make statues and fountains. Since sandstone is easy to carve, but does not weather, it is often used as paving stones and to make walkways.

Decorative columns made from sandstone in India [12]

Decorative carvings and columns made from sandstone on the front of a building [13]

Paving blocks made from sandstone [14]

Shale

Shale is also used in buildings, especially as a raw material to make bricks. Shale also splits very easily into thin sheets and is therefore used as as tiles for floors and roofs. Shale is used for floors in some houses in South Africa.

Shale splits easily into thin tiles which can be used in flooring and roofs. [15]

Cement is also made from shale. The shale is crushed to a powder and heated in a kiln (a kind of stove). Black shale rock is also a very important source of oil and natural gas all over the world.

KEY CONCEPTS

- Sedimentary rocks form when small grains of rock, mud and sand form layers and become compacted over a very long time.
- Rock breaks into small grains through the process called weathering.
- Sedimentary rock can be identified as it has visible layers.
- Examples of sedimentary rock are shale, sandstone and limestone.
- Sedimentary rocks have different uses.

REVISION:

Complete the following sentences using words from the Word box. Write the sentences out completely.

Word box:

- grains
- wind
- water
- sediment
- sandstone
- limestone
- shale
- weathering

1. Weathering breaks grains of rock off big rocks. __________ and __________ move these grains on top of each other in layers. A layer of rock grains is called a __________.
   Wind, water, sediment

2. Over many years, the __________ become stuck together and we get sedimentary rock. Three types of sedimentary rock are __________, and __________.
   grains, sandstone, limestone, shale

3. Explain how you would identify sedimentary rock in the natural world around you.
   Sedimentary rock has visible layers which are often different colours, so look for rock which has these layers in it.

4. Explain the difference between erosion and deposition. Provide a drawing to accompany your answer.
   Erosion is when something, normally rock, is gradually worn away over time by wind, water or other animals. Deposition is when wind or water carries sand along and then drops it (deposits) in another place where it also gradually builds up over time.

5. Use the space below to draw a series of drawings to show how a rock is broken down into smaller grains over time.

Label your drawing to explain the processes that are taking place to break down the rock.

Learners' drawings will vary, but there should be more than one drawing. The first drawing should show a big rock, then subsequent drawings should show smaller and smaller rocks, until there are coarse grains. Labels to include could be: Erosion due to wind, Erosion due to water, Weathering due to wind and water, Weathering due to impact from animals.

Now comes the section I am most excited about - learning about fossils and how they formed! Let's get started!

4 Fossils

KEY QUESTIONS

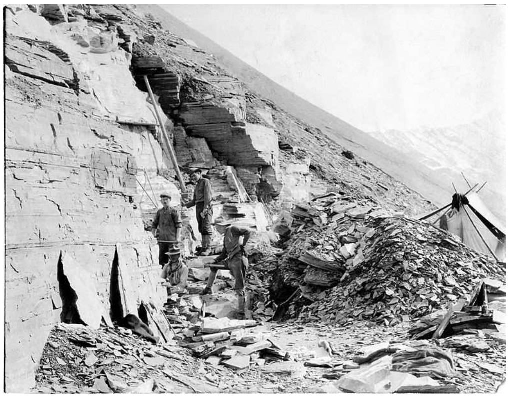
- What are fossils?
- Why were the animals long ago different to animals we can see nowadays?
- How do fossils form in rocks?
- Why are fossils so important?
- What is the Cradle of Humankind in South Africa? Why is it a World Heritage site?

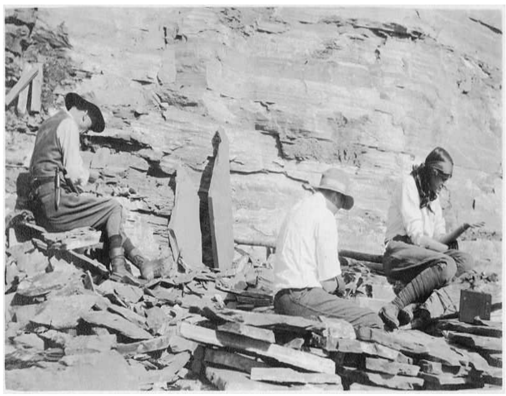
Chapter 4 deals with fossils - the shapes that are left in the rock when a plant or animal has died there and been covered with mud, and body fossils where the remains have been preserved over time. This chapter also deals with the importance of fossils and is a good chance to highlight the significant role that Africa and particularly South Africa has played in documenting the history of life on Earth, and the important fossils which have been found in South Africa. If you are based in Gauteng, you are well-placed to go on a school tour to the Cradle of Humankind at Maropeng and visit the museum which delights children and adults with its interactive display.

4.1 Fossils in rock

New Words

- fossil
- ancient
- evidence
- record
- preserve





These old photographs are of fossil hunters! These people are splitting open pieces of shale. They are looking for fossils in the rock. The layers of the shale split apart, and occasionally reveal the shape of a leaf or an animal in the rock. The shape is called a fossil.

All over the world, people find fossils of leaves and bones in the layers of sedimentary rock. These leaves and bones came from plants and animals that lived millions of years ago. They were not like the plants and animals we see today.

DID YOU KNOW?

A paleontologist is a scientist who studies prehistoric life, mostly by looking at fossils.

Fossils are the preserved remains of dead plants and animals

A fossil may look the same as the plant or animal when it was alive, but it is not the real leaf or bone you see. The fossil has changed to stone through a special process, and the stone has kept the **shape** of the leaf or the bone. This rock shape is called a **fossil**, or a **body fossil**.

Below you can see a photo of a fossil of the head of a dinosaur, and the next image shows you what scientists think this dinosaur looked like.

The fossil shape of the head of Massospondylus, a dinosaur that lived in the eastern Free State about 200 million years ago [1]

Paleontologists think that Massospondylus looked like this. [2]

VISIT

Find out how scientists use fossils to recreate dinosaurs (video)

goo.gl/uKzeQ

This fossil of the dinosaur's head is not the actual bones, but it is actually now a rock in the shape of the dinosaur's bones. Over millions of years, the bones turned into rock. So, a fossil is the remains of an ancient plant or animal which has been preserved in a rock. Most of the organisms that paleontologists study are now extinct. This means that they are no longer alive today.

VISIT

Early dinosaur evolution (video)

goo.gl/tWnJe

Why are fossils so important?

The Earth's past is fascinating to us! Imagine being around when all the dinosaurs were walking on Earth. As humans, we want to find out about Life's History on Earth.

In recent history, we have books written that record what happened. This means we can read what people who lived long ago wrote about that time period. But no human was around millions of years ago to record what happened then!

So we have to use other ways to find out about what life was like on Earth millions of years ago. To do this, scientists use fossils! Fossils are actually our most valuable source of information about the ancient past!

But what can fossils tell us about life long ago? Fossils tell us about the organisms that lived long ago. Imagine the first scientists that discovered a dinosaurs bones! These bones were much bigger than the bones of any other animal on Earth today! This immediately told the scientists that the animals from the past were really big!

The bones of the Tyrannosaurus Rex tell us that is was very, very big!

VISIT

When a T-Rex attacks! (video)

goo.gl/v4Ne5

Fossils can tell us much more than just which organisms lived millions of years ago. By studying fossils of plants and animals, scientists can also gather information on how these organisms grew, what they ate, the environment they lived in and even some aspects of their behaviour and how they interacted!

For example, studying fossilised faeces of an animal can give evidence about what an animal used to eat.

By working out which plants used to grow during a particular time period in Earth's history, scientists can work out what the climate was like during that time. We now know when there were ice ages where the whole Earth was covered in ice for thousands of years, and when it was warmer and there were droughts.

This may just look like a colourful rock, but it is actually fossilised wood. It was created millions of years ago when a forest was buried under mud.[3]

This is a close up photograph of a fossilised tree trunk. It is not wood anymore but has turned to stone over millions of years. Can you see the rings?![4]

This is a fossilised fern.[5]

DID YOU KNOW?

Ferns are actually prehistoric plants! Ferns are some of the oldest surviving organisms on Earth as they were around when dinosaurs walked on our planet.

A fossilised footprint can tell lots of things about a prehistoric animal, such as how much it weighed, how big it was, and even what speed it was running at!

Can you see the dinosaur tracks?! [6]

The layers of rock which are lower down will be the oldest as they were deposited first. So the fossils in these layers will be from earlier times than fossils in rock layers which are closer to the surface.

How did the bodies of animals and plants get into the rock?

Have you perhaps seen the body of a dead bird? Dogs, flies, ants and beetles all take away the parts of the body. The wind blows away the feathers and soon there is nothing left to see.

But sometimes it does not happen like that. Imagine an animal died in a river. There was a flood and the river quickly covered the body with sand. In years after that, more floods brought more sand and put it on top. The heavy sand pressed down on the bottom sediments. Slowly, the bottom sediments became sedimentary rock.

VISIT

How are fossils formed?

goo.gl/qyZTC

Let's try make our own model to understand how fossils are formed in sedimentary rock!

ACTIVITY: How to make a model of a body fossil

Fossil-hunters look for fossils in sedimentary rock. They never know whether they will find a fossil or not. They have to split open the rock layers to see any fossil. You are going to make a model of some rock that you will split open.

You will need to mix the plaster of Paris and get it ready for the learners. Show the learners how you do it, because this is part of their technology knowledge in the processing strand. Mix enough for two or three groups at a time, because it starts to set (harden) quite soon after you add the water. If you cannot get plaster of Paris, then get screed mix from a building supply shop. This is cement, mixed with very fine sand. Another material you can use is putty, also from a building supply shop or hardware store. Mix cement powder or Polyfilla with the putty to make it harden quickly. A fourth material you can use is salt dough. You mix a cup of cake flour with half a cup of water and add a teaspoon of salt. Mix the flour and water until you have a stiff dough that you can shape. Finally, a material you can use is river clay; make it stiff so that it can keep the shape of a bone or leaf. Let it harden in the sunshine.

MATERIALS:

- small container: a plastic dish that you can cut up, or the bottom of a milk carton
- a leaf with ribs that stand out, or
- an animal bone, for example, a chicken bone
- a little Vaseline
- plaster of Paris

INSTRUCTIONS:

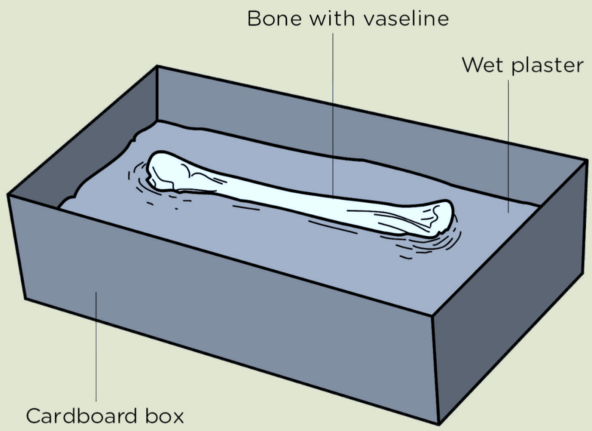
Each group must make a model rock with a fossil.

Of course, it's much more fun if every child can make his or her own fossil, so try to arrange the lesson for this to happen.

Day One:

1. First, spread Vaseline over the back of your leaf, or your chicken bone.

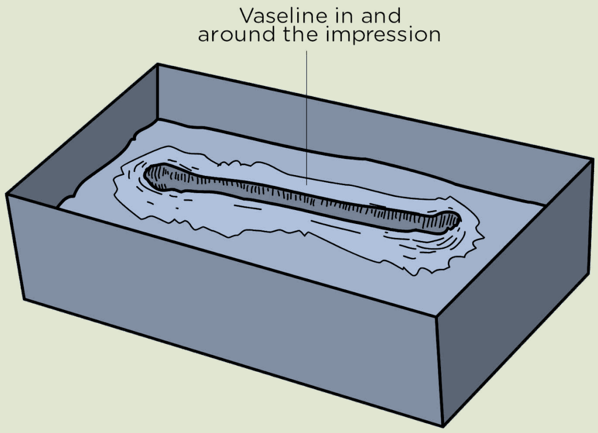
2. Next, take your cardboard container to your teacher. Pour the fresh plaster of Paris mixture into the container. The plaster of Paris will begin to set hard in about 10 minutes, so you must be ready with your bone of leaf.
3. Now put your leaf or bone onto the top of the wet plaster of Paris, and press it gently into the plaster. The bone must go in **only half-way** as you see in in the picture below. The leaf must go only far enough to leave the shapes of its ribs in the plaster.
4. Leave the plaster to set (to get hard). Notice how hot your container becomes while the plaster is setting.



Press the bone only half-way into the plaster.

Day Two:

5. First, pull out the leaf or the bone. It will come out easily because the plaster does not stick onto the Vaseline.
6. Now you have an **impression** of the leaf or the bone. An impression is like a footprint in mud.
7. Next, spread a very thin layer of Vaseline into the impression and around the impression, as you see in the picture below.

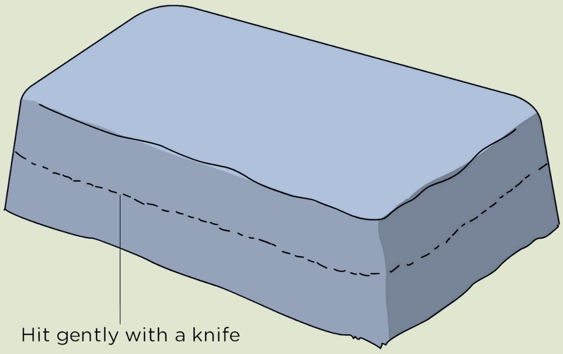


When you pull the leaf or bone out, you leave an impression in the hard plaster. Smear Vaseline into the impression and around it.

8. Then collect some runny wet plaster of Paris from your teacher and pour it over the Vaseline to cover the old plaster and fill the container almost to the top. Let the new plaster set for a day.

Day Three

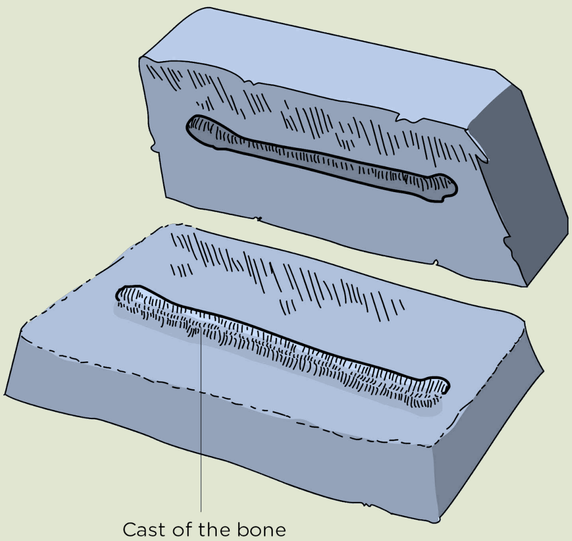
9. Tear off the cardboard or plastic container from the plaster 'rock' you have made. The fossil is hidden inside. You can paint the plaster to look like a rock.



Get a plaster 'rock' from another group, and tap gently on the side of their 'rock'.

Note that the mould has been turned upside down to get this out.

10. Now give your 'rock' to another group and get a different rock from them. Do not tell the other group what fossil is in your 'rock'.
11. Use the knife to tap gently on the edge of the 'rock'. Use a stick to tap on the back of the knife blade, so that you do not hit too hard.



You should find a cast of the bone.

12. Your 'rock' should split open if you tap in the right place. When it splits open, you will see a **cast** of a leaf or a bone on the top layer. The cast has the shape of the impression, but the impression goes inward and the cast stands up.

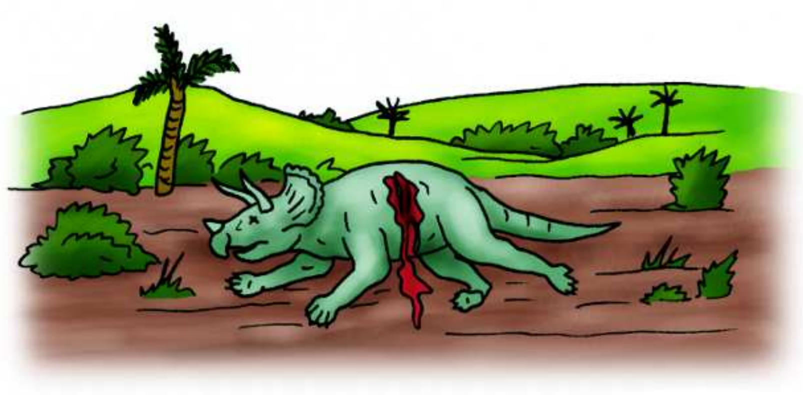
QUESTIONS:

1. Look carefully at the cast and try to draw the leaf or the bone as it really was.
2. Try to work out what kind of plant the leaf came from, or what kind of animal the bone came from.
3. Is the cast (the shape) really a bone, or really a leaf?
   No, it has kept the shape of the bone or leaf.
4. Do you remember learning about plaster of Paris in the second term in Matter and Materials? What properties of plaster of Paris make it useful in this activity?
   The plaster of Paris is wet and soft when you first mix the powder and water together. This is useful as it allows you to mould the plaster of Paris around the bone like the mud from long ago would have done. The plaster of Paris then sets and becomes very hard just as the mud and rock did over time. This is useful as it forms a cast of the bone which is hard and set.

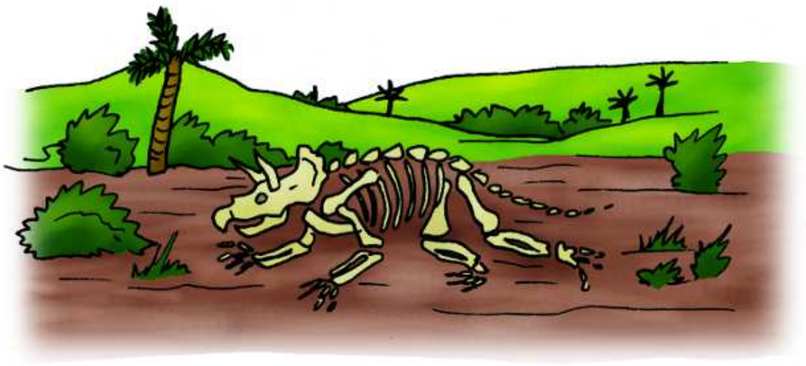
Now that you have seen you an impression of an object can be made by using plaster of Paris, let's have a closer look at how a dinosaur fossil was made millions of years ago.

Look at the pictures below and read the explanations for each stage of the fossil formation process.

Long, long ago, a dinosaur dies on the banks of a river, such as this triceratops in the picture.

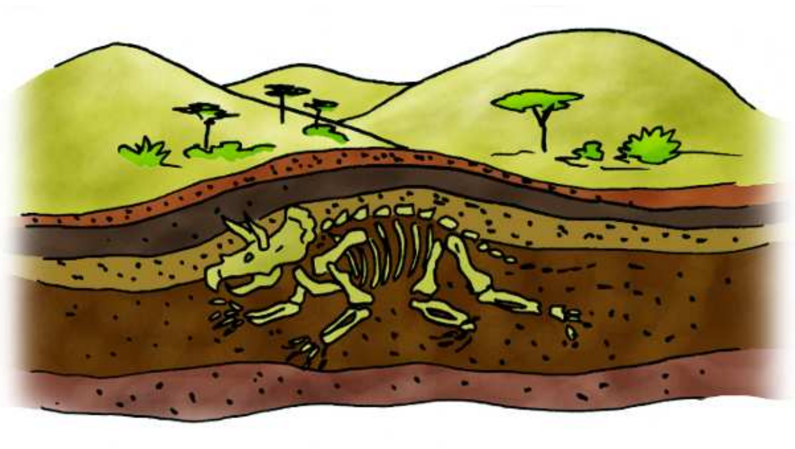


The flesh of the dinosaur decomposes, or other animals eat it. So, only the skeleton remains.



There was a flood and the river rose and covered the skeleton with mud and sand.

Over time, more floods deposit more layers of sand and mud over the skeleton. Over thousands of years, the bottom layers start to become compacted and turn into sedimentary rock. Under the ground, water carried substances from rock into each little space where a bone had been. Rock took the place of bone. We say the bones were fossilised. A fossil bone has the same shape as the original bone but much heavier.



Millions of years later, the conditions of the environment above the skeleton may change. The rock is eroded and weathered over time by wind and water and the fossil is exposed on the surface. A scientist sees the fossil and a great discovery is made!

Other scientists join in and they excavate the fossil by carefully removing the rock and sand around the skeleton. The fossils will be carefully packed and taken to a museum or research centre where the scientists will study them to see what they can learn about prehistoric life. They will try to reassemble the bones into a full skeleton - this may take many months to do!

VISIT

Fossilisation video

goo.gl/b906Z

4.2 Body and trace fossils

New Words

- body fossil
- trace fossil

We have seen many different fossils so far in this chapter. These fossils can be divided into two groups:

1. Body fossils
2. Trace fossils

A body fossil shows you the shape of the body of the plant or animal. Body fossils include teeth, bones, shells, stems, leaves and seeds.

Sometimes an animal left only a sign that it has been there. For example, if you walk across wet cement, you might leave a footprint which will be preserved in the cement when it hardens. Look at the picture below.

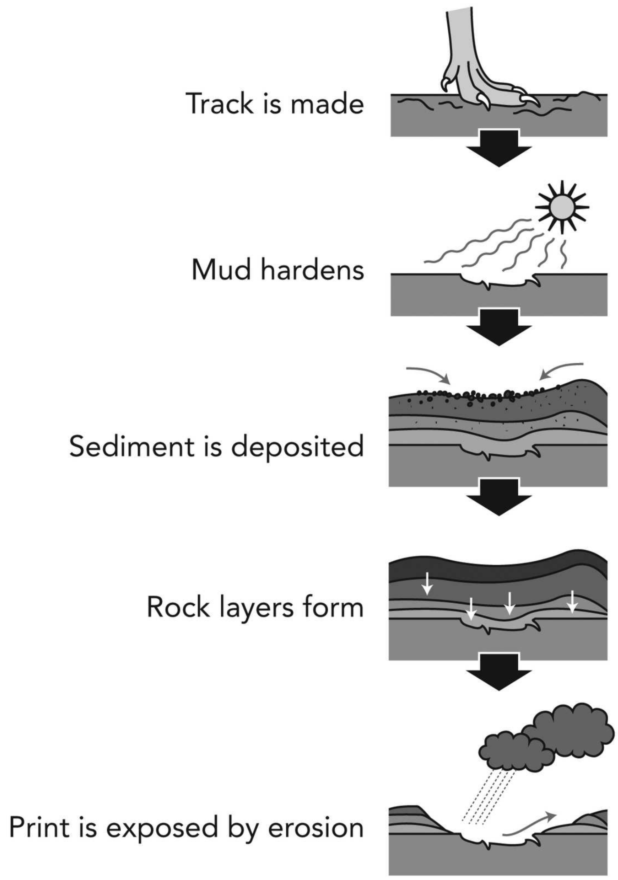
A footprint which has hardened in the cement [7]

A dinosaur left its footprints in the mud, and the mud turned to rock. This is a trace fossil. [8]

We said that body fossils are the preserved remains of the *body* of an animal or plant. So what about things like fossilised footprints? Fossils of footprints, egg shells, and nests, for example, are all remains of the *activity* of an animal. We call these **trace fossils**.

Some ancient animals, like dinosaurs may have walked across wet mud and left footprints in the mud, like in the picture below. The dinosaur leaves a trace behind. Over millions of years, this footprint can be preserved and become a trace fossil.

QUESTIONS



Trace fossils were also made from animals nests, eggs and droppings.

A body fossil would be in the form of the organism that has fossilised. A trace fossil indicates evidences other than a fossilised body part, that indicates the existence of an organism, such as burrows, trails, eggs, nests, and fecal matter (dinosaur poop).

Some fossils of ancient organisms look similar to plants and animals that are alive today.

Picture of some marine fossils which look very similar to the shells we get today.[9]

4.3 Importance of South African fossils

Did you know that South Africa is world famous when it comes to important fossil finds. South Africa has a very rich fossil record of plants, animals and early humans. Let's take a look at some of these.

QUESTIONS

Do you know of any important fossil findings in your area? If so, write it down below. If not, find out where the nearest fossil finding is to you and write it down.

Earliest life forms

Some of the most ancient fossils that are known to exist were found in rocks in Barberton area in Mpumalanga.

Do you know where this is in South Africa? Look it up on a map! These fossils are more than 3000 million years old! That is very, very old. They look like blue-green bacteria. Do you remember when we discussed microorganisms in the soil in Chapter 2? Bacteria are a kind of microorganism.

VISIT

What is bacteria? (video) [10]

QUESTIONS

What do you know about bacteria so far? Go on a fact-finding adventure to see if you can find just two more facts about bacteria. Think about where you find bacteria, if they are good or bad for humans, and what they look like. Can you name any other kind of bacteria?

Learners can mention, for example, that bacteria make up a large group of microorganisms, and each is made up of only one cell. Bacteria are everywhere: in our food, in the soil, and even in our bodies. They are microscopic which means they are very small and you can only see the individual bacterial cells under a microscope. Some bacteria are helpful while some can cause disease.

Earliest plants

Do you know where Grahamstown is in the Western Cape? Grahamstown is famous in the archaeological world for having some of the oldest and best preserved fossils of early plants from millions of years ago.

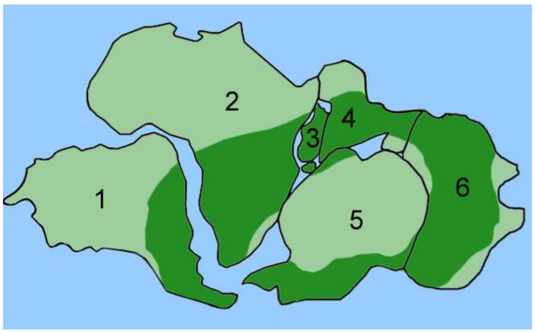
Look at the shape of Africa and South America on the classroom globe. The shapes could fit together like in this picture below. This diagram shows how scientists think the continents of Earth used to look millions and millions of years ago. This was called Pangaea.

A South African scientist thought that perhaps Africa and South America had been joined together long ago. But nobody knew if this was true.

New Words

- Pangaea
- Glossopteris
- therapsids
- ancestor
- coelacanth

Then scientists found fossils of a plant called *Glossopteris* in rocks in South Africa and they found fossils of the same plant in South America. This made more people think that perhaps Africa and South America were once joined, very long ago. The image below shows how scientists think the plant *Glossopteris* used to grow in the world, in the dark green.



Pangaea, showing the distribution of Glossopteris in dark green.

QUESTIONS

Which number represents South America and which number represents Africa today?

The number 1 represents South America, and 2 represents Africa.

These are fossils of Glossopteris leaves.

QUESTIONS

Do you think this fossil of *Glossopteris* leaves is a trace or body fossil? Explain your answer.

This is a body fossil as the leaf was covered in mud and then over time turned into a fossil. It is not an imprint, but the actual hard part of the plant has been preserved.

Dinosaurs

Fossils of dinosaurs have been found all over the world. But, one of the best places in the whole world is the sedimentary rock in the Drakensberg Mountains and the Maluti Mountains in southern Africa.

QUESTIONS

Where are the Drakensberg Mountains located in South Africa? Write down the provinces' names.

The Drakensberg are located mostly in Kwa-Zulu Natal and Mpumalanga.

Mammal-like reptiles

Reptiles came before mammals. However, the fossil record shows us some animals which were similar to mammals as we know them today, but they were actually reptiles. They were in between! They are called therapsids. Fossils of these animals have been found in the Karoo in South Africa.

Fossils of some of the first mammals on Earth were also found in the Drakensberg rocks in the Eastern Cape and in Lesotho.

A fossil of a therapsid that was found in the Karoo.
A therapsid is a small dinosaur with some features of mammals.[11]

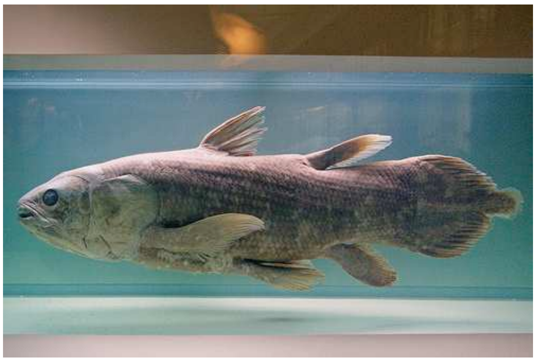
QUESTIONS

Where is the Karoo? A town in the Karoo is Graaff-Reinet. Find this town on the classroom globe. Find it on a map. Name some other towns found in the Karoo.

Somerset East, Willlowmore, Jansenville, Aberdeen

A strange fish that lives in the sea near South Africa

Look at the picture below. This fish that was caught in the sea near East London. The fish is called a coelacanth.



A preserved coelacanth in a museum [12]

VISIT

Finding the coelacanth (video)

goo.gl/pu6Ia

Scientists from other countries rushed to South Africa to see this coelacanth fish. They could not believe that any coelacanths still lived in the sea. The scientists knew about coelacanths because they had studied their fossils in England and Germany, but the fossils were 80 million years old. The scientists thought that coelacanths had all died millions of years ago! We now call coelacanths "living fossils"!

QUESTIONS

How is this fish different from other fish? Look at its tail and its front fins.

The tail is thick and fleshy. Four of the fins have flesh and scales on them; they look almost like legs. Scientists who had studied the fossils wondered about these "legs". They wondered whether this fish was the ancestor of four-legged animals that live on land.

The Cradle of Humankind

VISIT

Coelacanth discoveries (video)

goo.gl/clYvX

The Cradle of Humankind is a World Heritage Site. It is called the "Cradle of Humankind" as many people and scientists now believe that this was where humans first evolved. The birthplace of humans is right in our country!

I just love learning more and more about what makes our country so special and wonderful.

We can be proudly South African!

QUESTIONS

What does it mean if a place is a World Heritage Site? Find out and write your answer below.

It is a natural or man-made site, area, or structure recognised as being very important internationally and must therefore be protected.

The Cradle of Humankind is found in Maropeng just outside of Johannesburg in Gauteng. The name Maropeng, a Setswana word, means "return to place of origin".

The museum at Maropeng, Cradle of Humankind [13]

In the Cradle Of Humankind about 1000 fossils of pre-humans have been discovered, dating back to millions of years!

Altogether there are 15 major fossil sites in the Cradle of Humankind. The Sterkfontein Caves is the most famous. Swartkrans and Bolt Farm are also sites at Cradle of Humankind where fossils have been found.

The entrance to Sterkfontein Caves is down a long, winding staircase. [14]

VISIT

The Cradle of Humankind website

goo.gl/ZDkU7

The fossils of `Mrs Ples' and `Little foot' were both discovered at Maropeng. Thousands of hominid fossils (hominids are human ancestors) as well as plants and animals have also been discovered there.

The cranium of an Australopithecus Africanus found in Sterkfontein caves at Maropeng

Tourists come from all over the world , including South Africa, to view the caves and fossils at the Cradle of Humankind and get immense knowledge on the history of humankind. If you live in or near Johannesburg, maybe you have been lucky enough to visit Maropeng and the Cradle of Humankind?!

ACTIVITY: Thinking about the Cradle of Humankind

Use the information above on the Cradle of Humankind to answer the questions below.

1. Why is the Cradle of Humankind famous?
   Important fossils in the history of mankind have been found there.
2. Explain why you think it is called "The Cradle of Humankind".
   This is because Maropeng is thought to be the birthplace of modern humans. Humans are thought to have evolved from Africa.
3. Give the names of two of the most famous hominid fossils that have been found at the Cradle of Humankind.
   Mrs Ples and Little Foot
4. Explain why you think the fossils at Maropeng are protected by the country's law.
   The fossils are very important as they help explain the evolution of humans, hence they have to be protected lest they be moved or destroyed.
5. Which of the following is not one of the fossil sites in the Cradle of Humankind? Circle it.
   - Sterkfontein Caves
   - Cango Caves
   - Swartkrans
   - Bolts Farm

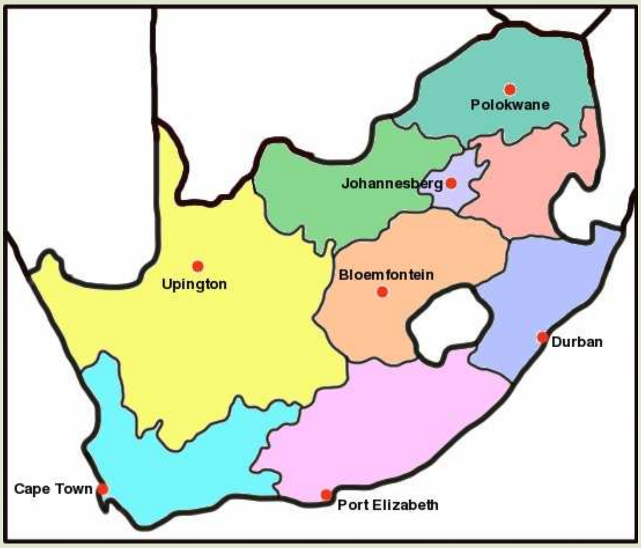
   Answer: Cango Caves
6. What does Maropeng mean?
   "Return to your place of origin"

As we have seen, there are many important fossil findings all over South Africa! Let's put all these places on a map in the next activity.

ACTIVITY: Plotting the important fossil sites in South Africa

INSTRUCTIONS:

1. Identify all the places that have been mentioned in this Chapter which are important archaeological sites in South Africa
2. Find these places on the map of South Africa and mark them in with an X and the name.
3. Next to the place names, write down the important fossils which were found there.



KEY CONCEPTS

- Animals and plants sometimes died in mud, and the mud kept their shape or preserved their remains.
- These remains of ancient plants and animals are called fossils.
- There are two main types of fossils - body and trace fossils.
- Fossils provide us with a record of the history of life on Earth.
- South Africa has a very important collection of fossils.

REVISION:

1. Are animal fossils made of bone? Explain what a fossil is.
   A fossil is stone in the shape of the bone. Substances from rock have taken the place of each little part of the bone.
2. Which type of rocks are fossils normally found in?
   Sedimentary rock
3. Why do you think we only find fossils in this type of rock?
   Sedimentary rocks can contain fossils because, unlike other rocks, they form at temperatures and pressures that do not destroy fossil remains. Dead organisms can become sediments which may ,over time, become sedimentary rock. Other rock types will destroy the fossils, such as magma.
4. Fossil wood does not burn. What is the reason?
   Fossil wood is made of stone.
5. Some rock comes out of a volcano. It is red hot and then it cools and becomes hard. Can you find fossils in rock like this? Why?
   No, because the red-hot rock would burn up any bone or plant that it fell on.
6. Name two fossils that show us the kinds of living things that lived long ago in South Africa.
   Massospondylus, therapsids, Glossopteris, etc.
7. Explain how you think fossils can help us understand what life was like long ago on Earth.
   Fossils give us a record of what life was like millions of years ago. We do not know what it was like as no one was there to write it down. So, fossils give us information such as what types of plants and animals lived long ago, how these organisms have changed over time, the effect of climate change on the Earth, we can even tell what animals ate from their fossils by studying their teeth and droppings.

That's all! We are finished with Gr. 5!!

Chapter 1 Stored energy in fuels

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