Natural Sciences and Technology

Grade 6-B

(CAPS)

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Natural Sciences and Technology

Grade 6-B

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 you 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 watch these links in your lessons, at home on a PC, laptop or on mobile phones.

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


Welcome to Grade 6 and to Natural Sciences and Technology!
Join the **Thunderbolt Kids** on an adventure to explore the world around us.

Hi there! My name is **Farrah.**

My favourite subjects at school are where I get to be creative and imaginative. But, did you know, this is not only in the art or drama classroom?! We can also be creative in the ways we do Science and Technology. This is especially true when thinking about new ways to answer a question with a science investigation or drawing a design to solve a problem.

I also really love being outdoors in the natural world around me. This is why I am going to go through **Life and Living and Processing** with you. This year we will learn more about the amazing fact that plants make their own food! I am also excited to learn about nutrition and how to be healthy. We will also process foods – I think I am going to make plum jam and decorate the lids to give as presents to my family.

Sophie is my best friend and she teaches me how to think carefully and solve problems using logic, which is a very good skill to have in Science. Although we can get on each other's nerves, just like best friends do, we have so much fun together and learn a lot from each other.

Hey! My name is **Tom**.

I have two places where I am most happy! The first is in the Science lab because this is where we get to be inventive and tinker away with projects and experiments! My second favourite place is the junk yard! Do you know how many interesting objects you can find there?! I use these objects in my latest inventions.

This is why I am really excited to be going through **Matter and Materials and Processing** with you. This year we are going to learn more about the states of matter, and some new topics such as mixtures and solutions. I am also really excited to design a system to purify water as I think this will be really useful to have!

I also really enjoy maths and thinking about how we can solve problems logically. Jojo is one of my best mates, although he can be very messy at times! But, Jojo helps me get involved with my whole body when trying to solve problems in our daily lives, and not just use my mind.

What's up! My name is **Jojo.**

I just want to dive straight into this year, and especially Natural Sciences and Technology. Sometimes though, I find it hard to sit still in class as I just want to get up and do things! My teacher often says I have too much energy and I battle to sit still in class. Maybe that's why I am going through **Energy and Change and Systems and Control** with you this year.

I am really looking forward to understanding more about electricity this year and why it is expensive. I have also heard that there are other ways to make electricity, besides burning coal, which are better for the environment. We will find out more later! The best part about Natural Sciences and Technology for me is that we get to learn actively. We have goals and questions which we want to answer and I am always the first to leap into action!

Tom and I make a very good team because he is very good at thinking and planning and then following a method. But, I think I can also help as sometimes Tom wants to think too much, whereas in Science and Technology you also have to get involved in the subject and start experimenting.

Hello! My name is **Sophie**.

One of my favourite places to be is in the school library. I love reading a new book – there is just so much to learn and discover about our world!

I am always asking questions and often these questions do not yet have answers to them. This is fascinating as we then get to make a theory about what we think the answer might be. This is why I really enjoy learning about outer Space as there is so much that we do not know. Throughout history people have been asking questions about Space and our place in the universe. I am going to go through **Earth and Beyond and Systems and Control** with you. Did you know that we only ever see one side of the Moon?! I am also excited to find out more about telescopes, especially since South Africa will be playing a major role in astronomical research in the future.

I also like expressing my opinion and debating about a topic. You have to give me a very good argument to convince me of your opinion! I love exploring with Farrah as she helps me to be more creative and imaginative in the way that I think. I can also be quite sceptical and do not believe everything I read. But, this is very important in Science as we must not always accept everything as fact.

Join the

Thunderbolt Kids

by adding your details here!

My name is:

My favourite subject is:

On the weekends, I love to:

My friends' names are:

One day, I want to:

STICK OR DRAW
A PICTURE
OF YOURSELF
HERE!

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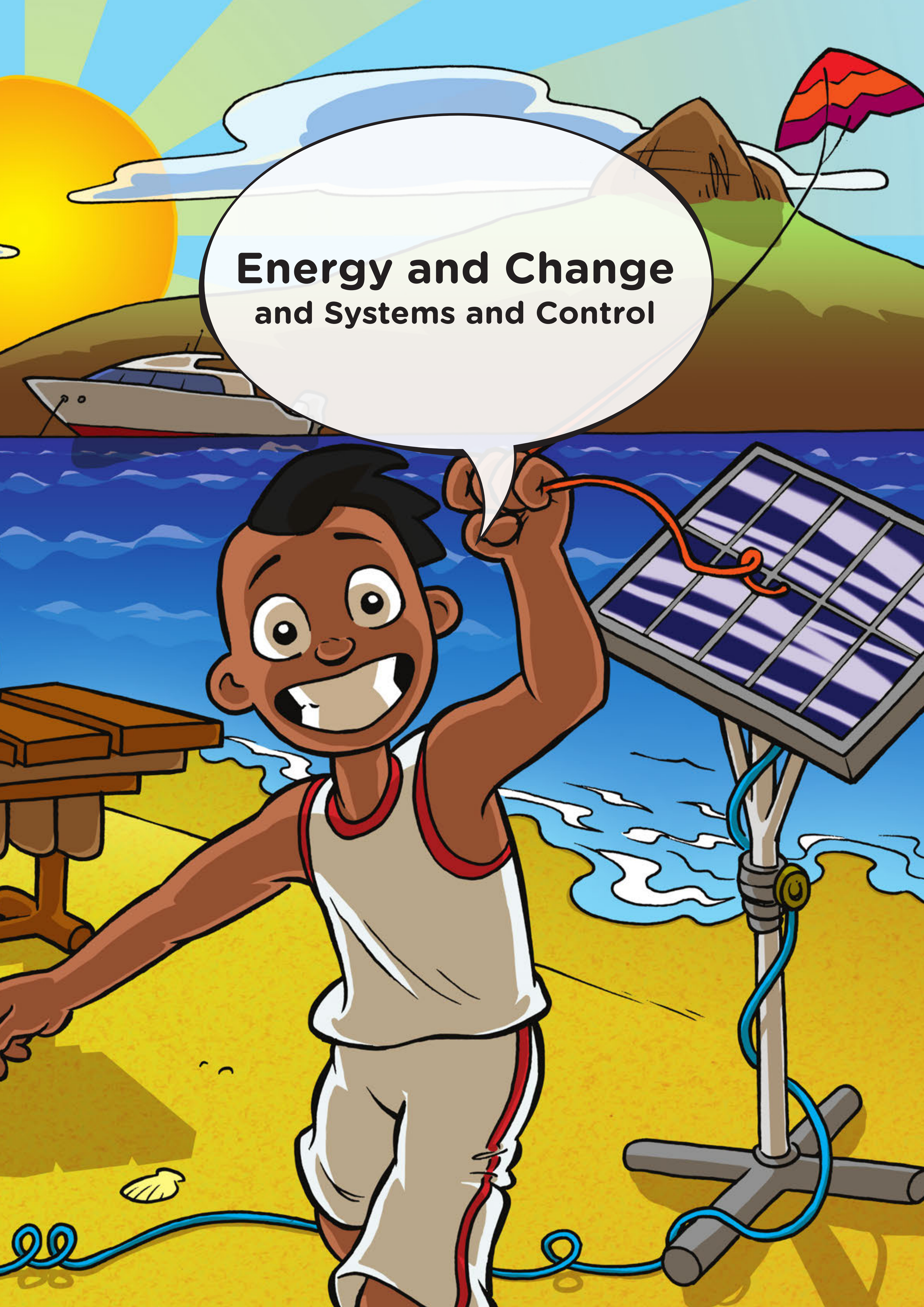

Energy and Change
and Systems and Control

1 Electric circuits

KEY QUESTIONS

- What is electricity?
- How do we construct a simple electric circuit?
- What are electric circuit components?
- What is the function of each circuit component?
- What is the difference between a closed and open electric circuit?

1.1 A simple circuit

If we think of the world that we are currently living in, one of the things that we encounter every day and almost everywhere is electricity.

ACTIVITY: What do you know about electricity?

Think about electricity and write your answers or responses in the spaces provided below.

QUESTIONS:

1. Name and draw five appliances in your home that need electricity to work.

New Words

- electric circuit
- electric current
- component
- device
- appliance
- battery
- switch

2. Name five applications (uses) of electricity in your neighbourhood.

3. Name five applications of electricity in your school.

4. Why is electricity important to you?

5. Why is electricity important for your city or town?

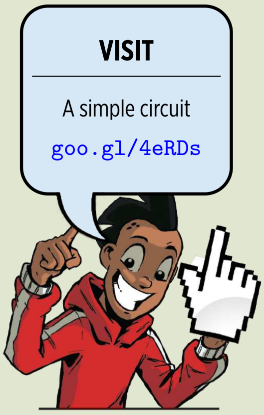
6. Why is electricity important for your country?

7. You are building a brand new house. You want an electric stove in your kitchen. Name all the things that must be done for your stove to work.

8. Cellphones work with electricity. How does your cellphone make use of electricity?

9. What is the difference between the way we can get an electric stove and a cellphone to work?

10. What would you say electricity is?



We are using electricity all the time. We need to understand what it is about and how to use it safely and correctly.

Have you ever used a flash light (torch)? What is it used for? How do you get the flash light to work? Let us try to get the bulb of a torch to work. We want to do this without using the torch itself.

ACTIVITY: How to get a light bulb to work

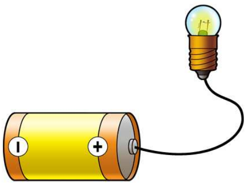
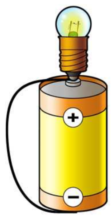
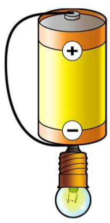
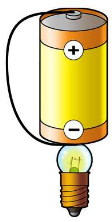
MATERIALS:

- D-size battery (1.5 V)
- torch light bulb
- three pieces of electric wire 15-20 cm long with the ends about 1 cm stripped of the plastic insulating material
- adhesive tape or Prestik
- piece of cardboard
- two thumbnails with metal (brass) tops (remove plastic if tops are covered)
- a metal paper clip (remove the plastic if covered)

INSTRUCTIONS:

1. Work in pairs.
2. The pictures below show four ways of connecting the battery

and the bulb using only ONE wire.
3. First predict if the bulb will light.
4. Then do the connection and test if your prediction was correct.

Circuit	**Prediction - Will the bulb light up? (Yes or no)**	**Experiment - Did the bulb light up? (Yes or no)**
		
		
		
		

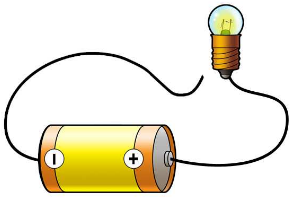
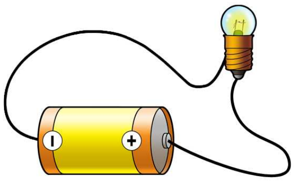
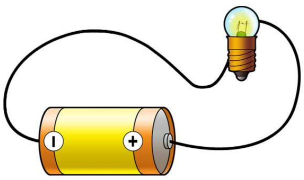
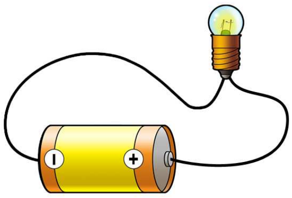
5. How many other ways can you light the bulb? Try different connections. Draw those that work and those that do not work in the table below.

Connections that work	**Connections that do not work**

6. Describe in words what you did to get the bulb to light.

7. You have just constructed a **simple electric circuit!** Let us now see if you can also find a way to light the bulb using two wires.
8. The next pictures show four ways of connecting the battery and the bulb with TWO wires.

9. Use adhesive tape or Prestik to keep the wires attached to the battery. Do the same as before:
10. First predict if the bulb will light.
11. Then do the connections and test if your prediction was correct.

Circuit	Prediction - Will the bulb light up? (Yes or no)	Experiment - Did the bulb light up? (Yes or no)
		
		
		
		

12. Try some more ways to connect the battery and the bulb with two wires. Draw one example of a setup that worked and one that did not work.

Setup that works	Setup that does NOT work

13. You have constructed another example of an electric circuit!
14. Describe in words what you have done to get the bulb to light in the case of using two wires.

____

____

Now that we have investigated different ways of making a simple circuit, let's define it in more detail.

QUESTIONS

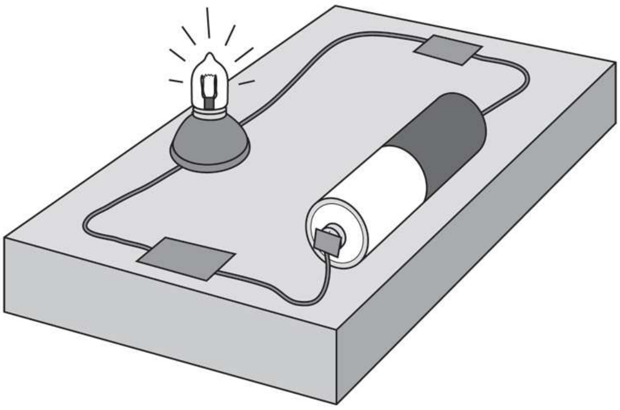
Electric circuits have different components. What does 'component' mean? Look up the definition for component in your dictionary and write it below.

____

____

A simple electric circuit has at least three components:

1. A source of energy, such as a battery.
2. Conducting material, such as the electric wires.
3. A device that transfers the energy for a useful purpose, such as the bulb that provides light.



A simple circuit

Do you think there is something flowing through the bulb when it lights up? When we connect the bulb so that it lights up there is something flowing through the whole circuit. When it does not light up, we have not made a proper or complete pathway for electricity. This flowing `thing' is called electric current. If the bulb lights up, we say there is an electric current in the circuit. The electric circuit is a system for transferring energy. Think again about the circuits that you have constructed so far.

QUESTIONS

What are the conditions for the bulb to light up?

___

___

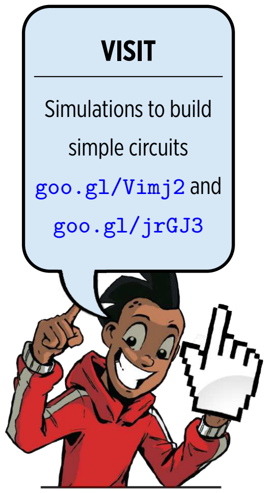
___

Let us look at the torch once more:

1. Is the bulb providing light all the time?
2. When does it provide light and when not?
3. What do we call the component of the flashlight that allows us to turn the light on and off?

A switch is used to put an electrical device on or off. But how does it work?

This is a typical torch - the big red button is the switch.



ACTIVITY: Investigating how a switch works

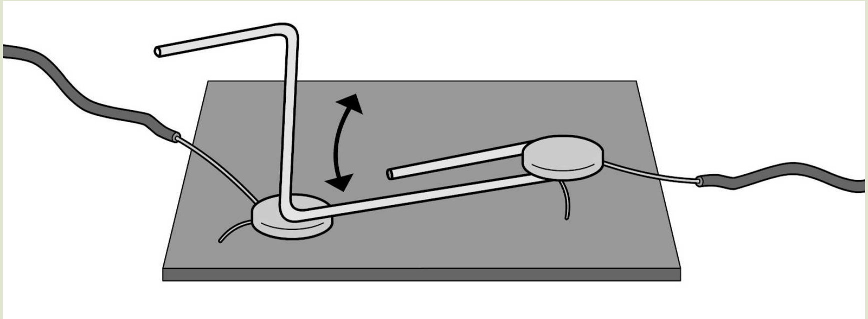
MATERIALS:

- a paperclip
- two thumbnails (drawing pins)
- a piece of cardboard
- a torch bulb
- 3 pieces of wire
- batteries

INSTRUCTIONS:

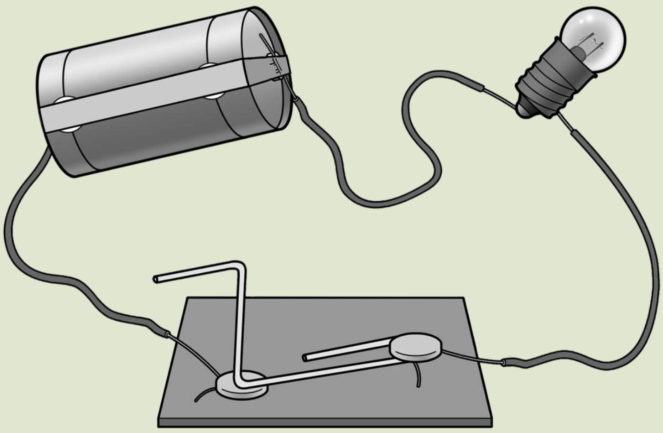
1. To make the switch, bend the paper clip as shown in the diagram.
2. Pin the ends of the two wires down on the cardboard with the thumbnails. One of the thumbnails should also pin down the paper clip.
3. The other end of the paper clip can be moved to make contact with the second thumbnail or not.

4. Move the paper clip away so that it does not make contact with this thumbnail.



The switch

5. We now want to use the switch. Use the same setup for a simple electric circuit with a bulb, battery and 2 wires as you did in the last activity.
6. Connect the paperclip switch to the battery by using a third electric wire. Remember to keep the wire ends in position with cellotape or Prestik.



The setup with the switch and simple circuit

QUESTIONS:

1. Move the paper clip onto the second thumbnail. What happens?

2. Move the paper clip away from the second thumbnail? What happens now?

3. Explain why you think the paper clip and cardboard device can be called a switch.

VISIT

Making a battery from a lemon (video)

goo.gl/YL7WR

We already said that a switch is used to turn an electrical device on or off. We can also say that a switch is used to close or open an electrical circuit. When the switch is on, the circuit is closed. An electric current then exists in the circuit. We could also say there is an unbroken electric pathway in the circuit.

When the switch is off the circuit is open. In this case there is no electric current in the circuit. The electric pathway is now broken.

QUESTIONS

Name four other electrical appliances in your home that has a switch.

Circuit components

We need to have a closer look at the components in the electric circuit. This will help us to understand how a circuit works.

ACTIVITY: Batteries come in all shapes and sizes

MATERIALS :

- a selection of different batteries, such as:
  - a torch battery
  - a watch battery
  - a cellphone battery
  - a hearing aid battery
  - a car battery (or photo)

INSTRUCTIONS:

1. Look at a typical torch battery.
2. Describe in words what the battery looks like. Refer specifically to the ends of the battery.

---

3. Look carefully to see if you can identify a positive (+) and a negative (-) sign on the battery. Which side of the battery is marked with a positive sign and which side with a negative sign?

---

4. Look at this image of a typical torch battery. Indicate on the image which is the positive and which the negative pole of the battery. Use a (+) and (-) sign as you have seen it on the battery.

5. Batteries come in all shapes and sizes. Look at the pictures below of different batteries.

Different sized and shaped batteries

6. You may be lucky enough to have different types of batteries in your class, such as from a watch, a cellphone or a car. If not, ask an adult in your family to show you a car battery, a cellphone battery and a battery used in a watch after school.
7. Draw sketches of such batteries below. Indicate on each sketch the positive and the negative pole of each kind of battery. Below are some photos to help you if you cannot find these batteries.

Car battery	**Cellphone battery**	**Watch battery**

A car battery

Watch batteries: these are quite small!

For some appliances it is very important that the batteries are put correctly into a specific position. Why do you think this is the case? This is because the battery is used to get an electric current in the appliance and in some appliances the electric current can only go in a specific direction through the appliance. To prevent the appliance from being damaged, the battery must be inserted in the correct direction.

ACTIVITY: Investigating bulbs

MATERIALS:

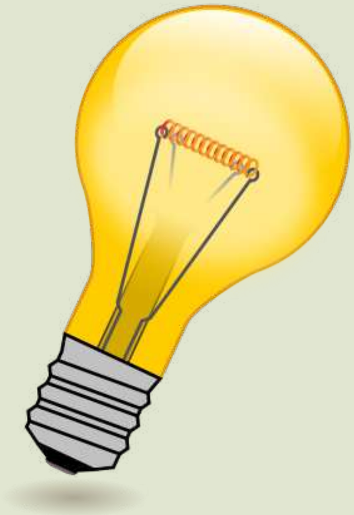
- a torch bulb used in the simple circuit activity
- a light bulb for a house fitting

INSTRUCTIONS:

1. Compare the bulb that you used for the circuits with a light bulb that is used in a light fitting in a house or in your classroom. Here is a close up of a light bulb used in a house fitting if you do not have an actual one.

A light bulb

2. Try to identify the following six parts of the bulb: glass cover, bottom metal casing, two metal pins, very thin wire between the metal pins, glass piece that keeps the metal pins in position and a metal contact point at the bottom. Label all parts of the bulb on the sketch below.



3. Assume the bulb is connected to a battery. Use a bright colour pencil or pen (red if possible) to draw the path of the electric current through the bulb.

4. We know now that a bulb lights up when it is connected correctly to a battery. Where in the bulb does the light come from?

---

5. How does the glass cover feel after the bulb was on for some time?

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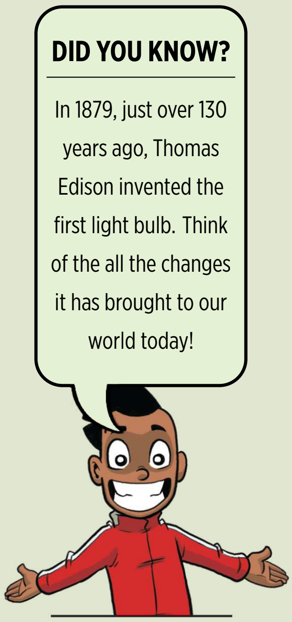
6. There are also other kinds of light emitters: Fluorescent, LEDs, halogen lamps, etc. See if you can identify what type of lights are used in your classroom.



The battery is the source of energy. Some of the energy is transported through the electric wires to the thin wire inside the bulb. The thin wire becomes hot and emits (gives off) light. From the thin wire, the energy dissipates to produce heat and light. **So, chemical energy from the battery is transferred to the bulb to provide light and heat.**

ACTIVITY: Let's look more at electric wires

MATERIALS:

- conducting wires

INSTRUCTIONS:

1. Look carefully at the end of a piece of electric wire, or else look at the photo below.
2. Examine the inside and outside of the wire.

The end of this wire has been stripped of the plastic.

QUESTIONS:

1. What are the two materials shown in this photo?

2. Why does the wire have different materials on the inside and the outside? What are the functions of the inside and outside materials?

We have already discussed and constructed a switch, but a light switch in a house looks a bit different.

A light switch

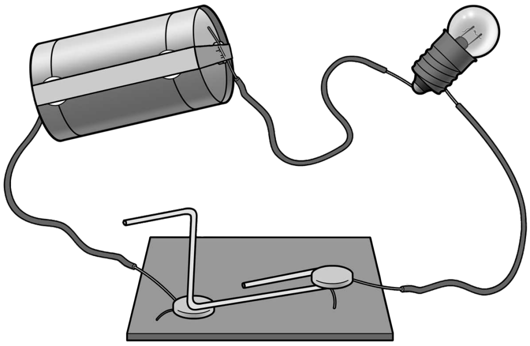
QUESTIONS

Describe in words how you think a light switch in your house works. Hint: look again how we made a switch with a paper clip.

1.2 Circuit diagrams

If we want to keep a record of how we constructed a specific electric circuit, we can take a photo of it. If we do not have a camera, we can remember the circuit by drawing a sketch.

Look at the sketch below which Farrah drew of the circuit that you made in the activity with the paperclip switch.



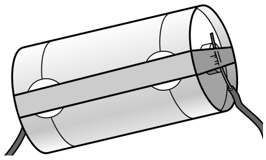
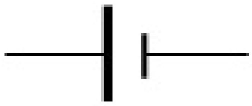
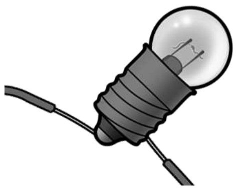
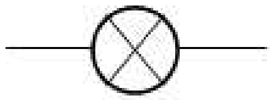
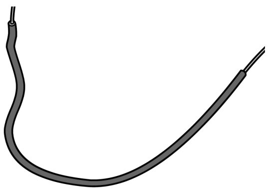
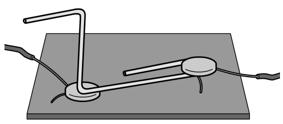
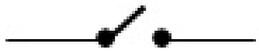
A sketch of the simple circuit with a paperclip switch, battery and bulb

Hey, but I can't draw as well as Farrah! It would take me forever to draw a sketch of the circuits we have made in class!

That's right Jojo. It takes time to draw a sketch like this one that Farrah drew. It will even take longer if we add more components to a circuit. We could have more than one bulb like in the case of all the lights in your home. There could be also more than one switch. Each light in your home has its own switch.

As Jojo pointed out, all of us do not draw equally well! To save time and to avoid bad sketches, scientists came up with a way of representing the components of a circuit with special symbols. These symbols are used all over the world. It helps scientists, engineers and technicians to draw or record circuits more quickly. It also helps everybody to understand the circuit in the same way.

The table shows the sketch Farrah drew and the symbol for each of the components of our circuit.

Component	**Sketch**	**Symbol**
Battery		
Bulb		
Electrical wire		
Switch		Open switch, circuit open:  Closed switch, circuit closed: 

REMEMBER: a battery is made up of chemical cells. Sometimes people refer to batteries as *cells*, but in this book we will mostly use the term *battery* or *batteries*.

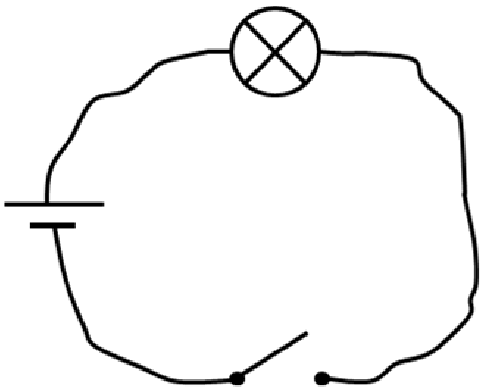
That's much better! I can definitely draw these easy symbols for circuit diagrams!

When we put these symbols together to represent an electric circuit, we call it a circuit diagram.

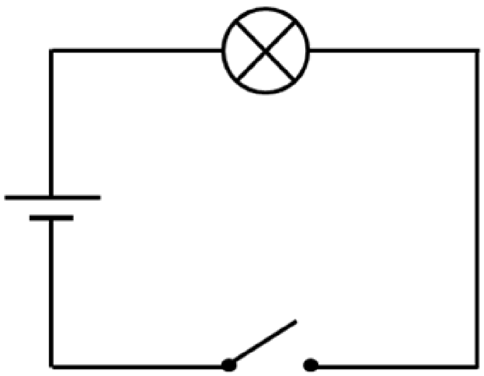
QUESTIONS

Draw a circuit diagram of the sketch above. Use the symbols in the table in place of sketching the components.

Compare your diagram with the one below. You might have drawn a diagram like the one below.



Take note that for electric circuit diagrams we represent the wires with straight lines.



This is a simple and quick way to represent an electric circuit and it should be clear to everyone that this circuit has a battery, a bulb and a switch, all connected with electric wires. Although we draw the wires as straight lines in a circuit diagram, remember that in real life, the wires are not straight. Just think of the electric wires that are attached to the appliances in your home, like to a kettle, a lamp, a vacuum cleaner or a computer.

ACTIVITY: Swap the components

MATERIALS:

- circuit components (battery, wire, bulb, switch)

INSTRUCTIONS:

1. Think again about our electric circuit and the diagram above. We have the battery on the left, the bulb at the top and the switch at the bottom.
2. Assume we swap the bulb with the battery. The bulb is now on the left and the battery at the top.
3. First of all, draw the circuit diagram for such a setup.

4. Predict what will happen if you close the switch.

5. Set up the circuit like this with the components you used before. Put the switch on and check if your prediction was correct. What do you conclude? Does it matter where in the circuit we position the components?

Let's now practise drawing circuit diagrams.

ACTIVITY: Drawing circuit diagrams

INSTRUCTIONS:

For each of the following, draw a circuit diagram in the space using all the components that are listed.

1. A circuit with 1 cell and 2 bulbs

2. A circuit with 2 cells and 2 bulbs

3. A circuit with 3 cells and 3 bulbs

4. A circuit with 3 cells, a bulb and an open switch

5. A circuit with 1 cell, 2 bulbs and a closed switch (the switch must be in between the bulbs)

KEY CONCEPTS

- An electric circuit is a system for transferring energy.
- A circuit is a complete and unbroken pathway for electricity.
- A simple circuit is made up of different components (a source of energy, conductors and a device).
- A circuit can have a switch to turn it on or off.
- Electric circuits can be drawn as circuit diagrams using symbols.

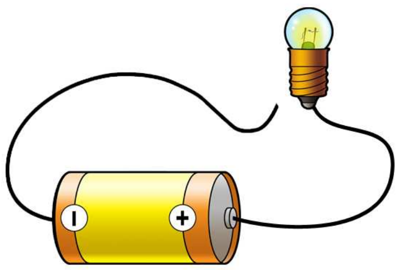
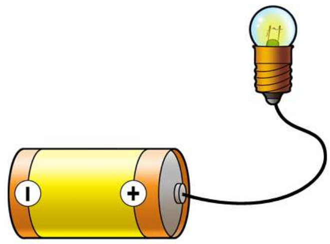
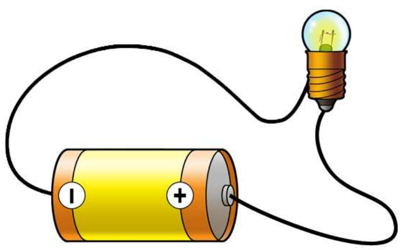
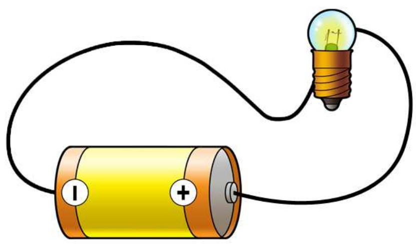
REVISION:

1. Explain in your own words what an electric circuit is.

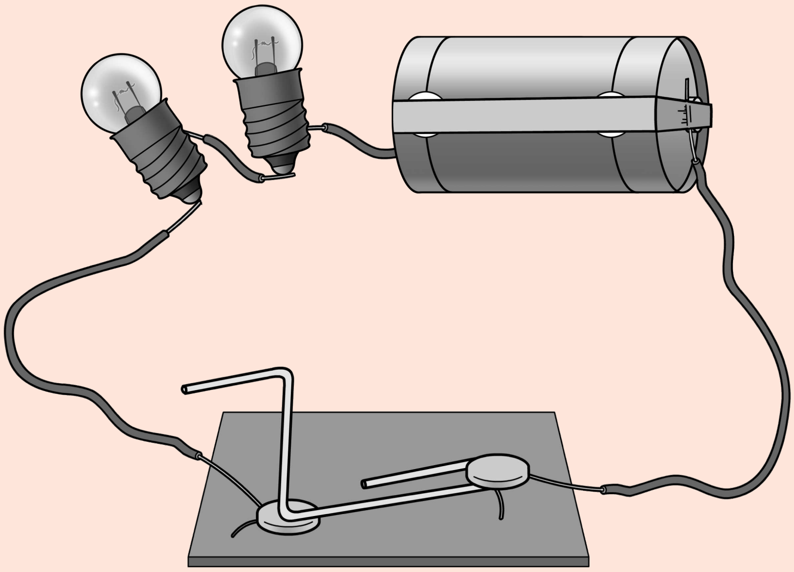
2. What is the function of each electrical component in the table below?

Component	**Function**
Electric wire	
Battery	
Switch	
Bulb	

3. In which of the following electric circuits will the bulb glow? Write yes or no next to each diagram. Write down a reason for your answer below the circuit.

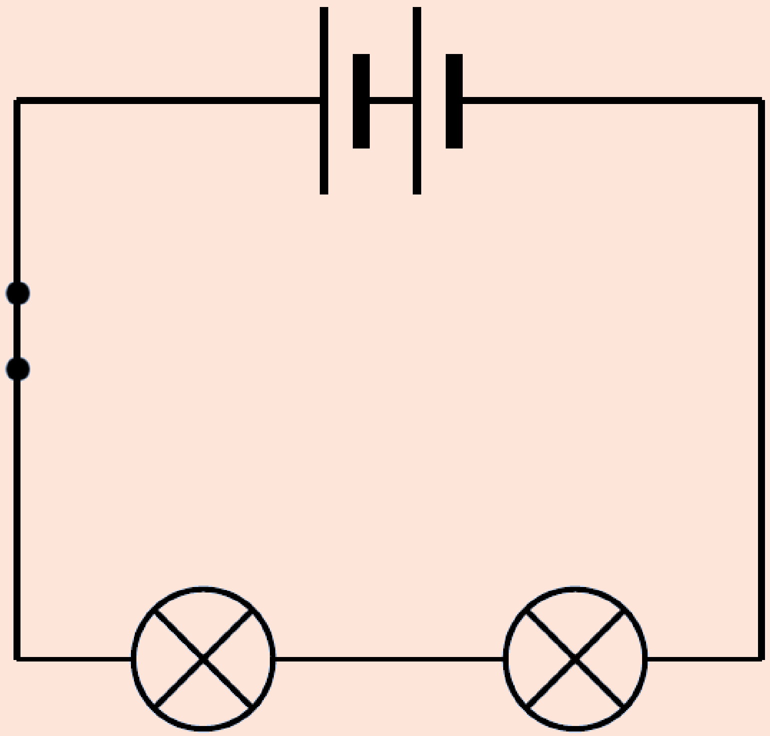
Yes or no:	**Yes or no:**
	
Reason:	**Reason:**
Yes or no:	**Yes or no:**
	
Reason:	**Reason:**

4. Draw a circuit diagram of the circuit shown below.



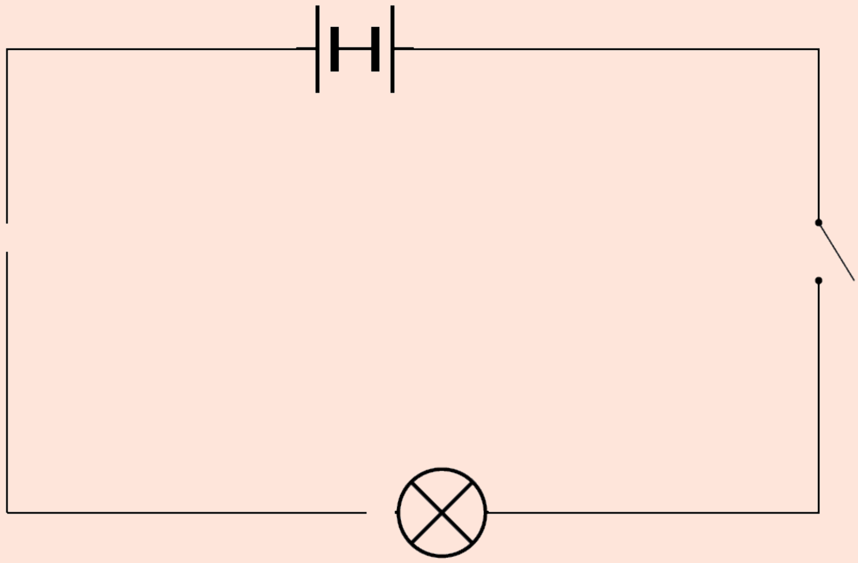
5. Look at the following circuit diagram. Write down all the components represented in this circuit. Include the number of

each component as well.



6. The circuit diagram in question 5 represents a real circuit. In the real circuit, are the bulbs lit up? Why do you say so?

7. Look at the following circuit diagram. The bulb does not light up for four reasons. Draw a circle around the parts of the circuit that prevent the bulb from lighting up. Give a reason why the bulb doesn't light up in each case.



8. The circuit diagram in question 7 represents a real circuit. Use the space below to draw what the real circuit might look like, if all the problems with the circuit were sorted out.

I hope you enjoyed drawing circuit diagrams too!

Let's find out more about electrical components.

2 Electrical conductors and insulators

KEY QUESTIONS

- What does it mean if something conducts electricity?
- What is the difference between an electrical conductor and insulator?
- Why are insulators important?

We use electric wires in electric circuits. Did you have a close look at the wire? Did you notice what materials are used on the inside and outside of the wire? We should also know why two different materials make up an electric wire.

New Words

- conductor
- insulator

2.1 What are conductors and insulators?

We can say that a material or object conducts electricity or it does not. But what does this mean? Let's do an investigation to find out. To do this we are going to use a simple circuit. We will connect pieces of different materials into a closed circuit with a light bulb in it. We can easily see if the material is a conductor.

QUESTIONS

How will you know if the material in the simple circuit conducts electricity?

____

____

____

INVESTIGATION: What kind of materials can we use in electric circuits?

AIM:

1. Write down an aim for this investigation.

____

____

MATERIALS AND APPARATUS:

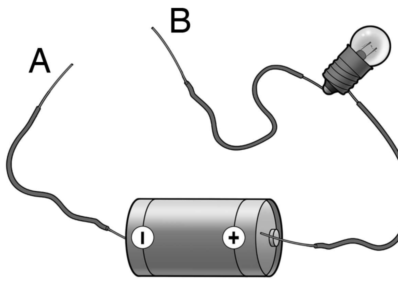
- D-size battery (1.5 V)
- torch light bulb
- three pieces of electric wire 15-20 cm long with the ends (about 1 cm) stripped of the plastic insulating material
- adhesive tape or Prestik
- various objects made of different materials like:
  - metal paper clip (remove the plastic if covered)
  - paper clip covered with plastic
  - rubber band
  - nail
  - glass object (rod, tube or just a piece of glass)
  - pen
  - coins (brass and silver)
  - cardboard
  - paper (fold the paper to form at least 4 layers to make it easier to connect in a circuit)
  - steel wool
  - piece of wood
  - pencil (contact points on the wood)
  - pencil with both sides sharpened to expose the lead, test the lead part of the pencil
  - rubber
  - chalk
  - piece of ceramic
  - aluminium foil
  - metal spoon
  - plastic spoon
  - piece of leather
  - drinking straw
  - styrofoam

METHOD:

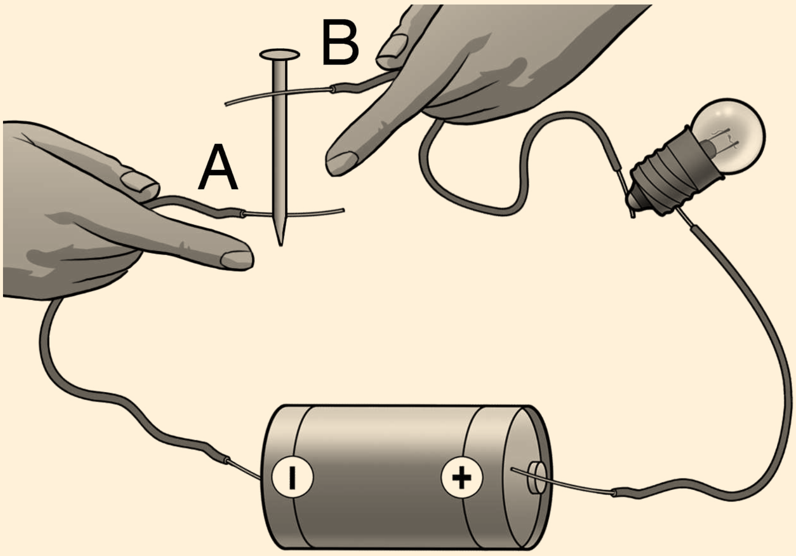
1. Use three electrical wires to set up the electric circuit as shown below. Note that the ends of two of the wires are not touching. What do we call such a circuit?

---

2. Draw the circuit diagram for the circuit shown in the sketch in the space on the right of the sketch.

Sketch	**Circuit diagram**
	

3. Test that the circuit is connected properly by touching A and B to each other and making sure that the bulb lights up/
4. Take the first one of the objects in the list above. Put the object between the two wire ends at A and B.
5. The sketch below shows how to do it. Make sure there is good contact between the object and the wire ends.



Test each object as shown here with the nail.

6. Does the bulb light up or not? Write the name of the object in the left or right column of the table below, depending if the bulb lights up or not.
7. Repeat for all the other objects in the list.

RESULTS AND OBSERVATIONS:

Record your results below

Bulb lights up	Bulb does not light up

1. What do the objects that lit up the bulb have in common?

____

____

2. What do all the objects that did not light up the bulb have in common?

____

____

CONCLUSION:

Write a conclusion for this investigation below.

____

____

If the circuit is closed, the bulb lights up. We have learnt before that in such a case there is an electric current in the circuit. A material that allows a path for an electric current is called an electrical conductor. The material conducts electricity.

QUESTIONS

1. What type of materials did not light up the bulb?

____

2. Although the circuit seems closed, the bulb did not light up. What does that mean?

____

In this case the path for the electric current is broken. We call a material that does not allow a path for an electric current an insulator.

2.2 Good electrical conductors and insulators

A good electrical conductor is a material or substance that allows an electrical current to pass through it easily. We call the ability to conduct *conductivity*. Electrical conductors are usually metal because metals generally have high conductivity. Copper is one of the best electrical conductors and this is why it is the most common material used for electrical wiring. Gold and silver are even better conductors than copper, but they are very expensive and only used sometimes.

Insulators are non-conducting materials that do not easily allow current to pass through them. This does not mean that current can not pass through them at all. For example, we generally consider air an insulator, however, lightning can cause electric current to pass through air. Similarly, rubber gloves and shoes will protect you from mains electric current, but not from lightning. Examples of insulators are plastic, rubber, and wood.

When two conducting materials make contact, electricity can pass through them. Our bodies are also good conductors of electricity. This means electric current can easily flow through you and into the Earth, giving you a shock. That is why we cover conducting wire with insulating materials (like the plastic around extension cords). We want to protect ourselves from being shocked, and prevent the electrical current from passing to other conductors.

The importance of electrical insulators

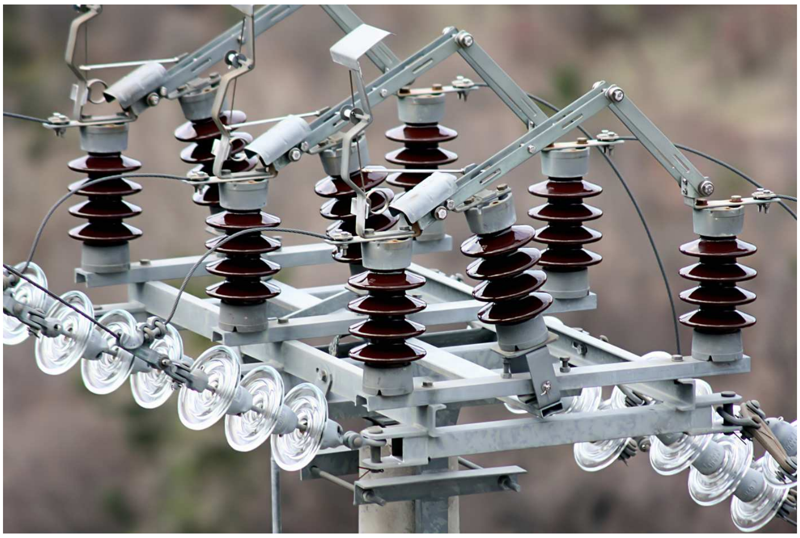
Think of the electric wires that you use in class for the activities. Why do you think they are covered in plastic? The plastic is an insulator and therefore prevents you from getting a shock. The plastic coating acts as a barrier that prevents you from getting a shock, allowing you to handle the wire when the circuit is on.

Electrical insulators are also used in other places. Have you ever looked up at power lines or telephone lines? You will see that the poles that carry the lines are sometimes made of wood. Wood does not conduct electricity so the electric current can therefore not get from the wires into the pole.

Sometimes you will also see little white or coloured caps holding the wires as in the photo below. These caps are made of ceramic which also does not conduct electricity.

In this photo, the wooden poles and white ceramic caps are electrical insulators.

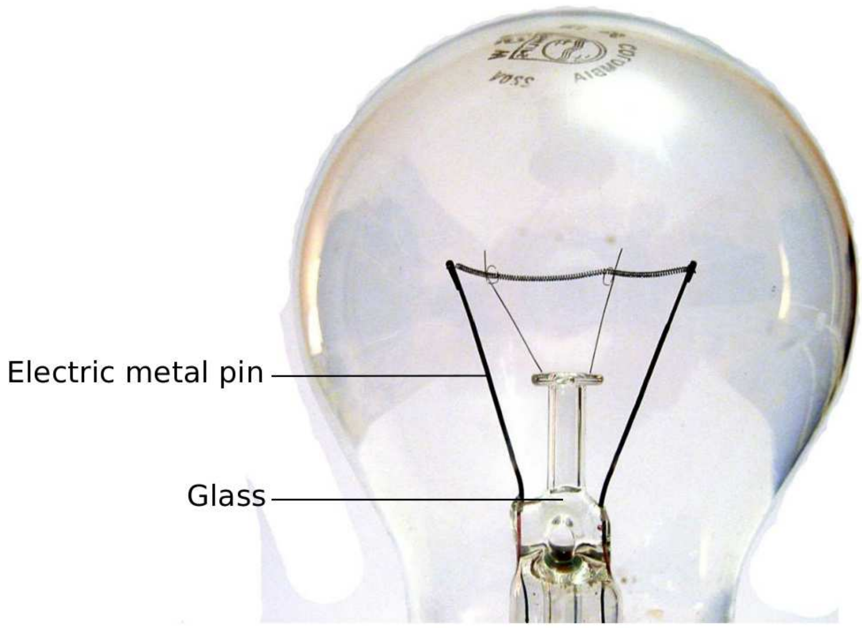
Sometimes, it is especially important to have ceramic electrical insulators between two different metal conductors to prevent electric current from flowing between the different parts such as in the photo below.



Can you see the dark red-brown ceramic electrical insulators?

QUESTIONS

Do you remember naming the different parts in a bulb? Look at the picture of a bulb again below and explain why you think the piece separating the electric metal pins (conductors) is made of glass.



Electricians are people whose job it is to work with electricity and fix the wiring in houses and other buildings. Electricians often wear rubber gloves to protect themselves from getting a shock. Rubber is an electrical insulator.

KEY CONCEPTS

- Some materials allow electric current in them. They are called conductors.
- Some materials do not allow electric current in them. They are called insulators.
- Metals are usually conductors and non-metals are usually insulators.
- Electrical insulators have important functions like insulating wires or protection from electrical shock, e.g. an electrician's rubber gloves.

REVISION:

1. Suppose you have found a piece of material. You are not sure what the material is. You want to find out if it is a good conductor or a good insulator. Describe in words what you would do to determine if the material is an electrical conductor.

2. What is the difference between an electrical conductor and insulator?

3. What kinds of materials are used to make electric wires? What are the functions of the materials?

4. Why are insulators important?

5. List five insulating materials.

6. Look at the owl sitting on the pole below. Why does it not get an electric shock from the powerlines?

An owl perched on a pole [1]

7. The man in the following picture is setting up an electric generator. Why is the man wearing gloves while he does this? Why is he also wearing boots with thick rubber soles?

This man is wearing gloves. [2]

3 Systems to solve problems

New Words

- system
- energy transfer

KEY QUESTIONS

- How can we use electric circuits to make useful devices and appliances?
- What happens to energy when we use electrical devices and appliances?

3.1 Using electric circuits

Electric circuits are used all around us, for example in lights in our homes, streets and shops. Let us imagine our world of today without electricity!

ACTIVITY: A world without electricity

INSTRUCTIONS:

1. Write a short paragraph of how our world would be like without electricity.

____

____

____

____

____

____

2. Describe the three things that will be the biggest disaster for you if there was no electricity.

3. Would there be any advantages of not having electricity? Discuss this with your classmates and write your answer below.

4. Your group should now compare the advantages and disadvantages of electricity. What is the group's conclusion, a yes or no for electricity? Write down your group's reasons for saying yes or no.

Electric circuits are often used to solve a problem where we need energy. A battery or mains supply is a source of energy. The energy is transported to a device or an appliance using electric wires. The device or appliance *dissipates* the energy. The effect could be light, sound, heat or movement. In other words, the device *gives off* energy in the form of light, sound, heat or movement.

A system is something that consists of different parts working together to form a whole. In an electric system, there is an input (energy) and an output (resulting in light, heat, movement, or sound). Let's look at some examples of electric systems where we use the output energy to do something useful.

ACTIVITY: Electric circuits influence our lives

INSTRUCTIONS:

1. Look at the photos or sketches below.
2. Name the appliance or device.
3. Say what it is used for and what the energy is transferred to (light, sound, heat or movement)? In some cases it might be more than one thing!

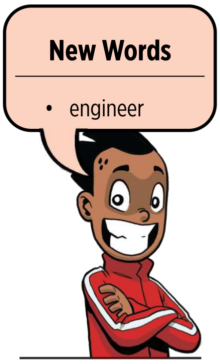
	Name: Use: Energy transferred from ______________ energy to ________________________
	Name: Use: Energy transferred from ______________ energy to ________________________

	Name: Use: Energy transferred from _____________ energy to ______________________
	Name: Use: Energy transferred from _____________ energy to ______________________
	Name: Use: Energy transferred from _____________ energy to ______________________
	Name: Use: Energy transferred from _____________ energy to ______________________

	Name: Use: Energy transferred from _______________ energy to __________________________
	Name: Use: Energy transferred from _______________ energy to __________________________
	Name: Use: Energy transferred from _______________ energy to __________________________
 *Scalectrix*	Name: Use: Energy transferred from _______________ energy to __________________________

	Name: Use: Energy transferred from ______________ energy to ________________________

Each of the examples in the previous activity uses an electric circuit to provide us with energy where we need it, whether it is light on the street, sound for our radio, or heat in a building. Or even in some toys and models such as a car racing game, or model electric train set! We can say that electrical appliances can solve problems for us. They are able to transfer electricity so that another useful form of energy is released.



3.2 Be an electrical engineer or technician

Let's say you want to become an electrical engineer or electrician. One of the things that you will be doing is to design systems that use circuits to solve problems for people, whether it is the wiring in a house, an alarm bell, a lighthouse on the coast, or constructing toys which use electrical energy to work.

Wow, I would love to be an electrical engineer!

ACTIVITY: Design, make and present a system using a circuit

DESIGN BRIEF:

You are an electrical engineer and you need to come up with a design for an electrical system to solve a problem. You need to design and make a system that uses a circuit to produce movement, light, sound or heat. Write a Design Brief where you identify what you are going to make and why it needs an electric circuit.

INVESTIGATE:

The next step in the Design Process is to do some research about the instrument that you are going to make. You can use books and the Internet to do your research.

Answer these questions when doing research about your electrical system:

1. How is this system normally made?

2. What components does it need?

3. What type of energy will be produced from electrical energy?

4. Why do people need this system? What problem does it solve?

DESIGN:

Now that you know a bit more about the system you want to make you need to design how you are going to make it.

Your system has the following specifications:

- The system must make use of an electrical circuit.
- The system must produce either movement, sound, light or heat.
- The circuit must make use of some of the components that you have learnt about, such as batteries, light bulbs, switches, buzzers, wires, etc.
- Your system must make use of a switch to turn it on and off.

Your system has the following constraints:

- You must make it in class.
- You cannot get an adult electrician to design your project for you! You must come up with your own design.
- Your system is not life sized, but must be a model.

Answer these questions:

1. What materials will you need to make it? For example, which electrical components will you need? Which other materials will you need, such as a cardboard box to put the system in, adhesive tape or Prestik, drawing pins, or paint to paint the box?

2. What tools will you need to make it? Such as pliers to cut the wire, scissors to cut cardboard. Make a list and collect some of these items from home, or else ask your teacher if he/she has any.

3. How many batteries will you need for your circuit?

4. Where will you place the switch? What type of switch are you going to make?

Now you need to draw some designs for your system. Use scrap pieces of paper to do your first designs. Once you are happy with your design, use the space below to draw your design. Label your drawing showing what materials you are going to use for the different parts.

When you are making your system you might get better ideas to improve the design as you test it out to see if it produces the required output. So come back afterwards and draw on the bottom half of the page; show what you really decided to make.

MAKE:

Now make your system! After you have all finished making your systems, perhaps go around and look at what others have done. Ask each other questions to see what you can learn from others. You will also have to present your project to the class so use this time to get ideas about how to present your idea and product that you made.

EVALUATE:

Before we get on to presenting the projects, you need to evaluate your own project. You can then use this evaluation in your presentation to show others what worked and did not work.

1. Does your system look like your initial design?

2. Does your system produce a movement, sound, light or heat?

3. Where would people use the system you designed to solve a problem in our daily lives?

4. Is there anything you might do differently to improve your design?

COMMUNICATE:

An engineer needs to be able to present their designs to show others what they have come up and communicate their ideas. Engineers can present a written report and hand in their design drawings. But, often an engineer will need to present the design and project by speaking and giving a verbal report.

Your last task in this Design project is to present your system to your class.

These are your instructions:

1. Present an oral report to the rest of the class to tell them about the system that you built.
2. You must have your system with you in the front of the class and show how it works.
3. You must explain the electric circuit that is used and what type of energy is produced.
4. Tell the class how your system could be used by people and why they might value your design. For example, could it be used in a house by people or maybe it could form a new toy on the market?
5. Lastly, tell the class what you learnt by doing this project and anything that you found tricky or difficult or that you might change if you had to do it again.

We have now seen how to make simple circuits and use a circuit to do something for us but how do we get electricity in our homes, school and shops?

Let's find out!

KEY CONCEPTS

- Electric circuits solve problems like getting electric lighting for example.
- There are many instances in the world around us where electric circuits are used, such as street lighting, alarms, electric gates, traffic lights, fans and heaters, some models and toys.

REVISION:

1. Name five things that we would not be able to do without using electricity. Explain why you think each of these things is important to us.

2. Jojo builds an electric circuit that includes a bulb and battery for his bedside table so that he can read at night, but the bulb does not light up. List three things that could be wrong.

3. Jojo does not want the battery in his bedside light to run out of energy. What could he do?

4. List three electrical devices that use energy from a battery.

5. List three electrical devices that use energy from a mains supply.

6. Draw an electric circuit diagram for the system that you designed and made in the Design Project.

4 Mains electricity

KEY QUESTIONS

- Where does mains electricity come from?
- What are fossil fuels and how did they form underground?
- Why should we save energy and how can we do it?
- Why are illegal electrical connections so dangerous?
- What is the difference between renewable and non-renewable energy resources?

We are so used to switching on electrical appliances that we hardly think what makes it possible to have these things. Our focus turns to appliances that need a mains electrical supply. You have listed examples like a television, a computer, a kettle and many others before.

New Words

- fossil fuels
- coal
- oil
- natural gas
- power station
- turbine
- generator
- renewable
- non-renewable

The big question here is "Where does mains electricity come from?"

4.1 Fossil fuels

A battery has stored energy which can provide electrical energy. However, our homes, schools, shops and factories cannot run on batteries because they cannot store or provide large amounts of energy. We use electricity every day. The main supplier of electrical energy is from power stations. We call this `mains electricity'. Power stations also need a source of energy to make electricity. In South Africa, this is mostly from fossil fuels.

What are fossil fuels?

Coal, oil and natural gas are fossil fuels. Some people think that fossil fuels are the remains of dead dinosaurs but this is not true! Actually, most of the fossil fuels we find today were formed millions of years before even the first dinosaurs. Fossil fuels were once alive!

QUESTIONS

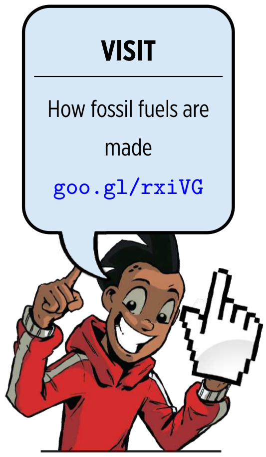
Do you remember learning about fossils in Gr. 5 Earth and Beyond? Write down what you think a fossil is.

____

____

So fossil fuels are actually the remains of prehistoric organisms that lived millions of years ago!

Wow, that's amazing! So the coal we burn was actually a real tree millions of years ago?!



Yes, that is right Jojo. But different fossil fuels come from different organisms and formed in slightly different ways.

ACTIVITY: Let's take a trip back in time, millions of years ago!

INSTRUCTIONS:

- Read the text below about how fossil fuels were formed and study the pictures

- Then answer the questions that follow.

300 million years ago...

Think about what the Earth must have looked like back then! There were swamps and marshes everywhere and it was warmer than it is today. Ancient trees, ferns and plants grew everywhere. Very weird looking animals roamed the earth, and even stranger looking fish lived in the rivers and deep in the oceans and seas.

An ancient, prehistoric world

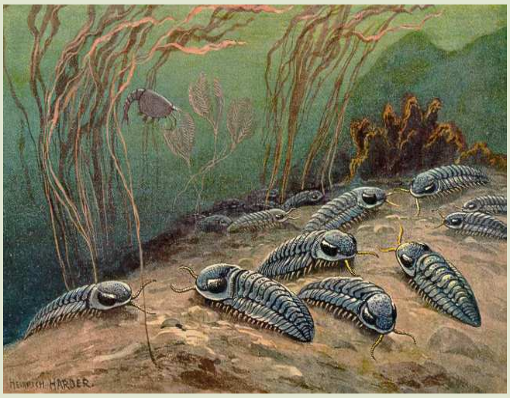
When these prehistoric plants and animals died their bodies their bodies decomposed just in the same way as organisms decompose today. The dead organisms became buried under layers and layers of mud, rock, sand and water. Over time, these layers built up and became very deep and they pushed down with a great pressure on the layers below it.

Millions of years passed, and the dead plants and animals slowly decomposed and formed fossil fuels. Different types of fossil fuels were formed depending on different factors. For example, whether it was the remains of plants or animals or a combination and how long the remains of the organisms had been buried for. The type of fossil fuels that formed also depended on the temperature and pressure conditions during the decay of the organisms.

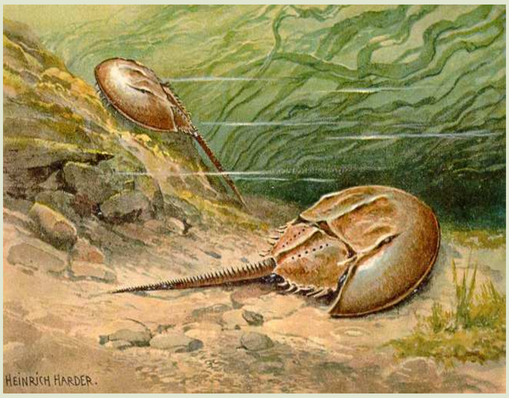
Oil and natural gas

Oil is a dark, thick liquid that can be used to make petrol to burn in vehicles, such as cars, buses and trucks. Natural gas is colourless and it is used mostly in homes for heating and cooking food.

Oil and natural gas formed from organisms (plants and animals) that lived in the oceans before there were dinosaurs. When these organisms died, they settled on the bottom of the river bed or ocean floor and the layers built up under mud and sand (silt). The mud and sand slowly changed into rock and the rock and water pressure pushed down on the remains of the dead plants and animals.



Trilobites



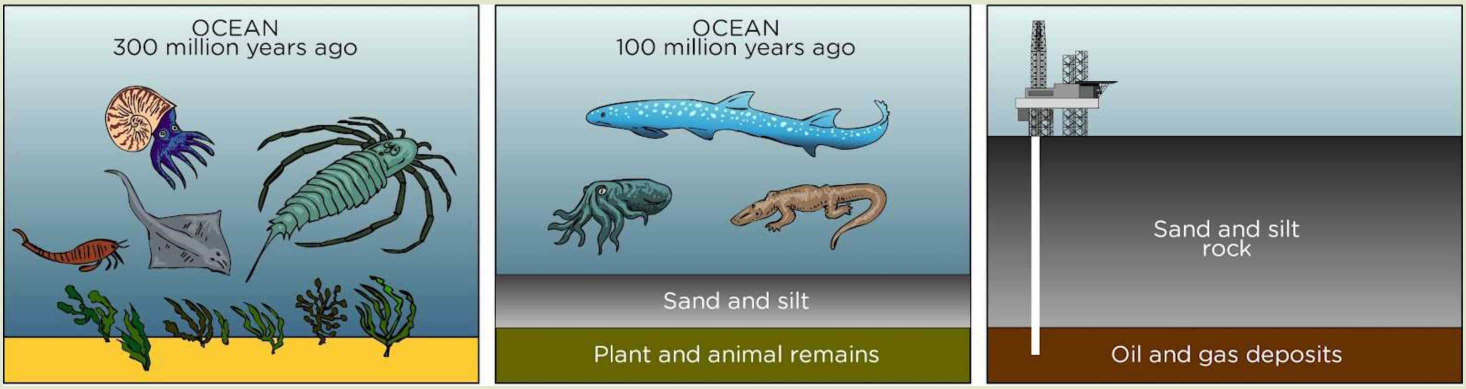
Limulus

Ceratodus

Ammonoids

Over millions of years of being under heat and pressure, the dead plants and animals changed into a thick liquid, called crude oil. In deeper, hotter places tiny bubbles of natural gas formed. These were trapped under the rocks.

Over time, some of the oil and natural gas began to work its way up through the rock and to the Earth's crust and into rock formations called 'caprocks'. Today, most of the oil and natural gas is collected from these caprocks by drilling down through the layers of rock.



Coal

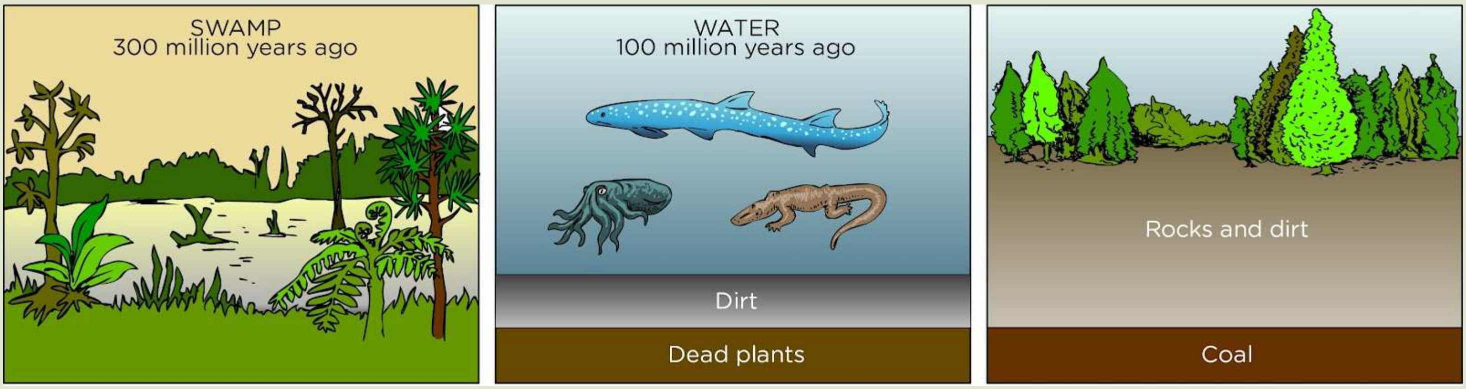
Coal is a black rock that can be burnt to produce energy in power stations all over the world.

Coal was formed from the dead remains of trees, ferns and some other plants that lived 300 to 400 million years ago. This was when the Earth was mostly covered in swampy forests. These kinds of plants were very different to the plants that we get today. Over time, the layer of dead plants at the bottom of swamps was covered with layers of water and mud. The top layers squashed down on the dead plants. Over millions of years the heat and pressure turned the plants into the coal that we mine today.

Ferns were very common in the prehistoric world of plants. [1]

Much of the Earth was covered in swamps millions of years ago.

The energy in coal originally comes from energy from the Sun. Plants on Earth used the energy of the Sun for photosynthesis and to grow. This energy was stored in the leaves, flowers and stems of the plants. As the plants died the energy was trapped.



QUESTIONS:

1. What are the three fossil fuels discussed in the above story.

2. The organisms that fossil fuels were formed from lived many years ago and are different to the organisms that we get today. How many millions of years ago was this?

3. The dead organisms are covered in sediments over time. Do you remember learning about sediments in Gr. 5 Earth and Beyond and how sedimentary rock forms? Write a description of what sedimentation is.

4. What are the two main factors which turned the remains of organisms into fossil fuels deep under the layers of rock and mud?

5. Explain why we say that all our energy originally comes from the sun, even in fossil fuels.

6. Do you remember learning about the states of matter in Matter and Materials. Each of the three fossil fuels discussed here is a different state of matter. Say what they are.

7. The process of coal formation and natural gas and oil formation have similarities, but also differences. Draw a table where you compare these two processes. Give your table a heading.

The way we obtain the different fossil fuels is also different. Coal is usually obtained by digging mines into the rock and sand to reach the coal deposits deep under the surface. This creates a huge hole in the surface of the earth as you can see in the photograph of a mine.

A coal mine [2]

An oil rig in the ocean which sinks a drill into the ocean floor to reach the oil deposits

Oil and natural gas is obtained by drilling down through the rock. A hole is sunk with a huge drill so that the oil and natural gas can be reached and then brought up to the surface. This normally takes place in the ocean, as you can see in the oil rig in the photo.

QUESTIONS

1. Search the Internet to find out which countries in the world have large quantities of coal, oil and natural gas.

____

____

2. Search the Internet to find out which three countries in the world use the most fossil fuels.

____

____

So we have spoken about fossil fuels and energy, but how do we then get electrical energy from fossil fuels?

That is a great question Jojo! A good scientist always asks questions!

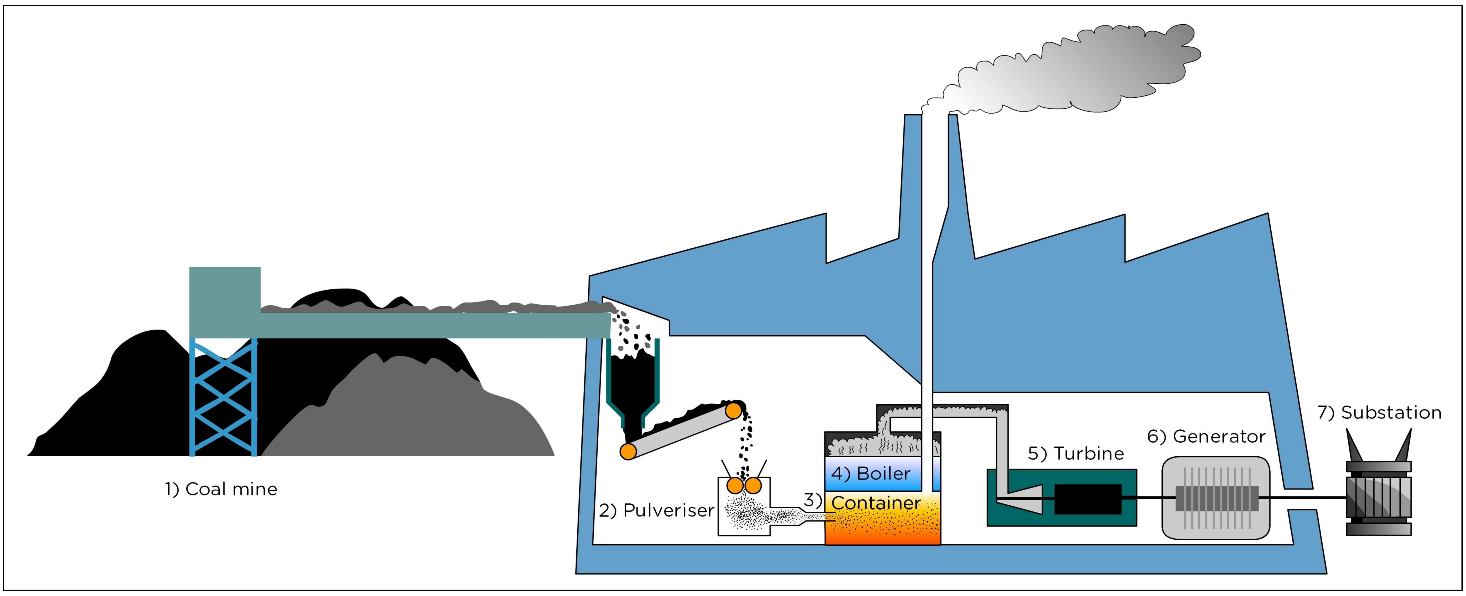
Fossil fuels and electricity

The main supplier of electricity in South Africa is ESKOM. ESKOM uses mainly coal to produce energy for industrial and household use.

Let's look at a power station to find out how coal is used to produce electricity.

Look at the diagram and the steps which outline the process to make electricity from coal:

1. Coal is transported from a coal mine to a power station.
2. At the power station, the coal is ground into a fine powder (pulverised).
3. The ground coal then goes into a container where it is burned.
4. The heat generated from the burning coal is used to boil water in a huge boiler.
5. The boiling water produces steam that turns a turbine (a turbine is a big wheel which turns).
6. The turbine is linked to a generator which uses a coil to produce energy.
7. From the generator the electric current is transported ("carried") by a system of electrical transmission lines (also called power lines) and substations to our homes.



The process of making electricity from coal in a power station

ACTIVITY: Make a poster to trace the source of our electricity

MATERIALS:

- poster size paper or cardboard
- colour pens or pencils

INSTRUCTIONS

1. Design and make a poster for your classroom on which you illustrate the chain of objects and processes that allow us to use an appliance in our homes (such as a television set, stove or refrigerator).
2. Start with a picture or drawing of the Sun in the top left corner and end with the appliance in the bottom right corner of the poster.
3. Use arrows to show the sequence of objects and processes.
4. Label each object or process on your poster.
5. Decide on a heading for your poster and write it in big letters at the top.

Fossil fuels are non-renewable resources of energy. This is because they take millions of years to form. Once these fuels are burnt, they cannot be recovered or reused. They are non-renewable.

New Words

- infrastructure
- expensive
- kilowatt

People on Earth are using up these deposits of fossil fuels much, much faster than they are being made as they take millions of years to be made! Look at the diagram of a power station again. Do you see the smoke that is given off when the coal is burnt? This causes huge environmental concerns as it is polluting our atmosphere. A bit later in this chapter we will look at other ways of producing energy which, unlike fossil fuels, are renewable.

4.2 Cost of electricity

Do you hear your parents and other adults talk about the cost of living? Do they remind you to switch off lights and other appliances that are not in use? Electricity is an expensive resource!

DID YOU KNOW?

The burning of coal produces billions of tonnes of carbon dioxide each year. Carbon dioxide is one of the greenhouse gases that contributes to global warming.

Why is electricity expensive?

Electricity is costly because:

- The production and delivery of electricity requires infrastructure (the structures and facilities) like coal mines, trucks and trains to transport coal, power stations, substations and wiring.
- All of these buildings, structures, materials and processes are very expensive to build and maintain.
- Some electrical appliances require a lot of energy, much more than others. For example, a geyser uses a lot of electricity to heat the water and so it becomes expensive.

When electrical energy enters your home, it must pass through a meter. Have you ever seen a white box outside your house? This is the electricity meter. A worker from the city council reads the meter so that they will know how much electricity you used. They then bill you for the cost. The more electricity we use, the more we pay and the more we use up fossil fuels. Some houses now have pre-paid electricity meters where you pay for your electricity before you use it.

This is an electricity meter. Can you see the number recording the electricity usage in kilowatt hours (kWh)? [3]

Running electrical appliances

We already mentioned that some electrical appliances use more electricity to run than others. Appliances that heat use the most energy, such as a geyser or heater. How do we know which electrical appliances use more electricity?

ACTIVITY: Energy required by electrical appliances and devices

This is how we find out!

INSTRUCTIONS:

1. Find the appliances or devices listed in the table. If you do not have them in your home or school, ask family, friends or neighbours if you could look at theirs.
2. Have a look at each appliance and check for a label with information like the one below. This information is usually at the back or the bottom of the appliance.

230 V - 240 V; 50 Hz; 2 kW

3. Record the number that is followed by a W or kW on the label in column 2 of the table. This number indicates how much energy is required by the device in a certain time. It is called the power required by the device. We measure power in watt (W) or kilowatt (kW). The higher the value the more energy the device uses in a specific time.
4. Add any other three appliances or devices to the list.
5. Record all the power values in column 3 in watt. If the power is given in kW, multiply this number by 1000 to get the value in watt (W), for example:

$$2 \text{ kW} \times 1000 = 2000 \text{ W}$$

If the device does not show a value in W or kW, look for two quantities given in volt (V) and milliampere (mA). Multiply these two numbers and then divide the answer by 1000 to get the power in watt, for example:

$$240 \text{ V} \times 150 \text{ mA} = 36\ 000$$

$$36\ 000 \div 1000 = 36 \text{ W}$$

Appliance or device	**Power in W or kW**	**Power in watt (W)**
Cellphone charger		
Electric kettle		
Television set		
Light bulb (old type)		
Energy saving light bulb		
Computer		
Electric iron		

Now arrange the appliances in the next table in terms of the power required. The list should be from small to large values of the power.

Appliance or device	Power in watt (W)

QUESTIONS:

1. What do you see in this table? Which two appliances have the lowest power requirements? What do these appliances have in common?

___

___

___

2. Which two appliances have the highest power requirements? What do these appliances have in common?

___

___

___

Saving electricity

Just when I am ready to run outside, my mom often makes me come back to turn my bedroom light off.

Good for her, Jojo! Electricity is expensive so we should try and save electricity.

QUESTIONS

This is not the only reason to try save electricity. Remember when we spoke about the pollution given off by coal power stations? Why else do you think it is important to try save energy and reduce your power usage?

____

____

____

There are many different ways to save electricity, from small actions, to larger actions, such as using renewable energy resources. We will discuss this a bit later in the chapter.

QUESTIONS

How can you prevent wastage of electricity in your home? Name four possible ways.

4.3 Illegal connections

We discussed a world without electricity and we all realised how dependent we are on this resource. It is illegal for anyone to use electricity that was generated by ESKOM without their permission. Some people make illegal connections because they don't want to pay for the electricity. They cut through the insulation in a power line and attach other cables to this line. They can then direct some electricity to their house or workplace. These connections are dangerous to people as they are often unsafe.

People who make illegal connections try to get electricity for free but the dangers are not worth it. It is not worth your life!

Look at this mess of illegal electrical connections. [4]

Electricity and safety

Accidents caused by electricity happen all the time. People often get hurt or even killed by electricity because they do not use it safely. Not only is it important to know how to use electricity safely, but also what to do if someone is hurt or shocked by electricity.

QUESTIONS

1. What types of emergencies can happen at home or at school with electricity?

___

___

___

2. Find out about the emergency services in your area and write down their names and telephone numbers. Also write this information on a piece of paper and stick it to the wall next to your phone or in a central place in your home.

___

___

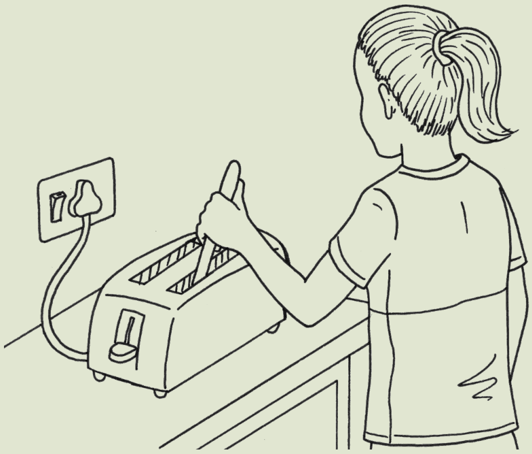
Accidents with electricity can be avoided. We just need to be smart about working with electricity. Let's formulate some safety rules for working with electricity.

ACTIVITY: Safety rules when working with electricity!

INSTRUCTIONS:

1. Look at each of the following pictures.
2. Each one shows someone doing something with electricity, and often the person is doing something dangerous!
3. Answer the questions about each of the pictures.

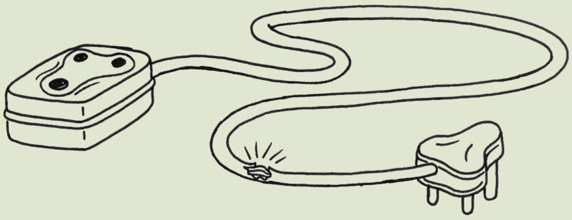
QUESTIONS:



1. The person in the illustration above is using a table knife to remove a coin that has fallen in the toaster before switching off the appliance. What are the dangers related to this act?

2. What safety rule can you formulate regarding this?

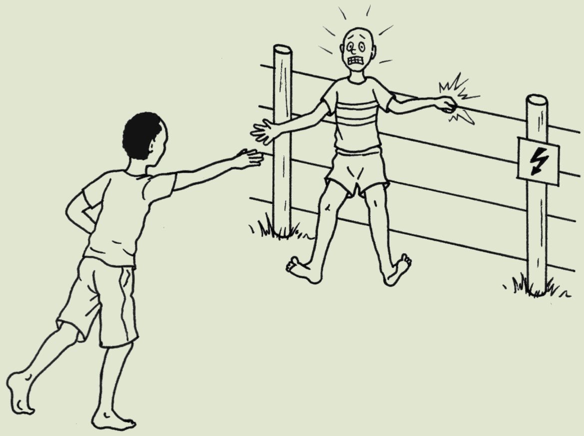
3. Why is this an unsafe cable to use ? Circle the area that makes it unsafe.



4. What could be done to the cable to make it safe to use?

5. What safety rule can you formulate regarding this?

6. Why is it dangerous to pull the boy from the electric wire?



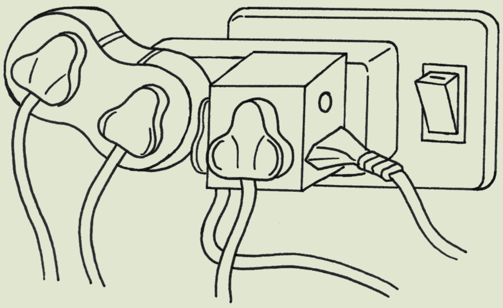
7. What can the helper do to save the boy without being shocked by the electricity?

8. What safety rule can you formulate regarding this?

9. Why is this not a safe place to play?

10. What safety rule can you formulate regarding this?

11. Why is this connection dangerous?



12. What safety rule can you formulate regarding this?

13. Why is it dangerous for the children to play outside during the lightning storm?

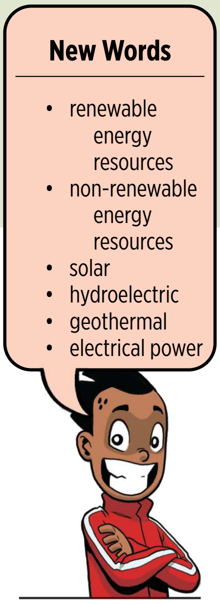
14. Why should no one play under a tree when it is storming?

15. Explain why it is not a good idea to be swimming when there is lightning in the sky?

16. What safety rules can you formulate regarding lightning?

17. Why is the gardener unsafe when mowing the lawn in the rain? Give at least two reasons.

18. What safety rules can you formulate regarding using electrical appliances outside in the garden?



4.4 Renewable ways to generate electricity

We have seen above that fossil fuels are non-renewable resources of energy.

QUESTIONS

What do you understand by the word `non-renewable'?

So, if we are using an energy resource which is non-renewable, then this will be a problem in the future when these resources run out. Are there other sources of energy?

Scientists and engineers are looking for ways to harness energy from renewable resources. A renewable resource is the opposite to a non-renewable resource. It will not run out and can be used over.

Renewable energy sources include natural phenomena such as sunlight, wind, tides and plant growth. The energy comes from natural processes that happen over and over.

VISIT

Renewable energy (video)

goo.gl/wKyHB

QUESTIONS

Why do you think natural phenomena such as sunlight and wind can be considered as renewable?

___

___

___

Examples of renewable energy resources are:

- solar (energy from the sun),
- wind,
- ocean (tides and waves),
- hydropower (waterfalls or fresh water dams),
- biomass (energy from plants and other organic material), and
- geothermal (energy from steam underneath the surface of the earth).

DID YOU KNOW?

The first windmills were developed in Persia in about 600 B.C. But, the first windmill to produce electricity was in Denmark in 1890.

Wind turbines use wind to generate electricity.

VISIT

Wind energy (video)
goo.gl/XthW5

DID YOU KNOW?

Solar panels, also called photovoltaics, convert sunlight energy to produce electrical energy. There are also solar water heaters, but this is a different system to solar panels. Solar heaters directly heat water.

Sun, wind and water can be used as sources of energy. Solar panels can be fitted to houses but this source of renewable energy works best on sunny days, and is less effective on cloudy days. Wind energy can be collected with a windmill or wind-turbine which can be big and noisy. Hydroelectric power stations harness the energy in water stored in high dams. It is only possible in areas where there are high mountains and rivers.

A water wheel uses the flow of water to push the wheel around which can then do work.

As the water flows through this large hydroelectric power station from the higher dam to the lower dam, electricity is made.[5]

Solar panels [6]

ACTIVITY: Renewable versus non-renewable energy

What are the advantages and disadvantages of renewable and non-renewable sources? There is a lot of debate around the use of renewable and non-renewable sources for energy. Let's join this debate!

INSTRUCTIONS:

1. Work in groups of four.
2. Discuss whether your house uses renewable or non-renewable sources of energy.
3. Does anyone in the group have solar panels at home?

4. Think about the advantages and disadvantages of renewable and non-renewable sources. You can use the Internet or other information sources to check for more ideas here.
5. Write some of your answers in the spaces below.
6. Report back to the class and see what others think about this debate.

	Advantages	**Disadvantages**
Renewable		
Non-renewable		

DID YOU KNOW?

South Africa has large reserves of uranium which are used in the Koeberg nuclear power station.

VISIT

How hydroelectricity works (video)

goo.gl/j60z1

That is all from me
for Energy and Change!

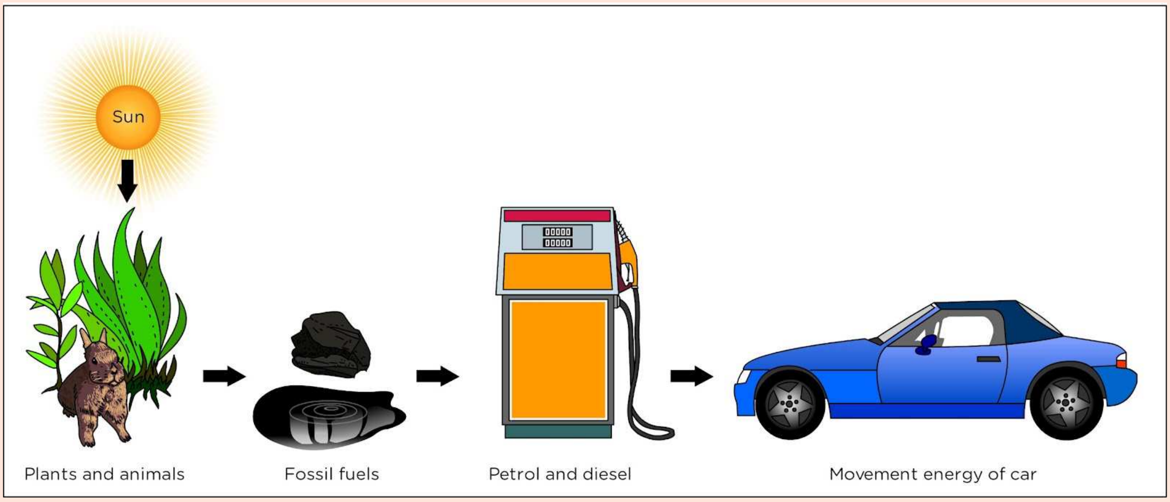
Join Sophie next to learn more
about our planet Earth
and outer Space!

KEY CONCEPTS

- Most of our electricity comes from fossil fuels such as coal, oil and natural gas.
- Fossil fuels are the remains of dead plants and animals from millions of years ago.
- The energy in fossil fuels originally comes from the Sun which was captured by the plants that lived millions of years ago.
- Electricity is expensive due to the infrastructure required to produce and deliver it.
- Fossil fuels are non-renewable meaning they will run out.
- We should try to be energy-efficient and not waste electrical energy.
- Illegal connections pose a huge threat to people as they can be unsafe.
- There are other resources which are renewable and can be used to generate electricity, such as wind power, solar power and hydropower.

REVISION:

1. Look at the flow diagram below. Describe what it is showing using what you have learnt in this chapter.



2. Why are fossil fuels considered non-renewable resources?

3. Write a paragraph in which you explain why you think humans should investigate alternative energy sources, such as renewable energy sources and how this might help the Earth.

4. What type of electrical appliances in our homes use the most energy in a specific time?

5. Imagine that you are writing an article for your local newspaper on how to save electricity in your homes. Use your imagination to write your article telling people how to save electricity. Use the space below. Give your article a catchy heading.

6. How do you think saving electricity will reduce the demand on ESKOM's power stations?

7. What is an illegal electrical connection? How do you think the local government could stop or reduce the amount of illegal connections?


Earth and Beyond
and Systems and Control

1 The solar system

KEY QUESTIONS

- How can we tell the difference between a star and a planet?
- What are asteroids?
- What is a moon? Does the Moon produce its own light?
- Can we see the Moon during the day?

Do you remember that in Gr. 4 we looked at Space and the objects found in Space? Last year, in Gr. 5 we mostly looked at Earth and the features of Earth. Now we are going to explore Space a bit more! Before carrying on, let's refresh our memories on some of the things about Space from Gr. 4.

ACTIVITY: Wordsearch about Space.

INSTRUCTIONS:

1. Find the following words in the wordsearch.
2. Draw a circle around each word.
3. When you find the word, discuss with your partner what you remember about this word from Gr. 4.

- space
- gravity
- astronomy
- orbit
- rotate
- moon
- axis
- galaxy
- sunrise
- sunset
- star

L	C	T	C	R	O	T	A	T	E
A	S	T	R	O	N	O	M	Y	G
S	C	Y	W	O	R	B	I	T	R
P	D	S	U	N	R	I	S	E	A
A	S	E	R	A	G	L	S	S	V
C	T	Z	S	T	A	F	M	U	I
E	A	V	B	V	L	Z	O	N	T
Q	R	C	P	R	A	L	O	S	Y
L	Z	X	J	R	X	J	N	E	M
K	A	X	I	S	Y	L	O	T	J

VISIT

The birth of our solar system

goo.gl/yDya6

1.1 The Sun, planets and asteroids

Do you remember what a solar system is? Our solar system is made up of the Sun and the planets. Let's take a look!

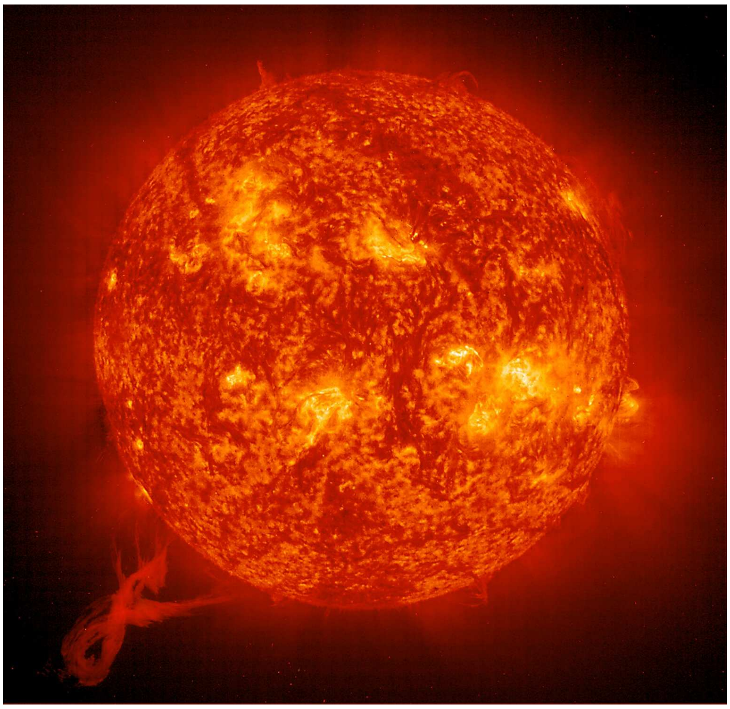
New Words

- asteroid
- furnace
- core
- wander
- object
- observatory
- record
- astronomer
- gravity

What is the Sun?

The Sun glows so fiercely that it is not safe to look straight at it, even though it is so far away. The Sun is a ball of gases.

The temperature at the centre of the Sun is about 15 000 000 degrees Celsius! The surface is about 5 500 degrees Celsius. That is extremely hot! Can you see the explosion from the surface of the Sun in the picture?!



Can you see the big burst of gas from the Sun in the bottom left?

VISIT

Comparing the sizes of planets and the Sun

goo.gl/3X1Oi

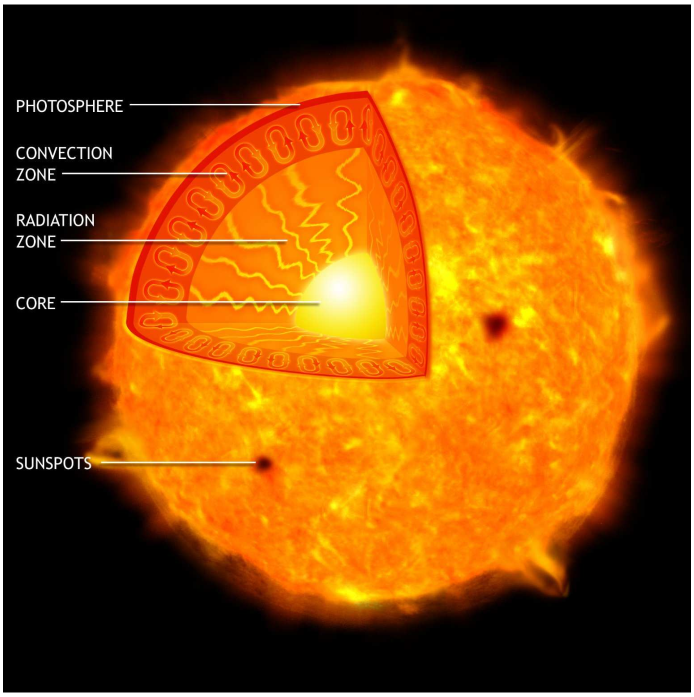
The Sun is a star, because it produces its own energy. The Sun appears bigger and brighter because it is much nearer to Earth than the other stars.

DID YOU KNOW?

The Sun is about 150 million kilometres from Earth and the next nearest star to us after the Sun is over 40 million million kilometres away.

The Sun is about 420 times bigger than the Earth and about 1700 times bigger than the Moon! The Sun is much further away than the Moon from the Earth. The Sun produces light and heat. The heat warms the surface of the Earth.

Study the image of the Sun, and then answer the questions that follow in the activity below.



This image shows the different layers of the Sun.

ACTIVITY: The core of the Sun

INSTRUCTIONS:

1. Look at the picture of the Sun showing the different layers inside.
2. Answer the questions.

QUESTIONS:

1. Which is the hottest part of the Sun?

____

2. The Sun's energy comes from gases being squeezed together until hydrogen turns into helium. Where do you think the gases are squeezed together the hardest?

____

3. What are the dark spots on the surface of the Sun called?

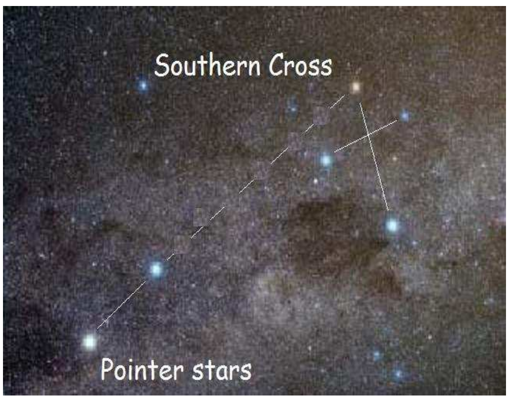
____

Come with me! We are going to hear a story about the planets. It's a bit of science, maths and history all mixed up!

Planets

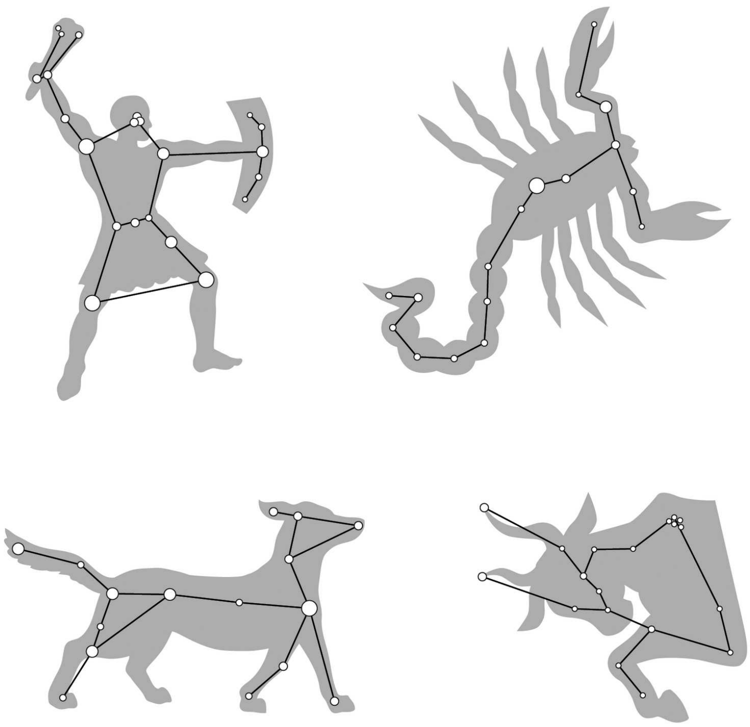
Long, long ago, people watched the stars at night. Shepherds looking after sheep and cattle would lie down and look at the night sky. People in hot regions like Mesopotamia (now Iraq) slept on the roofs of their houses. They had plenty of time to look at the stars. They knew the patterns of stars in the sky and how the stars moved across the sky during the night. The patterns were fixed (they did not change). For example, you can find a pattern like the Southern Cross if you look up towards the South. You can see it in the first photo below. The second photo with white lines helps you to see the Cross. It always looks the same because the stars are always the same distance apart.

This pattern of stars is the Southern Cross. The pattern does not change.

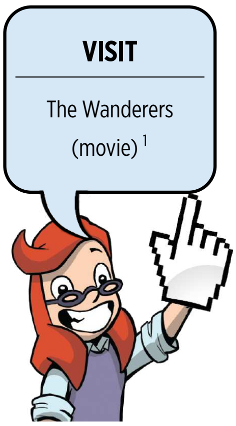


The white lines are not really in the sky, they just show you how to view the Southern Cross.

Patterns of stars are called constellations. The next image shows some other famous constellations of stars which you can see in the night sky.



Some constellations of stars making up patterns in the sky



People noticed that some bright objects did not behave like the others. These objects are close to a star one night and then the next night, at the same time, the object has moved away from the star. Night after night, these objects appear in new positions among the stars.

The Greeks of those times called these objects "the wanderers" because they were in a slightly different position each night. The Greek word for wanderer is "*planetes*" and so we get the English word "planet". A person who wanders is someone who walks around wherever he feels like going.

The planets were a science puzzle

People who study the stars are called astronomers. The planets were a puzzle for ancient astronomers. Why did they move differently to the stars? Were they just as far away as the stars? Why were they brighter at some times of the year than at other times?

You can see the planet Venus just after the Sun has set. Venus is usually very bright. At some times of the year, you have to look for Venus in the dark sky where the Sun will rise.

The ancient peoples gave names to the planets. For example, Mars was named after the god of war. One planet was so beautiful that they called it Venus after the goddess of love and beauty.

You can see Mars at some times of the year. Mars is orange-red, and at most times it looks smaller than Venus. It is not as easy to find as Venus is; sometimes you have to look late at night to see Mars rising in the east.

DID YOU KNOW?

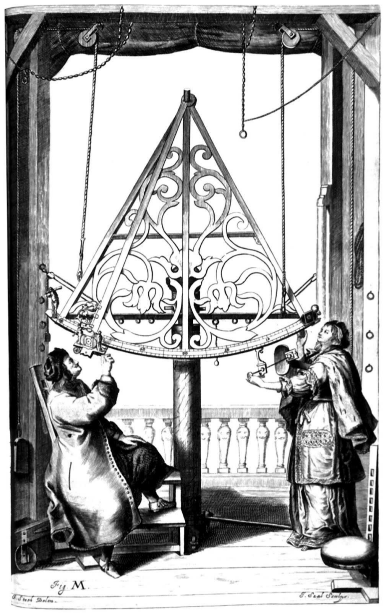
A **system** is a set of parts that work together. Any change or movement in one part causes changes in the other parts.

How astronomers solved the puzzle

Over hundreds of years, astronomers set up observatories in places like India, Egypt, Iraq, England and countries in Europe. An observatory is a building that has permanent measuring marks. These marks are always in the same position. The astronomers make notes of where stars and planets are compared to these fixed positions, and they note the dates and times.

Hypatia was an astronomer and mathematician at the University of Alexandria in Egypt. She lived about 1700 years ago. Can you see the globe next to her?

Over many years of careful observing, the astronomers kept records of where the planets moved. They used maths to predict where a planet would be on a future date. Then, on that date, they went to check if their prediction was correct. They became very good at measuring, doing maths and doing calculations with big numbers.



Ancient astronomers making observations

VISIT

The solar system (video)

goo.gl/c32vA

So they worked out that the planets are closer to us than the stars, and that the planets are moving around the Sun. Then they realised that Earth is a planet too, and it is moving around the Sun!

This idea upset some people who believed that the Earth was the centre of the universe and that everything moved around the Earth. Nowadays we know exactly where each planet in our solar system is at any time, and we can actually send spacecraft to the planets.

The Sun together with the planets moving around it is called the solar system. You will learn about that next.

VISIT

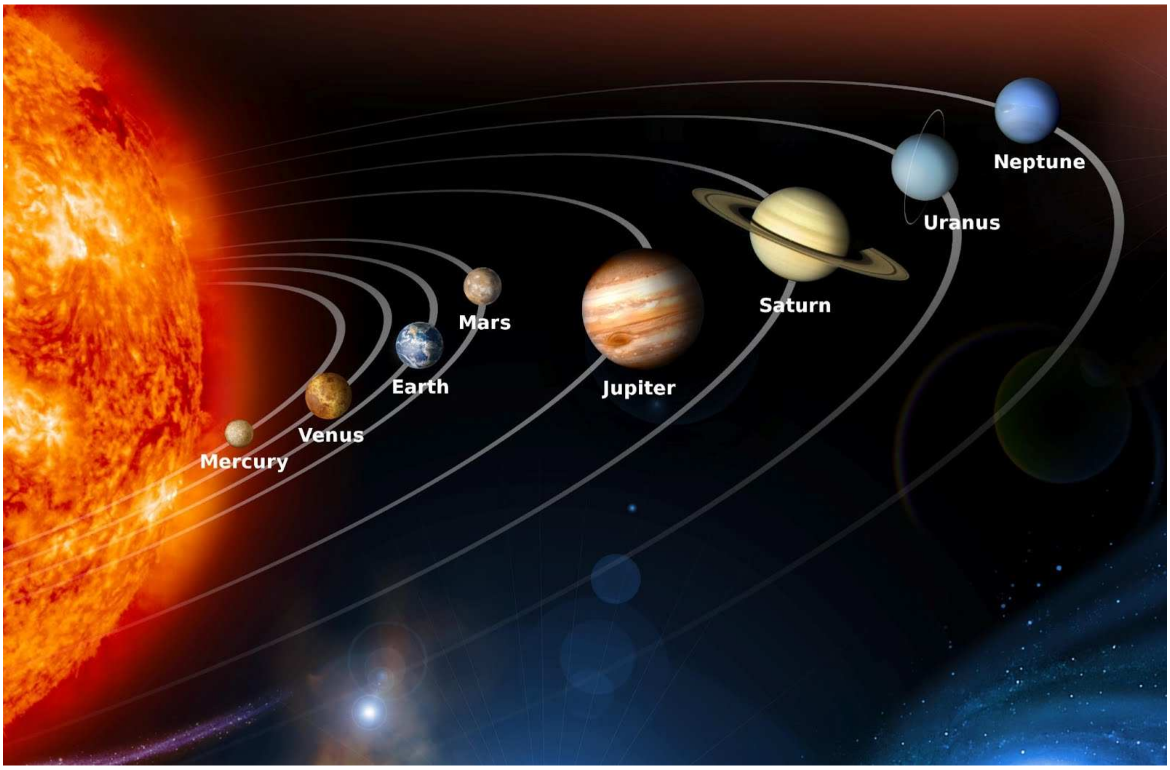
The birth of the planets

goo.gl/Nr0eL

The solar system

The solar system consists of the Sun and all the planets that orbit around it. It also includes asteroids and the planets' moons.

In the first image, you can see a diagram of the solar system. In the second image in the next activity, you can see another diagram of the solar system. Both these diagrams try to show you what the solar system is like.



The solar system consisting of the Sun and 8 planets

In the solar system, each object's force of gravity pulls on all the other objects. Gravity is a force of attraction between objects. The Sun is the biggest and heaviest object in our solar system and so it exerts the greatest force of gravity on all the planets. This force of gravity makes all the planets move in circles around the Sun.

The names of the planets in our solar system are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune. Mercury is the planet closest to the Sun and Neptune is the planet furthest from the Sun.

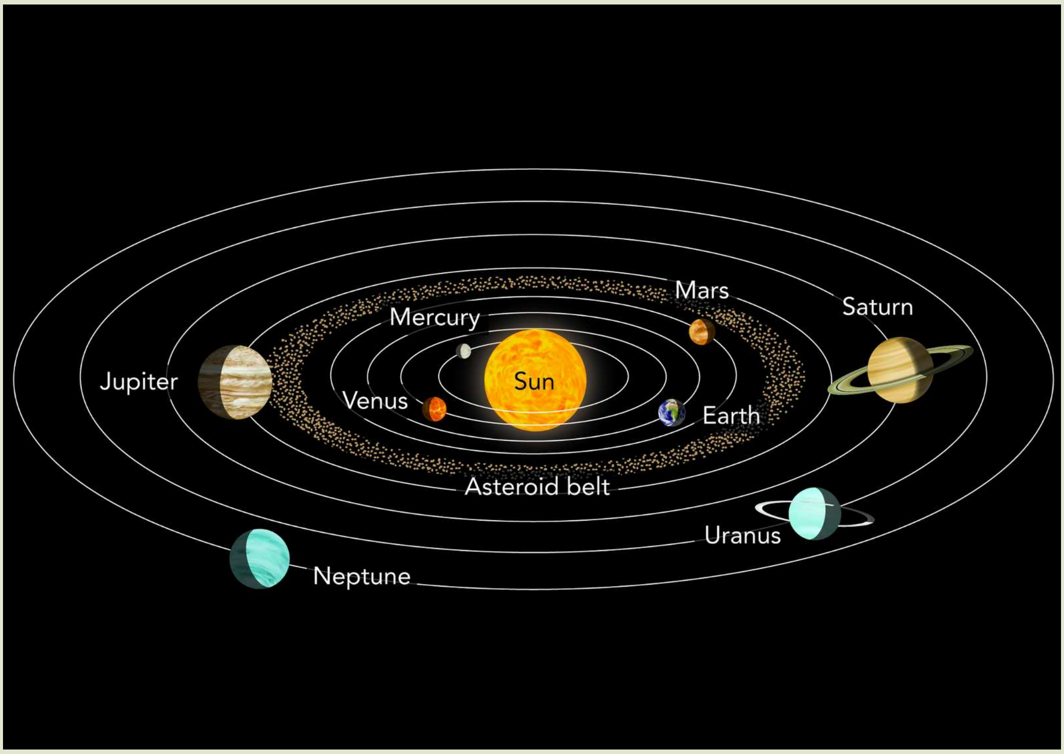
QUESTIONS

1. Earth is the third-closest planet to the Sun. Find Earth in the picture.
2. Could the planets really be as close to the Sun as the picture shows? Give some reasons for your answer.

ACTIVITY: Looking at the solar system from far away in Space

INSTRUCTIONS:

1. Imagine you are in a spacecraft very far from the Earth. You can see the planets all moving around the Sun in orbits, like in the picture. The white lines in the picture show the path that each planet follows when orbiting the Sun. These orbits (white lines) are not actually visible.
2. Look at the picture and answer the questions.



QUESTIONS:

1. Which planet is the closest to the Sun?

___

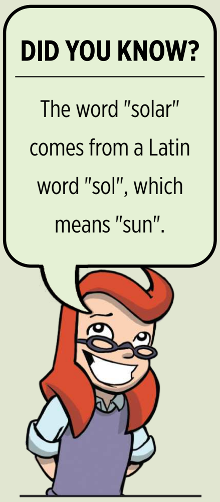
2. Is Venus or Earth closer to the Sun?

___

3. Write the names of the planets in order, beginning from the one that is closest to the Sun.

4. Which planet do you think is the coldest, and why?

5. Why do the planets all keep on moving in orbits around the Sun?



Let's now use our bodies to create a model of how the planets move around the Sun!

ACTIVITY: Make a model of two planets moving around the Sun

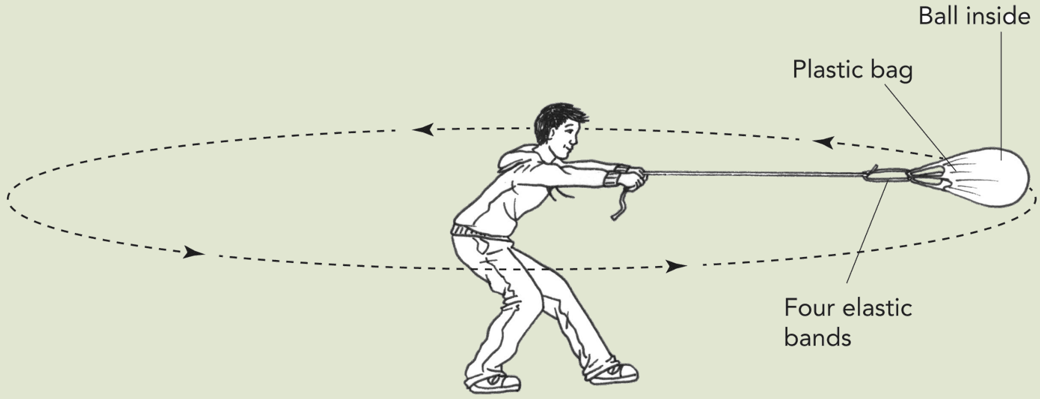
MATERIALS:

- strong string about 5 metres long
- another strong string about 3 metres long
- two balls in plastic bags
- eight thick rubber bands
- a small chair or a box like a plastic milk crate

INSTRUCTIONS (Part One):

1. Tie the four elastic bands onto the handles of the plastic bag. Then tie the string onto the four elastic bands. Put one ball inside the bag.
2. You are going to do as you see in the next picture.

3. Someone must run with the ball in the bag to help you get it going.
4. Then swing the ball around as fast as you can, on the end of the string.
5. The rest of the class must watch the plastic bag carefully to see whether the rubber bands stretch.
6. You see the learner in the picture swinging the ball around himself. The learner represents the **Sun** and the ball represents the **Earth**.
7. Take turns to swing the ball; feel how hard you need to pull on the ball to keep it going around.
8. The people who are watching will see the rubber bands stretch. This means that the ball is pulling on the string, and the string is pulling on the ball.



QUESTIONS:

1. What does the learner who is swinging the ball represent? What does the ball represent?

____

2. What do you feel is happening to the elastic as you swing the ball?

____

3. If the ball in its bag could feel, what would it feel?

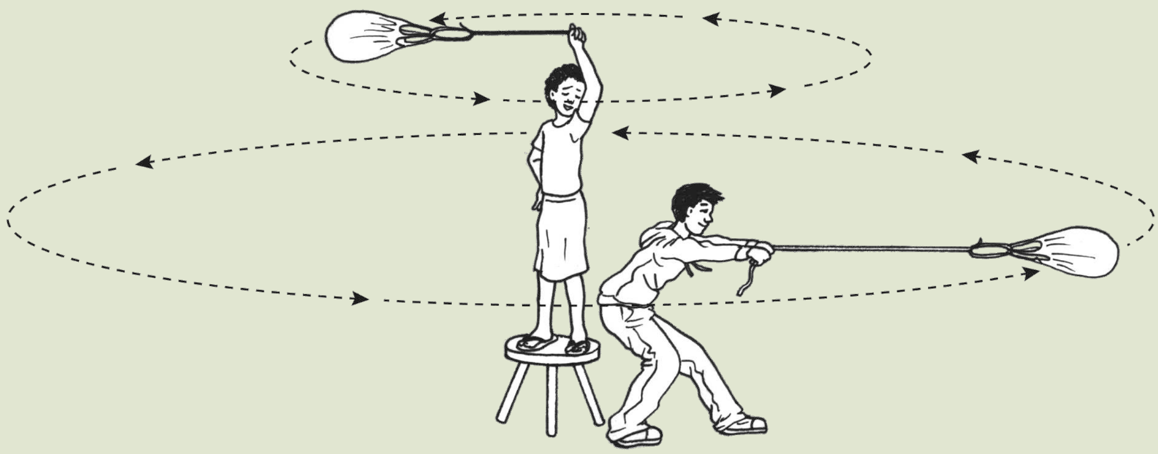
____

____

4. If the string breaks, in what direction will the ball carry on travelling? Draw an arrow on the picture to show the direction the ball would carry on moving in.
5. The ball represents the Earth. The learner swings it quite fast, but how long does the Earth really need to go once around the Sun?

INSTRUCTIONS (Part Two):

1. This part is more difficult and it needs some practice. You are still making a model of planets moving around the Sun.
2. Use the 3-metre string and tie it onto a bag and ball as you did before.
3. In the picture you see one learner standing on a stool and swinging another netball in a bag.
4. The first learner now has to walk around the stool to keep his ball moving.
5. This might take some time to get it right!



Two learners must now swing balls at the same time. This is quite tricky!

QUESTIONS:

1. Which part of this model represents the Sun?

---

2. Which part of the model represents planet Earth?

3. Which part represents planet Venus?

---

4. In this model, when Earth revolves around once, how long a period of time does that represent?

DID YOU KNOW?

The planet Venus orbits around the Sun in 224.7 days. Those are 224.7 Earth days.

The planet Earth orbits around the Sun in 365.25 days and we call that one year. As Earth moves to new positions around the Sun, we have four seasons: summer, autumn, winter and spring, and then summer comes again.

Now in Space, the Earth keeps on going around the Sun at more than 100 000 kilometres every hour. However, there is no string pulling on the Earth, so what keeps it moving?

The force of gravity pulls the Sun and the Earth towards each other.

There is no string in Space between Earth and the Sun! The Earth would move away, but the Sun "traps" the Earth with its much greater force of gravity. The Sun pulls on the Earth and the Earth pulls on the Sun with the force of gravity. The pull is so strong that it works at a distance of 150 million kilometres! Like the string, force of gravity keeps the Earth moving in its orbit around the Sun, year after year.

It does the same for the other planets too. The force of gravity pulls the planet Neptune into its orbit even though Neptune is 30 times further away from the Sun than Earth is.

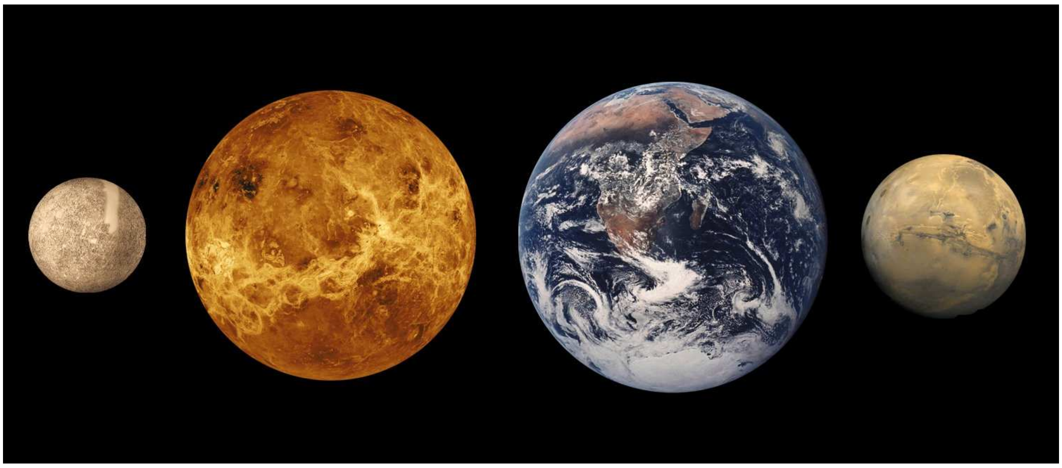
QUESTIONS

In the model in the previous activity, what does the string represent?

We visit the eight planets

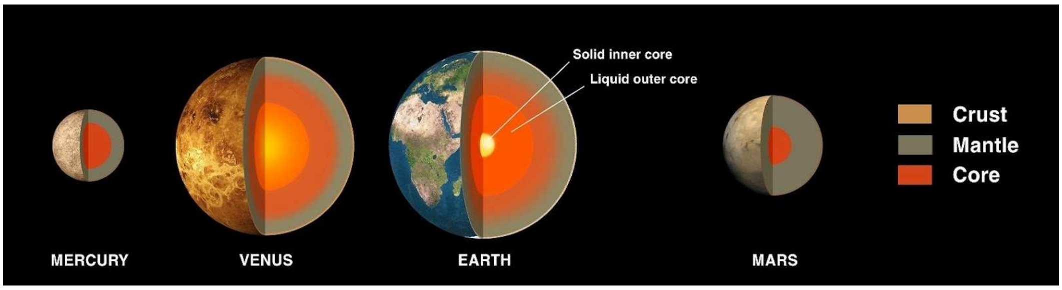
The four inner planets are rocky.

Look at the picture below of the solar system again. The 4 planets closest to the Sun are called the inner planets of the solar system. They all are made of rock; some of them have a thin layer of gas on the outside. Earth has a very thin layer of water and soil too.



These are the 4 inner rocky planets. This shows their sizes compared to each other. Can you name them?

The next image shows us what the core of each of the rocky planets looks like. The core is the inner part of the planet and it is made up of different layers.



The core of each of the four inner rocky planets of our solar system.

QUESTIONS

1. Give the names of the four inner, rocky planets by looking at the pictures above.

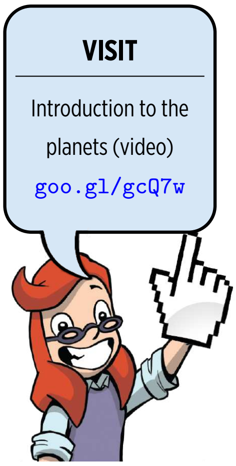
---

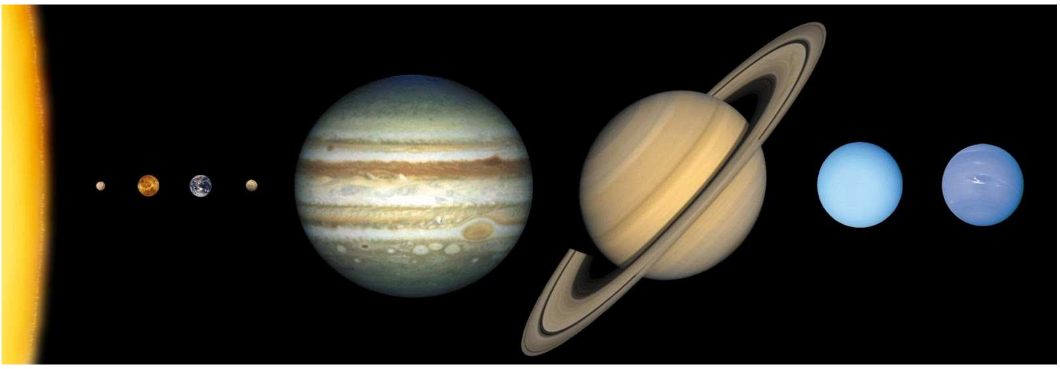
2. Name the three layers of the rocky planets. Hint: They

are each given a different colour in the image above.

The four outer planets are gas giants.

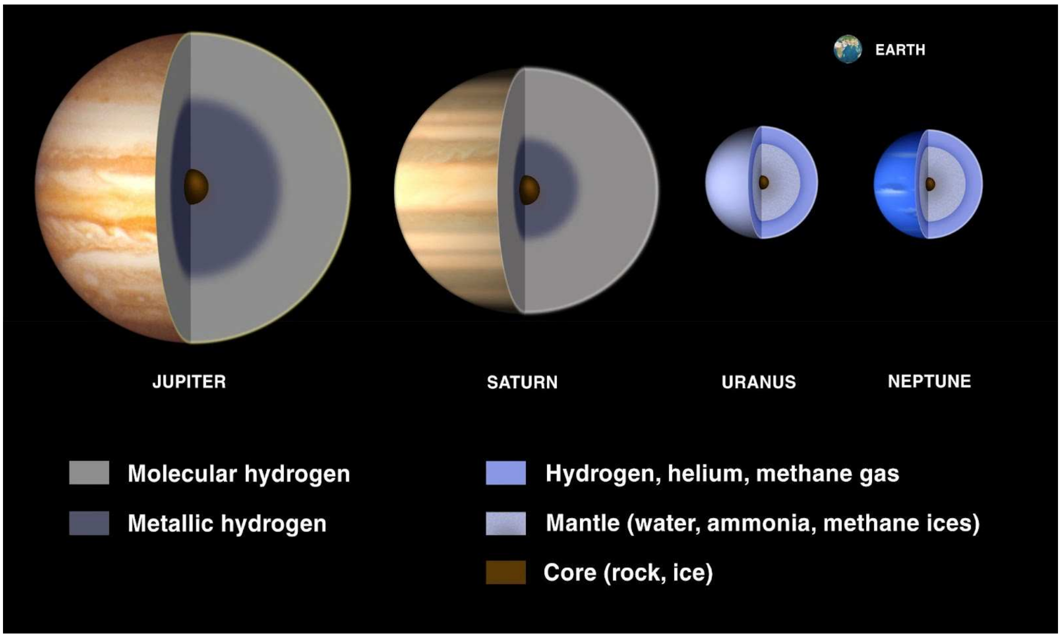
These planets are very far from the Sun. They don't have a hard surface that a spacecraft can land on. Instead, they are giant balls of very cold gases. Astronomers think that these planets have hot, solid cores, deep down inside them.





This diagram shows the different sizes of the planets. Can you see how much bigger the 4 outer gas giants are?!

This next image shows us what the inside of the gas giants is like. There are also different layers of gases.



The four gas giants, showing the gases which make up these planets

QUESTIONS

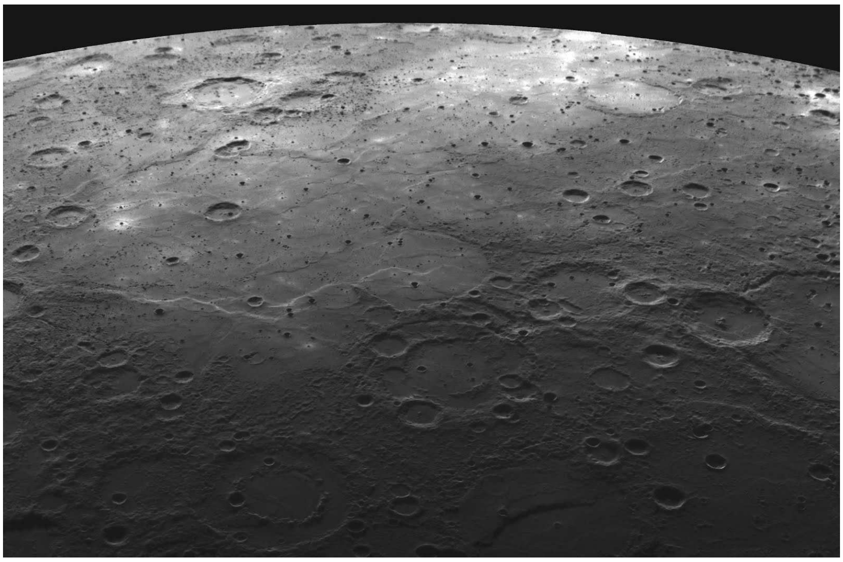
1. Give the names of the four outer, gas planets by looking at the pictures above.

---

2. Give the name of one of the gases that make up the gas planets.

Let's now take a closer look at each of the planets.

Mercury is closest to the Sun, and the smallest planet. It has no atmosphere and its grey surface is marked with thousands of craters. A crater is the mark that we see where a rock has crashed onto a planet or a moon.



Can you see all the craters on the surface of Mercury?!

DID YOU KNOW?

Venus alternates every 584 days between being an "Evening Star" and a "Morning Star", in other words shining brightest just after sunset, or just before sunrise.

Venus is second closest to the Sun. It is almost the same size as Earth. To us, it looks white and it shines brightly in the evening or morning.

Venus shines brightly like that because it is covered in a thick cloud of gas. It would be horrible to breathe the atmosphere on Venus, because the gas is mostly carbon dioxide and sulphuric acid!

DID YOU KNOW?

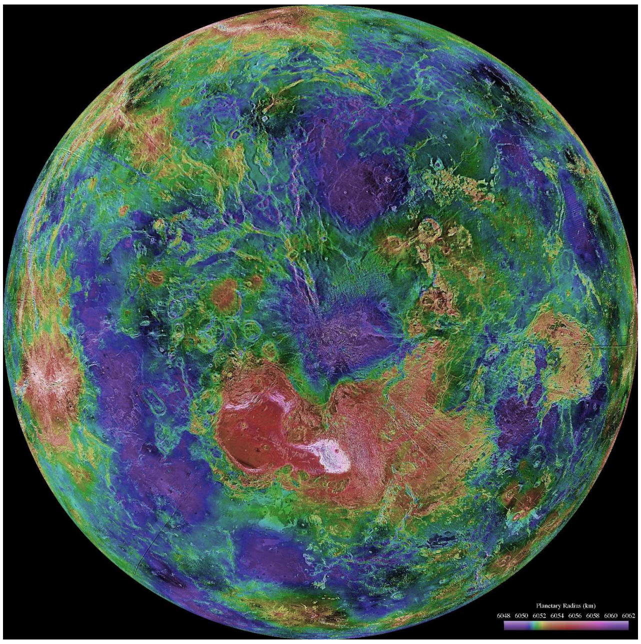
The temperature is about 450°C on the surface of Venus!

The atmosphere absorbs lots of heat from the Sun and does not cool down at night. Venus is the hottest planet in our solar system.

Venus rising next to the Moon.

VISIT

Video on Venus
goo.gl/1V0m7



This beautiful image of Venus was created from a whole lot of photographs taken by NASA over 10 years, put together to make a single image.

QUESTIONS

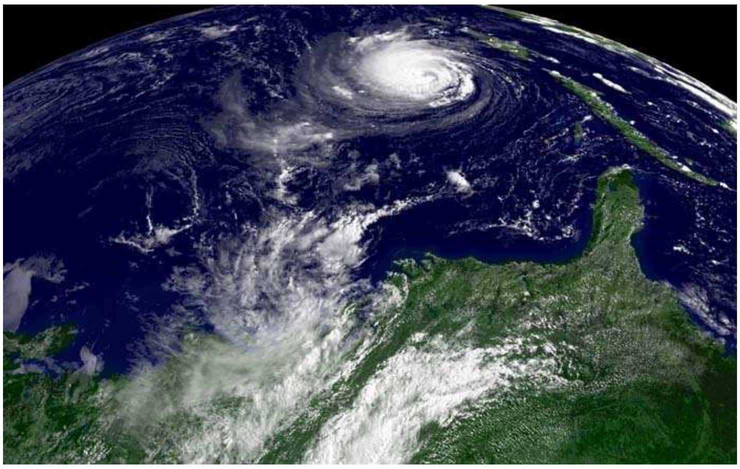
1. At what temperature does water boil?

____

2. Zinc melts at about 420°C, so what would zinc look like on the surface of Venus?

____

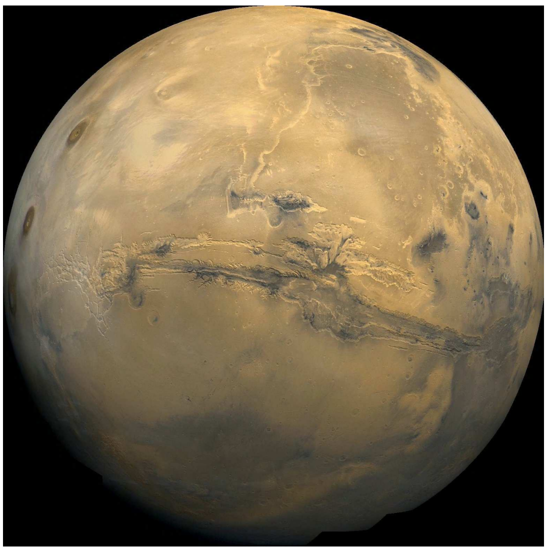
Then we reach **Earth** - the blue planet, our home in Space. You know a lot about Earth already. Earth has its Moon that we know well. The Moon moves in its orbit around the Earth.



This image is from a satellite tracking a hurricane moving over Earth's surface. Can you see the hurricane? It appears as the white swirl of cloud on the picture.

Next furthest out is **Mars**, the red planet. We know quite a lot about Mars. Many spacecraft have been sent to Mars to take photographs and some spacecraft even landed to take samples of the soil.

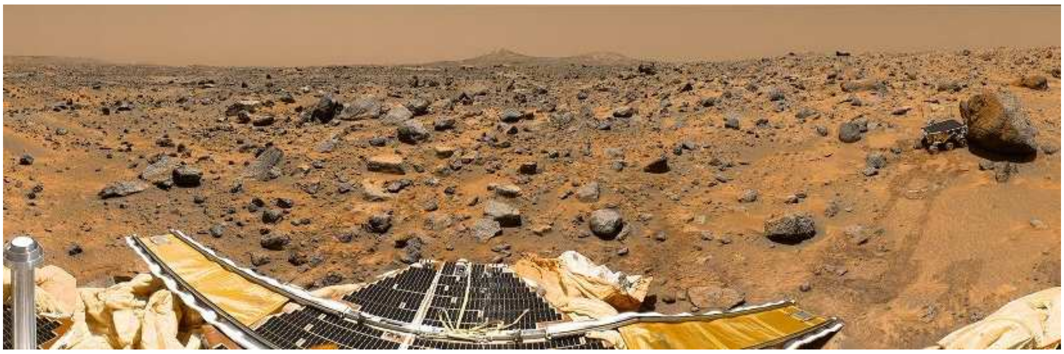
Mars needs almost two Earth years to complete one orbit around the Sun, so if you lived on Mars you would have to wait a very long time for your birthday. Mars spins like the Earth, and a day on Mars is almost the same length as a day on Earth. A day on Mars is called a sol.



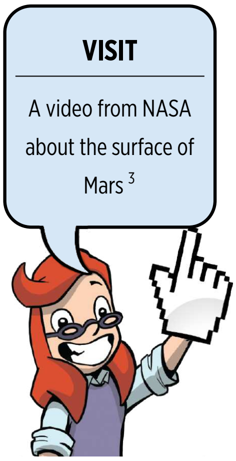
Can you see the long, darker mark across the surface of Mars? This is a deep valley.

This planet is further from the Sun than Earth, and for this reason it is very cold. It has a thin atmosphere but this atmosphere is mostly carbon dioxide gas. Humans cannot breathe that atmosphere.

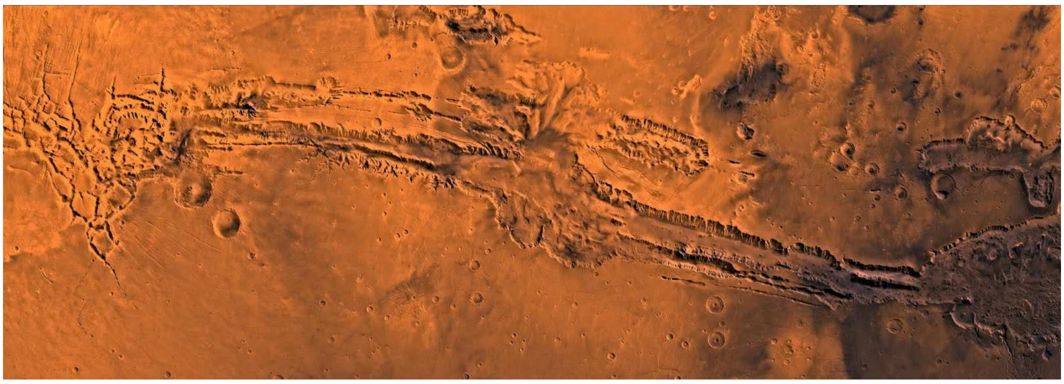
The surface is mostly sand and rocks. The sand is full of iron oxide, which is the same substance as red-orange rust. From Earth we see Mars as a small red-orange dot in the sky, because of the colour of the soil.



This is a very recent photograph of the surface of Mars, taken in 2012 by the rover called Curiosity. Can you see all the rocks?



There are some very big valleys on Mars. Valleys are caused by erosion when water flows downhill, so we can **make an inference** that there was a lot of water on the planet long ago. If there was water, perhaps there were living things on Mars too. But we cannot be sure. Scientists have sent another spacecraft to look carefully at the rocks and sand. The spacecraft is called *Curiosity* and it will try to find signs of living things in the ground.



This is a closer view of the valley you saw on the surface of Mars. On Earth, valleys like this are caused by water. Did Mars have water long ago?

QUESTIONS

Mars is smaller than Earth and if you went there, your weight would be only about a third ($\frac{1}{3}$) of your weight on Earth.

1. If your mass is 45 kg on Earth, you weigh 450 newtons (N). If you went to Mars, what would you weigh?

____

____

2. Would you feel heavier or lighter on Mars?

____

DID YOU KNOW?

Before we can get to Jupiter, we have to pass safely through the asteroid belt. You can read about the asteroid belt further down this page.

Now we have to go very far from the Sun, 5 times further than Earth is from the Sun. We begin to see the gas giants, which are the four outer planets. These gas giants have no solid surface we could land on. They are huge balls of gas and if we came close we would fly through clouds of cold gases.

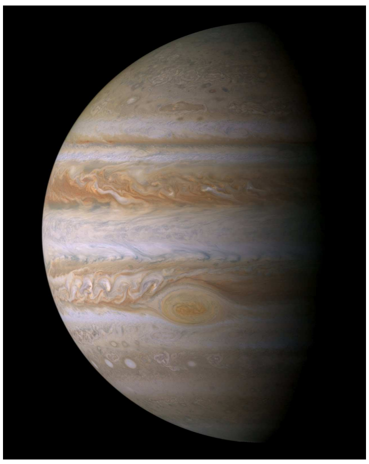
Jupiter is the first gas giant we come to, and it is the biggest of all the planets. From Earth we see it shining white but close up, its colour is light pink-brown. It is bigger than all the other planets put together.

DID YOU KNOW?

You will read about Galileo in Chapter 5. He was the first person to see the moons of Jupiter.

Jupiter is a huge ball of gases such as hydrogen, with clouds of ammonia. Winds blow from east to west on Jupiter's surface, and they blow at the speed of jet planes. The surface is very cold, and some of the gases are so cold that they have become liquid or solid.

Deep inside, Jupiter may have a very hot core of rock. Jupiter has four big moons, and sixty smaller ones.



Jupiter, showing the swirling light pink and brown colours on the surface.

VISIT

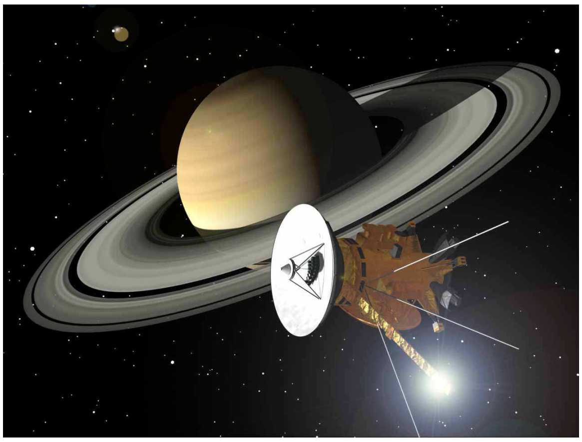
A video on Jupiter

goo.gl/T0rhi

DID YOU KNOW?

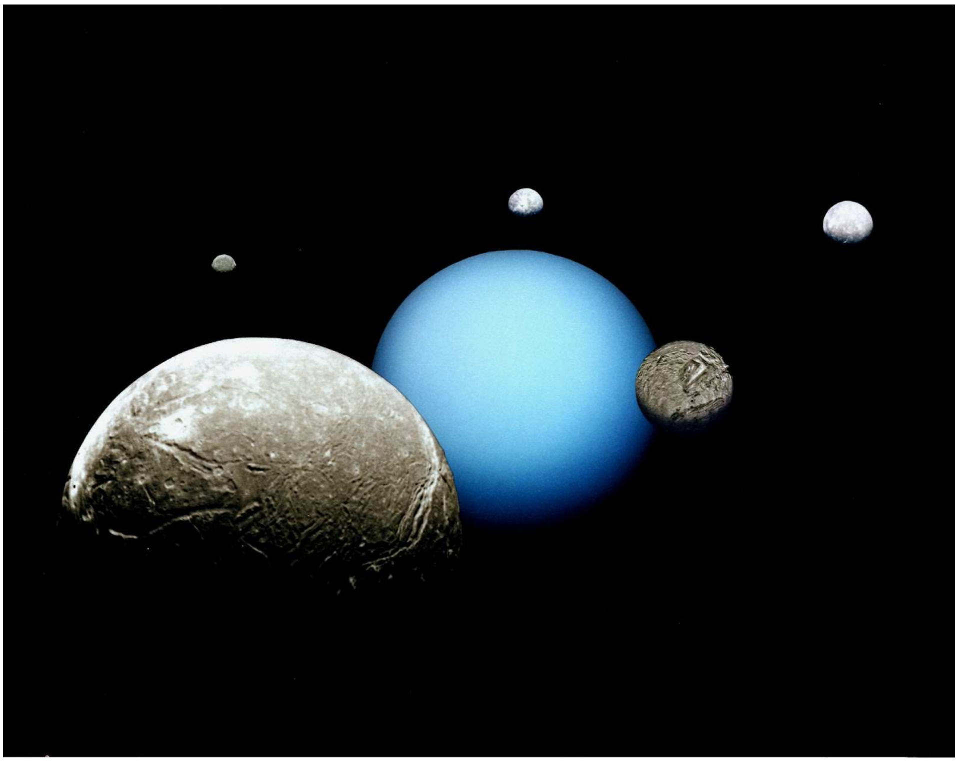
Saturn isn't the only planet with rings. The other gas giants, Jupiter, Uranus and Neptune also have rings - they are just less obvious.

If we now go even further into Space, to double the distance we went to reach Jupiter, we reach the planet Saturn. **Saturn** is almost as big as Jupiter but it has a light yellow colour. It is mostly gas and it has rings of rock spread out and spinning around it. Saturn has about 62 moons.



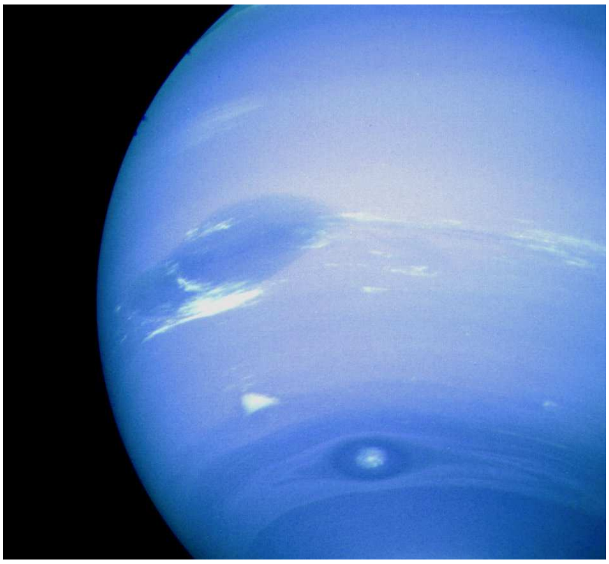
This image is an artist's drawing of the Cassini spacecraft approaching the planet Saturn and its magnificent rings.

Then we get **Uranus**, a smooth blue-green ball of gas, with almost no marks and shapes on it that we can see. It has more than 25 moons.



The blue globe of Uranus shown here with 5 of its major moons.

Now we are more than 30 times further from the Sun than Earth is, and we see the last planet, Neptune. **Neptune** is also a ball of gas and looks like Uranus. It has about 12 moons, and possibly more. Neptune has a very 'stormy' surface. Images of the planet often show huge storms and winds.



Look at this close-up of the surface of Neptune. Can you see the stormy surface? These are the darker blue and white spots.

ACTIVITY: Comprehension on the 8 planets of our solar system.

INSTRUCTIONS:

1. We have read a lot about the planets in our solar system.
2. Use all the information and images in the previous pages to answer the following questions.

QUESTIONS:

1. Name all the planets in order starting from the one closest to the Sun.

____

____

2. What are the 4 inner planets known as?

____

3. What are the 4 outer planets known as?

____

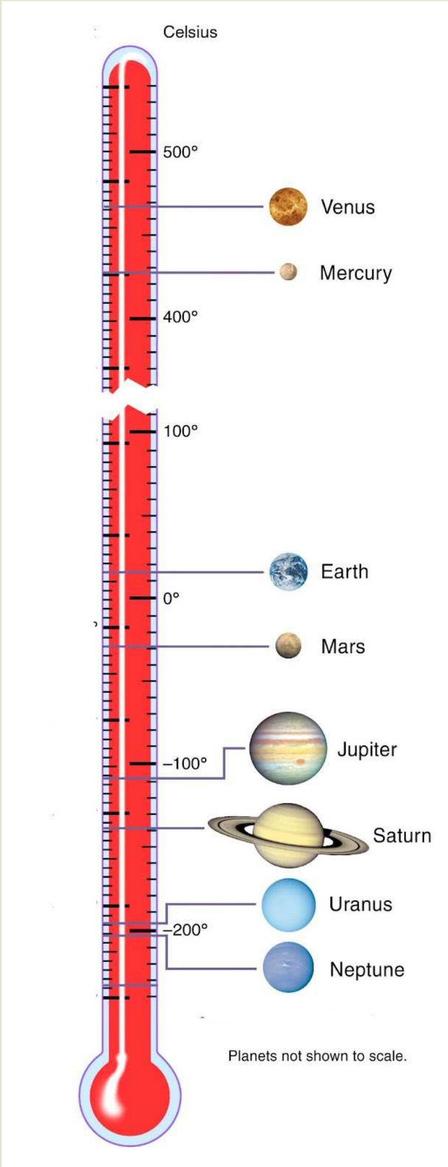
4. Which planet is the hottest?

5. On which planet do scientists think there might have been water long ago? Why?

6. Which planet has a "stormy" surface?

7. Venus also has an atmosphere like Earth, but we would not be able to breathe there. What gases make up the atmosphere on Venus?

8. Below is an image showing the temperatures of the planets. Mercury is the closest to the Sun, but Venus is actually hotter than Mercury. This is because of the dense atmosphere of Venus which acts like a greenhouse and traps the Sun's energy in the atmosphere. Use the image to give the temperatures of Earth, Jupiter and Neptune.



The temperatures of the planets

9. Which is the biggest planet in our solar system? What colour is it?

---

10. Which planet is blue-green in colour?

---

11. Saturn has rings around it. What are these rings made of?

---

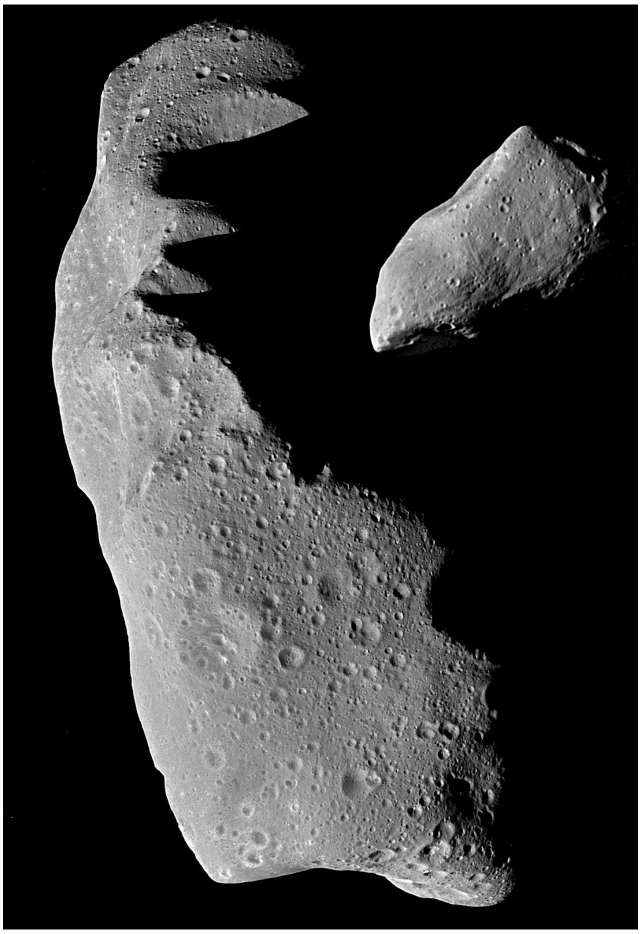
12. Draw a picture of Saturn in the space below.

Asteroids

What a strange word - asteroid! Have you heard this word before? Maybe when we mentioned the asteroid belt?

Let's find out what they are!

The asteroids are lumps of rock from planets that broke up long ago. Some of the lumps are bigger than a school building and some are only as big as small stones. They orbit around the Sun and so they are travelling very fast. Some of them are travelling as fast as 25 kilometres every second. That is much faster than a bullet.



This is a photo of the asteroids Ida and Gaspra.
Ida is the bigger one and is 30km long.

DID YOU KNOW?

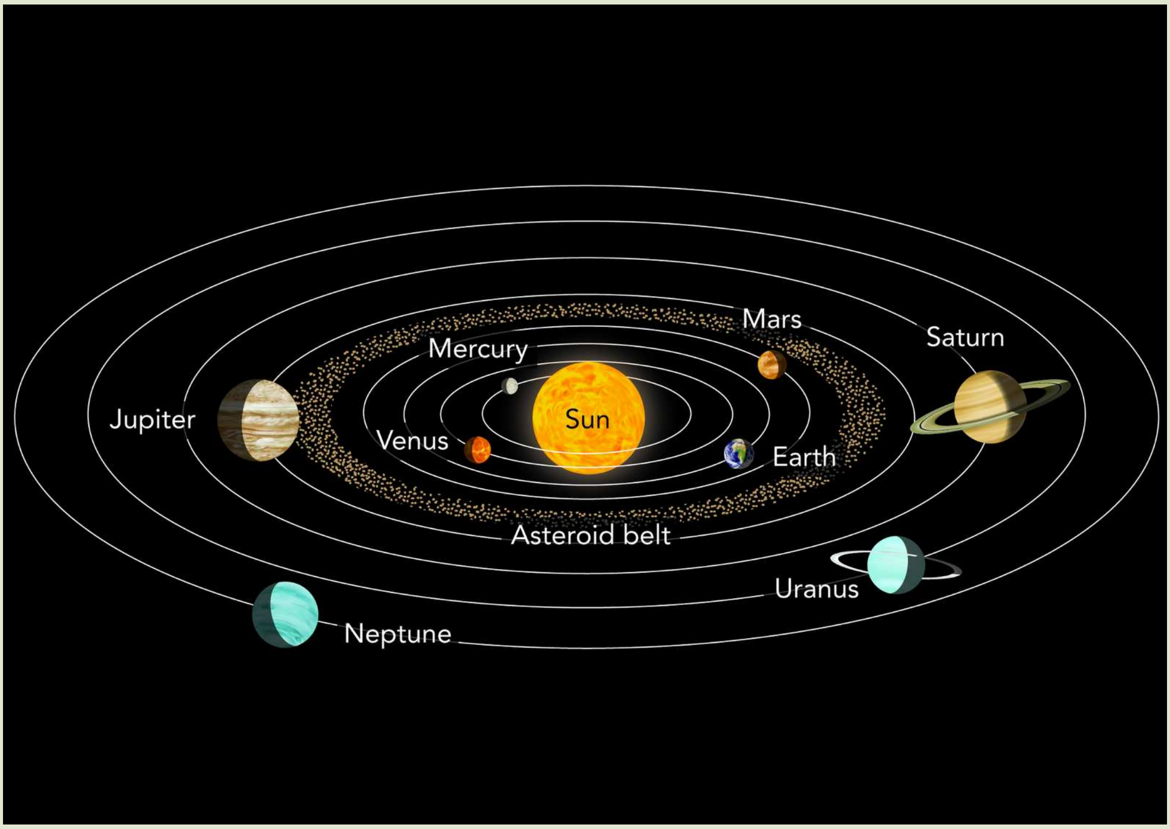
Many scientists believe that an asteroid hit Earth and caused the extinction of the dinosaurs around 65 million years ago.

The asteroids have gathered together in a ring in the solar system. This ring is called the **asteroid belt**.

ACTIVITY: Where is the asteroid belt?

INSTRUCTIONS:

1. Find the asteroid belt in the picture below.
2. Write out the whole sentence below and complete it.
3. Use some of the words from the box.



Word box
- Mars
- Jupiter
- Venus
- pieces of rock
- in orbit
- the Sun

Asteroids are __________ that move __________ around the Sun. The asteroid belt is in Space between the orbit of __________ and the orbit of __________.

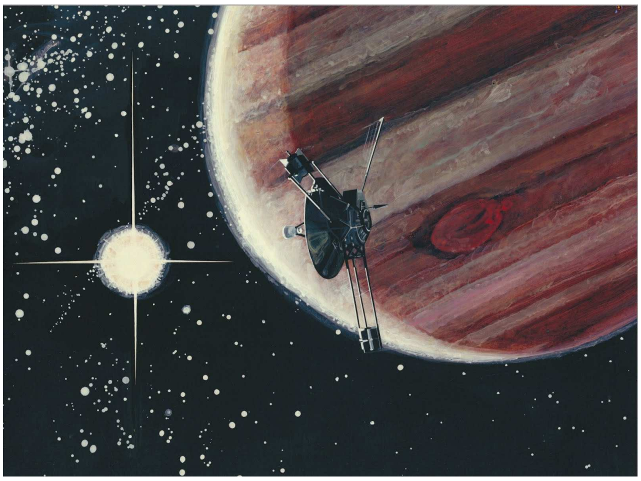
____

____

____

In 1973, Pioneer 10 was the first spacecraft to travel to Jupiter. To get there, Pioneer 10 had to go through the asteroid belt. Do you remember how fast asteroids are moving? If an asteroid had hit

Pioneer 10, the spacecraft would have been destroyed and smashed to pieces. However, Space is a very big place and the asteroids are usually far apart. Pioneer 10 got through safely and went on to take the first close-up photos of Jupiter.



An artist's painting of the Pioneer 10 spacecraft near Jupiter after it was the first to cross the asteroid belt.

1.2 Moons

You know from the section on planets that other planets have moons.

Earth's Moon

Let's begin with Earth's Moon. You learnt about Earth's Moon in Gr. 4. So what do we already know about Earth's Moon?

ACTIVITY: Let's revise what we learnt in Gr. 4 about the Moon.

QUESTIONS:

1. Does the Moon make its own light? Explain how the Moon gives us light at night.

___

___

___

2. Can we see the Moon during the day?

3. Does the full Moon look bigger when it rises at supper-time, and then smaller when it is high in the sky?

4. Why does the Moon sometimes look like a letter D or a letter C?

5. Is it easier to see the stars when the Moon is full or when it is not full?

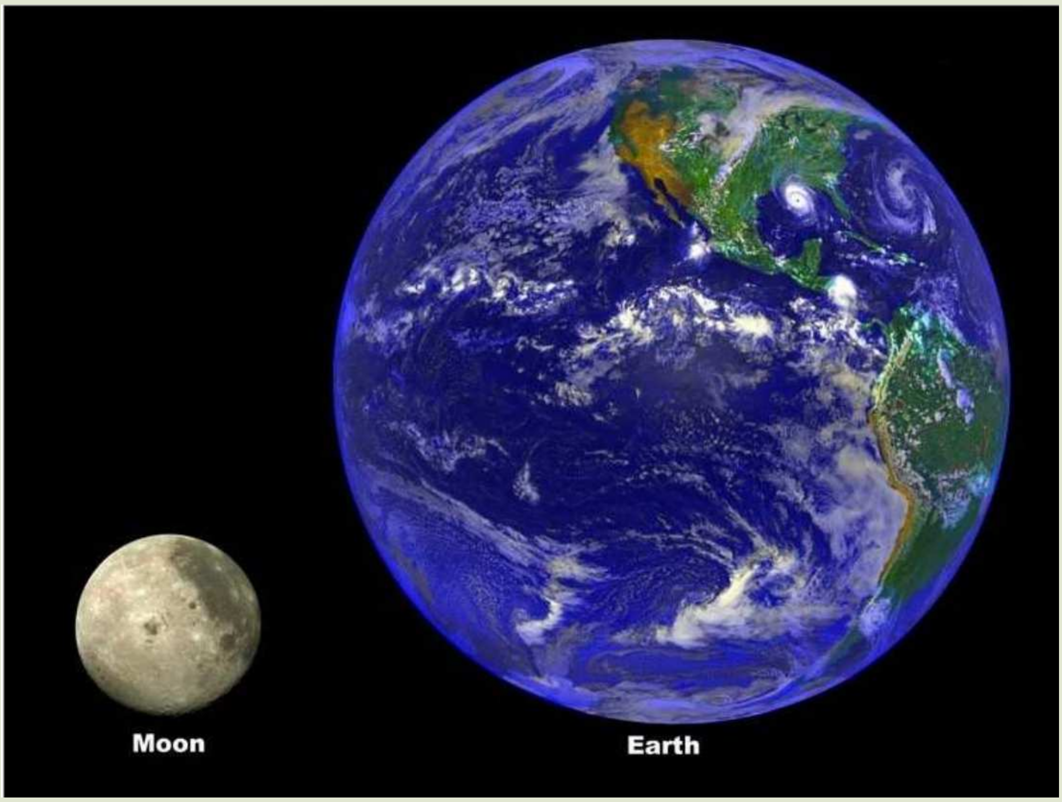
6. Why do we sometimes see the new Moon looking like this, in the next photo. The Sun is almost behind the Moon, so where is the light coming from?

Only one side of the Moon in this photo has light on it. Where is this light coming from?

ACTIVITY: Compare the Moon with the Earth

INSTRUCTIONS:

1. Work with a partner or in a small group.
2. Look carefully at the picture and answer the questions.



The Moon and the Earth - showing the difference in size

QUESTIONS:

1. List all the differences you can see between the Earth and Moon.

____

____

____

____

2. List some differences that you know about, even though you can't see them in the photos.

Many people say that the full Moon looks bigger when it rises just after sunset, and then looks smaller late at night. Is this true? Let's do an investigation to find out.

INVESTIGATION: Does the Moon look bigger when it rises than when it is high in the sky?

AIM (What you want to find out):

HYPOTHESIS (What you think will happen):

APPARATUS:

- You need to know the date when the Moon will be full.
- a piece of wire shaped like a V (you can make this from a paper clip)
- a ruler

METHOD:

1. Just after sunset on the right date, look for the rising Moon.
2. When you see it coming up behind some trees or buildings, hold out your width-measure as you see in the picture below.

Hold your width-measure at arm's length.

3. Bend the wires until the points (the tips) of the wire touch the sides of the Moon. **You must keep your arm straight while you measure the Moon**. Can you think of the reason why?

____

____

4. Go inside and use a ruler to measure how far apart the tips of the width-measure are.
5. Record your measurement in millimetres.
6. Go outside again about two hours later and measure the width of the Moon a second time. Remember to keep your arm straight while you measure.
7. Come inside and use the ruler again. Measure the distance between the tips on your ruler again.
8. Record your measurement in millimetres.

RESULTS AND OBSERVATIONS:

Width of the Moon when it was touching the trees: __________ mm

Width of the Moon when it was high in the sky: __________ mm

How could you have done this investigation better?

CONCLUSION (What you learnt):

Write down a conclusion about what you learnt from this investigation.

DID YOU KNOW?

The footprints from the astronauts who first walked on the Moon are still there! There is no wind on the Moon to blow them away.

The Moon has a pale grey surface with dark grey marks on it. Nobody knew what the surface was like until spacecraft landed on the Moon. The first astronauts to walk on the Moon stepped into fine, powdery dust. They collected rock samples (small pieces) to bring back to Earth.

The surface of the Moon is covered with holes called craters. These craters are made by space rocks that hit the Moon. These rocks may be as small as grains of sand or as big as a house. They travel so fast that they explode when they hit the Moon, and they make a round hole.

The footprint of the first person to ever stand on the Moon

The surface of the Moon - can you see all the craters?

The light-coloured areas on the Moon are mountains, and the darker areas are plains. Some of these plains were made by huge space rocks that made craters 300 km wide. Other plains were made by volcanoes on the Moon a long time ago. Lava* flowed out from those volcanoes. Nowadays the Moon has no volcanoes.

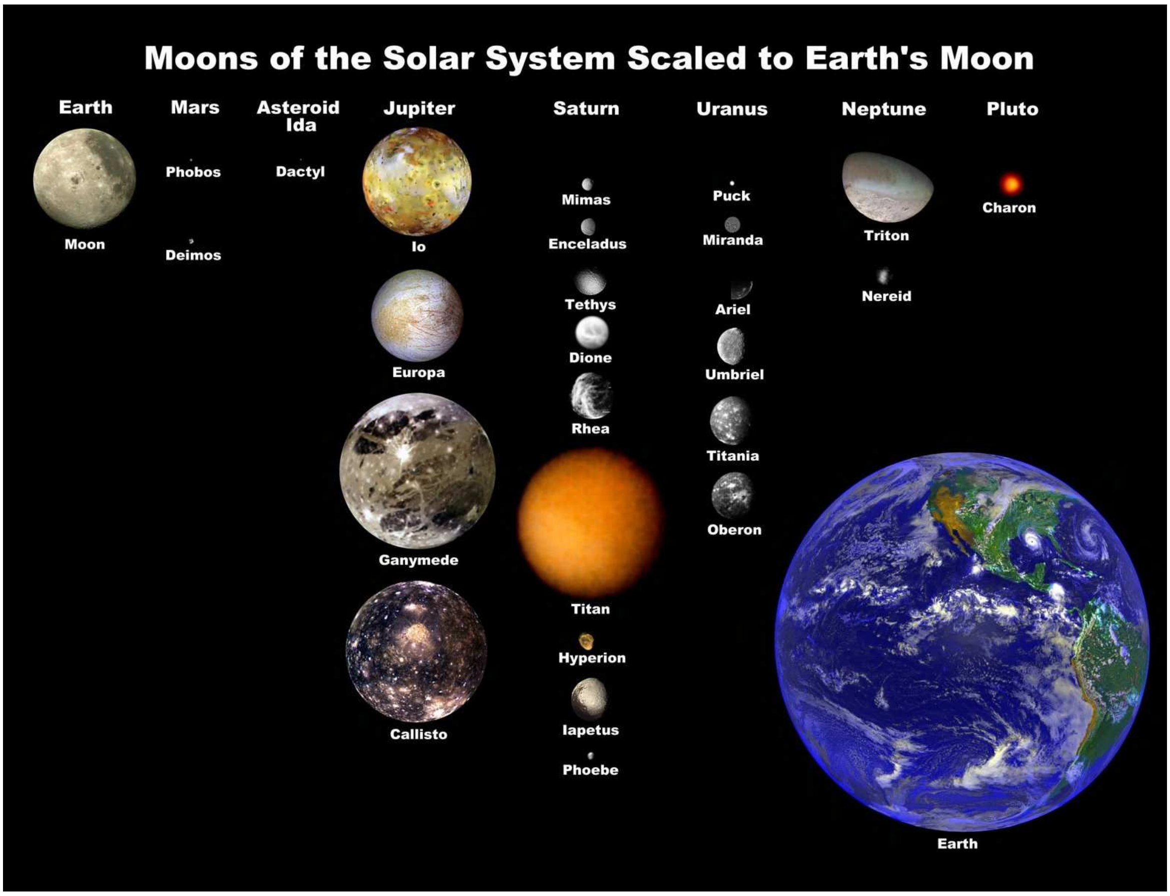
The Moon has no air so there is no wind to blow the dust. The Moon has no water, so there is no rain to wash away sand and cause erosion. That is the reason why we see the craters on the Moon so clearly.

Moons of other planets

Other planets have moons, too. Below is an image showing some of the moons in our solar system. Not all of them are shown here. They have been scaled to be the correct size compared to Earth and our Moon.

Mars has two moons, and astronomers called them Deimos and Phobos. Phobos has deep craters showing that it has also been hit by fast-moving rocks. Can you see how small these moons are compared to our Moon?

On the other hand, Jupiter has 66 moons which we have identified, and each time humans send another space probe to Jupiter, more moons are being discovered! Only Jupiter's 4 biggest moons are shown below.



Some of the moons in our solar system

DID YOU KNOW?

A spacecraft a few years ago found signs of water frozen under the south pole of the Moon. Scientists are not sure how the water got there.

VISIT

Quick tour of planets and their moons
goo.gl/nSwf8

ACTIVITY: Moons in our solar system

INSTRUCTIONS:

1. Look at the picture above of the moons in our solar system.
2. Answer the questions below.

QUESTIONS:

1. How many moons does Earth have?

____

2. What are the names of Mars' two moons.

____

3. Give the name of one of Jupiter's moons.

____

4. Pluto is not actually a planet anymore, but it has been classified as a dwarf planet. Pluto also has 3 moons. How many of Pluto's moons are shown in the picture?

____

5. There are two planets which are not listed here as they do not have any moons. Which two planets are these?

____

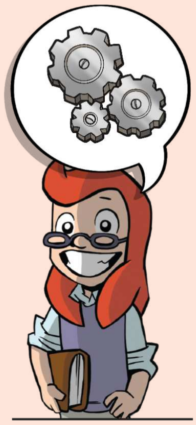
6. What is the name of Saturn's biggest moon?

____

KEY CONCEPTS

- The Sun is at the centre of our solar system.
- Planets move in orbits around the Sun.
- Planets cannot produce their own light; they reflect light from the Sun.
- Asteroids are rocks that move in orbit around the Sun. They are very much smaller than planets.
- Most of the planets have moons. A Moon is a body which orbits around a planet.

REVISION:



1. The table below is a comparison of planets and stars. Choose sentences from below and write them under the heading 'Planets'. Match your sentences about planets to the sentences about stars.

Stars	Planets
Stars are very hot balls of gas that give out light and heat.	
We can see thousands of millions of stars with a telescope.	
Stars are very, very far away from us.	
Stars do not orbit around our Sun.	
The stars seem to stay the same distance apart always.	

Sentences to select from:

- Planets do not make their own light; they reflect the light from the Sun.
- We can see only 7 other planets in our solar system.
- Planets change their positions each night, compared to the positions of the stars.
- Planets are not as far away as stars.
- Planets orbit around our Sun.

2. If you wanted to find Venus, where would you look? At what time would you look?

3. People call Venus the evening or morning star. Explain why Venus is not a star.

4. Here are two sentences about the solar system. The 2 sentences have been broken and the parts are mixed up. Work with a partner to sort out the parts. Then write out both sentences in your book.
   - The solar system is
   - the Sun.
   - The Sun and all the planets
   - a set of parts that
   - pull on each other.
   - the planets move around
   - pull on each other as

5. What made the craters on the surface of the Moon?

6. The surface of the Moon has many craters but the surface of the Earth has very few craters. Explain why that is so.

7. Neil Armstrong was the first man to put his foot on the Moon. His footprint is still there after 40 years. On Earth, a footprint

does not last so long. Explain why it lasts so long on the Moon.

8. The Earth is travelling through Space at 100 000 kilometres in every hour. How can we work that out? Here is information for you to use: The length of the Earth's path around the Sun is 942 million kilometres and it takes $365\frac{1}{4}$ days to go all the way around. Now you can work it out for yourself. **Hint to help you:** How many hours are there in one day?

It is amazing to think that our planet is one of just eight in our solar system, and our solar system is one of millions in our galaxy!

In the next chapter we find out about the movement of our planet in our solar system.

2 Movements of the Earth and planets

KEY QUESTIONS

- If it is nighttime in South Africa, is it also nighttime in Brazil?
- Do the other planets also take a year to revolve once around the Sun? Is their year the same length as our year on Earth?
- Why do we get day and night?
- What is the difference between revolution and rotation?

New Words

- rotate
- spin
- rotation
- direction

VISIT

Short video showing the Sun, Earth and Moon system

goo.gl/cXeog

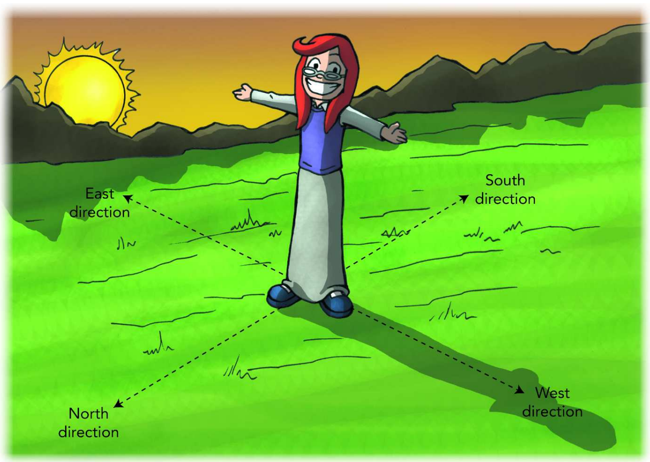
2.1 Rotation (Earth)

For a long time people believed that the Earth stood still and the Sun moved around the Earth. In this chapter we will find out what really happens. We'll start by thinking about day and night.

Day and night

During the day, it appears as though the Sun moves across the sky as it rises (comes up) in the morning and sets (goes down)in the evening.

East and West are two directions you must know. If you point at the Sun when it appears to rise in the morning, you are pointing in the direction of East. If you point at the place where the Sun sets, you are pointing direction of West. Have a look at the picture of Sophie. Sophie loves to get up early and watch the sunrise. She is standing with her arms stretched out, pointing in the directions East and West.



You can tell the direction from the rising and setting of the Sun.

ACTIVITY: Find East and West

MATERIALS:

- a place where you can stand in the early morning

INSTRUCTIONS:

1. Look at the picture of Sophie at sunrise and answer the questions.

QUESTIONS:

1. Which is Sophie's right hand? Show her right hand with your finger.
2. Why do we see a shadow of Sophie on the ground?

---

3. In which direction is her shadow pointing?

---

4. If Sophie looks straight in front of her, in which direction is she looking?

---

5. Now find the direction of East in your classroom. You must point to the place where you see the Sun come up in the morning. In the classroom, stretch out your arms and point in the direction of East and West. Clean the floor and stick some insulating tape on the floor so that everyone can remember which direction is East and which direction is West.

What does the word "direction" mean? You can walk in a **direction** towards a place. If the wind blows, you see leaves moving in the same **direction** as the wind. Remember, a direction is not a place that you can reach!

QUESTIONS

Let's have a discussion. To discuss something is to talk about it and your ideas with someone else or a group of people. Turn to your classmate next to you and discuss the following question. Write your answer down, then write your partner's answer down.

Where does the Sun go at night? Why do we get day and night?

Your answer is:

____

____

Your partner's answer is:

____

____

In this next section we will find out these answers!

Does the Sun really move, or does the Earth move?

When you ride in a bus, you may see houses outside the bus. It looks as if the houses move past your window.

To Sophie, who is riding in a bus, it looks like the houses are moving past.

QUESTIONS

Why do the houses seem to move past your window? Are the houses really moving? Discuss this question.

____

____

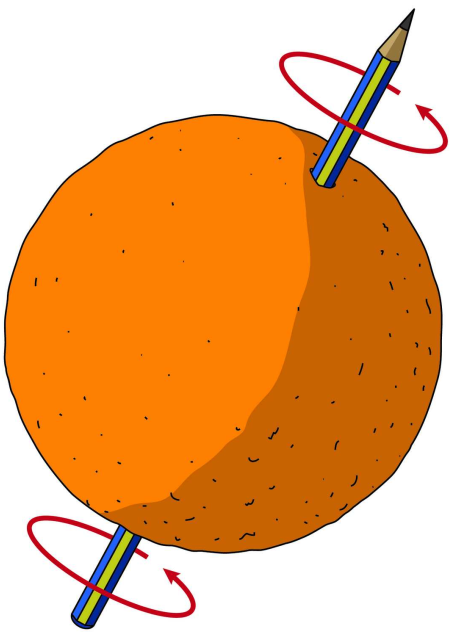
____

So it is really the person in the bus who is moving; it looks to the person as though the houses are moving, but they are not moving.

You saw how big the Sun is when we compare the Earth and the Sun. Go back to the beginning of this term's work to find the picture of the Sun and the Earth. That great big Sun does not move around the Earth.

The Earth is turning around and that is why we see the Sun move past us. We are like Sophie in the bus. She is in the bus and she is moving past the houses. The Sun is like the houses; they are not moving. It looks to us as though the Sun is moving, but it's really the Earth that is turning around.

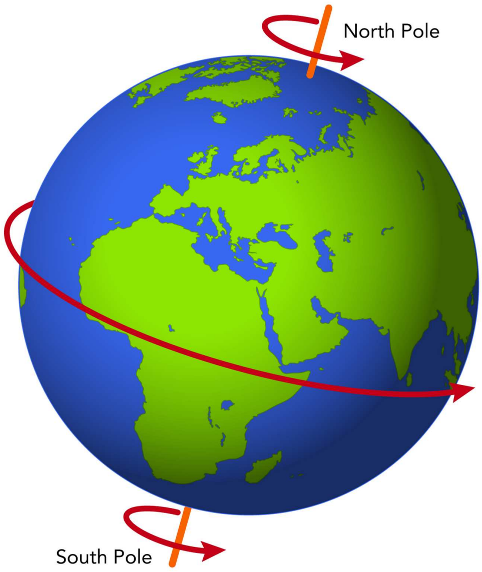
You can think of the Earth as an orange with a pencil through it.



The Earth spins like an orange on a pencil.

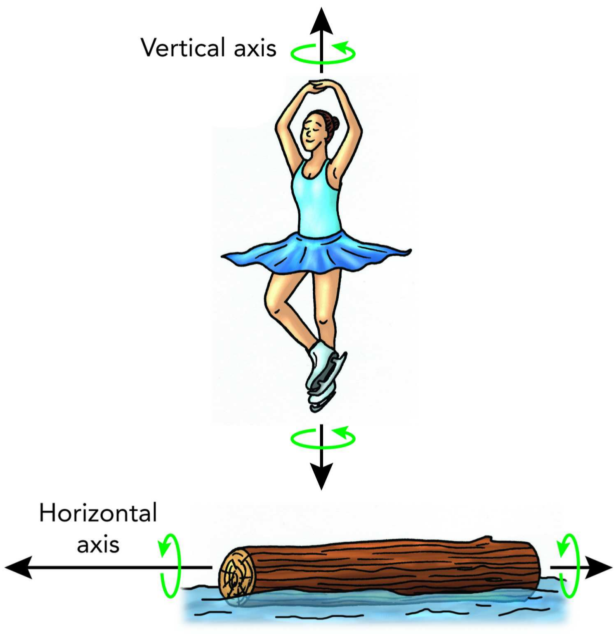
If you twist the pencil, the whole orange spins around. This is like the Earth spinning around. The pencil is called the axis of the orange. In the same way, we can think of an axis that goes through the Earth. The axis is a line that we can imagine, it is not a real thing. Earth spins around that axis. We say the Earth **rotates** (spins).

We say that the Earth has an axis that it rotates on. This axis runs from the North Pole to the South Pole as you can see in the picture.



Other objects also have axes of rotation. For example, an ice skater has a vertical axis that she rotates on when spinning on a spot during her performance.

A log which is floating in water can also roll around. It will have a horizontal axis of rotation.



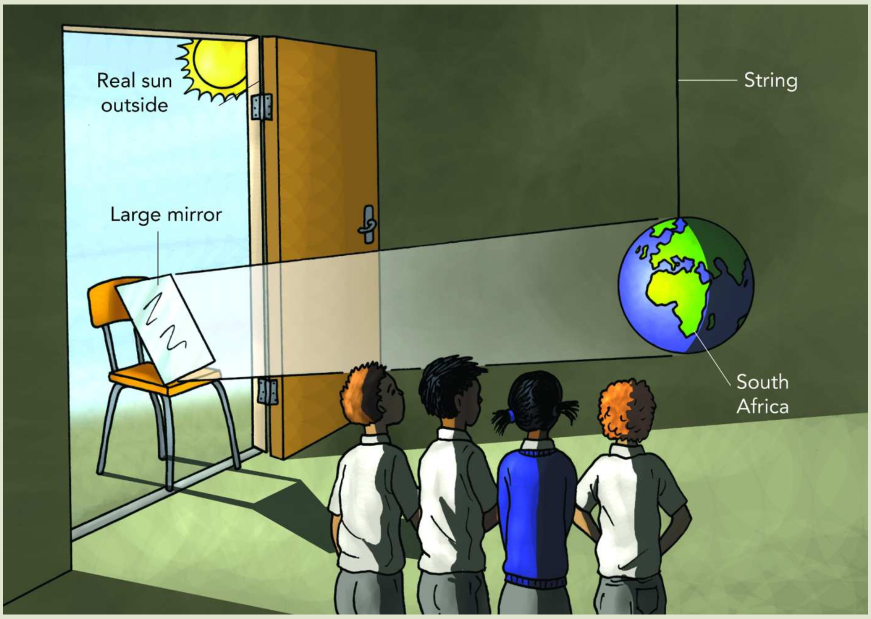
Different axes of rotation

ACTIVITY: Make a model of the Earth in daytime and nighttime

MATERIALS:

- a globe of the Earth or a balloon with the shapes of the continents drawn on it
- string to hang a globe or balloon
- a large mirror

INSTRUCTIONS:



Everyone must look at the globe from the same side. A globe is a model of the Earth.

1. This picture shows you how to set up the equipment.
2. Set up a mirror outside the room so that it reflects bright sunlight onto the Earth globe. Your globe must be able to spin around.
3. Everyone must look at the globe from the same side.
4. Find Africa on the globe. Turn the globe so that the Sun's light falls on South Africa.
5. One side of the globe is in shadow. Find the shadow in the picture. Write the word "shadow" next to it.
6. Find where Durban and Cape Town are on the globe.

7. Look at the globe in the picture. If you were in Durban, would it be daytime or nighttime?

---

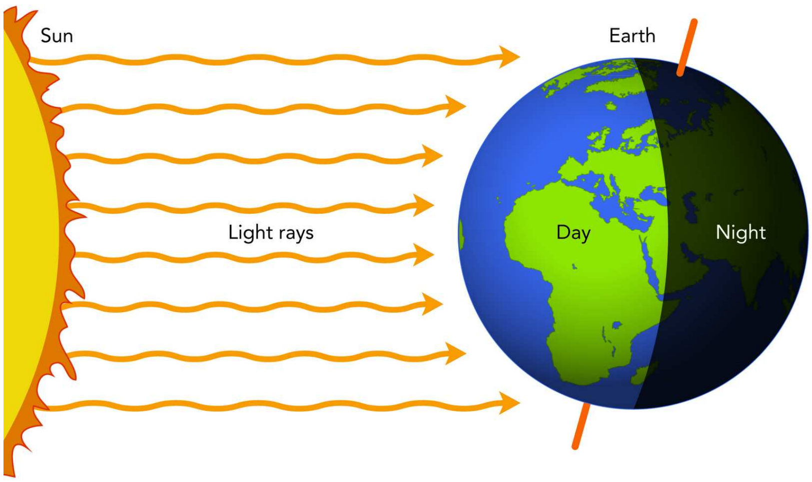
8. If you were in Cape Town, would it be daytime or nighttime?

---

9. Now turn the globe so that Africa moves to the right. That is, you turn the globe towards the East. You will see Durban becoming dark and moving into the shadow. When Durban is in nighttime, Cape Town will still be in sunlight.
10. Keep on turning the globe towards the East. Now Cape Town will go into the shadow. That is nighttime for the people in Cape Town.
11. Which city will come back into daytime first, Cape Town or Durban?

---

12. Keep on turning the globe to the East, and Durban will come back into daytime. You have to move to the other side of the model to see Durban move into sunlight.
13. How many hours pass for the Earth to turn around once?



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

We see the Sun *appear* to rise and move across the sky every day. But the Sun *does not really move*; it only seems to move! Earth is spinning round and round, and we are moving around with the Earth. The Earth takes 24 hours to complete one full rotation.

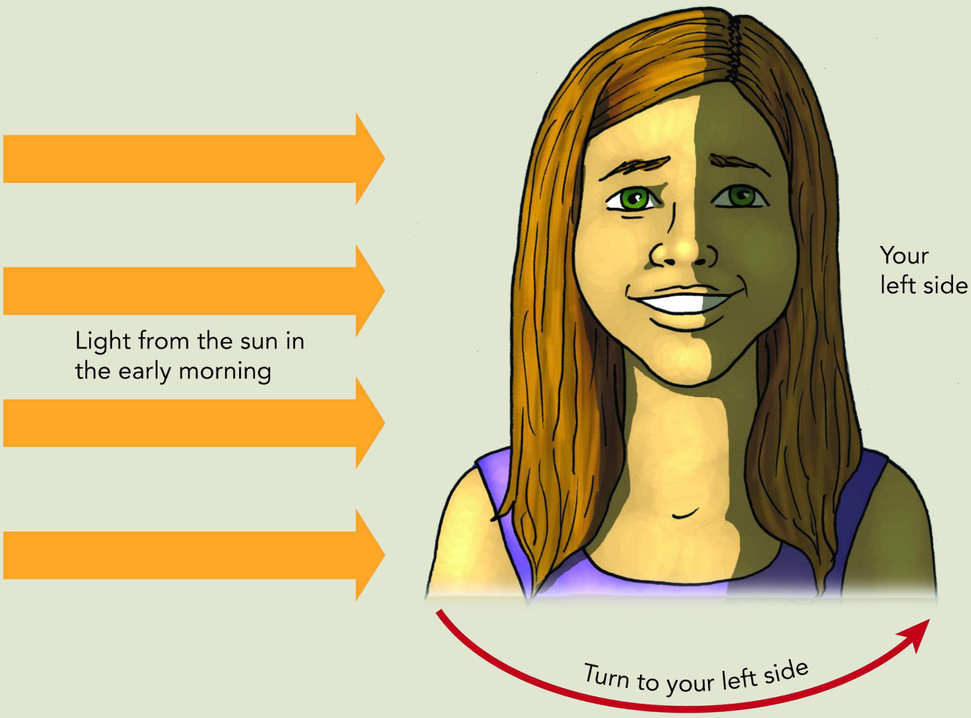
ACTIVITY: Your head can be a model of the Earth

MATERIALS:

- yourself
- sunlight coming from one side

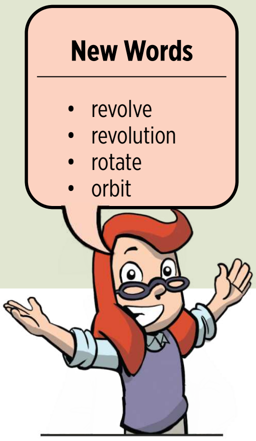
INSTRUCTIONS:

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. We will say that your nose is Africa. You are on Africa. Look at picture below.



Using your head as a model of the Earth.

3. Now 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 night time 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.

2.2 Revolution (Earth)

By now you know that all the planets revolve (travel) around the Sun. Each planet has its own pathway. This is called its orbit. We can also say planets orbit the Sun. Earth also moves in its own orbit around the Sun. This movement is called the **revolution** of the Earth around the Sun. We can also say that the Earth **orbits** around the Sun.

We have now come across two new words: rotation and revolution. Remember, these are not the same thing! Let's do an activity using our own bodies to understand the difference between revolution and rotation.

ACTIVITY: Make a model of the Earth revolving around the Sun

MATERIALS:

- room to move around

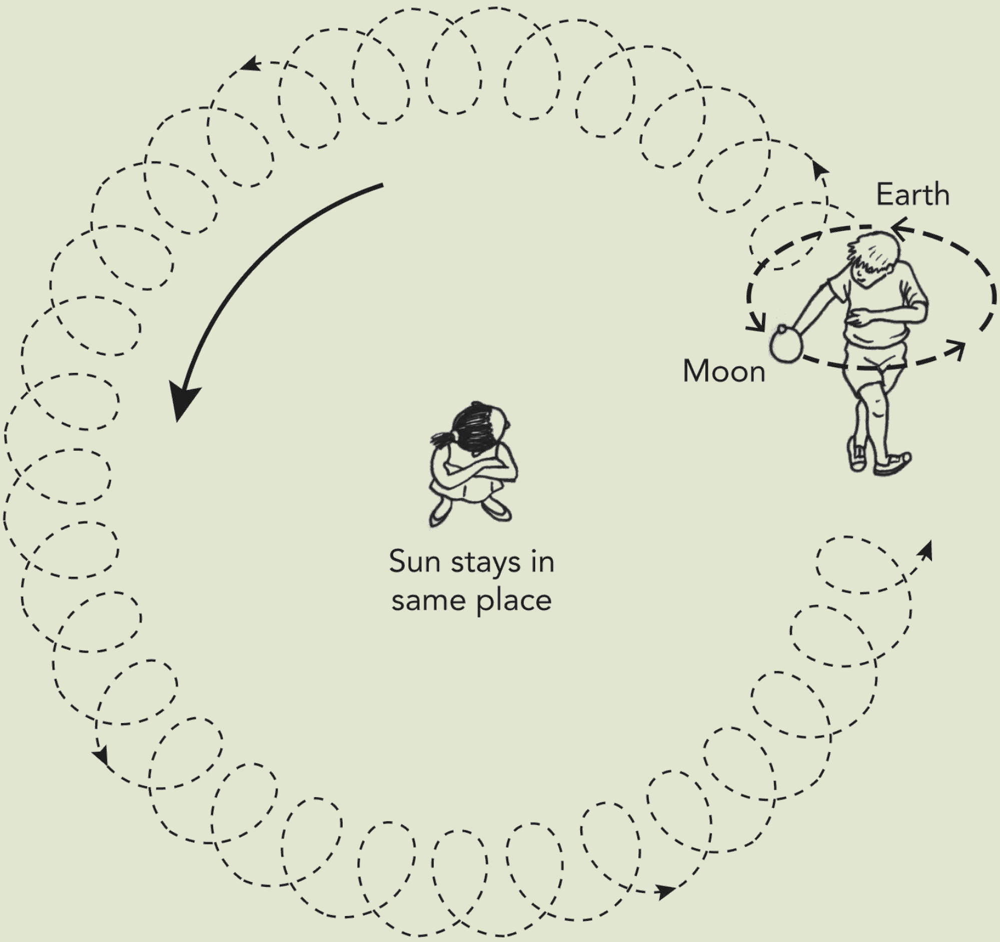
INSTRUCTIONS:

1. We are going to use our bodies to understand the difference between revolving and rotating.
2. First, the whole class must stand, and spread out. Now spin around with your arms out, staying on one spot. This is called rotation! The Earth rotates like this on its axis.
3. Now get into pairs. One learner must stand in one spot and the other learner must walk in a circle around the other person. This is revolution. The second learner is revolving around the learner standing still in the middle. The Earth revolves around the Sun like this.
4. Now, let's put both movements together! As the Earth rotates on its axis, it also revolves around the Sun. This might be

tricky! Spin around (rotate) while also moving in a big circle around your partner (revolve). Look at the picture below.

DID YOU KNOW?

Every 4 years we have a leap year, which is when there is one extra day in the year. This is because the Earth actually takes 365.25 days to revolve around the Sun, and not just 365 days. So every 4 years, we have an extra day to account for these quarter days.



The learner is rotating (spinning) and revolving around his partner.

QUESTIONS:

1. In this model, who represents the Sun and who represents the Earth?

____

____

2. When you are spinning and walking in a circle around your partner, sometimes you face your partner and sometimes your back is to your partner. Which of these represents day for you and which represents night for you?

____

3. You could spin around very quickly, but how many hours need to pass for the Earth to rotate once?

4. You could also move around your partner quite quickly. In reality, how long does it take for the Earth to go once around the Sun?

KEY CONCEPTS

- Wherever we are, we can find the East - West direction by the place where the Sun rises and sets.
- The Earth spins on its axis once in 24 hours. This spinning is called rotation.
- The part of the Earth that faces the Sun experiences daylight, and the part that is turned away from the Sun experiences night.
- The Earth travels in its orbit right around the Sun. This travel in orbit is called revolution.
- A complete travelling of the Earth around the Sun makes a year.

REVISION:

1. How can you find East?

2. How can you find North?

3. Why does it look as though the Sun moves across the sky when we know that the Sun does not move?

4. Where is the Sun, when it is nighttime where we are?

5. When we are having night, is everybody in the world also having night?

6. The Earth spins on its own axis. What term refers to this?

7. The Earth and the other planets travel in an orbit around the Sun. What term refers to this?

8. How many hours does it take the Earth to rotate once?

9. How many days does it take the Earth to revolve once around the Sun?

10. Do you think Mars would take more Earth days to revolve around the Sun than Earth does? Why?

11. **Bonus question:** Why do you think we have a leap year every 4 years and not every 3 or 5 years?

We have now seen how our planet Earth moves but what about our Moon? Does it also rotate and revolve? Let's find out!

3 The movement of the Moon

KEY QUESTIONS

- Does the Moon move around the Earth?
- Has anyone ever seen the far side of the Moon?
- What is a solar eclipse?

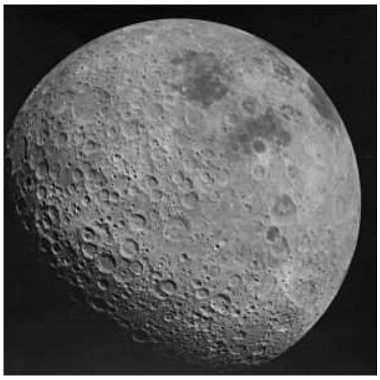
3.1 Rotation (Moon)

VISIT

Video showing the movement of the Moon

goo.gl/B9Jq8

On Earth we see only one side of the Moon. Nobody knew what the far side to the Moon looked like until the Soviet Luna spacecraft went into orbit around the Moon in 1959 and photographed the far side. The force of gravity between the Earth and Moon holds the Moon's near side facing us.



This photo was taken by a spacecraft orbiting the Moon. It shows the far side of the Moon that we never see.

ACTIVITY: Does the Moon rotate?

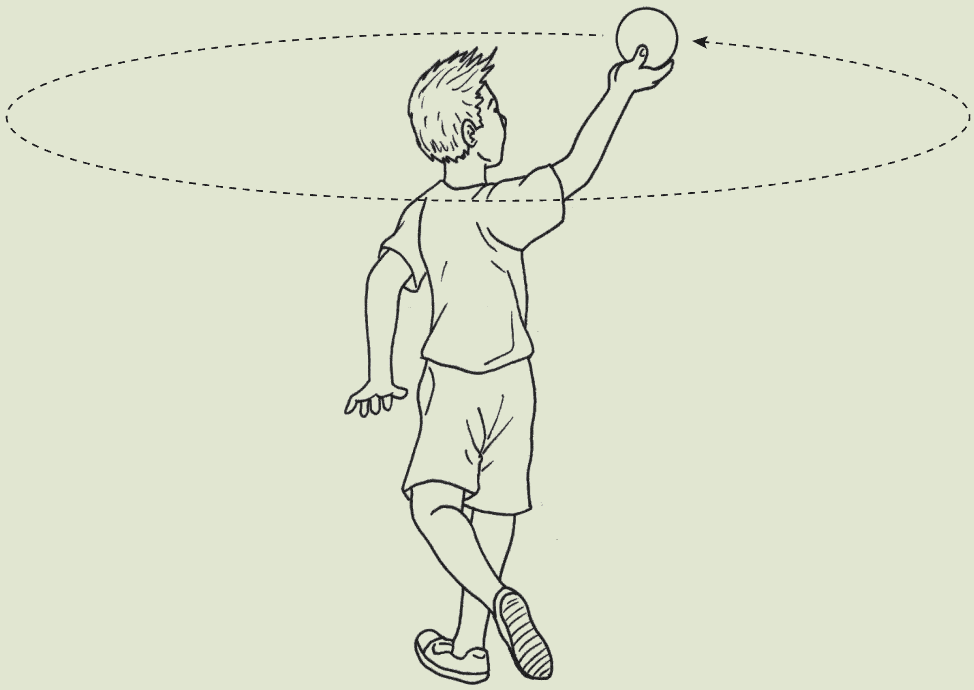
MATERIALS:

- a white ball with a red mark on it
- a person who will swing the ball around like the learner in the picture
- another person who will watch the ball as it swings around

INSTRUCTIONS:

1. Do as the learner in the picture is doing. Stretch out your arm and make the white ball revolve around your body by holding out your arm and moving on around on a spot.
2. As you are moving the ball around yourself, you only ever see one side of the ball. Do you agree?

3. Your partner must stand on one side of you as you swing the ball around. What does this person see? They will see different sides of the ball.
4. Take it in turns to be the one moving the ball around as you rotate and the one observing.



The learner represents the Earth and the white ball represents the Moon.

The learner swinging the ball always sees the same side of the ball, but a person standing watching the ball will say that it rotates. The red mark on the ball will point to the **side** of the room, then to the **back** of the room, then to the **other side**, and then to the **front** of the room.

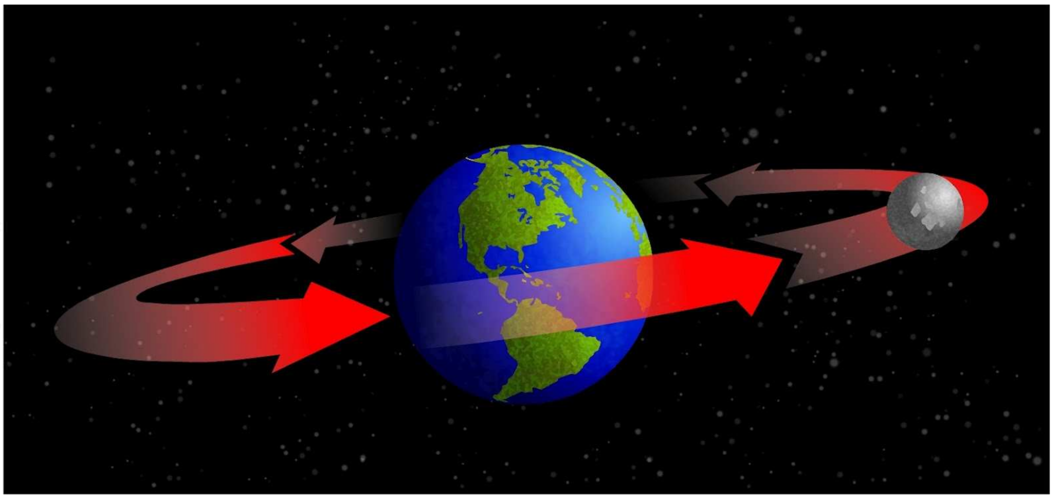
So the person watching will say that the ball has rotated, and also revolved.

The real Moon takes about 28 days to rotate once.

3.2 Revolution (Moon)

The Moon also revolves in orbit around the Earth, as you saw in the last activity. The Moon takes about 28 days to complete one orbit. The force of gravity between the Earth and the Moon holds the

Moon so that it always faces us on Earth.



The Moon revolves around the Earth.

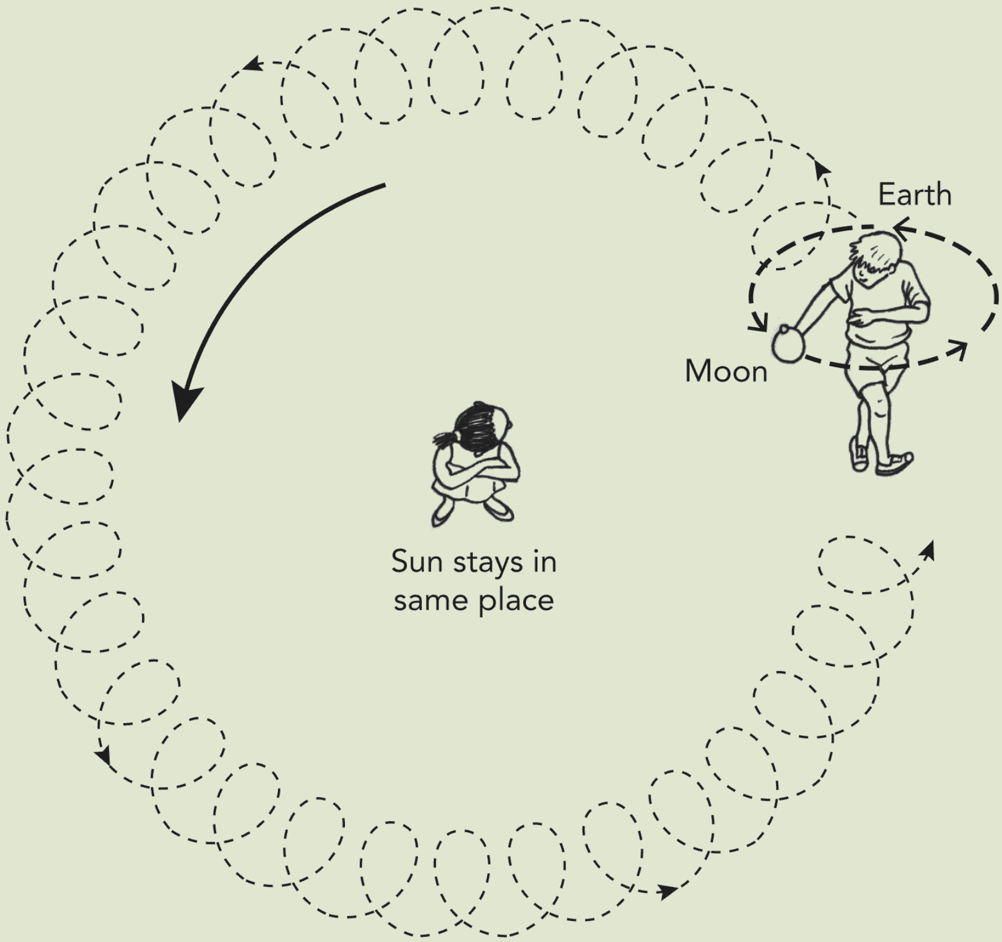
ACTIVITY: Make a model of the Earth and Moon revolving around the Sun

MATERIALS:

- a white ball
- two people who have practised the model in the previous activity

INSTRUCTIONS:

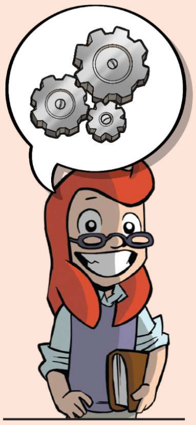
1. You must use your bodies and the white ball to act out this model of the Earth and Moon revolving around the Sun.
2. Work together in small groups to decide how you are going to perform this model.
3. You must put together the movement of the Moon around the Earth from the last activity, and the movement of the Earth with its Moon, around the Sun.
4. Then perform the movements for the class.
5. So the model you must perform will be like this diagram shows.



Acting out the Moon and Earth moving around the Sun

KEY CONCEPTS

- The Moon travels in an orbit around the Earth in about 28 days.
- The Moon rotates on an axis which also takes about 28 days.
- We always see only one side of the Moon.
- Together, the Earth and Moon revolve around the Sun.



REVISION:

1. Complete the sentences using all the words from the word box. write the sentences out in full on the lines below and number each sentence.

   a) The Sun stays in __________

   b) The Earth rotates on its own __________

   c) The Moon revolves __________

   d) The __________ revolve together in a big circle around the Sun.

   e) We only ever see __________ of the Moon.

Word box

- Moon and the Earth
- around the Earth
- one side
- axis
- the same place

____

____

____

____

____

____

____

2. Complete the table comparing the Sun, Earth and Moon. Some answers have been filled in for you.

Question	Sun	Earth	Moon
What is the object classified as?			a moon
What is the shape?			
What is the size relative to the other objects being discussed here?	The Sun is the biggest.		
What is the movement in relation to other objects?		The Earth revolves around the Sun.	
What is the object made of?			rock
Can this object produce light?			No, the Moon reflects the Sun's rays.
Is there water present?			

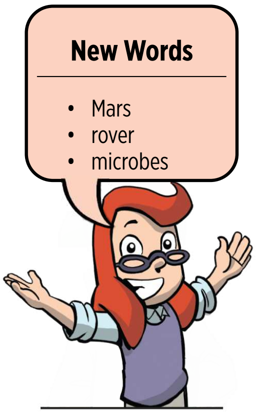
4 Systems to explore the Moon and Mars

KEY QUESTIONS

- How do we make a vehicle move on the Moon or Mars?
- How do we collect information about the rocks on the surface?
- What do scientists want to know about the Moon and Mars?

4.1 Vehicles used on Mars

No humans have ever been to Mars but scientists know a lot about the surface of Mars. You learnt about this planet in the first chapter. They have found out what Mars is like by using vehicles called rovers that send back information to Earth. Let's have a look at some of these different rovers and how they operate.



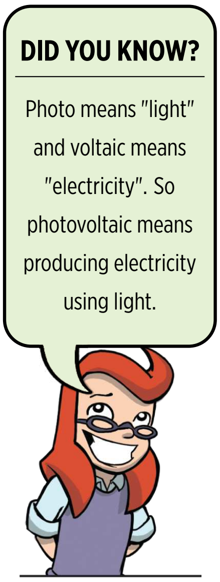
The Pathfinder rover

In 1997, the Pathfinder spacecraft landed on Mars. It had a small rover inside; the Pathfinder opened up and the rover came out and began taking photographs of Mars. Look at the picture below. The photo is not very clear but remember that it was taken with a robot camera; that camera sent the picture by radio signals, back to Earth.

This is the rover that was carried by the Pathfinder spacecraft. It has instruments to find out what the rock is made of.

The driver of the rover was millions of kilometres away on Earth and used radio signals to steer the rover.

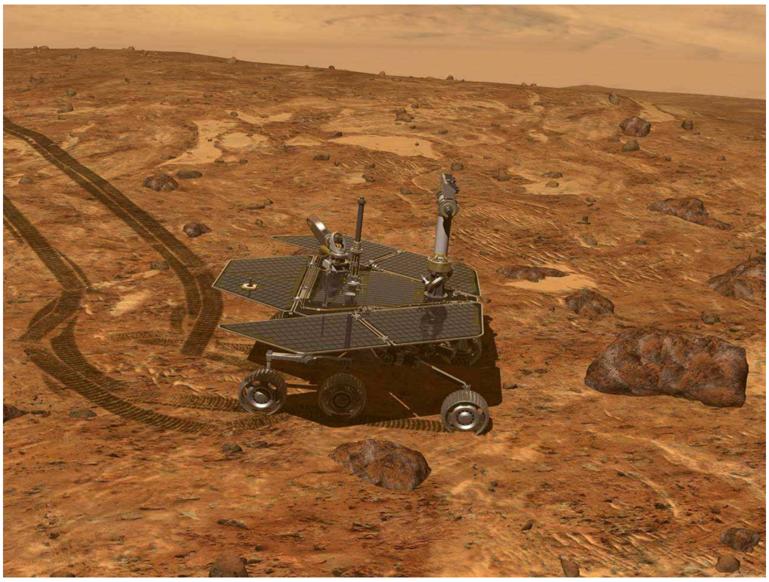
The Pathfinder rover used electric motors to move. The electricity for the motors came from photovoltaic (solar) panels on its top surface. Solar panels transfer energy from sunlight to the electric motors. Find the solar panels in the photo. The solar panels that you learnt about in Energy and Change last term are also photovoltaic panels.



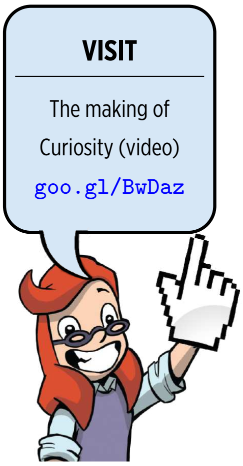
The rovers called Spirit and Opportunity

These two rovers landed on Mars in 2004. Like Pathfinder, they also used solar panels that generate electricity from sunlight. In 2010, after 6 years, the rover called Spirit got stuck in sand. Soon after this it stopped sending back messages.

The rover called Opportunity is still working, after 9 years on Mars! It has travelled over 35 km and sent back thousands of pictures.

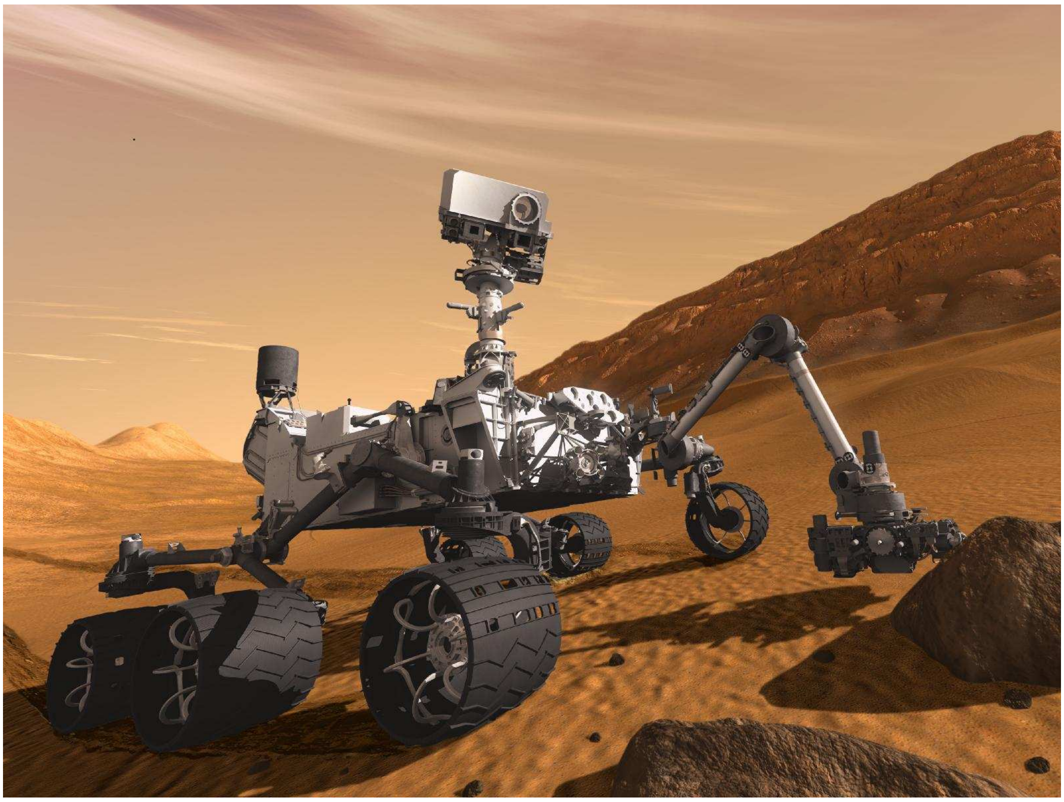


The Opportunity rover is going to scrape some grains off that rock and analyse it.

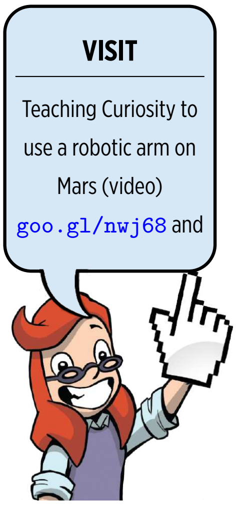


The rover called Curiosity

This rover is the size of a small car and will be able to travel further and collect much more information about the surface of Mars. Scientists want to know whether there are any living things on other planets. So the rover will look for signs that microorganisms lived on Mars a long time ago. Microorganisms are very tiny organisms that cannot be seen by the eye. They are so small that millions would fit onto the tip of a needle.



The Mars rover called Curiosity



The rover has video cameras to show the driver back on Earth what is in front of the rover, and it has a long arm with a scoop to pick up soil samples. It also has a laser that can heat rock until it turns into vapour. Then special cameras look at the vapour and find out what substances are in the vapour. Can you see the cameras in the picture?

QUESTIONS

1. Do you think that there could be living things on Mars? What do living things need to go on living?

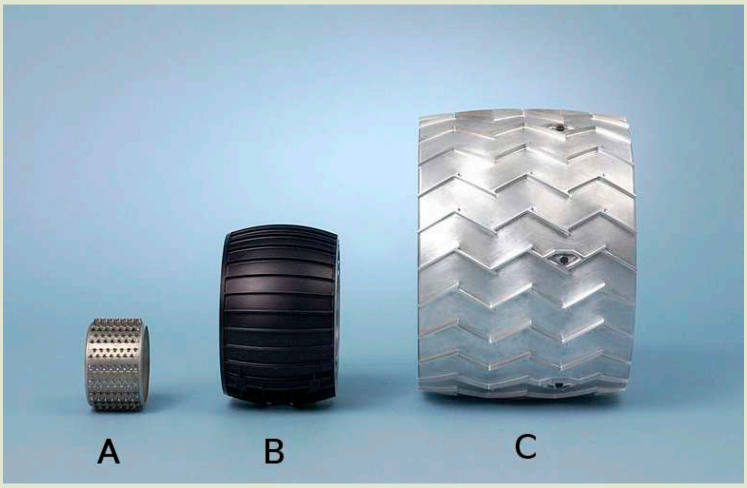
____

____

ACTIVITY: The wheels of Mars rovers

INSTRUCTIONS:

1. Look at the wheels of three Mars rovers below.
2. Answer the questions.



The wheels of three Mars rovers

QUESTIONS:

1. We know that wheels are round. Why do these wheels look like rectangles?

____

____

2. The diameters of the three wheels are 13 cm, 30 cm and 45 cm. Draw three circles on the board or paper to show these diameters.
3. The wheels shown belong to the rovers, Pathfinder, Opportunity and Curiosity. Match the wheels to the rovers. Write the letters A, B and C below with the name of the rover next to it.

____

____

VISIT

Landing Curiosity on Mars (video)
goo.gl/BwDaz and goo.gl/LBda0

4. Why are the wheels different diameters?

5. Why did the designers choose such wide wheels?

6. Use your ruler and work with the picture of the 3 wheels. Measure the diameter of each wheel in the picture and the width of each wheel. Write your measurements into this table.

	Diameter of wheel	**Width of wheel**
Pathfinder		
Opportunity		
Curiosity		

What is the pattern that you find? Write out the whole sentence The bigger the diameter, the …

4.2 Vehicles used on the Moon

Apollo 11 mission astronauts walked around on the Moon. This was the first time. But for Apollo 15, 16 and 17 each mission had a lunar rover called a Moon buggy. Lunar means "relating to the Moon".

Look at the picture of the lunar rover. This vehicle went to the Moon in 1972 and it is still there. Other spacecraft photographed it in 2011. You will find out more about this rover when you investigate rovers for your Technology project.

The Apollo 17 astronauts drove this lunar rover on the Moon.

Astronauts testing out a lunar rover on Earth

VISIT

Footage from the first landing on the Moon (video)

goo.gl/Yp2o7

Below is a photograph of astronauts testing out a lunar rover on Earth before they used it on the surface of the Moon.

New Words

- kinetic energy
- potential energy
- engineer

4.3 Design and make a vehicle to collect Moon rocks

Do you remember how, in the last term of Gr. 4, you were on your way to the Moon with the Thunderbolt Kids? You are now part of a crew in the Apollo scientific mission.

We are approaching the Moon!

Investigate the need for a Moon rover

Your mission is to collect rocks from the Moon. Scientists back on Earth want to study those rocks and find out whether they are the same as rocks on Earth. You have to collect from different places on the Moon so you need to be able to move around on the surface.

VISIT

Apollo 17 Lunar Rover (video)

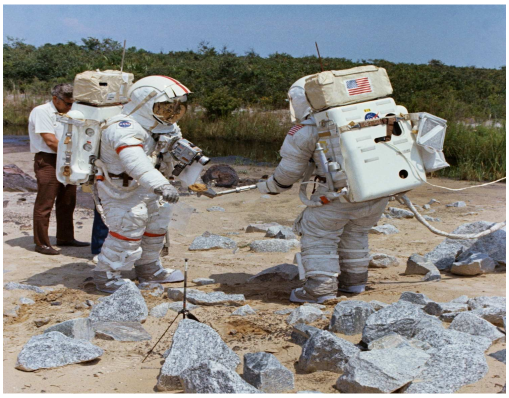
goo.gl/e3Cgj

In 1972, scientists really did go to the Moon to collect rocks. In the picture you see a photo of one of the rocks that came back to Earth with the Apollo 16 Mission.

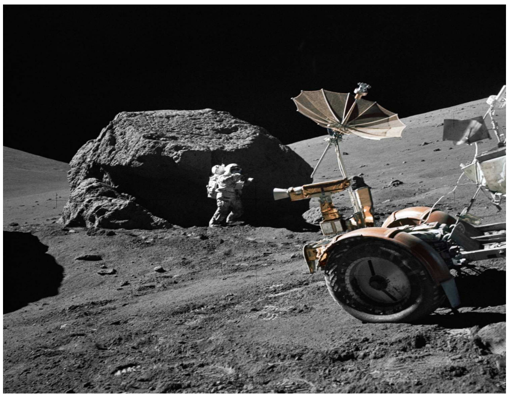
A rock from the Moon

The Sun heats the Moon's surface to the temperature of boiling water so you will have to wear a special suit to protect you and cool you. The suit will make it difficult to work and walk.

The Moon has no air, so you will have to carry air for yourself in tanks (bottles). To do all this work, you will need a vehicle to move around on the Moon. The vehicle is called a rover.



Astronaut Ceman and Schmitt practising to pick up rock samples before going on the Apollo 17 lunar mission



Astronaut Schmitt collecting samples on the Moon

Your Design brief

A Design brief for a Technology project is a short statement of what you are going to make, why you are going to make it and what you are going to make it for.

Question:

Write your Design brief in the space below using the following phrases:

- "I am going to design and make a ...."
- "that will help scientists to ..."
- "....the Moon"

Now that you have specified your Design brief for your project,we need to do some more investigating to answer some questions before we can start designing.

Investigate the surface of the Moon

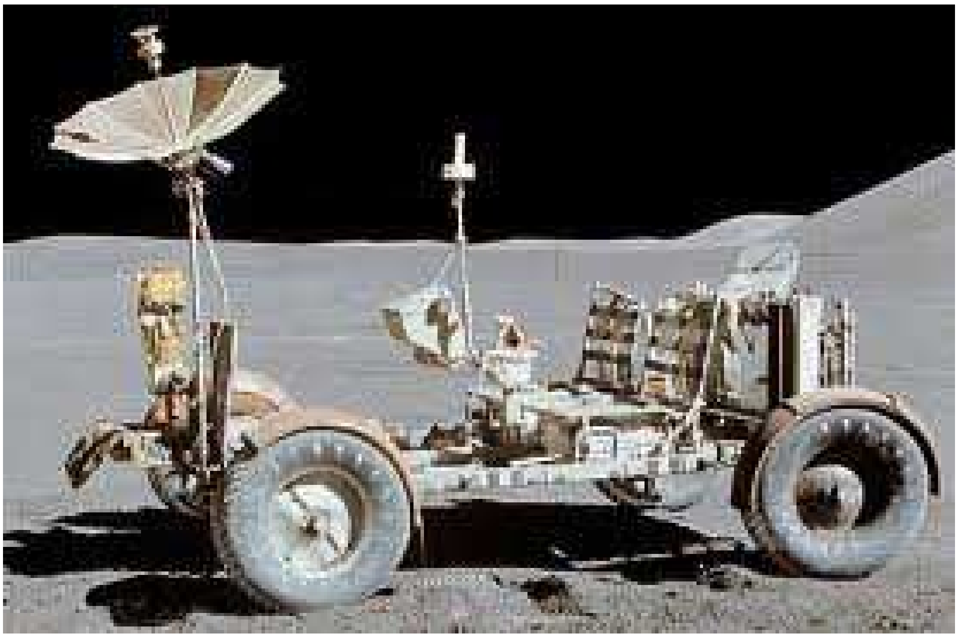
In Chapter 3, you learnt about the Moon. The rover needs to be able to drive over the Moon's surface, so we must investigate what the surface of the Moon is like.

QUESTIONS

Write one fact about the Moon that you must think about when you design your rover. Write a sentence to explain why that fact is important.

Investigate ways to move people and equipment

The rover on the Moon had four electric motors; one motor in each wheel. It did not need a steering wheel, because the driver can switch the motors on and off in each wheel. This steers the vehicle. It had two seats with seat-belts.



Astronauts used this rover on the Moon during the Apollo 17 mission.

The part that looks like an umbrella is an aerial that picked up radio messages from Earth. Can you see this in the picture? It looks a bit like a satellite dish you see on some houses for television.

QUESTIONS

1. How do you think the rover got energy to work the motors in the wheels?

____

____

2. The rover was made of very light materials. Why did the rover have to be light?

____

____

3. Why did the wheels have shields over them? The shields are the orange things over the wheels.

___

___

4. The wheels of the rover were quite wide. What would happen if the wheels were narrow like a bicycle wheel?

___

___

5. Why must cars on Earth have headlights?

___

6. Do you think the rover needed headlights?

___

Investigate ways to give energy to the rover

Your Moon rover needs energy to make it move. Do you remember that in Gr. 5 we looked at Energy and Movement when doing Energy and Change?

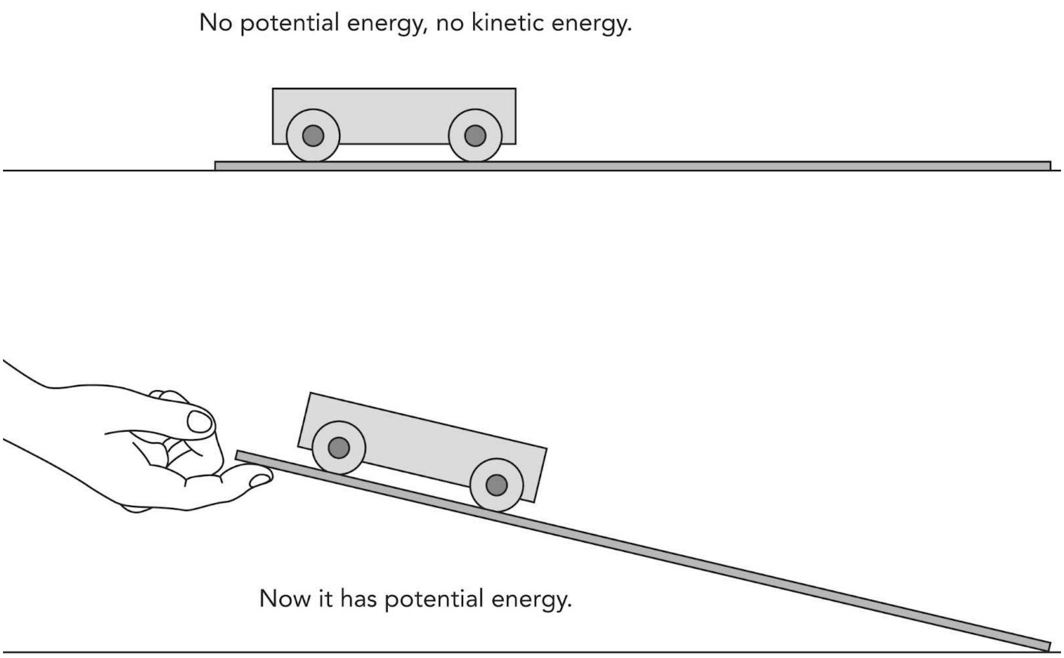
Hey, that was over a year ago when we did Energy and Movement! I don't remember much so can we please refresh our memories?!

Of course, Sophie! This is also quite a difficult topic and you will learn more about it in later grades, so let's refresh some of these terms.When you stretch an elastic you transfer energy to it, called stored energy. Another way of saying this is that you give the elastic potential energy. This means it has the potential to do work. Or in other words, in the future the stretched elastic band can do something.

This stretched elastic band has potential (stored) energy.

When you let the stretched elastic band go, it now moves as it springs back. This is movement energy, and is also called kinetic energy. Kinetic means movement. The potential energy stored in the stretched elastic band changed into kinetic energy as the elastic band was released and moved.

Now let's apply these terms to the rover. You can also give something potential energy by lifting it up off the ground as it then has the potential to fall or move back to the ground. You can give energy to your Moon rover if you lift it up on a plank, as you see in



One way to give your rover energy to move

When you lift up the plank and rover, your hand gives some of your energy to the rover. It now has potential energy to move.

QUESTIONS

When you let the rover go, what will happen? Use the words 'kinetic energy' in your answer.

____

____

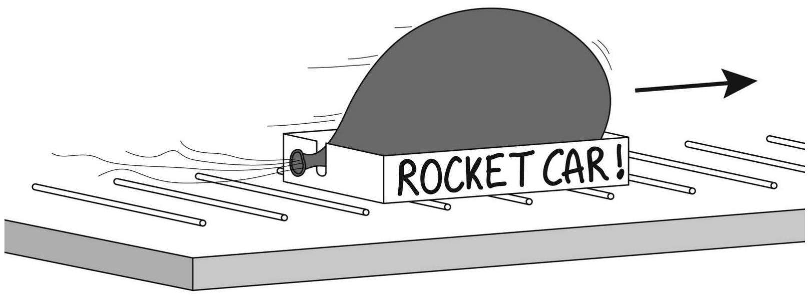
The plank is useful for testing the wheels of your model. But the rover must be able to go up hills, not only down them.

The second way to give your rover energy to move is to use an electric motor and battery. Do you remember last term we looked at electric circuits and the source of energy for a circuit is a cell or battery? You can fit an electric motor and a battery to your rover. The potential energy in that system is in the battery.

A battery is a source of potential energy for an electric motor. [1]

Another way to make your rover move on the Moon is to use a rocket. Rockets will work on the Moon. Inside the rocket, gas pushes against all the sides. Some gas pushes against the walls of the balloon and some gas pushes out through the opening of the balloon.

Look at the rocket car in the picture. The gas pushing through the opening of the balloon pushes the whole car forward.



The balloon works like a rocket. You have to give it potential energy first.

This rocket is on rollers. Could you fit wheels to this car?

The real Moon rovers had batteries and electric motors in each wheel. Many electric cars have a motor. This motor can give energy to your Moon rover.

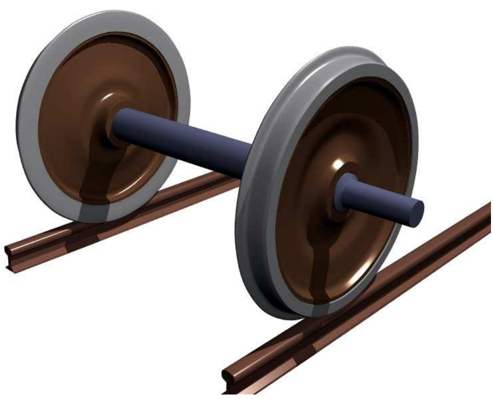
Investigate ways to make a body with wheels

Your Moon rover needs a body for the scientists to sit on and to put the rocks into. The body of a vehicle must have good ways to hold the wheels.

We looked at wheels and axles in Gr. 5 in Energy and Change. A wheel fits onto an axle, which is a solid rod or bar that allows the wheels to turn.

QUESTIONS

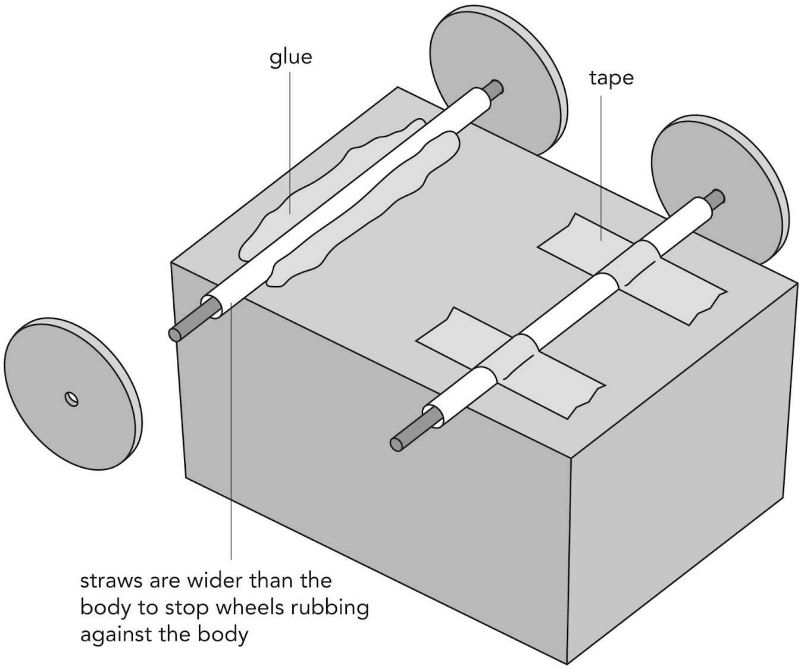
Label the two wheels and the axle in the following diagram.



You know there are different 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. What is the other way to let wheels turn?

1) Wheels fixed to the axle

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



Two ways to fix the bearing onto the body

QUESTIONS

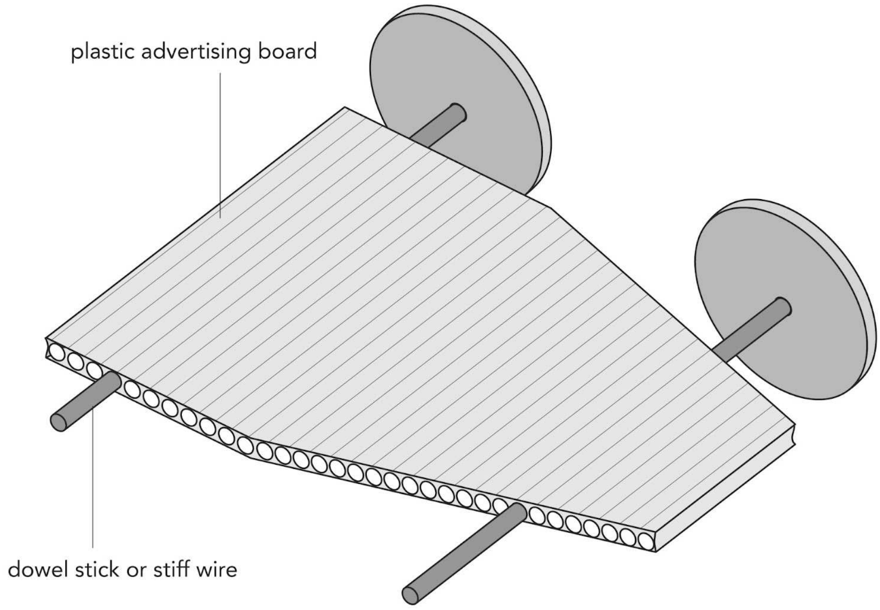
1. What are the two ways used in the picture to fix the bearing onto the body?

____

2. What are some materials that you could use to make the axle in the above picture?

____

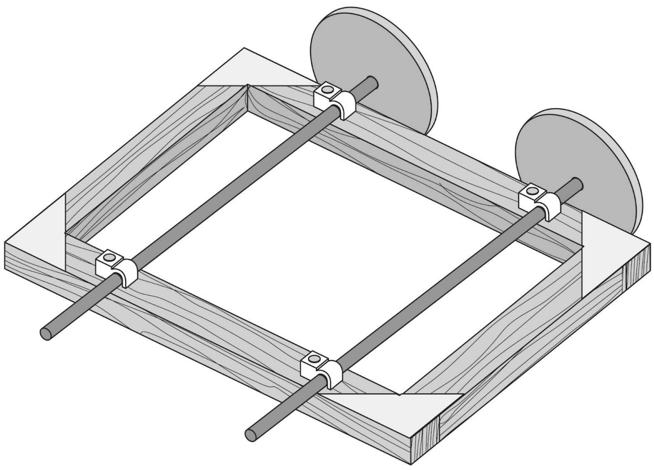
You can also use plastic signboard or strong corrugated cardboard to make a body with wheels. Can you see how the axle goes through the holes in the cardboard?



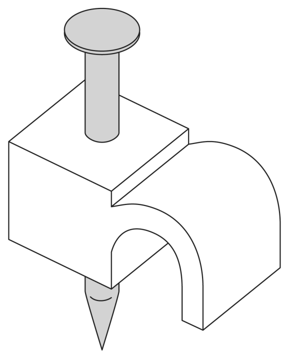
The board makes bearings for the axles which are fixed to the wheels. The axles turn in the holes.

2) Wheels turn on the axle

The next picture shows you another way to let the wheels turn. This time the axle remains still 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

Now that we are finished investigating, let's start designing!

Designing and Making

Your Moon rover can look different to the Apollo rovers.

One of the astronauts driving a Moon rover

DID YOU KNOW?

An engineer is someone who designs and builds machines and structures for a living. If you enjoy the Technology projects then maybe one day you could be an engineer!

The Apollo engineers designed other rovers, but in the end they chose this design. Your design will look different to their designs.

ACTIVITY: Designing and making your rover

SPECIFICATIONS (what your rover must be like):

1. Your rover must be balloon powered.
2. Your rover's wheels should be able to roll easily and it should go at least 2 metres on the floor.
3. Your rover must have two seats and it must have a model of you as a Moon explorer.
4. It must be able to carry two small stones for at least 2 metres. The stones represent rock samples from the Moon, to take back to Earth.

CONSTRAINTS:

1. You must build your rover in class.

DESIGN:

1. Draw a picture of a rover you could make in the space below.
2. Show the seats, with an astronaut in one seat. Show the place where the Moon rocks will go.
3. Add other parts that your rover should have. Write labels to tell everyone what the different parts of the rover are.
4. Leave some space at the bottom for a second design. When you begin making the rover, you will get better ideas. Then you can draw another picture of your design. The two pictures will show how your ideas changed.

MATERIALS:

Things to collect for wheels: You can collect snuffboxes, shoe-polish tins, the lids of bottles. You can also cut out cardboard circles.

Things to collect for axles: You can find sosatie sticks, stiff plastic straws, wooden dowel sticks, aluminium rods. The school may have plastic rods from a supplier. You can also use nails or wire to make axles.

Things you can use for wheels and axles

Tools and materials you need as a class:

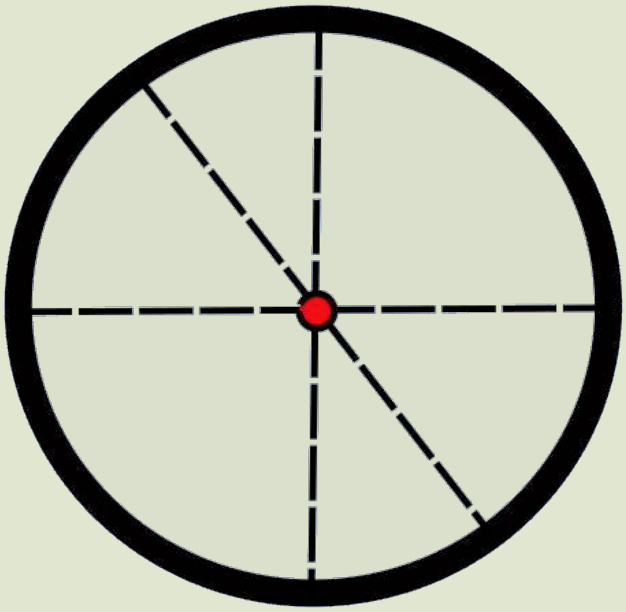
- some long-nose pliers to cut and bend wire
- hole-makers (small and big nails) and big scissors for cutting cardboard
- a small hammer to drive the nails
- some glue (or you can make flour glue in class)
- balloons to power the rover
- To decorate your rover car you need crayons or paint. Remember to colour the scientist who drives the rover.

MAKE:

Now let's make the rover. Below are some tips which will help you when making your rover. Remember that you may not have the perfect design from the start! So when making your rover, you need to go back and modify your design as you find things which work and do not work.

1. How to find the centre of a wheel (remember, a wheel is a circle)

    - Some plastic lids have a small dimple or lump that shows you where the centre is.
    - If your lids or discs do not have a dimple, you can use a ruler to draw diameter lines across the middle (a dimple is a small dent).
    - A diameter line is the longest line you can draw across a circle. Where diameters cross, that is the centre.



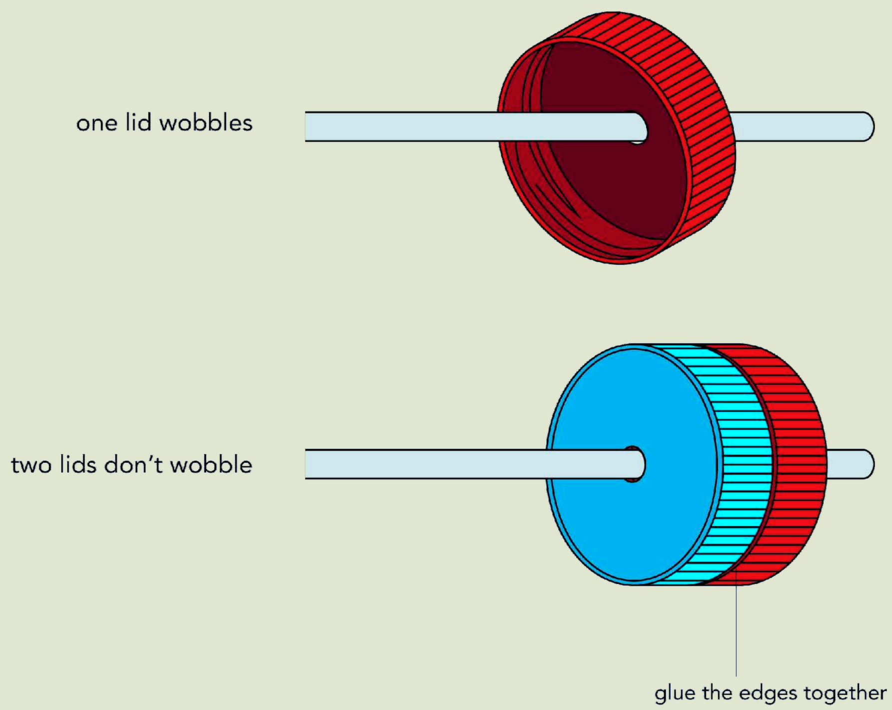
A wheel is a circle. Draw three diameters and mark the centre. In this example the centre is the red dot.

2. How to make the right size hole in the centre

    - If you want the wheel to **rotate** on the axle, then you must make a hole that is a little bit bigger than the diameter of the axle.
    - If you want the wheel to be **tight** on the axle, then you must make a hole that is smaller than the diameter of the axle. When you push the wheel onto the axle, it will grip the axle.

3. How to stop wheels wobbling on their axles

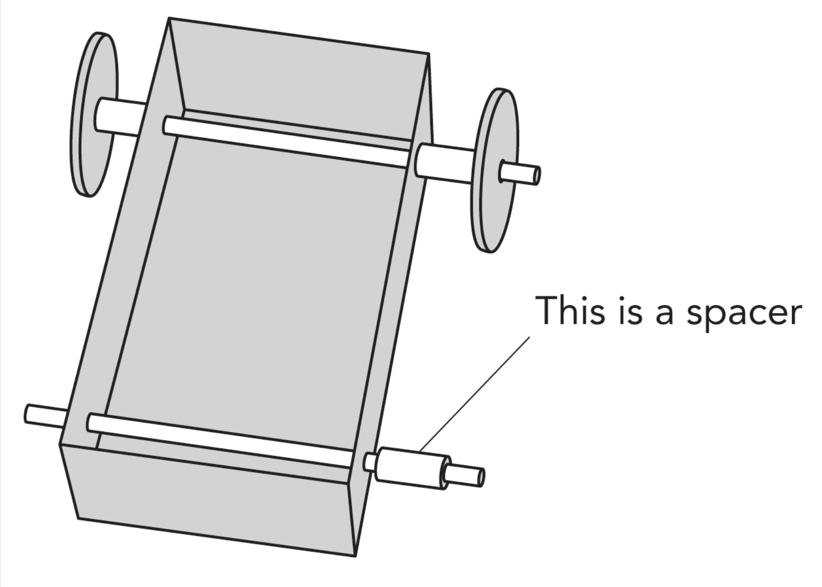
- If the axle goes through just one surface of the lid, this is what can happen: the wheel will wobble. You need to give the lid another surface. Glue two lids together.
- Or else, trace the shape of the lid on cardboard, mark a hole in the centre of the circle, and cut out the cardboard. Cut the cardboard so that the disc will be a tight fit in the lid. Then glue the cardboard into the lid.



You can stop the wobbling by glueing two lids together.

4. Does the wheel rub against the body of the rover?

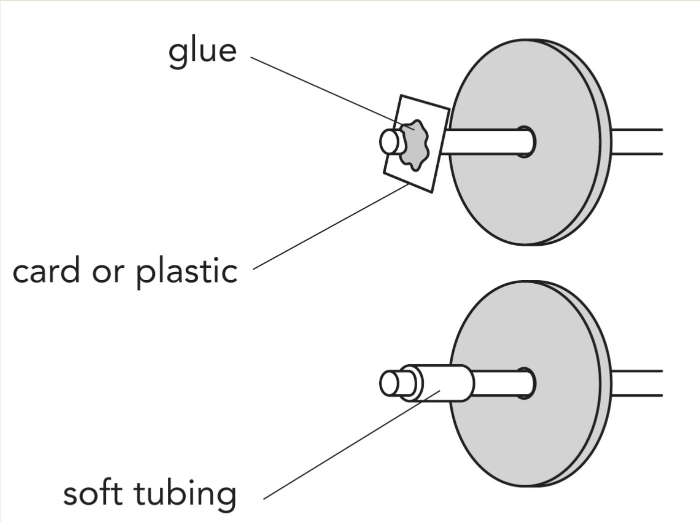
- You need a spacer on the axle, to keep some space between the wheel and the body.
- You can use a bead with a large hole, or you can make plastic washers from slippery plastic. Milk bottles are good for making slippery washers.
- Use an office punch for making neat holes in a piece of milk-bottle plastic. Then cut around the holes to make



Where to use a spacer or washer

5. Does the wheel come off the axle?

   - Push a piece of soft tubing onto the end of the axle as you see in the picture.
   - Or push on a flat piece of cardboard and hold it on the axle with glue.

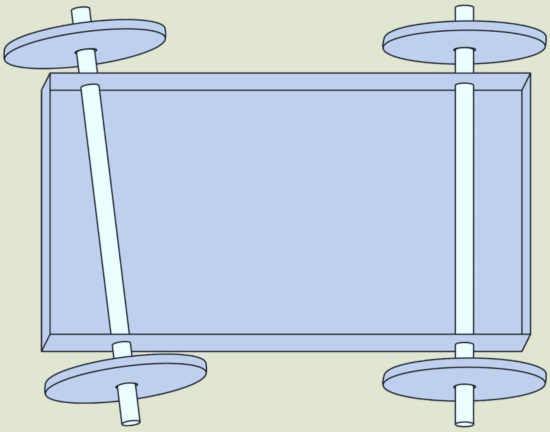


Soft plastic tubing or glue will stop the wheel coming off the axle.

6. Does the rover not run in a straight line?

   - The axles of your rover must be parallel.
   - These axles in the picture are not parallel. If your axles go through the body, then the axle holes must be the same distance apart on the left and the right side.

- If you need to make a hole in a new place, then you can glue a small piece of card with a hole in it over the old hole.



These axles are not parallel so the rover will not go straight.

Test your rover and make it run as well as you can. Go back and draw your improved design. Draw the rover you have made and write labels to explain what all the parts do. For example, you can write "This piece of straw stops the wheel rubbing against the body."

EVALUATE:

At this point in a technology project, you stop and ask yourself, did we do a good project? Did we make something that solves the problem?

Clear an area in the classroom to show the class's Moon rovers. Show your group's Moon rover. Show how it moves by itself or how it rolls down a sloping plank.

Discuss these questions in the class for each Moon rover:

1. What were the specifications for the Moon rover?
2. Does the rover have a model of the astronaut sitting on it?
3. Can your rover carry small Moon rocks back to your Moon lander?
4. Does your rover have a hinge anywhere in it?
5. Do the wheels roll easily?
6. Can your Moon rover go 2 metres?
7. Whose rover rolls the furthest?
8. Does it roll in a straight line, or does it roll in a curve?
9. Did you need to make the body of the rover stronger? What did you do to make it stronger?

10. If you really had to go to the Moon, what would you need on a real rover car?
11. Write down how far each Moon rover from each group can go after it rolls down the plank. You now need to draw a bar graph to present this data (information) in the space below. Your teacher will help you to get started and then you can finish drawing it yourself.

After you have tested and evaluated everyone's rovers as a class, use the following space to write an evaluation of your own rover. Remember to answer the questions above when evaluating how successful your rover is.

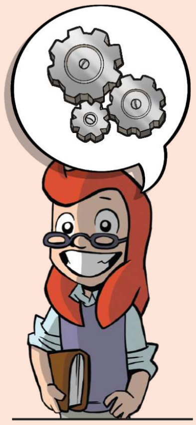
Below is a summary of some of the things that we learnt from doing this project:

1. Axles must be parallel for the car to run straight.
2. Axles can be fixed and wheels free to turn, or the axle can turn with the wheels fixed to it.
3. Axles turn in bearings. Bearings let axles turn freely.
4. A car must have energy from some source. The source can be a hand that lifts the car up to the top of a ramp, or the source can be a falling weight, or the source can be rubber bands or a blown-up balloon.

KEY CONCEPTS

- Scientists send vehicles to explore the surface of moons and other planets.
- These vehicles have radios that send back information to scientists on Earth.
- The vehicles need special wheels to move across the sand and stones.
- People have been to the Moon, but no people have yet been to Mars.
- Only vehicles (robots) operated by people back on Earth have been sent to explore the surface of Mars.

REVISION:



1. Give three names of vehicles used on Mars to explore the surface of the planet.

2. Which of these vehicles is the most recent one to go to Mars?

3. Why do people need Moon rovers when they are exploring the surface?

4. What is the main difference between vehicles used on the Moon and vehicles used on Mars to explore the surfaces? Hint: This has to do with whether people have visited the Moon or Mars.

5. What is the name given to the solid bar that connects two wheels?

6. Describe how you made sure that your Moon rover went straight and that the wheels did not fall off.

7. Why do you think the human race is so interested in exploring other planets and objects in our solar system?

textitMmm, how do we SEE into outer Space and OBSERVE the other planets? We can't just see them by looking up into the sky. Let's find out!

5 Systems for looking into Space

KEY QUESTIONS

- The stars we see at night - are those all the stars there are?
- How do scientists find out what stars are like?
- How come you can't see other planets when looking up at the sky, but we have some beautiful close-up photographs?

New Words

- bright
- dishes
- distant
- faint
- lens
- magnify
- Milky Way
- phases
- reflect
- Square Kilometre Array
- radio waves

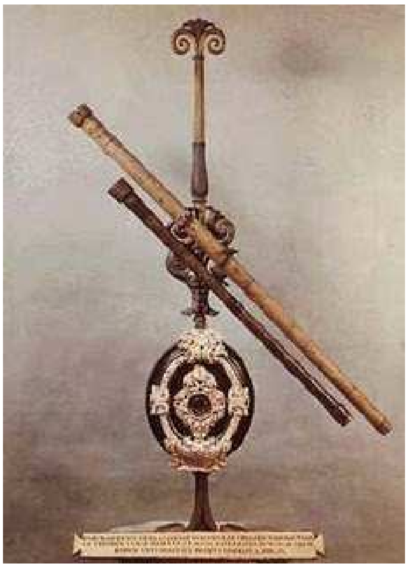
5.1 Telescopes

The telescope was first discovered by the Dutch. In Holland, a lot of the people were sailors and sea-explorers so they used their telescopes at sea to see if ships far away on the horizon were friends or maybe pirates.

A telescope makes faraway things look bigger and closer.

So a telescope is like a really big magnifying glass!

Galileo Galilei was a professor of mathematics at the University of Padua, Italy. In 1609 he heard that somebody in Holland had made a telescope, and he worked out how to make one himself.



Galileo Galilei's telescope looked like this. It could only see a small part of the sky at a time. [1]

Galileo Galilei showing his telescope to a group of scientists

DID YOU KNOW?

Galileo got into trouble with the authorities because they did not like what he wrote. They taught that the Earth was the centre of the universe and the Sun, Moon, stars and planets all revolved around the Earth. Galileo told people that was not true, and so he was put in jail.

Galileo used his telescope to look at the planets in the night sky, and he made careful notes of what he saw there. He was the first person to see that Jupiter had moons. He saw that Saturn has rings and he saw that Venus has phases like the Moon has. He also used his telescope to show people that the Milky Way was really made of billions of stars. He wrote books that taught people about telescopes and what they could show us in the night sky.

People can now buy telescopes like this to watch the stars from their own backyards. [2]

VISIT

The Hubble Space Telescope Story

goo.gl/vHZAV

Nowadays there are big telescopes in many parts of the world, and these telescopes have cameras to photograph the sky.

DID YOU KNOW?

The biggest space telescope in the world is the Hubble Telescope, named after Edwin Hubble who first showed there were other galaxies besides our own, the Milky Way.

VISIT

Real-time views from webcams at SALT

goo.gl/9mYji

VISIT

The South African Large Telescope (video)

goo.gl/0JgbE

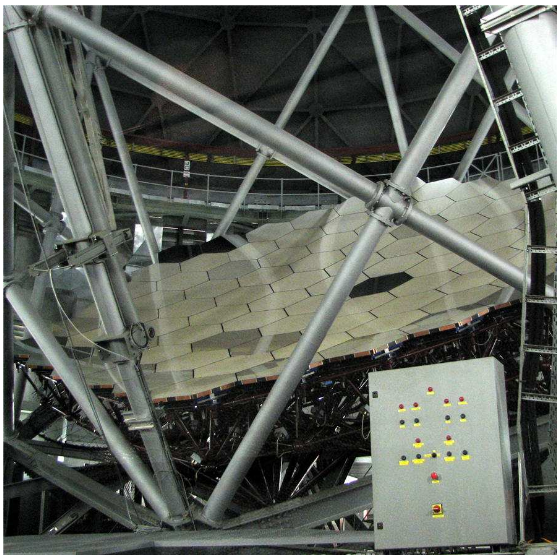
This photo of the sky was taken through a telescope. Each point of light is a star.

Telescopes have shown us that there are thousands of millions of stars that we could not see with our naked eyes. Some of those stars are so far away that their light has been travelling for millions of years to reach us.

The Southern African Large Telescope

One of the biggest telescopes in the world is here in South Africa, near the town of Sutherland. The telescope is called the Southern African Large Telescope or SALT. The telescope uses lenses and a very big mirror to see the stars and take photographs of them.

This is the SALT. Here the roof is closed, but at night it opens so that the telescope can see the sky.



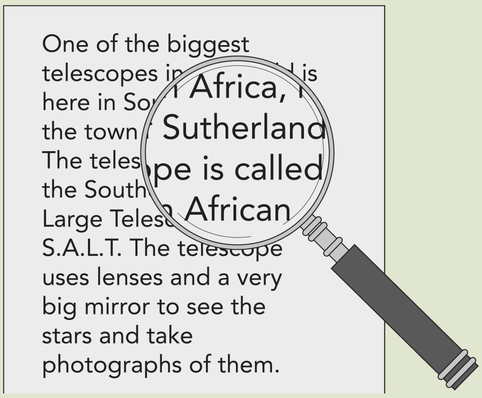
This photo is taken from inside the dome of SALT and shows the large mirror.

ACTIVITY: How lenses and mirrors make telescopes work

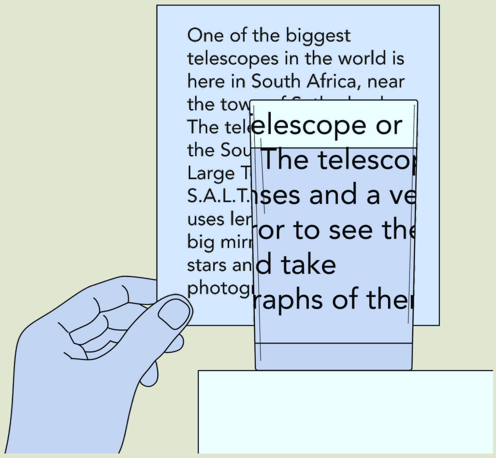
MATERIALS:

- Each group needs a lens. You can use hand-lenses, or round empty bottles with water in them. Or you can use the glass part of a light bulb, full of water. Your teacher will show you how to remove the inside parts of an old light bulb.
- Each group needs a mirror. It can be a small mirror, or you can make a mirror. You can glue the shiny foil from a potato-chip packet onto cardboard.

Put masking tape or Elastoplast on the broken edge of the glass to prevent children cutting themselves. Of course, we are talking about bulbs with a filament, **not** the new fluorescent energy-saver bulbs.



A lens can make things look bigger.



If you look through a bottle or glass full of water, you will see how it makes things look bigger.

INSTRUCTIONS (Part One):

1. Hold up the lens and look at something on the wall. You can look at a poster, for example.
2. If you are far away from the wall, the poster will seem to be upside down.
3. When you come closer to the wall, the poster will be right way up and bigger. The lens is **magnifying** the poster (to magnify means to make bigger).

QUESTIONS:

1. What do you notice about the shapes of lenses?

2. Why do you think this shape is necessary for the lens?

INSTRUCTIONS (Part Two):

1. Now the class must go outside into the sunshine. Take the lens and your mirrors with you. This will work best on a hot, clear day.
2. Your teacher can point out a place on the wall that is in the shade.
3. Use your mirrors to reflect sunlight onto that spot.
4. The class can spread out; it does not matter where you stand. Just make sure you move your mirror so that it helps to light up the spot your teacher showed you.
5. If everyone reflects sunlight onto that one spot, it will become very bright there.

Light from all the mirrors goes to one shady spot on the wall.

QUESTIONS:

1. How could you make the spot brighter?

2. Will the spot feel hot? Make a prediction. (To "predict" means you say what is going to happen.)

3. How will you find out whether your prediction was correct?

4. The Sun does not give us only light. It also gives us heat. You know that if you stand facing the Sun with your eyes closed, you can still feel heat from the Sun on your face.
   How could the class make the spot hotter?

5. Can you make it even hotter by passing all the sunlight through a lens, onto the wall?

INSTRUCTIONS (Part Three):

1. Put a candle inside a glass jar and put on the lid.

2. Can you melt the candle by using your mirrors?

3. Can you melt chocolate by using your mirrors?

All the mirrors work together like one big mirror, even though they are far apart. They all collect a little bit of energy from the Sun and send it to the bright spot.

The mirror of a telescope works like that. The light from some stars is very faint because the stars are very far away. But the big mirror collects all the faint light and focuses it to one lens. Then the telescope can gather (put together) enough light from the star to get a photograph of the star.

DID YOU KNOW?

Sound waves must have something like air or water to travel through, but electromagnetic waves can travel through empty space.

The Square Kilometre Array (SKA)

The SKA is a different kind of telescope for looking at the stars. Stars send out energy in light but also in radio waves. The SKA will receive radio waves that our eyes cannot see.

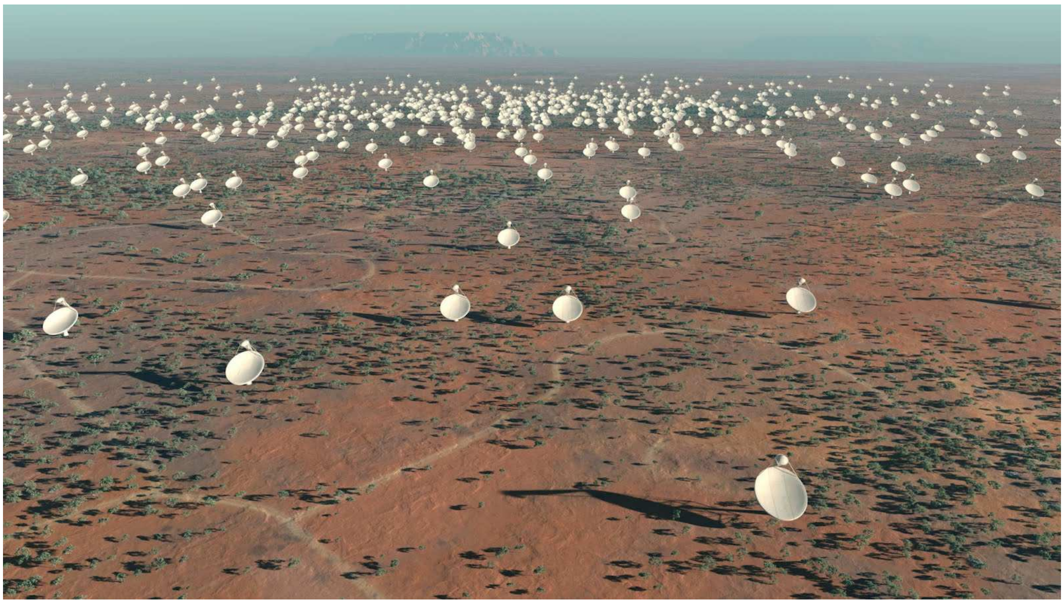
An **array** means a large number of the same items. For example, when the desks in your classroom are all lined up neatly, we can call that an array of desks.

The SKA will have an array of several thousand dishes like those in the picture. When you add together the area of all the dishes, the total area will be the same as one square kilometre. A square kilometer is an area in the shape of a square and the sides are each 1 km long. The area of the square will be 1 km^2. That is why the telescope is called the Square Kilometre Array.

VISIT

SKA video

goo.gl/ERYT4



This is how the SKA will look once it has been built. (Credit: SKA Organisation)

There was actually a contest between South Africa and Australia to see who would host the SKA. Both countries really wanted it and the bid and voting went on for 9 years. Then at the beginning of 2012, it was announced that it would rather be hosted in both countries, but the larger portion of the dishes is to be in South Africa and Africa.

But why does SKA need so many dishes? Isn't one enough?

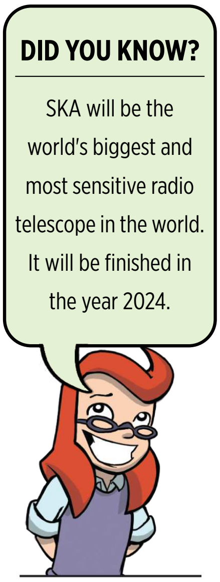
Good question, Sophie! Let's find out.

The dishes in the picture look like the satellite TV dishes that you see on some people's houses. Those dishes collect the weak TV signal that comes from a satellite high up in Space.

In the SKA, each dish collects a little of the radio signals that come from the stars, and sends it to a computer. The computer puts together all the signals to make a new picture of that star.

Scientists from many countries are working together to build the SKA in the Northern Cape. Most of the telescopes will be near the town of Carnarvon.

Some of the dishes will be very far away from Carnarvon. They will also collect signals from stars and send them to the computer in Carnarvon. This helps to improve the quality of the image that gets generated by the computer. Some dishes will be in Ghana, Zambia, Mozambique and Madagascar.



Some of the dishes will be far away from Carnavon, in other countries across Africa, as well as Australia and New Zealand. (Credit: SKA Project South Africa)

ACTIVITY: The SKA

INSTRUCTIONS:

1. Look at the pictures of SKA in the text before.
2. Answer these questions.

QUESTIONS:

1. How is the picture of the SKA dishes like the picture of the class using mirrors to make a bright spot on the wall?

2. Why does the SKA need so many collecting dishes?

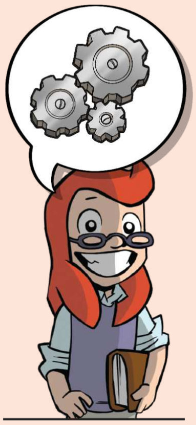
3. Why does it help the SKA to have dishes far away in Ghana, Kenya, and Mozambique?

4. How many dishes will be in Madagascar?

The SKA will be able to pick up signals that stars sent out thousands of millions of years ago. The signals have been travelling through Space for all that time. When the SKA picks up those signals, we will learn something about that time when the universe began, thousands of millions of years ago.

KEY CONCEPTS

- The objects we see in the sky are very far away.
- We can use telescopes to see them more clearly, and to measure how far away they are.
- Lenses can focus light to make a clear image.
- Mirrors help to collect more light when stars are very faint (not bright).



REVISION:

1. What does a telescope do?

2. Before Galileo, nobody knew that the planet Jupiter had moons. What was the reason?

3. What does SKA stand for?

4. Why are the words 'square kilometre' in the name?

5. With a telescope we can see very, very many stars. Why did we not know about all those stars before there were telescopes?

6. Astronomers build their telescopes far away from cities. Think of a reason why they do this and write it down.

Congratulations! You are finished Gr. 6!

Chapter 2 Electrical conductors and insulators

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2. http://www.flickr.com/photos/editor/72550973/sizes/l/

Chapter 3 Systems to solve problems

1. http://www.flickr.com/photos/andybutkaj/1495901113/
2. http://www.flickr.com/photos/54400117@N03/5069103310/
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Chapter 4 Mains electricity

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2. http://www.flickr.com/photos/herry/35148275/
3. http://www.flickr.com/photos/hendry/397510397/
4. http://commons.wikimedia.org/wiki/File:Alicia_Nijdam-rocinha.jpg
5. http://www.flickr.com/photos/ontariopowergeneration/413709598/in/photostream
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Chapter 1 The solar system

1. http://science.gsfc.nasa.gov/690/solarsystemtour.html

2. http://www.youtube.com/watch?feature=endscreen&v=FqX2YdnwtRc&NR=1

3. http://www.nasaimages.org/luna/servlet/detail/NVA2{\raise.17ex\hbox{$\scriptstyle\sim$}}27{\raise.17ex\hbox{$\scriptstyle\sim$}}27{\raise.17ex\hbox{$\scriptstyle\sim$}}65049{\raise.17ex\hbox{$\scriptstyle\sim$}}127816

4. http://www.nasaimages.org/luna/servlet/detail/NVA2{\raise.17ex\hbox{$\scriptstyle\sim$}}20{\raise.17ex\hbox{$\scriptstyle\sim$}}20{\raise.17ex\hbox{$\scriptstyle\sim$}}54397{\raise.17ex\hbox{$\scriptstyle\sim$}}125187:NASA-KSNN---Mars-Records

Chapter 4
Systems to explore the Moon and Mars

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Chapter 5 Systems for looking into Space

1. http://commons.wikimedia.org/wiki/File:Tel_galileo.jpg

2. http://www.flickr.com/photos/ryanwick/3461850112/

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