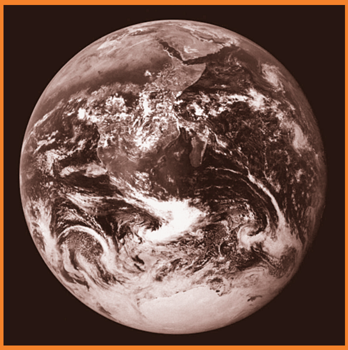
Book 3

Year 10



Science

Science

Year 10 Book Three

GOVERNMENT OF SAMOA
DEPARTMENT OF EDUCATION

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Unit 1: REVISION

Introduction
This is a revision chapter. Use it to remind you of what was covered in Year 9 Science.

Living World And Environment

Plants and animals can be grouped as native or introduced. Native plants and animals are those that are found naturally in Samoa. Introduced plants and animals have been brought into Samoa by people.

Plants that have flowers are called **angiosperms**. There are two types of angiosperms. These are broadleaf plants called **dicotyledons,** and the grasses and palms called **monocotyledons**. Dicotyledons have two cotyledons in the seed, net-like leaf veins, vascular bundles arranged in rings around the stem and they usually have a taproot and flower parts in multiples of four or five. Monocotyledonous plants have one cotyledon in the seed, parallel leaf veins, separate vascular bundles arranged around the stem, fibrous roots and flower parts usually in threes, sixes, nines or twelves.

Animals can be divided into groups in many different ways. One way of doing this is to decide if they have a backbone or not. Animals that have backbones are called **vertebrates**. These animals can include fish, birds, mammals, reptiles and amphibians.

Animals that do not have a backbone are called **invertebrates**. These animals have soft bodies or have shells on the outside of their bodies.

Living organisms can be grouped by what they eat. Green plants are **producers** because they use the chlorophyll in their leaves to produce their own food. All animals are **consumers** because they have to eat plants or other animals to get the food they need to live.

Consumers can be further grouped by what they eat. **Herbivores** eat plants or parts of plants. **Carnivores** eat other animals. **Omnivores** eat both plants and animals. Some carnivores are **predators**. This means that they chase and catch their food. Other carnivores are **scavengers** that eat dead animals.

Food webs and food chains show what each organism eats. A food web includes all the producers and consumers common in an area. Food chains always start with a producer and usually have one, two, three or four consumers.

The environment an organism lives in is made up of **biotic** and **abiotic** parts. All the plants and animals in an area make up the biotic environment. The physical aspects are the abiotic parts of the environment. Both the biotic and abiotic parts of the environment are important to organisms as they provide all the requirements that the organisms need to survive. Organisms will only live successfully if all parts of the environment are correctly balanced. The following table shows the biotic and abiotic parts of the environment.

Abiotic environmental factors		**Biotic environmental factors**
Light	Water pH	Predators
Temperature	Rainfall	Parasites
Humidity	Day length	Food supply
Oxygen levels	Minerals available	Human influence
Exposure to wind	Water flow rate	Competition
Wave action	Salinity (saltiness)	
Soil pH	Carbon dioxide levels	

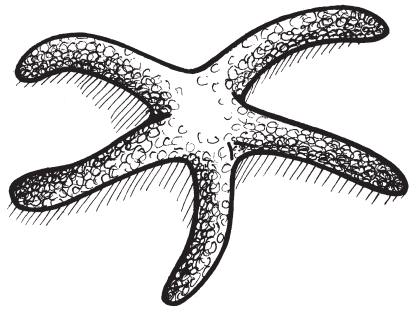
Activity 1 Living World And Environment

Aim To revise work on the living world and environment.

Answer the following questions:

1. What are the five main differences between monocotyledons and dicotyledons?
2. In your exercise book write whether each of the following organisms is a vertebrate or an invertebrate?

A



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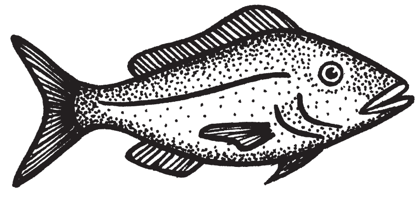


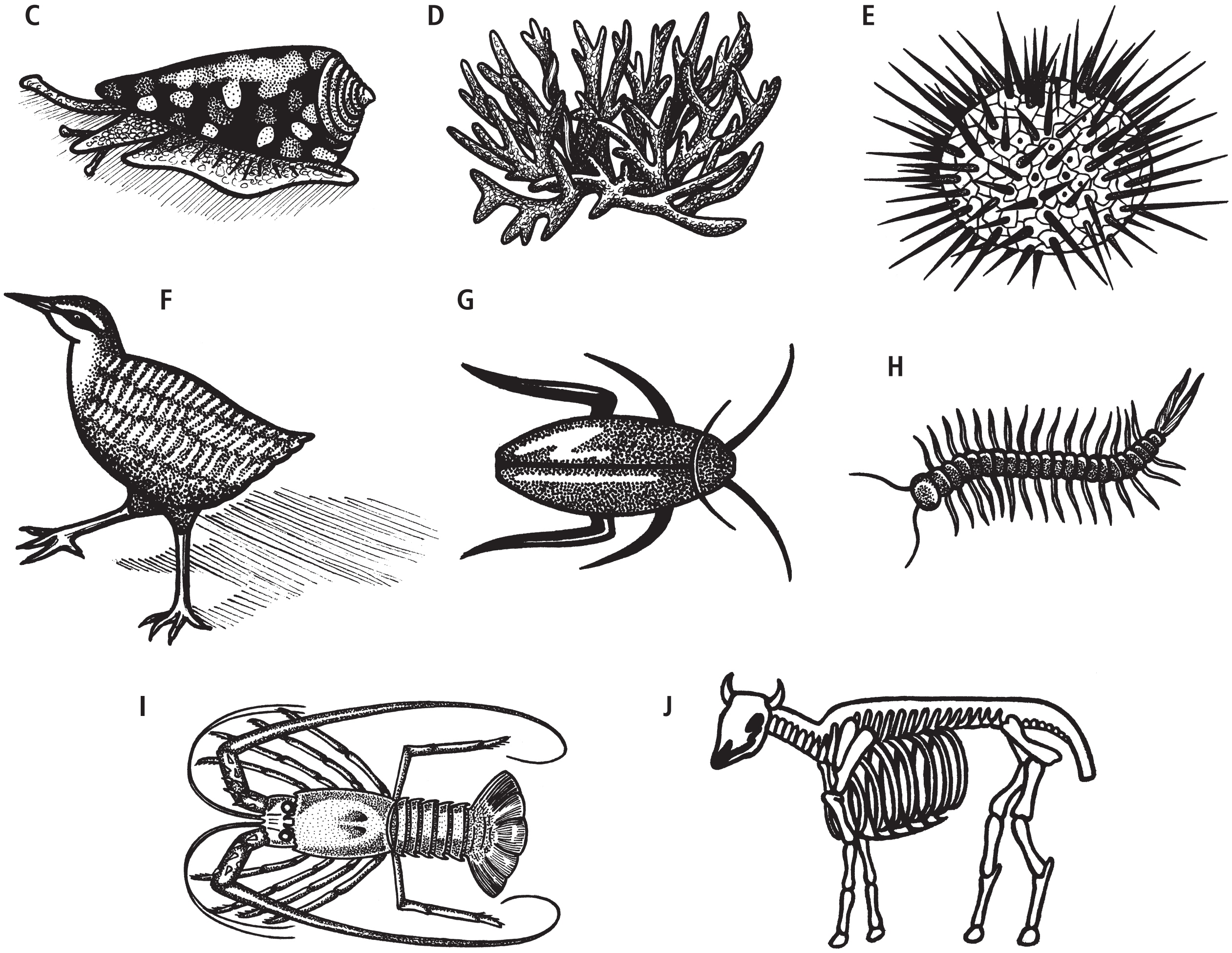


Diagram 1.1
Vertebrates and invertebrates.

3. Copy the chart below into your exercise book.

All living things

- **Producers**
  Make their own food
- **Consumers**
  Must eat
  - **Herbivores**
    Eat plants
    - **Scavengers**
      Eat dead plants
  - **Omnivores**
    Eat plants and animals
  - **Carnivores**
    Eat animals
    - **Predators**
      Catch animals
    - **Scavengers**
      Eat dead animals

4. List four things a member of each of the following groups will eat: herbivores, carnivores, and omnivores.

Rocks

The rock cycle is a naturally changing process that takes a long time to complete. The rock cycle is used to explain how the different types of rocks are formed.

Samoa is made up of igneous rock. There are two types of igneous rock. These are igneous plutonic rocks and igneous volcanic rocks. Igneous volcanic rock forms when lava cools quickly on the surface of the Earth. This rock has small crystals. Igneous plutonic rock forms when magma cools slowly under the Earth's surface. This rock has larger crystals.

Rocks on the Earth's surface get broken down into particles by weathering and erosion. This forms small sediments that get carried by rivers, wind and waves.

Sediments can be broken pieces of rock, mud, sand, shells and small stones. The sediments get deposited in layers. The layers may also include dead plants or animals, which may be changed into fossils. Sedimentary rocks are formed when the layers of sediments become very thick. This creates large amounts of pressure on the underlying layers, squeezing out any water they contain and causing new minerals to form.

Metamorphic rock is hard, has fine crystals and its particles are often arranged in coloured bands. It is rock that has been changed by heat and pressure, which make changes to the structure of the rock by forming new minerals and crystals. Sedimentary and igneous rocks may become buried by huge layers of rock. The pressure and heat produced by burial or movements of the crust will change these rocks into metamorphic rock.

Sedimentary, igneous and metamorphic rocks are brought up to the surface of the Earth by uplifting, folding and faulting. Sometimes sedimentary, metamorphic and igneous rocks are melted again, creating magma and a new igneous rock when cooled.

Sometimes people use keys to identify different rocks. These keys are made using knowledge of the rocks properties: *e.g. What it reacts with, the size of crystals, colour.*

Activity 2 Looking At Rocks

Aim To revise work on rocks.

Answer the following questions:

1. Describe how the four types of rock are formed.
2. List four things that may be sediments.
3. Copy the sentences below into your exercise book and choose from the brackets the word that fits best.
   a. Igneous plutonic rock has (small/large) crystals and is formed from (lava/magma) (underneath/on) Earth's surface.
   b. (Metamorphic/Sedimentary) rock is formed from sedimentary and igneous rocks (separating/joining) because of (heat/cold) and pressure.
   c. Igneous volcanic rock has (small/large) crystals and is formed from (lava/magma) (underneath/on) Earth's surface.

Earth's Patterns

Models are often used when studying the movement of the Earth and moon because the sizes and distances of the objects are so large. It is easier for people to understand the cycles when they are viewed from space.

Gravity is a force that all objects have because of their mass. The sun, Earth and the moon are large objects so have large gravitational forces. These forces keep Earth in orbit around the sun and the moon in orbit around Earth. Weight is the force of gravity on an object. On Earth, the force of gravity on one kilogram is 10 Newtons.

Day and night are caused by the Earth spinning on its own axis. It takes 24 hours for the Earth to spin around on its axis once. During this, half of Earth is in daylight and half is in night-time. It takes 365 and a quarter days, which is one year, for Earth to orbit once around the sun.

Earth spins on an angle or tilt of 23.5°. This tilt stays the same all the time so the two different hemispheres of Earth are closer to the sun at different times of the year. This is what causes seasons.

Countries that lie between the Tropic of Cancer and the Tropic of Capricorn experience tropical climates with two seasons, the rainy season and the cooler, dryer season. Cyclones can occur in the rainy season. The rainy season occurs in Samoa when the tilt of the Earth causes the southern hemisphere to be closest to the sun. The cooler seasons occur when the southern hemisphere is tilted away from the sun. Countries further away from the equator have a temperate climate with four seasons.

Phases of the moon occur because of the differences in the amount of the side of the moon lit by the sun that we can see from Earth. At the new moon we can see none of the lit side so the moon appears as a white disk in the daytime sky. At the full moon stage we can see all of the lit side so the moon appears as a full circle in the night-time sky.

The ocean tides are caused by the gravitational pull of the moon and sun on the water of the ocean. When the moon and sun line up together spring tides occur. These are very high and very low tides. When the moon and sun are pulling at right angles to each other neap tides occur. These tides have a smaller distance between high tide and low tide.

A lunar eclipse occurs when the moon moves in and out of the shadow of Earth. Lunar eclipses can only occur when the moon is further away from the sun in the full moon phase. Usually the moon orbits above or below the Earth's shadow so eclipses are rare. Solar eclipses occur when the full moon moves between Earth and sun and blocks the view of the sun from Earth. Solar eclipses are only seen in a small area of Earth where the shadow of the moon falls.

Activity 3 Earth's Patterns

Aim To revise work on Earth's patterns.

Answer the following questions:

1. What is the force of gravity on one kilogram?
2. What two seasons do countries with a tropical climate have?
3. What causes seasons?
4. Name two differences between spring tides and neap tides.
5. Why do the phases of the moon occur?
6. What causes a lunar eclipse?
7. What causes a solar eclipse?

Energy

Energy is something that can make things move or change. There are lots of different types of energy. Energy can be changed from one type to another.

Energy can be potential or active energy. Potential energy is stored energy. Types of potential energy include gravitational, chemical, elastic, nuclear, and magnetic. Objects have gravitational potential energy when they are above the Earth's surface. The higher they are above the surface and the more mass they have the more gravitational potential energy they have. Chemical energy is held in the chemical bonds that hold atoms together in a material. Springs and objects that are made out of stretchy materials store elastic potential energy whenever they are stretched or squashed. Nuclear energy is held in the nucleus of atoms. It is released when the nucleus splits or joins with another nuclei. Magnetic energy is stored in iron objects and in electromagnets.

Types of active energy include kinetic, radiant, sound, heat and electrical. Objects have kinetic energy whenever they are moving. The larger the mass of the object and the faster it is going the higher its kinetic energy. Radiant energy moves from place to place as a fast travelling wave. Sound energy is produced by objects that vibrate back and forward to make waves. These waves travel slowly. Atoms and molecules carry heat energy as they move about. The faster atoms and molecules move the more heat energy they contain. Electrical energy is carried by electrons as they move around an electrical circuit.

Energy can be **transferred** from one object to another. Energy can be **transformed** from one type to another. Energy stories and energy chains are used to show how energy is transformed and transferred in everyday situations. When people use energy the transfers and transformations have different efficiencies. Often only a small percentage of the energy stays as useful energy.

Fuels, food and batteries act as sources of energy. All energy sources must be used wisely. Some are renewable and can be replaced. Some are non-renewable, once they have been used they cannot be replaced.

Activity 4 Energy

Aim To revise work on energy.

Answer the following questions:

1. List five types of active energy and name one place each can be found.
2. List five types of potential energy and name one place each can be found.

3. Write out the following sentences and say if energy is being transferred or transformed.
   a. Light energy hits a shiny object and the light travels to our eyes.
   b. Some of the light energy heats up the shiny object.
   c. Heat from the umu cooks the food.
   d. A ball is thrown into the air and it comes back down.
   e. An electric light is used.
   f. A bird flies from the ground to a tree.
   g. A swimmer slides down the Papaseea Sliding Rocks.
   h. The water in the Falevai river rolls a stone along.
   i. Water goes up through an Alofaaga blowhole.
   j. Electrical energy flows from one wire to the next.
   k. A car starts to pull another car along.
   l. A plane lands at Maota airstrip.

Electricity And Magnets

Our ability to make and use electricity has changed the way people live. There are lots of transducers, such as radios, that use electricity.

Electricity can be made by changing another form of energy into electricity. The gravitational potential energy of water behind a dam or in a mountain lake can be changed into kinetic energy and then this energy can turn turbines to make electricity. Chemical energy in fuels, such as diesel, can also be used to make electricity.

Direct current (DC) electricity produced by dry cells up to 12 V will not cause harm to the human body. Care must be taken if a dry cell begins to corrode and when it is being thrown away.

Mains electricity (AC) must be used carefully as it can kill people by causing the muscles to contract violently and by upsetting the beating of the heart. Wet skin can conduct electricity. Always dry your hands before touching power sockets.

Magnets are found in a number of pieces of equipment such as telephones. Computer disks and videotapes use magnets to store information. Magnets come in different shapes, sizes and strengths. When a bar magnet is free to move, its north pole will line up with the Earth's magnetic field. Magnets are surrounded by an invisible magnetic field. Lines drawn around a magnet show the magnetic field. The closer the lines in the magnetic field, the stronger the magnet. The magnetic field of the magnet is stronger at the poles of the magnet and weaker in the middle or on the sides. The like poles of a magnet, north and north or south and south, repel and push away from each other. Unlike poles, north and south, will attract each other.

The atoms of some materials act as a magnet. In their unmagnetised state magnetic fields of the atoms are all in different directions. The magnetic fields of atoms in a magnet are all lined up in the same direction. The magnetic fields of atoms in materials, such as iron and steel, can be made to line up and make the material into a magnet.

Electromagnets are made up of a solenoid, a core and a power supply. They are used in a range of ways because the magnet field can be turned on and off.

Activity 5 Electricity And Magnets

Aim To revise work on electricity and magnets.

Answer the following questions:

1. Will the magnets below attract or repel each other. Give a reason for your answer.

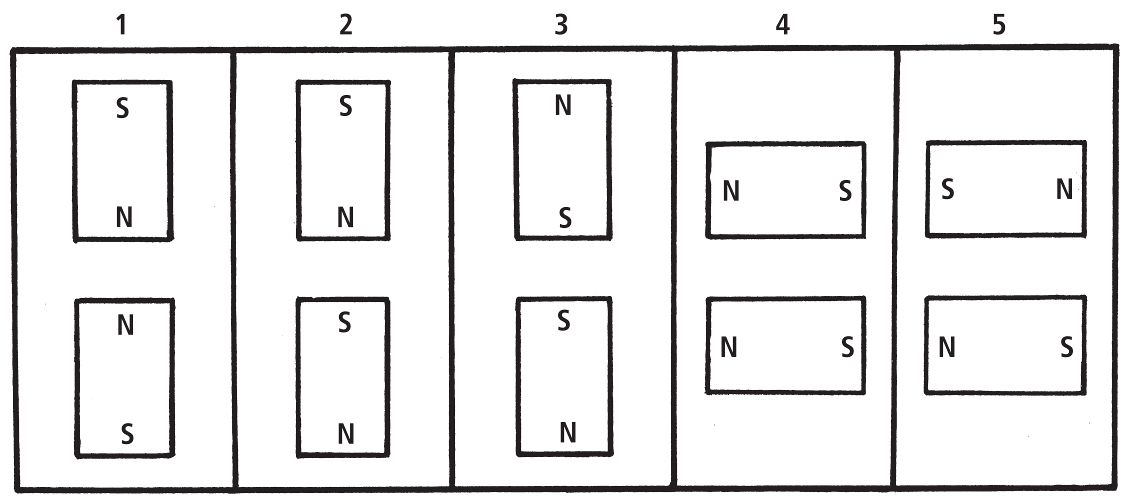
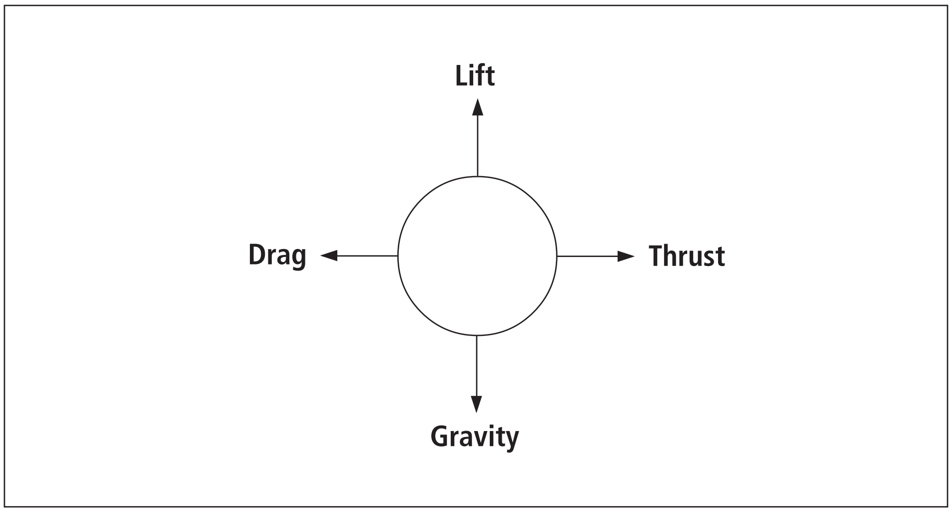


Diagram 1.2
Magnetic fields.

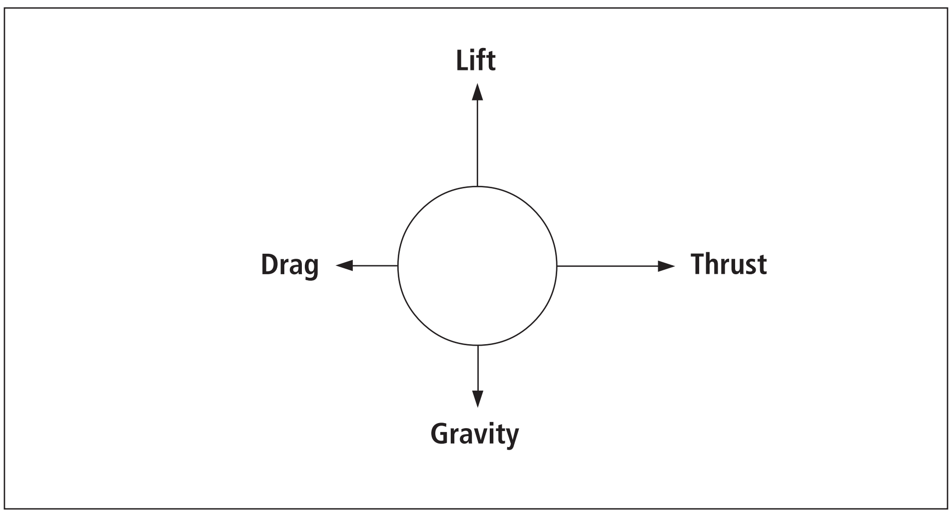
2. Why do computer disks and videotapes have magnets?
3. What can people do to the power supply of an electromagnet?
4. Describe the arrangement of magnetic fields of atoms in a piece of unmagnetised iron.
5. Copy the second paragraph in the electricity and magnets section about making electricity.
6. Name two advantages and two disadvantages of using dry cells instead of mains electricity.
7. Make a list of as many transducers as you can think of. Share your ideas with the rest of the class. How many transducers can your class name?

Forces And Motion

A force is something that pushes, pulls, stretches, squeezes or twists an object. Forces can change the shape, direction or speed of an object. Common forces are tension, gravity, support and friction. The strength of a force is measured using a force meter that measures Newtons (N) of force. The forces around an object in the air are lift, gravity, drag and thrust.



When the forces around an object are balanced there will be no change to the shape, direction or speed of the object. Unbalanced forces cause changes. If the thrust is larger than the drag, the object will move faster. If the gravity is larger than the lift, the object will fall back to Earth.



This object is speeding up because the thrust force is larger than the drag. It is going up because the lift force is stronger than the gravity.

Friction is caused by the bumps on surfaces of objects. It holds objects together. Friction slows moving objects and energy has to be used to work against friction to keep things moving. Drag is a friction force.

Contact forces only work when the objects touch each other. Friction, tension and support forces are all contact forces.

Some forces act at a distance without the objects touching. Gravity and magnetic forces act at a distance.

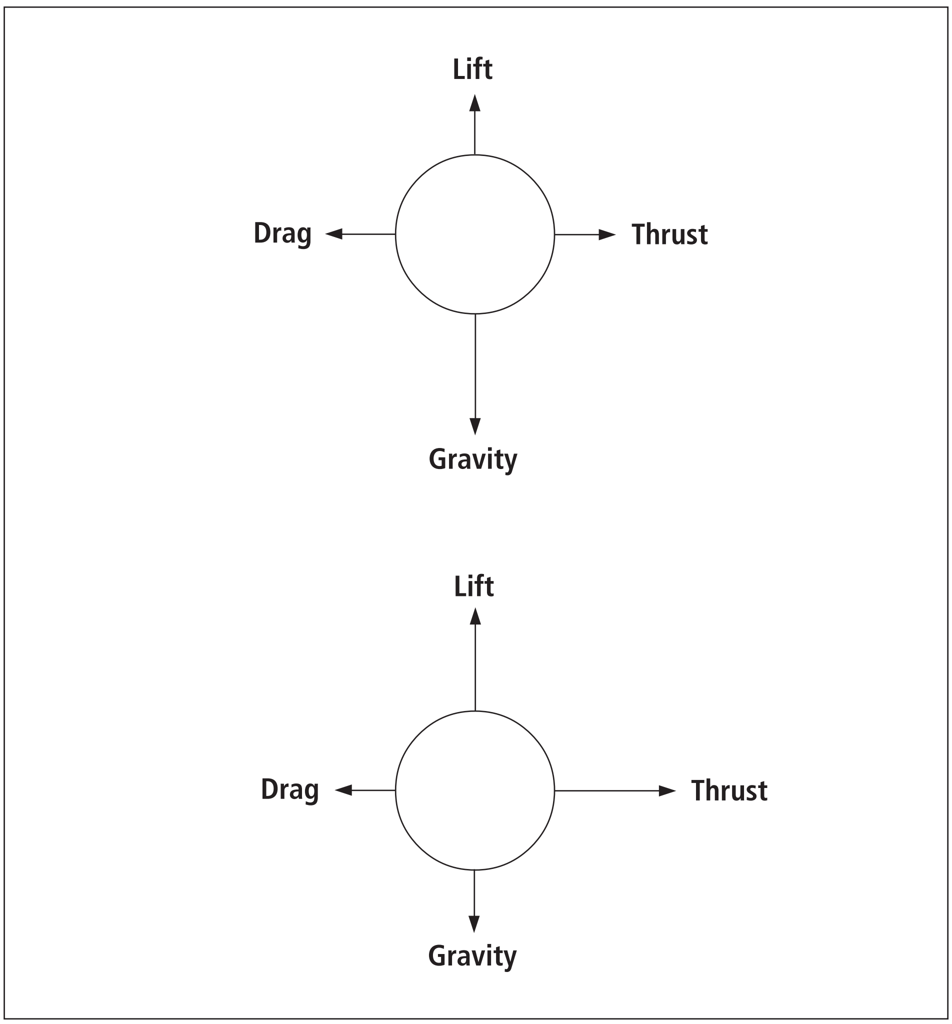
A magnet has a force field around it. The field gets weaker further away from the magnet.

Activity 6 Forces And Motion

Aim To revise work on forces and motion.

Answer the following questions:

1. Name four forces around an object on the ground.
2. Name four forces around an object in the air.
3. Name the three contact forces mentioned above.
4. What does a force change about an object?
5. Compare each of the forces on the objects below then decide which direction it will move as a result of the unbalanced forces.



Unit summary

Copy out each of the following sentences and fill in the missing word(s). The capital letter is the first letter of the missing word.

Living world and environment

1. Plants can be (N _ _ _ _ _) or (I _ _ _ _ _ _ _ _ _).
2. Plants that have flowers are (A _ _ _ _ _ _ _ _ _).
3. Carnivores can be split into two groups. They are (S _ _ _ _ _ _ _ _ _) and (P _ _ _ _ _ _ _ _).
4. A food (C _ _ _ _) or food (W _ _) shows what each organism eats.
5. The physical aspects of the environment are (A _ _ _ _ _ _).

Rocks

1. Samoa is made up of (I _ _ _ _ _ _) rocks.
2. (M _ _ _ _ _ _ _ _ _ _) rock is made up of igneous and sedimentary rock.
3. Sedimentary rocks are formed by compacted layers of (S _ _ _ _ _ _ _ _).
4. The (R _ _ _) (C _ _ _ _) shows how rocks are formed.
5. To identify rocks, sometimes people use a (K _ _).

Earth's patterns

1. Models are used because the (S _ _ _) of and (D _ _ _ _ _ _ _) between objects are often very large.
2. The force of gravity is measured in (N _ _ _ _ _ _).
3. The Earth is on a (T _ _ _) of 23.5°.
4. The path planets take around the sun and the moon takes around the Earth is called an (O _ _ _ _).
5. Day and night are caused by the Earth (S _ _ _ _ _ _ _) on its own axis.

Energy

1. Energy can either be (P _ _ _ _ _ _ _ _) or (A _ _ _ _ _) energy.
2. (E _ _ _ _ _ _ _ _) carry electrical energy in a circuit.
3. Renewable energy can be (R _ _ _ _ _ _ _).
4. Potential energy is (S _ _ _ _ _) energy.
5. Energy can be (T _ _ _ _ _ _ _ _ _ _) to another object or (T _ _ _ _ _ _ _ _ _ _) into another type of energy.

Electricity and magnets

1. Electricity is used by objects called (T _ _ _ _ _ _ _ _ _ _ _).
2. Lines drawn around a picture of a (M _ _ _ _ _) show the magnetic field.
3. Never have (W _ _   S _ _ _) when you touch power sockets.
4. (E _ _ _ _ _ _ _ _ _ _ _ _ _ _ _) are made from a solenoid, a core and a power supply.
5. We can get up to 12V of electricity from some (B _ _ _ _ _ _ _ _ _) or (D _ _   C _ _ _ _ _).

Forces and motion

1. (C _ _ _ _ _ _ _   F _ _ _ _ _ _) only work when objects are touching each other.
2. A force that slows down moving objects is (F _ _ _ _ _ _ _ _).
3. Unbalanced forces cause changes to the (S _ _ _ _ _) or (S _ _ _ _ _) of an object.
4. A magnet has a magnetic (F _ _ _ _   F _ _ _ _ _) around it.
5. To measure a force you would use a (F _ _ _ _   M _ _ _ _ _).

Unit 2: ADAPTATIONS AND ENVIRONMENT

Introduction
In this unit, you will investigate the adaptations and life histories of different plants and animals.

A **habitat** is the place where an organism lives. Each habitat has a range of biotic (living) and abiotic (non-living) factors that make up the **environment**. Adaptations and life histories of plants and animals show how they can live in a particular habitat and are suited to that environment.

Adaptations

Different living things have different ways of life. Each organism has many **adaptations** that help it to survive so that it can grow and reproduce. Adaptations can be:

- **Structural** — These are the body parts of animals and plants. For example, wings on birds and flowers on plants are structural adaptations.
- **Behavioural** — These are the ways plants respond to their environment and the ways animals behave such as the complicated set of movements that birds follow before they mate. Plant responses are usually shown by growth towards or away from an environmental factor. For example plant shoots grow towards light and water. The roots grow towards gravity. Some plants respond to touch by closing their leaves. Other plants move their leaves towards the sun and open and close their flowers.
- **Functional** — These are the abilities of a plant or animal to produce chemicals, control chemical reactions and a range of other things that happen inside their bodies.

Adaptation type	Examples	Use of the adaptation
Structural	Flat, thin ulu leaves.	Shape helps trap sunlight for photosynthesis.
	Long toes on vea.	Able to walk on mud and soft soil.
	Spines on satula.	To protect the animal from predators.
	Fau flowers.	Allow the plant to reproduce.
	Fe’e arms.	Use their arms to catch and hold food.
Behavioural	Niu plant grows toward light.	Able to get more light for photosynthesis.
	Female uu carries her eggs under her body.	Protection for the eggs from predators.
	Fe’e hunt at night.	Hunt at a different time from other predators in order to get more food.
	Roots of fala seedlings grow down into soil.	Able to support the plant and absorb minerals and water from the soil.
Functional	Body temperature of pe’a vao.	Able to keep a warm body temperature.
	Chemicals in the digestive system of the uu.	Ability to make the chemicals needed to digest nui meat.
	Moso’oi flowers smell.	Ability to make a scent to attract insect pollinators to the flowers.
	Body colour of fe’e.	Ability to change colour to suit surroundings.
	Esi leaves are green.	Ability to make chlorophyll and carry out photosynthesis.

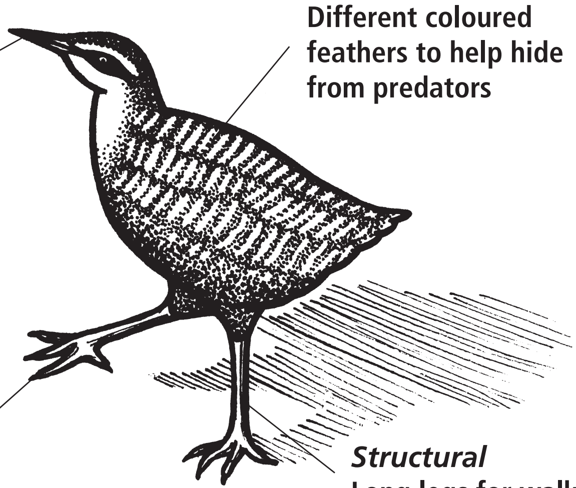


Diagram 2.1
Adaptations of vea.

Activity 1 Adaptations

Aim To record information about different types of adaptations.

1. List the three different types of adaptations and explain what each type is.

Plant adaptations

1. Select a plant and draw a diagram to show what it looks like. Label a number of structural adaptations.
2. Copy and complete the following table:

Adaptations of ____________		
Type of adaptation	Description of adaptation	How the adaptation helps the plant survive
Structural		
Behavioural		
Functional		

Use the notes above to record information about the response of plants to the environment.

Record at least two functional adaptations. These could include the ability to make flower colours, scent or nectar and the ability to make the chemicals needed to carry out photosynthesis.

3. Discuss the adaptations of the plant with others in the class and compare the adaptations of different plants.

Animal adaptations

1. Select an animal and draw a diagram to show what it looks like. Label a number of structural adaptations.
2. Copy and complete the following table:

Adaptations of ______________		
Type of adaptation	Description of adaptation	How the adaptation helps the animal survive
Structural		
Behavioural		
Functional		

   Record examples of behaviours the animal has. Do this by observing the animal or record behaviours you have seen the animal do in the past.

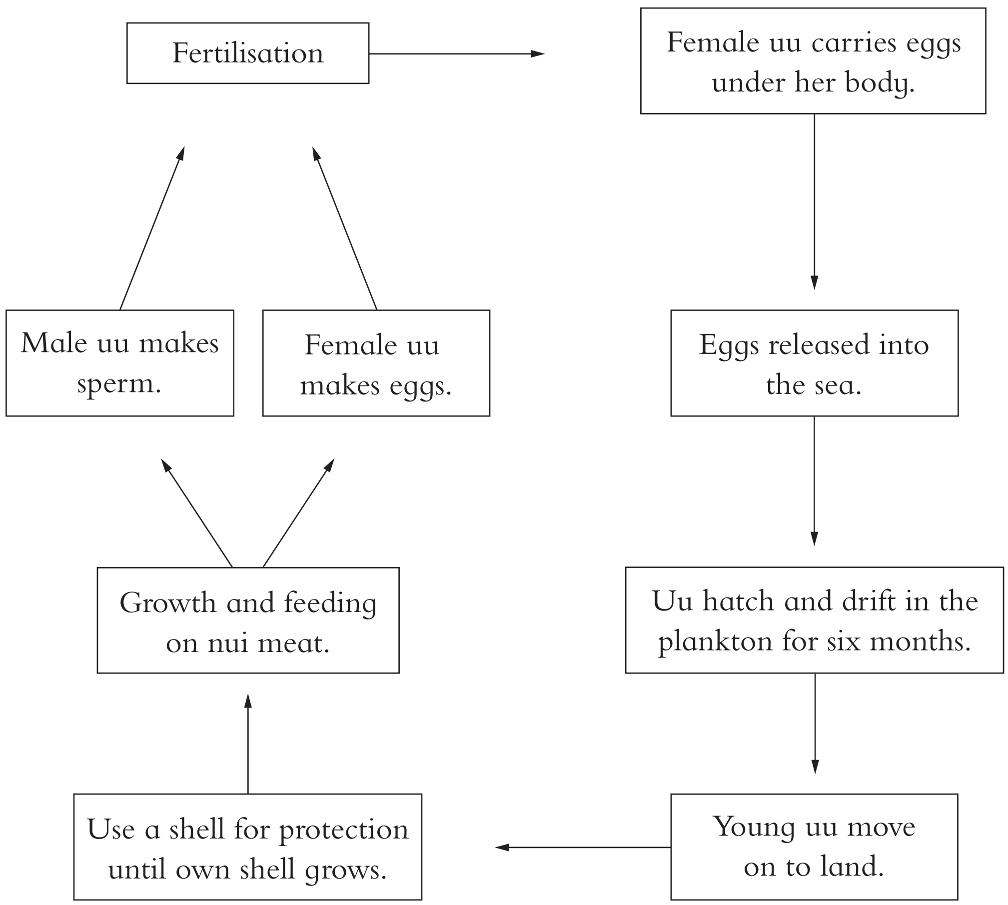
   Record at least two functional adaptations. These could include the ability to make chemicals to help digestion or chemicals to give skin, feathers, scales or hair different colours.

3. Discuss the adaptations of the animal with others in the class and compare the adaptations of different animals.

Activity 2 Life History

Studies of life history are used to learn more about an organism, its way of life and how it is adapted to its environment. A life history diagram is usually drawn in a circle to show that the life history is a repeating cycle. Each life history has information about the growth and reproduction of the organism. The diagram on the next page shows the life history of uu:

1. Look at the diagram of the life history of the uu on the next page. Write this out in a paragraph, using your own words.



Activity 3 Recording Life Histories

Aim To record the life history of a plant and an animal.

1. What are life history diagrams?

Plant life history

1. Work in groups. Different groups select a different plant and research information about the way the plant reproduces and grows. Try to record information about the time of year when the plant carries out different activities such as flowering and making fruit.
2. Use the information you have found to draw a poster of the life history of the plant.
3. Discuss your life history poster with other members of the class. What are the differences in the ways and time of year that different plants carry out different activities?

Animal life history

1. Work in groups. Different groups select a different animal and research information about the way the animal reproduces and grows. Try to record information about the time of year when the animal carries out different activities such as mating, laying eggs and raising young.
2. Use the information you have found to draw a poster of the life history of the animal.
3. Discuss your life history poster with other members of the class. What different activities do different animals carry out? What are the differences in the way different animals carry out the same activity?

Human Activities

A number of human activities cause changes in the habitats and environments of other living things. For example, the hunting of laumei in the past removed large numbers of these organisms from the sea. This caused changes in the feeding patterns of other organisms. Activities such as clearing land for planting, building a road, collecting food from the reef and washing clothes in the river, change the habitat in some way.

Some organisms such as manumea and pe'a vao are so closely adapted to their habitat that they cannot live in other types of forests. The removal of forests by people has caused the loss of habitat for these organisms and the result is much lower numbers of these organisms.

Humans living in large groups in towns produce large amounts of body wastes and other waste materials. Often the body wastes are released into water and this changes the habitats of the fish and other sea-life living there. Some organisms will no longer be able to live in the area. Some new organisms, such as bacteria, will now be found in the area. Often these bacteria cause diseases in people.

Activity 4 Effects Of Human Activities

Aim To investigate the way human activities change local habitats and environments.

1. Select a local area that has been or is being changed by human activities.
2. Describe the human activities that are being carried out. Do the activities have a positive or a negative affect on the environment?
3. Describe the effect the human activities have on the plants, animals and environment in the area. For example, what changes are the activities causing?
4. Discuss how people can carry out the activities they need to do in a way that has a low impact on the organisms and their environment.

Abiotic Environment

The weather in an area is an important part of the abiotic environment. The weather in Samoa is tropical. This means that the weather is warm all year round and there are two seasons: the rainy season and the cooler, dry season. The seasons are a result of weather patterns that are caused by differences in the heat from the sun and the effect this has on ocean currents and winds.

The sun warms the air and water around the equator of Earth more quickly than other areas of Earth. Because the water around Samoa is warmer, the land becomes warmer. This causes a warmer climate all year round. The water in the oceans moves in convection currents. The warm water at the equator flows along the surface of the ocean and cooler, more dense water flows along the bottom of the ocean. When the cooler water gets to the areas around the equator it gets warmed up, it rises and then flows back along the surface of the ocean. The boundary between cold water and warm water in the ocean is called the thermocline.

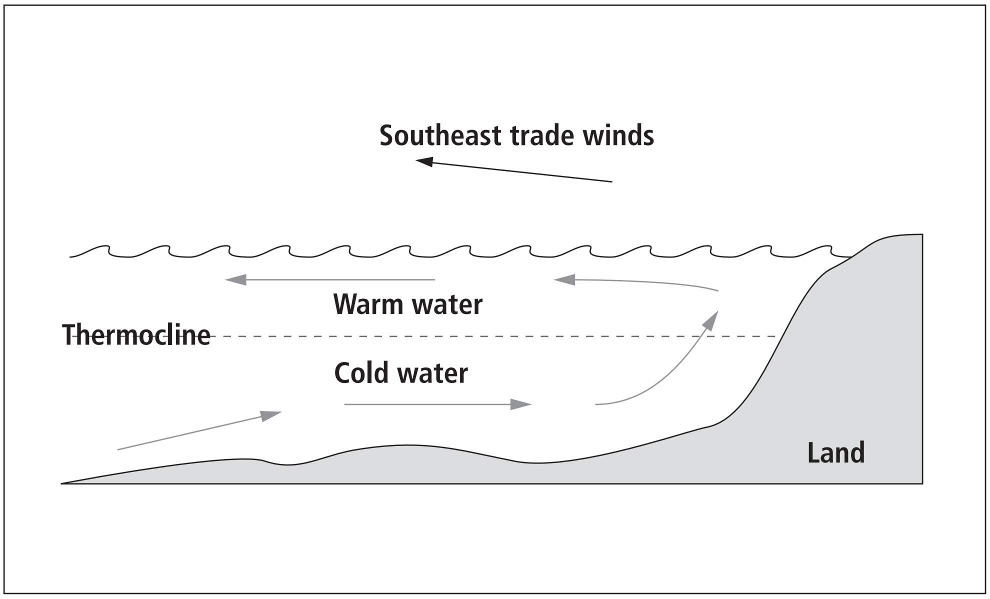


Diagram 2.2
Convection currents in the ocean.

The air around the world also forms global weather patterns. The warm air at the equator becomes less dense so it rises up taking heat energy with it. As the warm air rises, cooler air from nearby moves over the sea to replace it. This air is then warmed and rises. This causes a series of convection currents to be set up around Earth. Areas where the air is rising have a low air pressure and areas where the air is sinking will have a slightly higher air pressure. The wind at the surface of the ocean will blow from an area of high pressure towards a low pressure area.

In normal global weather conditions, the trade winds blow towards the west across the tropical Pacific. These winds pile up warm surface water in the west Pacific, so that the sea surface is about half a metre higher at Indonesia than at Ecuador. The sea surface temperature is about eight degrees celcius higher in the west, with cool temperatures off South America, due to an upwelling of cold water from deeper levels. This cold water is nutrient-rich and supports diverse marine ecosystems and major fisheries.

Activity 5 Global Weather Patterns

Aim To record information about global weather patterns.

1. Explain how convection currents cause ocean currents that warm the land in Samoa.
2. Explain how convection currents in the air cause winds.

El Niño

El Niño is a change in the ocean-atmosphere system in the tropical Pacific which has important consequences for weather around the globe. It is caused by an unusual warming of the sea surface off the coast of South America that occurs once every two to seven years. Recent El Niño weather patterns occurred in 1986–1987, 1991–1992 and 1997–1998.

One of the effects of El Niño is increased rainfall across the southern part of the USA and in Peru, which has caused destructive flooding. Drought has occurred in the West Pacific, sometimes associated with bush fires in Australia. The most recent cyclones that have struck Samoa, French Polynesia and Hawai'i have occurred in El Niño years.

During El Niño the trade winds relax in the central and western Pacific leading to changes in the thermocline. Weather observations show, for example, that during 1982–1983, the thermocline dropped to about 150 m depth. This stopped the upwelling of cool water to the surface and cut off the supply of nutrient rich water. The result was a rise in sea surface temperature that caused changes in the food chains and commercial fisheries in the area.

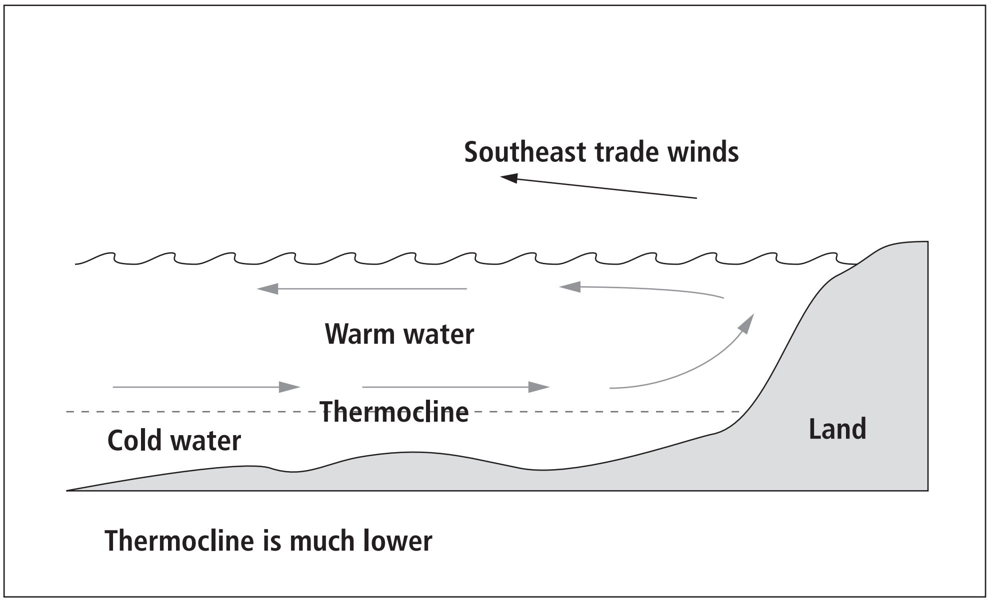


Diagram 2.3
Changes to the thermocline during El Niño.

The weakening of easterly tradewinds occurs during El Niño as well. Rainfall follows the warm water eastward, causing flooding in Peru and drought in Indonesia and Australia. The eastwardly move of the warmest water also causes large changes in the global air circulation, which in turn forces changes in weather in regions far removed from the tropical Pacific.

In December 1993, measurements showed that the sea surface temperatures and the winds were near normal, with warm water in the Western Pacific Ocean, and cool water, called the 'cold tongue' in the Eastern Pacific Ocean. The winds in the Western Pacific were very weak, and the winds in the Eastern Pacific were blowing towards the west (towards Indonesia).

In December 1997 there was a strong El Niño weather pattern. The warm water spread from the Western Pacific Ocean towards the east (in the direction of South America), the 'cold tongue' weakened, and the winds in the Western Pacific, usually weak, blew strongly towards the east, pushing the warm water eastward. This made the water in the centre of the Pacific Ocean much warmer than in a normal year.

More information on El Niño can be found at:

http://www.elnino.noaa.gov/

http://www.pmel.noaa.gov/tao/elnino/el-nino-story.html

http://www.pbs.org/wgbh/nova/elnino/

http://www.cnn.com/SPECIALS/el.nino/

http://www.vision.net.au/~daly/elnino.htm

La Niña is associated with cooler than normal water temperatures in the Pacific Ocean around the equator. La Niña sometimes but not always follows El Niño.

Activity 6 El Niño Weather Pattern

Aim To record information about El Niño weather patterns.

Read the text on page 24 again. Use this to help you answer these questions:

1. What is El Niño?
2. Make a list of all the words in the text that show cause and effect. For example, in the first paragraph: "... are caused by. . ."
3. What changes does El Niño cause to global weather patterns?
4. How does El Niño cause these changes?

Weather Measurements

In Samoa the Meteorology Division records information about the weather. This information gives accurate information on daily weather patterns and also provides information useful in predicting storms. The following diagrams show the equipment used to collect the weather information.

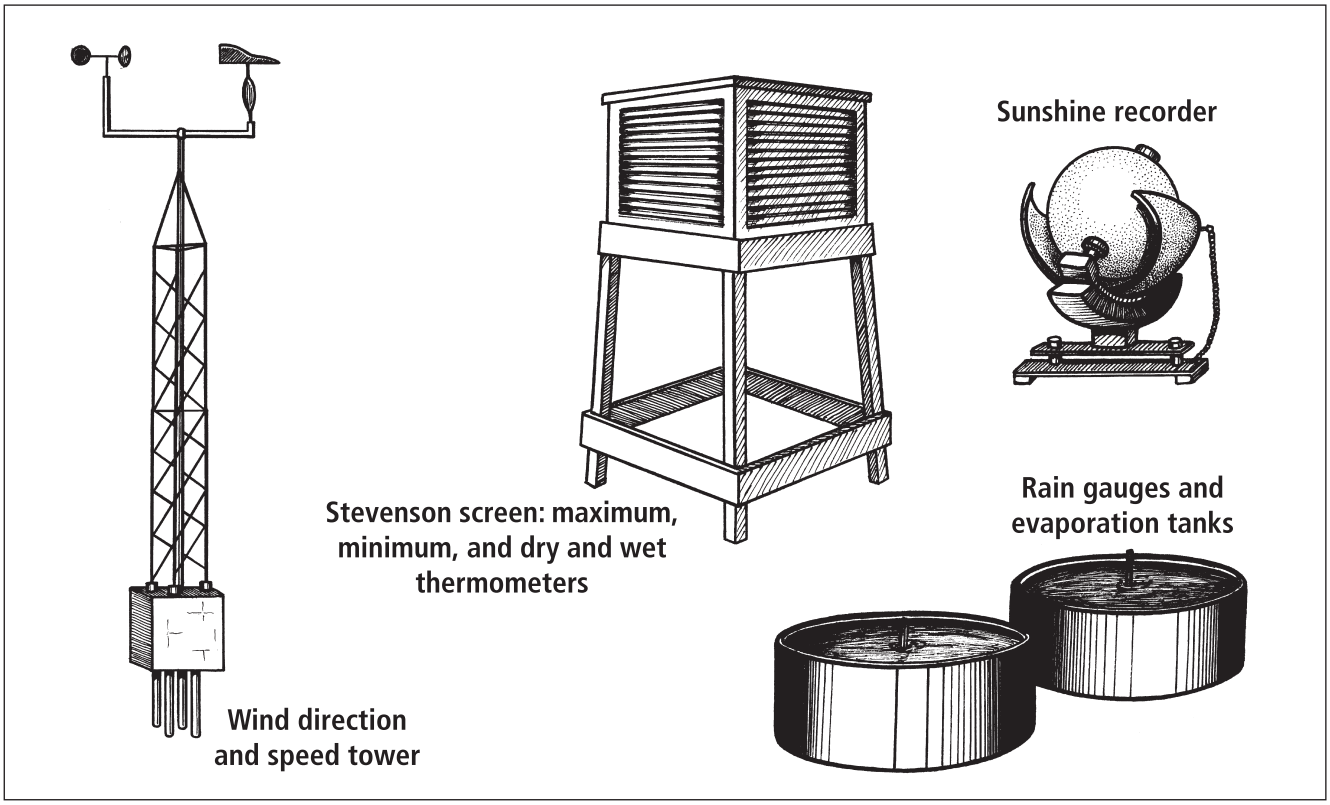


Diagram 2.4
The equipment used to collect weather information (not to scale).

The weather information is collected at Apia and is also collected by six automatic weather stations at Avao, Asau, Cape Tapaga, Faleolo, Lata and Tatitoala. The information collected by the automatic weather stations can be viewed on the internet at:

http://www.samoa.ws/weather_samoa.cfn

(which links to) http://www.meteorology.gov.ws/forecast.htm

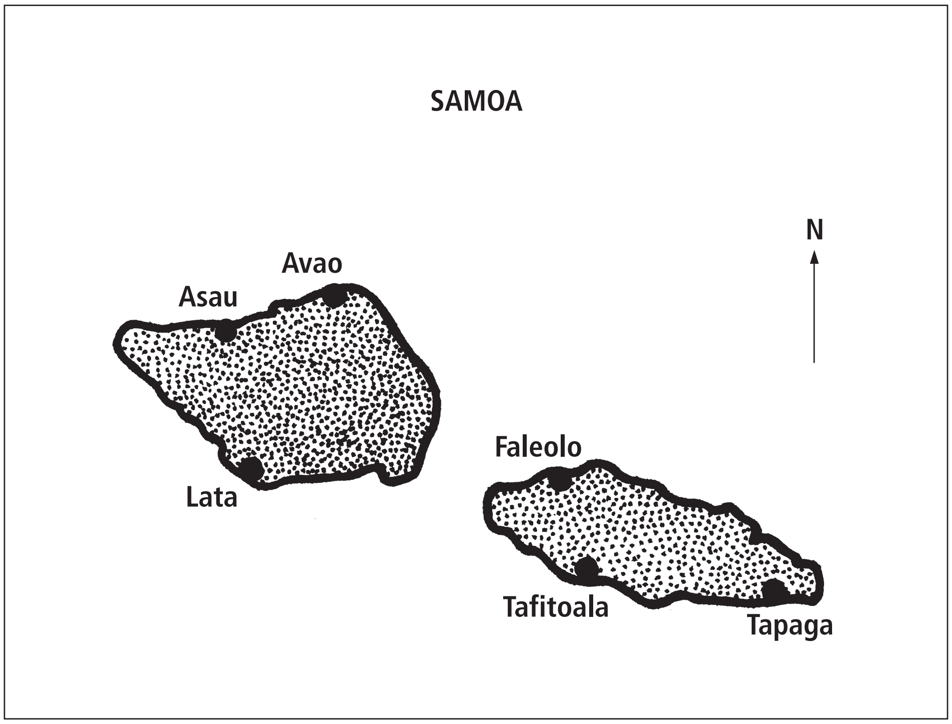


Diagram 2.5
Locations of the automatic weather stations.

A copy of one page from the Faleolo station follows:

Date	Time	Wind direction	Wind speed	Wind gusts	Temp (F°)	Rain (in)	SLP
10 May	1857	130	001	007	80	0	1006.5
10	2057	0	000	0	–	–	–
10	2157	070	003	009	85	–	1008.4
10	2357	310	005	005	89	–	1007.9
11	0057	300	002	008	89	–	1007.2
11	0157	220	004	009	87	–	1006.6
11	0857	120	000	0	–	–	–
11	0957	120	006	010	82	–	1007.8
11	1857	130	001	0	–	–	–
11	2057	100	011	015	88	–	1008.7
11	2157	100	013	017	88	–	1008.6
11	2257	100	012	018	89	–	1008.1
11	2357	100	013	0	–	–	–
12	0157	090	015	023	90	–	1005.6
12	0257	080	012	0	88	–	1005.4
12	0357	110	010	027	82	0.03	1005.8
12	0557	110	008	014	83	–	1006.2

Date	Time	Wind direction	Wind speed	Wind gusts	Temp (F°)	Rain (in)	SLP
12 May	0657	100	004	014	82	0.01	1006.7
12	0757	110	004	007	83	–	1007.2
12	0857	120	002	005	82	–	1007.9
12	1457	0	000	0	–	–	–
12	1657	0	000	0	–	–	–
12	1757	110	008	021	78	0.04	1007.8
12	1857	130	006	018	78	0.04	1008.1
12	2057	130	002	0	79	0.08	1008.6
12	2157	210	002	006	81	0.02	1008.7
12	2257	040	004	005	84	–	1009.1
13	0157	090	008	0	85	–	1006.7
13	0357	080	006	013	87	–	1006.2
13	0957	110	005	009	83	–	1009.6
13	1057	0	000	0	–	–	–
13	1757	150	004	004	83	–	1009.0
13	1957	010	000	003	82	–	1010.4
13	2057	0	000	0	–	–	–
13	2357	210	002	0	86	–	–
14	0057	0	000	0	–	–	–
14	0457	080	012	016	86	–	1006.9
14	0657	060	006	011	86	–	1008.8
14	0857	250	003	004	82	–	1009.9
14	1257	180	001	002	80	–	1009.9
14	1357	110	002	003	80	–	1009.8
14	1457	180	003	003	82	–	1009.5
14	1557	200	001	006	81	–	1009.6
14	1657	010	000	004	79	–	1009.6
14	2257	060	008	010	88	–	1011.3
14	2357	050	006	010	89	–	1010.5
15	0057	020	003	007	91	–	1009.9
15	0311	040	005	0	88	–	1008.8

Activity 7 Weather Information

Aim To record information about collecting and using Samoa's weather information.

1. Find out what each of the following pieces of equipment measures:
   - Wind tower.
   - Stevenson screen.
   - Rain gauges.
   - Evaporation tank.
   - Thermometers.
   - Sunshine recorder.
2. Use any weather equipment the school has to collect weather information in the school grounds.
3. Present the information from the Faleolo automatic weather station or information from one of the other stations in a series of graphs.

Unit summary

- The habitat and its environment are important to living things.
- Different organisms have different adaptations that help them to live in the habitat.
- Adaptations can be structural, behavioural or functional.
- Structural adaptations are the physical parts of plants and animals. For example, your heart or the branches of a tree.
- Behavioural adaptations are the way a plant responds to its environment or the way an animal behaves. For example, some plants respond to their environment by growing toward the most light. The way pusi move quickly out of holes to catch another animal is a behavioural adaptation.
- Functional adaptations are the ability of the living thing to make chemicals or control something inside itself. The ability of the nofu to produce poisonous chemicals is a functional adaptation. Another functional adaptation is the ability of nui to produce strong fibres in its leaves.
- Life histories show how an organism lives and carries out growth and reproduction.
- Human activities change the habitats and environments of plants and animals. Sometimes the changes mean the organism can no longer live in the area. Sometimes the human activities change the balance.
- Weather is part of the abiotic environment.
- Convection currents in the air and water around the world influence the weather in Samoa.
- El Niño weather patterns occur every two to seven years. Often cyclones occur with these weather patterns.
- The Meteorology Division uses measuring equipment at weather stations around Savai'i and Upolo to collect information about the weather conditions in Samoa.

Unit 3: OBJECTS IN OUR SOLAR SYSTEM

Introduction
In this unit, you will make models of the sun and the nine planets of the milky way galaxy. You will also present a project to your class about an object in our solar system.

Size And Distance Models

When learning about stars, planets, moons and space we have to think about the sizes of the objects and the distances between them. The sizes and distances are usually very, very big. For example, the distance between Faleolo and Auckland is about 3000 km and the distance between the Earth and the moon is 384 000 km. The sun is 150 000 000 km from Earth.

The sun is 1 400 000 km across, Earth is 12 756 km and the moon is 3476 km. If you were to make a model of these three objects using a one billionth scale then the sun would be 1.4 metres across and the Earth would be a ball 13 mm wide, 150 m away from the sun. The moon would be a 3 mm ball 38 cm from the Earth. Even these scale distances are impossible to show accurately in a book.

The cycles of Earth are part of everyday life, but it is often very hard to think about how the sun, moon and Earth move to cause these cycles. Looking from Earth it is the sun that moves across the sky each day, but people use the changing patterns of the stars to show that it is really the Earth that is moving. Because it is difficult to work out what is happening from here on Earth people use models to help them pretend they are looking down at the Earth, moon and sun from space.

Activity 1 Size And Distance Model

Materials needed:

Object that is 1.4 metres across to represent the sun: e.g. A table, mat;

Object that is 5 mm across to represent Mercury: e.g. A very small stone, leaf, stick;

Object that is 12 mm across to represent Venus;

Object that is 13 mm across to represent Earth;

Object that is 7 mm across to represent Mars;

Object that is 143 mm across to represent Jupiter: e.g. A large stone, leaf;

Object that is 121 mm across to represent Saturn;

Object that is 51 mm across to represent Uranus;

Object that is 50 mm across to represent Neptune;

Object that is 2 mm across to represent Pluto;

Tape measure.

Aim To make a scale model to show the size and distance between the sun and the nine planets of our solar system.

1. Label each object with the planet or star they represent: *e.g. Jupiter*. You may have to glue the objects to a piece of paper.
2. Take the objects outside into an open area of 600 metres.
3. Place the object representing the sun at one end of the area.
4. Measure 5.8 metres from the 'sun' and hold the object labelled Mercury at this place.
5. Measure 5.1 metres from 'Mercury' and hold the object labelled Venus.
6. Measure 4.1 metres from 'Venus' and hold the object labelled Earth.
7. Measure 7.8 metres from 'Earth' and hold the object labelled Mars.
8. Measure 55 metres from 'Mars' and hold the object labelled Jupiter.
9. Measure 64.8 metres from 'Jupiter' and hold the object labelled Saturn.
10. Measure 144.4 metres from 'Saturn' and hold the object labelled Uranus.
11. Measure 162.6 metres from 'Uranus' and hold the object labelled Neptune.
12. Measure 141.6 metres from 'Neptune' and hold the object labelled Pluto.
13. Compare the sizes and distances. These are really 1 billionth of the real sizes and distances.
14. Draw a diagram in your exercise book to show the model.
15. Label the objects and record the distances between them.
16. Write a heading for the diagram such as: 'Scale model of the distances and sizes of the sun and planets of our solar system'.
17. Write 'Not to scale' below the heading.
18. Explain two reasons why people use models when studying objects in space.

Activity 2 Research

Aim To research information about objects in space.

1. Form 10 groups.
2. In your group find information about one of the topics below, using the information from the appendix of this book, other books, the Internet, or local people. Two of the groups will research information about planets and make comparisons between the statistics of each planet and those of Earth: *e.g. Temperature*, *distance from sun*, *mass*, *number of moons*. The topics are:

   milky way galaxy
   planets
   moon
   sun
   stars
   artificial satellites
   comets
   meteors
   asteroids

3. With the information you find make a speech, poster, project or model.
4. Present your findings to the class.
5. Listen carefully to each of the presentations and take some notes in your book about what you have learnt from each group presentation.

Unit summary

- Scale models are used when the size of objects or distance between a group of objects is too big to be made using the real measurements. For example the model of the sun and planets.
- Scientists use models to help them research and understand what is happening in space.

Unit 4: CHANGING EARTH

Introduction
In this unit, you will investigate soil and the effects of erosion and weathering. You will also investigate volcanoes and earthquakes.

The islands of Samoa are formed from lava and magma released by volcanic eruptions. These rocks are very hard, but are slowly being changed into smaller sediments by weathering. When this process continues for a number of years the sediments get broken down such small pieces that they form **soil**. Soil is important for plant growth as it supplies plants with minerals that are used to make other materials. The soil also supports the plant by holding the roots firm.

What Is Soil?

Soil is the surface layer of Earth that supports plant life. It is made up of fine particles know as sand, silt and clay as well as gravel, water and air. Soil also has living organisms such as earthworms in it and it contains dead plant and animal materials called **organic matter**. The non-living particles of sand, silt, clay and gravel are called the **inorganic matter**.

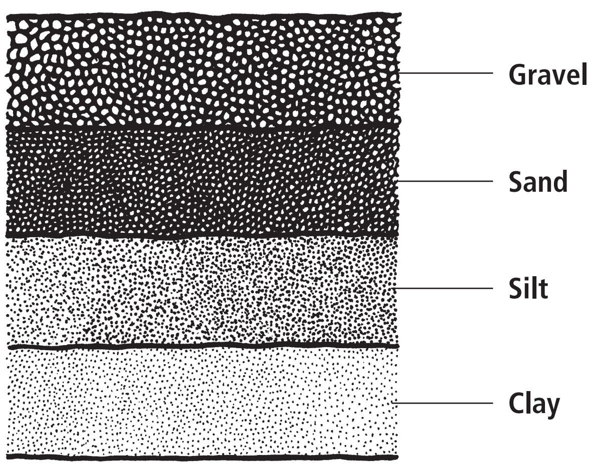


Diagram 4.1
Sizes of soil particles.

The soils in different places can be very different. The amounts of sand, silt and clay particles in the soil cause differences. A soil with a mixture of different sized particles is called a **loam**.

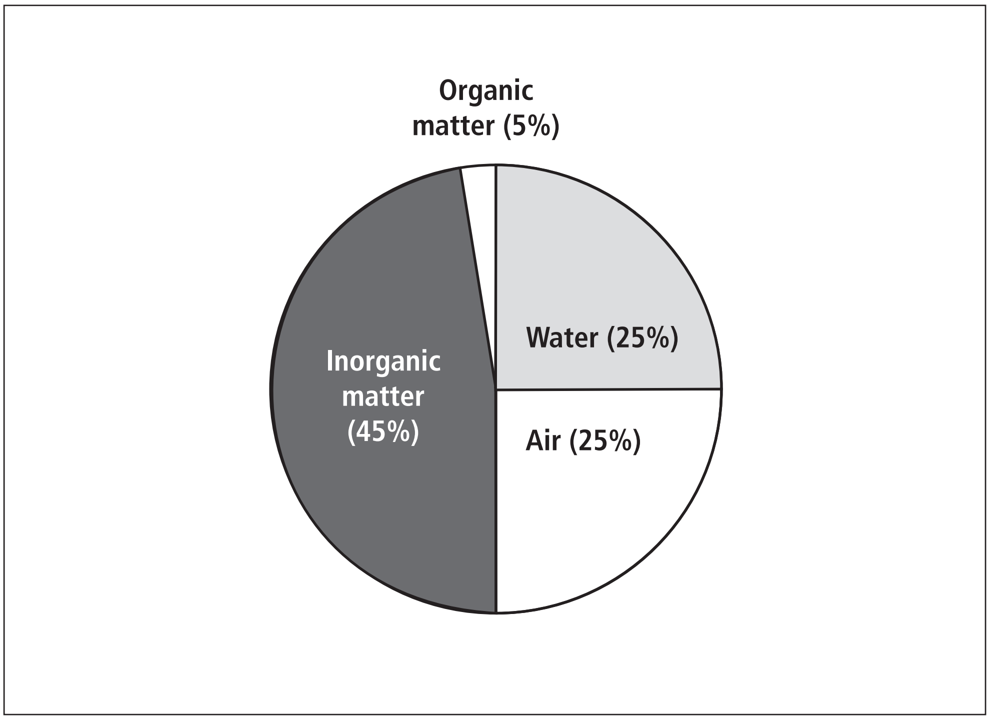


Diagram 4.2
Materials in loam soil by volume.

Properties Of Soils

When a small amount of damp soil is rubbed between the fingers the different amounts of sand, silt and clay particles can be felt. This is called the **soil texture**. Different soils feel different. Soils with lots of clay particles feel smooth. Soils with lots of sand particles feel rough or gritty. Soils with medium textures are usually the best for growing plants in. This is because they are well drained and have lots of air spaces in them.

The texture of a soil can be found by adding a small amount of water to it then squeezing it between your thumb and first finger to see if a ribbon will form. If a ribbon forms, bend it into a ring. Use the table on the next page to name the texture of the soil sample.

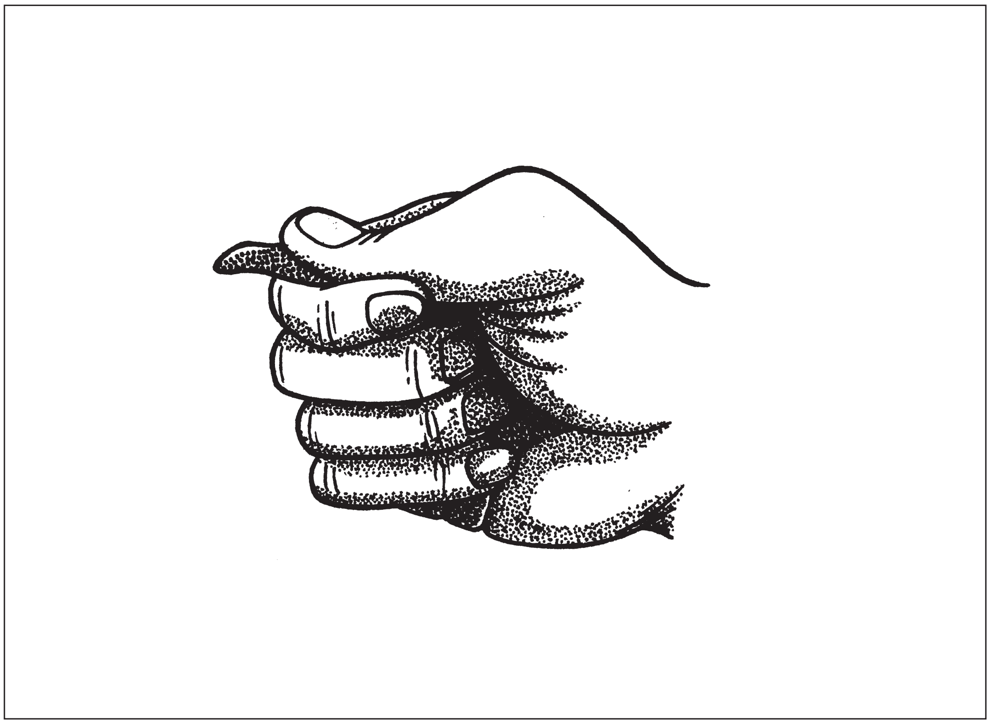


Diagram 4.3
Testing the texture of a soil.

Results of texture test	**Texture by feel**	**Soil type**
Ribbon forms easily and can be made into a ring	Fine	Clay
Ribbon forms but breaks when made into a ring	Fine to smooth	Clay/loam
It is hard to form a ribbon which then breaks	Fairly smooth	Loam
No ribbon forms	Gritty	Silt/loam
No ribbon forms	Gritty and rough	Sand

The **structure** of a soil describes how the sand, silt and clay particles have joined together to form small groups called **peds**. Soils that have large peds contain lots of air, and have larger spaces through which plant roots can grow.

To test the structure of a soil first add a little water to the sample of soil then make it into a ball. Drip water slowly onto the ball of soil. Use the following table to name the structure of the soil sample.

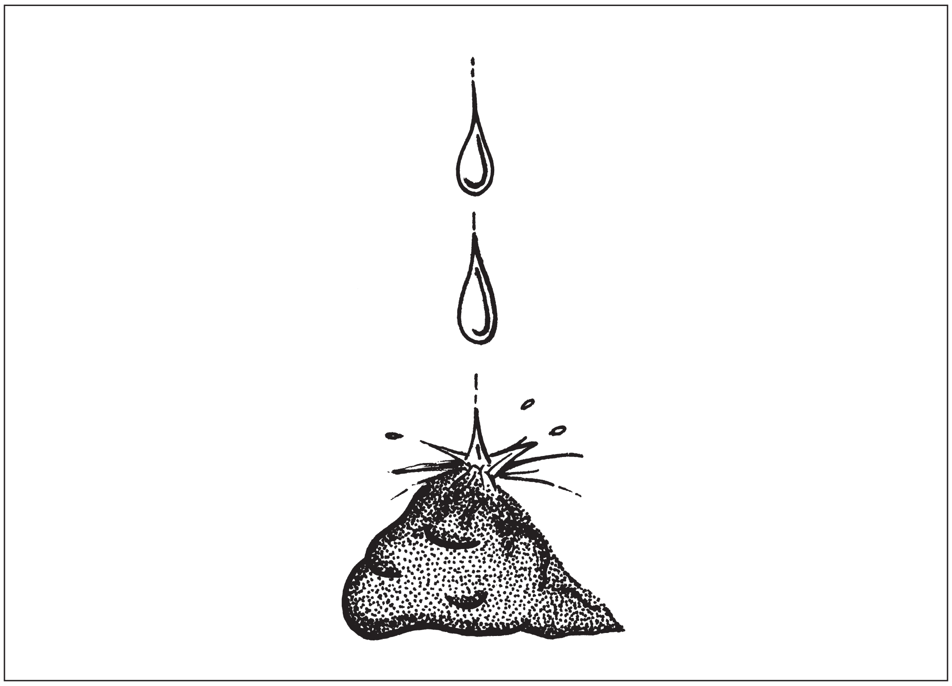


Diagram 4.4
Testing soil structure.

Results of structure test	**Soil type**	**Soil structure**
Breaks up quickly	Sand	Loose
Breaks up slowly	Silt	Friable
Does not break up at all even after a long time	Clay	Solid

The quality of a soil is related to its structure and texture, how deep it is and the amounts of minerals and organic matter present in it. Deep loam soils, rich in minerals and organic matter, grow better quality plants. Good plant growth depends on the plant absorbing minerals from the soil and using the minerals to make new materials. Dead plant and animal material gets broken down into humus and the minerals are released back into the soil so that plants can again absorb them (see Diagram 4.5).

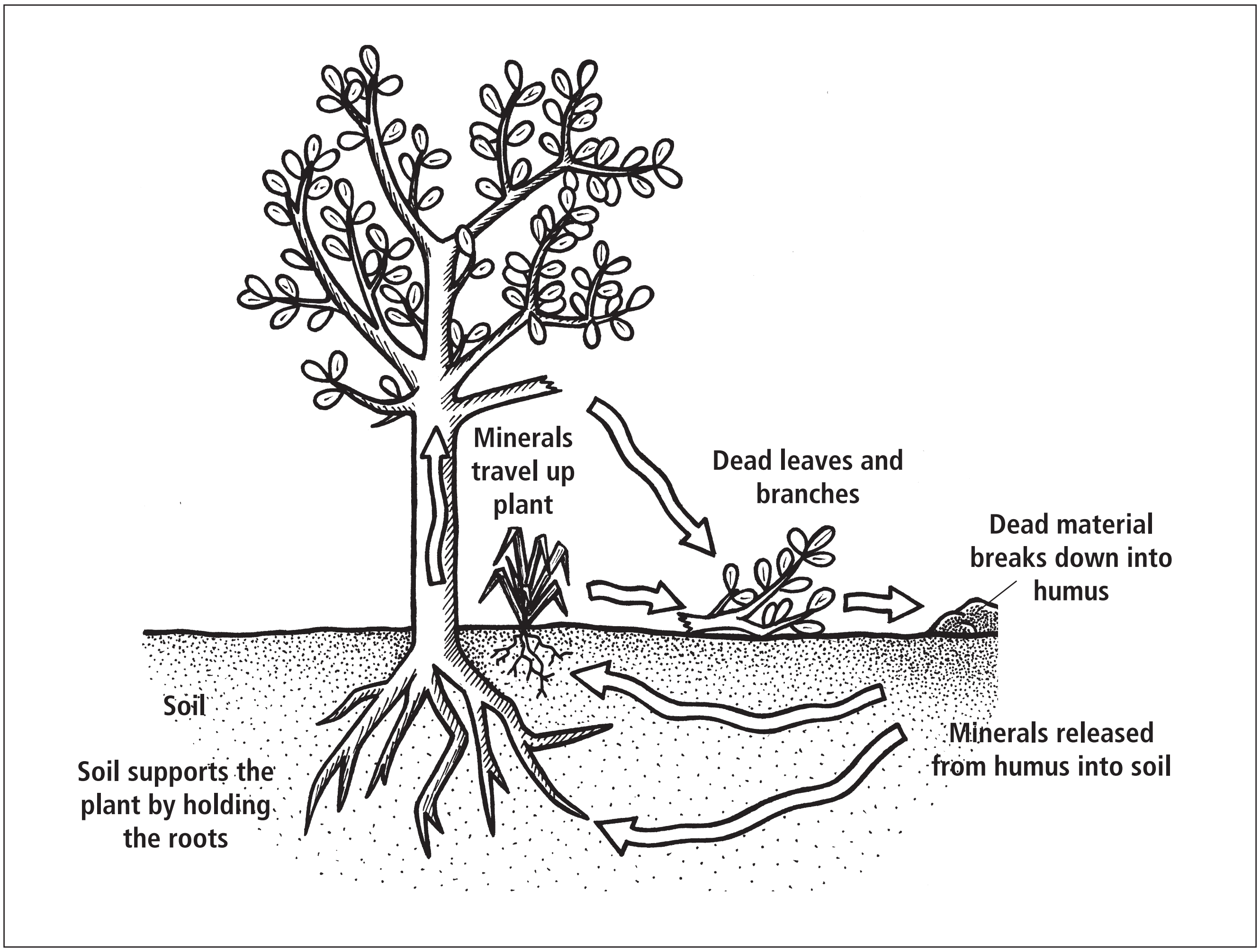


Diagram 4.5
Recycling minerals.

Activity 1 Soil

Aim To record information about soils.

Answer the following questions in your exercise book:

1. What is soil?
2. Name the eight things that can be present in different amounts in different soils.
3. What is the difference between organic and inorganic matter?
4. What is a loam soil?
5. Describe soil texture and structure.
6. Explain how soil is good for plant growth.
7. How do minerals get recycled?

Activity 2 Soil Investigation

Materials needed:
Soil samples;
Water.

Aim To investigate the texture and structure of soils.

1. Collect three or four different looking soil samples.
2. Carry out an investigation into soil texture and structure using the information in the notes on soil properties.
3. Write a report on your investigation.

Soil Profile

A soil profile shows all the layers of soil down to a rock layer called the **parent material**. Each layer of the soil profile is a different thickness and is made up of different materials. Soil profiles in different places give information about how the different layers of soil have formed.

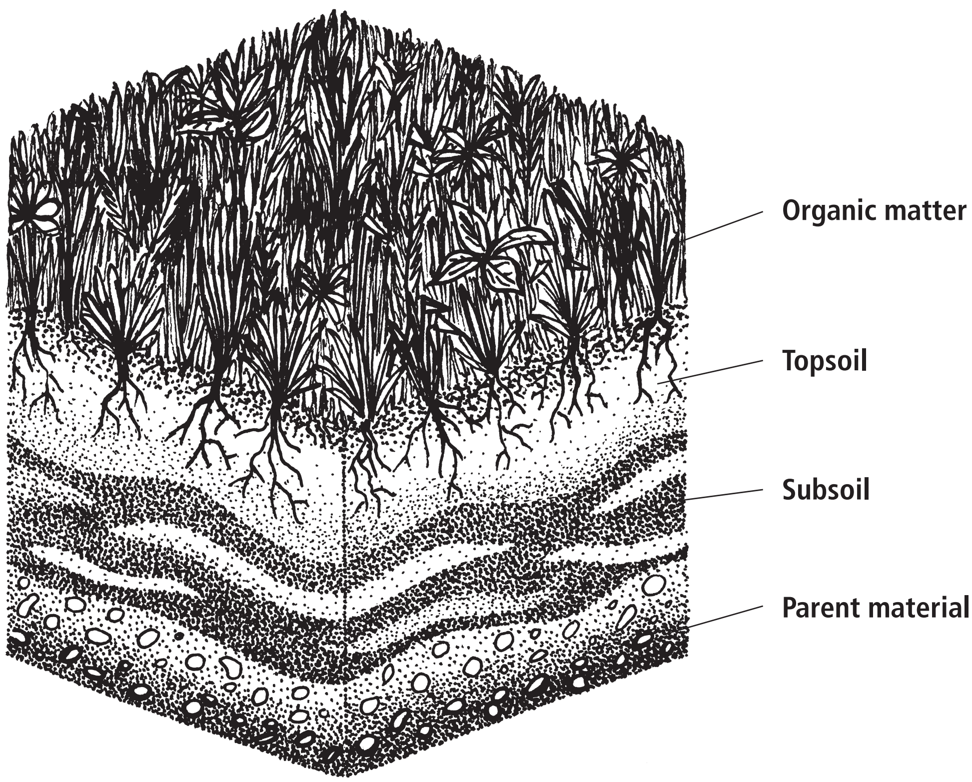


Diagram 4.6
A soil profile.

Activity 3 A Local Soil Profile

Materials needed:
Spade or shovel;
Ruler or measuring tape.

Aim To investigate a local soil profile.

1. Select a suitable site for a soil profile. The best site is a natural river bank or other place where the layers of soil are able to be seen. If no sites are available then mark out a two metre by two metre square and dig down two metres to expose a soil profile.
2. Draw a scale diagram of the profile. Use a scale such as 2 cm in the drawing being equal to 20 cm in the soil profile. Label the following layers: Plants, organic matter or humus, topsoil, subsoil and parent material.
3. Copy and complete the following table. The material present in each layer could include clay, silt, sand, gravel, rocks, animals (such as earthworms), plant roots, dead leaves.

Location of soil profile: ____________			
Name of layer	Thickness (cm)	Colour	Material present
Organic matter			
Topsoil			
Subsoil			
Parent material			

Soil Formation

Soil is formed by the **weathering** of rocks. Weathering means breaking rocks down into smaller pieces. Water and wind can cause the weathering of rock. Sea water and water in rain and rivers weathers rock by flowing over the rock with a strong force or by pushing pieces of rock together so that they bang together and break.

Living organisms also cause weathering of rock. The roots of plants break up rocks as they grow between pieces of rock.

Changes in temperature cause water to expand and contract. When water is caught in small gaps in the rock the changes in temperature and expansion of water cause small pieces of rock to break off. These small pieces become particles in soils.

Soil Loss

Heavy rain and rivers cause soil to be washed away. This is called **erosion**. Erosion, like weathering, is a natural process that is occurring all the time. Soil loss by erosion becomes a problem when more soil is lost than is being formed. This can happen in places where people are using land for houses and agriculture. When land is being used by people it often has the protective plant cover removed. When it rains the water washes the exposed soil away into the river and out to sea.

Activity 4 Soil Formation And Loss

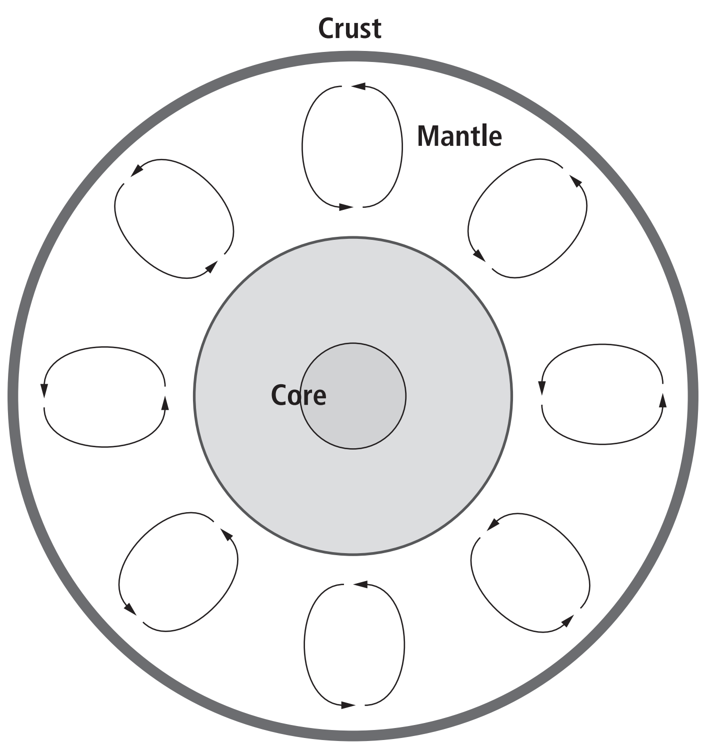
Aim To record information about soil formation and loss.

Carefully read the text on soil formation and soil loss again.

1. Draw a diagram to show the cycle of soil formation, and another to show soil loss, beside it. Can you join them together?

Inside Planet Earth

Planet Earth is made up of a series of layers. The rocks, soil and land we live on is a very thin part of the crust layer around the outside of Earth. There are another three layers under the crust. Each layer has different properties.



Crust
A thin layer of surface rock

Mantle
Very hot rock that moves in convection currents

Core (Inner and outer core)
Very dense and very hot. The outside is liquid and the inside is solid

Diagram 4.7
Inside planet Earth.

The crust layer of Earth is made up of a number of large plates that are slowly moving across the surface of the planet. Each plate is about 80 km thick. Some plates are made out of heavier ocean material. The land we live on makes up the lighter continental plates.

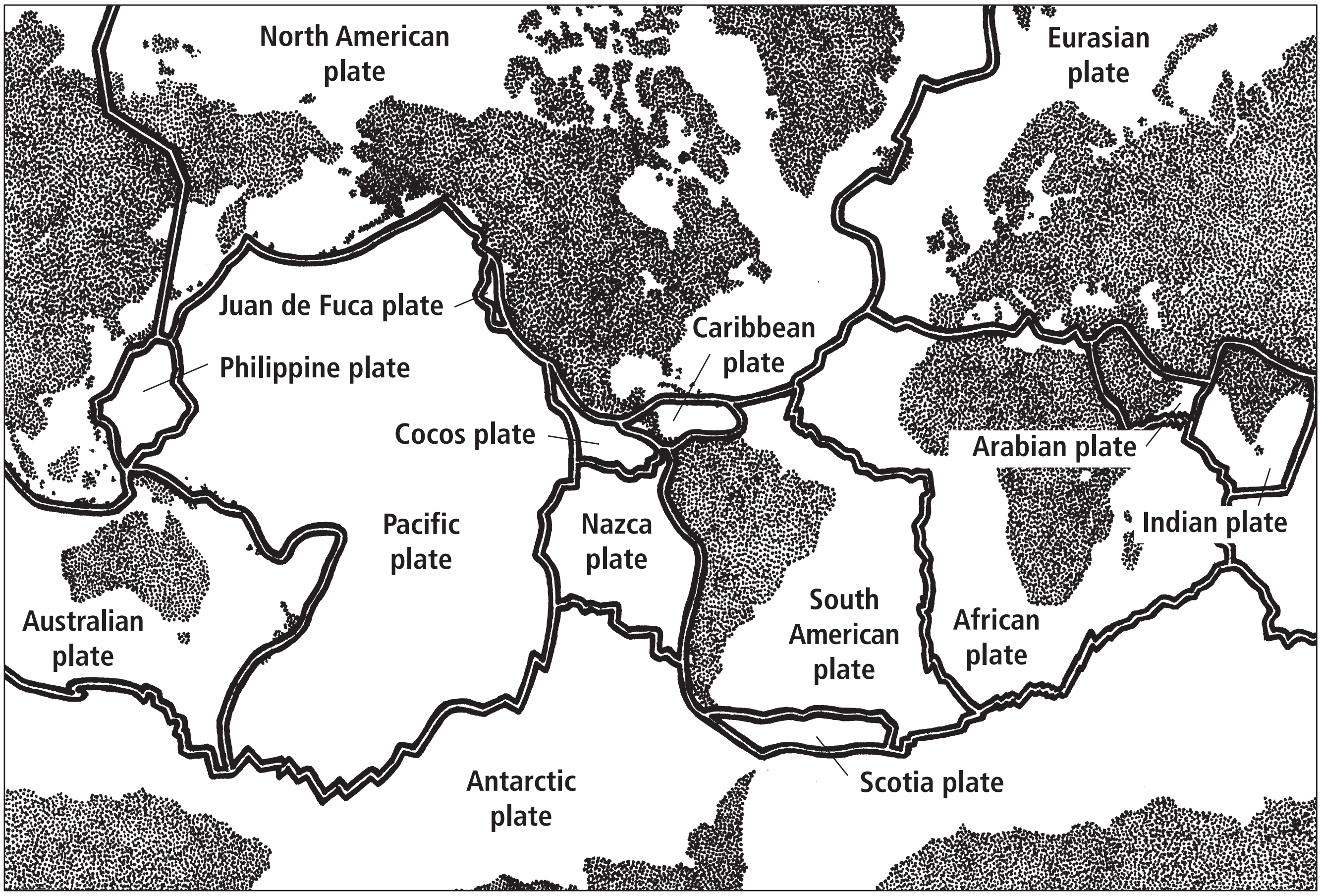


Diagram 4.8
Plates that cover the surface of Earth.

Volcanoes And Earthquakes

The scientific theory called **Plate Tectonics** is used to explain what causes these plates to move. This theory also provides an explanation for many of the world's earthquakes and volcanoes. Most earthquakes and volcanic eruptions take place near the edges of the plates. Samoa lies near the boundary of the large Pacific Plate and the Australian Plate.

The convection currents in the mantle move the plates across the surface of Earth. In some areas the plates are moving towards each other and in others they are moving away. There are also areas where the two plates slide past each other.

When the plates are moving away from each other hot material called magma comes up from the mantle. This sort of boundary between the plates is sometimes called a construction boundary because here the magma hardens and forms new parts of the plates. Mid-ocean ridges are examples of this type of boundary.

A boundary where two plates collide is called a **convergent** boundary. When an oceanic plate meets a continental plate the edge made out of the denser and heavier oceanic crust slides under the continental plate. This process is called subduction and the edge of the heavier plate becomes melted as it moves into the mantle. The results of subduction are ocean trenches at the boundary of the oceanic plate and mountain chains with volcanoes on the continental plate. These sorts of boundaries result in lots of earthquakes.

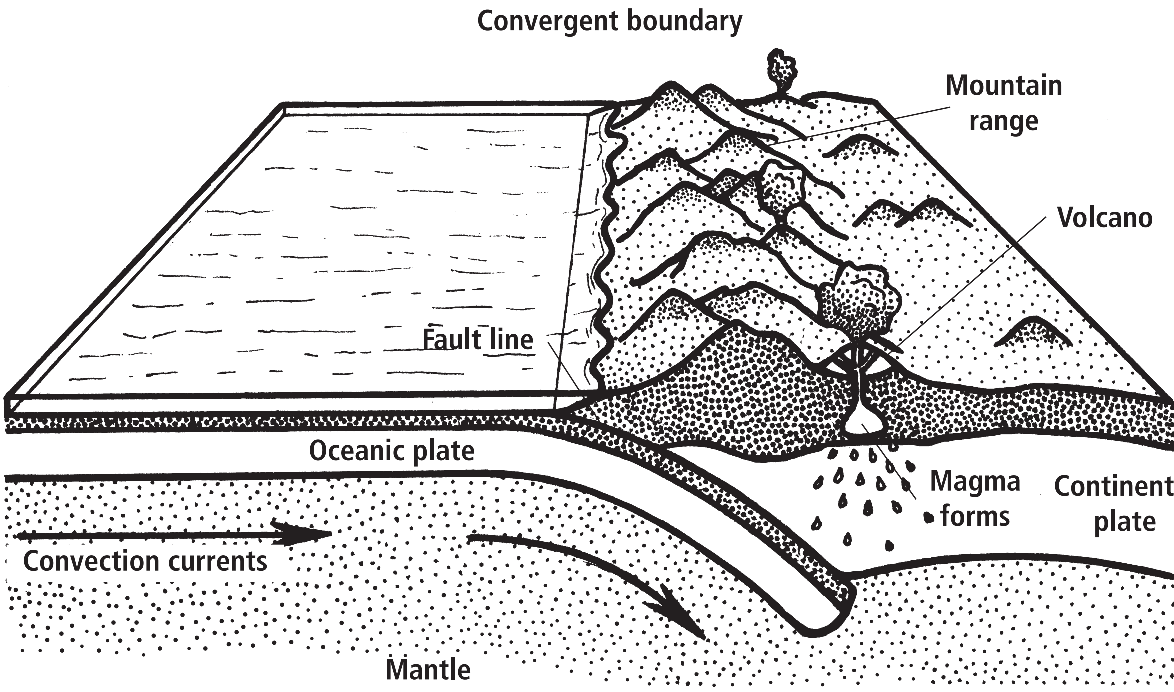


Diagram 4.9
A convergent plate boundary.

At a transform boundary, plates move past each other in opposite directions. Usually this sort of boundary does not have volcanic activity but large, shallow Earthquakes can occur. The San Andreas Fault in California (USA), is the most famous example of this type of boundary.

Ring Of Fire

The 'Ring of Fire' is an area around the outside of the Pacific Ocean where there are a lot of subduction zones. The movements of the plates at subduction zones cause a large number of volcanic eruptions and Earthquakes. Most of the world's Earthquakes occur in countries in the area called the 'ring of fire'.

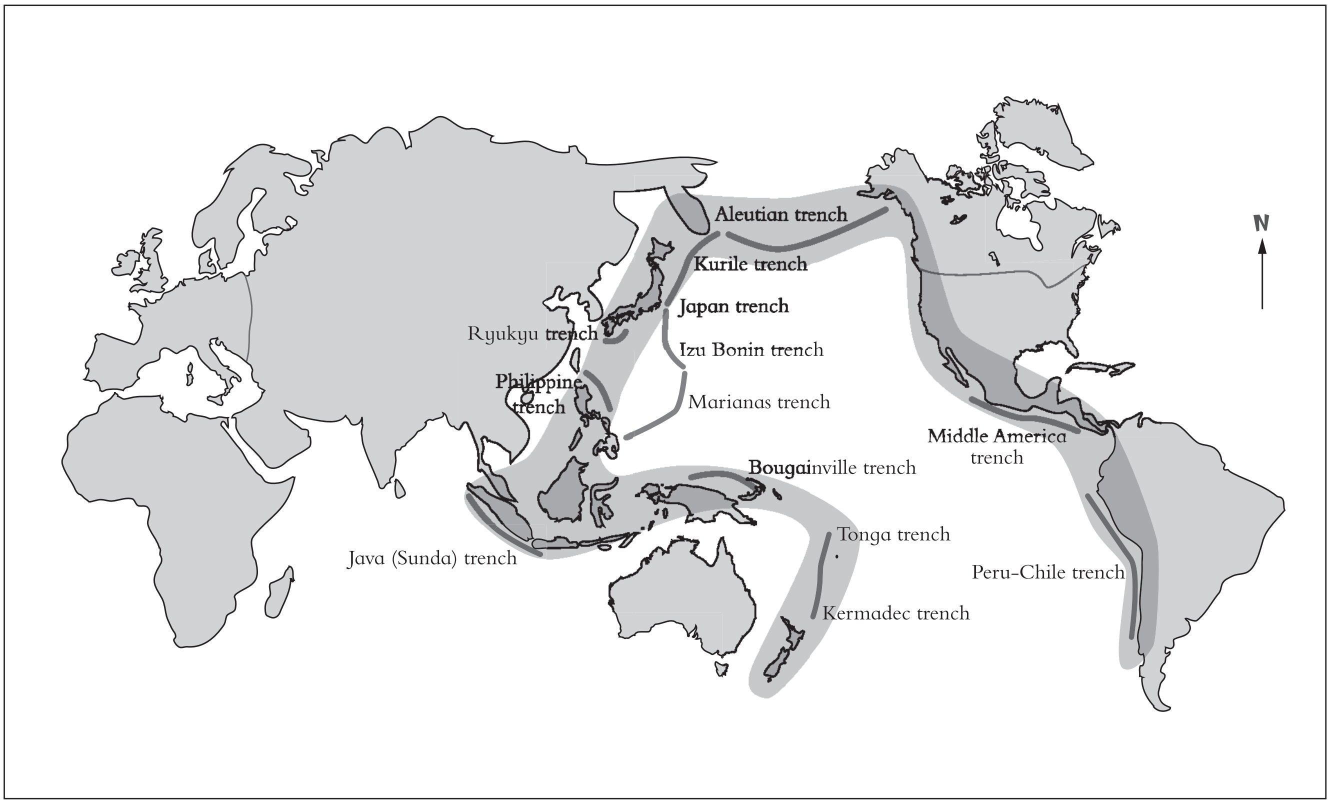


Diagram 4.10
The ring of fire.

The island of Savai'i has a chain of volcanic cones across its centre.

There are other places in the world, such as the Hawaiian Islands, that have high volcanic activity. These areas are known as hot spots. They have a thin layer of crust so magma can escape easily.

Activity 5 Plate Tectonics

Aim To record information about plate tectonics.

1. Where in the world are the majority of earthquakes felt?
2. Explain how plate movements cause earthquakes and volcanic eruptions.
3. Carry out research to find information on methods used to detect, predict and reduce the effects of earthquakes and volcanic eruptions.

Unit summary

- Soil is the surface layer of the Earth that supports plant life. It is made up of fine particles of inorganic matter, living organisms and dead plant and animal material called organic matter.
- Loam soils are made up of a mix of silt, sand, and clay particles. These soils are good for growing plants because the different particles they contain make them well draining and well aerated (filled with air).
- Soil texture can be from smooth to gritty. Clay soils feel smooth and sand is very gritty. Good soils for growing plants have textures somewhere in between smooth and gritty.
- Soil structure is related to the way the particles in the soil group together in peds. Good soil structure allows lots of air spaces between the peds.
- The organic matter in the soil is broken down into minerals which are then absorbed by plants. Having lots of organic matter or humus in the soil improves the structure of the soil and provides a good supply of minerals for plant growth.
- A soil profile shows all the layers in the soil from the plants on the top to the parent material or rock at the bottom.
- Weathering breaks rock into smaller pieces that then form soil.
- Soil can be lost by erosion. During erosion, soil is washed away by the flow of water such as heavy rain or the effects of a river.
- The Earth is a sphere made up of four layers: the crust, mantle, liquid outer core and solid inner core.
- The crust layer is made up of a number of large plates. Some plates are mostly heavy ocean bottom material. Other plates are mostly lighter continental material.
- The plates move across the surface of the Earth, pushed by convection current of the magma in the mantle layer.
- There are three different types of plate boundary. Places where new materials are formed are called construction boundaries.
- Convergent boundaries are areas where two plates are moving into each other. The plate made out of the heavier material subducts under the lighter plate. This causes lots of earthquakes and volcanic eruptions.
- Transform boundaries, where the plates slide passed each other, are also areas where earthquakes occur.
- The 'ring of fire' is an area around the Pacific Ocean where there are a number of plate boundaries that are subduction zones. Most of the Earth's earthquakes and volcanic activity occur in the 'Ring of Fire'.
- Hot spots are areas in the Earth's crust where volcanoes occur that are not on plate boundaries.

Unit 5: HEAT ENERGY

Introduction
In this unit, you will investigate how heat is transferred by conduction, convection and radiation. You will also investigate sound energy.

Heat energy moves from hot objects to colder objects around them or from a hot part of an object to a cold part of the object. Heat energy makes the particles in materials move. The more heat energy a particle has, the more quickly it moves. In solids the particles cannot move about freely, so the more heat energy a solid has, the more its particles vibrate back and forth.

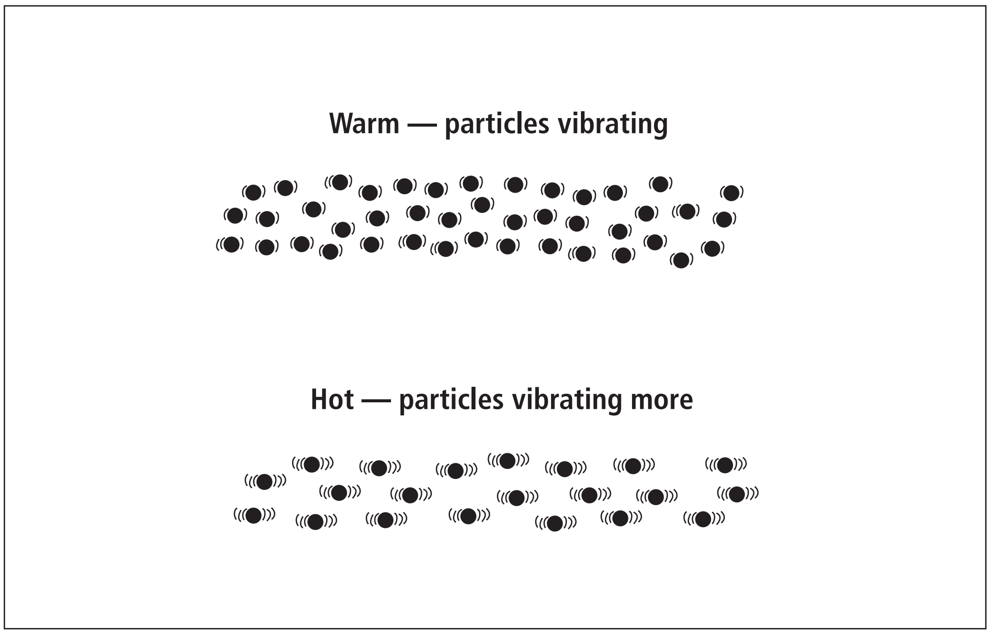


Diagram 5.1
Solids with different amounts of heat energy.

A thermometer measures the **temperature** of a material. The temperature is the average kinetic energy of the particles in the material. The greater the heat energy, the greater the kinetic energy therefore the higher the temperature.

There are three methods by which heat energy is transferred from one place to another. These are conduction, convection and radiation.

Conduction is the way heat energy is transferred through solid materials. The heat energy is passed from one particle to another making the next particle vibrate more quickly. Then this particle bumps into the next particle causing it to also vibrate more quickly. This keeps happening as the heat energy moves through the material.

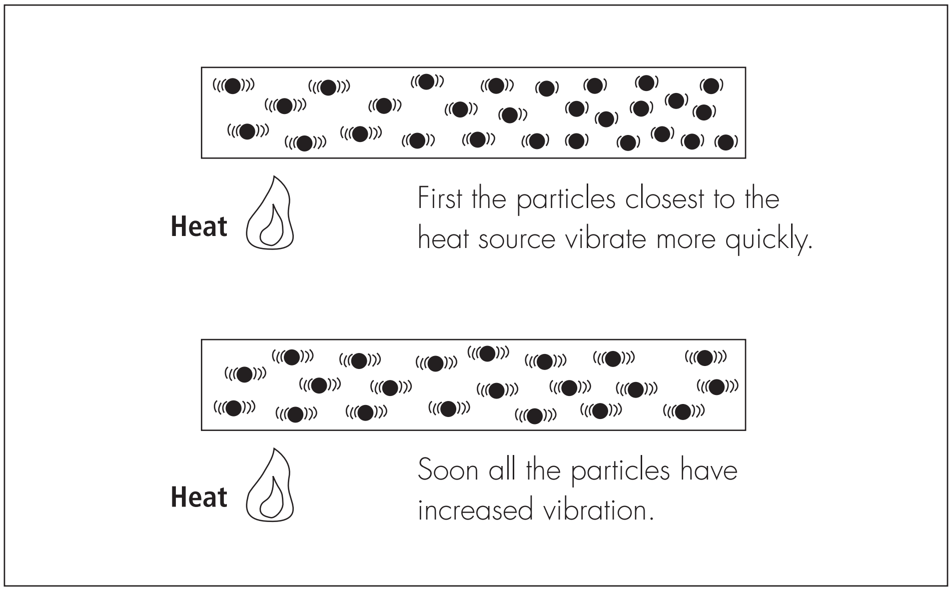


Diagram 5.2
Conduction in a solid.

In liquids and gases heat energy moves by **convection currents**. When part of a liquid is heated, the particles vibrate more quickly and move further apart. This makes the heated part of the liquid less dense so it rises to the top of the liquid. A cooler part of the liquid sinks down to replace the hot liquid as it rises. This movement sets up convection currents throughout the liquid. The same thing will happen if part of a gas is heated.

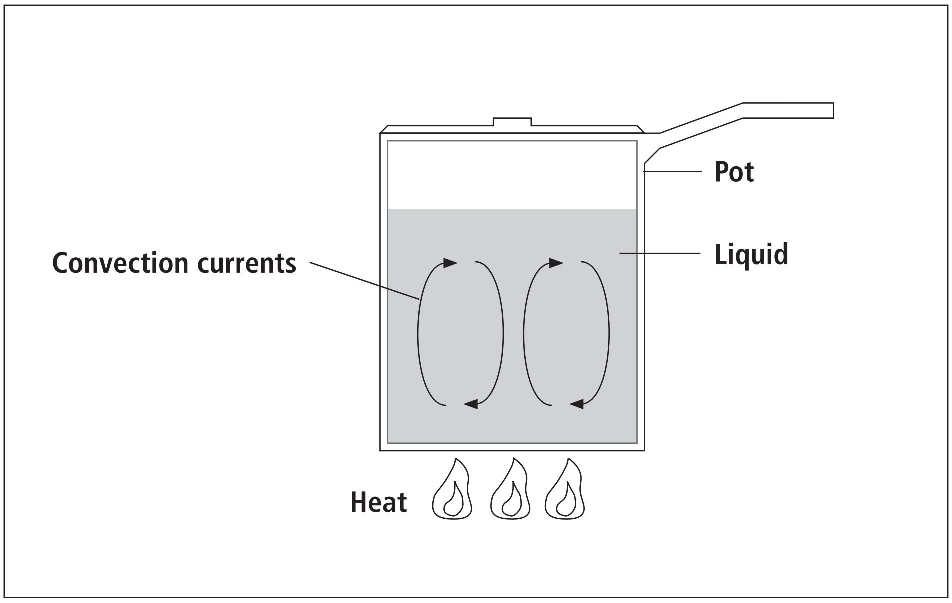


Diagram 5.3
Convection currents in a liquid.

Radiation is the name for transfer of heat energy as **electromagnetic** radiation. Radiation is the way heat energy gets transferred through space from the sun to the Earth. Radiation can transfer heat through a **vacuum** where there are no particles. The transfer of heat energy by conduction and convection needs particles.

Radiation can be reflected and absorbed. When radiation is absorbed the temperature of the object increases. Surfaces absorb and reflect radiation differently.

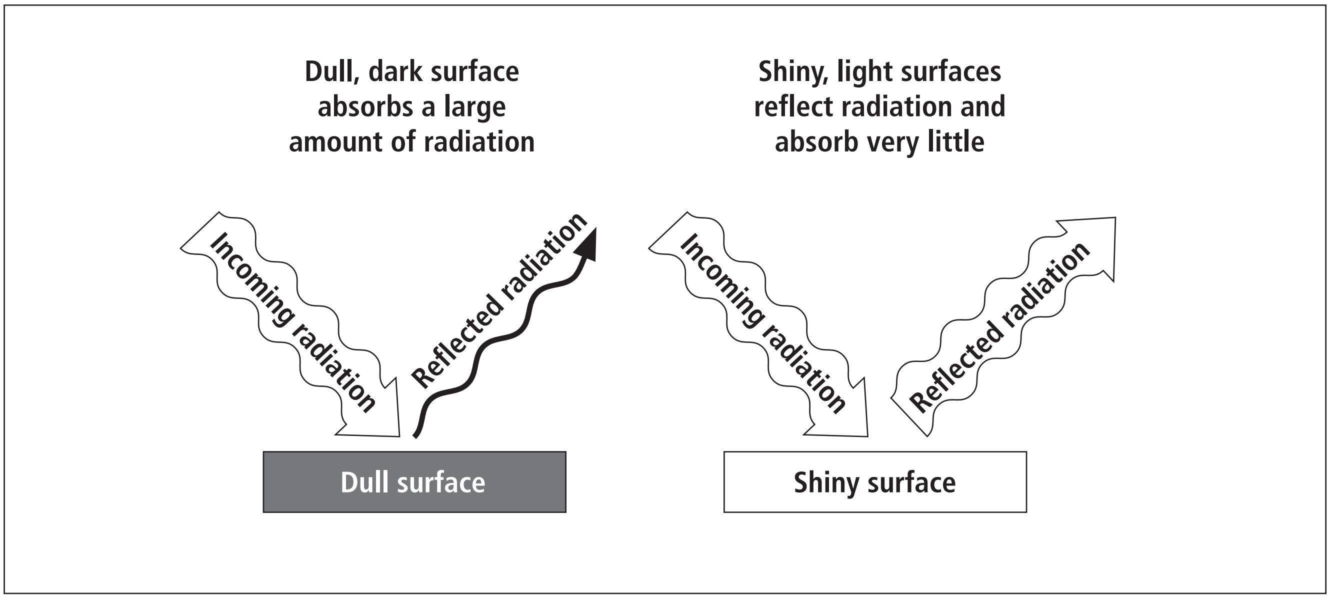


Diagram 5.4
Absorption and reflection of radiation.

Activity 1 Heat Transfer

Aim To record information about heat transfer.

1.Answer the following questions:

a. What happens to the particles in a solid when they absorb heat energy?

b. What happens to the particles in a liquid or gas when they absorb heat energy?

c. What is 'temperature'?

d. What is a 'vacuum'?

2. Complete the table on the next page to compare how conduction, convection and radiation transfer heat energy.

Type of heat energy transfer	How the heat energy is transferred
Conduction	
Convection	
Radiation	

Activity 2 Conduction

Materials needed:
Burner;
Conduction ring;
Wax.

Aim To compare conduction rates in different metals.

1. Set up the conduction ring with wax on the end of each metal as shown in Diagram 5.5.
2. Heat in the centre of the pointed ends of the metal.
3. Time how long it takes for the wax on each metal to melt?
4. Record your results in a table.

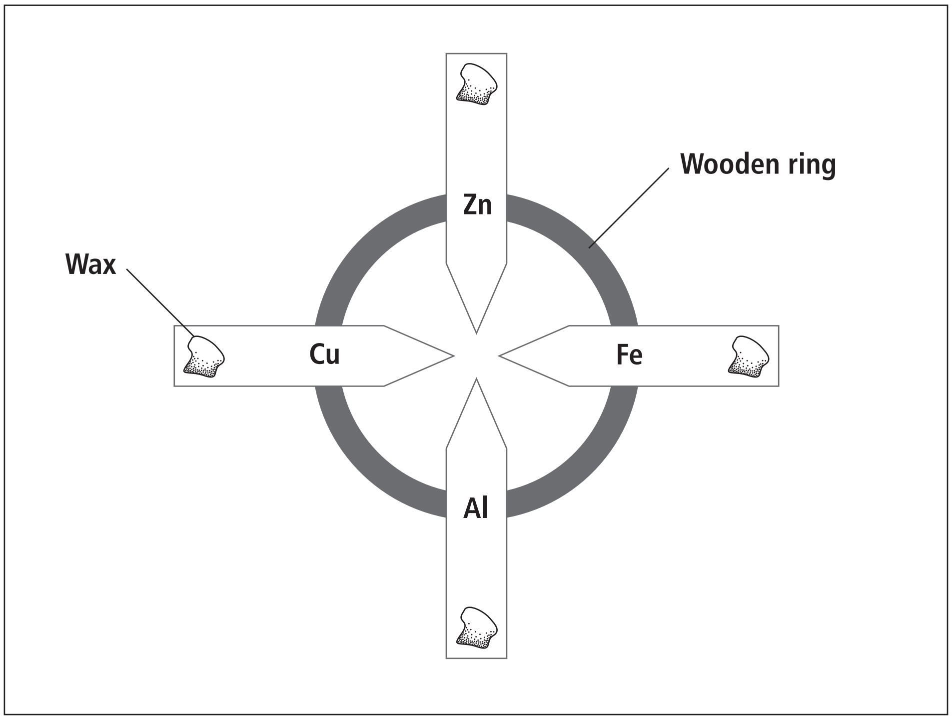


Diagram 5.5
Conduction ring.

5. Write a conclusion in which you compare rate of heat conduction in each of the metals.
6. Write a discussion where you comment on the way the investigation worked.

Activity 3 Convection Currents

Materials needed:
Tea leaves;
Water;
Burner, candle or hot-plate;
Flask, glass beaker or pot.

Aim To investigate convection currents in liquids.

1. Place tea leaves in the bottom of a flask or large beaker.
2. Gently add cold water, trying to leave the tea leaves on the bottom of the flask.
3. Heat the flask gently and every two minutes observe what happens to the tea leaves. Record you observations in drawings. Continue recordings until the water boils.
4. Write a conclusion to describe what this investigation shows about convection currents.

Activity 4 Radiation

Materials needed:
Two objects the same except that one is shiny and the other is dull black: e.g. Pots, tin cans, aluminium cans, OR several objects the same shape and size but a range of different colours and surfaces;
Thermometer;
Cold water;
Watch, stopwatch or clock.

Aim To investigate the absorption of radiation by different objects.

1. Fill the two objects with cold water. Check that the water is at the same temperature.
2. Place the two objects in the sun.
3. Every two minutes record the temperature of the water. Record the results in a table. Record results until the temperatures of the water stops changing.
4. Graph the results.
5. Write a conclusion about the different temperatures that resulted from the absorption of different amounts of radiation.
6. Write a discussion about reflection and absorption of radiation.
7. Explain why most cars in Samoa are light coloured, not dark coloured.

Insulators

Some materials are **insulators** which means that they slow down or stop heat transfer.

Polystyrene foam is a good insulator. Polystyrene slows down the transfer of heat by conduction. Chilly bins are made out of plastic materials, such as polystyrene, that are good insulators. When competing in local competitions the 7's rugby teams use chilly bins full of ice to keep things cold.The insulating walls of the chilly bin slow down heat transfer from the surroundings into the ice inside. The ice also absorbs heat as it changes state from solid to liquid, which also helps to keep things cold. Fridges and freezers have been designed to stop heat transfer and keep food cold or frozen.

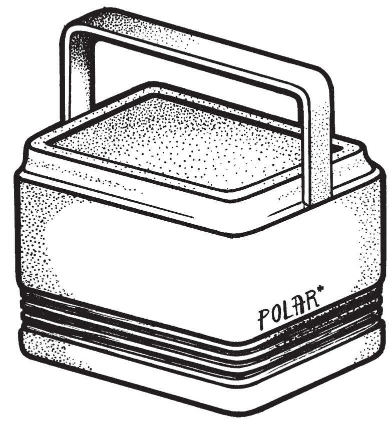


Diagram 5.6
Chilly bin.

Using ideas about insulation and heat transfer
People use a lot of equipment that is designed to increase or decrease heat transfer by conduction, convection and radiation. An electric jug or kettle is an example. Any equipment designed to heat water has the element at the bottom. Convection currents will cause the heated water to rise to the top and bring the cold water down to the element to be heated.

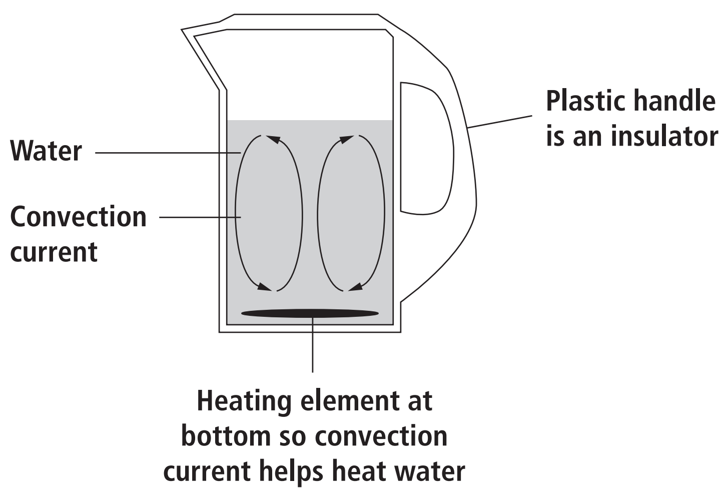


Diagram 5.7
Electric jug.

Understanding of convection currents can be used to explain land and sea breezes that occur along the coast. These breezes occur because of the differences in the heating and cooling of land and water. The water in the oceans does not change temperature very much. The temperature of the land changes as it absorbs heat during the day and loses it during the night.

During the night the land is cool and the sea is warmer. The air above the sea rises pulling the air above the land out over the sea.

During the day the land is warmer than the sea. The warmer air above the land rises. This pulls the air from above the sea in towards the land.

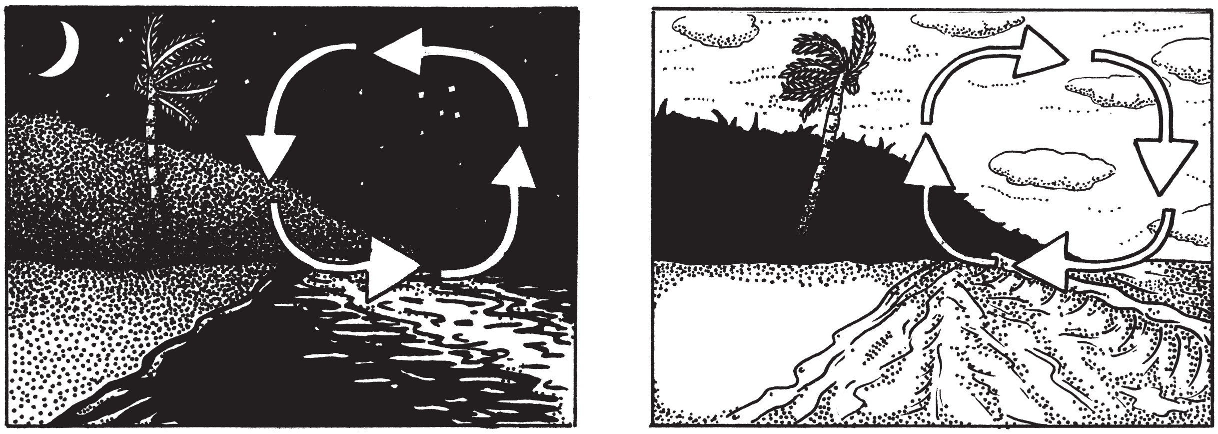


Diagram 5.8
Land and sea breezes.

Activity 5 Insulators And Heat Transfer

Aim To record information about insulators and heat transfer.

1. Select an example of: the use of an insulator, or the use of, or application of, heat transfer.
2. Draw a diagram to show the example chosen.
3. Explain how the example chosen either acts as an insulator or improves heat transfer. Use one of the following words in your answer: conduction, convection currents, radiation.

Sound

Sound is a form of energy. Sound can be transferred and transformed like other types of energy. Sounds are made when an object moves. As an object moves it causes vibrations and the vibrations cause sound waves. Sound waves can only travel in materials that are made up of particles. Solids, liquids and gases have particles and act as a **medium** for the sound waves to travel through. There are no particles in a vacuum so sounds do not travel through a vacuum.

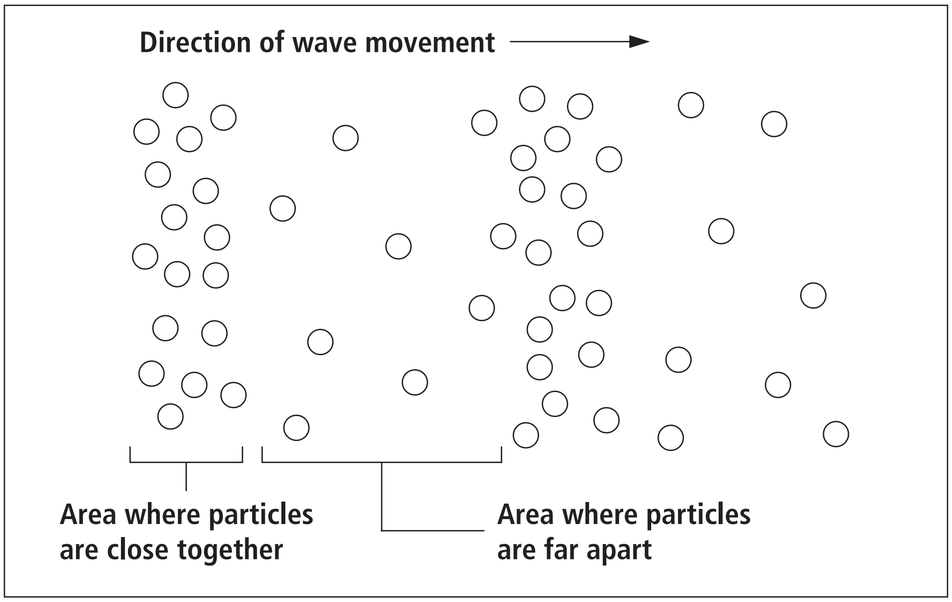


Diagram 5.9
A sound wave travelling in air.

Sound waves are called **longitudinal waves**. This means that the particles move in the direction of the wave. Sound waves have areas of high pressure where the particles are pushed together and areas of low pressure where the particles are far apart.

The following diagram shows how a vibrating object makes sound waves. When the object moves forward, it pushes the particles together causing an area of high pressure. When the object then vibrates back it spreads the particles out. As the object continues to move back and forth it forms more and more of these high and low pressure areas.

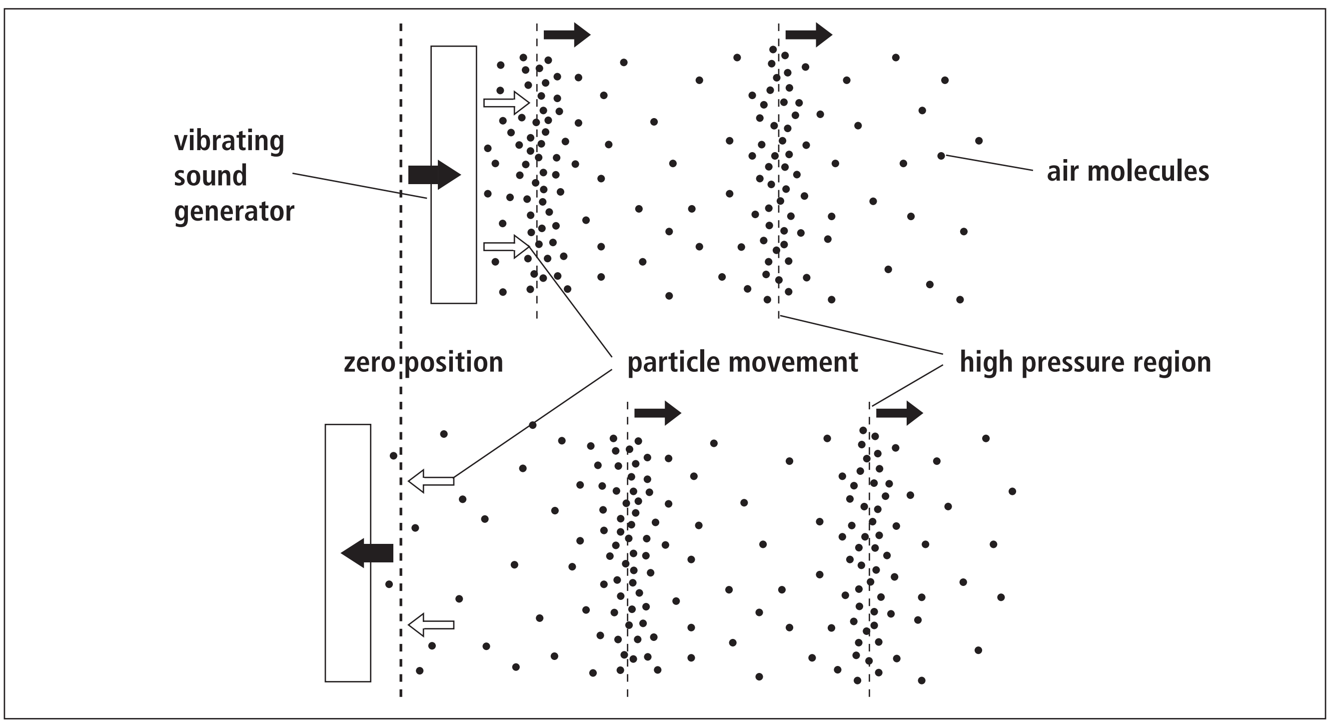


Diagram 5.10
Making sound waves.

Activity 6 Sound Waves

Materials needed:
Slinky spring.

Aim To record information about sound waves.

1. What causes sound waves?
2. What is a longitudinal wave?
3. Explain why sounds need a medium such as water to travel through.
4. Copy Diagram 5.9 into your exercise book.
5. Hold both ends of a slinky spring. Gather up a number of coils at one end and then let them go again. The wave that moves down the slinky is a longitudinal wave (see Diagram 5.11).
6. Explain how a vibrating object makes sound waves.

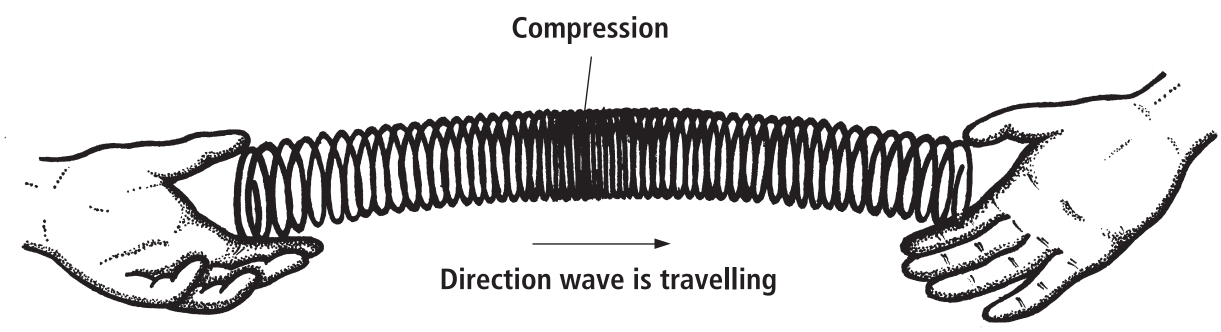


Diagram 5.11
Longitudinal wave in a slinky spring.

Echo

Sound waves can be reflected back from objects such as cliffs and tall buildings. The sound waves hit the object and then go back towards the object making the sound. If it is a person making the sound, the person hears the first sound and then hears the sound return a few seconds later. This second sound is called an **echo**.

Activity 7 Speed Of Sound

Materials needed:
Two blocks of wood or other objects to make a short, loud sound;
A place where there is a high wall or cliff face;
Watch, stopwatch or person to count the seconds by saying 1000, 2000, 3000, etc.

Aim To investigate a sound echo.

1. Stand 120 metres from the wall or cliff face. Bang the blocks of wood together to make a loud noise and listen for the echo about a second later.
2. Can you hear more than one echo?
3. Experiment with different noises until you get an echo that is easily heard.
4. Make the sound and then time how long it takes for the echo to be heard.
5. Repeat at least five times and record your results in a table.
6. Calculate the average time it took for the echo to be heard.
7. Work out the distance the sound has traveled from the person making the noise to the wall and back again.
8. Use the formula below to calculate the speed of the sound.

$$\text{Average speed} = \frac{\text{distance}}{\text{time}}$$

9. Write a conclusion for the investigation in which you compare your calculated speed for the sound with the known speed for sound in air.

Properties Of Sound Waves

A machine called an oscilloscope can be used to show sound waves as wave patterns on a screen. The following diagram shows the wave pattern of three different sounds.

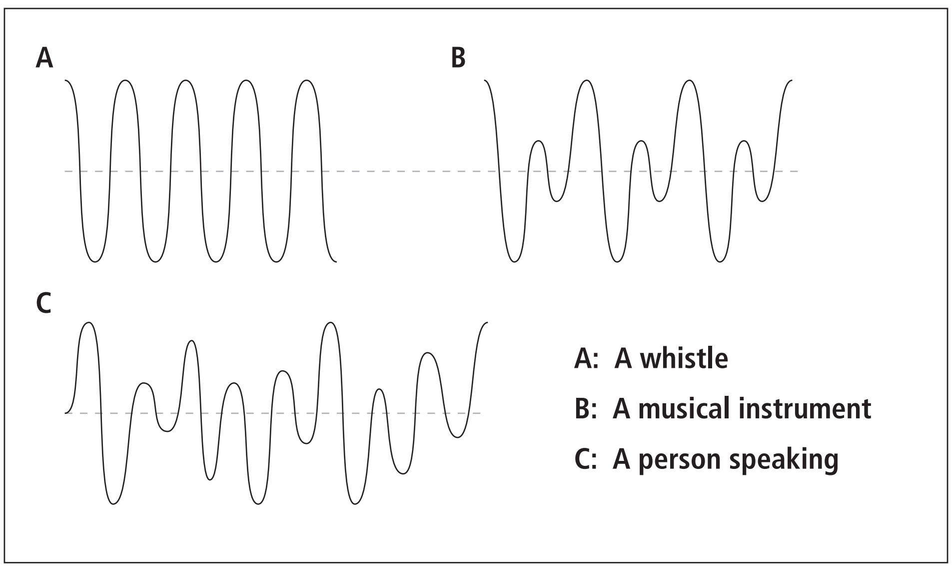


Diagram 5.12
Wave patterns of sound waves.

- **Speed** — Sound waves travel in air at a speed of 331 metres per second. Sound travels at different speeds in different objects. This is because the particles in different materials are packed together and held together in different ways in each different material. Sounds usually travel faster in solids than liquids and faster in liquids than gases.
- **Amplitude** — This is the size of the wave. Different sizes of waves make sound waves loud or soft. Loud sound waves have high amplitude. Amplitude is measured in decibels (dB). A whisper is about 10 decibels and thunder directly overhead is about 100 dB. Sounds over 130 dB will cause pain in people. The roar of jet aeroplanes and high amplitude dance-party music can cause damage to a person's hearing.

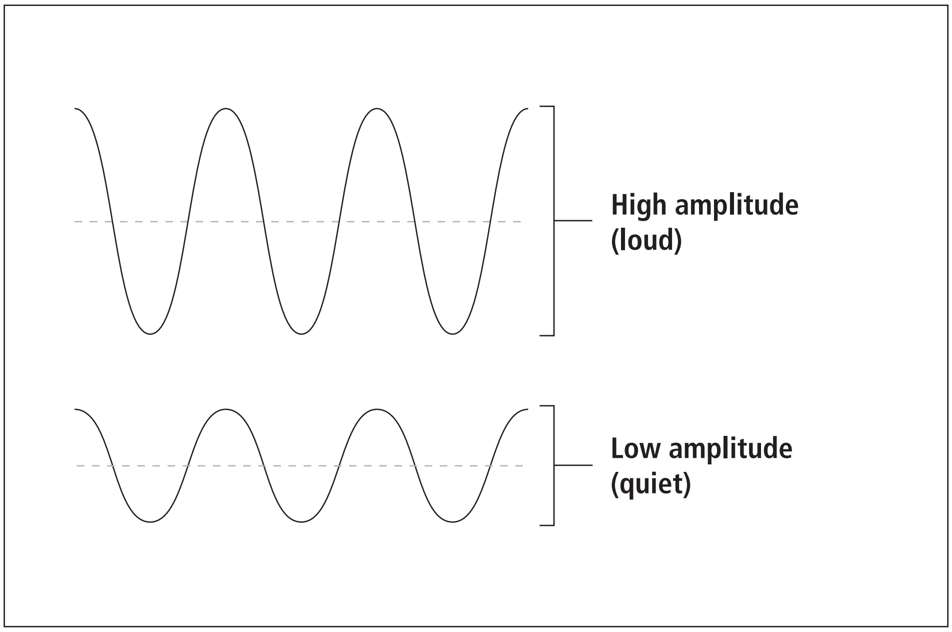


Diagram 5.13
Sound wave patterns showing different amplitude.

- **Wavelength** — sound waves are repeating patterns. A wavelength is the distance between a point and when it is repeated again. It is easier to see a wavelength by looking at two peaks or two troughs.

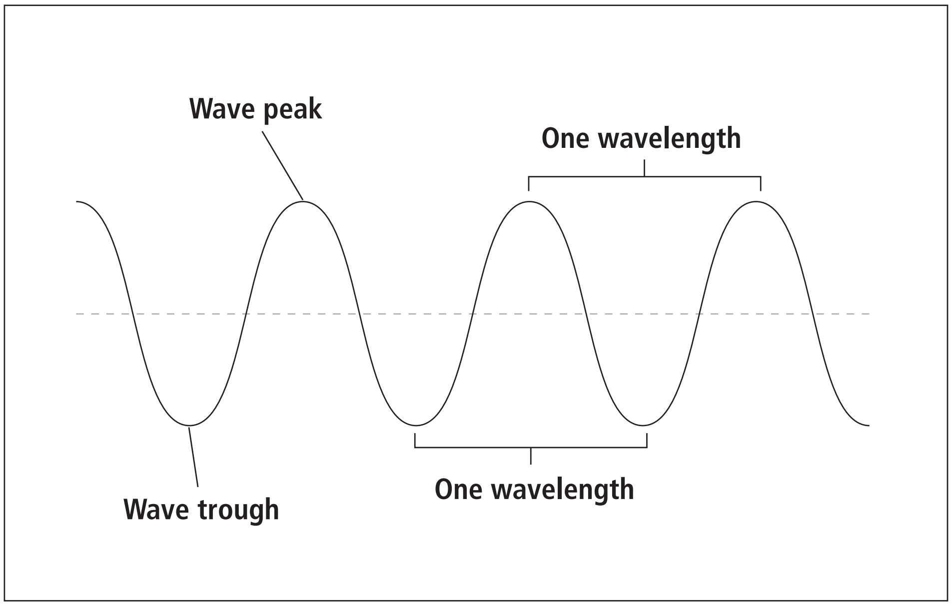


Diagram 5.14
Sound wave patterns showing a wavelength.

- **Frequency** — This is the number of wavelengths that pass a point in one second. Frequency is measured in hertz (Hz). The frequency of a sound is linked to its pitch. Pitch is the way a sound wave sounds to the person hearing it. High pitch sounds, such as squeaks and squeals have a high frequency. The wave patterns of high frequency waves look pushed together.

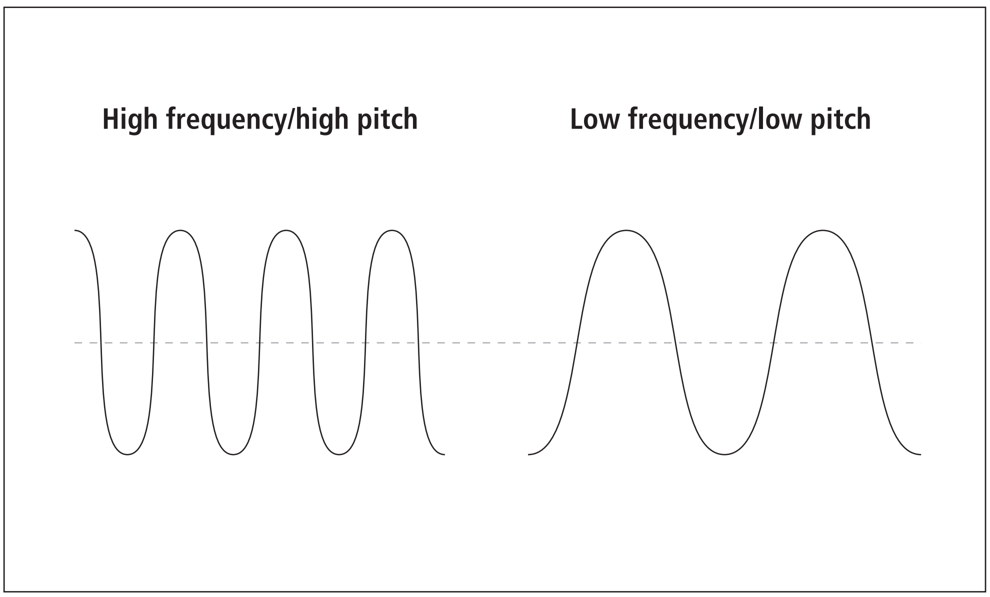


Diagram 5.15
Sound wave patterns showing different frequencies.

Activity 8 Properties Of Sound Waves

Aim To record information on properties of sound waves.

1. What speed does sound travel in air?
2. Why does sound travel at different speeds in different mediums?
3. Draw and label diagrams to show the means of the following properties of sound waves:
   a. Amplitude.
   b. Frequency.
   c. Wavelength.
4. What unit is frequency measured in?
5. What does a high pitched sound wave sound like?

How We Hear Sounds

When we hear sounds the sound waves come into the auditory canal of the outer ear.The sound waves hit the ear drum and are then transferred through the bones of the middle ear and on to the oval window.The oval window is a membrane that vibrates.The vibrations cause movement in the fluid in the cochlea.The movement bends small sensory hairs and sends messages to the brain which we interpret as sounds.

The human ear can hear sounds with frequencies between 15 hertz and 20 000 hertz. Sound at frequencies of 20 hertz are heard as a low rumble and at 18 000 Hz the sound would be a high-pitched squeak. Sounds with frequencies above 20 000 Hz are called **ultrasonic** because they are above what people can hear. Sounds with frequencies below 15 Hz are called **subsonic** because they are below what people can hear. Dogs can hear sounds that are ultrasonic to people.

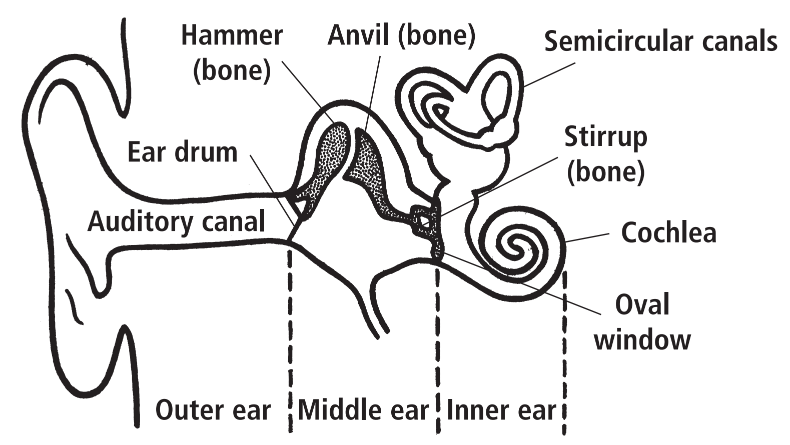


Diagram 5.16
Structure of the ear.

Activity 9 Hearing Sounds

Aim To record information about hearing sounds.

1. Put the following in the order that sounds travel through when we hear sounds:

hammer	cochlea	anvil
auditory canal	ear drum	oval window
stirrup		

2. What happens to the vibrations when the sounds reach the cochlea?
3. What frequency sound waves can people hear?
4. What is the name given to sounds that have a frequency too low for people to hear?

Making Music

Making music depends on making something vibrate. Guitars have strings that vibrate. Drums vibrate when they are hit. Trumpets and saxophones, when blown, become filled with vibrating air.

Three features of musical instruments change the sounds that the instruments make. These are:

1. Longer or larger objects vibrate with lower frequencies. The longer piano strings sound the lower notes.
2. Lighter strings vibrate faster. The lighter nylon strings on a guitar give the higher frequency notes.
3. Tighter strings vibrate faster. Some strings on a guitar are tighter than others.

When you blow across the top of an empty bottle the air inside the bottle vibrates and makes a sound. If different amounts of water are added to the bottle it changes the amount of air in the bottle and therefore the note produced. With a higher amount of air in the bottle, the air vibrates slowly, and the note is low.

When you tap against a bottle containing water, you make the water and the bottle vibrate instead of the air. Bottles with a small amount of water produce high notes and bottles with a lot of water produce low notes.

Activity 10 Making Your Own Music

Materials needed:
Eight bottles, the same size and shape;
Water;
Metal spoon.

Aim To investigate making music

Try one of the following:

Bottle organ

1. Put eight bottles in a line.
2. Fill the first bottle with water almost to the top, leaving just a little air above the water
3. Put a little less water in the next bottle, then a little less again in the third bottle. The last bottle should have just a small amount of water in the bottom and a lot of air above.
4. Blow across the top of each bottle. Which bottle makes the highest pitch note? Which bottle makes the lowest pitch note?
5. Tap each bottle gently with a metal spoon. What happens to the notes that you hear?
6. Experiment making sounds and tunes. Write numbers on the bottles then write down the music you make by recording the bottle number.

String pitch

1. Tie a long piece of string to the leg of a table.
2. Tie the other end of the string to a weight and hang it over the table's opposite side so that the string is lying tight across the table.
3. Put a thick pen under the string so that the string is slightly raised above the table top. Pluck the string and listen for the sound produced.
4. Move the pen to various positions under the string, plucking the string each time. When does the string make low-pitched sounds? When does the string make high pitched sounds? What causes the differences in pitch?
5. Try one of the following investigations:
   a. What happens when you use a thicker string?
   b. What happens when you use a thinner string?
   c. What happens when you use a heavier weight on the end of the string?
   d. What happens when you use a lighter weight on the end of the string?
   e. Repeat the investigation using a rubber band stretched around a book. Place two pencils under the rubber band.
6. Design a musical instrument on which you can play various notes.

Unit summary

- Heat energy moves from hot areas to cold areas.
- Temperature is a measure of the average kinetic energy of the particles in a material.
- Heat energy is transferred from one place to another by conduction, convection and radiation.
- During conduction heat energy is passed from one particle to the next. When a particle gains heat energy it vibrates more quickly. The particle bumps into the next particle and passes some heat energy to it.
- Convection currents occur in liquids and gases. When particles at the bottom gain heat energy they move apart and this causes them to rise. Colder, more dense material moves down to replace the warmer material.
- Radiation transfers heat energy as electromagnetic radiation. Radiation can travel through a vacuum.
- Shiny objects reflect radiation and dull, dark objects absorb radiation. When an object absorbs radiation its temperature rises.
- Insulators are materials that slow down heat transfer by conduction, convection and radiation.
- Equipment used by people are designed to take advantage of, or slow down, heat transfer. Fridges and freezers are designed to stop heat transfer and keep food cold or frozen.
- Sound is a form of energy made by vibrating objects.
- Sound travels as longitudinal waves through a medium that has particles such as solids, liquids and gases.
- An echo is a reflected sound wave.
- Properties of sound waves include speed, amplitude, wavelength and frequency.
- The speed of sound changes with the medium it is travelling through.
- The amplitude is the size of the wave. The larger the amplitude the louder the sound.
- Wavelength is the length of the repeating pattern of the sound wave.
- Frequency is the number of wavelengths that pass a point in one second. High frequency waves have a high pitch.
- Our ears are designed to allow us to hear sound waves with frequencies between 15 and 20 000 hertz.
- Musical instruments are used to make different sounding notes: longer or larger objects vibrate with lower frequencies. Lighter strings vibrate faster. Tighter strings vibrate faster.

Unit 6: SPEEDING OBJECTS AND PRESSURE

Introduction

In this unit, you will investigate the speed of moving objects and how pressure is used in everyday objects.

Look at the picture of a car. To describe the way it is moving you could say it is going fast. To know how fast the car is moving you need to measure its speed. Looking at the speedo reading will tell you the speed of the car at the moment you looked. The speed over a longer time can be calculated.

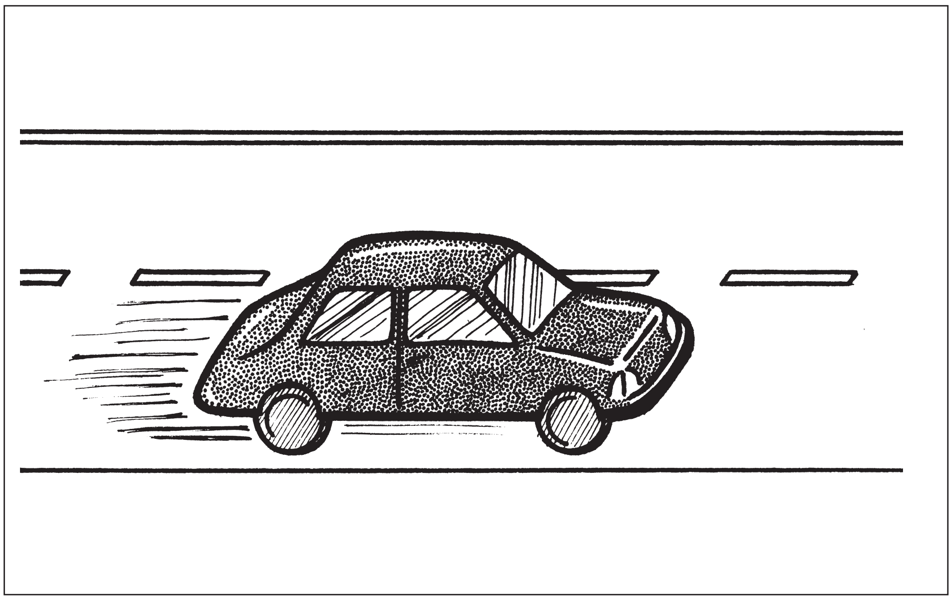


Diagram 6.1
A speeding car.

Distance And Time

The way an object is moving can be described using time and distance. In science, symbols are used instead of writing the words. Both time and distance can be measured in different units. The table below gives the symbols and common units for time and distance used in science. All these symbols are written in lower case letters.

Quantity	**Symbol**	**Measured in**	**Unit**
Time	t	seconds	s
		minutes	min
		hours	h
Distance	d	centimetres	cm
		metres	m
		kilometres	km

- 60 seconds = 1 minute and 60 minutes = 1 hour.
- 100 centimetres = 1 metre and 1000 metres = 1 kilometre.

Speed

How quickly or how slowly an object is traveling depends on the distance it travels and the time it takes to travel that distance. This is called the objects average speed. Usually it is the average speed over a whole journey or parts of the journey that we are working out. The symbol for average speed is:

$$\mathbf{v_{av}}$$

The formula used to work out average speed is:

$$\text{Average speed} = \frac{\text{distance travelled}}{\text{time taken}} \qquad v_{av} = \frac{d}{t}$$

The units for speed match the units used to measure distance and time.

Distance unit	**Time unit**	**Speed unit**
Centimetre or cm	second or s	centimetres per second, cm/s, or cm s^{-1}
Metre or m	second or s	metres per second, m/s, or m s^{-1}
Kilometre	hour or h	kilometres per hour, km/h, or km h^{-1}
Kilometre	minute or min	kilometres per minute, km/min, or km min^{-1}

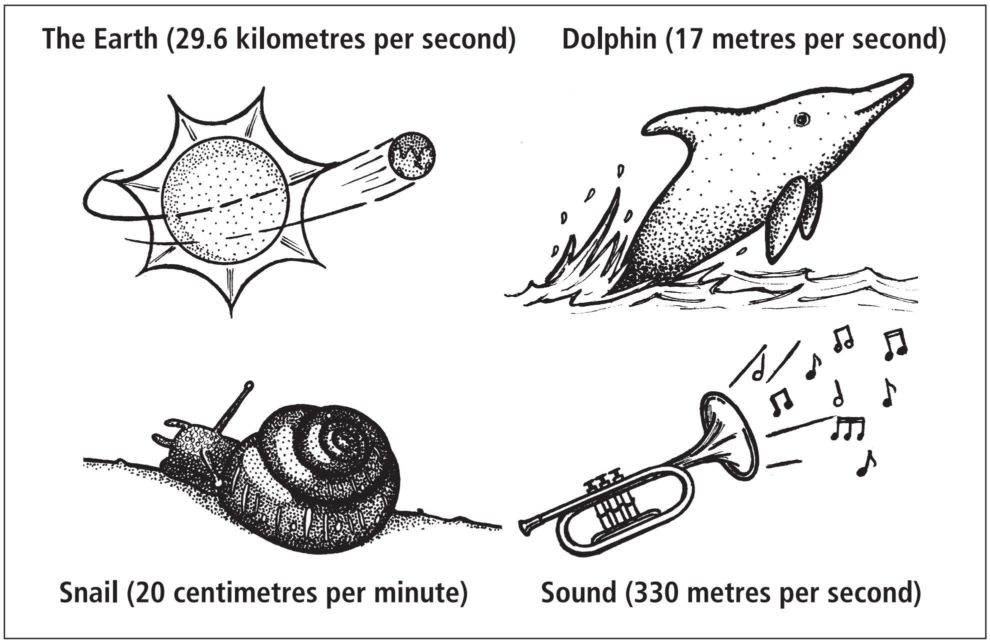


Diagram 6.2
Examples of speeds.

Working Out Average Speed

To work out the average speed of an object always use the following steps:

Step 1 The **data** given in the problem.

Step 2 The **formula** being used.

Step 3 A **working** step that shows the distance and time in the formula.

Step 4 The **answer** and the correct **units** for speed.

For example, to work out the average speed of a boat that moved 20 metres in 5 seconds, you would complete the steps as follows:

Step 1 What is the data: d = 20 m, and t = 5 s

Step 2 What is the formula: $v_{av} = \frac{d}{t}$

Step 3 The working: $v_{av} = \frac{20}{5}$

Step 4 The answer and units: $v_{av} = 4$ m/s

In this example the boat was moving 4 metres each second or 4 m/s. The speed converter on the next page (Diagram 6.3) can be used to change this speed from metres per second to kilometres per hour. To do this run your finger up the right hand side of the converter until you get to the speed in metres per seconds, then read the kilometre per hour speed on the left hand side. You should find that the speed is about 14 km/h.

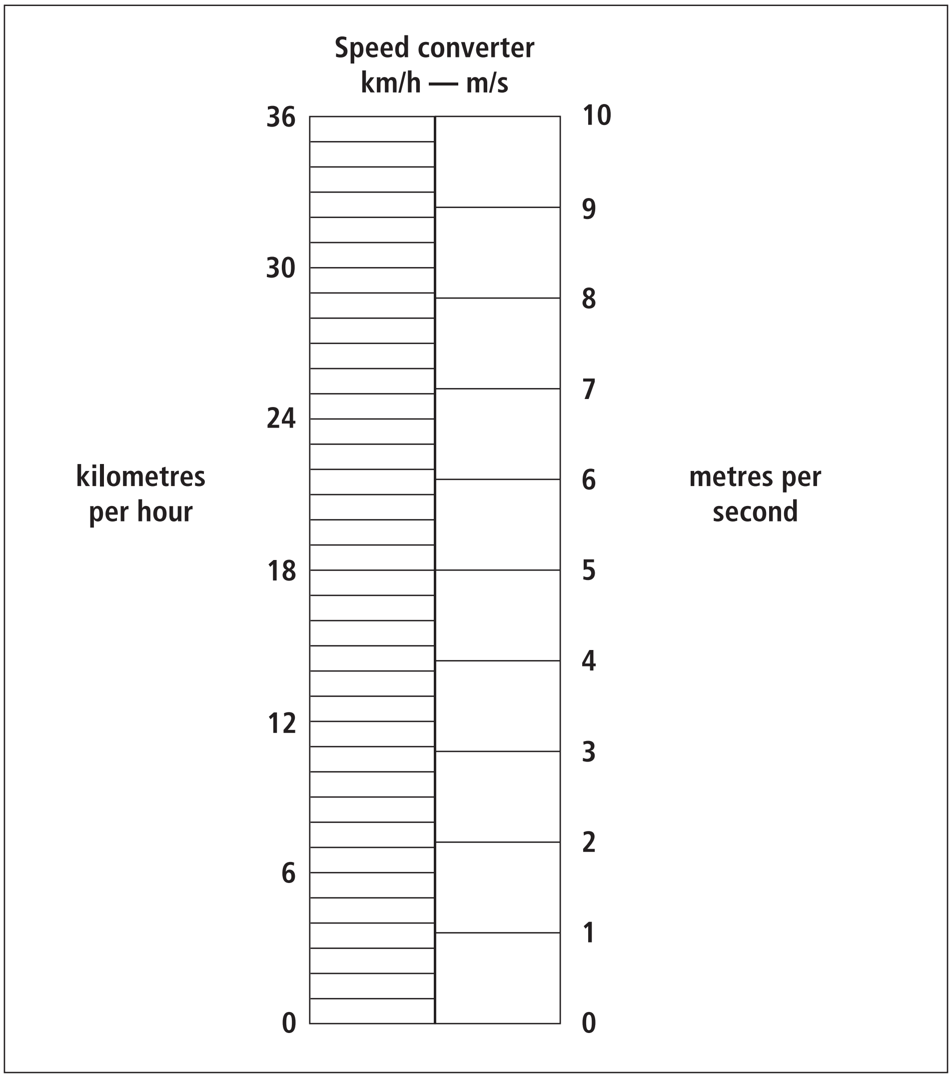


Diagram 6.3
Speed converter.

Usually in science, we work out speeds in metres per second or kilometres per hour. Sometimes the units need to be changed before we begin the calculation. For example if the distance given was 500 cm and the time was 2 minutes, then:

a. There are 100 centimetres in 1 metre so 500 cm = 5 m

b. There are 60 seconds in a minute so 2 min = 120 s

Activity 1 Working Out Average Speed

Aim To record information about distance, time and speed.

1. Write the title 'Time and distance', then copy the table showing the symbols and units used in science for time and distance.
2. What is the meaning of the term 'average speed'?
3. Record the formula used to work out average speed.
4. Copy the table showing the units for distance, time and speed.
5. Write out the four steps that are followed when calculating the average speed of an object.
6. Use the four steps to calculate the average speed of a person on a bike that goes 30 metres in 5 seconds. Use the speed converter to work out the speed of the person in km/h.
7. Use the four steps to calculate the following speeds in m/s and then use the speed converter to change the speed to km/h.
   a. Siti ran 80 metres in 10 seconds.
   b. May took 12 seconds to walk 24 metres.
   c. Sa biked 1 kilometre in 100 seconds. Remember to convert the 1 kilometre to metres before you start.
   d. Dylan drove his car 2400 metres in 2 minutes. Remember to convert the 2 minutes into seconds before you start.

Activity 2 Walking Speed

Materials needed:
Way of measuring distance, tape measure or stepping out;
Clock, watch, stopwatch or count seconds by counting 1000, 2000, 3000, 4000, etc.

Aim To investigate how fast you walk.

1. You are to work outside to find out the time it takes to walk 20 metres. Copy the following table so that you can record your results in it.

Time taken to walk 20 metres			
Trial	**Distance (m)**	**Time (s)**	**Speed (m/s)**
1			
2			
3			
		Average	

2. Go outside and measure a distance of 20 metres.
3. Get someone to time how long it takes you to walk 20 metres.
4. Write the distance and time for your first trial in the table.
5. Measure the time it takes to walk 20 metres two more times. Record this information in the table.
6. Calculate the speed for each trial.
7. Calculate the average of the speeds over the three trials by adding up the three speeds and then dividing the total by three.
8. Collect and organize into a table the class data for average speed when walking.

Activity 3 Human Speeds

Materials needed:
Way of measuring distance, tape measure or stepping out;
Clock, watch, stopwatch or count seconds by counting 1000, 2000, 3000, 4000, etc.

Aim To investigate jogging and running speeds for members of the class.

1. Work in groups. Use the instructions in activity 2 to plan how you will collect and record distance and time data so that you can work out the average of each persons speed when they are jogging (slow running) and running.
2. Collect and organize into a table the class data for average speed when jogging and running.

Activity 4 How Fast?

Materials needed:
Way of measuring distance, tape measure or stepping out;
Clock, watch, stopwatch or count seconds by counting 1000, 2000, 3000, 4000, etc.

Aim To investigate the speed of an object.

Plan and carry out an investigation that will give you the information needed to calculate the average speed of an object. Ideas for investigation:

- A person biking.
- Cars on the road.
- A person paddling a boat.
- A ball being thrown.
- A ball rolling down a slope.
- A ball being hit by a bat.

Calculating Distance And Time

If we know the speed of an object and the time it is moving, we can work out the distance it will travel in that time. For example if a car is travelling at 20 km/h for 2 hours we know that in the first hour it will travel 20 kilometres and then another 20 kilometres in the second hour.

20 + 20 = 40 so the car will travel 40 kilometres.

If the car is traveling at 5 m/s, how far will it travel in 100 seconds?

5 m/s × 100 seconds = 500 m

We can also use the average speed formula to work out the time it will take an object to travel a distance at a particular speed. For example, how long will it take a car traveling at 20 km/h to travel 60 kilometres?

60 km ÷ 20 km/h = 3 h

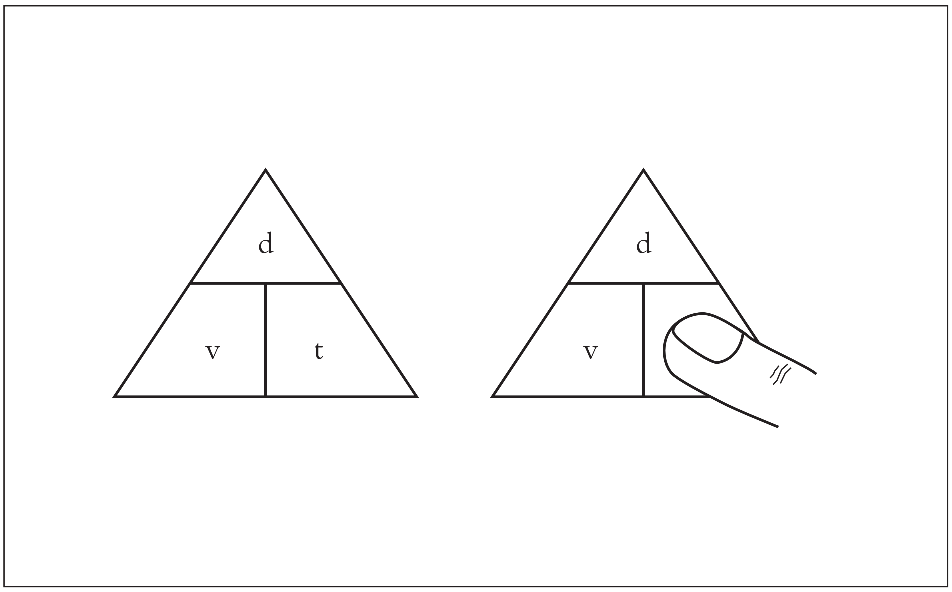


Diagram 6.4
Average speed formula triangle.

Use the speed formula triangle to find the formula to calculate time:

Step 1 Place your finger over the t.

Step 2 Read the formula from the triangle, t = d ÷ v

Use the speed formula triangle to find the formula to calculate distance:

Step 1 Place your finger over the d.

Step 2 Read the formula from the triangle, d = v × t

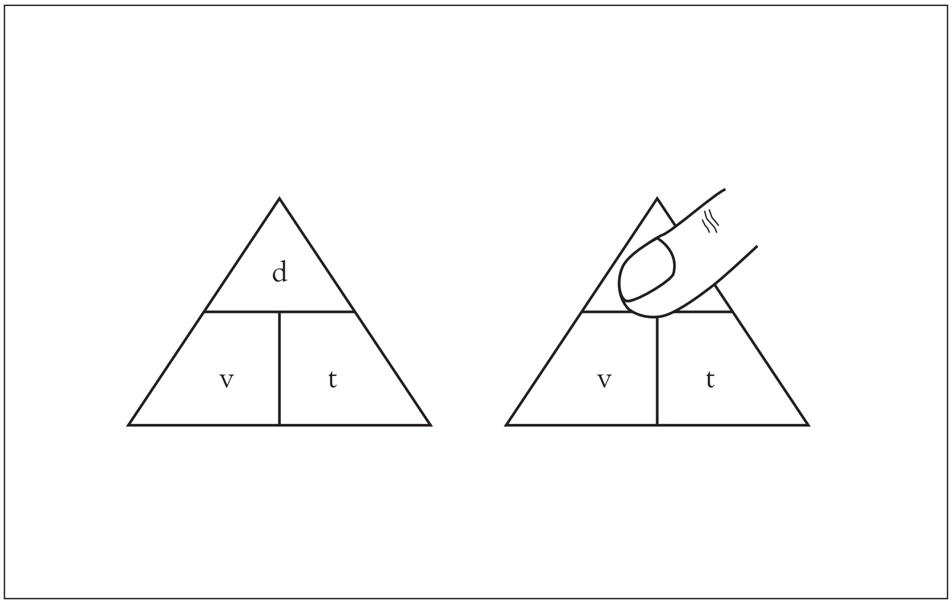


Diagram 6.5
Working out the formula for distance.

To work out the units for distance and time you will need to look carefully at the unit for the speed. For example, if the speed is in m/s then distance is in metres and time is in seconds. If the speed is in km/min then the distance will be in kilometres and the time will be in minutes.

Activity 5 Calculating Distance And Time

Aim To use the average speed formula to calculate distance and time.

1. Copy out the following steps to use when calculating distance and time from the average speed formula:

Step 1 Write down the **data** given in the problem.

Step 2 Use the average speed triangle to work out the formula to use.

Step 3 Write down the **formula** being used.

Step 4 Write down the **working** step that shows the data in the formula.

Step 5 Write down the **answer** and the correct **units**. You will need to look carefully at the units for speed to work out the unit for distance and time.

2. Complete the following using the above listed previously:
   a. Teuila's running speed is 6 m/s. What distance can she run in 10 seconds?
   b. Vi's jogging speed is 5m/s. What distance will he go in 20 seconds?
   c. A horse moves at 16 m/s. How far will it go in 300 seconds?
   d. A coconut crab travels at 1 cm/s. How far will it go in 5 seconds?
   e. A bus travels at 30 km/h. How far will it go in 1 hour?
   f. A bus is moving 30 km/h. How far will the bus go in 0.5 hour?
   g. Sharon walks at 1 m/s. How long would it take her to walk 1000 metres?
   h. Tama jogs at 5 m/s. How many seconds will it take her to jog 2000 metres?
   i. Elaine is driving at 20 m/s. How long does it take her to drive 2000 metres?
   j. A coconut crab moves at 1 cm/s. How long does it take to travel 20 centimetres?
   k. A coconut crab travels at 10 cm/s. How long does it take to travel 20 centimetres?

Describing Movement

One way to record the movement of an object is to describe it in words.

> For example: the bus was stopped for 20 seconds, then it sped up until it reached 20 km/h. This took 60 seconds. It then travelled at 20 km/h for 40 seconds, then sped up to 50 km/h in 40 seconds. It travelled at 50 km/h for 40 seconds then took 60 seconds to slow down to a stop.

This information can also be shown in a graph. A graph of speed against time is called a speed-time graph. The speed-time graph on the next page shows the journey of the bus shown above.

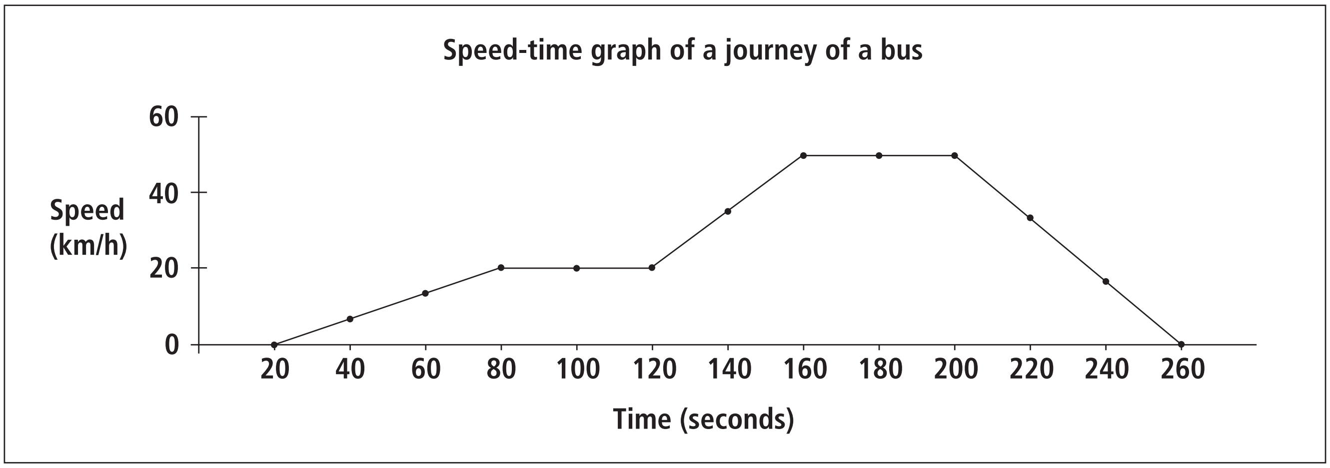


Diagram 6.6
Speed-time graph of a journey of a bus.

The shape of a speed-time graph shows what is happening to the moving object.There are four main types of movement shown on speed-time graphs. These are:

- **Stopped**.
- Staying at the same or steady speed, called **constant speed**.
- Speeding up or increasing speed, called **acceleration**.
- Slowing down or decreasing speed, called **deceleration**.

Each of the following speed-time sketch graphs shows one of these different types of movement. Sketch graphs have no numbers on the axis because they are used to show what the different shaped lines means.

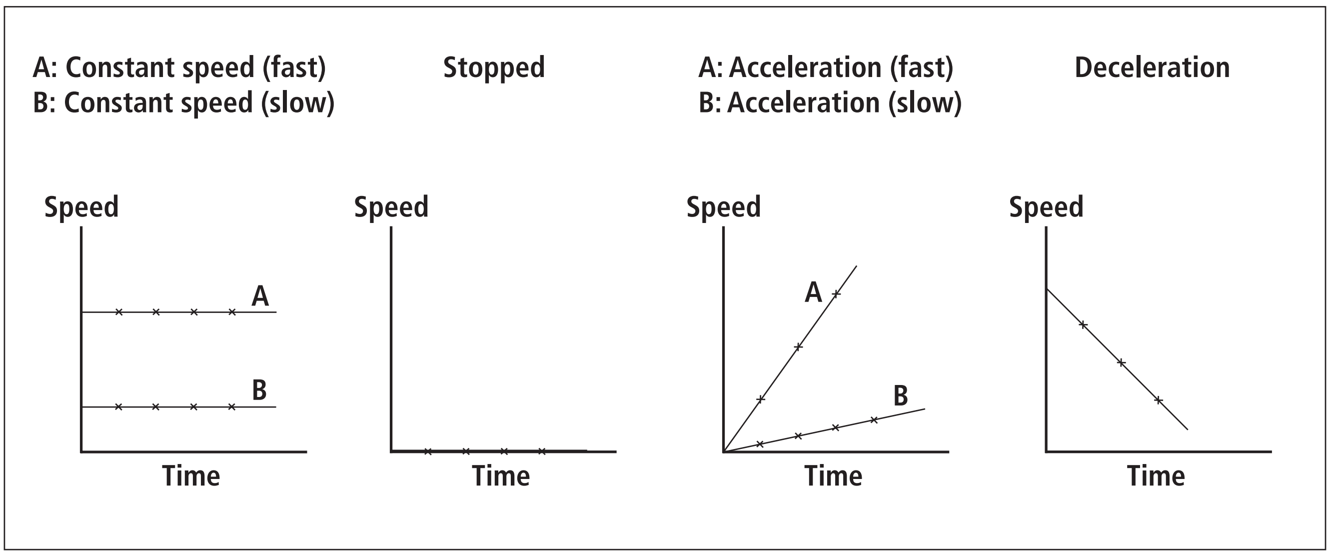


Diagram 6.7
Speed-time graphs.

Activity 6 Speed–Time Graphs

Aim To describe movement of objects using words and graphs.

1. Copy the speed-time graphs in Diagram 6.7 into your exercise book.
2. Describe the bus journey in Diagram 6.6 using the words constant speed, stopped, acceleration and deceleration.
3. a. Draw a speed-time graph of the information in the table.

Time (s)	0	10	20	30	40	50	60	70	80	90
Speed (m/s)	2	2	4	8	8	8	8	4	4	0

   b. Describe the way the object is moving.

4. a. Draw a speed-time graph of the information in the table.

Time (s)	0	10	20	30	40	50	60
Speed (km/h)	50	50	45	40	45	47	50

   b. Describe the way the object is moving.

5. Measure the speed of different objects and then draw graphs of the movement. Describe the movement of the object using the words constant speed, stopped, acceleration and deceleration.
6. Use the words constant speed, stopped, acceleration and deceleration to describe the movement of objects and people. For example a ball being kicked, a bus journey, walking to school.

Distance–Time Graphs

Distance-time graphs show how far an object moves in each block of time.

Time (s)	0	10	20	30	40	50	60
Distance (m)	0	3	6	9	9	11	13

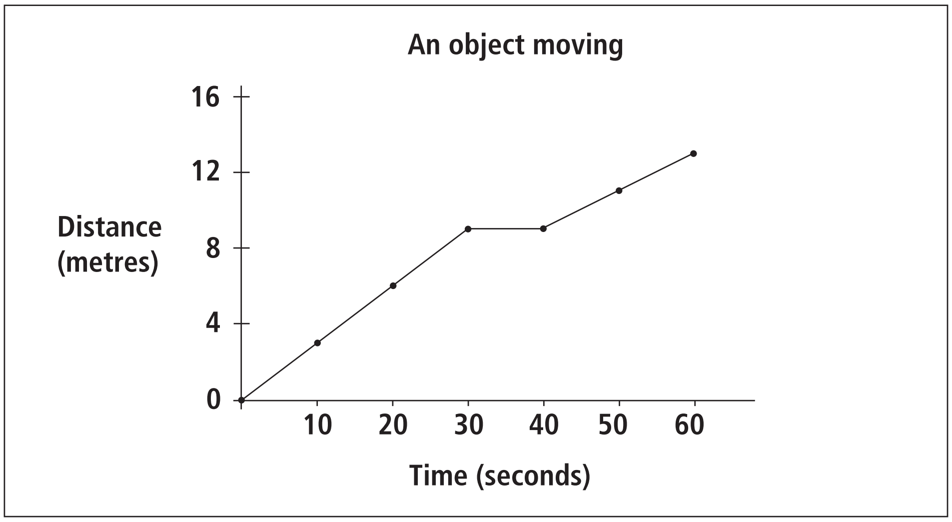


Diagram 6.8
Distance-time graph of a moving object.

The shape of a distance-time graph shows what is happening to the speed of a moving object. The four main types of movement shown on speed-time graphs are also shown on distance-time graphs but the shape is different. The sketch graphs below show what stopped, constant speed, acceleration, and deceleration look like on a distance-time graph.

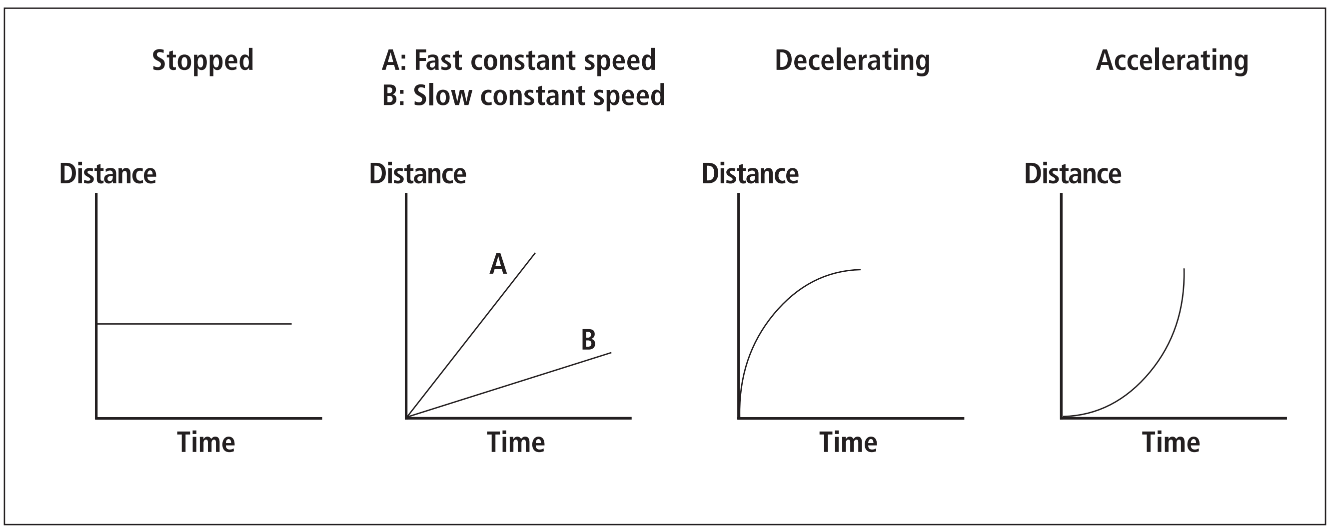


Diagram 6.9
Distance-time graphs.

Activity 7 Distance–Time Graphs

Aim To describe movement of objects using words and graphs.

1. Copy the distance-time graphs in Diagram 6.9 into your exercise book.
2. Describe the movement of the object in Diagram 6.8.
3. The graphs below show the journeys of two cars. Describe the movement of cars A and B. During which section of the graph is each car moving the fastest?

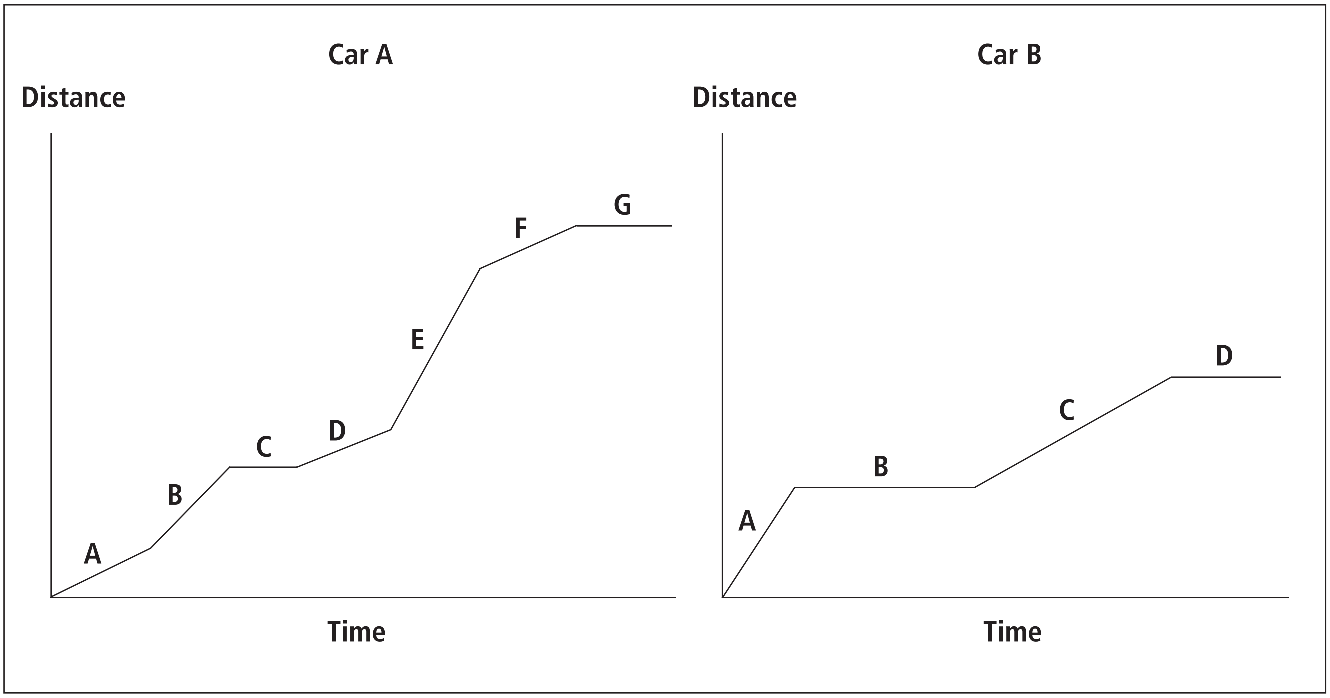


Diagram 6.10
Distance-time graphs of two car journeys.

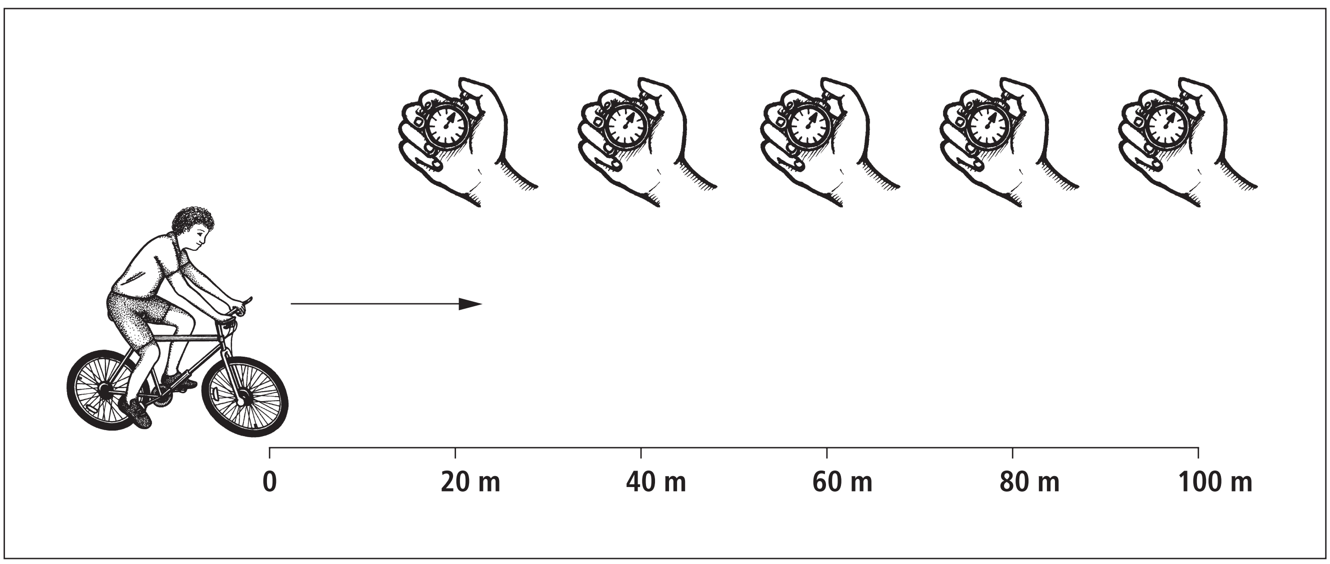


Diagram 6.11
Timing a person biking.

4. A class collected distance time information from a person biking.

Time (s)	0	9	15	18	19	20
Distance (m)	0	20	40	60	80	100

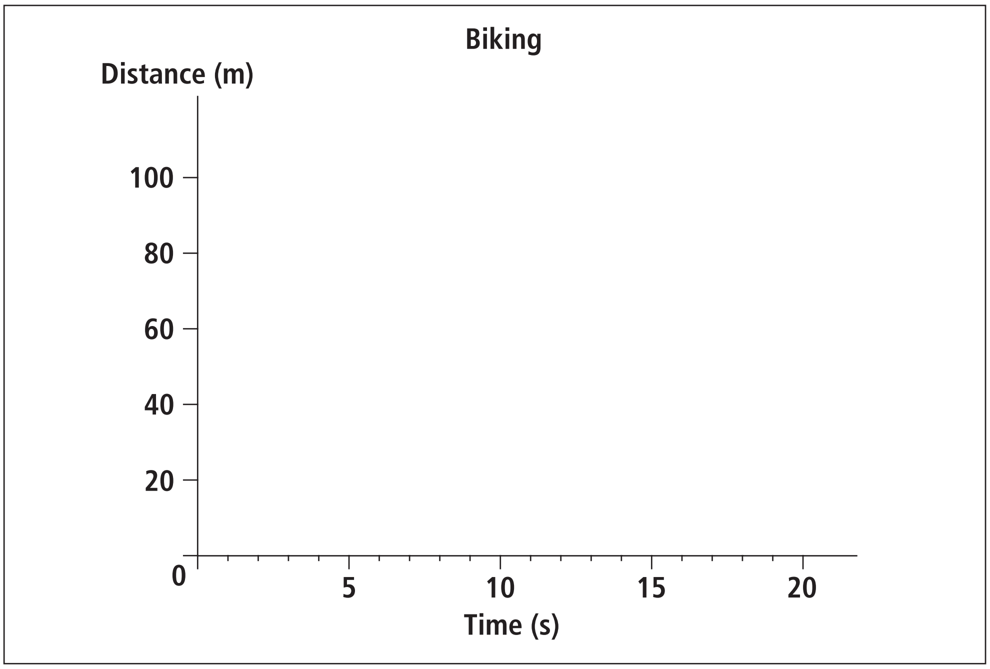


Diagram 6.12
Distance-time graph.

5. Copy Diagram 6.12 and then plot these results to make a distance-time graph.
   a. Describe the movement of the bike from 0 to 18 seconds.
   b. Describe the movement between 18 and 20 seconds.
   c. Use the formula below to work out the average speed of the bike between 18 and 20 seconds.

$$\text{Average speed} = \frac{\text{distance travelled}}{\text{time taken}} \qquad v_{av} = \frac{d}{t}$$

6. Use the formula to work out the average speed of the bike over the whole journey.
7. Plan and carry out different investigations to measure distance and time. See ideas for investigations on the next page.
   a. Use the data collected to draw a distance-time graph.
   b. Describe how the object moves.
   c. Calculate the average speed over the whole journey.

Possible investigations could include:

- One or more people biking.
- Rolling or kicking a ball.
- A horse walking and trotting.
- People walking, skipping, jogging or running.
- Buses or cars on the road.
- A boat moving.
- A turtle or fish swimming.

Pressure

Gases and liquids are made up of a large number of very small molecules that are always moving. The molecules frequently collide with each other and with the walls of the container they are in. When the molecules collide with the walls of a container, the molecules cause a force on the wall. The sum of the forces of all the molecules striking the wall divided by the area of the wall is called pressure.

$$\text{Pressure (p)} = \frac{\text{force}}{\text{area}}$$

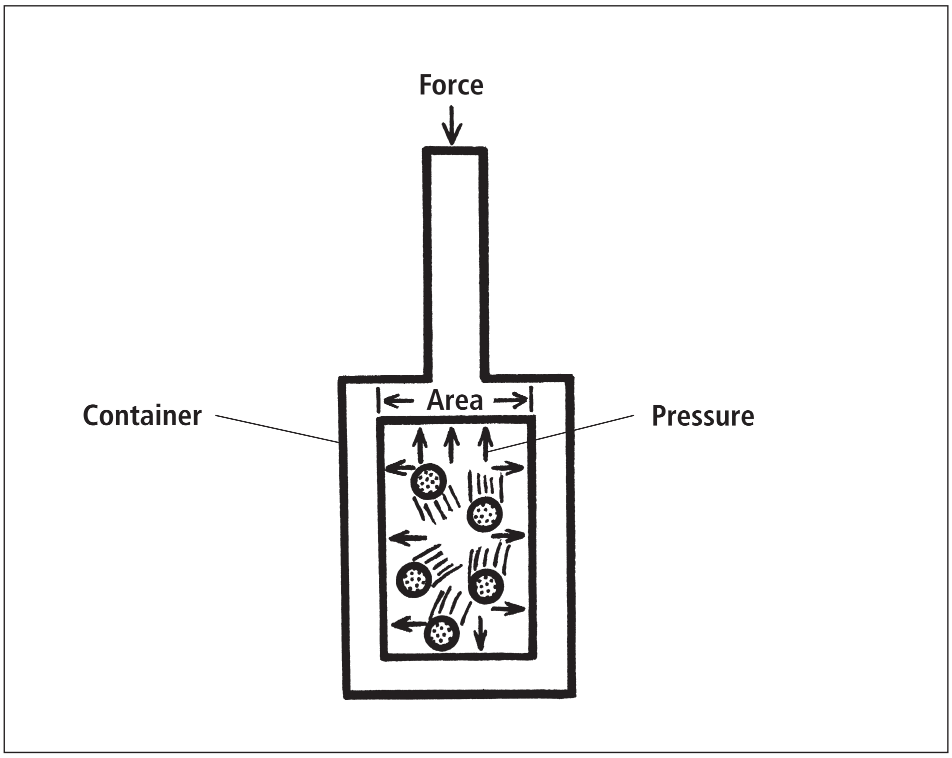


Diagram 6.13
Pressure of a gas on its container.

Pressure is important in bike and car tyres, balloons and balls used in netball, basketball, rugby and soccer. Air is pumped into tyres, balloons and balls and this increases the pressure that the air molecules cause on the inside of the object, making it firmer. If some of the air gets out of the tyre or ball it goes 'flat' which is a way people describe something that has lower pressure. Tyres and balls do not work as well when they have lower pressure.

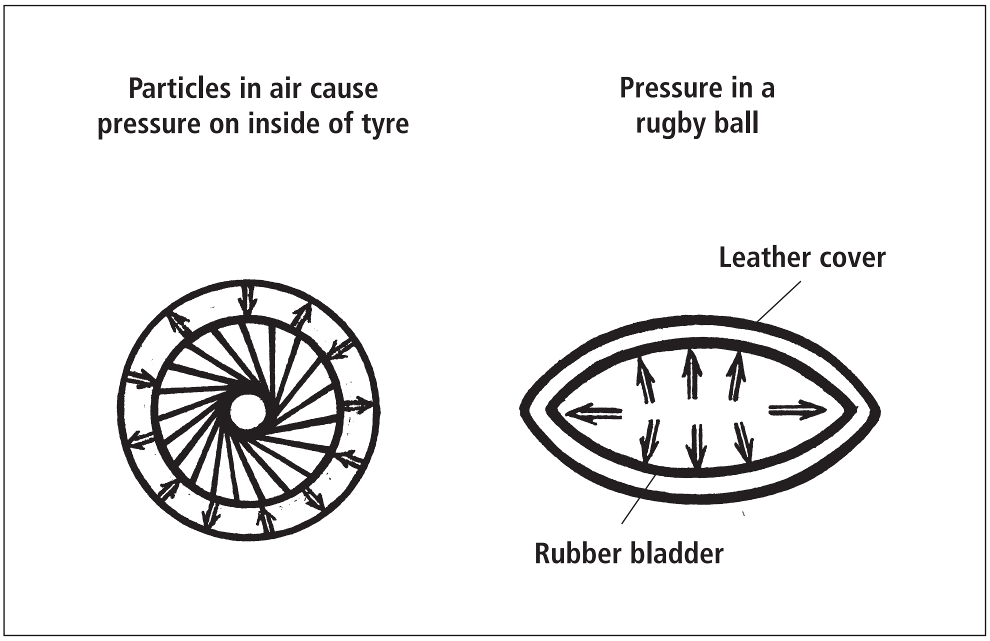


Diagram 6.14
Pressure in a tyre and ball.

People use water systems made up of pumps and pipes or hoses to move water from place to place. Taps are used to turn the flow of water on and off. Sometimes the pressure of the water in the water system is high so that when the tap is turned on completely the water flows out quickly. People increase the pressure of water in hoses by putting their fingers over the end of the hose and making the water squirt out quickly.

The difference in pressure on the top and bottom surfaces of aeroplane wings is what causes the lift forces that allow aeroplanes to fly. The wings are shaped in a way that lets the air move more quickly over the top surface which causes a lower pressure on the top of the wing. The pressure under the wing is higher and this pushes the wing up.

Another example of pressure and its effect can be found in the use of handles on objects such as buckets and pots. If a bucket has a thin handle, then when it is full the force per area or pressure on the person's hand is high. If the handle is wider the force per area is smaller and the handle is much more comfortable to hold.

Activity 8 Pressure

Aim To record information about pressure and investigate its effects.

1. What causes pressure in gases and liquids?
2. Work in groups. Record as many different examples of pressure as you can.
3. Select an example of pressure that you can investigate. For example you could investigate pressure in balloons and answer questions such as:

- How many puffs of air does it take to fill a balloon?
- How does the shape of the balloon change with increased pressure as it is being filled with air?
- How quickly can you increase the pressure inside the balloon?
- How does squeezing the balloon change the pressure?

Unit summary

- The way an object is moving can be described using distance and time.
- The symbol for distance is d. Distance can be measured in centimetres (cm), metres (m) and kilometres (km).
- The symbol for time is t. Time is measured in seconds (s), minutes (min) and hours (h).
- The formula used to work out average speed is:

$$\text{Average speed} = \frac{\text{distance travelled}}{\text{time taken}} \qquad v_{av} = \frac{d}{t}$$

To work out the average speed of an object always write down:

Step 1 The **data** given in the problem.

Step 2 The **formula** being used.

Step 3 A **working** step that shows the distance and time in the formula.

Step 4 The **answer** and the correct **units** for speed.

- Distance can be calculated using the formula:

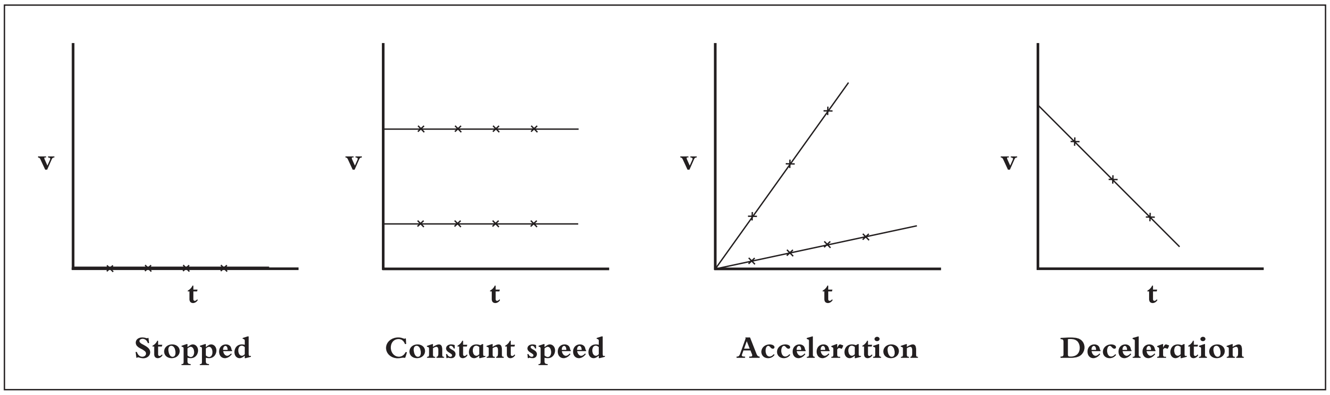
$$\text{Distance} = \text{average speed} \times \text{time} \qquad d = v_{av} \times t$$

- Time can be calculated using the formula:

$$\text{Time} = \frac{\text{distance travelled}}{\text{average speed}} \qquad t = \frac{d}{v_{av}}$$

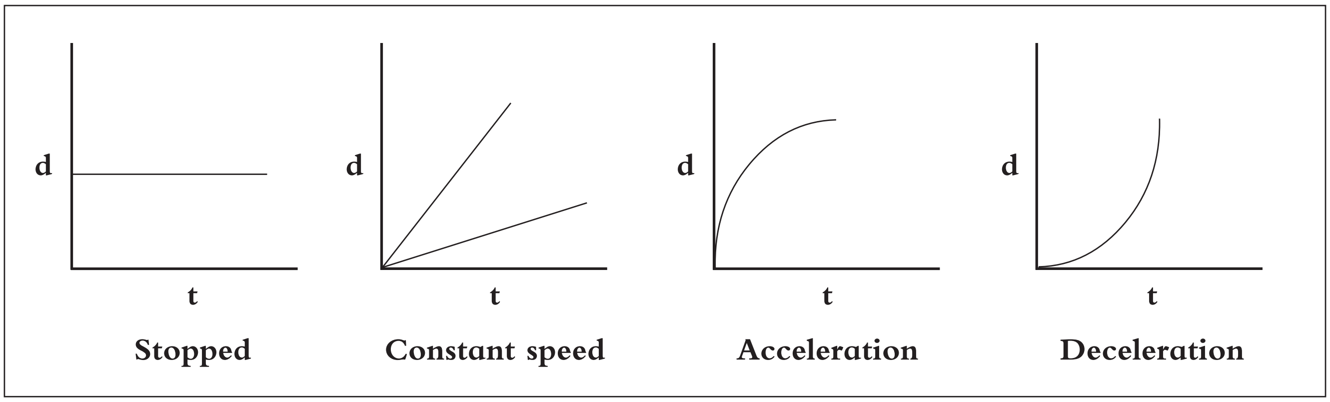
- Summary — speed time graphs.

Movement of an object can be shown in a speed-time graph.



- Summary — distance-time graphs.

Movement of an object can also be shown in a distance-time graph



- Pressure is the force per area. The molecules in gases and liquids pushing on the sides of the container cause pressure.
- Bike and car tyres use air pressure inside the tyres to make the ride smoother. Basketballs bounce because of the pressure inside the ball.

APPENDIX I: THE MILKY WAY

The Milky Way is the galaxy which is the home of our solar system together with at least 200 billion other stars (more recent estimates have given numbers around 400 billion) and their planets, and thousands of clusters and nebulae.

As a galaxy, the Milky Way is actually a giant, as its mass is probably between 750 billion and one trillion solar masses, and its diameter is about 100 000 light years.

http://www.seds.org/messier/more/mw.html

Our own galaxy consists of about 200 billion stars, with our own sun being a fairly typical specimen. It is a fairly large spiral galaxy and it has three main components: a disk, in which the solar system resides, a central bulge at the core, and an all encompassing halo.

Disk
The disk of the Milky Way has four spiral arms and it is approximately 300 pc thick and 30 000 pc in diameter. It is made up predominantly of *Population I* stars which tend to be blue and are reasonably young, spanning an age range between a million and ten billion years.

Bulge
The bulge, at the centre of the galaxy, is a flattened spheroid of dimension 1000 pc by 6000 pc. This is a high density region where *Population II* stars predominate — stars which tend toward red and are very old, about ten billion years. There is growing evidence for a very massive black hole at its centre.

Halo
The halo, which is a diffuse spherical region, surrounds the disk. It has a low density of old stars mainly in globular clusters (these consist of between 10 000–1 000 000 stars). The halo is believed to be composed mainly of dark matter which may extend well beyond the edge of the disk.

http://www.damtp.cam.ac.uk/user/gr/public/gal_milky.html

Our galaxy is only one of billions of other galaxies in the universe, but it is special to us, because it is home to Earth and our solar system. The Milky Way has been studied extensively by astronomers, and today our ideas about it's nature are set on a more firm foundation. Here we set out to examine what this faint band of light is, where it came from, and where Earth and the Sun fit into the picture.

The birth of our Galaxy

Long before the Sun and the solar system formed, before the galaxy existed, the universe was filled with gas — mainly hydrogen, with some helium. This gas was eventually to be turned into stars, planets and people. But before these things could happen, the galaxy had to form.

Astronomers believe that the galaxy formed out of a large, fairly spherical cloud of cold gas, rotating slowly in space. At some point in time, the cloud began to collapse in on itself, or condense, in the same way that the clouds which formed individual stars also condensed. Initially, some stars may have formed as the gas cloud began to fragment around the edges, with each fragment condensing further to form a star or group of stars. Because the cloud was spherical at that time, we do see some very old stars distributed in a spherical halo around the outside of the galaxy today. At such early times, these stars consisted only of the hydrogen and helium gas which made up the cloud.

The cloud continued to collapse, with more and more stars being formed as it did so. Since the cloud was rotating, the spherical shape began to flatten out into a disc, and the stars which were formed at this time filled the disc regions. Once again we see this shape today in the main body of the galaxy. As the formation of new stars continued, some of those which had been created earlier had enough time to evolve to the end of their active lifetimes, and these stars began to shed their atmospheres or explode in huge supernova events. In the process, these older citizens of the still young galaxy enriched the gas in the cloud with the new, heavier elements which they had formed, and the new stars being created in the disc regions contained the heavier elements. Astronomers call these younger, enriched stars *Population I* stars, and the older stars *Population II*.

This process of star formation, then manufacturing heavier elements inside stars and finally returning these elements into the gas between the stars (called the interstellar medium) continued, as it still does today, all the time enriching the medium so that today the gas within our galaxy consists not only of Hydrogen and Helium, but also the other elements which are needed to form the Earth and the rest of the universe we see around us.

The Milky Way today

The Milky Way galaxy in which we now live is a very different place to the cold gas from which it formed over 16 billion years ago. No longer is it a spherical mass of hydrogen; today astronomers with radio telescopes have charted the clouds of gas and have found that the Milky Way is a Spiral Galaxy, one of countless others. Whilst we can't 'stand back' and see our galaxy as a whole, we can look out into space and see other galaxies which we think may be similar to our own.

http://www.star.le.ac.uk/edu/mway/

APPENDIX II: THE SUN

The Sun is an ordinary G2 star, one of more than 100 billion stars in our galaxy.

Diameter: 1 390 000 km.

Mass: 1.989×10^{30} kg

Temperature: 5800 K (surface)

15 600 000 K (core)

The Sun is by far the largest object in the solar system. It contains more than 99.8% of the total mass of the Solar System (Jupiter contains most of the rest).

The Sun is personified in many mythologies: the Greeks called it *Helios* and the Romans called it *Sol*.

The Sun is, at present, about 75% hydrogen and 25% helium by mass (92.1% hydrogen and 7.8% helium by number of atoms); everything else ('metals') amounts to only 0.1%. This changes slowly over time as the Sun converts hydrogen to helium in its core.

Conditions at the Sun's core (approximately the inner 25% of its radius) are extreme. The temperature is 15.6 million Kelvin and the pressure is 250 billion atmospheres. At the center of the core the Sun's density is more than 150 times that of water.

The Sun's energy output (3.86×10^{33} ergs/second or 386 billion billion megawatts) is produced by nuclear fusion reactions. Each second about 700 000 000 tons of hydrogen are converted to about 695 000 000 tons of helium and 5 000 000 tons of energy in the form of gamma rays. As it travels out toward the surface, the energy is continuously absorbed and re-emitted at lower and lower temperatures so that by the time it reaches the surface, it is primarily visible light. For the last 20% of the way to the surface the energy is carried more by convection than by radiation.

The surface of the Sun, called the photosphere, is at a temperature of about 5800 K. Sunspots are 'cool' regions, only 3800 K (they look dark only by comparison with the surrounding regions). Sunspots can be very large, as much as 50 000 km in diameter. Sunspots are caused by complicated and not very well understood interactions with the Sun's magnetic field.

A small region known as the chromosphere lies above the photosphere.

The highly rarefied region above the chromosphere, called the corona, extends millions of kilometres into space but is visible only during eclipses. Temperatures in the corona are over 1 000 000 K.

http://www.seds.org/nineplanets/nineplanets/sol.html

The sun is a star that, by the gravitational effects of its mass, dominates the planetary system that includes the Earth. By the radiation of its electromagnetic energy, the sun furnishes directly or indirectly all of the energy supporting life on Earth, because all foods and fuels are derived ultimately from plants using the energy of sunlight.

'Sun,' Microsoft (R) *Encarta*. Copyright (c) 1994 Microsoft Corporation. Copyright (c) 1994 Funk & Wagnall's Corporation.

APPENDIX III: COMETS

Naked eye appearance

Seeing a comet with the naked eye is a somewhat rare occurrence. On the average we get a naked-eye comet once every five or six years and this includes comets that become barely visible to the naked eye. Classic comets with long tails only appear about once every 10–12 years. The motion is very difficult to detect and comparing its place with naked-eye stars over several days is the only way to see it move. In general, comets are best observed with telescopes or binoculars.

What are they?

Comets are primarily composed of ice and dust, causing some astronomers to refer to them as 'dirty snowballs'. They typically move through the solar system in orbits ranging from a few years to several hundred thousand years. Comets are not on fire. As they near the sun, the sun's heat melts the comet's ices and releases dust particles which are most evident as the comet's tail. Comets rarely come within a few million miles of Earth and, thus, have a slow apparent motion across our sky. Typical comets remain visible for periods of several weeks, up to several months.

http://comets.amsmeteors.org/educate/educate.html

Comets are small, fragile, irregularly shaped bodies composed of a mixture of non-volatile grains and frozen gases. They have highly elliptical orbits that bring them very close to the Sun and swing them deeply into space, often beyond the orbit of Pluto.

As comets approach the Sun they develop enormous tails of luminous material that extend for millions of kilometres from the head, away from the Sun. When far from the Sun, the nucleus is very cold and its material is frozen solid within the nucleus. In this state comets are sometimes referred to as a 'dirty iceberg' or 'dirty snowball', since over half of their material is ice. When a comet approaches close to the Sun, the surface of the nucleus begins to warm, and volatiles evaporate. The evaporated molecules boil off and carry small solid particles with them, forming the comet's coma of gas and dust.

When the nucleus is frozen, it can be seen only by reflected sunlight. However, when a coma develops, dust reflects still more sunlight, and gas in the coma absorbs ultraviolet radiation and begins to fluoresce. At about five AU from the Sun, fluorescence usually becomes more intense than reflected light.

As the comet absorbs ultraviolet light, chemical processes release hydrogen, which escapes the comet's gravity, and forms a hydrogen envelope. This envelope cannot be seen from Earth because its light is absorbed by our atmosphere, but it has been detected by spacecraft.

The Sun's radiation pressure and solar wind accelerate materials away from the comet's head at differing velocities according to the size and mass of the materials. Thus, relatively massive dust tails are accelerated slowly and tend to be curved. The ion tail is much less massive, and is accelerated so greatly that it appears as a nearly straight line extending away from the comet opposite the Sun.

..\cap/comet/west.htm..\cap/comet/west.htm

Each time a comet visits the Sun, it loses some of its volatile substances. Eventually, it becomes just another rocky mass in the solar system. For this reason, comets are said to be short-lived, on a cosmological time scale. Many scientists believe that some asteroids are extinct comet nuclei, comets that have lost all of their volatiles.

www.solarviews.com/eng/comet.htm

APPENDIX IV: THE MOON

The Moon is the only natural satellite of Earth:

Orbit: 384 400 km from Earth

Diameter: 3476 km

Mass: 7.35×10^{22} kg

The Moon, of course, has been known since prehistoric times. It is the second brightest object in the sky after the Sun. As the Moon orbits around the Earth once per month, the angle between the Earth, the Moon and the Sun changes; we see this as the cycle of the Moon's phases. The time between successive new moons is 29.5 days (709 hours), slightly different from the Moon's orbital period (measured against the stars) since the Earth moves a significant distance in its orbit around the Sun in that time.

Due to its size and composition, the Moon is sometimes classified as a terrestrial 'planet' along with Mercury, Venus, Earth and Mars.

The Moon was first visited by the Soviet spacecraft Luna 2 in 1959. It is the only extraterrestrial body to have been visited by humans. The first landing was on July 20, 1969; the last was in December 1972. The Moon is also the only body from which samples have been returned to Earth. In the summer of 1994, the Moon was very extensively mapped by the little spacecraft Clementine and again in 1999 by Lunar Prospector.

The Moon has no atmosphere. But evidence from Clementine suggested that there may be water ice in some deep craters near the Moon's south pole which are permanently shaded. This has now been confirmed by Lunar Prospector. There is apparently ice at the north pole as well.

The Moon's crust averages 68 km thick and varies from essentially 0 km under Mare Crisium to 107 km north of the crater Korolev on the lunar far side. Below the crust is a mantle and probably a small core (roughly 340 km radius and 2% of the Moon's mass). Unlike the Earth's mantle, however, the Moon's is only partially molten. Curiously, the Moon's center of mass is offset from its geometric center by about 2 km in the direction toward the Earth. Also, the crust is thinner on the near side.

There are two primary types of terrain on the Moon: the heavily cratered and very old highlands and the relatively smooth and younger maria. The maria (which comprise about 16% of the Moon's surface) are huge impact craters that were later flooded by molten lava. Most of the surface is covered with regolith, a mixture of fine dust and rocky debris produced by meteor impacts. For some unknown reason, the maria are concentrated on the near side.

A total of 382 kg of rock samples were returned to the Earth by the Apollo and Luna programmes. These provide most of our detailed knowledge of the Moon. They are particularly valuable in that they can be dated. Even today, 20 years after the last Moon landing, scientists still study these precious samples.

Most rocks on the surface of the Moon seem to be between 3 billion and 4.6 billion years old. This is a fortuitous match, as the oldest rocks found on Earth are rarely more than 3 billion years old. Thus the Moon provides evidence about the early history of the Solar System not available on the Earth.

http://www.seds.org/nineplanets/nineplanets/luna.html

The Moon is the name given to the natural satellite of the Earth, and sometimes applied to the satellites of the other planets in the solar system. The diameter of the moon is about 3480 km (about 2160 miles), or about one-fourth that of the Earth, and the moon's volume is about one-fiftieth that of the Earth. The mass of the Earth is 81 times greater than the mass of the moon. Thus the average density of the moon is only three-fifths that of the Earth, and the pull of gravity at the lunar surface only one-sixth that of the Earth. The moon has no free water and essentially no atmosphere, no weather exists to change its surface; yet it is not totally inert.

The moon moves about the Earth at an average distance of 384 403 km (238 857 miles), and at an average speed of 3700 km/hr (about 2300 mph). It completes one revolution in an elliptical orbit about the Earth in 27 days, 7 hr, 43 min, and 11.5 sec with reference to the stars

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APPENDIX V: METEORS

Naked eye appearance:
Meteors appear as fast-moving streaks of light in the night sky. They are frequently referred to as 'falling stars' or 'shooting stars'. Most are white or blue-white in appearance, although other frequent colours are yellow and orange. The colours seem more related to the speed of the meteor rather than composition. Red meteors occasionally appear as very long streaks and are usually indicative of a meteor that is skimming the atmosphere. Green meteors are also occasionally seen and are usually very bright. The green colour may be a result of ionized oxygen.

What are they?
Meteoroids are the smallest particles orbiting the sun, and most are no larger than grains of sand. From years of studying the evolution of meteor streams, astronomers have concluded that clouds of meteoroids orbiting the sun were produced by comets. Meteoroids cannot be observed moving through space because of their small size. Over the years numerous man-made satellites recovered by manned spacecraft have shown pits in their metal skins which were caused by the impact of meteoroids.

Meteoroids become visible to observers on Earth when they enter Earth's atmosphere. They are then referred to as meteors. They become visible as a result of friction caused by air molecules slamming against the surface of the high-velocity particle. The friction typically causes meteors to glow blue or white, although other colours have been reported. Most meteors completely burn up in the atmosphere at altitudes of between 60 and 80 miles. They are rarely seen for periods of more than a few seconds.

Occasionally, a large meteor will not burn up completely as it moves through Earth's atmosphere. The subsequent pieces that fall to Earth's surface are known as meteorites.

http://comets.amsmeteors.org/educate/educate.html

A Meteor, in astronomy, is a small solid body entering a planet's atmosphere from outer space and raised to incandescence by the friction resulting from its rapid motion. Brilliant meteors, known as fireballs, occur singly and generally consist of a luminous head, followed by a cometlike train of light that may persist for several minutes; some, called bolides, have been seen to explode with a sound like thunder.

APPENDIX VI: SATELLITES

Satellites (artificial) are any of the objects placed into orbit around the Earth and used for a variety of scientific and technological purposes.

The first artificial satellite, Sputnik 1, was launched by the Soviet Union on October 4, 1957. The first U.S. satellite, Explorer 1, was launched on January 31, 1958, and was instrumental in the discovery of the radiation belts. In the years that followed, several thousand were launched, mostly by the U.S. and the USSR until 1983, when the European Space Agency began launching from a space center in French Guiana.

Satellites are used for both exploration and communication. Exploratory satellites are equipped with instruments to measure the density, temperature, and ionization of the upper atmosphere; cosmic radiation; the number and size of micrometeorites; and the strength and direction of the geomagnetic field.

Since the launching of the first artificial satellite in 1957, thousands of these 'man-made moons' have been rocketed into Earth's orbit. Today, artificial satellites play key roles in the communications industry, in military intelligence, and in the scientific study of both Earth and outer space.

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The term satellite refers essentially to one thing—a small body, natural or artificial, that revolves around a larger astronomical object. Data gathered from these satellites help us learn about the environment, the world, and the universe. The exciting new technologies being developed from these satellites have additional applications that benefit life on Earth.

So, what do satellites have to do with you?
Well, without satellites we would not be able to know about tomorrow's weather, communicate across the globe with beepers, and cell phones or receive T.V. from the different parts of the globe. Soon you'll be doing some serious surfing on the Web with brand high speed satellite data feeds. That's what they have to do with you.

http://www.smgaels.org/physics/97/home.htm

APPENDIX VII: ASTEROIDS

Naked eye appearance

Out of more than 10 thousand numbered asteroids, only Vesta has consistently been a naked-eye object if the observer has extremely dark skies and the asteroid is moving in relatively star-poor regions of the sky. The motion of asteroids is similar to that of comets in that the position must be plotted on a star chart over two or three days for motion to be detected.

What are they?

Asteroids, or minor planets, have been described as 'mountains in space'. They are large rocks typically ranging from a few feet to several hundred miles across. The vast majority of asteroids move between the orbits of Mars and Jupiter in what is commonly called the 'asteroid belt'. They always appear starlike and their motion with respect to the stars is usually so slow that several hours may pass before any movement is noticed. Most asteroids within the asteroid belt never come closer than 100 million miles from Earth, but there are some asteroids which come close to and even cross Earth's orbit. These objects can occasionally pass within a few million miles of Earth, and even within the orbit of the moon, and then exhibit a rapid motion that is discernable after only a few minutes. Asteroids within the asteroid belt can be observed every year, while the ones passing especially close to Earth may only be visible for a few weeks or months.

http://comets.amsmeteors.org/educate/educate.html

APPENDIX VIII: STARS

Stars are large celestial bodies composed of gases emitting electromagnetic radiation, especially light, as a result of nuclear reactions inside the star. The sun is a star. With the sole exception of the sun, the stars appear to be fixed, maintaining the same pattern in the skies year after year. In fact the stars are in rapid motion, but their distances are so great that their relative changes in position become apparent only over the centuries.

The number of stars visible to the naked eye from Earth has been estimated to total 8000, of which 4000 are visible from the northern hemisphere and 4000 from the southern hemisphere. At any one time in either hemisphere, only about 2000 stars are visible. The other 2000 are located in the daytime sky and are obscured by the much brighter light of the sun. Astronomers have calculated that the stars in the Milky Way, the galaxy to which the sun belongs, number in the hundreds of billions.

Physical description

The sun is a typical star, with a visible surface called a photosphere, an overlying atmosphere of hot gases, and above them a more diffuse corona and an outflowing stream of particles called the solar (stellar) wind. Cooler areas of the photosphere, such as the sunspots on the sun, are likely present on other typical stars; their existence on some large nearby stars has been inferred by a technique called speckle interferometry. The internal structure of the sun and other stars cannot be directly observed, but studies indicate convection currents and layers of increasing density and temperature until the core is reached where thermonuclear reactions take place. Stars consist mainly of hydrogen and helium, with varying amounts of heavier elements.

APPENDIX IX: PLANETS

Planet	Distance (000 km)	Radius (km)	Mass (kg)
Mercury	57 910	2439	3.30×10^{23}
Venus	108 200	6052	4.87×10^{24}
Earth	149 600	6378	5.98×10^{24}
Mars	227 940	3397	6.42×10^{23}
Jupiter	778 330	71 492	1.90×10^{27}
Saturn	1 426 940	60 268	5.69×10^{26}
Uranus	2 870 990	25 559	6.90×10^{25}
Neptune	4 497 070	24764	1.02×10^{26}
Pluto	5 913 520	1160	1.31×10^{22}

http://www.seds.org/nineplanets/nineplanets/sol.html

Mercury (planet), in the solar system, the planet closest to the sun. Its mean distance from the sun is approximately 58 million km; its diameter is 4878 km; its volume and mass are about one-tenth that of the Earth; and its mean density is approximately equal to that of the Earth. Mercury revolves about the sun in a period of 88 days.

Because its surface consists of rough, porous, dark-coloured rock, Mercury is a poor reflector of sunlight.

Venus (planet), one of the planets in the solar system, the second in distance from the sun. Except for the sun and the moon, Venus is the brightest object in the sky. The planet is called the morning star when it appears in the east at sunrise, and the evening star when it is in the west at sunset.

Venus's complete cloud cover and deep atmosphere make it difficult to study from Earth, and most knowledge of the planet has been obtained through the use of space vehicles, particularly those carrying probes that descend through the atmosphere.

Atmosphere of Venus

The surface temperature on Venus is highly uniform and is about 459° C (732 K/858° F); the surface pressure is 96 bars (compared with 1 bar for Earth); the atmosphere of the planet consists of nearly all carbon dioxide (CO_2). The cloud base is at 50 km, and the cloud particles are mostly concentrated sulfuric acid. The planet has no detectable magnetic field.

That 97 percent of Venus's atmosphere is CO_2 is not as strange as it might seem; in fact, the crust of Earth contains almost as much in the form of limestone. About 3 percent of the Venusian atmosphere is nitrogen gas (N_2). By contrast, 78 percent of Earth's atmosphere is nitrogen. Water and water vapor are extremely rare on Venus.

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Earth, one of the planets in the solar system, the third in distance from the sun and the fifth largest of the planets in diameter. The mean distance of the Earth from the sun is 149 503 000 km. It is the only planet known to support life, although some of the other planets have atmospheres and contain water.

The Earth is not a perfect sphere but is slightly pear-shaped.

The approximate length of the Earth's orbit is 938 900 000 km, and the Earth travels along it at a velocity of about 106 000 km/hr. The Earth rotates on its axis once every 23 hr 56 min 4.1 sec (based on the solar year).

The rocks of the lithosphere have an average density of 2.7 and are almost entirely made up of 11 elements, which together account for about 99.5% of its mass. The most abundant is oxygen (about 46.60% of the total), followed by silicon (about 27.72%), aluminum (8.13%), iron (5.0%), calcium (3.63%), sodium (2.83%), potassium (2.59%), magnesium (2.09%) and titanium, hydrogen, and phosphorus (totaling less than 1%). In addition, 11 other elements are present in trace amounts of from 0.1 to 0.02%. These elements, in order of abundance are: carbon, manganese, sulfur, barium, chlorine, chromium, fluorine, zirconium, nickel, strontium, and vanadium. The elements are present in the lithosphere almost entirely in the form of compounds rather than in their free state. These compounds exist almost entirely in the crystalline state, so they are, by definition, minerals.

The dense, heavy interior of the Earth is divided into a thick shell, the mantle, surrounding an innermost sphere, the core. The mantle extends from the base of the crust to a depth of about 2900 km. Except for the zone known as the asthenosphere, it is solid, and its density, increasing with depth, ranges from 3.3 to 6. The upper mantle is composed of iron and magnesium silicates, as typified by the mineral olivine. The lower part may consist of a mixture of oxides of magnesium, silicon, and iron.

'Earth', Microsoft (R) *Encarta*. Copyright (c) 1994 Microsoft Corporation. Copyright (c) 1994 Funk & Wagnall's Corporation.

Mars (planet), a planet in the solar system named after the Roman god of war. It is the fourth planet from the sun and the third in order of increasing mass. Mars has two small, heavily cratered moons, Phobos and Deimos, which some astronomers consider asteroid-like objects captured by the planet very early in its history. Phobos is about 21 km across; Deimos, only about 12 km (about 7.5 mi).

Through a telescope Mars can be seen to have bright orange regions and darker, less red areas, the outlines and tones of which change with Martian seasons. (Because of the tilt of its axis and the eccentricity of its orbit, Mars has short, relatively warm southern summers and long, relatively cold southern winters.) The reddish colour of the planet results from its heavily oxidized, or rusted, surface.

Atmosphere of Mars
The Martian atmosphere consists of carbon dioxide (95 percent), nitrogen (2.7 percent), argon (1.6 percent), oxygen (0.2 percent), and trace amounts of water vapor, carbon monoxide, and other noble gases. The average pressure at the surface is 0.6 percent that on Earth and equal to the pressure at a height of 35 km in Earth's atmosphere. Surface temperatures vary greatly with time of day, season, and latitude. Maximum summer temperatures may reach 290 K (63° F), but average daily temperatures at the surface do not exceed 240 K (–27° F). Due to the thinness of the atmosphere, daily temperature variations of 100° C (180° F) are common. Poleward of about 50° latitude, temperatures remain cold enough (less than 150 K/–189° F) throughout winter for the atmosphere's major constituent, carbon dioxide, to freeze out into the white deposits that make up the polar caps. The total atmospheric pressure on the surface fluctuates by about 30 percent due to the seasonal cycle of the polar caps.

The amount of water vapor present in the atmosphere is extremely slight and variable. The concentration of atmospheric water vapor is highest near the edges of the receding polar caps in spring. Mars is like a very cold, high-altitude desert. Surface temperatures are too cold and surface pressures too low for water to exist in the liquid state in most places on the planet. It has been suggested, however, that liquid water may exist just below the surface in a few localities.

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Jupiter (planet), fifth planet from the sun, and the largest planet in the solar system. Named for the ruler of the gods in Roman mythology, Jupiter has 1400 times the volume of Earth but is only 318 times more massive. Thus, the mean density of Jupiter is about one-fourth that of Earth, indicating that the giant planet must consist of gas rather than the metals and rocks of which the Earth and other inner planets are composed.

Orbiting the sun at a mean distance 5.2 times greater than that of Earth, Jupiter makes a complete revolution in 11.9 Earth years but takes only 9.9 hours to rotate once on its axis.

Sixteen satellites of Jupiter have so far been discovered.

Infrared studies from the Voyager spacecraft indicated that 87 percent of Jupiter's atmosphere is H_2, with helium, He, constituting most of the remaining 13 percent.

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Saturn (planet), sixth planet in order of distance from the sun, and the second largest in the solar system. Saturn's most distinctive feature is its ring system, which was first seen in 1610 by Galileo, using one of the first telescopes. He did not understand that the rings were separate from the body of the planet, so he described them as handles

These rings are now known to comprise more than 100 000 individual ringlets, each of which circles the planet.

As seen from Earth, Saturn appears as a yellowish object — one of the brightest in the night sky.

Saturn's atmospheric constituents are, in order by mass, hydrogen (88 percent) and helium (11 percent); and the remainder comprises traces of methane, ammonia, ammonia crystals, and such other gases as ethane, acetylene, and phosphine. Voyager images showed whirls and eddies of clouds occurring deep in a haze that is much thicker than that of Jupiter because of Saturn's lower temperature. The temperatures of Saturn's cloud tops are close to −176° C (–285° F), about 27° C (49° F) lower than such locations on Jupiter.

Based on the movements of Saturnian storm clouds, the period of rotation of the atmosphere near the equator is about 10 hr 11 min. Radio emissions that have been detected coming from the body of the planet indicate that the body of Saturn and its magnetosphere rotate with a period of 10 hr 39 min 25 sec. The approximately 28.5 minute difference between these two times indicates that Saturnian equatorial winds have velocities close to 1700 km/hr.

The visible rings stretch out to a distance of 136 200 km from Saturn's centre, but in many regions they may be only five metres thick. They are thought to consist of aggregates of rock, frozen gases, and water ice ranging in size from less than 0.0005 cm in diameter to about 10 m in diameter — from dust to boulder size.

More then 20 satellites have been discovered orbiting Saturn. Their diameters range from 20 to 5150 km. They consist mostly of the lighter, icy substances that prevailed in the outer parts of the gas and dust nebula from which the solar system was formed and where radiation from the distant sun could not evaporate the frozen gases.

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Uranus (planet), major planet in the solar system, equivalent in brightness to a sixth-magnitude star. It ranks seventh in order of distance from the sun, revolving outside the orbit of Saturn and inside the orbit of Neptune. Uranus was accidentally discovered in 1781 by the British astronomer Sir William Herschel. Uranus has a diameter of 52 200 km and its mean distance from the sun is 2.87 billion km. Uranus takes 84 years for a single revolution, or orbit, and 17 hr 15 min for a complete rotation about its axis. Uranus's atmosphere consists largely of hydrogen and helium, with a trace of methane. Through a telescope the planet appears as a small, bluish-green disk with a faint green periphery. Compared to the Earth, Uranus has a mass 14.5 times greater, a volume 67 times greater, and a gravity 1.17 times greater. Uranus's magnetic field, however, is only a tenth as strong as Earth's, with an axis tilted 55° from the rotational axis. The density of Uranus is approximately 1.2.

In 1977, while recording the occultation of a star behind the planet, the American astronomer James L. Elliot discovered the presence of five rings encircling the equator of Uranus. Named Alpha, Beta, Gamma, Delta, and Epsilon (starting from the innermost ring), they form a 9400 km-wide belt extending to 51 300 km from the planet's center. Four more rings were discovered in January 1986 during the exploratory flight of Voyager 2.

In addition to its rings, Uranus has 15 satellites

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Neptune (planet), fourth largest of the planets in the solar system, and eighth major planet in order of increasing distance from the sun. The mean distance of Neptune from the sun is 4.5 billion km, and its mean linear diameter is approximately 49 400 km, or about 3.8 times that of the Earth. Its volume is about 72 times, its mass 17 times, and its mean density 0.31 that of the Earth (about 1.7 times that of water). The albedo of the planet is high; 84 percent of the light falling on it is reflected. The period of rotation is about 16 hr, and the period of revolution about the sun is 164.79 Earth years. The average stellar magnitude of the planet is 7.8, and it is therefore never visible to the naked eye, but it can be observed in a small telescope as a small, round, greenish-blue disk without definite surface markings. The temperature of the surface of Neptune is about –218° C (–360° F), much like Uranus, which is more than 1 billion miles closer to the sun. Scientists assume, therefore, that Neptune must have some internal heat source. The atmosphere consists mostly of hydrogen and helium, but the presence of up to three percent methane gives the planet its striking blue colour.

Eight known satellites orbit Neptune, two of which are observable from Earth.

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Pluto (planet), in astronomy, ninth planet from the sun and outermost known member of the solar system. Pluto revolves about the sun once in 247.7 years at an average distance of 5.9 billion km.

Visible only through large telescopes, Pluto is seen to have a yellowish colour. For many years very little was known about the planet, but in 1978 astronomers discovered a relatively large moon orbiting Pluto at a distance of only about 19 000 km and named it Charon. The orbits of Pluto and Charon caused them to pass repeatedly in front of one another from 1985 through 1990, enabling astronomers to determine their sizes fairly accurately. Pluto is about 2284 km in diameter, and Charon is about 1192 km in diameter, making them even more closely a double-planet system than are the Earth and its moon. Pluto was also found to have a thin atmosphere, probably of methane, exerting a pressure on the planet's surface that is about 100 000 times weaker than the Earth's atmospheric pressure at sea level. The atmosphere appears to condense and form polar caps during Pluto's long winter.

With a density about twice that of water, Pluto is apparently made of much rockier material than are the other planets of the outer solar system. This may be the result of the kind of cold-temperature/low-pressure chemical combinations that took place during the formation of the planet. Many astronomers think Pluto may be a former satellite of Neptune, knocked into a separate orbit during the early days of the solar system. Charon would then be an accumulation of the lighter materials resulting from the collision.

YEAR 10 GLOSSARY

Word/phrase	**Meaning**
Abiotic	The non-living parts of an environment.
Acceleration	An object getting faster or speeding up
Adaptations	Features which living things have that help them to survive.
Average Speed	Objects often move at different speeds over a journey. The average speed is the average of all the speeds over the journey.
Behavioural adaptation	A behaviour that helps the living thing survive.
Biotic	The living parts of an environment.
Carnivores	Animals that only eat other animals.
Conduction	This is how heat energy moves through a solid. Particles vibrate back and forward faster when heated. The heat energy passes from one particle to the next when they bumping into each other.
Constant speed	An object moving at the same speed for a period of time.
Consumers	Animals that eat plants or other animals to get energy to live.
Convection currents	Heat energy is transferred in a gas or a liquid using the circular motion of convection currents.
Convergent boundary	The boundary of two of the Earth's plates that are moving into each other.
Deceleration	An object speed is getting slower.
Distance	A measure of how far it is between two things.
Echo	Sound hits a hard surface and bounces back to the listener.
Electromagnetic radiation	A number of different types of energy carrying waves including light, radio waves and X-rays.
Environment	The biotic and abiotic
Erosion	Soil being washed away by the flow of water.
Functional adaptation	The ability of a living thing to control parts of the life processes. For example people's ability to grow nails.
Habitat	The home of an organism.
Herbivores	Animal that only eat plants.
Inorganic matter	Parts of the soil that are made up of non-living chemicals.
Insulator	Objects that slow down or stop the flow of heat or electricity.
Loam	Soil that contains particles of different sizes.
Longitudinal waves	Waves in which the particles move back and forth in the direction that the wave is travelling.
Medium	Material that a sound wave can travel through.

YEAR 10 GLOSSARY

Word/phrase	**Meaning**
Omnivores	Animals that feed on both plants and animals.
Organic matter	Waste products and dead plant and animal material in soil.
Parent material	Rock layer at the bottom of a soil profile.
Peds	Small lumps of materials in the soil.
Predators	Carnivores that get their food by hunting, chasing and catching animals.
Pressure	The force of molecules and other objects on another object.
Producers	Living things such as plants that make their own food.
Radiation	Method by which heat energy travels from one object to another.
Scavengers	Carnivores that find dead plant or animal matter to eat.
Soil	Top layer of the Earth's crust.
Soil structure	The way the particles of the soil have joined together.
Soil texture	The way soil feels in your hand.
Stopped	The object is not moving anymore.
Structural adaptation	A structure an animal has that helps it to survive.
Subsonic	Sounds that have a frequency too low for the human ear to hear.
Temperature	The average amount of kinetic energy of the particles in a material.
Time	How long it takes for something to happen.
Transferred	Energy that goes from one object to another.
Transform boundary	A boundary between two of the Earth's plates that move past each other in opposite directions.
Transformed	Energy changed from one form of energy to another.
Ultrasonic	Sounds that have a frequency too high for the human ear to hear.
Vacuum	A place where there are no particles.
Weathering	The process of breaking down rocks into smaller pieces by wind or the movement of water.