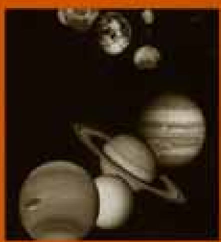
Book 3

Year 9



Science

Science

Year 9 Book Three

GOVERNMENT OF SĀMOA
MINISTRY OF EDUCATION, SPORTS AND CULTURE

Acknowledgements

The Ministry of Education, Sports and Culture would like to thank Cara and Michelle Scott for their vision, patience and hard work in putting together this valuable book.

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Produced by Egan Reid Ltd, Auckland, as part of the Sāmoa Secondary Education Curriculum and Resources Project for:

Reprinted 2004 and 2006 through Egan Reid Ltd.

Funded by the New Zealand Agency for International Development,
Nga Hoe Tuputupu-mai-tawhiti.

Managing Contractor: UniServices Limited, Auckland.

ISBN 982–517–027–1

TABLE OF CONTENTS

Unit 1: LIVING THINGS AND THEIR ENVIRONMENT

Introduction

In this unit, you will learn about the environment and the living and non-living parts of it.

The land and waters around Sāmoa provide a variety of different places for plants and animals to live. The coral reefs also provide special places. The land is covered in different types of tropical rain forest, mangroves, swamps and managed land such as grasslands and plantations.

The plants and animals living in Sāmoa can be divided into different groups depending upon the purpose of the grouping. One important way to group living things is to decide if they are native or introduced.

Native plants and animals are those that are found naturally in Sāmoa. Vivao trees and moso'oi trees are common in the cloud forests of Savai'i. Laumei sami and pea vao are native animals.

Introduced plants and animals are those that people have brought into Sāmoa. There are often introduced plants like niu, fa'i and pulu growing on managed land.

Activity 1 Introduced Plants And Organisms

Aim To find out about native and introduced plants and animals.

1. Ask different people that work in Government Departments for information about which plants and animals have been introduced to Sāmoa. Find out:
   a. When and how the organism was introduced, if known.
   b. Why was it introduced?
   c. What is it used for now?
   d. What effect has it had on native organisms?
   e. Is it a useful organism or are people trying to remove it from Sāmoa?

Plant groups

A way to group plants and animals is by the features that the living thing has. For example, plants can be divided into two groups. Those that use flowers for reproduction and those that don't. The plants that have flowers, such as hibiscus and frangipani are called **angiosperms**, which means flowering plant. Angiosperms can also be divided into two groups: broad-leaf plants called **dicotyledons**; and grasses and palms, which are called **monocotyledons**.

An ulu tree is an example of a dicotyledon. It has wide leaves — not long, thin ones. Pi and the moso'oi tree are also dicotyledonous plants. Saga and 'ofe are examples of monocotyledonous plants. They have long, thin leaves. The diagram below shows the special features of monocotyledons and dicotyledons.

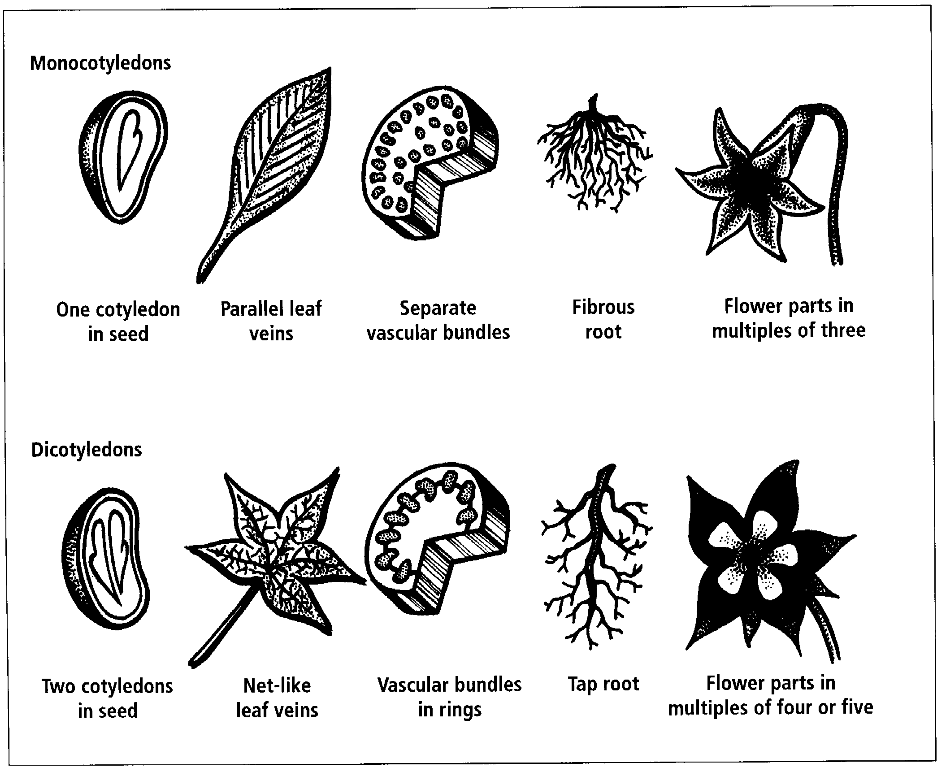


Diagram 1.1
The differences between monocotyledon and dicotyledon plants.

Activity 2 Plant Groups

Aim To record information about plant groups.

1. What are angiosperms?
2. Describe the five main differences between monocotyledons and dicotyledons.
3. List the names of ten monocotyledonous and ten dicotyledonous plants that grow locally.

Animal groups

Animals can be divided into two groups: those that have a backbone, called **vertebrates**, and those without a backbone, called **invertebrates**.

Animals that have backbones include fish, birds, mammals, reptiles and amphibians. Sāmoa has a large number of different types of fish and birds but has few mammals and reptiles and no amphibians (frogs and toads).

The following table gives examples of each different group of vertebrates.

Reptiles	Fish	Birds	Mammals
Laumei sami, Gata sami, Pili	Fo, Laea, Tifitifi, Sumu, Filoa, Tamala, Savane	Vea, Lulu, Lupe, Miti, Toloa, Fuia, Manutagi	Solofanua, Maile, Pua'a, Pusi, Povi,

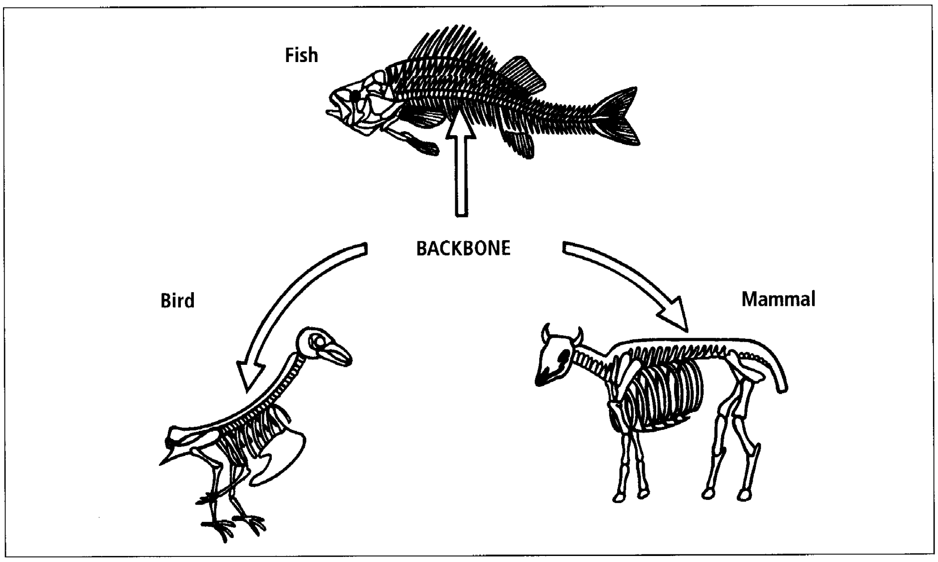


Diagram 1.2
Skeletons showing the backbone of vertebrates.

Invertebrates are animals that do not have a backbone. They have soft bodies or have shells on the outside of their bodies. There are lots of different animal groups that are invertebrates.

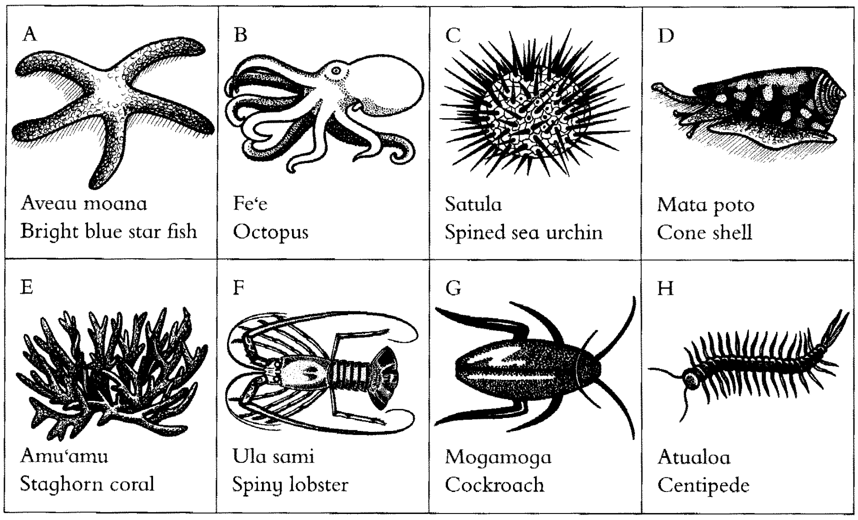


Diagram 1.3
Examples of invertebrate animals.

Activity 3 Animal Groups

Aim To record information about animal groups.

1. Describe the main differences between vertebrate and invertebrate animals.
2. List the names of ten vertebrate and ten invertebrate animals that are found locally.
3. What differences do you notice about the sizes of invertebrates compared to vertebrates?
4. What advantages does having a backbone give vertebrates?

Producers and consumers

Another way to group living things is to use what they eat to divide them into groups. Green plants, such as fa'i, esi and ta'amu are **producers**. They are called producers because they have **chlorophyll** in their leaves. During the process of **photosynthesis** they use sunlight, carbon dioxide and water to make 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 grouped by what they eat. **Herbivores**, such as manumea and uu, eat plants or parts of plants. **Carnivores**, such as mata poto, alamea and atualoa, eat other animals. Some carnivores are **predators**. This means that they chase and catch their food. Other carnivores are **scavengers**. This means that they eat dead animals. **Omnivores**, such as lalafi and laea, eat both plants and animals.

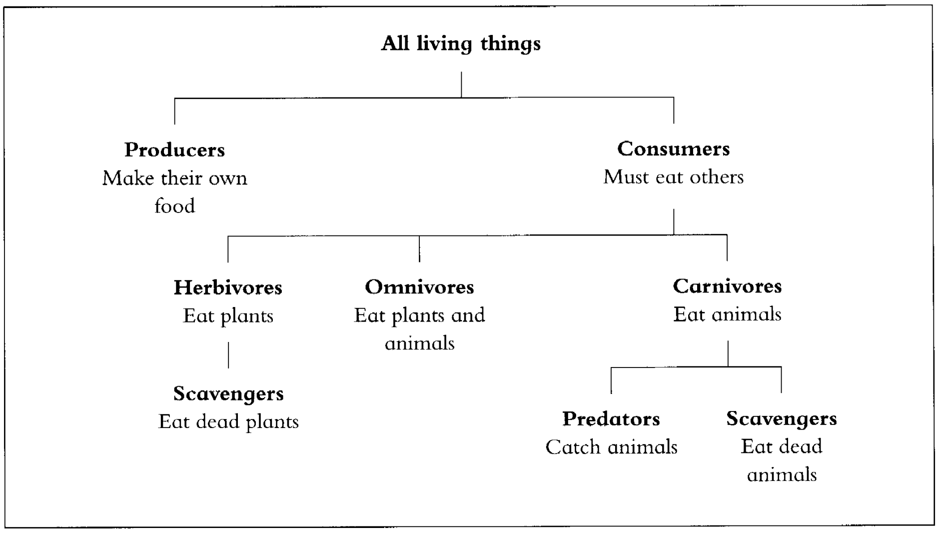


Diagram 1.4

Groups of living things based on what they eat.

Food chains and food webs are two different types of diagrams that are used to show what each organism in a community eats. A food web includes all the producers and consumers common to an area. Lines are drawn between the organisms to show what each organism eats. The following food web shows what some local sea organisms eat:

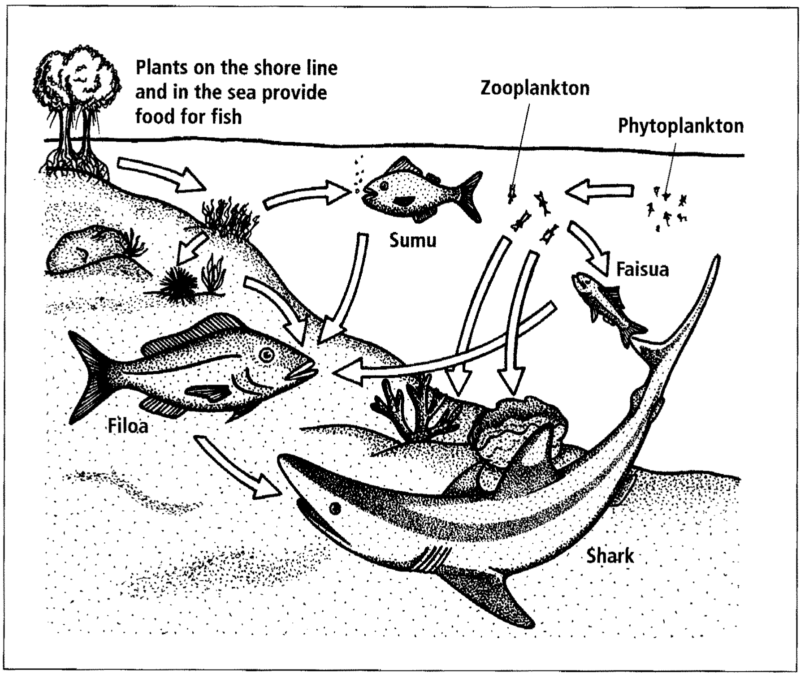


Diagram 1.5
A food web for sea organisms.

The food web shown above can be written as a number of single food chains. Food chains always start with a producer and usually have one, two, three or four consumers. For example:

Producer	First consumer	Second	Third	Fourth
Phytoplankton →	Zooplankton →	Small fish →	Filoa →	Shark
Algae →	Sumu →	Filoa →	Shark	
Phytoplankton →	Zooplankton →	Faisua		

Activity 4 Feeding Groups

Aim To record information about feeding groups.

1. Describe the difference between a producer and a consumer.
2. List eight examples of each.
3. Describe the differences between a herbivore and a carnivore.
4. List eight examples of each.
5. Describe the difference between a predator and a scavenger.
6. List eight examples of each.
7. Explain the difference between a food web and a food chain.
8. Draw a food web for a local community.
9. Draw up two food chains from the community.

The environment

The environment is made up of two parts. All the plants and animals in an area make up the biotic environment. All the physical aspects of the environment, such as water, temperature and light make up the abiotic part of the environment. The table below gives information on environmental factors.

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	Inter-species competition
Wave action	Salinity (saltiness)	
Soil pH	Carbon dioxide levels	

Inter-species competition

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. If one part of the environment is outside the range that the organisms require, then the organisms will not be able to live in that environment for long. For example, if a plant needs a lot of sunlight to grow it will not grow in the shade on the floor of a rain forest. The following information gives the requirements for yams to grow:

> Yams should be grown in areas with 1100 mm of rain or more per year. They grow best in areas that have a distinct dry season. They do not live in waterlogged soil. Good weed control is needed during the first four months of growth. Add NPK fertiliser if soil is poor.

The information about yams covers aspects of both the biotic and abiotic environment. This information has been separated out in the table below.

Environmental needs of yams	
Biotic environment	Abiotic environment
Weeds need to be removed.	1100 mm of rain per year. Don't grow in waterlogged soils. Use NPK fertiliser in poor soil. Grows best where there is a clear difference between dry and rainy seasons.

Activity 5

Materials needed:
Thermometers;
Light meters;
pH paper or Universal Indicator;
Test tubes;
Any other equipment available to measure the abiotic environmental factors.

The Abiotic Environment

Aim To investigate the abiotic environment of a local plant and animal community.

1. Select a local plant and animal community: *e.g. Stream, rainforest, grassland, plantation.*
2. Use the chart on the previous page to help you. Make a list of each of the factors in your exercise book; they are useful headings. Measure or find out about as many of the abiotic parts of the environment as you can. For example, visit the community and measure the temperature, then try to find out about the daily and yearly temperature ranges for the area. The Meteorological Service has automatic weather stations at the following places: Avao, Asau, Cape Tapaga, Faleolo, Lata, Tafitoala. These stations give information on wind direction, speed and gusts, temperature and rain. This information can be viewed by going to the internet website http://www.sāmoa.ws/weather_sāmoa.cfm or your teacher could contact the Meteorological Service.
3. Record as much information as you can about the abiotic environment. For example observe or measure the amount of light available. Will the same amount be available all day? All year? Put this information under the headings in your exercise book.

4. Write a description about the abiotic environment in the local community using your notes to help you.
5. Explain why the abiotic environment is important to organisms.
6. Describe how the abiotic environment of the community will change daily, monthly and yearly.

Unit summary

- Native plants and animals are those that are found naturally in Sāmoa. Introduced plants and animals are those that people have brought into Sāmoa.
- Plants that have flowers are called angiosperms. Angiosperms can be divided into two groups: the broadleaf plants called dicotyledons and the grasses and palms which are called monocotyledons.
- The features of monocotyledonous plants are: 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.
- The features of dicotyledonous plants are: two cotyledons in the seed, net-like leaf veins, vascular bundles arranged in rings around the stem, taproot usually present and flower parts usually in multiples of four or five.
- Animals can be divided into groups that have a backbone, called vertebrates and those without a backbone, called invertebrates.
- Animals that have backbones include fish, birds, mammals, reptiles and amphibians.
- Invertebrates are animals that do not have a backbone. They have soft bodies or have shells on the outside of their bodies.
- Living things can be grouped by what they eat. Green plants are producers. They have chlorophyll in their leaves and carry out photosynthesis.
- All animals are consumers because they have to eat plants or other animals to get the food they need to live.
- Consumers can be grouped by what they eat. Herbivores eat plants or parts of plants. Onmivores eat both plants and animals. Carnivores eat other animals.
- Some carnivores are predators. This means that they chase and catch their food. Other carnivores are scavengers that eat dead animals.
- Food chains and food webs show what each organism eats. A food web includes all the producers and consumers common to an area.

- Food chains always start with a producer and usually have one, two, three or four consumers.
- The environment 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.

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	

- 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 in the correct amount.

Unit 2: ROCKS

Introduction

In this unit, you will learn about different types of rocks and about the rock cycle.

Igneous Rock

Sāmoa is made up of **igneous rock.** The Saleaula lava flows on Savai'i show the way the molten lava cools to become igneous rock. There are two types of igneous rock. These are **igneous plutonic rock** and **igneous volcanic rock**. The rock in the Saleaula lava flow is called igneous volcanic rock because it has formed from lava that cooled quickly on the Earth's surface. This sort of rock has small crystals in it because it cools quickly before large crystals have had time to form. The type of igneous volcanic rock found in Sāmoa is basalt. Igneous rock often forms very fertile soils.

There are lots of different types of igneous volcanic rock around the world. Another example is pumice. Pumice is a light rock and it is full of holes where gas escaped from the hot lava.

Igneous plutonic rock forms when magma cools slowly under the Earth's surface. Because the rock cools slowly crystals have time to grow larger. Granite is an example of this type of rock.

Sedimentary rock

Sedimentary rock is made up of broken pieces of rock, mud, sand, shells and small stones that have been carried by water, wind or waves and dumped to form layers. The different layers get pushed together which makes the layers join to become a rock. Examples of sedimentary rock are limestone, sandstone and mudstone.

Metamorphic rock

The term *metamorphic* means 'change'. **Metamorphic rock** is formed when igneous and sedimentary rocks are changed because of the large amounts of heat and pressure deep under the Earth's surface. The heat and pressure can make large changes to the structure of the rock by causing new minerals and crystals to form. Most metamorphic rock is hard and the particles are often arranged in bands. Marble, slate and schist are metamorphic rocks.

Each of the three types of rock, sedimentary, igneous and metamorphic, has key features that can be used to identify them. A sedimentary rock has sand, shells and other types of rocks inside it. The different materials in a sedimentary rock occur in layers.

An igneous plutonic rock has large crystals. An igneous volcanic rock has small crystals. Metamorphic rock will be hard and have fine crystals. It often has layers of different coloured materials.

Keys can be used to identify different rocks. The key on the next page also gives information about the properties of rocks that are common in New Zealand.

Rock Key

1.	Rock fizzes when drop of dilute acid added	Go to 2
	Rock doesn't fizz when acid added	Go to 3
2.	White or yellowish, fine grained	Chalky limestone (S)
	Contains shells	Shelly limestone (S)
3.	Crystals or grains can be seen without lens	Go to 8
	Crystals or grains cannot be seen without lens	Go to 4
4.	Powder can be scratched off with a ball point pen	Go to 5
	Powder cannot be easily scratched off	Go to 11
5.	Soft, has many holes	Go to 11
	Does not have holes	Go to 6
6.	Dark, burns easily, may be shiny	Coal (S)
	Dull, does not burn	Go to 7
7.	Thin layers	Shale (S)
	Not layered. May be soft or very hard	Mudstone (S)
8.	Made up of particles smaller than 2 mm	Go to 9
	Made up of particles larger than 2 mm	Go to 10
9.	Grains can be scratched off with ball point pen	Sandstone (S)
	Grains cannot be scratched off easily	Go to 15
10.	Particles are rounded (worn by water)	Conglomerate (S)
	Particles are sharp and angular	Breccia (S)
11.	Light, soft, has many holes	Pumice (I)
	Is not light and soft	Go to 12
12.	Black and glassy	Obsidian (I)
	Is not black and glassy	Go to 13
13.	Dull, very fine grain, splits in layers	Slate (M)
	Does not split into layers	Go to 14
14.	Very hard, smooth and dark	Basalt (I)
	Hard, rough, many holes, dark and reddish	Basalt scoria (I)
15.	One colour, usually white, large crystals	Quartzite (M)
	Made of particles of several colours	Go to 16
16.	Particles in bands	Go to 17
	Mixture of light and dark, with many crystals	Granite (I)
17.	Thin plates, with shiny flakes	Schist (M)
	Broad layers of light and dark crystals	Gneiss (M)

Activity 1

Materials needed:
Samples of local rock;
Rock samples from around the world;
Hand lens;
Dilute hydrochloric acid.

Naming Rocks

Aim To name different rock types.

1. Choose a local rock sample. Work through the rock key to find the name of the sample.
2. Choose another rock sample and work through the rock key to find the name of the sample.
3. Use the key to name the following rocks

   Rock A — Doesn't fizz with acid, crystals or grains can't be seen without a lens, powder can be scratched off with a ball point pen, does not have holes, dark, burns easily and may be shiny.

   Rock B — Powder cannot easily be scratched off, light, soft, has many holes, crystals or grains cannot be seen without a lens. (The information is not in same order as in the key.)

   Rock C — Grains cannot easily be scratched off, made of particles of several colours, mixture of light and dark, with many crystals.

4. Use the information on the key to describe the properties of these rocks.

   Rock D — Shale.

   Rock E — Basalt.

   Rock F — Breccia.

The rock cycle

The rock cycle is a naturally changing process, like the weather or the growth of plants, but the rock cycle takes much longer to complete. The rock cycle is used to explain how rocks are formed, broken down and formed into a different type of rock over time. Rocks are made of minerals, such as quartz and calcite. Rocks can be changed by changing the amounts of different minerals within the rock, or by changing the minerals themselves. Pressure, heat and the effect of the weather can all change rocks.

The rock cycle began when the Earth and solar system formed from dust 4.8 billion years ago. At this time the radioactive heat and pressure from gravity melted the dust and formed the first igneous rocks. Sāmoa is a young volcanic island which explains why all the local samples of rock are igneous.

Activity 2 Rock Cycle

Aim To record information about the rock cycle.

1. Copy the diagram of the rock cycle over the page and label each stage.
2. Write notes to explain what is happening in each stage of the rock cycle.
3. Look in the rivers and streams around the school or village. What size are the particles being transported by the river or streams? Can you find large stones, small stones, sand or silt (fine sand)? Are the stones smooth or do they have sharp points? Smooth means that they have been in the river or stream a long time.
4. Read the following information then explain which parts of the rock cycle are currently happening in Sāmoa.

> Every time rock comes up to the Earth's surface the process of weathering and erosion begins. Igneous rock, like the basalt found in Sāmoa, is very hard and takes a long time to weather down.
>
> Small particles and dissolved chemicals from these rocks are carried by rivers and streams to the ocean where layers of sediments form on the ocean floor. These layers are changed into sedimentary rock. Over time some of the sedimentary rock will get buried and then changed by heat and pressure to become metamorphic rock. In future some of the metamorphic rock may get uplifted to the surface of the islands and the weathering process will begin again.

5. Find out more about the geological history and the rocks in Sāmoa from local people, geologists and CDU books.

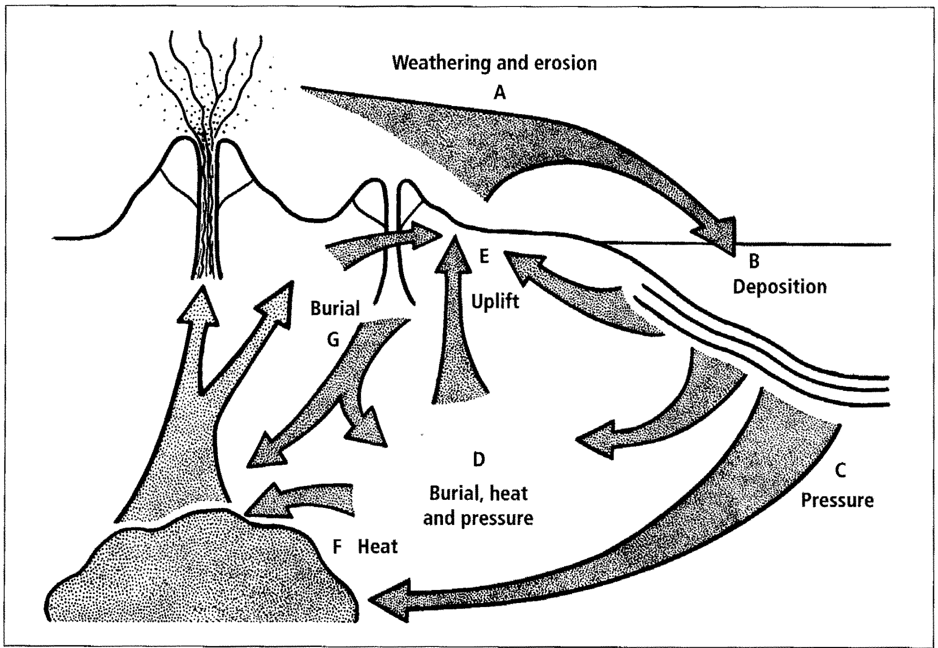


Diagram 2.1
The rock cycle.

Stage A

Weathering and erosion — When rocks are on the Earth's surface the weather begins to cause chemical and physical changes in them. The chemical changes occur because most rocks are formed at high pressures and temperatures, away from oxygen or water. When these rocks are brought to the surface by volcanoes or the Earth's movements, oxygen and water will cause chemical changes to occur.

Rocks are also weathered from erosion by rain, rivers, wind and waves. Erosion is a physical change which means that the rocks are broken down into small pieces called sediments.

Stage B

Deposition — Sediments include pieces of rock, sand, silt and clay that are transported into lakes, and oceans where they form layers. The layers may also include other transported objects such as dead plants or animals, which may be changed into fossils.

Stage C

Pressure — The layers of sediment can become very thick and this creates large amounts of pressure on the underlying layers, squeezing out any water they contain and causing new minerals to form. When this happens the layers of sediments become sedimentary rocks.

Stage D

Burial, heat and pressure — Sedimentary and igneous rocks may become buried by huge layers of rock, or they may be caught in areas where movement of the Earth's crust takes them downwards. The pressure and heat produced by burial or movement of the crust will change the original rock so completely that a new, metamorphic rock is formed. Mildly altered sedimentary rock, such as shale, turns into slate when metamorphosed. Further pressure and heat will turn slates into schist or gneiss.
Note: 'Metamorphosed' means changed by heat and pressure into a metamorphic rock.

Stage E

Uplift — Movement of the Earth's crust such as uplift, folding or faulting, brings the metamorphic, sedimentary and igneous rocks to the surface where the weathering process will begin again.

Stage F

Heat — Sometimes heat will completely melt the sedimentary and metamorphic rocks again, creating magma and a new igneous rock when cooled (**Stage G**).

Stage G

Burial — Igneous rock may never be weathered, but instead is re-melted to become metamorphic or new igneous rock.

Unit summary

- Sāmoa is made up of igneous rock. There are two types of igneous rock. These are igneous plutonic rock and igneous volcanic rock.
- Igneous volcanic rock forms from lava that cooled quickly on the Earth's surface, therefore it has small crystals.
- Igneous plutonic rock forms when magma cools slowly under the Earth's surface, therefore it has larger crystals.
- Sedimentary rock is made up of broken pieces of rock, mud, sand, shells and small stones that form layers in the rock.
- Metamorphic rock is hard, has fine crystals and the 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.
- Keys can be used to identify different 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.
- 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.
- The sediments get deposited in layers. The layers may also include dead plants or animals, which may be changed into fossils.
- Sedimentary rock is formed when the layers of sediment 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.
- 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.

Unit 3: EARTH'S PATTERNS

Introduction

In this unit, you will learn about the ways the sun, Earth and the moon move and work together to give repeating cycles such as day and night, seasons, tides and phases of the moon. You will also discuss eclipses and cyclones.

Size, distance and 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, but the distance between Earth and the moon is 384 000 km. The sun is 150 000 000 km away from the Earth.

The sun is 1 400 000 km across, the Earth is 12 756 km across and the moon is 3 476 km across. If you were to make a model of these three objects using a 1 billionth scale, then the sun would be 1.4 m across and Earth would be a ball 13 mm wide, 150 m away from the sun. The moon would be a 3 mm wide ball, 38 cm from Earth. Even these scale distances are impossible to show accurately in a book so all the diagrams in this unit are not drawn to scale. Some of the drawings will have some parts made larger to show special features. The tide diagrams are examples of this.

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 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. In this unit you will complete a number of activities that use models to show how the different cycles occur.

Activity 1

Materials needed:
Object 1.4 m across (e.g. Table, mat);
Object 13 mm across (e.g. Stone);
Object 3 mm across (e.g. A small stone);
Tape measure.

Size And Distances Model

Aim To make a scale model to show the size and distance between the sun, Earth and the moon.

1. Take the objects that represent the sun, Earth and moon, outside into an open area larger than 150 m.
2. Place the object representing the sun at one end of the space.
3. Measure 150 m from the 'sun' in any direction and then hold the object representing the Earth at this place.
4. Measure 38 cm from the Earth and then hold the 'moon' at this place.
5. Compare the sizes and distances. These are really 1 billionth of the real sizes and distances.
6. Draw a diagram in your exercise book to show the model.
7. Label the objects and record the distances between them.
8. Write a heading for the diagram such as: **Scale model of the distances and sizes of the sun, Earth and moon.** Write: **Not to scale** below the heading.
9. Explain two reasons why people use models when studying the cycles of the sun, Earth and moon.

Gravity

Gravity is a force that pulls objects closer together. The **mass** of the object, that means how much material there is in an object, determines the amount of gravity it will have. Very large objects like stars, planets and moons have large **gravitational forces**. The gravitational force of a large object pulls smaller objects towards it. We, and all the objects around us, are held to Earth by its gravitational force. When we lift an object we lift it against the force of gravity and when we let it go gravity makes it fall back to the surface of Earth. We call the force of gravity on an object its **weight**.

It is the gravitational force of the sun that keeps Earth in orbit around it and the gravitational force of Earth keeps the moon in orbit around it. Even though the moon is small compared to Earth, its gravitational force is strong enough to cause the water in the Earth's oceans to move in and out. These movements are called **tides**.

The force of gravity on an object is measured with a force meter or can be calculated. On the surface of the Earth the force of gravity is 10 **Newtons** per kilogram. The symbol for Newtons is N. If an object has a mass of five kilograms then the force of gravity on it will be 50 N.

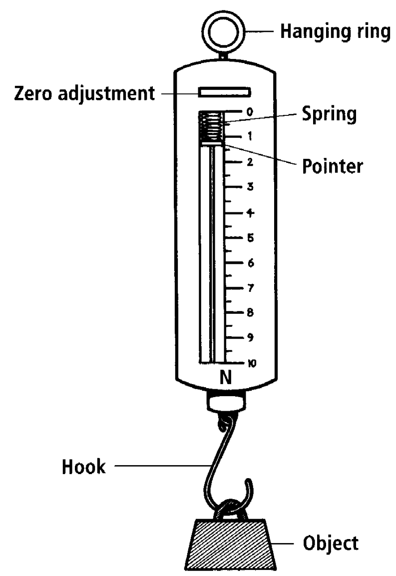


Diagram 3.1
Using a force meter.

Activity 2

Materials needed:
Force meter;
Range of small objects that can be measured with the force meter.

Measuring The Force Of Gravity

Aim To use equipment to measure the force of gravity on objects.

1. Hold the force meter by the hanging ring. Check that the pointer is at the zero mark. Adjust it if needed.
2. Pick up an object. Estimate the force of gravity (weight) on the object. Record this in a table like the one below.

Object	Estimate of weight force (N)	Measured weight force (N)

3. Place the object on the hook of the force meter and carefully read the scale. Record the weight force of gravity on the object in a table.
4. Estimate and measure the weight force of several other objects.

Earth's cycles
Day and night, seasons, tides and phases of the moon are all cycles that occur on Earth or can be viewed from Earth. They are controlled by the positions of the sun, Earth and moon in relation to each other. The following activities use models and ideas to investigate each of these cycles.

Activity 3

Materials needed:
Large light bulb and holder without a shade or a torch;
Plug and electricity for light bulb;
Globe or large ball;
Small figure of a person cut out of paper;
Sticky tape.

Day And Night

Aim To use a model to investigate day and night.

1. In groups discuss the following questions.
   a. Why is there night and day?
   b. What happens to cause night-time?
   c. What happens to cause daytime?
2. Record your ideas and report back to the rest of the class.
3. Complete the following model investigation exercises:

Model 1: To Investigate What Causes Day And Night

Key words for this activity are:

day	night	spin	sun	earth
sunrise	morning	sunset	evening	

1. If possible dim the light in the room then put a light bulb in the middle of the room. Turn it on and stand in a circle around it. Pretend that the light is the sun and your body is the Earth.
2. Can you see the sun (light bulb) now? Is it daytime or night-time?
3. Spin your body to the right until you can't see the sun (light bulb) anymore. Is it day or night now?
4. Continue to spin slowly to the right, stop when you can just see the sun (light bulb) appearing on your right side. It was dark and night time and now it is starting to get light again. What is this part of the day called?
5. Continue to spin slowly to the right, stop when you are directly facing the sun (light bulb) again. What time is it now?
6. Spin slowly to the right until you can just see the sun on your left side. It was bright and now it is beginning to get dark again. What time of the day is it now?

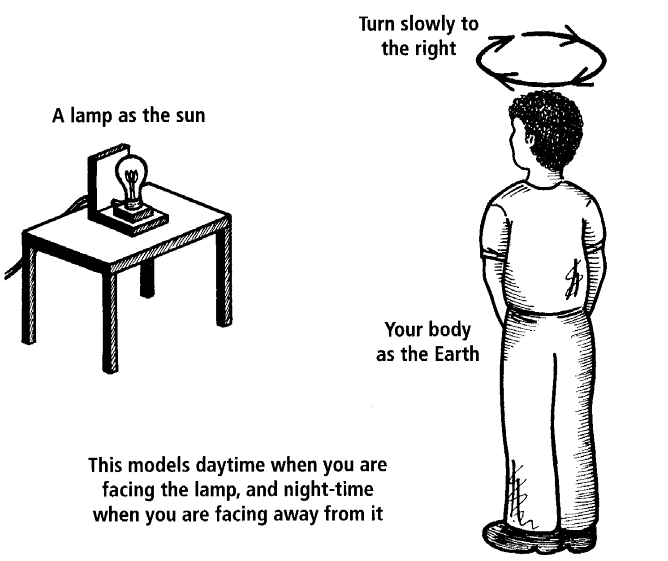


Diagram 3.2
Using your body to model day and night.

Model 2: To Investigate Day And Night

1. Use sticky tape to put the cut-out model of a person on the globe over Sāmoa.
2. Sit in a circle around the sun (light bulb). One person stands inside the circle holding the globe.
3. Hold the globe near the sun (light bulb) and spin it slowly until the cut out person is facing the sun. Would the cut out person be able to see the sun? Is it day or night for the cut out person?
4. Turn the globe slowly to the right, watching what happens to the cut out person. Stop when the person is facing away from the sun. Would the cut out person be able to see the sun? Is it day or night for the cut out person?
5. How should Earth spin so that it is daytime again for the cut out person? Turn the globe to show daytime again.
6. One person tells the person holding the globe how to turn it to a time when the person would be sleeping.
7. Another person tells the person holding the globe how to turn it to a time when the person would be seeing sunrise.

8. Another person tells the person holding the globe how to turn it to a time when it would be morning for the person.
9. Another person tells the person holding the globe how to turn it to a time when it would be evening for the person.
10. Another person tells the person holding the globe how to turn it to a time when it would be day for a person on the opposite side of Earth from Sāmoa.
11. Another person tells the person holding the globe how to turn it to a time when it would be night for a person on the opposite side of Earth from Sāmoa.
12. In your exercise book draw one or more diagrams of Earth and the sun to show what causes day, night, sunrise and sunset. Make sure you show which way the Earth is spinning.

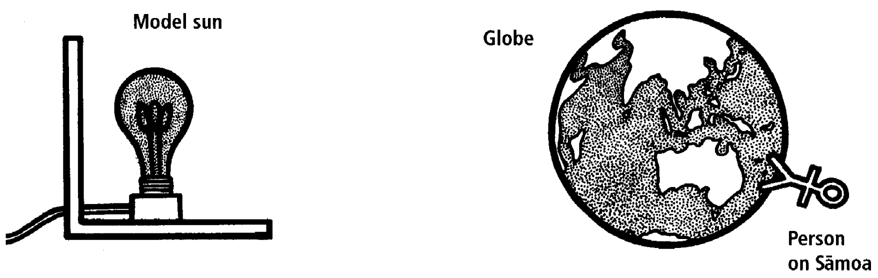


Diagram 3.3
Using a globe to model day and night.

Earth in space
While Earth is spinning to cause day and night it is also moving around the sun in an **orbit**. It takes **one year** of 365 and a quarter days to orbit once around the sun.

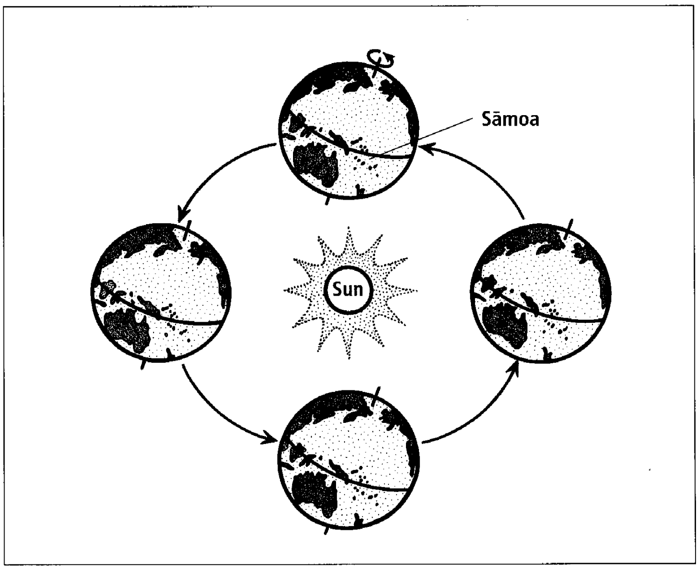


Diagram 3.4
Earth in orbit around the sun.

The Earth is a ball that is on a **tilt** to one side as it spins and moves through space. The angle of the tilt is 23.5°. This tilt stays the same all the time. This means that different parts of Earth are closer to the sun at different times of the year.

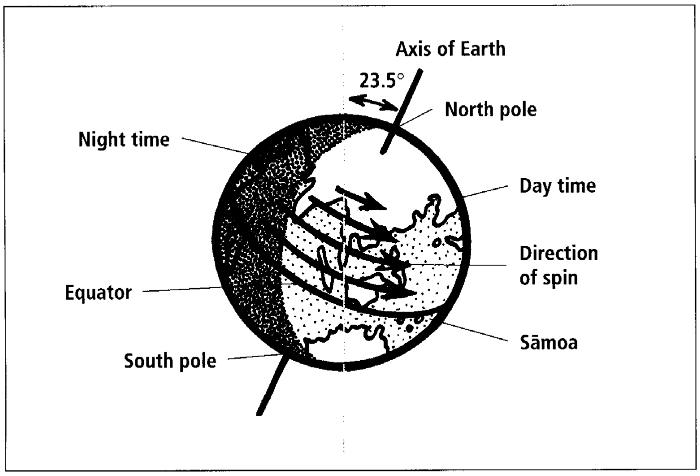


Diagram 3.5
Earth spinning with a 23.5° tilt to one side.

Seasons

A **season** is a time of the year when the weather follows a similar pattern that is different to the next season. Countries in different parts of the world have different seasonal changes.Three things work together to cause seasons. These are:

- The movement of Earth around the sun each year.
- The way Earth tilts on an angle of 23.5°.
- The position of the country in relation to the equator.

Countries like Sāmoa, that are between the Tropic of Capricorn and the **equator**, or between the equator and the Tropic of Cancer have **tropical climates**.

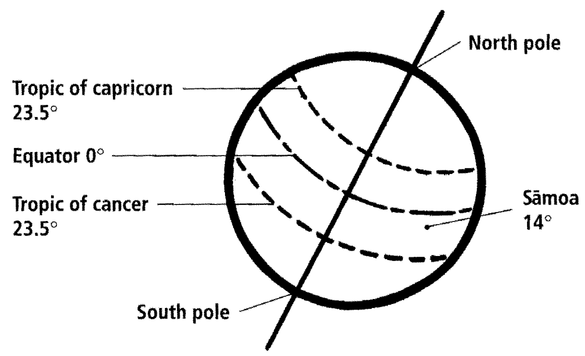


Diagram 3.6
Where is Sāmoa on Earth?

Sāmoa has a climate with two seasons. During the hot and rainy season, from December to April, the temperatures go up over 30°C. Although there are long periods of dry sunshine each day, up to three centimetres of rain can fall on a typical day. Often the temperature is cooled by tradewinds and the effects of afternoon downpours. Sāmoa sometimes has hurricanes and cyclones in the rainy season.

The season between May and November is cooler and drier, with less humidity and pleasantly cool evenings.

Activity 4

Materials needed:

Large light bulb and holder without a shade, or a torch;

Plug and electricity for light bulb;

Globe or large ball;

Small figure of a person cut out of paper.

Seasons In Sāmoa

Aim To investigate why Sāmoa has two seasons each year.

Model to investigate seasons

1. Place the cut-out person on the globe over Sāmoa.
2. One person holds the globe. Make sure it is on a tilt. Some globes are on stands that hold it on a tilt of 23.5° but if it is not tilted it is up to the person holding it to keep it on a tilt.
3. Sit or stand in a circle and place the sun on a table in the centre of the circle.
4. The person holding the globe walks in a circle around the sun holding the globe on the same tilt. This is how the Earth would move around the sun over a year.

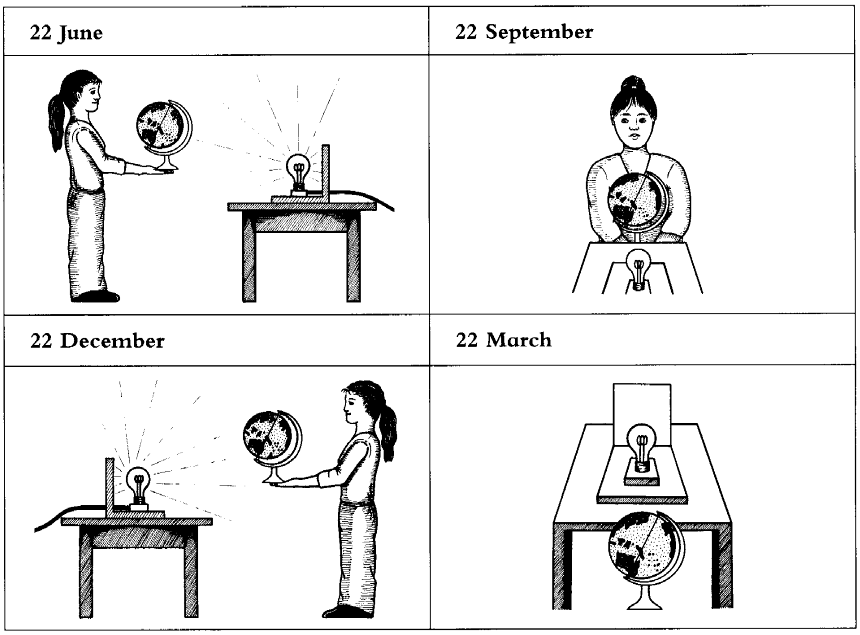


Diagram 3.7
How the Earth moves around the sun each year.

5. Get the person holding the globe to walk around the circle again, this time stopping every 90° (as shown in Diagram 3.7). At each stop, spin the globe so that Sāmoa is facing the sun and check that the tilt is correct.
6. Discuss how the position of the cut-out person changes as the Earth moves through a year. How do you think this causes the seasons?

Look at Diagram 3.7 again. Then read the following notes:

In March and September the sun is directly over the equator. In December the tilt causes the lower half or southern hemisphere to be closer to the sun and this becomes the hot, rainy season. In June the tilt causes the southern hemisphere to be further away from the sun which gives the slightly cooler, dryer season.

During the rainy season cyclones can occur. The British Meteorological website has this to say about cyclones:

> Tropical cyclones are amongst the most powerful and destructive meteorological systems on Earth. Globally, 80 to 100 develop over tropical oceans each year. Many of these make landfall and can cause considerable damage to property and loss of life as a result of high winds and heavy rain. In recent years, the Met Office has taken an active role in improving the forecasts of these weather systems.
>
> http://www.met-office.gov.uk/sec2/sec2cyclone/sec2cyclone.html

Because cyclones can cause so much damage it has become important to predict when and where cyclones will happen.

Activity 5 Predicting Cyclones

Aim To investigate the effects of cyclones and methods used to predict them.

1. Set up a questionnaire to find out about the experiences local people have of cyclones. Take care with your questions as some people will have had bad experiences during cyclones. Questions could include:
   a. Where were you when the cyclone arrived?
   b. What were you doing?
   c. What do you remember most about it?
2. Ask some questions about the traditional methods that older people in the village use to predict when and where cyclones occur.
3. Ask some questions about how people are prepared for future cyclones. What preparation or plans have people made to reduce the effects of future cyclones?
4. Write a report of the information you find out. The report should have the following headings:
   a. What are cyclones?
   b. A case study of one cyclone.

c. Traditional methods of predicting cyclones.

d. Methods that people are using or will use to reduce the effects of future cyclones.

5. Share your information with others in the class.

Activity 6 Research On Cyclones

Aim To process and interpret information on the causes of cyclones and how equipment and models are used to predict and locate cyclones.

1. Research a range of sources of information to find out the answers to the following questions:

   a. What causes cyclones?

   b. How is equipment used to detect cyclones?

   c. How are models used to predict cyclones?

The following websites have information about cyclones:

http://www.metoffice.gov.uk/sec2/sec2cyclone/sec2cyclone.html

http://cimss.ssec.wisc.edu/tropic/tropic.html

http://www.solar.ifa.hawaii.edu/Tropical/tropical.html

http://www.nrlmry.navy.mil/~chu/

http://weather.unisys.com/hurricane/

http://www.nhc.noaa.gov/aboutnames.shtml
(This site lists the names to be used for the cyclones that will occur in the next few years.)

Seasons in other countries
Countries that are further away from the equator have **temperate climates** with four seasons, summer, winter, spring and autumn. The months that these seasons occur in are different in the southern and northern hemisphere.

Season	Southern hemisphere	Northern hemisphere
Summer	December	June
Autumn	March	September
Winter	June	December
Spring	September	March

The weather pattern for each season is so different that plants respond and animals behave in different ways in each season. For example, plants will flower at a particular time of the year. They have adapted to flower during that season and will not normally flower at any other time of the year. In autumn horses will loose their fine, short, summer coat hair and grow longer, thicker coats to keep them warm for the winter.

There are three reasons why the winter season is colder than summer. These are:

- Winter days are shorter, so less heat is gained from the sun.
- Winter nights are long, so more heat is lost to space each night.
- The sun is low in the winter sky, so less heat is delivered to a given area.

In Sāmoa the differences in temperature and daytime length are very small compared to other island countries such as New Zealand that have four seasons.

Activity 7

Materials needed:
Torch;
Piece of paper;
Globe.

Temperature Differences

Aim To investigate why the temperatures at different times of the year are slightly different.

1. Shine the torch light straight onto the piece of paper, so you see a circle of light. All the light from the torch is in that circle. Draw around the circle.
2. Now slowly tilt the paper, so the circle changes shape to become an ellipse. All the light is still in that ellipse, but the ellipse is spread out over more paper. This means that the **density** of light drops. In other words, the amount of light per square centimetre is less. However, the number of square centimetres increases, so the total amount of light stays the same. This is expected as the light from the torch has not changed.
3. Draw around the ellipse.
4. Cover the front of the torch so that only a small amount of light is seen. Now take the globe, tilt it and move it and the torch around without changing the direction of the tilt. Record how the light on the surface of the globe changes as the globe is moved around the torch.

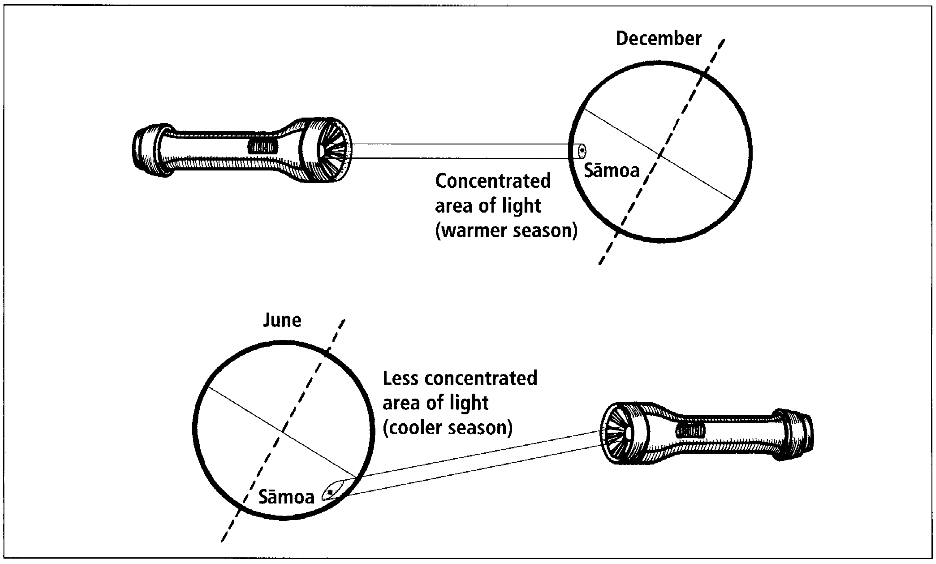


Diagram 3.8
Light covers a wider area when the Earth is tilted away from the sun.

5. Look at the following diagram and explain why the weather in Sāmoa is hotter in December than in June.

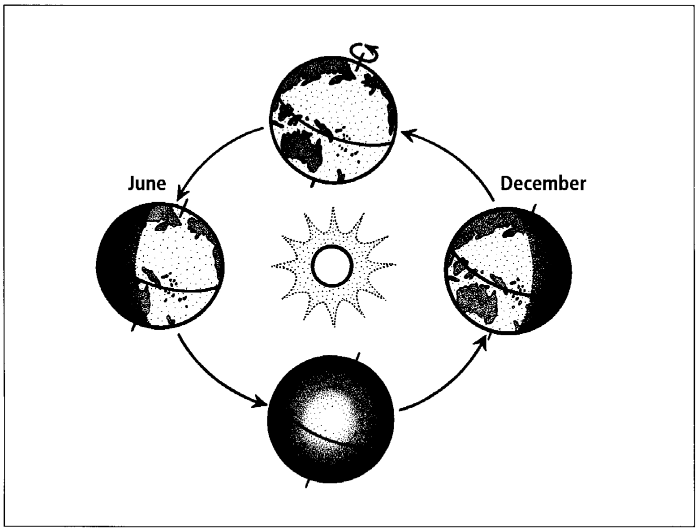


Diagram 3.9
Less light and heat per area in the dry season.

Activity 8 Seasons Research

Aim To research information about seasons.

Check out some of the following websites but remember that they are usually written for the Earth's northern hemisphere and Sāmoa is in the southern hemisphere.

http://csep10.phys.utk.edu/astr161/lect/time/seasons.html

http://www.badastronomy.com/bad/misc/seasons.html

http://www.aspsky.org/education/tnl/29/29.html

http://www.stardome.org.nz/School/school.htm

http://www.yahooligans.com/science_and_nature/the_earth/Seasons/

http://www.ndbc.noaa.gov/educate/seasons.shtml

http://www.howstuffworks.com/question165.htm

Activity 9 Seasons Around The Globe

Aim To record information about the seasons.

1. Describe the weather in Sāmoa during each of the two seasons.
2. Use information from Activities 3 and 4 to explain why Sāmoa has a tropical climate with two different seasons.
3. Use a globe to compare the location of Sāmoa with New Zealand, then use your knowledge to explain why New Zealand has a temperate climate with four seasons.
4. Which season will it be on 1 January in Sāmoa, New Zealand, and the USA?

The moon in space

The moon is our closest neighbour in space. It is a sphere 3476 kilometres wide and is made up of rock similar to that found on Earth. The moon orbits around the Earth. It stays in orbit because of the Earth's gravitational pull on it. The moon has its own gravitational force that is much smaller than the Earth's, because the moon only has 1/6 the mass of the Earth.

The moon orbits in an easterly direction and it takes about 28 days to orbit once around Earth. Looking from Earth the moon appears to rise in the east and set in the west just as the sun does. Because the moon moves 12 degrees further east in its own orbit every day it rises later each day.

The moon shines because of light from the sun hitting it and being reflected to us on Earth. Half of the moon is always in light and half in dark, just as the Earth is.

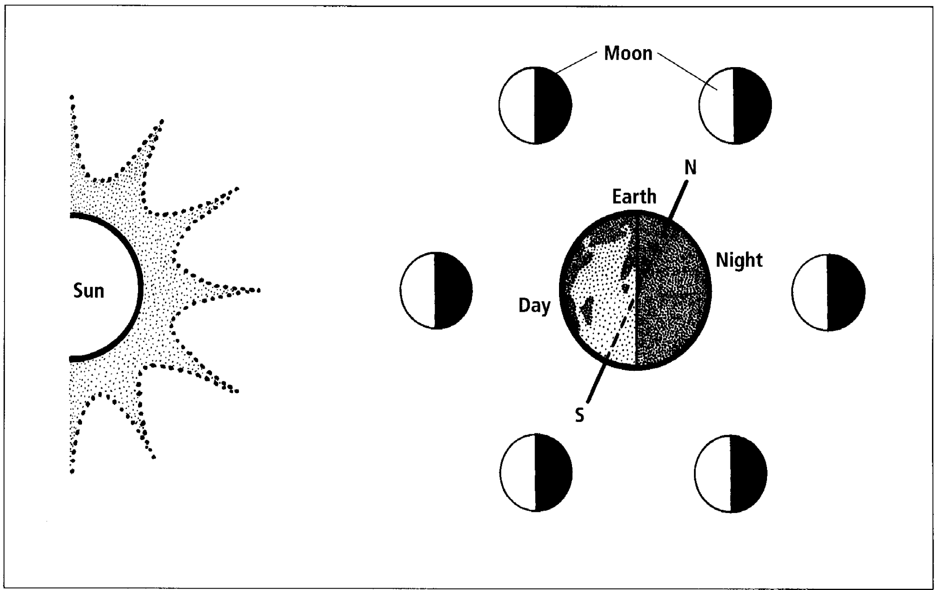


Diagram 3.10
Wherever the moon is in its orbit it is half in day and half in night.

As the moon moves around its orbit we see different parts of the surface that is in the light. This is what causes the **phases of the moon**. The following set of diagrams shows the phases of the moon. It gives the relative positions of the sun, Earth and moon, what the moon will look like from Earth and when during the day and night you are likely to see the moon. The first quarter is named for its position a quarter of the way through the cycle, not for how much of the moon you can see.

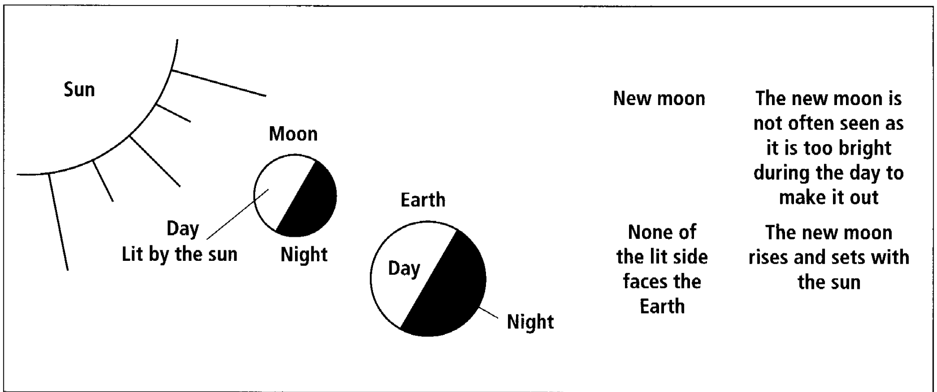


Diagram 3.11a
Phases of the moon.

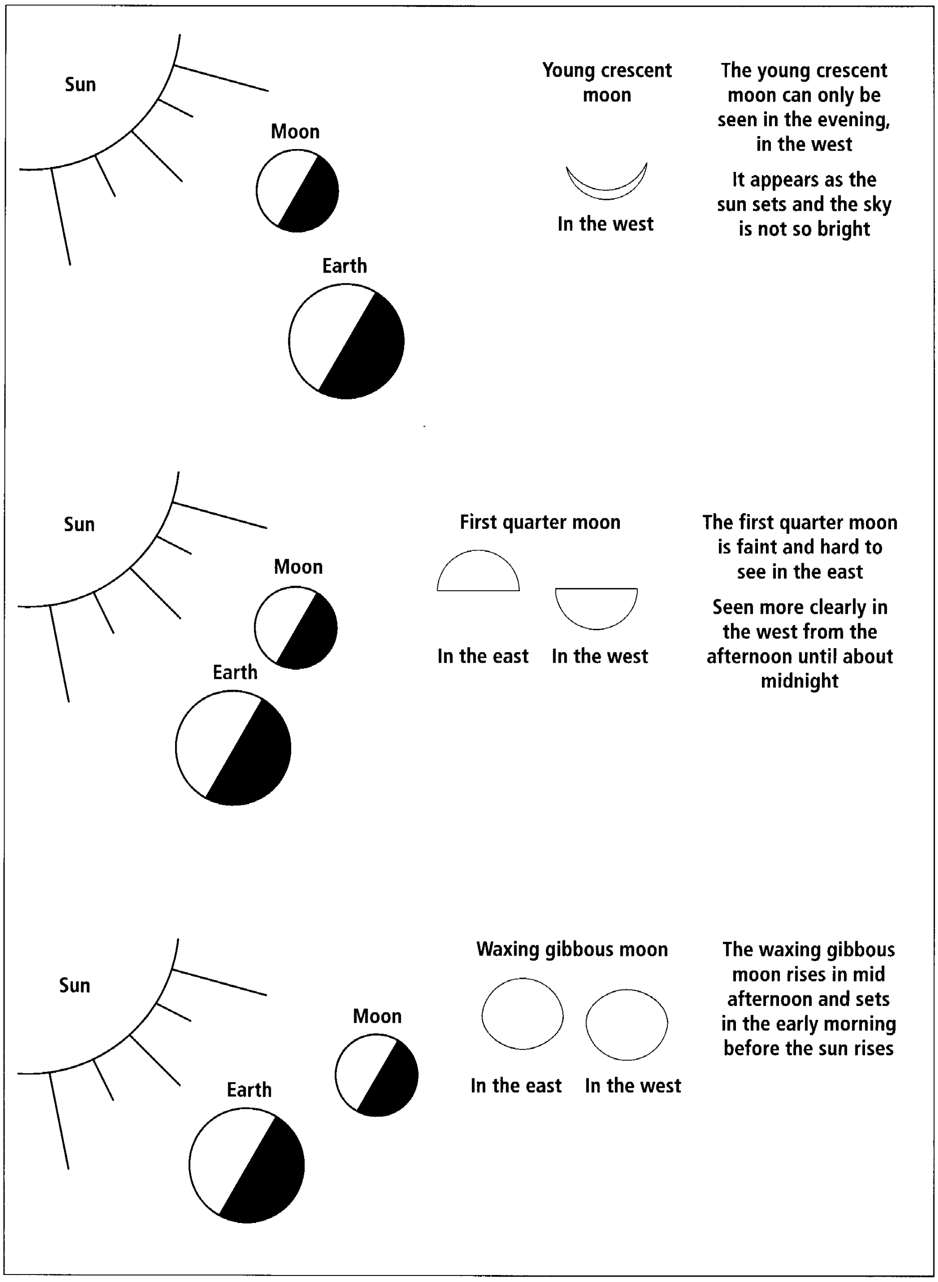


Diagram 3.11b
Phases of the moon.

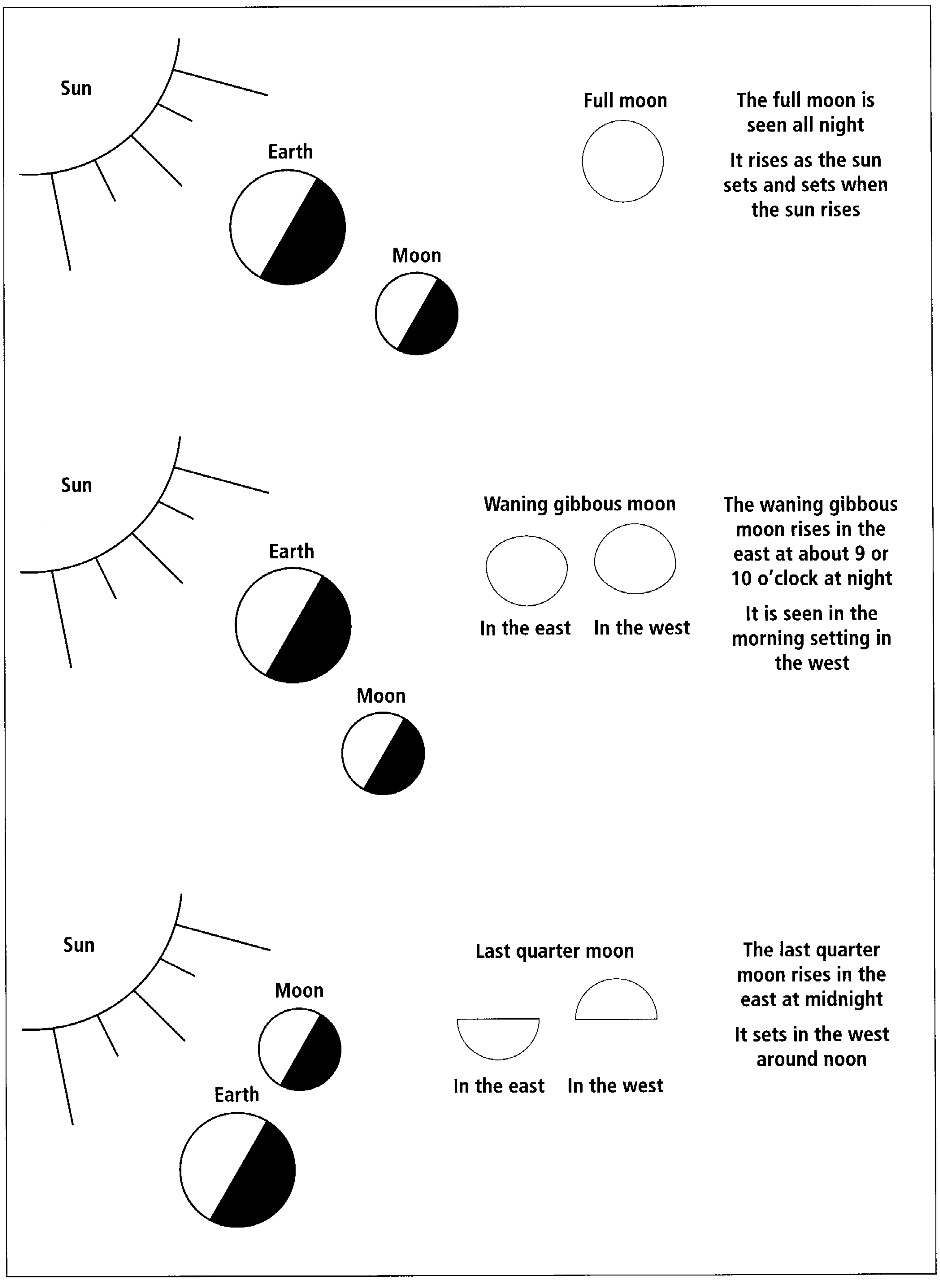


Diagram 3.11c
Phases of the moon.

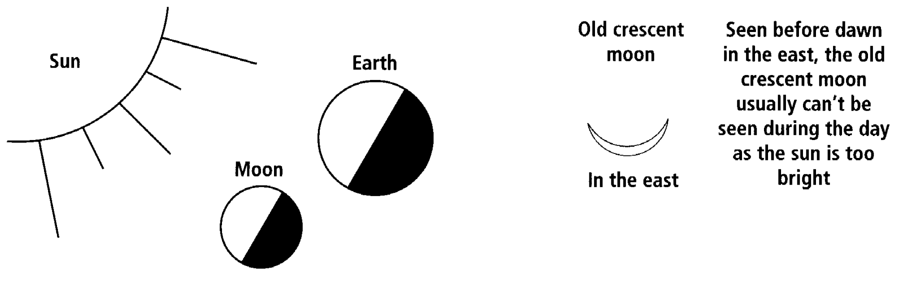


Diagram 3.11d
Phases of the moon.

Activity 10 Moon Phases

Aim To record information about the phases of the moon.

1. Copy and complete the following table:

Phase	Position of sun, Earth and moon during this phase	What the moon looks like from the Earth	Time of day and night phase can be seen

2. Explain each of the following:
   a. A full moon is seen only at night
   b. The surface of the new moon can't be seen
   c. The moon rises later each day

Activity 11 Observing The Moon

Aim To observe the changing phases of the moon.

1. Draw and complete the following moon diary (the top of the next page) to record the way the appearance of the moon changes over a month.

Date and time observed	Drawing of the shape of the moon that can be seen	Position of the moon in the sky	Phase of the moon

Tides

All around the world the waters of the ocean move in and out in regular **tides**. Sea organisms often have feeding and reproduction patterns that fit with the tides. Tides are caused by the force of gravity from the moon and sun on the water in the ocean. The gravity of the moon causes the water in the oceans facing the moon to be pulled upward slightly by about two or three metres. This causes a high tide. As the Earth turns the water that was pulled up returns to a lower level or low tide while the water in the new area facing the moon gets pulled up.

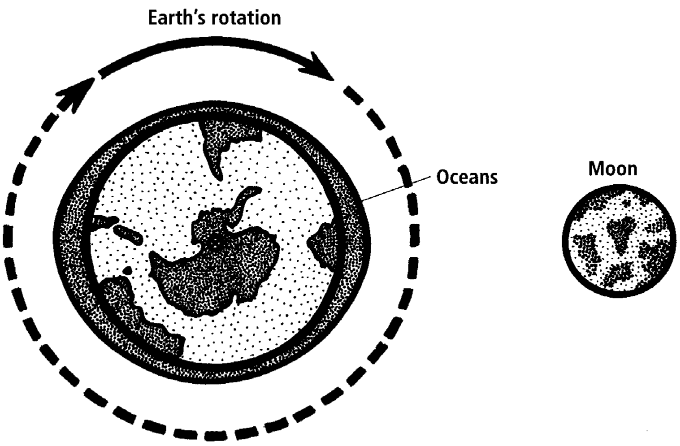


Diagram 3.12
The gravity of the moon causes tides.

As a high tide occurs on the side facing the moon a high tide also occurs on the opposite side of Earth. This is why there are two high tides each day. One when Sāmoa is facing the moon and one when Sāmoa is on the side of Earth opposite to the moon. One explanation for the tide on the opposite side of Earth is that the ocean floor on the opposite side is pulled more strongly than the water so it causes a high tide above it.

Some high tides are higher than others and some low tides are lower than others. This is because of the effect of the sun's gravity as well. Once each month when the moon and sun are in line the gravitational forces of both work together to cause a higher high tide and lower low tide called **spring tides**. Also each month when the moon and sun are at 90° to each other their gravitational forces work against each other and there is less difference between the high and low tides. These tides are called **neap tides**.

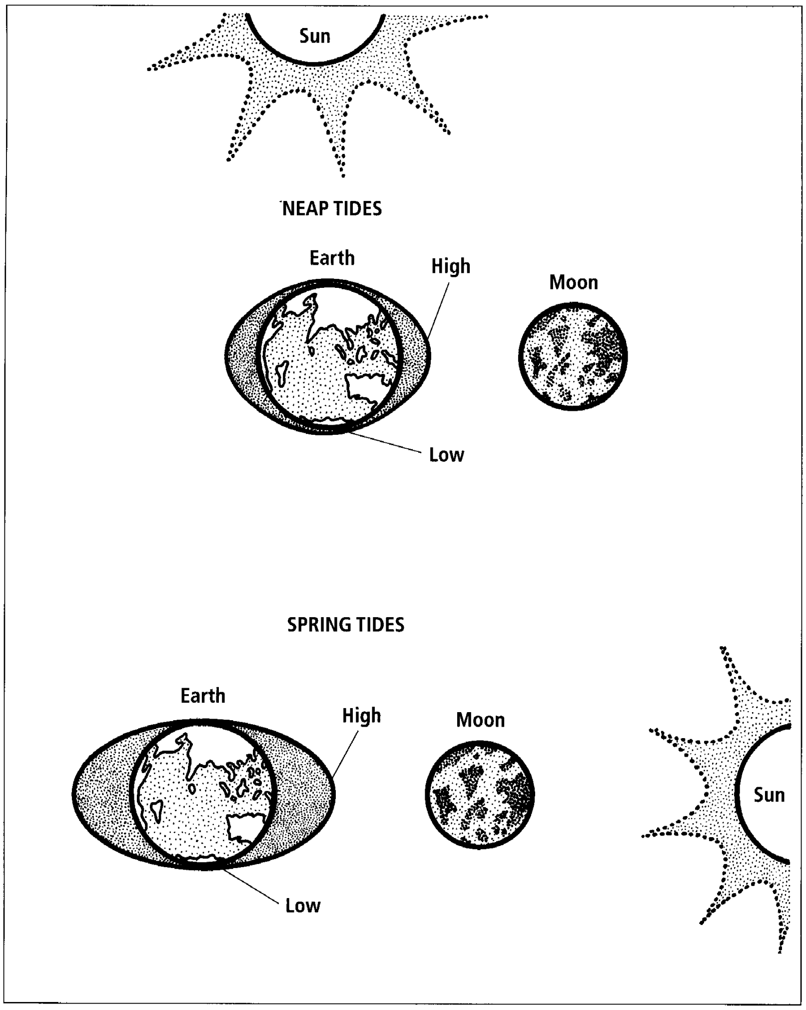


Diagram 3.13
Spring and neap tides.

In some places the tides are naturally higher or lower than other places because of the shape of the land in that area. The air pressure also affects the tides.

The following information was downloaded from the website of the Division of the Government of Sāmoa, Ministry of Agriculture, Forestry, Fisheries and Meteorology at http://www.meteorology.gov.ws/forecast.htm

Tide Table For Sāmoa

Monthly Tide Tables are available at $1.50 each from the Geophysics Section of the Division: phone 20855 for purchase enquiries.

Tide times for the week beginning 10/03/02

Tide	Sunday	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday
High	**2.28 am**	**3.05 am**	**3.49 am**		**12.03 am**	**1.18 am**	**2.22 am**
Low	**8.40 am**	**9.22 am**	**10.14 am**	**4.45 am**	**5.53 am**	**7.08 am**	**8.16 am**
High	**2.56 pm**	**3.44 pm**	**4.42 pm**	**11.20 am**	**12.33 pm**	**12.42 pm**	**2.42 pm**
Low	**9.03 pm**	**9.51 pm**	**10.51pm**	**5.50 pm**	**7.05 pm**	**8.12 pm**	**9.09 pm**

Activity 12 Tides

Aim To record information about the cause of high and low tides.

1. Draw a diagram to show the shore line close to where you live.
2. Describe where on the shore line the water is at high and low tides.
3. Draw a set of labelled diagrams to explain how the Earth moves to cause the tide in Sāmoa to go from high to low to high and to low again.
4. Explain why the high tide time is different at different places.
5. If possible, visit this website. It uses a graph to show how the tides change each day: http://www.ofu.co.nz/graph/tides.htm
6. Look at the tide timetable for Sāmoa given above. How long is it between the high and low tide times on Sunday?
7. Why is there only one high tide time listed on Wednesday?

8. Look at the tide timetables for Auckland, listed on pages 97–99 at the end of this book. Choose one of the three months given, then complete the following:
   a. What is the range of heights for high tides?
   b. What is the range of heights for low tides?
   c. Spring tides are extremely high tides and extremely low tides. Which dates are spring tides occurring on?
   d. Neap tides are high tides that are very low, and low tides that are very high. Which dates are neap tides occurring on?
   e. How many days is there between spring tides and neap tides?
   f. Which phases of the moon do spring and neap tides occur with?
9. Use the information in the Auckland tide timetables to graph the changing height of the tides for 10 days. Choose a different month than the one you chose to answer question 8.

Eclipses

An eclipse occurs whenever the sun, moon and the Earth line up so that part or all of the sun or moon are hidden from our view. Eclipses do not happen very often and when they do they can only be seen at certain locations on Earth. Both the Earth and the moon form shadows and these shadows cause eclipses.

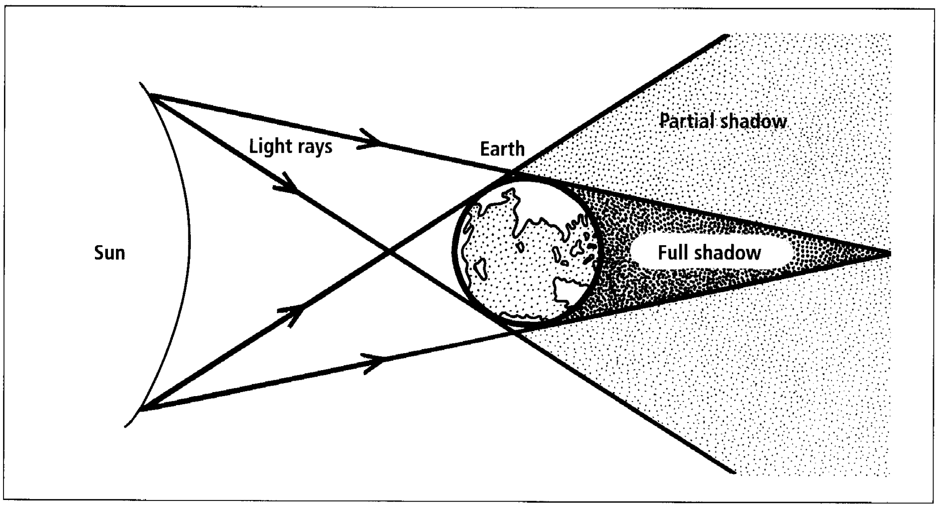


Diagram 3.14
The Earth's shadow.

Lunar eclipse

Lunar is a word used to mean something to do with the moon. A lunar eclipse occurs whenever the full moon moves into the shadow caused by the Earth. An eclipse does not happen each full moon phase because the moon is usually above the shadow. When a lunar eclipse does occur it only lasts a short time and the surface of the full moon becomes dark red as the shadow of the Earth passes over it.

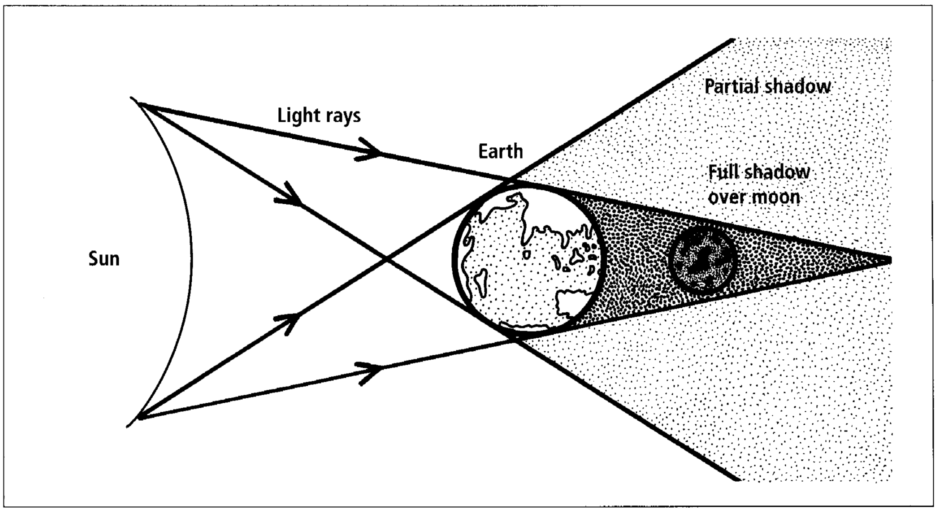


Diagram 3.15
A lunar eclipse.

Solar eclipse

Solar is a word used to mean something to do with the sun. A solar eclipse occurs whenever a new moon casts a shadow on Earth and blocks out our view of the sun. A total solar eclipse only lasts for a few minutes but it makes the sky darken and the stars can be seen.

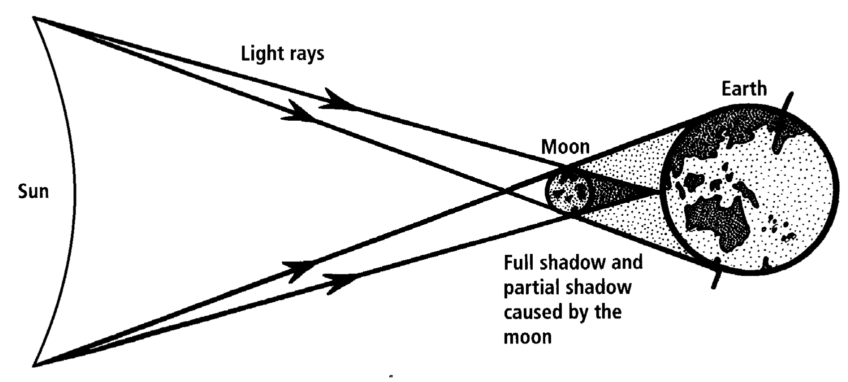


Diagram 3.16
A solar eclipse.

Activity 13

Eclipses

Aim To record information about lunar and solar eclipses.

1. Copy Diagram 3.15 of a lunar eclipse.
2. Describe what a lunar eclipse is.
3. Explain why a lunar eclipse only occurs when there is a full moon.
4. Copy Diagram 3.16 of a solar eclipse.
5. Describe what a solar eclipse is.
6. Explain why a solar eclipse only occurs sometimes and not every month.

Unit summary

- Models are often used when studying the movement of the Earth, and moon because the sizes and distances of the objects are so large and it is easier 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 the Earth in orbit around the sun and the moon in orbit around the Earth.
- Weight is the force of gravity on an object. The force of gravity on 1 kg is 10 Newtons.

- Day and night are caused by Earth spinning on its own axis. It takes 24 hours for Earth to spin around once. During this time half of the Earth is in daylight and half is in night time.
- It takes 365 and a quarter days or 1 year for Earth to orbit once around the sun.
- The Earth spins on an angle or tilt of 23.5°. This tilt stays the same all year so the two different hemispheres of Earth are closer to the sun at different times of the year. This 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 when the tilt of the Earth causes the Southern Hemisphere to be closest to the sun. The cooler seasons occurs 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 phase 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 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.
- 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 the sun and blocks the view of the sun from Earth. Solar eclipses are only seen in a small area where the shadow of the moon falls on the Earth.

Unit 4: ENERGY

Introduction
In this unit you will learn about potential and active forms of energy.

What is energy?
Everything around us is either matter or energy. Matter is easy to talk about because it can be seen, touched and smelt. Energy is more difficult to talk about because usually it cannot be touched or held. Energy is something that can make things move or change. Every time something moves or changes energy of some sort is involved. There are lots of different types of energy. Energy can be changed from one type to another. Energy can only be detected when it is changing from one type to another.

Activity 1 What Is Energy?

Aim To record ideas about energy.

1. Read the information above on what energy is. Then write down four keys points from the information.
2. Brainstorm ideas on energy to find out what your group knows about energy. Give examples of energy moving or changing things.
3. Share your ideas with the class.
4. Record the ideas from the whole class by grouping similar ideas.

Energy can be divided into two groups. The first group is stored energy called **potential energy** and the second group is called **active energy**.

Potential energy
Some examples of potential energy include gravitational, chemical, elastic, nuclear and magnetic energy.

Gravitational Potential Energy

Gravitational potential energy is energy that objects have because they have been lifted above the Earth's surface. For example, the materials in a fale roof have been lifted up off the ground so they have gravitational potential energy. A coconut growing on the tree has gravitational potential energy. As a person is climbing the tree to get the coconut they are gaining gravitational potential energy. The higher they go the more gravitational potential energy they will gain. The greater the mass they have, the more gravitational potential energy they will gain.

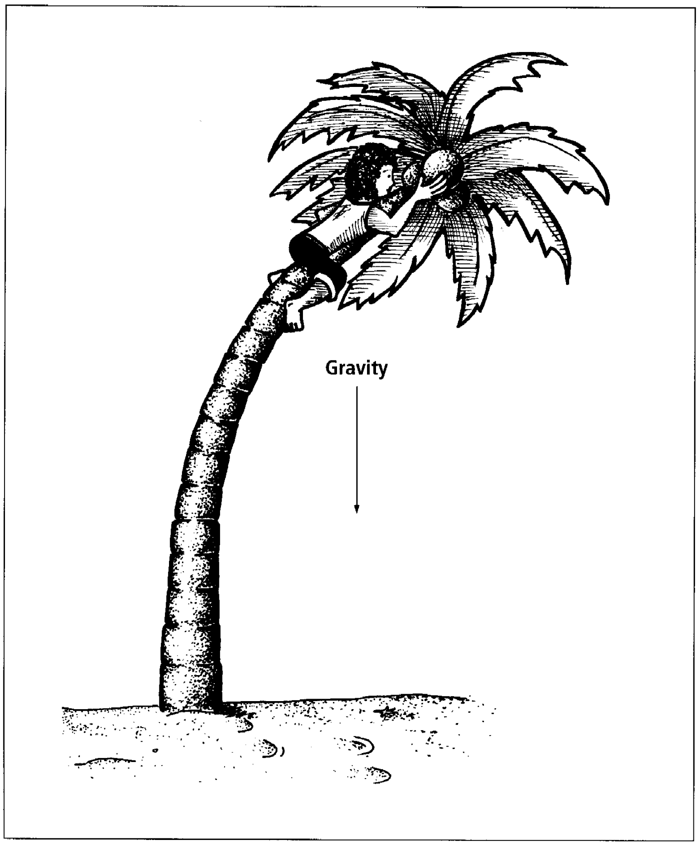


Diagram 4.1
The person gains gravitational potential energy as they climb.

Activity 2

Materials needed:

Two small objects the same eg two pencils or pens;

String or rubber band to join objects together;

Rulers.

Gravitational Energy

Aim To compare the amount of gravitational energy gained by an object.

1. Select a small object, place it on the floor then lift it from the floor to the desk.
2. Measure the height of the desk.
3. Now lift the object the same height above the desk. Each time you lift the object you are doing work and the object gains gravitational potential energy from your work.
4. Draw a diagram showing the object in the three positions, on the floor, on the desk and above the desk.
5. In which position does the object have the most gravitational energy? Explain why. Label the amount of gravitational energy in the object in the three positions on the drawing as 'a little', 'some', and 'double'.
6. Tie the second object to the first and repeat the lift from floor to desk. Add the objects tied together to your diagram.
7. Does the object by itself or the two tied together have the most gravitational energy? Explain why. Use 'double' to label the diagram.
8. Find some other objects to lift. Where is the energy coming from that you are using to do the work to lift these objects?

Chemical Energy

This type of energy is stored in foods, fuels, explosives and batteries. The energy is held in the chemical bonds that hold atoms together. Petrol, used in cars, is a fuel that has lots of chemical energy stored in it. Car engines burn the fuel and use the energy to make the car go forward. The chemical energy stored in batteries is used in portable tape recorders and radios. The foods we eat contain different amounts of energy. We use the energy in the food we eat to move and think. If we don't use all the energy in the food we eat, our body can store it as fat.

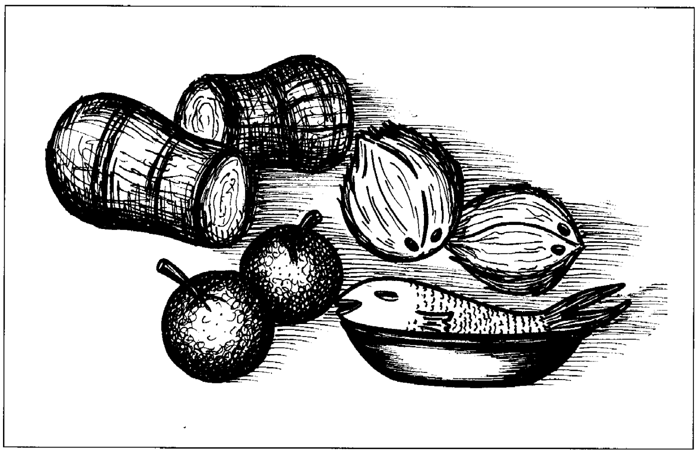


Diagram 4.2
Food has chemical potential energy in it.

Activity 3

Materials needed:
Peanuts;
Crucible or small tin lid;
Burner, tripod and gauze;
Boiling tube;
Thermometer;
Measuring cylinder;
Water;
Test tube holder.

> **Warning!**
> **Be careful when doing this experiment. Follow your teacher's instructions.**

Chemical Energy

Aim To investigate the amount of chemical energy in a peanut.

1. Measure 10 mL of cold water and pour it into the boiling tube.
2. Record the temperature of the water.
3. Start the peanut burning and immediately use the flame from the peanut to heat the water in the boiling tube. (See Diagram 4.3 on the next page.)
4. Once the peanut has burnt out, take the temperature of the water again.
5. It takes 42 joules of energy to heat 10 mL of water by 1°C. To work out the amount of energy released by the peanut multiply the increase in temperature of the water by 42.

   Amount of energy from the peanut = increase in temperature × 42.
6. The real energy value for the peanut would have been higher than this amount. Suggest possible reasons for this.
7. Modify the investigation to get more accurate results, then carry out your modified investigation.

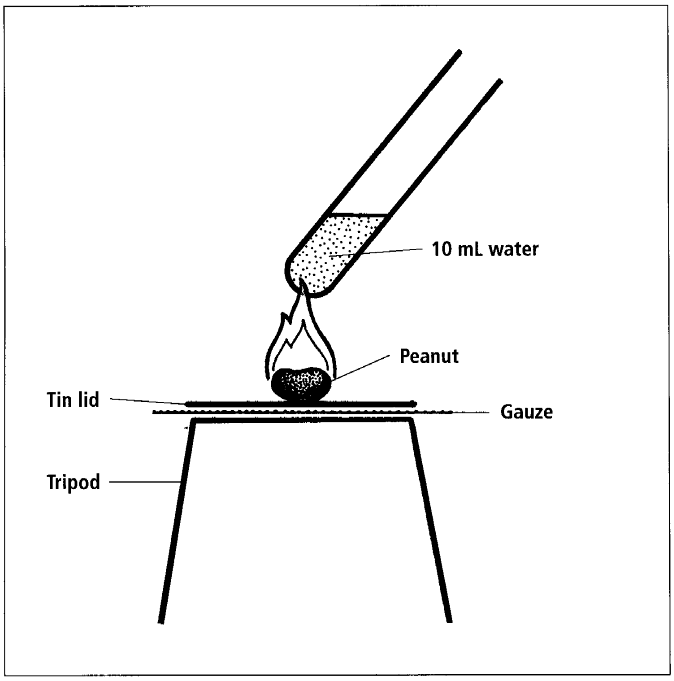


Diagram 4.3
Energy in a peanut.

Activity 4

Materials needed:
Materials that will burn;
Crucible or small tin lid;
Burner, tripod and gauze;
Boiling tube;
Thermometer;
Measuring cylinder;
Water;
Test tube holder.

Energy Investigation

Aim To investigate the energy released when materials burn.

Plan an investigation to compare the amounts of energy given off when different materials burn. You could try different materials such as other nuts and compare them with the peanut used in activity 3. Another suitable investigation would be to compare plastics or fabrics or paper or wood. Another idea is to compare the energy given off when different amounts of paper are burnt.

You will have to do an initial investigation to find out what size pieces of material can be used. If the water boils before the material has finished burning use a smaller amount of material or a larger amount of water. Another possibility is to time how long it takes to boil the 10 mL of water.

Copy and complete the investigation plan sheet on the next page, then complete the exercise that follows.

What is the investigation called? (*e.g. Burning.*)

What is the aim or purpose of this investigation? (*e.g. To compare the amount of energy given off when plastic and paper burn.*) To compare . . .

What variable will be changed? (*e.g. The type of material being burnt* OR *the amount of material being burnt.*)

How will the variable be changed? (*e.g. I will use plastic and paper* OR *I will use different sized pieces of paper.*)

Which variables will be kept the same? (*e.g. The amount of each material, the amount of water* OR *the type of material, the amount of water.*)

What will be measured? (*e.g. The temperature of the water at the start and end.*)

How will you make sure the results are accurate and reliable? (*e.g. Repeat each test three times.*)

1. Hand your plan to your teacher for checking.
2. Record the step-by-step instructions for carrying out your investigation. Write them in a way that someone else could follow the instructions to carry out the same investigation.
3. Carry out your planned investigation.
4. Calculate your results using the equation:

   Amount of energy = increase in temperature × 42
5. Record your results in a table.
6. Write a conclusion comparing the amount of energy released from each material.

Activity 5

Materials needed:
Small plastic bottle with a cork or stopper;
Vinegar or dilute acid;
Baking soda;
Thin paper.

Soda Bomb

Aim To investigate energy changes from a chemical reaction.

1. Half fill a bottle with vinegar or dilute acid.
2. Check that the cork fits.
3. Put about a tablespoon of baking soda onto a sheet of thin paper. Lightly roll it up so that it will slip easily into the bottle.
4. Drop the soda into the vinegar or acid and quickly put the cork on.
5. Shake the bottle to spread the soda out into the vinegar or acid.
6. Point the cork away from people and wait!

Elastic Energy

This type of energy is stored in springs or things made of stretchy materials such as rubber bands and balloons. Elastic energy is stored whenever any of these are stretched or squashed. The energy is released when the material goes back to its original shape or size.

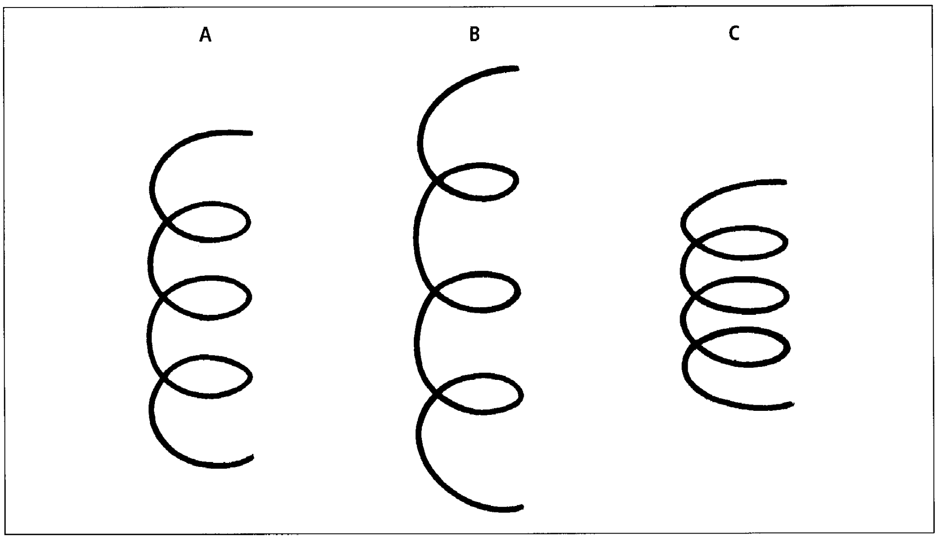


Diagram 4.4
Elastic energy is held in stretched and squashed springs.

The spring is at its normal length in (A). When stretched (B) and when squashed (C) the spring is holding elastic potential energy.

Activity 6

Materials needed:
Rubber band or elastic;
Paper, marble or small stone.

Making A Catapult

Aim To investigate elastic potential energy.

1. Form the rubber band into a catapult and use it to flick a small piece of screwed-up paper along the desk.
2. Measure how far the paper goes.
3. Repeat twice more and then work out an average over the three trials.
4. Change the paper to a larger piece of paper and flick it along the desk. Try to use the same amount of stretch in the rubber band as you did with the smaller piece of paper.

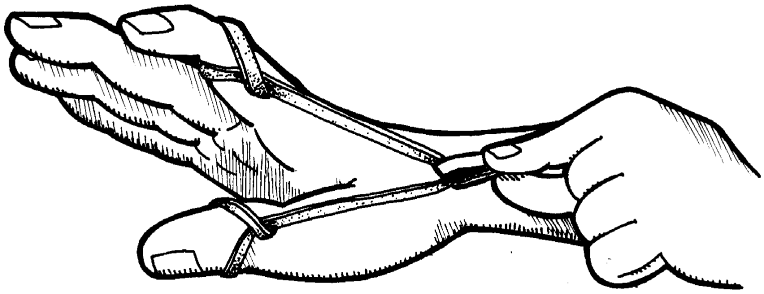


Diagram 4.5
A catapult.

Warning!
Be careful when doing this experiment. Follow your teacher's instructions.

5. Repeat twice more. Calculate the average and then compare the two sets of results.
6. Select one of the following to investigate further. Plan, carry out and report on your investigation.
   a. The effect of different amounts of stretch on the distance a piece of paper travels.
   b. The effect of different rubber bands on the distance a piece of paper travels.
   c. The effect of different shaped pieces of paper on the distance travelled.
   d. The effect of different numbers of rubber bands on the distance travelled.

Nuclear Energy

This is energy that is stored inside the nucleus of atoms which is the central part of the atom. Large amounts of energy are released when the nucleus splits apart or joins to another nucleus. People have used the release of nuclear energy in nuclear bombs. Some countries use nuclear energy to make electricity.

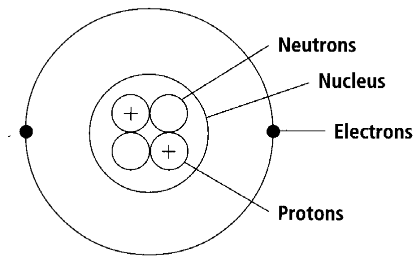


Diagram 4.6
Helium atom.

Magnetic Energy

This is energy that is stored in an iron object moved away from a magnet and released when the iron moves towards the magnet. Magnetic energy is also stored when an electric current flows through a coil of wire causing the coil to become an electromagnet.

Activity 7

Materials needed:
Magnet;
Objects made up of different materials including some made from iron.

Magnetic Energy

Aim To investigate magnetic potential energy.

1. Place the magnet on the table and move objects made from different materials towards the magnet. Which materials are affected by the magnet? These are the ones that can store magnetic potential energy.
2. Group the materials into those that are able to store magnetic potential energy and those that are not.
3. Continue to investigate the material that is affected by the magnet. Does the size of the object make any difference to the way it behaves?

Active Energy

Some examples of active energy include **kinetic**, **radiant**, **sound**, **heat** and **electrical** energy. Active energy is the energy in things that are moving or changing.

Kinetic energy

This energy is the energy of moving objects. Every object that is moving has kinetic energy. Often gravitational, chemical and elastic potential energy are changed into kinetic energy. The larger an object is, the more kinetic energy it has and the faster an object is moving the more kinetic energy it has.

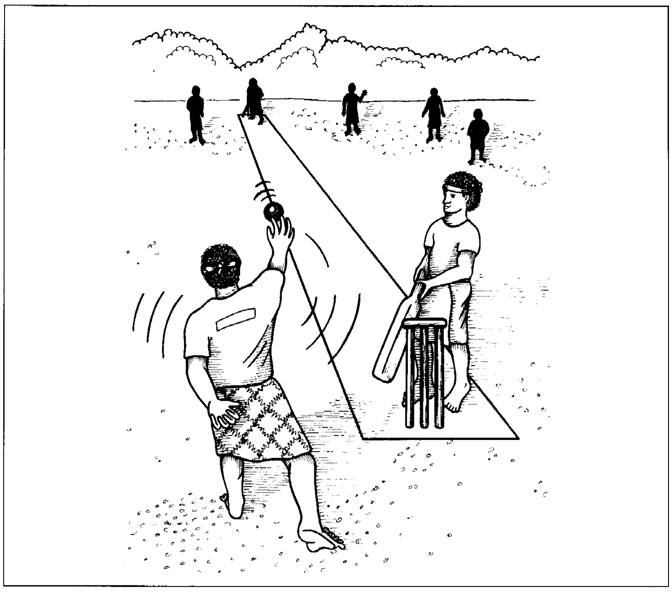


Diagram 4.7
Playing kilikiti.

People playing kilikiti have lots of kinetic energy when they run between the wickets, run to get the ball, and support the players.

Radiant energy

This type of energy includes light, radio waves, X-rays and microwaves. Radiant energy moves from place to place as a wave. The wave travels at the speed of light which is 300 000 kilometres per second. The sun gives out a large amount of radiant energy and small amounts are given out by hot materials and objects when they burn.

Sound energy

This type of energy is made by vibrating objects. The vibrations cause the energy to travel as sound waves through air, water and solid materials. In air, sound waves travel at 330 metres per second.

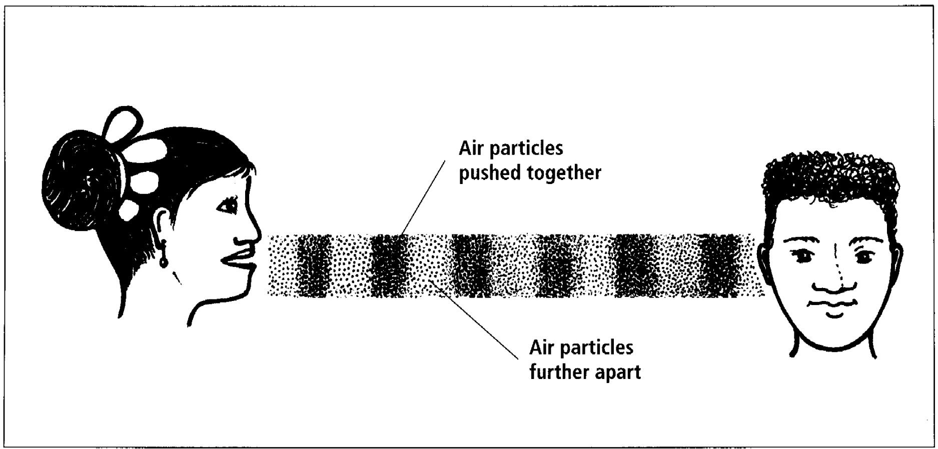


Diagram 4.8
Sound waves in air.

When a person speaks, their vocal cords move back and forth. When the vocal cords move forward they push the air molecules together and when they move back the molecules in the air become further apart. This causes a sound wave. Our ears are designed to hear these sound waves.

Heat energy

This type of energy causes atoms and molecules in materials to move. The more heat energy the atoms and molecules have, the faster and more freely they move. When a material gains heat energy, its particles have more kinetic energy so its temperature goes up. Heat energy and radiant energy are given out when a material burns.

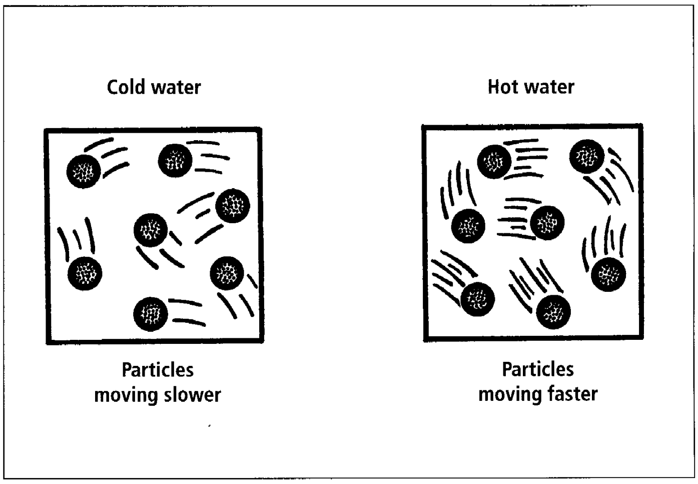


Diagram 4.9
Particles in cold and hot water.

Electrical energy
This type of energy is carried by electrons that flow through a metal when it is conducting an electrical current. When a wire is carrying an electrical current, all the free electrons move along the wire in the same direction carrying electrical energy.

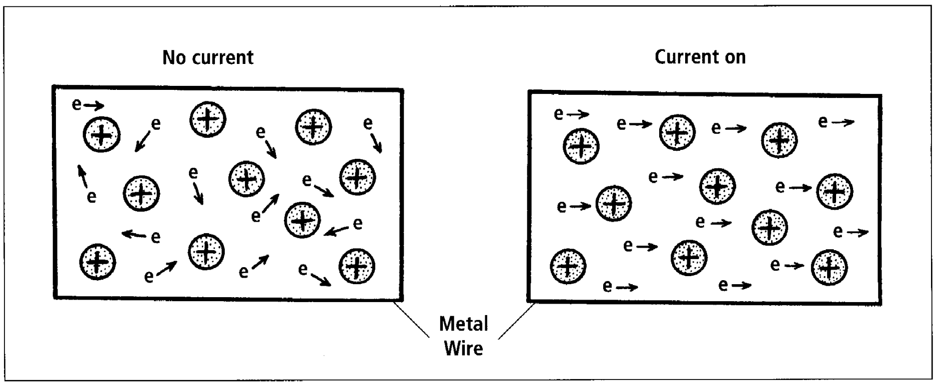
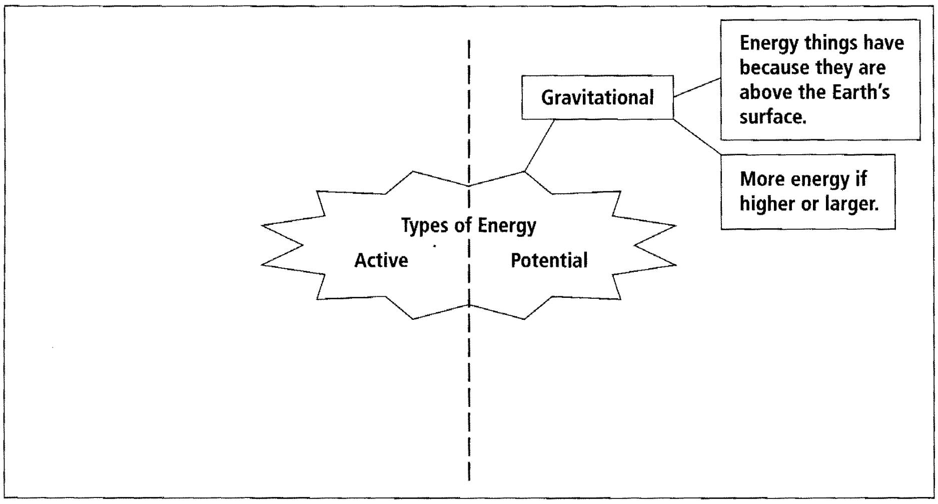


Diagram 4.10
Electrical current in a wire.

Activity 8 Types Of Energy

Aim To record information about different types of energy.

Copy the following mindmap and then complete it to show information about each of the types of energy discussed.



Energy Changes

Energy can be **transformed** from one type to another. A fire transforms the chemical energy in the wood into heat and light energy. When a ball is thrown up into the air, its kinetic energy is transformed into gravitational potential energy until it slows to a stop and then begins to fall down again. As it falls, the gravitational potential energy is changed back into kinetic energy. In a car engine the chemical energy in the petrol is transformed into kinetic, heat and sound energy.

Energy transformations are not always very efficient. Whenever energy is transformed some of the energy gets changed into forms of energy that are not so useful. Only about 30% of the chemical energy in petrol is transformed into the kinetic energy of the car. The other 70% of the energy is changed into heat energy which is no longer able to be used and is lost into the environment.

Transformations can have one step or be in several steps. Transformations or energy stories can be easily shown in energy chains.

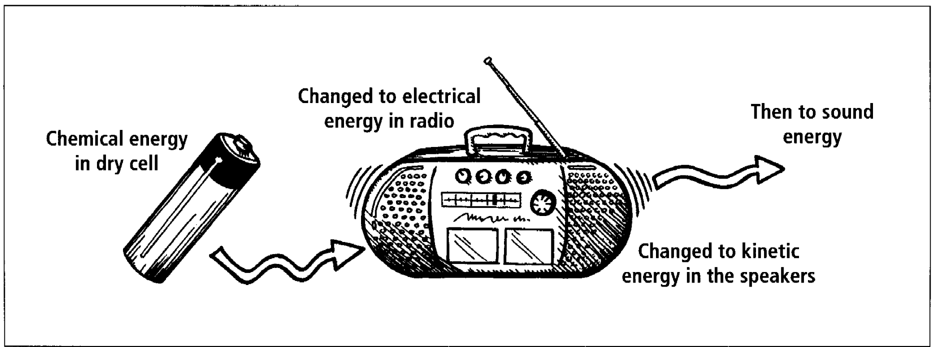


Diagram 4.11
Music energy story.

The energy chain for this energy story is:

Chemical ⟶ electrical ⟶ kinetic ⟶ sound

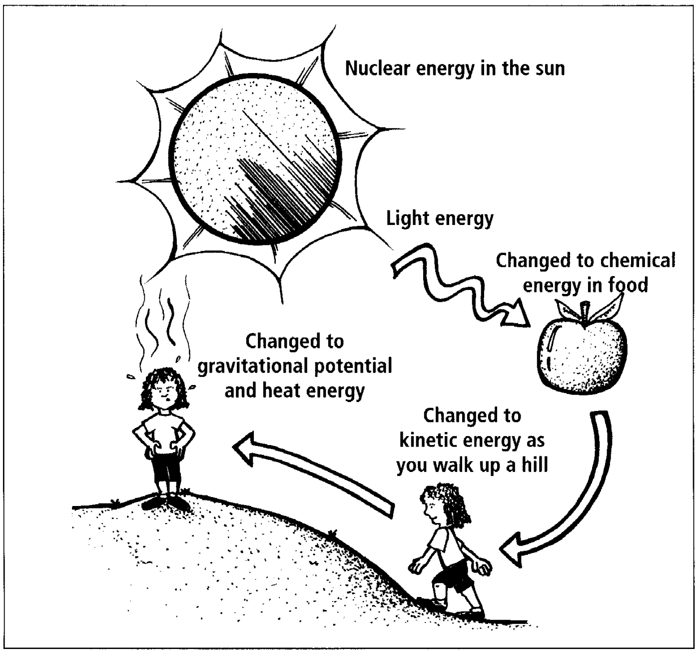


Diagram 4.12
Food energy story.

Nuclear ⟶ light ⟶ chemical ⟶ kinetic ⟶ gravitational potential and heat

Here are some other energy chains:

In a moving car

Chemical → kinetic + heat + sound

In a light

Electrical energy → light + heat

In a television

Electrical energy → light + sound + heat

In a person biking up a hill

Chemical energy → kinetic + gravitational potential + heat

In a car slowing down

Kinetic energy → heat

Energy can also be transferred from one object to another. Heat energy from a fire is transferred to a person standing next to it. When energy is transferred it stays in the same type of energy.

Activity 9 Transfer And Transform

Aim To record information about transfer and transformation of energy.

1. Write a paragraph to show you understand the difference between the transfer and the transformation of energy.
2. Rewrite the following sentences in your book and say if they are 'transfer' or 'transformation' of energy. If you think both a transfer and a transformation is occurring you must explain them.
   a. Light energy hits a shiny object and the light travels to our eyes.
   b. Some of the light energy heats up a 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 Papaseea Sliding Rock.
   h. The water in the Falevai river rolls a stone along.
   i. Water goes up through an Alofaaga blowhole, in Taga Savaii.
   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.
3. Think about energy transformations that occur in your everyday life. Write down an energy story for three different situations.
4. Write energy chains for each of the transformations in your energy stories.

Activity 10 Energy Efficiency

Aim To graph information on energy efficiency.

1. Here are efficiency figures for some energy transformations:

- Diesel power station: 30%
- Solar water heater: 50%
- Electric motor: 60%
- Electric light bulb: 5%
- Fluorescent tube light: 19%

2. For each of the above draw a bar graph 100 millimetres long then shade in the percentage of useful energy for each. For example 30% efficiency will have 30 mm shaded.

Sources And Uses Of Energy

People use lots of sources of energy in their everyday lives. Fuels are a common source of energy. They can be burnt to give heat for cooking, kinetic energy in a car or electricity in a power station.

Batteries are a source of electrical energy. Because electrical energy is active and cannot be stored, batteries contain chemical potential energy that is changed into electrical energy when the battery is used in an electrical circuit.

The source of energy for all living systems is the sun. Plants are called **producers**. They use the radiant energy from the sun, in a process called photosynthesis, to make sugars. During photosynthesis that radiant energy is stored in the chemical bonds between the atoms in the sugar. The plant can then use the stored chemical energy for growth and respiration.

Animals, including people, eat plants and other animals to get the stored chemical energy so that they can use it for their growth and respiration. Animals are called **consumers** because, to live they need to eat food as a source of energy.

Renewable and non-renewable energy sources

The energy sources that people use in their everyday lives can be divided into **renewable** and **non-renewable** sources. These terms came into use when people were concerned that the fossil fuels such as coal, oil and gas, were going to run out. Energy sources that will run out are called non-renewable. Energy sources such as the sun, wind and tides are called renewable sources because energy from the sun, wind and tides is constantly being replaced or renewed.

People now have more understanding that all the Earth's different resources are limited and we should use all of them with care.

Activity 11 Wise Use Of Energy Sources

Aim To discuss ways to use energy sources wisely.

1. Work as a group to list all the sources of energy used in Sāmoa.
2. Work in pairs, select a source of energy and produce a poster about the energy source. Include information about:
   a. What the source is used for.
   b. Where it comes from.
   c. If it is renewable or non-renewable.
   d. Why it is important to use the energy source wisely.
3. Show your poster to others and discuss the wise use of energy sources.
4. Have a class discussion about the wise use of energy sources and what each class member can do to help. Record the ideas in your book.
5. Make up a short statement to remind yourself about the wise use of energy sources.

Unit summary

- 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, chemical 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 forth to make waves. These waves travel slowly.
- Atoms and molecules carry heat energy as they move about. The faster they 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 all act as sources of energy.
- All energy sources must be used wisely. Some are renewable and are replaced. Some are non-renewable, once they have been used they cannot be replaced.

Unit 5: ELECTRICITY AND MAGNETS

Introduction
In this unit, you will learn about how electricity is made and how people use it safely. You will also learn about magnets, magnetic fields and electromagnets.

Electricity
People's ability to make and use electrical energy has changed the way we live. Think of all the places around the village and in Apia that electricity is used. People use electricity to run lighting and a range of machines that do work for us. For example, a car has a battery that stores chemical energy that can be changed to electrical energy when it is needed. The battery is used to provide energy to start the motor. The car has an electrical circuit to deliver the spark that burns the petrol and another to work the lights.

Electricity is a good way to transfer energy over long distances. The energy can then be transformed into other energy by **transducers** such as televisions, radios and electrical cooking equipment.

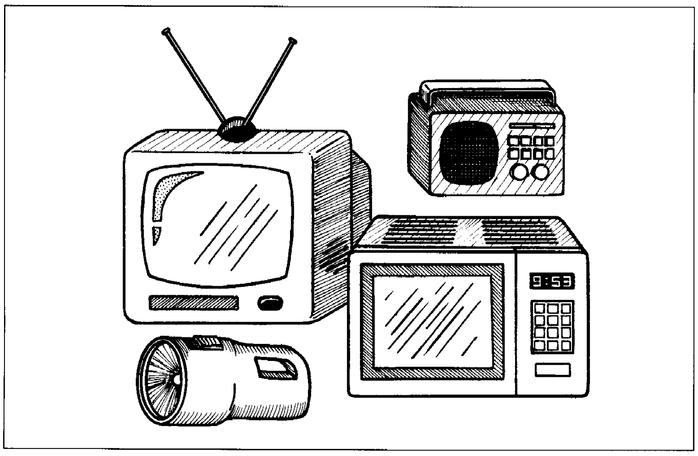


Diagram 5.1
Transducers use electrical energy.

Activity 1 Use Of Electricity

Aim To compare the way an activity is done with and without electricity.

1. Choose an activity that you have seen done with and without electricity. For example, cooking, washing clothes, pumping water, transporting food to the market.
2. Compare the way the activity is carried out with and without electricity.
3. Explain why people use electricity to do this activity.
4. Do you have television? How has the use of television and video changed the way people entertain themselves?

Safety with electricity
The batteries that are used in homes are more correctly called dry cells. Dry cells are only able to store small amounts of chemical energy that is used to produce electricity. Each dry cell used in a torch, for example, produces **direct current** electricity with 1.5 volts of energy. Dry cells are safe to use. In fact electrical circuits with voltages up to 12 volts are safe.

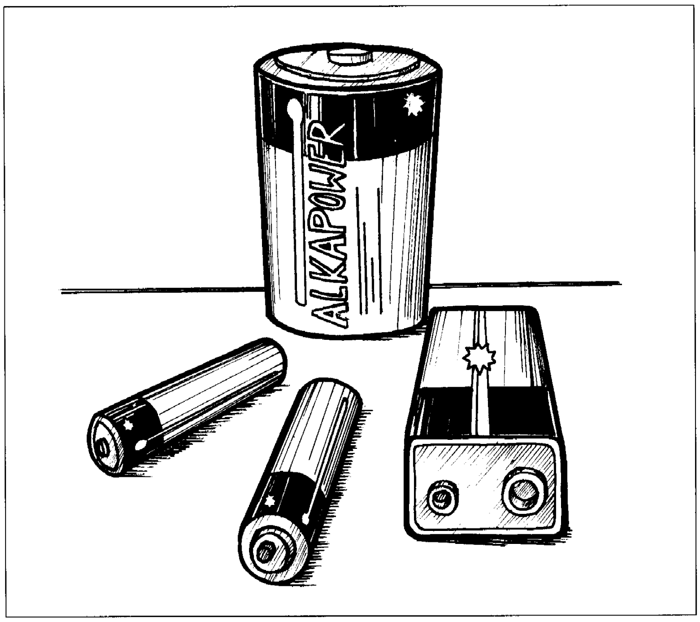


Diagram 5.2
Dry cells.

Care must be taken if dry cells corrode and the material inside begins to leak out. Care must also be taken not to burn dry cells when finished with them. Diagram 5.3 shows what is found inside a dry cell. The following warning label appears on a torch dry cell:

> Do not open batteries, dispose of in fire, recharge, put in backwards, mix with used or other battery types — may explode or leak and cause personal injury. Replace all batteries at the same time.

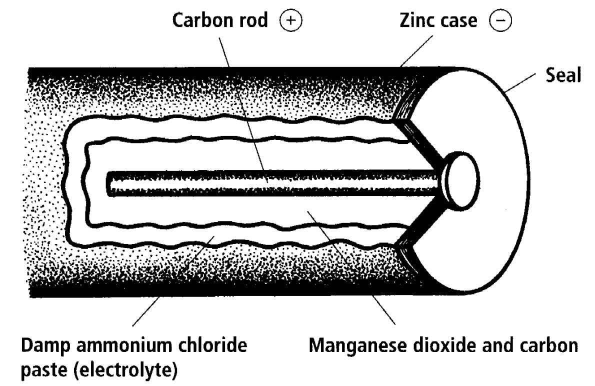


Diagram 5.3
Inside a dry cell.

The electrical circuits in a building are called mains electricity. They are **alternating current** circuits that carry electricity at 240 volts. This sort of electricity must be used carefully as it can easily kill a person. Our bodies have their own small electrical circuits that control our muscles and keep our heart beating correctly. Small amounts of electricity from outside the body can upset the way the body works and stop the heart from beating. Wet skin is a conductor of electricity so remember to dry your hands before touching plugs, sockets and cables that are plugged in.

The following points should be remembered when using electricity:

- Never use mains electricity where there is a chance of water getting on to the equipment.
- Never handle a plug when your hands are wet.
- Never risk touching overhead cables or getting objects such as ladders and kites caught up in them.
- Never unplug a device when it is turned on.
- Never use electrical cables outside without a safe device such as an RCD (residual current device) or isolating transformer connected into the plug.
- Never use equipment with damaged wires.

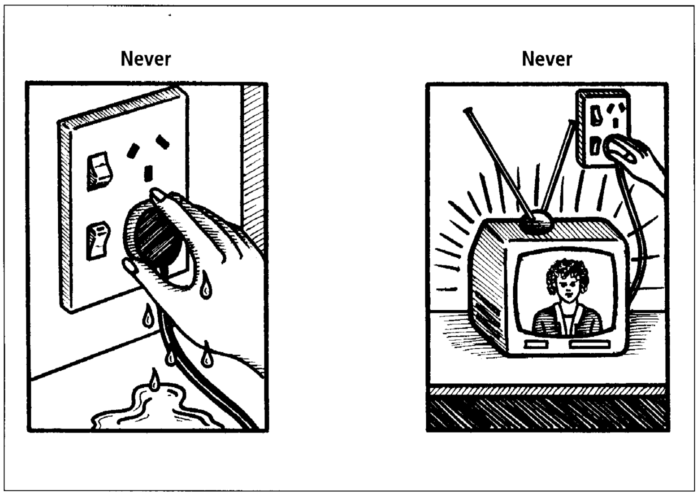


Diagram 5.4
Safety rules.

Some people protect their computers and other electronic equipment from surges of electricity using equipment commonly called Zap Catchers or Spike Busters.

Activity 2 Safe Use Of Electricity

Aim To record information about the safe use of electricity.

1. Explain why dry cells are safe to use.
2. List five things that the warning label from a torch dry cell says not to do.
3. Explain why mains electricity is dangerous to people if not used correctly.
4. Explain why it is important to have dry hands when using mains electricity.
5. Record the five bullet points about safe use of mains electricity into your exercise book.
6. Select one of the five points about safe use of mains electricity and use one page to illustrate the point using drawings or pictures and text.

Making electricity

Electricity cannot be stored so another form of energy is used to make the electricity so that it can be easily transferred around the islands of Sāmoa. The two main forms of energy used to make electricity are gravitational potential and chemical potential.

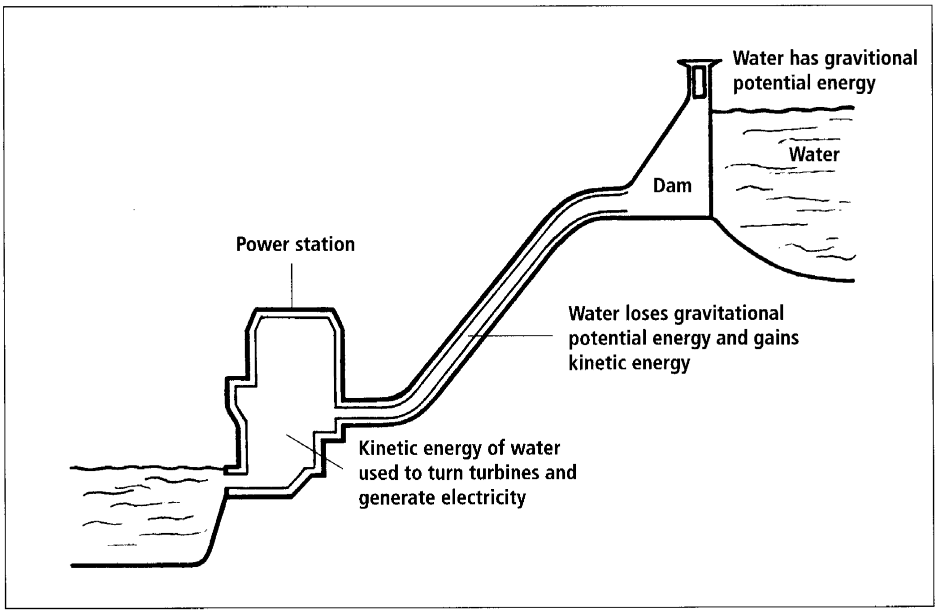


Diagram 5.5
Making electricity using the hydroelectric method.

Hydroelectric production of electricity uses the gravitational potential energy of water held behind a concrete or earth dam or in a mountain lake. The water is allowed to run down through pipes into a power station. As it goes down the pipes, its gravitational potential energy is changed into kinetic energy. In the power station the kinetic energy of the water is used to turn large turbines. Turbines are made up of thousands of loops of wire in a coil that is being turned between the poles of large magnets. As the coil moves through the magnetic field electricity forms in the wires. Power lines are then used to take the electricity to where it will be used.

Diesel generators are used to make electricity on Savai'i. In this case the chemical potential energy in the diesel fuel is being used as the source of energy to make the electricity.

Activity 3

Electricity From Kinetic Energy

Materials needed:
One or two bar magnets;
Galvanometer;
Two wires;
Coil;

Aim To find out about making electricity using movement.

1. Set up the equipment as shown in the diagram.
2. Move a magnet around the coil. Look at the meter to see how much electricity is being produced.
3. Move the magnet inside the coil and out again. What happened to the needle on the meter?
4. Turn the magnet around in your hand and move it in and out of the coil again. What happened to the needle on the meter this time?

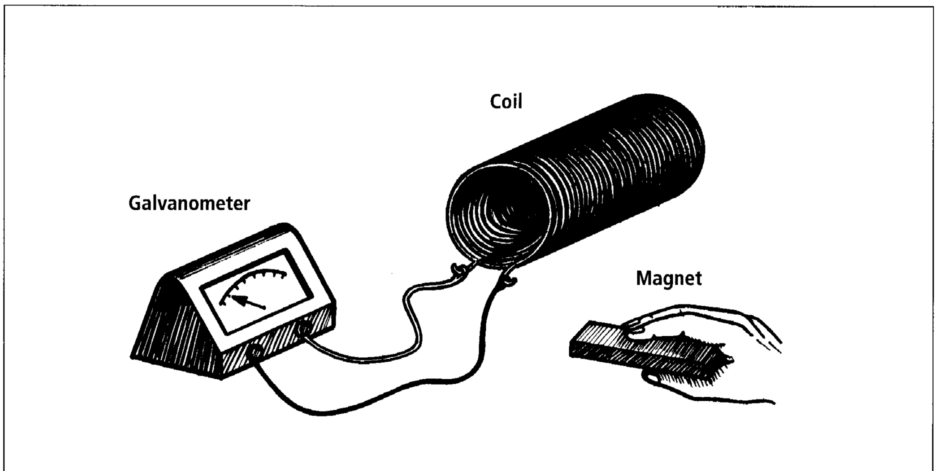


Diagram 5.6
A coil and meter.

5. Investigate the best way to produce lots of electrical energy. You could try:
    a. Moving the magnets quickly.
    b. Moving the magnets slowly.
    c. Moving the magnets around different parts of the coil.
    d. Using two magnets.
6. Write a conclusion for your investigation.

Activity 4 Making Electricity In Sāmoa

Aim To investigate how electricity is made locally.

1. Ask a range of people what they know about how electricity is made on each of the islands. Also try to find out about the history as well as the issues that the making and use of electricity raises for local people.
2. Collate the information from the class and record this information in your exercise book.

Activity 5

Using Chemicals To Make Electricity

Materials needed:
Hydrochloric acid;
250 ml beaker;
Several metals (iron, copper, lead, zinc);
Two wires;
Voltmeter.

Aim To make electricity using different chemicals.

1. Connect two metals to the voltmeter.
2. Place the metals in a beaker of acid in such a way that the metals do not touch.
3. Look at the meter to see if there is a voltage reading. If the needle on the meter does not move to the right swap each wire onto the other metal.
4. Look at the metals. Can you see a reaction taking place?

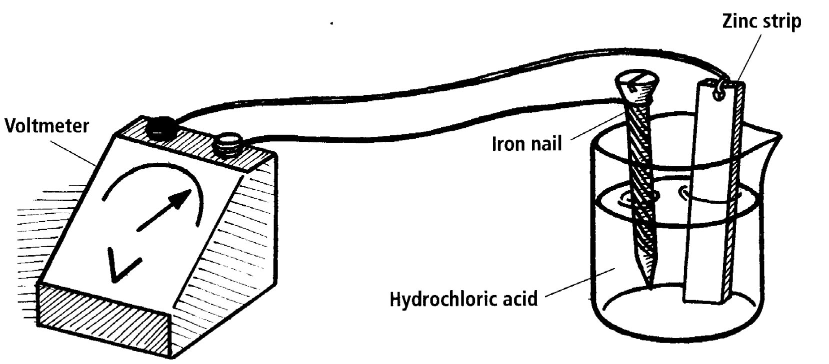


Diagram 5.7
Using metals to make electricity.

5. Copy and complete the following table.

Metal joined to the positive side of the meter.	Metal joined to the negative side of the meter.	Voltage(volts)	Comments

6. Which pair of metals gave the best reading?

Magnets

Telephones, televisions, radios, computer disks, electric motors, credit cards, video tape players and tape recorders all use magnets. The storage of information using magnetic media has allowed huge amounts of information to be stored and transferred quickly.

Magnetic resonance scanners are used in medicine to take pictures of all parts of the body. A strong magnetic field is set up around the body and radio waves are used to change the magnetic field of the bodies atoms. This causes electrical signals in the scanner that are used to form the pictures.

Magnets can be different sizes and shapes. When a magnet is allowed to turn freely one end will line up with the Earth's magnetic north pole. This end is called the north pole of the magnet. The other end is called the south pole. Often the people who make magnets put a dip in the north pole end of the magnet so that it is easy to see which end is which.

Magnets are surrounded by an invisible magnetic force field. The shape of the field is shown using lines drawn around the magnet. Magnetic fields have different strengths. The closer the magnetic field lines the stronger the force.

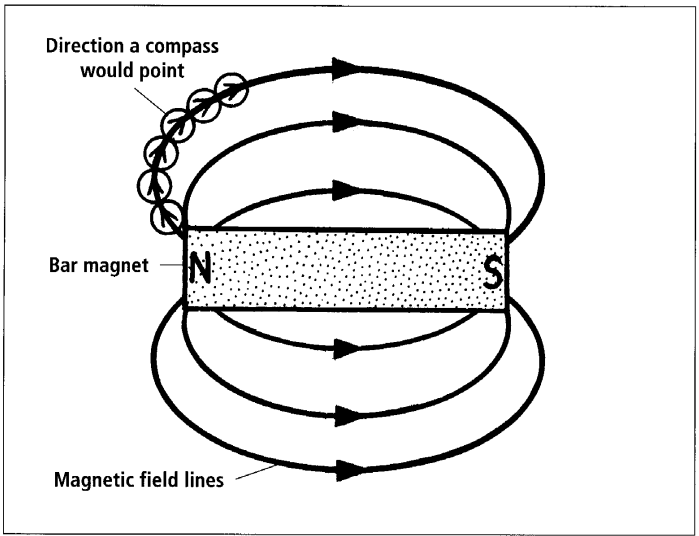


Diagram 5.8
Magnetic field lines around a bar magnet.

The magnetic fields around different magnets interact. If the same poles of two magnets are pushed together they will repel and push each other away. If a north and south pole are brought up together they attract each other and pull towards each other.

Activity 6

Materials needed:
Magnets;
Iron filings sealed in a plastic bag;
At least 2 paper clips or pins.

Magnetic Fields

Aim To investigate the shape of a magnetic field around a magnet.

Part A
Magnetic fields

1. Place a magnet on the desk. Spread the iron filings around in the plastic bag so that they form a thin layer wide enough to cover the area around the magnet.
2. Place the bag of iron filings over the magnet and observe the position of the iron filings.
3. Draw a diagram to show the shape of the magnetic field around the magnet. Label the north pole if known.
4. Place two magnets on the table close together in each of the positions shown below.

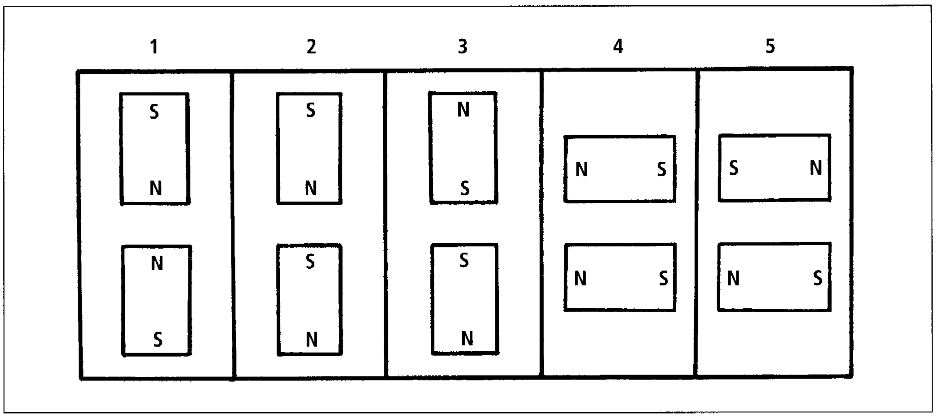


Diagram 5.9
Magnet positions.

5. Place the bag of iron filings over the two magnets and observe the position of the iron filings, especially those between the two magnets.
6. Draw a diagram to show the shape of the magnetic field between the two magnets. Label the poles if known.

Part B
Paper clip races

1. Place a paper clip on the desk. Hold a magnet under the desk directly below the paper clip. Move the magnet. Does the paper clip follow the magnet? If not, try a thinner surface — a thin piece of wood, a mat, cardboard or stiff paper.
2. Mark out a start and finish line. Put two or more paper clips on the start line. Move the magnets underneath the desk and race to the finish line.
3. Answer the question: Can magnetic forces work through other materials?

Activity 7

Materials needed:
A bar magnet;
Paper clips or pins;
Other magnets of different sizes and shapes, if possible.

Magnet Strength

Aim To find out which part of the magnet is the strongest.

1. Place a paper clip or pin on one end of a magnet: *e.g. The north pole.*
2. Carefully add another paper clip or pin to the first so that they both hang down in a chain.
3. Try adding another clip. Keep adding clips until no more will hang on. You may have to hook the paper clips together. At this point the force of gravity is slightly stronger than the strength of the magnet.
4. Repeat the test at least three more times to make sure your results are consistent.
5. Work out the average number of paper clips.

Length of chain at the north pole		**Length of chain in the middle**		**Length of chain at the south pole**	
Trial 1		Trial 1		Trial 1	
Trial 2		Trial 2		Trial 2	
Trial 3		Trial 3		Trial 3	
Average		Average		Average	

6. Test the strength of the other end of the magnet in the same way.
7. Test the strength of the middle of the magnet in the same way.

Making a magnet

When a piece of iron is unmagnetised, all the atoms inside it act as small magnets but because they are pointing in different directions their magnetic fields cancel each other out. In a magnet, the magnetic fields of all the iron atoms line up so they are all in the same direction.

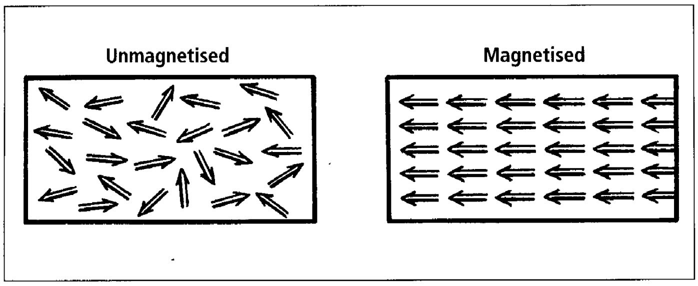


Diagram 5.10

Atoms in unmagnetised and magnetised iron.

Unmagnetised iron and steel can be changed into a magnet using one of the following methods.

- A magnet attached to, or close to, iron will cause temporary magnetism in the iron.
- A permanent magnet can be made by stroking a steel bar with a magnet several times.
- Placing steel inside a coil of wire and supplying a large electrical pulse to the wire creates a magnet.

A magnet can be demagnetised by being knocked and dropped, so care is needed when using magnets. A magnet can also be demagnetised by being heated to a temperature above 700°C.

Activity 8

Materials needed:

A magnet;

Large nail;

A range of other objects such as a needle, hammer, stainless steel spoon, screwdriver.

Making A Magnet

(Aim) To make a magnet.

1. Hold the nail in your hand and use a magnet to stroke the nail along its entire length. Make sure that you stroke the nail in the same direction each time. Do not go backwards and forwards.
2. Stroke the nail twenty times to turn it into a magnet.
3. Test your nail magnet by seeing how many paper clips or pins it will pick up.

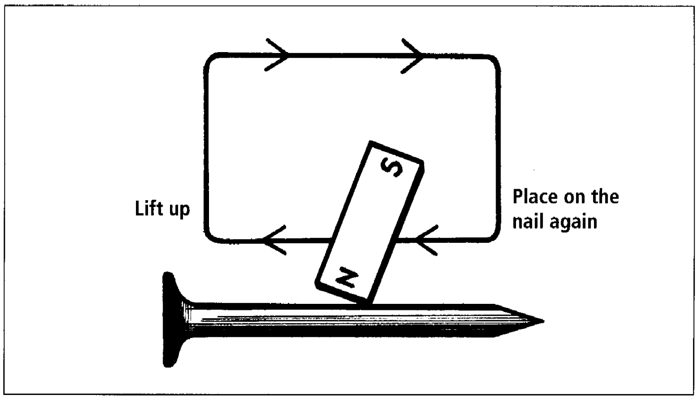


Diagram 5.11
Magnetising a nail.

4. Draw up a table to record your results.
5. Stroke the nail 40 times and then repeat the paper clip test.
6. Continue to increase the number of times that the nail is stroked and test to see how many paper clips it can pick up. Record your results.
7. Other things to try:

- Try to magnetise other objects. Some will be difficult to magnetise. Record the number of strokes needed and the number of paper clips the newly-magnetised object can pick up.
- The nail is only a temporary magnet. The magnetism will disappear after a while. Test the nail magnet to see if it is still a magnet after 10 minutes, an hour and a day. Record your results.
- The nail magnet can be demagnetised easily. Drop it a couple of times then test it to see how many paper clips it can pick up. Increase the number of times it is dropped and test. Record your results.
- Point the nail away from north and hit a nail magnet with a hammer then try to pick up paper clips. Hit it several more times. How many paper clips can it pick up now?

Electromagnets

Electric currents can be used to make temporary magnets called **electro-magnets**. Electromagnets are useful to people because they act just like other magnets but they can be turned on and off by switching the electricity to them on and off.

Electromagnets are made up of:

- A coil of copper wire called a **solenoid**.
- A power supply: *e.g. A dry cell, battery or mains electricity*.
- A **core** of soft magnetic material such as iron. The core concentrates the magnetic field around the coil.

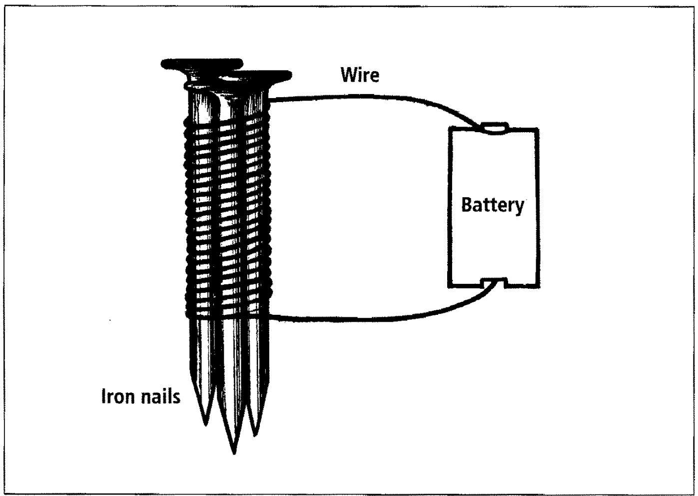


Diagram 5.12
An electromagnet.

Electromagnets can be used in lots of different ways. They are used to make electrically operated locks in banks and to separate and move iron scrap metal. They are used instead of other magnets because the magnetic force field can be switched on and off.

Activity 9

Materials needed:
Nails or bolts;
Copper wire with a plastic coating;
Paper clips or pins.

Making An Electromagnet

Aim To make an electromagnet.

1. Coil the wire around three nails or bolts about twenty times.
2. Join the ends of the wire to a dry cell.
3. Test the strength of your electromagnet by seeing how many paper clips it will pick up from a pile of paper clips. How many will it pick up in a single chain of paper clips?
4. Take one wire off the dry cell while the electromagnet is holding some paper clips up in the air. What happens? Why does it happen?
5. Plan, carry out and report on one of the following investigations:
   a. What difference to the electromagnet does the number of nails in the core make?
   b. What difference to the electromagnet does the number of turns of wire in the solenoid make?
   c. What difference to the electromagnet does it make if the turns of wire in the solenoid are closer together or further apart?
   d. What difference to the electromagnet does the number of dry cells in the circuit make?

Activity 10 Magnets And Electromagnets

Aim To record information about magnets and electromagnets.

1. Produce a summary in your own words of the information you have learnt about magnets.
2. Copy the following diagram that shows the magnetic fields between two magnets.

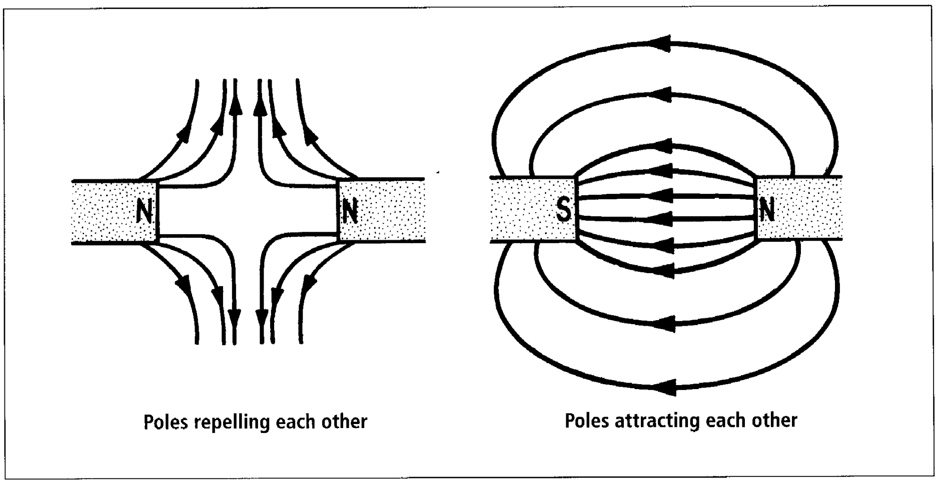


Diagram 5.13
Magnetic fields between two magnets.

3. Explain the advantage of using an electromagnet instead of a magnet.

Unit summary

- Our ability to make and use electricity has changed the way we live. Electricity is used by transducers such as a radio.
- The direct current electricity produced by dry cells up to 12 volts 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 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.
- 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.
- Magnets are found in a number of pieces of equipment such as telephones. Computer disks and video tapes 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. The magnetic field can be shown by lines drawn around a magnet. The closer the lines in the magnetic field, the stronger the magnet.
- The magnetic fields are stronger at the poles of the magnet and weaker in the middle or on the sides of the magnet.
- The like poles of a magnet, north and north or south and south, repel and push away from each other. The unlike poles of a magnet, north and south, attract each other. Magnetic field lines can be drawn to show poles attracting and repelling each other.
- The atoms of some materials act as a magnet. In their unmagnetised state the 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 magnetic field can be turned on and off.

Unit 6: FORCES AND MOTION

Introduction
In this unit, you will learn about how forces act on objects.

Forces
The word force has a meaning in science that is different to the way it is used in everyday English. In science a **force** is something that pushes, pulls, stretches, squeezes or twists an object. Forces are measured in units of force called Newtons (N). Forces cannot always be seen but the effects of the force on an object can be seen. When a force acts on an object it can change the shape, direction and speed of the object.

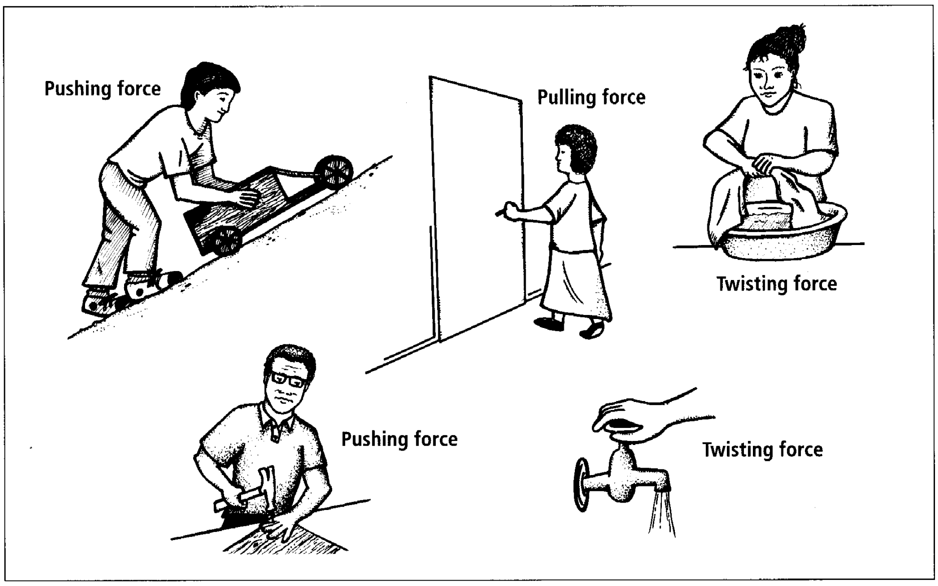


Diagram 6.1
Examples of forces.

The following are common forces used by people:

- Tension forces in ropes and muscles.
- Gravity. The downward force caused by the mass of the Earth.
- Support force. The upward push from a surface.
- Friction force.

The bumps and dips on the surface of an object cause friction. When two objects rub together the bumps on the two surfaces lock into each other. This holds the two surfaces together and tries to stop the objects from moving. If the force causing the movement is stronger than the force of friction then the two surfaces keep rubbing against each other and they get warm. They get warm because some of the kinetic energy from the two objects is being changed to heat energy.

Friction is a very useful force because it holds things together and allows us to move. Sometimes friction is not helpful. When a car is used, some energy has to be used to overcome friction between the tyres and the road and the car and the air.

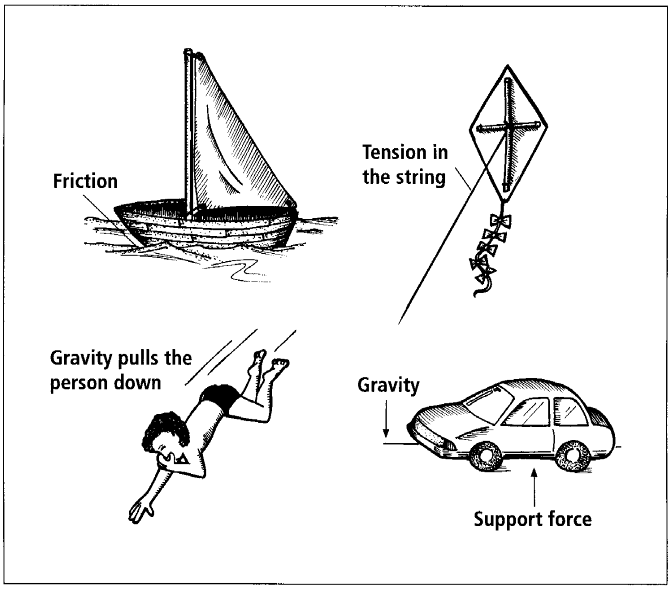


Diagram 6.2
Gravity, tension, support and friction forces.

Some forces act when two objects are touching. For example if you were to throw a ball up in the air, you have to touch the ball yourself or hit it up with a stick. This is a contact force because there has to be contact between the two objects. Friction is a contact force.

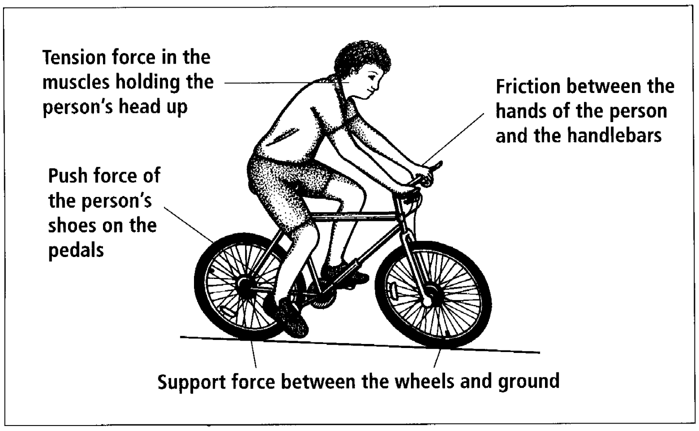


Diagram 6.3
Contact forces.

Some forces can act without the objects touching. For example, a magnet attracting a paper clip. The magnet doesn't have to touch the paper clip to start attracting it. Gravity is another force that acts over a distance. The gravitational force of the Earth will pull a ball thrown up into the air back down to Earth.

An object that causes a force that acts over a distance has a force field around it. A force field is the area around the object in which the force has an effect on an object. As you get further away from an object causing a force, the strength of its force field gets less and less. A magnet will not attract a paper clip that is a large distance away. If the paper clip is slowly moved closer and closer to the magnet it will become more strongly attracted. If the paper clip is let go close to the magnet it will quickly slide up to and touch the magnet.

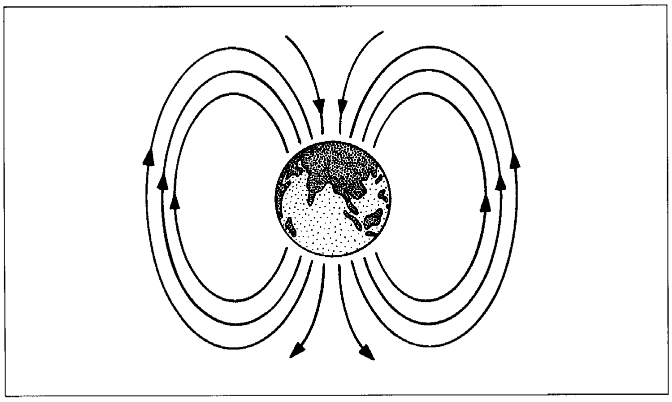


Diagram 6.4
The Earth's magnetic field.

Activity 1

Materials needed:
Cloth or sponge rubber;
Stone or shell;
Spring;
Ball;
Other objects.

Forces

Aim To record information about forces.

1. What is a 'force'?
2. Complete: When a force acts it can change the ______________, ______________ or ______________ of the object.
3. Which force: tension, gravity, support or friction, is being shown at A, B, C and D in the following diagram?

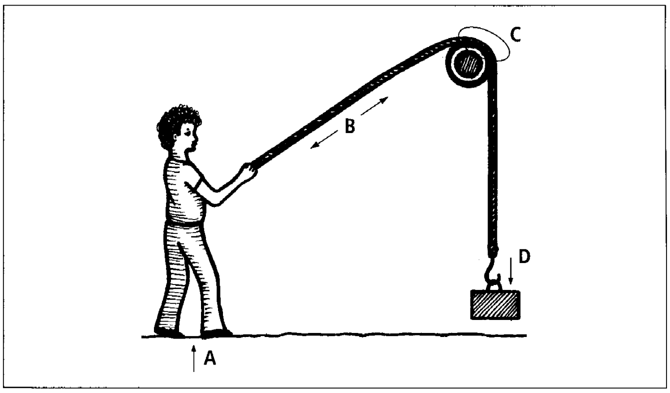


Diagram 6.5
Lifting a heavy object.

4. Rub your hands together quickly until they feel warmer. Explain how a force is causing the warmth.
5. What is the difference between the way contact forces and force field forces act?
6. Select an object and try to change the shape and movement of the object using a push, pull, stretch, squeeze and twist. Record what happens in a table.

Object	Push	Pull	Stretch	Squeeze	Twist
Sponge rubber or cloth					
Stone					
Shell					
Spring					
Ball					

7. Use the information on the table to write a conclusion about the effect of different forces on objects.

Activity 2

Materials needed:
Bar magnet;
Small compass;
Paper clips or pins;
Magnets of different shapes and sizes, if possible.

Force Field

Aim To find the size of the force field around a magnet.

1. Place a bar magnet on a page in your book. Mark where the magnet is on the page by drawing around the magnet.
2. Place a small compass near the end of the magnet. Mark the direction the compass is pointing. Move the compass in the direction it is pointing. Stop when it begins to point in a different direction. Mark the direction and begin to move the compass again in the direction it is pointing. Continue marking the direction the compass is pointing. Join up the points.
3. Repeat instruction number two, starting from a number of different places around the magnet. Each time join up the points to show the force field.
4. Slowly move a paper clip or pin closer to the magnet. Stop when you can feel the force field of the magnet. Mark where you stop the paper clip or pin.
5. Measure the distance between the magnet and the paper clip or pin.
6. Move the paper clip or pin closer until the point where, if the paper clip or pin is let go, it slides up to the magnet. Mark and measure this point.
7. Repeat this at different points around the magnet.

Activity 3

Measuring Forces

Material needed:
Force meter that measures in Newtons;
Small objects.

Aim To measure forces and find out how small a Newton is.

1. Hold the meter up in the air and check that the meter is reading zero.
2. Place your little finger on the hook of the force meter and gently pull downwards until the meter reads one Newton (1 N). Describe the size of the force of 1 N.
3. Now use the force meter to measure the forces needed to do some tasks. If the force is too big to measure, hook two force meters up and add the reading on each one together to get the force.

Do not fully extend the spring in the force meter as this damages it.

Task	Force needed	Force working against
Pressure of little finger.	1 N	Tension force in spring.
Slide a small object along the floor.		Friction.
Lift an object up in the air.		Gravity.
Move an object along a table or desk at a steady speed.		
Move an object along so that it speeds up.		

4. Say which of the forces — tension, gravity or friction — is involved in each task.
5. Make up five more tasks to do and measure the forces involved.
6. Write a conclusion for your investigation.

Activity 4

Materials needed:
Rough and smooth objects;
Rough and smooth surfaces;
Weight;
String;
Force meter.

Measuring Friction

Aim To use a force meter to measure friction.

1. Use a force meter to pull an object along a surface.

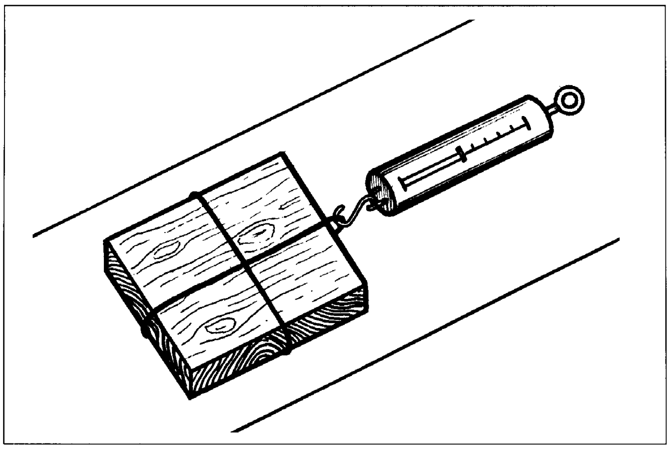


Diagram 6.6
Using a force meter to pull a block of wood along.

2. Measure the force needed to pull the object slowly and steadily along the surface. Record the force in a results table like the one below.
3. Repeat using the same object and same surface until you have three measurements in the table. Work out the average force used.

Object	Surface	Force (N)			Average
		Trial 1	Trial 2	Trial 3	Forces (N)

4. Repeat using a different object OR a different surface.
5. Compare the friction force for different objects or different surfaces. Write a conclusion.
6. Repeat some of the tests using a weight on the object. Compare the force needed to move the object with and without the weight.
7. Copy down the heading for each of the examples in Diagram 6.7.
8. Beside each heading write down where friction is occurring and how friction is being helpful in that example.
9. Describe some examples of friction that are not helpful.

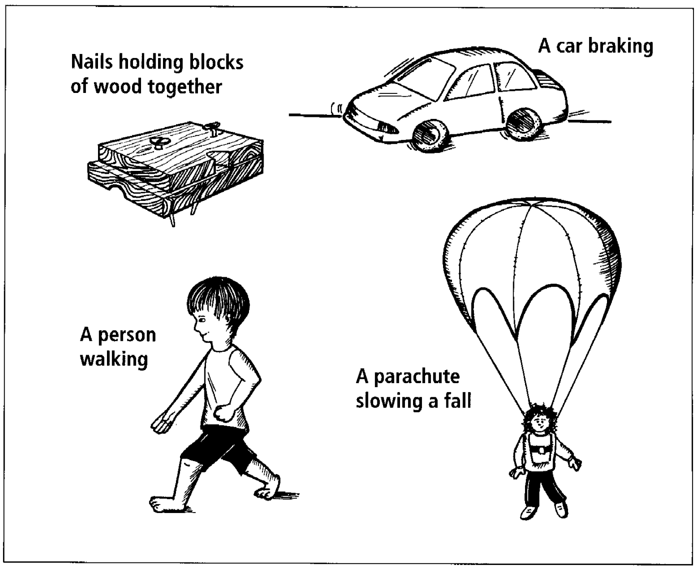


Diagram 6.7
Examples of useful friction forces.

Balanced and unbalanced forces

Balanced forces cause objects to stay as they are. For example, if an object is sitting still then the forces on it are balanced. Also, the forces are balanced if the object stays the same shape, stays moving in the same direction or stays at the same speed.

Forces on an object are shown using arrows. The size and direction of the arrows give information about the size and direction of the forces. If all the forces cancel each other out then the forces are balanced.

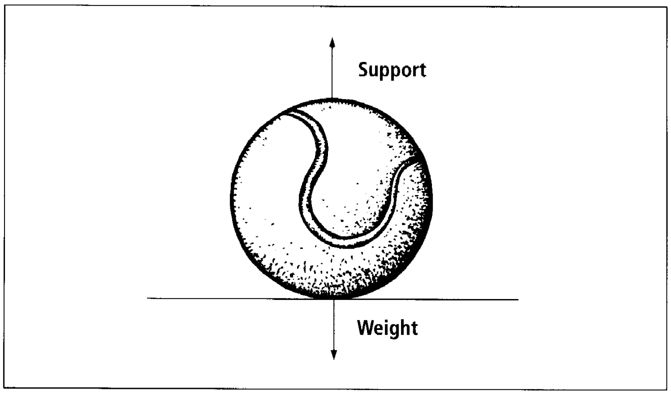


Diagram 6.8
Balanced forces.

If the forces acting on an object are unbalanced then the shape, direction or speed of the object will change.

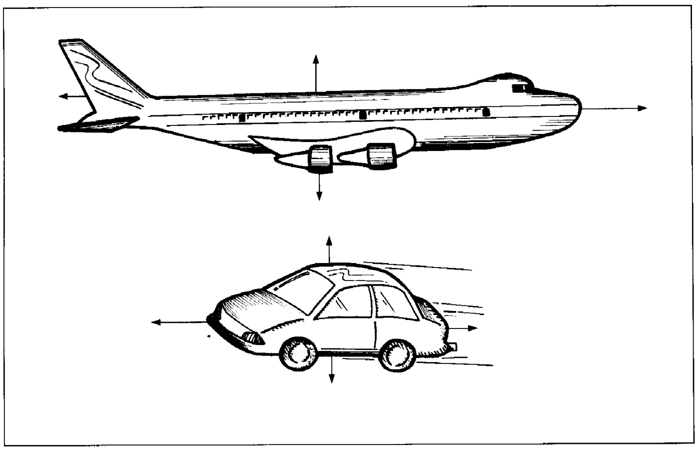


Diagram 6.9
Unbalanced forces.

Activity 5 — Balanced And Unbalanced Forces

Aim To record information about balanced and unbalanced forces.

1. Explain the difference between balanced and unbalanced forces.
2. Look at each of the following diagrams then describe what will happen to the direction and speed of the ball.

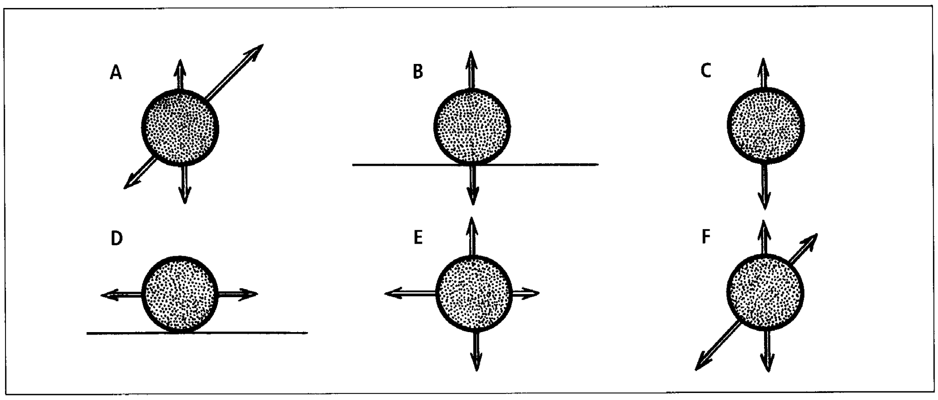


Diagram 6.10
Forces on a volleyball.

Activity 6

Forces And Movement

Materials needed:
Small or light ball;
Drinking straw or blow pipe.

Aim To investigate how forces can change movement.

1. Blow through the straw or blow pipe at the ball. Practise until you are good at getting the ball to move. Your breath is the force that pushes the ball and the straw gives the direction of the force.
2. The diagram below shows the ball and different forces. Try each one out. Copy the table and record your results in a force diagram in the 'after' column.

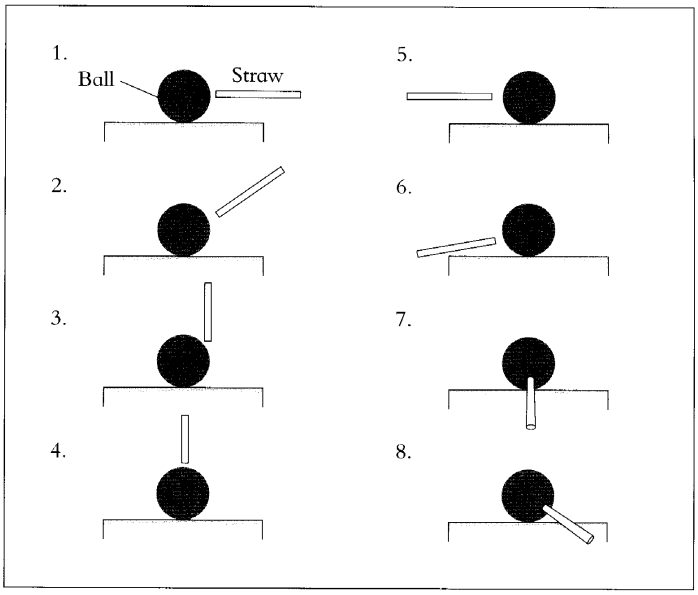


Diagram 6.12
Different forces on a ball.

3. Draw a diagram to show the straw and ball and the force on the ball when you are blowing on to it.

Force	Before	After
1.		
2.		
8.		

4. Draw the following diagram in your exercise book. Add force arrows to show the following information: The boat is slowing down, so the drag force is larger than the thrust force (the thrust force is the force that causes the boat to move forward). The support force from the water is equal to the force of gravity on the boat.

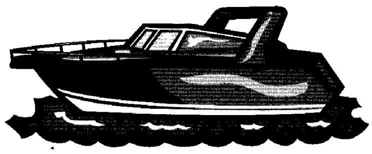


Diagram 6.13
The force on a boat.

Unit summary

- A force is something that pushes, pulls, stretches, squeezes or twists 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.
- Forces can change the shape, direction or speed of an object.
- Friction is caused by the bumps on surfaces of objects and it holds objects together. Friction slows moving objects and energy has to be used to work against friction to keep things moving.
- 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.
- 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.

YEAR 9 GLOSSARY

Word/phrase	Meaning
Active energy	Energy in moving or changing objects.
Alternating current	Type of electricity in mains electricity.
Angiosperms	A group of plants that reproduce using flowers.
Carnivores	Eat other animals to get energy.
Chlorophyll	Chemical, used for photosynthesis, that gives plants their green colouring.
Consumers	Animals that get energy by eating plants and/or other animals.
Contact force	A force that occurs between two objects when they are touching: *e.g. Friction.*
Core	Material in the centre of the solenoid of an electromagnet.
Dicotyledons	Broadleaf angiosperm plants.
Direct current	Type of electricity that comes from a dry cell or battery.
Equator	An imaginary circle around the Earth dividing the world into the northern hemisphere and the southern hemisphere.
Force	A force pushes, pulls, stretches, squeezes or twists an object to change the objects speed, direction or shape.
Gravitational energy	Objects get this energy when they are lifted off the ground.
Gravitational force	All objects have this force and it pulls smaller objects towards them.
Herbivores	Animals that eat plants or parts of plants to get their energy.
Igneous	Rocks made from lava or magma.
Igneous plutonic rock	Rock formed by slowly cooled magma under the Earth's surface.
Igneous volcanic rock	Rock formed by quickly cooled lava on the Earth's surface.
Introduced organism	A species of organism brought into Sāmoa by people: i.e. An organism not native to Sāmoa.
Invertebrates	Animals that do not have a backbone.
Mass	The amount of matter an object has.
Metamorphic rock	Rock formed by igneous and sedimentary rocks being changed by the heat and pressure under the Earth's surface.
Monocotyledons	Plants that have long narrow leaves: *e.g. Grasses or palms.*
Native	Plants that were already in Sāmoa before people were there.
Neap tides	When the difference between the size of high tide and low tide is small.
Newton	A unit of force.
Orbit	The path planets take around the sun and the moon takes around Earth.

YEAR 9 GLOSSARY

Word/phrase	Meaning
Phases of the moon	Different parts of the lit surface of the moon that can be seen on Earth.
Photosynthesis	A chemical process used by plants to make their own food.
Potential energy	Energy that is stored and not being used.
Predators	Chase and catch their own food.
Producers	Make their own food using photosynthesis.
Scavengers	Eat dead animals they find to get energy.
Season	When the weather is similar for a period of time during the year.
Sedimentary rock	Rock formed by broken up pieces of rock, sand and mud pushed together in layers.
Solenoid	A coil of copper wire used in an electromagnet.
Spring tides	The higher high tides and lower low tides during the new moon phase.
Temperate climate	The climate of countries that are further away from the equator. The climate has four seasons, without extremes of temperature and rain.
Tides	The movement of water in and out caused by the gravitational force of the moon and sun.
Tilt	The Earth always has a 23.5° tilt or angle.
Transducers	Objects which transform energy: *e.g. Television.*
Transferred	When the same type of energy is given from one object to another.
Transformed	When energy is changed into another type of energy.
Tropical climate	The climate of countries that are close to the equator. Hot humid weather in two seasons.
Vertebrates	Animals that have a backbone.
Weight	The force of gravity on an object.
Work	People do work to lift objects. Work = force × distance.
Year	The time it takes the Earth to orbit once around the sun (365 and a quarter days).

AUCKLAND TIDE TIMETABLES

AUGUST 2002

TIMES AND HEIGHTS OF HIGH AND LOW WATERS: HEIGHTS IN METRES

	TIME	HGT		TIME	HGT		TIME	HGT		TIME	HGT
1 Th	0026	2.9	**9 Fr**	0112	0.7	**17 Sa**	0153	3.1	**25 Su**	0241	0.7
	0632	0.8		0730	3.1		0803	0.6		0857	3.0
	1244	2.8		1332	0.4		1432	3.0		1454	0.7
	1846	1.0		1956	3.3		2038	0.8		2119	3.2
2 Fr	0107	2.8	**10 Sa**	0203	0.5	**18 Su**	0252	3.0	**26 Mo**	0319	0.7
	0717	0.9		0821	3.2		0901	0.7		0936	3.0
	1326	2.7		1421	0.3		1537	3.0		1529	0.7
	1938	1.1		2045	3.4		2139	0.9		2157	3.1
3 Sa	0151	2.7	**11 Su**	0252	0.4	**19 Mo**	0354	2.9	**27 Tu**	0355	0.7
	0804	0.9		0912	3.3		1002	0.8		1014	3.0
	1415	2.6		1509	0.2		1642	3.0		1604	0.7
	2033	1.1		2135	3.5		2240	0.9		2233	3.1
4 Su	0242	2.7	**12 Mo**	0341	0.3	**20 Tu**	0457	2.9	**28 We**	0432	0.7
	0855	1.0		1003	3.4		1104	0.8		1051	3.0
	1515	2.6		1557	0.2		1740	3.0		1641	0.8
	2128	1.1		2225	3.5		2338	0.9		2310	3.0
5 Mo	0340	2.7	**13 Tu**	0431	0.3	**21 We**	0555	2.9	**29 Th**	0510	0.7
	0948	0.9		1054	3.4		1203	0.8		1129	2.9
	1624	2.7		1646	0.3		1830	3.1		1722	0.9
	2224	1.1		2316	3.5	**22 Th**	0031	0.8		2348	2.9
6 Tu	0442	2.7	**14 We**	0521	0.4		0646	3.0	**30 Fr**	0551	0.8
	1044	0.9		1146	3.3		1254	0.8		1207	2.8
	1726	2.8		1739	0.4		1917	3.1		1808	1.0
	2322	1.0	**15 Th**	0007	3.4	**23 Fr**	0119	0.8	**31 Sa**	0029	2.8
7 We	0543	2.8		0613	0.4		0733	3.0		0635	0.9
	1142	0.7		1238	3.2		1339	0.7		1249	2.7
	1819	3.0		1836	0.6		1959	3.2		1900	1.1
8 Th	0018	0.8	**16 Fr**	0059	3.3	**24 Sa**	0202	0.8			
	0638	2.9		0707	0.5		0816	3.0			
	1239	0.6		1333	3.1		1418	0.7			
	1908	3.1		1937	0.7		2040	3.2			

SEPTEMBER 2002

	TIME	HGT		TIME	HGT		TIME	HGT		TIME	HGT
1 Su	0113	2.7	**9 Mo**	0229	0.3	**17 Tu**	0333	2.8	**25 We**	0320	0.7
	0724	0.9		0852	3.4		0942	0.9		0943	3.0
	1336	2.7		1448	0.2		1619	2.9		1534	0.7
	1955	1.1		2112	3.6		2220	0.9		2200	3.0
2 Mo	0202	2.7	**10 Tu**	0318	0.2	**18 We**	0436	2.8	**26 Th**	0357	0.7
	0816	0.9		0943	3.5		1046	0.9		1020	3.0
	1434	2.6		1537	0.2		1716	3.0		1612	0.8
	2053	1.1		2203	3.6		2317	0.9		2238	2.9
3 Tu	0300	2.6	**11 We**	0407	0.2	**19 Th**	0535	2.8	**27 Fr**	0435	0.7
	0914	0.9		1034	3.5		1143	0.9		1057	2.9
	1543	2.7		1626	0.3		1806	3.0		1653	0.9
	2153	1.0		2254	3.5	**20 Fr**	0008	0.9		2317	2.9
4 We	0406	2.7	**12 Th**	0456	0.3		0626	2.9	**28 Sa**	0516	0.7
	1015	0.8		1125	3.4		1231	0.9		1137	2.9
	1651	2.8		1720	0.4		1851	3.1		1738	0.9
	2254	0.9		2345	3.3	**21 Sa**	0053	0.8		2359	2.8
5 Th	0513	2.8	**13 Fr**	0547	0.4		0711	2.9	**29 Su**	0600	0.8
	1117	0.7		1217	3.3		1312	0.8		1220	2.8
	1749	3.0		1817	0.6		1932	3.1		1829	1.0
	2353	0.8	**14 Sa**	0037	3.2	**22 Su**	0132	0.8	**30 Mo**	0044	2.7
6 Fr	0614	3.0		0641	0.5		0752	3.0		0649	0.9
	1216	0.5		1311	3.1		1349	0.7		1308	2.7
	1841	3.2		1916	0.7		2010	3.1		1926	1.0
7 Sa	0048	0.6	**15 Su**	0132	3.0	**23 Mo**	0209	0.7			
	0709	3.2		0738	0.7		0830	3.0			
	1310	0.4		1410	3.0		1424	0.7			
	1932	3.4		2018	0.8		2047	3.1			
8 Su	0139	0.4	**16 Mo**	0230	2.9	**24 Tu**	0245	0.7			
	0801	3.3		0838	0.8		0907	3.0			
	1400	0.2		1514	2.9		1459	0.7			
	2022	3.5		2119	0.9		2123	3.1			

OCTOBER 2002

	TIME	HGT		TIME	HGT		TIME	HGT		TIME	HGT
1 Tu	0134	2.7	**9 We**	0253	0.1	**17 Th**	0410	2.7	**25 Fr**	0326	0.6
	0744	0.9		0922	3.5		1019	1.0		0952	3.0
	1404	2.7		1516	0.2		1646	2.9		1547	0.8
	2025	1.0		2140	3.5		2247	0.9		2211	2.9
2 We	0232	2.7	**10 Th**	0342	0.1	**18 Fr**	0508	2.8	**26 Sa**	0406	0.7
	0845	0.9		1012	3.5		1113	1.0		1031	3.0
	1510	2.8		1607	0.3		1735	2.9		1630	0.8
	2127	1.0		2231	3.4		2335	0.9		2252	2.9
3 Th	0338	2.7	**11 Fr**	0431	0.2	**19 Sa**	0559	2.8	**27 Su**	0448	0.7
	0949	0.8		1103	3.4		1159	0.9		1112	2.9
	1618	2.9		1700	0.4		1819	3.0		1716	0.9
	2228	0.8		2322	3.2	**20 Su**	0018	0.9		2336	2.8
4 Fr	0447	2.8	**12 Sa**	0522	0.4		0643	2.9	**28 Mo**	0533	0.7
	1053	0.7		1155	3.3		1240	0.9		1157	2.9
	1719	3.1		1756	0.6		1900	3.0		1808	0.9
	2327	0.6	**13 Su**	0015	3.1	**21 Mo**	0056	0.8	**29 Tu**	0023	2.7
5 Sa	0551	3.0		0616	0.6		0723	3.0		0623	0.8
	1152	0.5		1248	3.1		1318	0.8		1246	2.8
	1814	3.3		1855	0.7		1938	3.0		1904	0.9
6 Su	0022	0.4	**14 Mo**	0109	2.9	**22 Tu**	0133	0.8	**30 We**	0114	2.7
	0647	3.2		0713	0.7		0801	3.0		0719	0.8
	1246	0.3		1345	3.0		1354	0.8		1341	2.8
	1906	3.4		1955	0.8		2015	3.0		2003	0.9
7 Mo	0114	0.3	**15 Tu**	0206	2.8	**23 We**	0210	0.7	**31 Th**	0211	2.7
	0740	3.4		0814	0.9		0837	3.0		0821	0.8
	1338	0.2		1447	2.9		1431	0.7		1443	2.9
	1958	3.5		2055	0.9		2052	3.0		2103	0.8
8 Tu	0204	0.2	**16 We**	0307	2.8	**24 Th**	0247	0.7			
	0831	3.5		0918	1.0		0914	3.0			
	1427	0.1		1549	2.9		1508	0.7			
	2049	3.5		2153	0.9		2131	2.9			

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