3 Earth resources

HAVE YOU EVER WONDERED...

- if humans could run out of resources like coal or oil?
- why you should save energy?
- how clouds form?
- why people should care about what they put in the air or soil?

After completing this chapter students should be able to:

- describe the Earth's major resources, such as soils, air, rocks, water, living things and sunlight
- explain what is meant by a 'renewable' resource
- discuss timescales for the regeneration of resources
- classify energy sources as either renewable or non-renewable
- compare renewable and non-renewable energy sources
- describe how renewable and non-renewable energy sources are used in Australia and the world
- describe the changes of state that occur in the water cycle
- investigate factors affecting the water cycle in nature
- explore ways that humans manage water and affect the water cycle.

3.1 Major Earth resources

Humans need many things to stay alive, like food, air, water and shelter. Other living things have similar needs. These needs are met by the natural resources on Earth. It is the responsibility of everyone to protect these vital resources.

INQUIRY science 4 fun

Rocks

What is in a rock?

Collect this …

- stereomicroscope or hand lens
- samples of different rocks

Do this …

1. Carefully study one of the rock samples with the microscope at about ×40 magnification or with a hand lens. Is the material in the rock all the same or is the rock made of different materials?
2. Study the other rocks to see if they have the same materials in them.

Record this …

Describe what you saw.

Explain how these rocks could be used by humans.

Natural resources

A **resource** is anything supplied by the Earth to satisfy a particular need of humans or other living things. Most natural resources are substances, such as rocks or water. However, sunlight is a vital resource that is not a substance. Sunlight is a form of energy and is needed by almost all living things on Earth. Though it enters the Earth from space and is not a substance, it can be considered to be an Earth resource.

The major natural resources of Earth are its:

- rocks
- minerals and fossil fuels (like coal and oil) found in rocks
- soil
- air
- water
- living things
- sunlight.

Some of these resources are shown in Figure 3.1.1.

Figure 3.1.1 Birds, animals, trees, soil, rocks, water, air and sunlight are resources.

These resources are not just used by humans to make things with or to supply us with energy. Almost all life depends on these resources. Many of these resources need to be protected by humans to assist in the survival of all living things, including ourselves.

Renewable and non-renewable resources

The time taken for a resource to be replaced determines whether it is classified as renewable or non-renewable.

A **renewable resource** is a resource that is replaced by natural processes that occur in a timescale shorter than an average human life. This means that renewable resources take less than eighty or so years to be replaced. For example, most trees can be regarded as renewable resources because they grow to maturity in less than eighty years. The major renewable resources are air, water, sunlight and living things.

Some resources like coal and oil take millions of years to be replaced naturally. So to a human these resources would seem like they are not being replaced. As such, they are considered to be **non-renewable resources**. Rocks and soils are also considered to be non-renewable resources because they take so long to be replaced.

Living things as a resource

Living things are a resource for humans and other organisms. For instance, animals eat plants and other animals. Sometimes living things even use other organisms as places to live. For example, tapeworms live in the gut of other animals. Plants use waste materials from animals and other plants as nutrients. Some plants rely on animals as a way of pollinating flowers, such as in Figure 3.1.2. Humans use plants and animals for food, shelter, building materials, clothing, medicines, fertilisers, fuel and many other purposes.

Figure 3.1.2 This plant relies on the hummingbird to pollinate its flowers. To attract the hummingbird the plant produces a sugary substance called nectar.

Living things also depend on their surroundings to supply other resources that they need. Water, rocks, air and soil supply the materials needed for all life. Sunlight is also essential for plants to make their own food and to keep the Earth warm enough for life to exist.

Living things: a renewable resource

Living things are a renewable resource because they reproduce. A forest that has been cut down can regrow. Animals like the cows in Figure 3.1.3 on page 70 are replaced through reproduction. Replacing some forests may take just a few decades. Others forests take longer. Plantations (where humans deliberately plant trees for timber) can be replaced faster than a natural forest. Replacing animals on farms may take a year or so.

Figure 3.1.3 Animals are a renewable resource because they reproduce.

Air as a resource

Air is a mixture of gases and suspended particles such as dust, smoke and water droplets. The main gases in air and their importance to life on Earth can be seen in Table 3.1.1.

Table 3.1.1 Gases in the air

Gas	Percentage in air	Importance to life
Nitrogen	78	Provides nutrients for plants to make proteins and other chemicals, which humans and other animals can use as food.
Oxygen	21	Essential for most living things, to release energy from food that their bodies can then use.
Carbon dioxide	0.03	Essential for plants to make their own food by photosynthesis.
Other gases such as ozone, water vapour and argon	0.97	Many uses depending on the gas. Ozone shields humans from ultraviolet rays (reducing our risk of skin cancers). Water vapour is part of the water cycle that carries water around the planet. Argon is used in light globes.

Air: a renewable resource

About 21% of the air (by volume) is oxygen gas. Oxygen is constantly being used by animals and plants, but is also constantly being replaced by plants. This allows the oxygen level of the atmosphere to stay about the same. Scientists describe the movement of materials from one place to another and then back again as a 'cycle'. Oxygen cycles through Earth and its atmosphere.

All of the oxygen on Earth is thought to have originally been produced by microscopic plant-like organisms and green plants. Green plants like the one in Figure 3.1.4 use the energy from sunlight, carbon dioxide and water to make their own food. The process is called **photosynthesis**. As well as producing the plant's food, photosynthesis also produces oxygen.

Figure 3.1.4 Green plants use carbon dioxide, water and energy from sunlight to make their food by the process of photosynthesis.

SciFile

Earth's fragile atmosphere

The atmosphere is the very thin layer of air around the Earth's surface. The first astronauts who ventured into space were amazed at how thin and fragile the atmosphere looked from space. Many said it made them think very deeply about the damage humans are doing to the atmosphere.

Only about 0.03% of air is carbon dioxide. This is enough to supply the carbon dioxide needed in photosynthesis. Animals breathe out carbon dioxide because it is a waste product of the processes that release energy in their bodies. So carbon dioxide is also being replaced in the air. It is part of a cycle, where it goes from the atmosphere to plants, and then back again from animals to the air. This cycle of oxygen and carbon dioxide is shown in Figure 3.1.5.

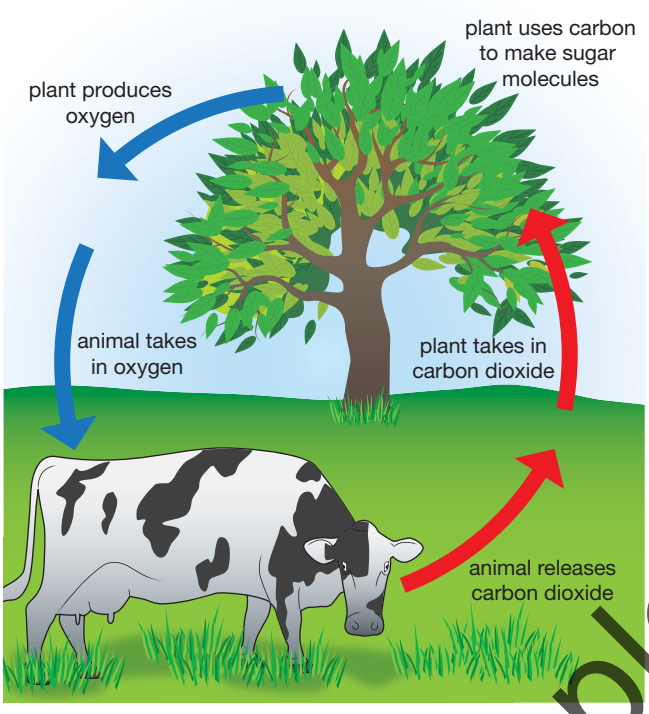

Figure 3.1.5 The exchange of oxygen and carbon dioxide between plants and animals renews these gases in the atmosphere.

Nitrogen gas also has its own cycle as it is absorbed by some organisms and released by others. Gases such as oxygen, carbon dioxide and nitrogen can also move to areas of low concentration where one of them is being used up.

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Sunlight as a resource

Sunlight has an essential role in supporting life on Earth.

- Plants use sunlight to produce food.
- Sunlight warms the Earth's atmosphere, land and water, keeping it warm enough for most water to stay liquid. If the Earth cooled too much, then all water would freeze and turn to ice. Living organisms contain a lot of water and so they would also freeze.

Sunlight: a renewable resource

Sunlight is a renewable resource and will be for as long as the Sun keeps shining. The Sun is a star, and will continue to shine for billions of years.

Water as a resource

Water covers most of the Earth's surface and all living things (like the bird in Figure 3.1.6) need it. No organism can live without water for long. For this reason, water is the Earth's most important resource.

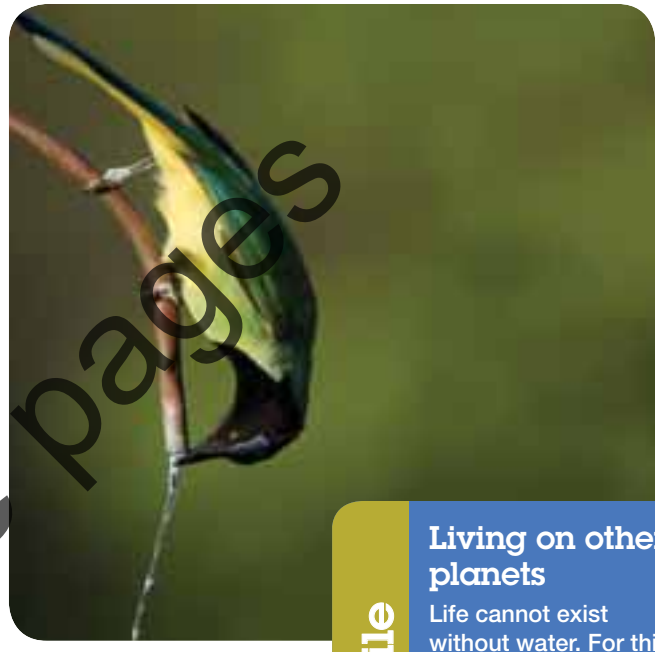

Figure 3.1.6 Water is a very important resource on Earth because no living thing can survive without water.

SciFile

Living on other planets

Life cannot exist without water. For this reason, scientists searching for signs of life in space are only looking at planets and moons where water can be detected.

Water: a renewable resource

Water is a renewable resource because it can move from place to place and replenish an area. It has a cycle. However, only a tiny fraction of the water on Earth is made new each day. Some water is made when:

- living things like trees burn
- fossil fuels like petrol and coal burn
- living things release energy in their bodies.

The total amount of water on Earth is thought not to have changed much since the planet formed.

Water will be covered in detail in Unit 3.3 and in Chapter 4.

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Rocks as a resource

Rocks provide two different resources:

- the rocks themselves
- materials found in rocks.

There are many different types of rock. Some rocks are hard and can be used without altering them or removing any materials from them. These solid rocks are used mainly for roads and buildings, like the one shown in Figure 3.1.7. Other rocks are soft, like limestone and sandstone. These rocks are easy to cut, so they are used in paving and walls. Many of the founding buildings of cities are often built from the local bedrock.

Figure 3.1.7

Stone buildings are built from rocks.

Rocks are made from substances called **minerals**. Minerals differ in their physical properties such as colour and hardness. You can see how minerals appear in a magnified view of a rock in Figure 3.1.8. Many minerals are important resources for humans. A variety of minerals and their uses are shown in Table 3.1.2.

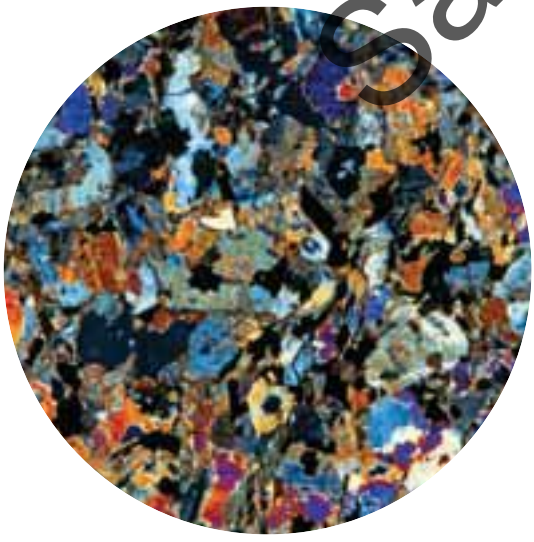

Figure 3.1.8

This is a magnified view of a rock showing that it is composed of different minerals. Each different colour is a different mineral.

Table 3.1.2 Minerals and their uses

Mineral	Main use
Bauxite	Contains aluminium. Aluminium is used for making aircraft, drink cans and high voltage powerlines.
Haematite	Contains iron. Iron is used to make steel, which is used in car bodies, nails, ships and bridges.
Malachite	Contains copper. Copper is used in electrical wiring.
Halite	Contains sodium chloride (table salt). Sodium chloride is used in food preparation and medical applications.

Rocks contain some of the minerals that are needed by living things. As the rocks gradually break down, they release minerals which end up in the water of oceans and lakes, and in the soil. From the water and soil, the minerals are taken up by plants and animals, providing them with necessary trace elements.

Rocks also contain resources that are not minerals. Water is often found in rocks. The fossil fuels oil, natural gas and coal are energy sources that are found in or between layers of rock deep below the ground.

Rocks: a non-renewable resource

Most of the rocks of the Earth were formed millions of years ago. However, in a few places, rocks are still forming today. Some rocks form when hot liquid from inside the Earth cools either below or above the ground. This type of rock is called **igneous rock**. Volcanoes (like the one in Figure 3.1.9) are places where igneous rocks form. The igneous rocks that form below ground can take thousands to millions of years to form. Igneous rocks form on the surface in a day or so because the liquid rock (lava) cools quickly in the air.

Figure 3.1.9

Although new rocks form in and around volcanoes every day, they cannot be considered a renewable resource because the overall process takes so long.

Other types of rocks form when sediments stick together and harden to become rock. This type of rock is called **sedimentary rock**. Most sedimentary rocks form over many thousands or millions of years.

Only a tiny fraction of the Earth's rocks is being replaced each year. The replacement takes so long that rocks are not considered to be renewable resources. Therefore the minerals in the rocks are non-renewable resources. Oil and coal are materials that are found in or between rock layers, and are also non-renewable resources. Oil and coal were formed from dead plants and animals that lived many millions of years ago and are not being formed today.

Soil as a resource

Rock can be worn away by the processes of weathering and erosion. These natural processes have been wearing away rocks throughout the Earth's history.

Weathering

Weathering is the process of breaking rocks down into smaller pieces. Weathering happens in the following ways:

- Changes in temperature between day and night or because of weather and the seasons, can split rocks.
- Water settles in cracks in rocks. As water freezes into ice it expands (gets larger), widening the crack even more.
- Running water and waves can gradually wear away rocks.
- Strong winds blast rocks with small rock particles that wear the rocks away.
- Natural chemicals in the air, soil and water attack substances in the rock. The rock then crumbles and may form a cave like the one shown in Figure 3.1.10.

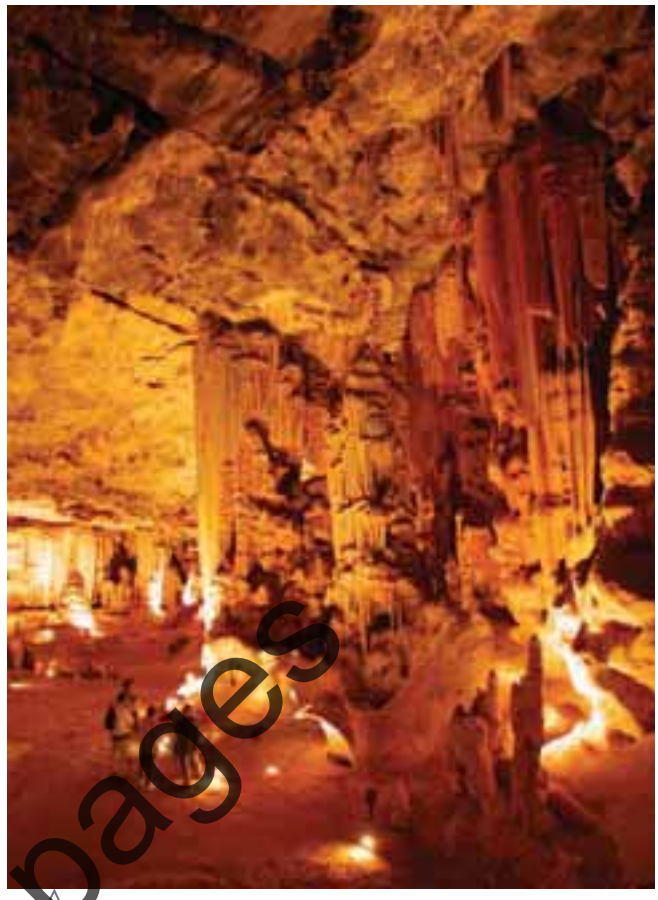

Figure 3.1.10 This limestone cave was formed by the action of rainwater containing acid that attacked the limestone rocks over a long time.

Erosion and deposition

Rocks are broken down into **sediments** by the process of weathering. Sediments can build up around the parent rock or can be carried away by water, wind and ice in a process called **erosion**. Water, wind and ice are referred to as **agents of erosion**.

The sediments that are carried away from weathered rock by water, wind or ice are eventually dropped somewhere. You can see this in Figure 3.1.11 on page 74. The process where sediments drop out of a moving stream of water, wind or ice is called **deposition**.

Sink holes

Sink holes can appear suddenly in areas where limestone is the common type of rock. Sink holes are formed when the limestone below the surface is weathered by chemical action and caves form and then collapse. This sink hole appeared in 2010, in Guatemala, South America, right next to someone's home!

SciFile

Figure 3.1.11 This sandstorm approaching the Saudi Arabian capital Riyadh shows how much erosion and deposition the wind can cause.

The deposited sediments are added to any soil they fall on, making new soil in the process. Soils are composed of:

- fine rock particles (sediments)
- living organisms (such as worms and moss)
- **humus** (decaying wastes and dead organisms)
- water
- dissolved minerals and gases.

You can see these in Figure 3.1.12.

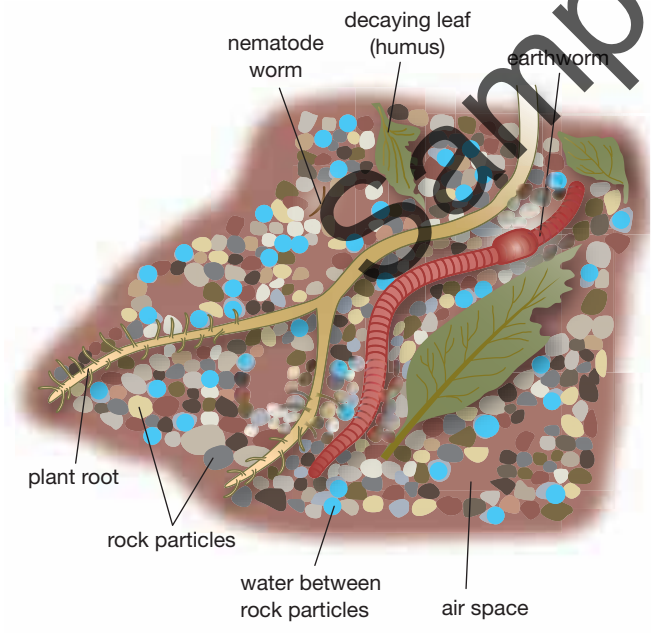

Figure 3.1.12 Soil consists of many components which can support the growth of plants and animals.

INQUIRY science 4 fun

In the dirt

What is in soil?

No

Collect this …

- stereomicroscope or hand lens
- samples of different soils

SAFETY

Wear gloves and do not inhale dust.

Do this …

1. Study one of the soil samples with a stereomicroscope at about ×40 magnification or with a hand lens. Is the material in the soil all the same or is it made of different materials? Try to work out what things are in this soil.
2. Study the other soils to see if they have the same materials in them.

Record this …

Describe what you saw.

Explain why some samples were similar while others were different.

Soil profiles

When you dig down into the soil you can often see different layers (as shown in Figure 3.1.13). These layers are called **horizons** and together the horizons make up the soil profile. The top layer (A horizon) is often a dark brown or black colour due to the high humus content from the organic matter it contains. Most plant roots are found in this top layer of soil. This horizon provides nutrients needed for plant growth. The next layer (B horizon) is called the subsoil. The subsoil is usually more compacted, contains less air and less humus and is therefore lighter in colour. The third layer (C horizon) is broken bedrock. At the bottom is unaltered rock. Horizons B and C usually have little impact on plant growth.

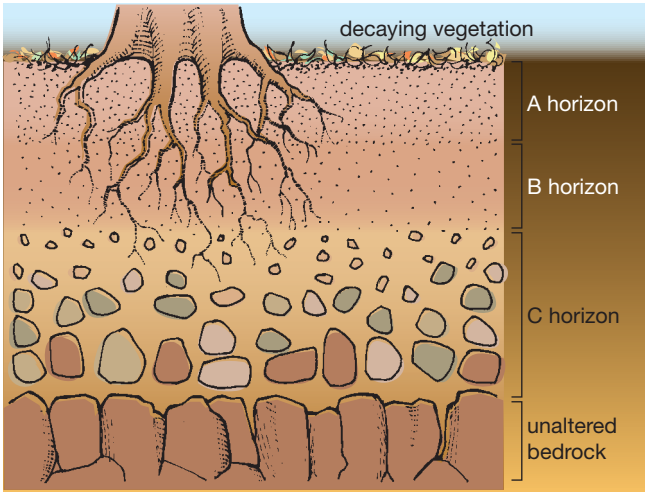

Figure 3.1.13 A soil profile shows that soil has clear layers which are revealed as you dig down.

Fertilisers

Fertilisers are materials that supply mineral nutrients to plants. They contain substances like phosphorus and nitrogen, which plants need to live. Farmers often add them to the soil to improve crop growth.

Common fertilisers are:

- untreated animal droppings such as manure from sheep or chickens
- 'blood and bone'. This is the dried and cooked remains of meat and bone from abattoirs
- chemical fertilisers. Many are manufactured from animal droppings. For example, bird droppings can be processed into a fertiliser called superphosphate.

There is evidence that excessive use of chemical fertilisers is damaging soils and streams and rivers. For this reason, some farmers are reducing their use and are using natural fertilisers instead.

Soil: a non-renewable resource

In some places the rock particles carried by water, wind and ice can build up quickly. An example is where many rivers carrying sediments meet in one place called a river flood plain. In this way the soil is continually added to. Soil can also be enriched by humans in home gardens or on farms. Adding fertilisers or mulch (rotting leaves, bark and twigs) adds nutrients to the soil.

However, in most places on Earth, soils are not being renewed. If a farmer's soil blows away in the wind (or a tornado like the one in Figure 3.1.14) or is washed away in floods, then it is not likely to be replaced in the farmer's lifetime. Some soils form in places where the rocks on the Earth's surface are weathered. However, this process takes hundreds or thousands of years to form soil only a few centimetres thick. Therefore most soils are not considered to be a renewable resource.

Figure 3.1.14 A tornado is a rapidly spinning column of air that forms during certain weather conditions. Tornadoes can strip topsoil from the ground and make it very difficult for any crops to grow.

3 p79 3.1 3.2

3.1 Unit review

Remembering

1 **List** the major resources of the Earth.

2 **List** the main causes of weathering.

3 **List** the ways rock particles can be carried away by erosion.

4 **List** the components of soil.

5 **Recall** what is produced by green plants in photosynthesis.

Understanding

6 **Define** the term *resource*.

7 **Explain** why living things can be considered a renewable resource.

8 **Explain** why minerals in rocks are not considered a renewable resource.

9 **Explain** why soil is such an important resource.

10 **Explain** how rocks are a resource for humans.

Applying

11 **Identify** the major resource on Earth that sustains all life.

12 **Identify** the major Earth resources that are:
- a renewable
- b non-renewable.

Analysing

13 **Classify** the following as renewable or non-renewable:
- a gum trees
- b water
- c sand
- d cows.

14 **Compare**:
- a renewable resources with non-renewable resources
- b erosion and weathering
- c erosion and deposition.

Evaluating

15 **Justify** the following statements:
- a Forests are renewable resources.
- b Soils are non-renewable resources.

Creating

16 **Construct** a table summarising the major resources of the Earth, including how they are a resource for humans and whether the resources are renewable or not.

Inquiring

1 Research the methods used to reduce the effects of soil erosion at the beach or on farms.

2 Research the benefits of adding compost to soils.

3 Forests are renewable. However, to replace them so that they reach the condition called *old growth forest* can take a long time (up to 250 years). Research old growth forests and why scientists consider them important.

4 Research the evidence that Aboriginal people in Australia have used fire to manage the land for thousands of years. In your answer discuss the benefits of the use of fire, particularly the recent discoveries of the effect of smoke on germination of seeds.

3.1 Practical activities

1 Renewing air

Purpose

To investigate whether a green plant produces oxygen.

Materials

- 3 × 250 mL conical flasks labelled A, B and C
- 3 small test-tubes
- 3 one-hole stoppers each with a filter funnel
- aluminium foil to cover one conical flask
- pieces of a leafy green plant such as geranium
- straw
- 3 test-tube stoppers
- test-tube rack
- wooden splint
- matches

Procedure

1. Place a number of pieces of the plant in each conical flask and fill the flasks to the brim with water.
2. Using the straw, blow bubbles through the water in flasks A and C for one minute. This adds carbon dioxide to the flasks.
3. Place a stopper with the filter funnel into each flask. Make sure some water enters the stem of the funnel.
4. Wrap flask C with foil so no light can enter.
5. Carefully add water to three-quarter fill each filter funnel. Then fill each test-tube with water and carefully turn the test-tubes upside down and place them in the filter funnels as shown in Figure 3.1.15.
6. Place the conical flasks outside in direct sunlight for the day if possible. Otherwise use a strong light in the laboratory and leave it on until the next day.
7. The next day, carefully lift the test-tube out of flask A, place a stopper in the top of the test-tube and place it in a test-tube rack.
8. Light the wooden splint and hold it near the test-tube in the rack. Quickly blow out the wooden splint, remove the test-tube stopper and hold the glowing splint in the test tube.

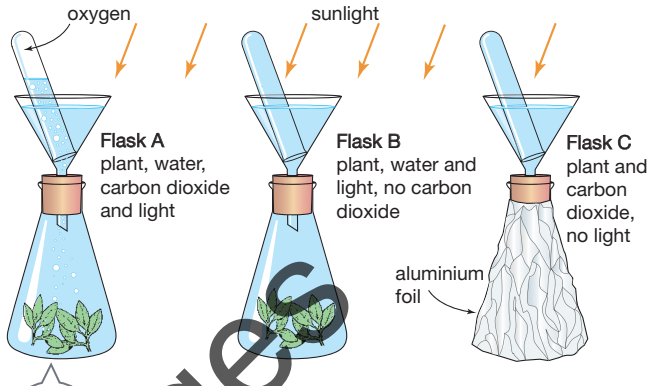

Figure 3.1.15

9. Repeat steps 7 and 8 with the other test-tubes and record what happens.

Results

Record your results in a table like the one below.

What happened to splint		
Test-tube A	Test-tube B	Test-tube C

Discussion

1. **Describe** the results for each test-tube.
2. Oxygen gas has the ability to make a glowing splint of wood catch fire again. **Deduce** whether any of the test-tubes contained oxygen.
3. **Propose** what happened in the three conical flasks.
4. **Explain** how this experiment is relevant to the importance of air as a resource.

2 Water-holding capacity

Purpose

To compare the water-holding capacity of different soils.

Materials

- 3 plastic filter funnels
- retort stand and 3 clamps, or filter stand
- 3 × 100 mL beakers
- 50 mL measuring cylinder
- cotton wool
- dry soil samples such as clay, loam, sand

SAFETY

Care must be taken not to inhale any soil particles. Wash your hands after completing the practical.

Procedure

1 Set up the equipment as shown in Figure 3.1.16, with a cotton wool plug in the neck of each funnel.

2 Half fill each funnel with a different type of soil.

3 Pour 20 mL of water into each funnel and collect any water that comes through. If no water comes through a particular soil, add another 20 mL water to that soil until some water runs through it.

Results

Record in a table how much water you added to each soil and how much water collected in the beaker.

Discussion

1 a **Identify** the soil with the largest water-holding capacity and the soil with the smallest capacity.

b **Justify** your decision.

2 **Outline** some possible reasons why the soils had different water-holding capacities.

3 Soils described as 'well drained' allow much of the water that enters them to pass through them. Labels on plants at a plant nursery sometimes say that the plant likes well-drained soils. **Propose** the characteristics of soils that make them well drained.

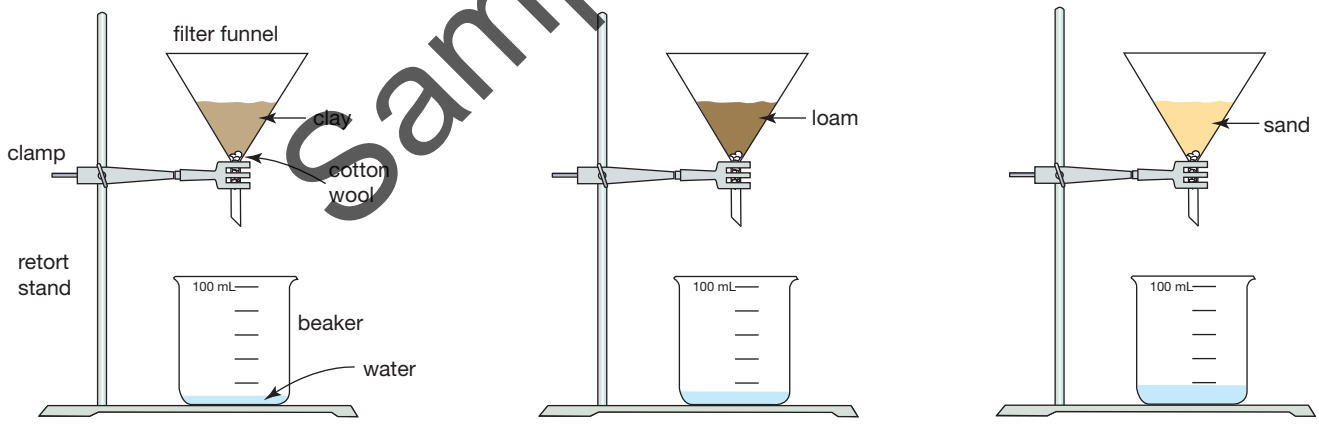

Figure 3.1.16

3 Erosion on a slope

Purpose

To design and conduct an investigation to test if the amount of soil erosion caused by water depends on the slope of the land over which the water runs.

Materials

- plastic gutter
- loam soil
- sandy soil
- bucket
- tap
- hand lens or microscope
- protractor
- wooden blocks or bricks

SAFETY

Care must be taken not to inhale any soil particles. Wash your hands after completing the practical.

Procedure

1. In your design you can use any equipment your teacher has provided or agreed to supply to you.
2. Decide in your group how you will proceed. Draw a diagram of the equipment you need and the procedure you will use to conduct your investigation. Construct a list of the materials you will need.
3. Show your teacher your procedure, and if they agree, collect your materials and conduct your investigation.
4. Record your results.

Discussion

Construct a prac report for your investigation.

Figure 3.1.17 Does the slope of the land affect the amount of soil erosion caused by water?