SCIENCE

Level

F	1	2	3	4	5	6	B6

Interactions of systems of Earth and beyond

Strand
Earth and Beyond

Key concepts
The Earth, solar system and universe are dynamic systems.

Events on Earth, in the solar system and in the universe occur on different scales of time and space.

Purpose

Activities in this module are designed to help students understand that there are physical systems of the Earth and beyond it, that changes occur as a result of interactions within these systems, and that some of these changes follow predictable patterns. Students have opportunities to:

- collect information about regular and irregular events related to systems of Earth and beyond;
- identify changes to features and events related to systems of Earth and beyond and some time spans related to them;
- construct meaning about changes to features and events and the time in which they occur on Earth and beyond;
- make links between the timing and nature of observed events involving interactions between components of systems of Earth and beyond;
- illustrate and explain their understandings of the nature of interactions of systems of Earth and beyond;
- use scientific terminology to communicate their understandings of the interactions between components of the solar system.

Overview of activities

The following table shows the activities in this module and the way in which these are organised in **introductory**, **developmental** and **culminating** phases.

Introductory ►	Developmental ►	Culminating
The changing Earth and sky	The planet Earth	Captain's log
What's out there?	Weather, seasons and climate	Interactions concept map
	The water cycle	
	Tropical cyclones	
	Weathering	
	Erosion	
	Tracking the sun	
	Meteors and comets	
	Creating craters	

QUEENSLAND SCHOOL CURRICULUM COUNCIL

Core learning outcomes

This module focuses on the following core learning outcomes from the Years 1 to 10 Science Syllabus:

Earth and Beyond

2.1 Students identify and describe changes in the obvious features of the Earth and sky (including changes in the appearance of the moon).

2.2 Students identify and describe short- and longer-term patterns of events (including weather and seasons) that occur on the Earth and in the sky.

3.1 Students identify and describe some interactions (including weathering and erosion) that occur within systems on Earth and beyond.

3.2 Students discuss regular and irregular events in time and space that occur on the Earth and in the sky.

4.1 Students recognise and analyse some interactions (including the weather) between systems of Earth and beyond.

4.2 Students collect information which illustrates that changes on Earth and in the solar system occur on different scales of time and space.

Core content

This module incorporates the following core content from the syllabus:

Earth and Beyond

The Earth as a system
- features — landforms, bodies of water, soil, wind, clouds
- components — hydrosphere, lithosphere, atmosphere
- interactions between components — erosion, weathering

The solar system as a system
- features — sunrise/sunset
- components — sun, moon, planets, comets, meteors
- interactions — orbits of planets/moons, rotations and revolutions

Changes on Earth and beyond
- water cycle
- weather, climate, seasons
- day/night

Scales of distance
- astronomical distance — effect on space exploration

Changes in Earth and beyond
- cyclical — day/night, seasons
- catastrophic — droughts/floods

Evidence of past events in present-day events and features
- soil types, patterns of erosion

Assessment strategy

Suggestions for gathering information about student learning are provided in each of the activities in this module. Once sufficient information has been collected, judgments can be made about students' demonstrations of outcomes. Typical demonstrations of this module's intended outcomes are provided here to indicate the pattern of behaviour to look for when making judgments.

Earth and Beyond

2.1 Students identify and describe changes in the obvious features of the Earth and sky (including changes in the appearance of the moon).

Students may:

- make observations about changes that occur to components of Earth such as mountains and rivers;
- make comparisons between features of Earth and beyond at different times — for example, apparent positions of the sun, tidal changes at a beach;
- create diagrams to describe changes to features of and events related to the Earth and sky.

Earth and Beyond

2.2 Students identify and describe short- and longer-term patterns of events (including weather and seasons) that occur on the Earth and in the sky.

Students may:

- collect and present images and pictures relating to events on Earth and in the sky (for example, weather and seasons) and determine what is meant by 'weather', 'climate' and 'seasons';
- construct meaning about changes and patterns in natural events such as weather, sunrise, erosion;
- identify and illustrate various short- and longer-term patterns of the Earth and sky;
- compare scales of daily variation (for example, day and night) with those of seasonal climatic variation (for example, spring and autumn, summer and winter, hotter and cooler, wetter and drier).

Earth and Beyond

3.1 Students identify and describe some interactions (including weathering and erosion) that occur within systems on Earth and beyond.

Students may:

- reflect upon and construct meaning about interactions such as weathering and tropical cyclones;
- develop and test hypotheses about how features, such as craters on the moon or rivers, were formed;
- collect information and explain ideas about the Earth–moon–sun system and components of these systems;
- create diagrams illustrating cycles such as the water cycle or the appearance of comets related to Earth and beyond;
- explore and describe phenomena such as erosion.

Earth and Beyond

3.2 Students discuss regular and irregular events in time and space that occur on the Earth and in the sky.

Students may:

- explore aspects of natural phenomena that follow predictable patterns, such as seasons (characterised by hours of daylight, rainfall pattern), and progress of the sun across the sky;
- discuss regular and irregular changes and interactions that they have experienced directly or that they know about — for example, floods, tropical cyclones, droughts, comets, seasons;
- compare the regularity and predictability of various natural phenomena, such as formation of tropical cyclones or appearance of meteors;
- create models and diagrams that demonstrate how interactions affect the environment, plants and animals — for example, rain, flood, drought and meteorite impact;
- describe some of the processes and effects of interactions, such as erosion, explaining the time spans over which they occur.

Earth and Beyond

4.1 Students recognise and analyse some interactions (including the weather) between systems of Earth and beyond.

Students may:

- investigate problems related to the interactions between systems of Earth, and between systems of Earth and beyond — for example, weathering and erosion, and the formation of tropical cyclones;
- model and analyse the interactions between meteorites and the moon and between meteorites and the Earth.

Earth and Beyond

4.2 Students collect information which illustrates that changes on Earth and in the solar system occur on different scales of time and space.

Students may:

- collect information about the time scales of changes related to Earth and beyond, such as storm formation and orbits of comets;
- describe the time scales and distances involved in the erosion and weathering of mountains.

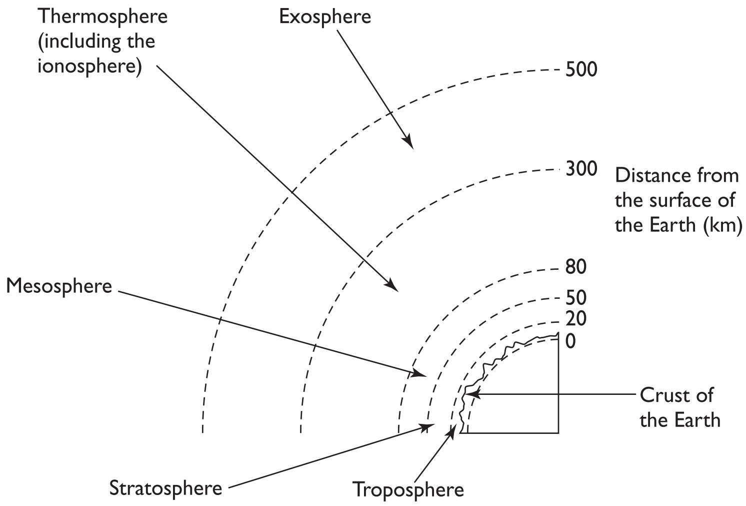
Background information

Current scientific conceptions

Atmosphere, weather and climate

The **atmosphere** is the layer of gases surrounding the surface of the Earth. Atmospheric pressure is created by the weight of this air pressing down on the Earth's surface. It is measured in hundreds of Pascals or hectoPascals (hPa). Normal atmospheric pressure measured at sea level is 1013 hPa.

The Earth's atmosphere changes composition as the distance from the Earth increases. The layer nearest the Earth is called the troposphere. It is in this layer that most weather events occur. Above the troposphere, in both the stratosphere and the mesosphere, ultraviolet radiation is absorbed by oxygen, and ozone is produced. Ozone has the ability to absorb ultraviolet radiation. This absorption of ultraviolet radiation causes the temperature of the stratosphere and mesosphere to increase. The next layer, the thermosphere, is very hot. This is due to absorption of high-level radiation by particles in the ionosphere, which forms part of the thermosphere. The communication industry uses the ionosphere to bounce short wave radiation to different places on Earth. The exosphere is the outermost layer of the Earth's atmosphere.



Weather refers to atmospheric conditions of temperature, humidity, precipitation (rain, hail, sleet, snow), sunshine and cloud cover at any one place and time. The **climate** is the long-term pattern of weather in any place. It is determined by latitude, altitude, prevailing winds, distance from the ocean and proximity to mountain ranges. The typical annual pattern of weather in an area can be described in terms of seasons.

Weathering and erosion

Weathering is the general term for the processes by which rocks of the Earth's surface are broken down. The rate at which a rock weathers depends on the rock's structure, its chemical stability, the climate (temperature and moisture), and the intensity and duration of the weathering process. A hot, wet climate promotes chemical weathering; a cold, dry climate promotes physical weathering.

Chemical weathering alters the basic material of rock by reactions of the minerals in the rock with other substances. This weakens the structure. Exposed rocks may undergo chemical reactions with oxygen in the air or with substances such as carbonic acid, carbon dioxide (CO_2) dissolved in water, flowing over them. Another substance that contributes to the chemical weathering of rocks is sulfur dioxide (SO_2), a gas ejected from volcanoes and released when coal and oil are burnt. When dissolved in ground water or rain, SO_2 forms sulfurous acid (H_2SO_3).

Physical weathering is the alteration of the structure of a rock. The mechanisms of physical weathering include freezing and thawing of water in crevices and pores in the rock; pressure (stress) release; plant roots penetrating the rock then expanding with growth; the diurnal cycle of heating and cooling; fires; and salt crystallisation.

Erosion occurs when an agent of erosion moves weathered material away from the parent rock. Water, wind and gravity are all agents of erosion. Water includes waves, streams, rivers and glaciers. Glaciers erode the surface layers and bedrock of the valleys down which they flow. Sea waves crash against the shoreline moving any loose material. Wind moves dry uncompacted materials such as sand and topsoil.

Energy is required to move weathered materials. The amount of energy available will determine the size of weathered material that is moved. As energy levels reduce (for example, as a river meets the sea) larger particles will no longer be carried. Layers of sediment are formed. The effects of cementing agents, heat and pressure change these sediments into rocks.

The Earth–moon–sun system

The sun is the central and largest object in our solar system and the nearest star to Earth. The Earth is the third of the nine planets that orbit 'our' sun. It is the largest of the inner planets, with a diameter of 12 756 km. Because the Earth's orbit is elliptical, the distance between the Earth and the sun varies throughout the year from 147 million km in January to 152 million km in July. The path traced out by the Earth in its annual journey around the sun is called the plane of the ecliptic.

The time the Earth takes to complete one orbit around the sun — the period of its **revolution** — is approximately 365.25 days, so in the calendar every fourth year is a **leap year** with an extra day in it (29 February) to accommodate the quarter-days.

The Earth spins on its axis from west to east, making a complete **rotation** once in (almost) 24 hours. The Earth's rotation makes the sun appear to rise in the east (sunrise, morning) and set in the west (sunset, evening).

The moon has a diameter of 3476 km and is our closest celestial neighbour, revolving in an elliptical orbit around the Earth at an average distance of 384 000 km. The moon takes just over 29.5 days to complete its orbit around the Earth — that is, about one month. (The word 'month' comes from the word 'moon'.) Because the moon takes the same time to rotate on its axis as it does to revolve around the Earth, the same side of the moon always faces the Earth.

Students' prior understandings

Students' prior understandings may differ from current scientific conceptions in a range of ways.

Atmosphere, weather, and climate

Some students may think that:

- weather and climate mean the same thing;
- droughts and floods are accidents and not aspects of climate;
- climate is dependent on the cycle of the seasons alone.

Weathering and erosion

Some students may think that:

- weathering is a harmful process that should be stopped;
- weathering and erosion are interchangeable terms;
- erosion occurs only as a result of people's activity.

The Earth–moon–sun system

Some students may think that:

- the moon and sun have little effect on living things;
- the sun orbits around the Earth;
- the Earth, sun and moon do not affect each other very much.

Teachers can help students to develop their understandings of the events and interactions of Earth and beyond, by providing opportunities to:

- observe natural phenomena;
- investigate interactions that take place between components of the Earth;
- formulate and elaborate the idea that interactions beyond Earth affect the Earth;
- gather and collate information from different sources about a variety of interactions.

Terminology

Terms associated with the Earth, solar system and the universe are essential to the activities in this module — for example:

asteroids	earth tremor	meteoroid	satellites
atmosphere	erosion	meteors	seasons
climate	evaporation	monsoonal floods	solar system
clouds	galaxy	ocean	telescope
comets	hydrosphere	planet	tropical cyclone
crater	leap year	precipitation	weather
crescent moon	lithosphere	rays	weathering
crust	lunar eclipse	revolution	
drought	meteorites	rotation	

Students may already be familiar with some of these terms and understand their meanings and use in scientific contexts. If so, the activities in this module will provide opportunities for them to evaluate current usage. If not, these activities will provide opportunities for students to develop their understandings.

School authority policies

Teachers need to be aware of school authority policies that may be relevant to this module.

Safety policies are of particular relevance to the activities that follow. It is essential that demonstrations and student activities are conducted according to procedures developed through appropriate risk assessments at the school.

In this module, teachers need to consider:

- safety issues relating to observing the sun and the night sky, especially with binoculars and telescopes;
- the need for adult supervision of students during observations of the night sky out of school hours.

Support materials and references

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ACTIVITY

The changing Earth and sky

Introductory

Focus

This activity provides opportunities for students to reflect on their understandings about changes to the Earth and sky and the time scales in which these changes occur.

Materials

For each group of students:

- 2 large sheets of paper (A3 or larger)
- marker pens

For the teacher:

- Resource Sheet 1, 'The water cycle' (optional)
- Resource Sheet 6, 'Changes to Earth and sky over time' (as a model)

Teaching considerations

Resource Sheet 1

Assist students to reflect on changes to the Earth and sky by using a familiar scenario of local events that occur in the seasons of a year and/or using music that includes sounds of the environment. The picture on Resource Sheet 1 could be used as a stimulus.

Resource Sheet 6

Discuss the nature of events with students to ensure that the ideas used on the concept map they develop are significant and relate to daily, seasonal and yearly patterns. Resource Sheet 6 could be used as a model for the concept map.

Be sensitive to some students' past experiences with tropical cyclones, floods, rock slides or earth tremors.

Working scientifically

Exploring phenomena
Reflecting and considering
Creating diagrams

Time: 30 minutes

▶ The teacher describes a river flowing from the hills through rural and urban areas to the sea. Students imagine natural events occurring over the period of a year. Questions to prompt students' thinking could include:

Daily changes

- What changes do you expect to occur on the Earth or in the sky during one day?
- How does the night sky vary from the day sky?
- How does the night sky vary throughout a night or from one night to the next?
- How does the atmosphere change throughout the day?

Seasonal changes

- What weather events would you expect to occur during summer (school holidays)?
- What differences would you expect between summer in your area and summer in other parts of Australia?
- What weather events would you expect to occur during the winter?

- What differences would you expect between winter in your area and winter in other parts of Australia?
- How do some of these events affect rivers? What effect could this have on your local area?
- How does the soil change:
  - in the heat of summer?
  - after a heavy storm?
  - during the dry season?
- How does the atmosphere change during these events and seasons?

Yearly and less frequent changes

- What type of change would you expect to occur on the Earth or in the sky over a year?
- What are some longer-term changes that occur on the Earth and in the sky? Explain.
- Suggest events that occur occasionally, but not in a regular or predictable pattern.
- How often have you experienced tropical cyclones, floods, rock slides or earth tremors? Describe any experiences you have of these events.

▶ Students consider the changes identified and discuss which ones can be grouped together. They work in small groups to make a concept map (see initial in-service materials, p. 38) with the central idea of 'Changes to Earth and sky'. The map displays the range of features, events and changes discussed. Related ideas are linked with lines, which are annotated with explanations.

▶ Students compare their concept maps. They formulate questions about issues requiring clarification and research answers to their questions. A class list of events and changes to features is made on the board. Students consider the time frame in which the changes or events occur.

▶ Individually or in groups, students draw three concentric circles on a large sheet of paper. The inner circle is labelled 'daily changes', the middle circle 'seasonal changes' and the outer circle 'yearly changes'. Students categorise the events and place them in the appropriate circles. Changes that do not fit these groupings are placed beyond the outer circle.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' questions and comparisons;
- students' concept maps and groupings of events.

ACTIVITY

What's out there?

Introductory

Focus

This activity provides opportunities for students to reflect upon their understanding of concepts related to the solar system and interactions that occur within it on a regular or irregular basis.

Students imagine they are travelling from the outer edge of the solar system to explore Earth. They identify major ideas to explore and clarify.

Materials

- art materials
- materials and resources for presentations (as required)
- research resources about the solar system

Teaching considerations

Students will be imagining they are on a journey of exploration to planet Earth from the outer part of the solar system. They may require support as they identify changes and interactions 'seen' during their 'voyage' through space, as they enter and travel through the atmosphere and after they 'land' on the sea or land. Discuss with them the time span over which this journey and the events might occur.

When allocating research topics (Part 2), ensure that students, collectively, develop a comprehensive presentation. If possible, provide access to research resources in a variety of media — for example, books, journals, Internet and video.

Working scientifically

Time: Part 1, 30 minutes; Part 2, 30 minutes (negotiable); Part 3, 40 minutes

Accessing resources
Collecting information
Exploring phenomena
Looking for patterns and meanings
Applying ideas and concepts
Making links
Creating presentations
Discussing thinking

Part 1

▶ As a class, students briefly discuss:

- the meanings of the terms 'solar' and 'system';
- words or phrases with 'solar' or 'system' in them — for example, solarium, solar cell, river system, systematic;
- the meaning of the term 'solar system'.

▶ Students imagine they are travelling towards Earth from the outer parts of the solar system. They visualise components, features and events including changes to features that they might see:

- in the solar system as they approach Earth;
- as they travel through the atmosphere;
- as they come to rest on the sea or land.

▶ Students brainstorm a list of components, features and interactions or changes to features, they would expect to see on such a voyage. If necessary, they refine the list to a more manageable size by using words which are inclusive of a range of ideas — for example, 'planets' instead of the individual names of the planets.

▶ The words from the list are written randomly on the board with the sun at the centre. Students discuss the ways that components of the solar system affect each other, interactions that occur and the time scales over which they occur. They draw lines between these components and add words or phrases to express the relationship — for example:

- moon's gravity causes tides on Earth;
- day and night are due to the Earth's position relative to the sun.

This concept map should be kept for comparisons at the end of Part 2.

Part 2

▶ Students research one major component of the solar system, working individually or in small groups. They use the results of their research to create a product — for example:

- crossword or board game;
- quiz show questions;
- poem or story;
- painting or poster enticing people to go to one of the planets for a holiday;
- website;
- written or recorded interview with a space researcher about what it would be like to live on a particular planet;
- model of components.

Part 3

▶ Students decide on a sequence for presenting the components, then present to the class what they have discovered and what they have created. The class responds to and questions presenters where appropriate.

▶ Students refer to the concept map from Part 1 to add new interactions they have learned about and change those they have reconsidered.

Additional learning

▶ Students group the components of the solar system according to their characteristics — for example:

- objects in the sky that can be seen with the unaided eye from Earth / those that cannot be seen directly;
- permanent components / transitory components of the solar system;
- hot / cold components;
- objects visited by humans or their probes / those not visited;
- objects that orbit the sun / objects that orbit other bodies.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' concept maps;
- products of students' research — for example, crossword;
- students' presentations of research and products;
- modifications made to concept maps.

ACTIVITY

The planet Earth

Developmental

Focus

This activity provides students with opportunities to develop an understanding of the Earth as a whole.

Students explore phenomena related to interactions between the lithosphere, hydrosphere and/or atmosphere.

Materials

- dictionaries (optional)
- research resources

Teaching considerations

Some students with vision impairment may require assistance for this activity. Seek advice from their support teacher.

Ensure that the dictionaries provided define 'atmosphere', 'lithosphere' and 'hydrosphere'. Be guided by students' development in choosing appropriate terms to use.

If access to the Internet is available, the following sites have useful images:
http://pao.gsfc.nasa.gov/gsfc/gallery/index.html
http://jsc.nasa.gov/ [Search using 'Earth landscapes'.]

Working scientifically

Exploring phenomena
Formulating questions
Looking for patterns and meanings
Constructing meaning
Suggesting
Retelling and restating

Time: 40 minutes

▶ Students visualise what an astronaut might see on an approach to Earth as a space capsule passes through the atmosphere. They list major components, features and events such as clouds and storms, the changing day–night line, land masses and seas. Students share their ideas first in pairs and then in a class group. A group list of ideas is compiled.

▶ Students look up the meaning of 'atmosphere' in the dictionary and write the word and its meaning in a table like the one below. If appropriate to their level, they also look up 'hydrosphere' and 'lithosphere' and similarly mark these as a heading to a list. (Alternatively, 'water on Earth', and 'crust', could be used as headings.)

Atmosphere	Hydrosphere	Lithosphere
What it is:	What it is:	What it is:

▶ Students work in small groups to suggest specific examples of the major features of the Earth and sky that fit in each category and write them in the appropriate columns. For example, they may suggest mountains, volcanoes, and deserts for the lithosphere (crust); lakes, rivers and oceans for the hydrosphere (water on Earth); clouds, storms and air for the atmosphere.

▶ Students share their suggestions with other groups and amend their lists as appropriate.

▶ Students discuss the idea that there are interactions between and within the atmosphere, hydrosphere and lithosphere. They formulate questions about interactions and select one of their questions to research individually or in pairs. They complete their research and present their responses to the class. Interactions students could select for study include:

- the water cycle;
- wind patterns;
- rainfall patterns;
- development of river systems;
- ocean currents;
- climate patterns;
- seasonal changes.

Gathering information about student learning

Sources of information could include:

- students' suggestions and questions about obvious components, features and interactions of the Earth;
- students' groupings of ideas;
- students' presentations to the class.

ACTIVITY

Weather, seasons and climate

Developmental

Focus

This activity provides opportunities for students to develop an understanding that the weather and the appearance of the environment may change throughout the year, and that these changes follow a predictable pattern.

Materials

- art materials
- butcher's paper

Teaching considerations

In discussions with students, clearly distinguish between the concepts of weather, seasons and climate.

Tropical areas tend to have two seasons — the wet and the dry. Subtropical and temperate areas experience four seasons.

Use pictures to stimulate discussion and ideas. The Bureau of Meteorology website may be helpful (http://www.bom.gov.au/).

Working scientifically

Time: 60 minutes

Exploring phenomena
Looking for patterns and meanings
Suggesting
Creating presentations
Describing
Discussing thinking
Exploring and elaborating ideas

▶ Guided by the teacher, students discuss and describe the weather, seasons and climates that they have experienced.

Students initially clarify what weather is and what factors contribute to weather. They suggest and describe types of weather they have experienced and identify behaviour and clothing associated with different weather conditions. Questions and ideas that may be discussed and developed include:

- Which phenomena do you associate with weather?
- How frequently does weather change?
- What changes can be seen?
- What types of information does a weather forecast include?

▶ Students reflect upon the types of weather that typify the seasons they experience. They describe factors such as sun, rain, temperature, relative humidity and wind. They compare conditions typical of summer and winter (or wet and dry seasons). Discussion questions and ideas could include:

- What is meant by the term 'season'?
- How many seasons does this part of Australia experience?
- What names are given to the seasons in the local area?
- Describe the usual weather patterns of these seasons.
- What seasons do other parts of Australia experience?
- Discuss familiar seasonal phenomena, such as plants flowering, leaves falling, different behaviours of animals.
- Describe the relationship between time of year and the position of the Earth as it orbits around the sun.
- Discuss the time span over which the seasons occur.

▶ Students discuss what they understand by the terms 'tropical', 'subtropical' and 'temperate'. The teacher explains that these terms all describe 'climates', or the long-term pattern of weather in any place, and that the climate in different parts of Australia may be used to categorise the major areas. Discussion questions and ideas could include:

- What climate is typical of the local area?
- Describe the main features of, and factors affecting, local climate.
- Compare the time spans over which climatic events occur (including floods, droughts, tropical cyclones and other irregular events).
- Name other climates of which you are aware, describing the main features of these climates.

▶ In groups, students identify and illustrate the differences between 'weather', 'seasons' and 'climate'. They negotiate within their groups how each term could be illustrated and each student in the group assumes responsibility for illustrating one term. (The differences illustrated may, for example, relate to components or types of weather; features of the seasons; comparisons of climate; or foods, clothes, sports and games.) Each student writes a brief explanation of the illustration and why that idea was used. They describe the time scale over which the weather, season or climate occurs.

▶ As a class, students discuss similarities between the illustrations they have created — for example, summer and winter illustrations based on Queensland weather patterns are both unlikely to depict snow. Students note any differences between the illustrations — for example, differences in types of sporting activity enjoyed during different seasons, clothing worn, or appearance of particular plants.

▶ Students and teacher discuss their thinking about the various cycles and time frames that the collection of illustrations represents. Concepts of weather, season and climate are clarified and elaborated.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions and explanations;
- students' illustrations and descriptions.

ACTIVITY

The water cycle

Developmental

Focus

This activity provides opportunities for students to develop an understanding that the water cycle of the Earth is a major system with many interactions.

Materials

- dictionaries

For each student:

- Resource Sheet 1, 'The water cycle'

Working scientifically

Time: 40 minutes

Collecting information
Looking for patterns and meanings
Applying ideas and concepts
Making inductions
Creating diagrams
Retelling and restating

▶ Students consider and formulate answers to the question 'How do you know it is going to rain?'. They discuss their responses to clarify their ideas.

Students use dictionaries to find the meaning of the word 'precipitation' as it relates to weather. They discuss their thinking about precipitation and its different forms. Discussion questions could include:

- What forms of precipitation are experienced in Queensland?
- In areas where winters are very cold, what forms of precipitation are experienced in winter?
- What causes the different forms of precipitation?
- Where in Queensland might there be snow? How frequently does it occur?

▶ Students discuss their ideas about where the water that falls as precipitation comes from. Discussion questions could include:

- What happens to rain (or snow or hail) after it hits the ground?
- When it rains on a concrete or bitumen surface on a hot day what happens to the rain? What can you see above the surface?
- What is the process called when liquids change into gases?
- What are clouds?
- Where do the droplets of water making up the clouds come from?
- What is the process called when gases (vapour) change into liquids?
- What happens to rain that lands on soil? How far down into the soil does it go and where does it eventually end up?
- Australia is the driest continent on Earth after Antarctica. What sources of water do people in western Queensland rely on? Describe these water sources in terms of how regular, predictable or reliable they are.

Resource Sheet 1

▶ Students name the illustrations on Resource Sheet 1. They cut and paste (or draw) the simple landscape in their notebooks and then cut out the illustrations and paste them in a way that shows the water cycle. Students write a brief summary statement explaining the water cycle and how they have represented it. Students share their illustrations and explain their summary to the class.

► Questions to assist students engage more deeply with issues surrounding the availability of water could include:

- About how much of the Earth's surface is covered with water?
- Why is sea water not suitable for drinking?
- What happens to plants if they are watered with sea water?
- What is a drought?
- Is drought predictable or regular?
- What causes floods? Are they predictable or regular?
- How does society attempt to control and extend the availability of water throughout the year?

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' summaries and explanations;
- students' completed resource sheets.

ACTIVITY

Tropical cyclones

Developmental

Focus

This activity provides opportunities for students to understand how tropical cyclones form, and that their occurrence is confined to one part of the cycle of seasons but within that part of the cycle their location and timing is unpredictable.

Materials

- photographs or video segments of a tropical cyclone (optional)
- graph paper

For each student:

- Resource Sheet 2, 'Tropical cyclones'

Teaching considerations

As tropical cyclones cross the coast, they gradually lose energy and become rain depressions. It is the long period of high intensity rainfall resulting from this depression that causes the flooding associated with tropical cyclones. Other relevant factors are the effect of dams and timing of king tides. Flooding in the Brisbane River was related to tropical cyclones in 1893, 1931, 1971 (TC Dora) and 1974 (remnants of TC Wanda). Dams on the Brisbane River and its tributary, the Bremer River, became operational as follows: Lake Manchester — about 1916; Somerset Dam — finished 1959; and Wivenhoe Dam — held water from 1975 and was completed in 1985. However, ensure students understand that not all floods are caused by tropical cyclones and not all tropical cyclones cause flooding.

New Scientist (May 1999) features the article 'Big weather' by John and Mary Gribbin which has useful information on tropical cyclones and their formation.

The flood data provided on Resource Sheet 2 is an extract and simplification of more detailed data from the Bureau of Meteorology in Brisbane. The flood levels have been rounded to the nearest half metre. Some students will need the axes provided on which to plot a graph of the data.

Records of weather events are extensive and weather packages are available from the Bureau of Meteorology (http://www.bom.gov.au/). The website has current information and useful links.

Be sensitive to some students' past experiences with tropical cyclones and floods.

Working scientifically

Time: 40 minutes

Collecting information
Exploring phenomena
Interpreting data
Retelling and restating

► Students view photographs or a video segment of a tropical cyclone or recall one they have experienced. They each write a brief explanation about what they think a tropical cyclone is and comment on the timing, regularity and frequency of tropical cyclones. They might include a simple illustration if they feel that it will help explain some aspect of the tropical cyclone.

▶ Students share their ideas and refine them, with help from the teacher. The students' ideas about tropical cyclones are listed and grouped in categories. One category should relate to features of the tropical cyclone: how and when they are formed. Others might, for example, relate to the effects of tropical cyclones or to people's feelings about, and actions during, tropical cyclones.

Resource Sheet 2

▶ Students read the information on Resource Sheet 2, 'Tropical cyclones', and study the map of past tropical cyclones affecting Australia. With teacher assistance, students compare the information provided on the resource sheet with their own ideas. Students suggest additional material to go on the list of ideas about tropical cyclones. They may also suggest, with reasons, that some ideas should be modified or removed from the list.

▶ Students use the information about flood heights of the Brisbane River on Resource Sheet 2 to construct a graph. They look for patterns in the data. Students discuss what further information is required to suggest a cause-and-effect relationship between the tropical cyclone and the flooding. If time and resources are available, students locate the necessary additional information and report their findings to the class.

▶ Using the information about categories of tropical cyclones on Resource Sheet 2, students consider how tropical cyclones affect people. They discuss:

- the aspects of tropical cyclones that cause most damage to homes and businesses;
- what could be done by communities to minimise this damage;
- the effects of the tropical cyclone felt on the coast compared to 1 or 2 kilometres inland;
- rules related to town planning that could reduce the effects of flooding on the community;
- the parts of Australia that are unlikely to be affected by tropical cyclones (see map).

▶ Students, individually, rewrite their explanation of a tropical cyclone explaining their new understandings. They comment on the predictability of tropical cyclones, the regularity with which they form and how often they affect a single location.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' explanations of tropical cyclones;
- students' graphs and ideas about flooding and tropical cyclones.

ACTIVITY
Weathering

Developmental

Focus

This activity provides opportunities for students to develop an understanding about some of the processes of weathering and to distinguish it from erosion.

Materials

For the teacher:

- Resource Sheet 3, 'Weathering: Teacher demonstration'
- materials listed on Resource Sheet 3

Teaching considerations

Introducing concepts and terms

This activity is designed to promote discussion among students and with the teacher. If students are to be involved in setting up the demonstrations in Part 2, as well as observing the results, then time would have to be allocated to this prior to the observations.

Introduce the terms 'weathering' and 'erosion', clearly distinguishing between each (see p. 5). By the end of the activity, students should understand that in 'weathering' large pieces are broken into smaller pieces.

Explain physical and chemical weathering and acid rain in age-appropriate terms — for example, 'acid rain is rain that has chemicals in it that react with some materials'.

Acid rain

'Acid rain' is rain that is unusually acidic (pH 3 to 5.5). One cause of the low pH is an increased concentration in the atmosphere of oxides of carbon, nitrogen and sulfur. These oxides result from the burning of coal, wood and oil and from volcanic activity. Carbon dioxide is a common gas produced when carbon-rich fuels (wood, oil or coal) burn. In water, it forms a very weak acid, carbonic acid. Sulfur dioxide is another common gas, given off in large quantities from volcanoes. Sulfur dioxide in water forms sulfurous acid. Acid rain can also occur without burning having taken place. Forests produce numerous natural substances, some of which are acidic. These evaporate into the atmosphere where the vapour can acidify the water in clouds.

Classroom organisation

Resource Sheet 3

Consider setting up the demonstrations (see Resource Sheet 3) in Part 2 at learning centres with writing materials and worksheets in place to assist students in making notes about the processes demonstrated.

At appropriate points in the activity, discuss the time scale over which the modelled events actually occur.

Visiting a cemetery

Consider taking the class to a cemetery to examine weathering of headstones, statuary and grave surrounds. Many of the headstones or grave markers will have dates on them, giving an indication of the time that the material has been exposed to the weather. The degree of weathering (for example, staining and crumbling of the surface layers, legibility of lettering on the headstones, growth of lichens) will be more advanced on older headstones.

This activity will also give students the opportunity to examine and identify different types of material used, such as concrete, granite, marble, iron and bronze. If a trip to a cemetery is inappropriate, students could examine the extent of weathering of the facades of buildings and of statues in public parks.

Working scientifically

Time: Part 1, 15 minutes; Part 2, 45 minutes; Part 3, 20 minutes

Exploring phenomena
Handling materials
Making and judging observations
Generalising
Discussing thinking

Part 1

▶ The teacher and students discuss ways in which the Earth changes. Discussion questions could include:

- How does the land surface of the Earth change with time?
- How do we know that there have been changes?
- What are the agents of change?

▶ Students suggest ways that they believe parts of the Earth are worn away and agents that cause this wearing away. They clarify the difference between weathering and erosion.

Part 2

▶ Students observe the demonstrations prepared by the teacher. They discuss the materials in each, how they have changed and the agent of change. They make links between the demonstrations and natural weathering processes. They discuss where weathering of each type would occur, and suggest some materials that would weather more or less easily than others.

▶ Students write notes about the demonstrations and suggest further questions to research. If time and resources are available, students research answers to their questions and report their findings to the class.

Part 3

▶ When the demonstrations have been discussed and ideas clarified, students compare the kinds of materials weathered and the processes that cause each type of weathering. They discuss the time scale over which different weathering processes are likely to occur in nature.

▶ Students work as a class to create a concept map that includes all the aspects of weathering they have considered. They suggest connections between the weathering agent(s), the material that has been weathered, and the rate at which weathering takes place.

▶ Working individually, students illustrate the demonstrations. They annotate the illustrations with a description of what has occurred in each, a hypothesis about the time scales over which the events they illustrate would be likely to occur, and a generalisation about the process of weathering.

Additional learning

▶ Students plan their own investigation into the difference between the effects of rain and acid rain on larger and smaller specimens of the minerals provided (see sourcebook guidelines, appendix 3).

▶ Students visit a cemetery and compare the extent of weathering on headstones of different types and ages.

Gathering information about student learning

Sources of information could include:

- students' suggestions and contributions to discussions;
- students' concept maps;
- students' illustrations, descriptions, hypotheses and generalisations.

ACTIVITY

Erosion

Developmental

Focus

This activity provides opportunities for students to develop an understanding of some of the processes of erosion by modelling the process in a sandpit.

Materials

For each group of students:

- area in a sandpit
- gravel, larger stones
- wooden stirrers and sticks
- garden hose or watering can

For each student:

- drawing materials

Teaching considerations

Students in some areas of Queensland may not have any experience of erosion by water. A video could be used to stimulate discussion.

Advise students in advance to wear clothing appropriate to an activity in which they play with sand, soil and water.

Working scientifically

Time: Part 1, 30 minutes; Part 2, 40 minutes; Part 3, 30 minutes

Collecting information
Identifying
Describing
Making observations

Part 1

▶ Students discuss what they know about the processes of erosion. Discussion questions could include:

- What do you see happening to bare soil when there is a lot of heavy rain?
- What changes can be seen in the colour of creek water after heavy rain? Why has this occurred?
- What do you see when soil is washed away from under a tree?
- The moving water of the river or creek is wearing away the Earth's surface. What other natural processes cause this to happen?

▶ Students compile a class list of their ideas about erosion. Working individually, students then create a concept map (see initial in-service materials, p. 38) about erosion. These concept maps may be kept and compared with other concept maps made at the end of the activity or after several related activities.

Part 2

▶ In small groups, students create contoured mounds in an area of the sandpit. Within the groups, they discuss how to simulate water erosion on this mound and decide whether they will use a light, medium or strong spray of water. They predict what will happen when the water is applied to the area, test their prediction and explain the results.

Part 3

► Students consider how they might vary the test with the materials provided. They formulate questions to which they seek answers through investigation. They could use the planning and reporting worksheets in appendix 3 of the sourcebook guidelines for assistance with their investigations. Questions could include:

- What effect will a steeper / less steep slope have on the material carried down by water?
- What effect will 'packing' the sand have on removal of material by water?
- What effect will gravel placed at a particular point have on material removed?
- What effect will isolated trees (simulated by sticks or wooden stirrers) have on the material removed by water?
- What effect will a fence (simulated by sticks or wooden stirrers) placed at a particular point have?
- What effect will gravel and a fence have?

► Students reflect on and review their investigation within their groups. Each group then explains its results to the other students.

Gathering information about student learning

Sources of information could include:

- students' discussion, reflection and review;
- students' ideas for investigation;
- students' investigations, planning and reporting worksheets, and explanations.

ACTIVITY

Tracking the sun

Developmental

Focus

This activity provides opportunities for students to observe and record the apparent movement of the sun across the sky.

Materials

For the class:

- magnetic compass

For each group of students:

- clear plastic hemispherical bowl (or overhead transparency sheet cut and taped to form a hemisphere)
- permanent marker pen
- one sheet of thin white cardboard, larger than the diameter of the bowl
- fine thread or clear fishing line
- tent pegs or lengths of wire that can be driven into the ground (optional)
- transparent adhesive tape

Teaching considerations

This activity requires a sunny, cloudless day. Depending on availability of resources, this activity could be undertaken by the whole class or by groups of three to five students working cooperatively.

The experiment requires full sun all day and needs to be started first thing in the morning. As the experiment will be left outside and unattended for most of the day, people in other classes should be asked not to disturb it.

Safety

Warn students never to look directly at the sun, as doing so will injure their eyes.

Working scientifically

Time: Part 1, 40 minutes; Part 2, 30 minutes (5 minutes every hour for 6 hours); Part 3, 40 minutes

Collecting information
Analysing
Drawing conclusions
Describing

Part 1

▶ Students discuss the sun and how it appears to move across the sky each day. Discussion questions could include:

- Does the sun appear to follow the same path each day or does the path change?
- Where is east?
- Does the sun always rise directly in the east, or can it rise from different parts on the horizon?
- Where is west?
- Does the sun always set directly in the west, or can it set in different places on the horizon?
- Why is it important to know where the sun travels in the sky?

▶ The teacher explains that some people believed that the universe was organised with the Earth at the centre and that everything else revolved around the Earth.

▶ Students begin an experiment to gain understanding of how the sun appears to move through the sky. Students place the bowl upside down on the cardboard, trace a pen line around its rim and then remove the bowl and draw a tiny smiley face in the centre of the circle to represent the student standing at the centre of the celestial sphere. They then take the paper and bowl outside to a place that will be free of shadows and undisturbed all day, place the paper on the ground, with the drawing showing, and put the bowl on top of it. (The bowl may need to be secured against the wind. Using clear tape, stick lengths of fine thread or clear fishing line over the bowl and tie these to tent pegs driven into the ground. Alternatively, the paper and bowl could be taped down onto a table placed out of doors.) Students use the magnetic compass to locate the directions of north, south, east and west. They mark these on the paper.

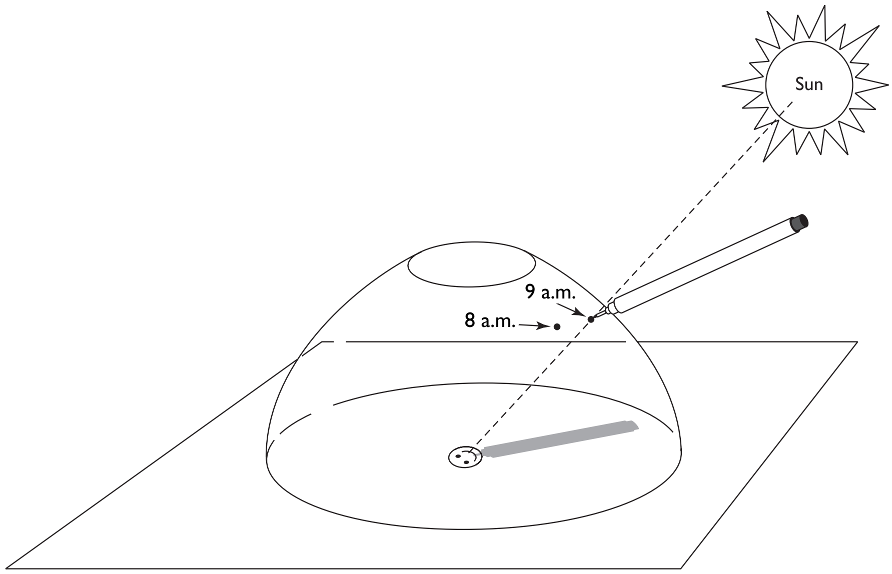
▶ Students touch the surface of the bowl with the marker pen so that the shadow of the tip of the pen touches the nose of the smiley face in the centre. They mark the bowl with a dot and write the time of observation near the dot.

Part 2

▶ Students mark the bowl with a dot and the time every hour for six hours so that by 3 p.m. there are six or seven dots on the bowl. They connect the dots in a smooth arc, extending both ends of the arc to touch the rim of the bowl. The arc so drawn traces the apparent path of the sun through the sky on that day.

Part 3

▶ Students make a permanent record of their experiment by photographing the bowl with the arc drawn on it. They discuss people's various explanations for the sun travelling the path shown and compare this with the current scientific explanation. They write a report of their experiment explaining what they did and the conclusions they have drawn.



▶ Discussion questions could include:

- The arc drawn on the bowl touches the rim at two points. What point is each likely to be?
- Does the sun really go around the Earth as it appears to us to do?

Additional learning

▶ Students perform the experiment at home, marking the position of the sun at sunrise and sunset.

▶ Students perform the same experiment in the middle of every season and compare the position of the arcs and the sunrise and sunset points.

▶ Students relate the sun's different paths to the tilt of the Earth's axis.

▶ Students examine how the tilt affects the path and angle of the sun in the sky as Earth revolves around it.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussion;
- students' reports and explanations.

ACTIVITY

Meteors and comets

Developmental

Focus

This activity provides opportunities for students to explore the nature of objects that apparently occur irregularly in the sky.

Materials

For the class:

- research resources

For the teacher:

- Resource Sheet 4, 'Meteors, asteroids and comets'

Teaching considerations

If observations of the sky are included in this activity, some students with vision impairment may require assistance. Please discuss this with their support teacher.

Resource Sheet 4

Resource Sheet 4 provides useful information on comets, asteroids and meteors for the teacher; it could also be provided to students as a starting-point for research.

The following websites have useful information on comets, asteroids and meteoroids:

http://www.ozkidz.gil.com.au/rm/sci.html

http://www.ozkidz.gil.com.au/rm/student/student.html [Select 'General education' then 'Planets/solar system'.]

Working scientifically

Time: 40 minutes

Exploring phenomena
Formulating questions
Analysing
Making comparisons
Retelling and restating

▶ Students reflect upon and discuss what can be seen in the night sky. In small groups, and then as a class, they assemble a list of objects and phenomena they recognise. If 'shooting star' does not appear on the list, the teacher asks if anyone has seen one and what is meant by the term.

▶ Led by the teacher, students discuss the idea that when an object rubs against another quickly, heat is generated by friction. People have used this knowledge for thousands of years to light fires from striking flint, rubbing sticks together and, more recently, striking matches. Students rub their hands together briskly to experience the feeling of heat generated by surfaces rubbing together.

▶ Students explore the idea of why a shooting star suddenly appears and then stops. They explore a variety of reasons why the object may be visible. It may:

- reflect light, as do artificial satellites and the moon;
- give off light, like the sun;
- generate light as it enters Earth's atmosphere.

Students brainstorm what is causing the glow in this situation.

▶ Students discuss what they know about comets, meteors and asteroids. They identify questions for research. Questions identified could include:

- What are they made of and how were they formed?
- Where are they found?
- What size are they and can we see them from Earth?
- Do they have any effect on the Earth?

More specific questions could include:

- How have people been able to find out about the structure, behaviour and origins of comets, meteors and asteroids?
- What evidence is there on Earth today of meteorite impacts in the past?
- What causes the tail of a comet and why does it always point away from the sun?

▶ In small groups, students find answers to these questions. In larger groups, they collate the information on comets or meteors or asteroids and create a presentation for the class.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions;
- students' answers to questions;
- students' presentations to the class.

ACTIVITY

Creating craters

Developmental

Focus

This activity provides opportunities for students to investigate the formation of craters on the moon.

Students model volcanic and impact craters.

Materials

For the class:

- lunar atlas or poster of the moon
- pictures of volcanic craters and meteorite impact craters on Earth

For each group of students:

- area in the sandpit or deep tray containing sand or flour
- rocks and pebbles ranging in size from 1 cm to 10 cm in diameter
- bendable straws or plastic tubing (30–40 cm long)

For each student:

- goggles
- ruler
- Resource Sheet 5, 'Craters'
- planning and reporting worksheet (sourcebook guidelines, appendix 3)

Teaching considerations

Prior to this activity, students should have engaged in a variety of activities such as observing the moon and its phases, predicting and modelling aspects of the moon's orbit, and gathering information about meteors and comets.

This activity is best done outside. However, a deep tray containing sand or flour could be used as an alternative. Students work in groups of three or four to conduct the experiments.

For the teacher

Articles in *New Scientist*, 12 September 1998 — 'Survivors from Mars' by Paul Davies, and 'Bolts from the blue' by John and Mary Gribbin — provide background information supporting particular theories.

Safety

Inform students about the use of goggles to protect their eyes from blown sand during the experiment. Remind students that rocks and sand are not to be thrown.

Working scientifically

Time: 40 minutes

Collecting information
Hypothesising
Measuring
Drawing conclusions
Making comparisons
Constructing and using models

▶ Students examine a picture of the moon, then discuss lunar landforms and what may have caused them. Discussion questions could include:

- What are the most obvious features of the moon?
- Where, on Earth, can craters be seen?
- What events could have caused craters to form?
- What obvious differences are there between volcanic craters and impact craters?

▶ Students discuss the distinctly different shape of craters produced by volcanic processes and those produced by meteorite impacts.

Students examine pictures of meteorite impact craters and volcanic craters on Earth, and look for similarities between these and craters on the moon.

Students look for evidence in the moon photos to support a particular theory, paying particular attention to craters on the terminator (the border between the illuminated and dark hemispheres). They look for shapes that could be lava flows around craters, and look for rays extending from a crater that could have been formed when material was thrown up and out by meteorite impact. Students record their ideas about the characteristics of craters on Resource Sheet 5.

Resource Sheet 5

▶ The class separates into those who support the meteorite theory and those who support the volcanic theory to explain craters on the moon. Students form groups of four or five and use Resource Sheet 5, and planning and reporting worksheets (see sourcebook guidelines, appendix 3) to help them design an experiment to test their theory.

In groups, students conduct their experiments. Students may refine their experiments after initial data is collected. They interpret their results by comparing the craters they made with photographs of craters on the moon and look for any similarities such as rim shape, or presence or absence of rays. Based on results from their experiments, students draw conclusions about crater formation on the moon.

▶ All the groups that investigated impact craters collate their results and create a presentation for the class. Similarly, the groups that investigated volcanic craters collate and present their results.

Additional learning

▶ Students test the effects of dropping the same object through different media.

- They drop the object through air onto sand to model a meteorite impact on the moon with no atmosphere.
- They drop the same object through water onto sand to model a meteorite travelling through the denser medium of air to impact on the Earth.

▶ Students make a permanent record of an impact crater by dropping the object into wet, stiff plaster of Paris.

▶ Students demonstrate how various models can be combined to explain the different appearance of impact craters on Earth and on the moon.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions and planning;
- students' completed resource sheets;
- students' completed planning and reporting worksheets;
- students' presentations to the class.

ACTIVITY

Captain's log

Culminating

Focus

This activity provides opportunities for students to reflect on the understandings they have developed about interactions and events in the solar system and the frequency with which they occur.

Materials

- students' work from previous activities

Teaching considerations

This activity complements the introductory activity 'What's out there?' (pp. 12–13). The brainstorm in the earlier activity will be a useful reference point for assessing the development of students' ideas.

Students are required to prepare a piece of science-fiction writing in the form of a log or diary of their voyage through space to planet Earth. Be explicit about where the voyage is to begin and the type of 'observations' they are expected to include in their descriptions. Encourage students to include many events and interactions in their logs.

Support students' use of understandings developed in the previous activities. Lead them through a review of their recent work emphasising the different types of interactions that could be encountered as they:

- travel through space towards Earth;
- enter the atmosphere of Earth;
- experience the activity of the atmosphere, land and seas.

If the facilities are available, prepare students for their science-fiction writing role by showing them some scenes from science-fiction movies.

Working scientifically

Time: 50 minutes

Applying ideas and concepts
Preparing scenarios
Reflecting
Retelling and restating

▶ Students review relevant parts of their recent work. They clarify ideas and concepts related to interactions of Earth and beyond. They review their understanding of the time scales over which events or interactions occur. Ideas about day and night, weather, volcanic activity and earthquakes, seas, moons, asteroids, comets and meteors could be included.

▶ Students prepare a log or diary in which they record events and interactions encountered during a voyage to Earth and on arrival. Students describe the nature and frequency as well as the regularity or irregularity with which these events and interactions occur.

Gathering information about student learning

Sources of information could include:

- students' contributions to discussions as they review their understandings;
- students' diaries or logs.

ACTIVITY

Interactions concept map

Culminating

Focus

This activity provides students with the opportunity to reflect on and collate information gathered previously about the interactions of Earth and beyond.

Students construct a concept map about interactions of Earth and beyond that are observable on Earth.

Materials

- students' recent work
- Resource Sheet 6, 'Changes to Earth and sky over time'

Teaching considerations

This activity complements the introductory activity 'The changing Earth and sky' (pp. 10–11). The original concept map will be useful as a point of reference for assessing the development of students' ideas.

If the work on interactions of Earth and beyond has been extensive, it may be necessary to focus on only a part to make the task reasonable for students. To assist students to clarify their understanding, review the recent, relevant activities. Highlight clearly the major concepts and interactions. Distinguish clearly between interactions that are regular and predictable and those that are irregular.

Working scientifically

Time: 50 minutes

Clarifying and challenging
Formulating questions
Applying ideas and concepts
Reflecting and considering
Retelling and restating
Summarising and reporting

▶ Students review completed work relevant to the interactions of Earth and beyond. They consider what they know and formulate questions to clarify ideas and concepts about which they are unsure. They discuss the regularity of specific events and interactions and identify those that are irregular or infrequent.

▶ Students consider the diagram on Resource Sheet 6 and individually make a list of significant events that they understand fit into the categories shown. They group any that are related (for example, clouds, weather, rain) and place them together in the appropriate circle. Events that occur on a time scale greater than a year may be placed outside the circle. Students link related events, or groups of events, with a line and an annotation explaining the connection. They also categorise events as regular or irregular.

Resource Sheet 6

▶ Students explain their concept map to the class or in a personal interview with the teacher.

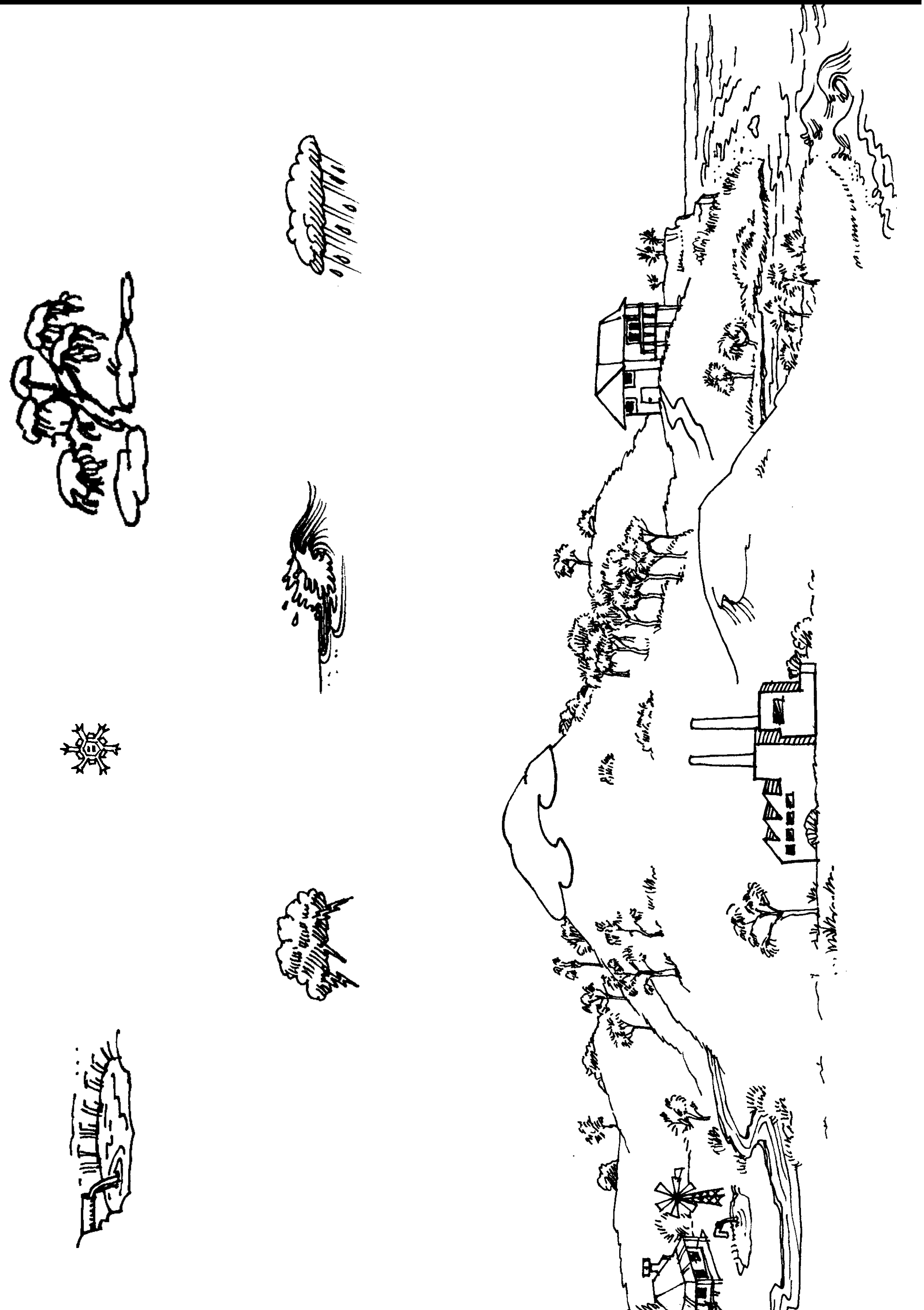
Gathering information about student learning

Sources of information could include:

- students' contributions to discussions and formulation of questions;
- students' completion of Resource Sheet 6;
- students' explanations of their concept maps.

The water cycle

Resource Sheet 1



Tropical cyclones

The tropical cyclone is the largest meteorological system known. 'Hurricanes' and 'typhoons' are other names for the same phenomenon in other parts of the world. Storms which develop wind speeds between 89 and 118 kilometres per hour are known as tropical storms. Those with wind speeds over 118 kilometres per hour are tropical cyclones.

In the Northern Hemisphere, the winds in tropical cyclones move anticlockwise around the storm's centre. In the Southern Hemisphere, winds in tropical cyclones move in a clockwise direction. The 'eye' is a region of relative calm at the centre of the tropical cyclone which may extend from a few metres across to 20 kilometres across.

Tropical cyclones develop over the sea near the equator where the surface temperature of the water is greater than 27°C.

Warm, moist air over the ocean rises rapidly; as it rises the air cools. Moisture in the air condenses to form clouds, releasing enormous amounts of energy. The rapidly rising air causes a drop in air pressure at the ground surface. Air moving into the area of low pressure moves up rapidly in a spiralling motion. This leads to more condensation, more energy being released and as the cycle continues a severe storm develops.

The condensation in the system eventually falls as vast amounts of rain, accompanied by strong destructive winds. As a tropical cyclone passes overhead, the winds first of all come from one direction. As the eye passes overhead, there is a period of calm. The winds then start up again and come from the opposite direction. The system is self-sustaining as long as it remains over water. Once the tropical cyclone moves onto the land, it degenerates into a rain depression. The wind speed reduces but the rainfall remains very intense and often causes severe flooding.

(continued)

Tropical cyclones *(continued)*

Categories of tropical cyclone

Category	Strongest gust (km per hour)	Typical effects (indicative only)
1	Less than 125	Negligible house damage. Damage to some crops, trees and caravans. Boats may drag moorings.
2	125–169	Minor house damage. Significant damage to signs, trees and caravans. Heavy damage to some crops. Risk of power failure. Small boats may break moorings.
3	170–224	Some roof damage and structural damage to houses. Some caravans destroyed. Power failure likely.
4	225–279	Significant roofing loss and structural damage to houses. Many caravans destroyed and blown away. Dangerous airborne debris. Widespread power failures.
5	More than 280	Extremely dangerous with widespread destruction.

(continued)

Source: Department of the Environment, Sport and Territories, Bureau of Meteorology, *Surviving Cyclones*, © Commonwealth of Australia, reproduced by permission.

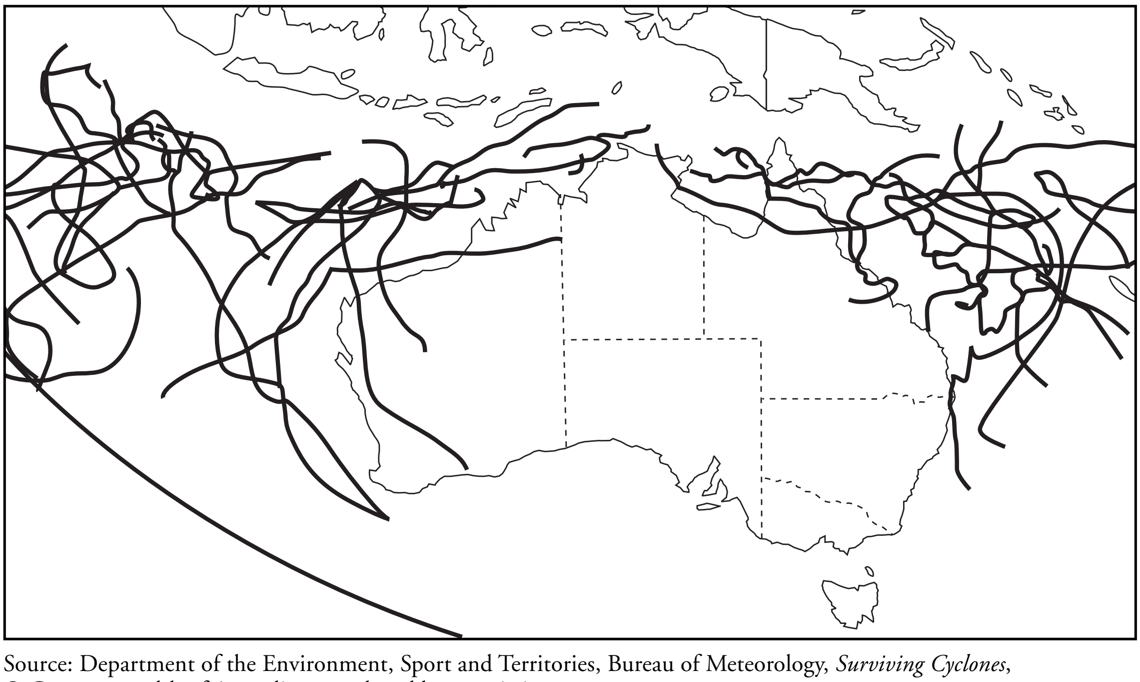
Tropical cyclones *(continued)*

Selected flood levels from the Brisbane city flood gauge (rounded to the nearest 0.5 m)	
14 January 1841	8.5 m
20 March 1864	4.0 m
5 February 1893	8.5 m
12 February 1893	2.0 m
19 February 1893	8.0 m
7 February 1931	3.5 m
6 February 1971	1.5 m
29 January 1974	5.5 m
4 May 1996	2.0 m

Source: Department of Environment, Bureau of Meteorology.

Paths of past tropical cyclones

Between July 1909 and June 1984, 173 tropical cyclones are recorded as crossing the Queensland coast.



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Weathering: Teacher demonstration

Physical weathering: water

Focus of demonstration: If water penetrates into crevices in rock and then freezes, the rock may split due to the expansion of the water as it turns to ice.

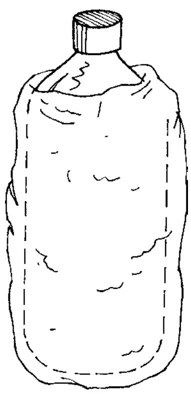
Materials

- plaster of Paris
- wooden stirrer
- water
- mixing bowl
- 2 small plastic bottles with screw caps
- newspaper
- plastic cling wrap

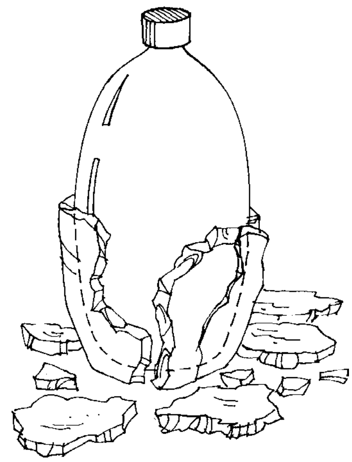
Fill one bottle with tap water and replace the cap securely. Drain any liquid from the other bottle and cap it. Mix plaster of Paris and completely coat each bottle. This could be done by spreading a layer of plaster of Paris about 2 cm thick on a sheet of moistened plastic cling wrap, then wrapping up each bottle. Plaster over any gaps or bare patches and leave the plaster coating to dry.

When the plaster has set rock hard, place both bottles in the freezer. When the liquid in the full bottle freezes, it will expand and split the 'rock' surrounding it. The 'rock' around the empty bottle should remain intact.

Note: It is not essential to coat the bottle with plaster of Paris to demonstrate the force of expansion of water when it freezes. If the bottle is completely full and capped, it will burst when frozen. The plaster of Paris coating serves as a model of 'rock' that is fractured by water freezing.



A control would contain an empty bottle.



Freezing will cause the bottle to expand and the surrounding plaster of Paris to break into pieces.

(continued)

Weathering: Teacher demonstration *(continued)*

Physical weathering: roots

Focus of demonstration: Materials such as germinating seeds or plant roots may cause splitting of rocks as they expand and grow.

Materials

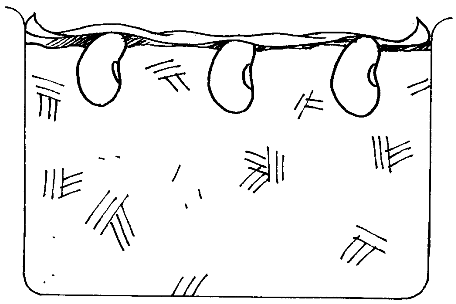
- plaster of Paris
- wooden stirrer
- water
- mixing bowl
- fresh seeds (such as garden peas, mung beans, bauhinia or nasturtium)
- transparent disposable plastic cups or the bases of soft drink bottles

Boil four of the seeds in water to kill them. These will be the control seeds. Soak the other seeds in cool water for the same period of time as the control seeds are in water.

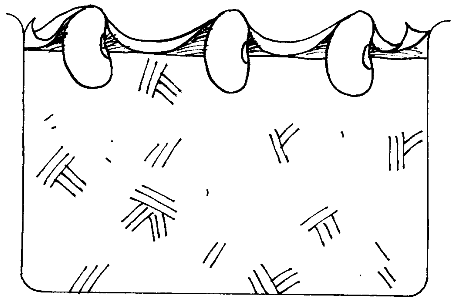
Mix plaster of Paris with water to form a stiff, creamy paste and pour the mixture to a depth of 5–8 cm into each of three containers labelled A (submerged), B (half-submerged) and C (control). Level the top of the plaster in the container. While the plaster is still wet, press three or four living seeds into the plaster in cup A, submerging the seeds so that only their tops are showing. In cup B insert the seeds to half their height. Put the killed seeds in the plaster in the third cup (C). Space the seeds apart from each other and about 5–10 mm in from the edge of the cup.

Moisten paper towelling with tap water and place it over the seeds in all three cups. Write the date on each of the cups. Keep the paper towelling moist during the experiment.

Students will see from this demonstration that as seeds germinate they may exert sufficient force to crack rock. If the plaster of Paris is smashed with a hammer (under suitably safe conditions) some time after the seeds have sprouted, the penetration of the rootlets into apparently solid 'rock' may be observed.

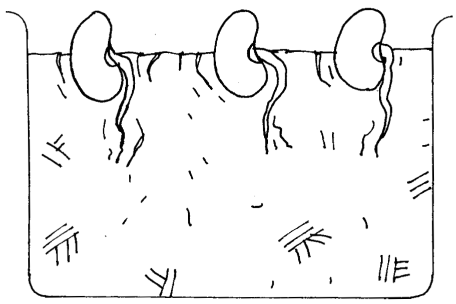


submerged seeds (A)



half-submerged seeds (B)

The controls would be set up in the same way using boiled beans (C).



Roots growing as the seeds germinate cause cracks to appear in the plaster of Paris.

(continued)

Weathering: Teacher demonstration *(continued)*

Chemical weathering

Focus of demonstration: Natural materials such as iron, and processed materials such as concrete used in buildings, may be weathered by chemical reaction with other naturally occurring substances.

Demonstration A — water reacting with iron

Materials

- water
- 2 clear glass tumblers labelled 'Test' and 'Control'
- 2 flat dinner plates or similar
- 2 pads of wire wool (also called steel wool). If the wire wool is coated in oil as a preservative, remove it by rinsing in methylated spirits. Allow the wire wool to dry completely before using. Note the colour and texture of the wire wool.

Dampen one pad of wire wool, put it on the plate and cover it with the 'Test' tumbler turned upside down. Explain that the tumbler maintains the humidity near the damp wire wool to accelerate the rusting process for this demonstration.

Make sure that the other plate, tumbler and pad of wire wool are dry. Place the second pad on the second plate and cover it with a tumbler labelled 'Control'.

Every few days lift the tumblers and examine the wire wool pads. Note any change in colour and feel the texture. The wire wool pad that was dampened will soon become coated in rust; the dry pad will take much longer to rust. Within two to three weeks the test pad will have lost its wiry texture and springiness and will crumble to red-brown powder when touched.

A pad of stainless steel wool may also be set up in parallel with the two pads of wire wool. This will not rust as rapidly as the wire wool, if it rusts at all, and serves as an example of how combining materials influences their usefulness (Natural and Processed Materials 3.3). In this case, combining chromium (8–25%) with iron produces stainless steel which is resistant to rust and many corrosive agents.

(continued)

Weathering: Teacher demonstration *(continued)*

Demonstration B — acid reacting with concrete or limestone

Materials

- mixing bowl suitable for mixing cement
- stirrer
- plastic cling wrap
- 6 glass beakers, each 250 mL capacity
- 400 mL vinegar, 400 mL dilute hydrochloric acid
- blackboard chalk or limestone chips
- water (need not be pure)
- small quantity of cement (50 g) and sand (250 g). *Note:* The sand must be free of salt; beach sand is not suitable unless washed very thoroughly first.

Safety

Wear impervious strong gloves when mixing and working with cement. Be careful not to inhale the cement powder; it is very light and floats readily when disturbed. Wear a mask if you are at all sensitive to dust.

Add one volume (or slightly more) of cement powder to five volumes of sand. The proportions are not critical; err on the side of more rather than less cement. Mix the cement powder through the sand, then add water, a small quantity at a time, and continue mixing until the concrete is the consistency of thick cream.

Scoop blobs of concrete (2–5 cm across) onto a sheet of plastic cling wrap and allow them to set overnight.

Label each of the beakers as follows — A: concrete in vinegar; B: concrete in acid; C: concrete in water; D: limestone (chalk) in vinegar; E: limestone (chalk) in acid; F: limestone (chalk) in water.

Arrange the beakers at the learning centre and pour into each about 200 mL of liquid. To A and D add vinegar. To B and E add dilute hydrochloric acid. To C and F add water.

When the students are ready to observe the reactions, add the concrete blobs to A, B and C; add limestone chips or chalk to D, E and F.

Explain that concrete 'sets' as the result of a reaction between the chemicals in cement and carbon dioxide in the air. That reaction is reversed by acid with the release of carbon dioxide. The gas formed when limestone or chalk (calcium carbonate) reacts with acid is also carbon dioxide.

Meteors, asteroids and comets

Meteors

A meteor or 'shooting star' is not a falling star at all, but a streak of light in the sky produced as a meteoroid enters Earth's atmosphere.

A meteoroid is made of stone or metal and is smaller than an asteroid. It can be any small body travelling through space which, when it meets Earth's atmosphere, is heated to the point where it vaporises, thus becoming a meteor.

If such an object collides with the Earth, it is called a 'meteorite'. Scientists have strong evidence that some immense meteorites in the past have landed upon Earth. They believe some meteorite impacts have generated immense clouds of dust and heat. The heat may have penetrated up to a kilometre into the Earth's crust, boiled off surface water, removed most of the atmosphere and sterilised the surrounding area. The dust is believed to have been sufficient to block out the sun. Such an event may have killed off the dinosaurs.

Asteroids

An asteroid is one of many minor bodies orbiting the sun, mostly between the orbits of Mars and Jupiter. Asteroids may be fragments of a shattered planet or, more likely, leftovers from the formation of the planets. Some asteroids are also believed to be 'dead' comets.

An estimated 2000 different asteroids may cross Earth's orbit at some time. The largest known asteroid is Ceres, with a diameter of more than 900 kilometres.

Asteroids may be made of many different materials; however, the most common are ices and rocks. The rocks may be similar to Earth's rocks, or be made of iron-nickel compounds.

(continued)

Meteors, asteroids and comets

Comets

Comets are huge balls of ice mixed with pebbles and rocky materials, like dirty snowballs. They orbit the sun with highly elliptical orbits that bring them both very close to the sun and deep into space, often beyond the orbit of Pluto. Comets have a central solid nucleus surrounded by a misty mass (the coma) that forms a tail. The tail is always directed away from the sun.

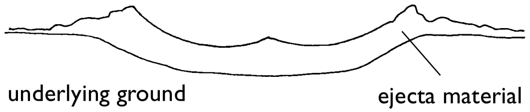
No-one knows how comets were formed, but they seem to pre-date the formation of the solar system. They may be formed in the Oort and Kuiper Clouds in a part of space beyond the orbit of the planet Pluto. Comets that impacted with Earth early in its development are believed by scientists to have provided the organic material and water from which life as we know it developed.

Some comets, such as Halley's, are 'short period' comets, with an orbital period of only about 76 years. Others are 'long period' comets, which take thousands of years to complete an orbit.

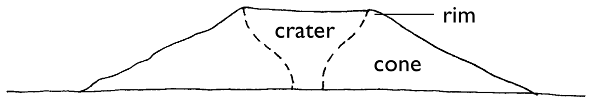
Source: Based on information supplied by Sir Thomas Brisbane Planetarium.

Craters

Resource Sheet 5 R5



Impact crater



Volcano crater

Characteristics of impact crater

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Characteristics of volcanic craters

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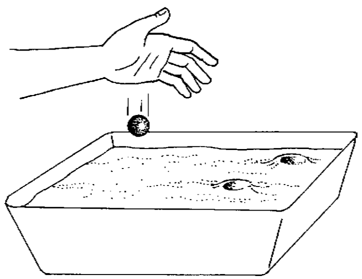


Creating craters

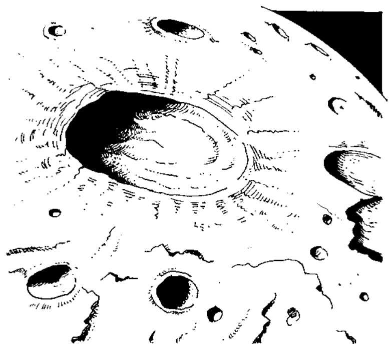
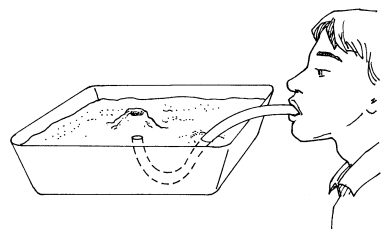
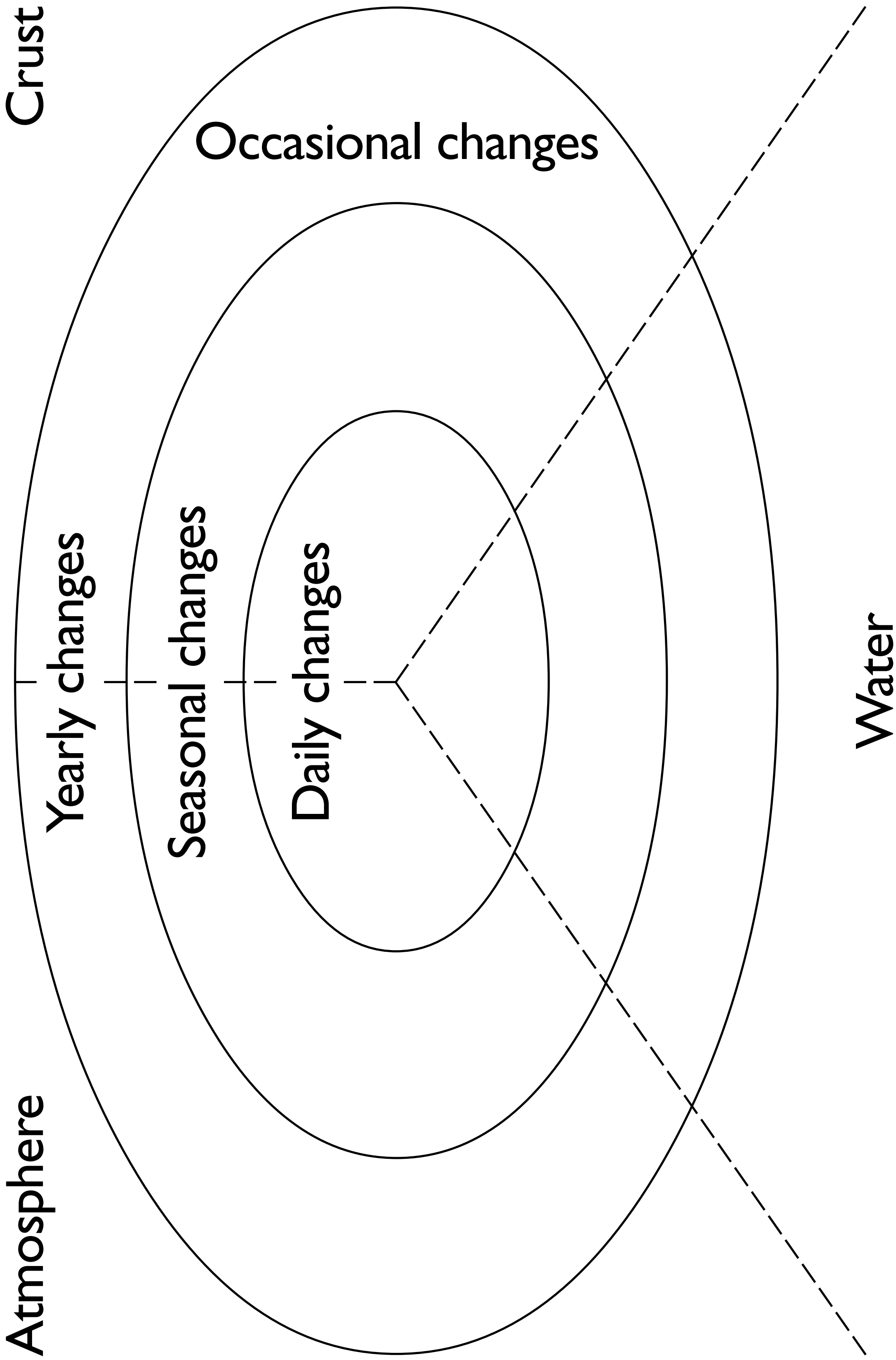


Image of craters on the moon



Making volcanic effects

Changes to Earth and sky over time



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This sourcebook module should be read in conjunction with the following Queensland School Curriculum Council materials:

> ***Years 1 to 10 Science Syllabus***
> ***Years 1 to 10 Science Sourcebook: Guidelines***
> ***Science Initial In-service Materials***

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Any inquiries should be addressed to:
Queensland School Curriculum Council
PO Box 317
Brisbane Albert Street, Q 4002
Australia

Telephone: (07) 3237 0794
Facsimile: (07) 3237 1285
Website: http://www.qscc.qld.edu.au
Email: inquiries@qscc.qld.edu.au

Illustrations by Stephen Francis

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