OXFORD

obook pro

SCIENCE

OXFORD SCIENCE 7

Sample chapter

This sample chapter is provided in draft format for inspection purposes.

To access a sample of the digital resources that support the series, visit:
oup.com.au/ac-sci-info

HELEN SILVESTER

SECOND EDITION

AUSTRALIAN CURRICULUM

OXFORD SCIENCE 7

1 Science toolkit
Scientists work collaboratively and individually in the laboratory or the field, to plan or conduct investigations safely and ethically. Scientists make predictions, control variables and record their results accurately. Scientists communicate their results using scientific language.

2 Particle model
The properties of the different states of matter can be explained using the particle model. Scientists' understanding of matter has developed over thousands of years.

3 Mixtures
All things are made of materials. Many materials are mixtures. Some materials are not mixtures – they consist of one pure substance. Mixtures contain a combination of pure substances that can be separated using a range of techniques.

4 Forces
A force is a push or pull, arising from the interaction between two objects. Change is caused by unbalanced forces acting on the object. Earth's gravity pulls objects towards the centre of the Earth.

5 Classification
Living things are called organisms. There are differences within and between groups of organisms. Classification is a system that helps organise the diversity of life on Earth. The system of classification continues to develop and change.

6 Ecosystems
Organisms interact with each other in their environments. Scientists use food webs and food chains to represent these interactions. Humans are part of the food chain and human activity can affect the interaction of the organisms.

7 Earth, Sun and Moon
The position of the Sun, Earth and Moon in the sky causes change on Earth, including seasons, tides and eclipses. Scientists can make predictions based on the relative positions of the Sun, Earth and Moon.

8 Experiments

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CONTENTS

INTRODUCING *OXFORD SCIENCE 7–10 AUSTRALIAN CURRICULUM*

Oxford Science Australian Curriculum has been developed to meet the requirements of the *Australian Curriculum: Science* across Years 7–10. Taking a concept development approach, each double-page spread of Oxford Science represents **one concept**, **one topic** and **one lesson**. This new edition ensures students build science skills and cross-curriculum capabilities, paving a pathway for science success at VCE.

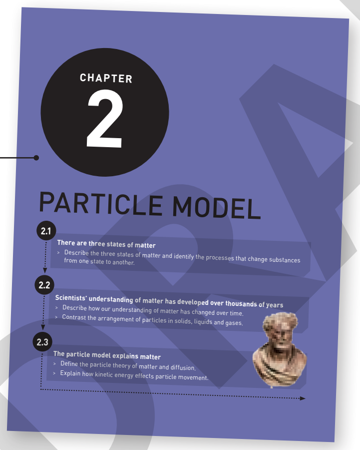
The series offers a completely integrated suite of print and digital resources to meet your needs, including:

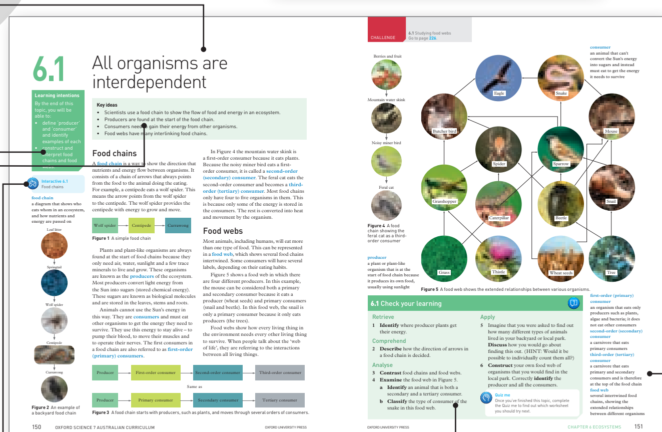
> Student Book
> Student obook pro
> Teacher obook pro.

Key features of this Student Book

> This Student Book combines complete curriculum coverage with clear and engaging design.
> Each print Student Book comes with complete access to all the digital resources available on Student obook pro.

Focus on concept development





Chapter openers

- Every chapter begins with a clear learning pathway for students.

Reflect

- Students are encouraged to self-assess their learning against a set of success criteria in the Chapter checklist tables at the end of each chapter. If students do not feel confident about their learning, they are directed back to the relevant topic.

Concept statements

- Every topic begins with a concept statement that summarises the key concept of the topic in one sentence.

Learning intentions

- Learning intentions are clearly stated for every topic.

Key ideas

- Key ideas are summarised for each topic in succinct dot points.

Margin glossary terms

- Key terms are bolded in the body in blue text, with a glossary definition provided in the margin.

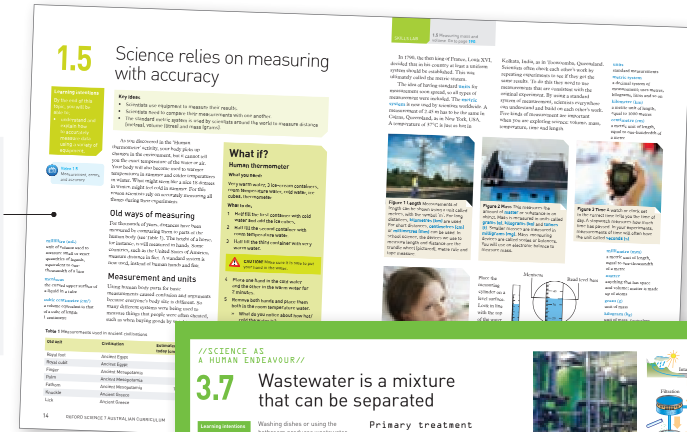
Integrated links to engaging digital resources

- Where relevant, digital icons flag engaging resources that can be accessed via Student obook pro. These resources are directly integrated with the topic being covered.

Check your learning

- Each topic finishes with a set of 'check your learning' questions that are aligned to the learning intentions for the topic. Questions are phrased using bolded cognitive verbs from Marzano and Kendall's taxonomy, which state what is expected of a student and prepares them for studying senior science subjects.

Focus on science inquiry skills and capabilities



Science toolkit

- The Science toolkit is a standalone chapter that explicitly teaches important science inquiry skills and capabilities.

Science as a human endeavour

- 'Science as a human endeavour' topics explore real-world examples and case studies, allowing students to apply science understanding.

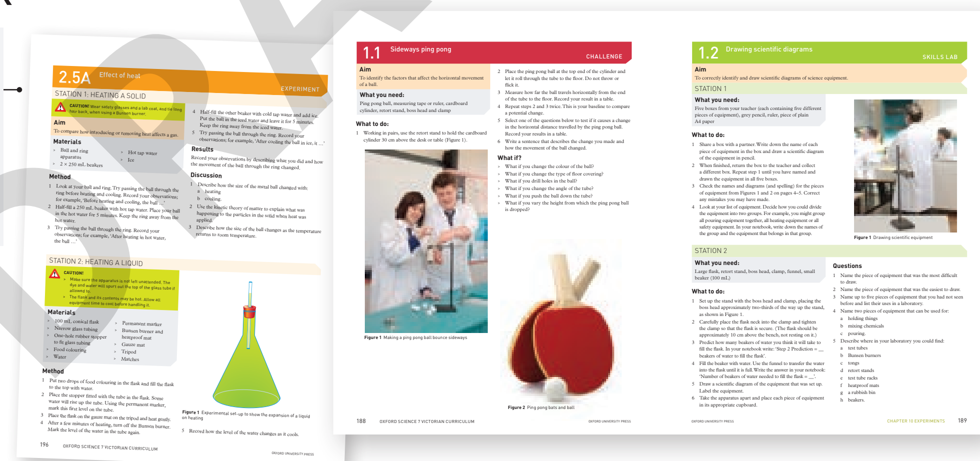
Test your skills and capabilities

- This section provides scaffolded opportunities for students to apply their science understanding while developing skills and capabilities.

Focus on practical work

Practical work appears at the back of the book

- All practical activities are organised in a chapter at the end of the book and signposted at the point of learning throughout each chapter.



Challenges, Skills labs and Experiments

- These activities provide students with opportunities to use problem-solving and critical thinking, and apply science inquiry skills.

Focus on STEAM

Integrated STEAM projects

- Take the hard work out of cross-curricular learning with engaging STEAM projects. Two fully integrated projects are included at the end of each book in the series, and are scaffolded and mapped to the Science, Maths and Humanities curricula. The same projects also feature in the corresponding Oxford Humanities and Oxford Maths series to assist cross-curricular learning.

Problem solving through design thinking

- Each STEAM project investigates a real-world problem that students are encouraged to problem solve using design thinking.

Full digital support

- Each STEAM project is supported by a wealth of digital resources, including student booklets (to scaffold students through the design-thinking process of each project), videos to support key concepts and skills, and implementation and assessment advice for teachers.

Key features of Student obook pro

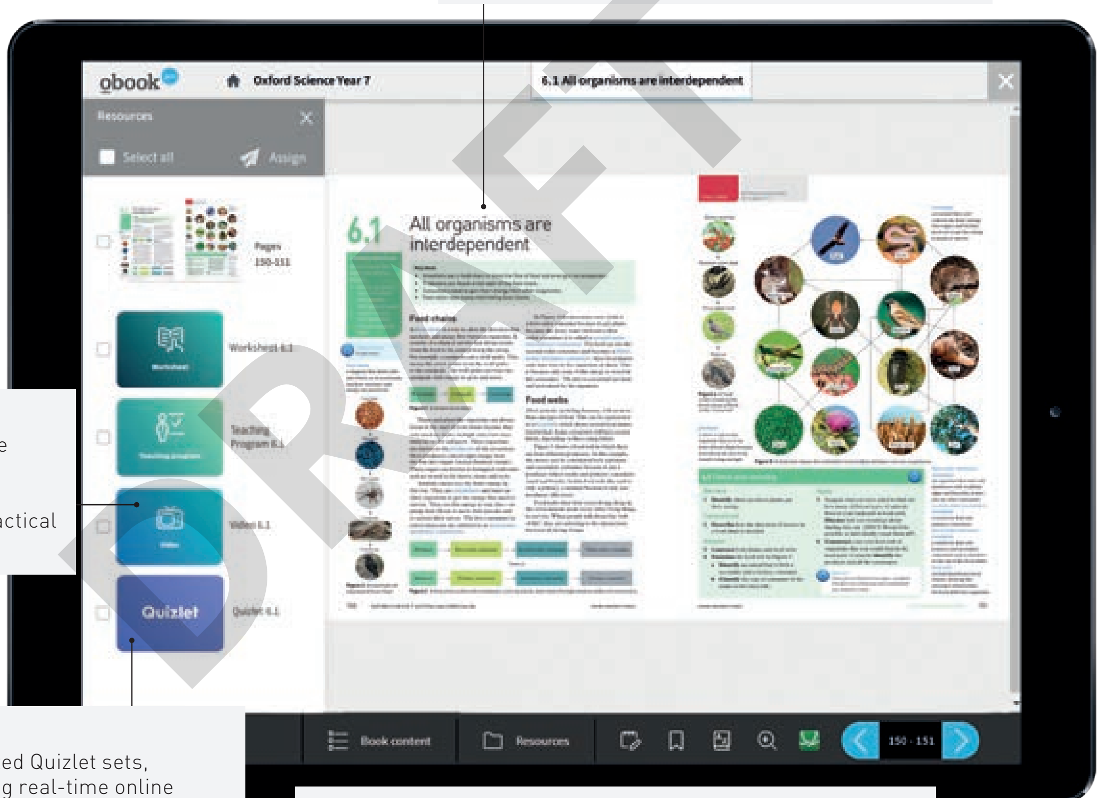
obook pro

- Student obook pro is a completely digital product delivered via Oxford's online learning platform, **Oxford Digital**.
- It offers a complete digital version of the Student Book with interactive note-taking, highlighting and bookmarking functionality, allowing students to revisit points of learning.
- A complete ePDF of the Student Book is also available for download for offline use and read-aloud functionality.

Focus on eLearning

Complete digital version of the Student Book

- This digital version of the Student Book is true to the print version, making it easy to navigate and transition between print and digital.



Videos

- Videos are available online to support understanding of concepts or key practical activities.

Quizlet

- Integrated Quizlet sets, including real-time online quizzes with live leaderboards, motivate students by providing interactive games that can be played solo or as a class. Quizlet can be used for revision or as a topic is introduced to keep students engaged.

Interactive quizzes

- Each topic in the Student Book is accompanied by an interactive assessment that can be used to consolidate concepts and skills.
- These interactive quizzes are autocorrecting, with students receiving instant feedback on achievement and progress. Students can also access all their online assessment results to track their own progress and reflect on their learning.

Benefits for students

- integrated Australian Concise Oxford Dictionary look up feature
- targeted instructional videos for key concepts, practicals and worked examples
- interactive assessments to consolidate understanding
- integrated Quizlet sets, including real-time online quizzes with live leaderboards
- access to their online assessment results to track their own progress.

Key features of Teacher obook pro

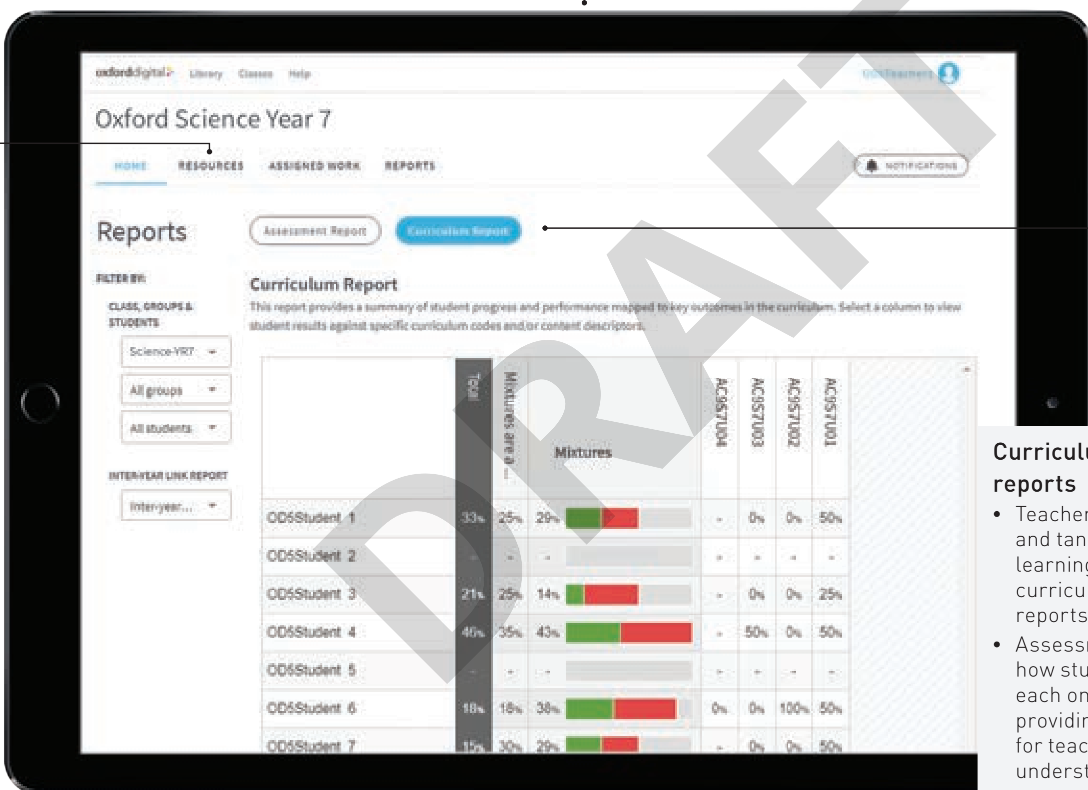
obook pro

- Teacher obook pro is a completely digital product delivered via **Oxford Digital**.
- Each chapter and topic of the Student Book is accompanied by full teaching support. Teaching programs are provided that clearly direct learning pathways throughout each chapter, including ideas for differentiation and practical activities.
- Teachers can use their Teacher obook pro to share notes and easily assign resources or assessments to students, including due dates and email notifications.

Focus on assessment and reporting

Complete teaching support

- Teaching support includes full lesson and assessment planning, ensuring there is more time to focus on students.



Curriculum and assessment reports

- Teachers are provided with clear and tangible evidence of student learning progress through curriculum and assessment reports.
- Assessment reports directly show how students are performing in each online interactive assessment, providing instant feedback for teachers about areas of understanding.
- Curriculum reports summarise student performance against specific curriculum content descriptions and curriculum codes.

Additional resources

- Each chapter of the Student Book is accompanied by additional worksheets and learning resources to help students progress.

Benefits for teachers

- In addition to online assessment, teachers have access to editable class tests that are provided at the conclusion of each chapter. These tests can be used as formative or summative assessment and can be edited to suit the class's learning outcomes.
- Teachers are provided with laboratory support through experiment answer guidance, laboratory technician notes and risk assessments to ensure safe learning experiences.

CHAPTER

7

EARTH, SUN AND MOON

7.1

The Earth, Sun and Moon interact with one another

- explain how the length of a day and a year relate to the movements of the Earth
- describe the differences between a total and partial solar eclipse.

7.2

The Moon reflects the Sun's light

- identify and describe the phases of the Moon and lunar eclipse
- contrast a solar and a lunar eclipse.

7.3

The Moon's gravity causes tidal movements

> explain how the Moon's gravity causes tidal movements
> describe the relationship between the Moon and tides that was recognised by early First Nations Australians.

7.4

Seasons are caused by the tilt of the Earth

> define the terms 'solstice' and 'equinox'
> explain how seasons are related to the position of the Sun and Earth
> describe the importance of seasons and seasonal calendars to First Nations Australians.

7.5

Science as a human endeavour: Astronomers explore space

> identify examples that show how advances in technology and scientific knowledge have improved our understanding of the solar system.

What if?

Modelling the Earth and Moon

What you need:

Ruler, 2 balloons

What to do:

1 Blow up one balloon until it is 20 cm in diameter. This balloon represents the Earth.
2 Blow up the other balloon to 5 cm in diameter. This balloon represents the Moon.
3 Move the two balloons until they are 5 m apart. This represents approximately how far the Earth is from the Moon.
4 With your partner, discuss what effect the Moon has on the Earth. Does the Moon always appear to be the same size when viewed from Earth?

What if?

» What if the Moon was closer to the Earth? Would we notice any differences?

7.1 The Earth, Sun and Moon interact with one another

Learning intentions

By the end of this topic, you will be able to:

- explain how the length of a day and a year relate to the movements of the Earth
- describe the differences between a total and partial solar eclipse.

Key ideas

- The solar system is the collection of planets, their moons and smaller bodies (asteroids, meteors and comets) that orbit the Sun.
- The Moon orbits the Earth every 27.3 days.
- The Earth orbits the Sun every 365.25 days.

star
a celestial body appearing as a luminous point in the night sky

solar energy
energy made by atoms colliding with each other in the centre of the Sun

axis
an imaginary straight line joining the North and South Poles of the Earth

solar system
the Sun and all the planets, dwarf planets, moons and asteroids that travel around it and each other

orbit
the path a planet follows around the Sun or a star; the path a moon follows around a planet

leap year
a year, occurring once every four years, with 366 days

Our solar system

Our Sun is a **star**. It is the closest star to Earth and provides all the energy for every living thing. This **solar energy** is made by atoms colliding with each other in the centre of the Sun. Without the heat and light given off by the Sun, there would be no life on Earth.

Figure 1 The Earth is held in orbit by the Sun's gravitational pull.

Our small planet (it is the fourth smallest in the solar system) is 1 000 000 times smaller than the Sun. The **solar system** is made up of the Sun at the centre and all the planets, dwarf planets, moons and asteroids that travel around the Sun or each other. The path taken by a planet is called its **orbit** because of its oval or 'elliptical' shape.

A year

A year is the time it takes a planet to make one orbit around the Sun. It takes 365.25 days for the Earth to complete one orbit. This means that every four years our calendar is one full day behind (4 × 0.25 days). We account for this by adding an extra day (29 February) every **leap year**.

Night and day

Day and night are caused by the Earth spinning on its **axis**, an imaginary straight line joining the North and South Poles. You can model this in your classroom. Stand facing the front of the room and turn around on the spot until you face the front once again. This is one complete rotation. The Earth takes 24 hours to complete one full rotation.

Because of its shape, only half the Earth is exposed to sunlight at any given time. The other half is in shadow. The part facing the Sun is experiencing daytime, whereas the part facing away from the Sun is experiencing night. Because the Earth rotates, all parts of the Earth experience day and night, just at different times.

In Figure 2, it is daytime for countries on the right and night-time for those on the left. Can you tell in which countries the Sun would be rising or setting?

Figure 2 The half of the Earth facing the Sun experiences day and the half in shadow experiences night.

Have you ever watched the New Year's Eve celebrations around the world on television? The celebrations in New Zealand are always just before those in Australia. The Earth rotates west to east.

We know this because as the Earth spins toward the Sun, we see the Sun rise above the horizon in the eastern sky. Sunset occurs when the Earth rotates away from the Sun. New Zealand is east of Australia, so the Sun rises in their sky first.

Solar eclipse

One of the first scientists and mathematicians who investigated the time it took for the Moon to travel around the Earth was al-Battani (whose full name was Abu Abdallah Muhammad ibn Jabir ibn Sinan al-Raqqi al-Harrani al-Sabi al-Battani) in the tenth century. Although he was not the first astronomer to build a model of how the Moon travelled around the Earth, his was one of the most accurate. He was able to correctly calculate the cause for a solar eclipse.

This occurs when the Moon passes between the Sun and the Earth once every 27.3 days. Occasionally, the Moon will be in a position where it blocks some of the light from the Sun. This is known as a **solar eclipse** (Figure 3). During a **total solar eclipse**, the Moon blocks the maximum amount of light from the Sun and the sky goes dark for a short time during the day. The last total eclipse of the Sun visible from northern Australia was on 13 November 2012; the next one is due on 20 April 2023 in Western Australia.

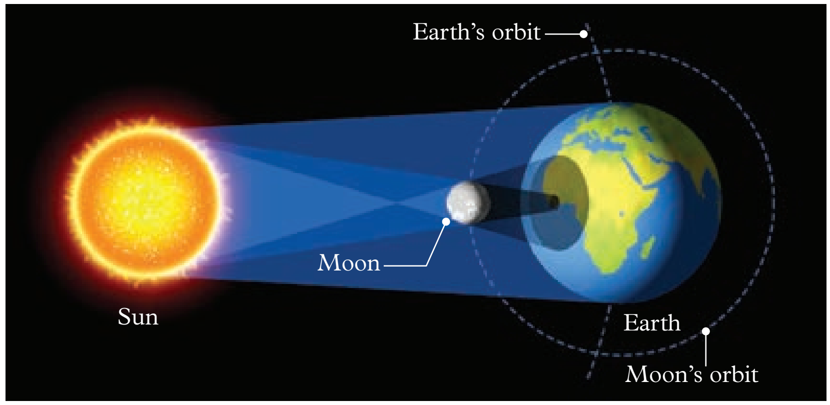


Figure 3 When the Moon is positioned between the Sun and the Earth, it is called a solar eclipse.

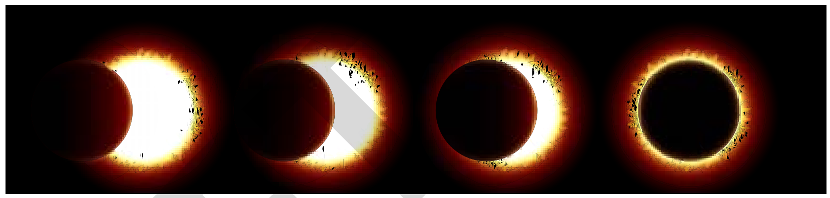


Figure 4 The phases of a solar eclipse

When a total solar eclipse is visible in Australia, people somewhere else in the world may only see a **partial solar eclipse**. This is when only some of the Sun's light is blocked. Because the Earth and Moon are always moving around their orbits, an eclipse takes a few minutes and then gradually passes as the Earth and Moon continue their motion (Figure 4).

You should never look directly into a solar eclipse as it could damage your eyes!

solar eclipse
when light from the Sun (as seen from Earth) is blocked by the Moon

total solar eclipse
when the Moon blocks the maximum amount of light from the Sun, as seen from Earth

partial solar eclipse
when only some of the Sun's light is blocked by the Moon

7.1 Check your learning

Retrieve

1 **Define** the terms 'rotation' and 'orbit'.

Comprehend

2 **Explain** why the calendar adds an extra day in February every four years (leap year).

3 **Explain** the difference between a total solar eclipse and a partial solar eclipse.

4 **Explain** why a person in Victoria and their friend in Darwin do not see exactly the same solar eclipse.

5 Figure 3 shows the shadow caused by the Moon during a solar eclipse. If people living in the region of the darkest shadow experience a total solar eclipse, **describe** the type of eclipse seen by the people living in the region of the lighter shadow.

Analyse

6 **Contrast** the different time zones around the world. **Describe** what people in the United States of America, China, Tanzania and France might be doing while you are having lunch in Australia.

7 **Connect** the terms 'day', 'night' and 'year' with the listed explanations:
- **a** experienced by the part of the Earth that is facing away from the Sun
- **b** the name for the rotation of the Earth over 24 hours
- **c** the time for the Earth to orbit the Sun once.

Quiz me
Complete the Quiz me to check how well you've mastered the learning intentions and to be assigned a worksheet at your level.

7.2 The Moon reflects the Sun's light

Learning intentions

By the end of this topic, you will be able to:

- identify and describe the phases of the Moon and lunar eclipse
- contrast a solar and a lunar eclipse.

Key ideas

- The Moon rotates as it orbits the Earth.
- The same face of the Moon always faces towards the Earth.
- The phases of the Moon are caused by the light from the Sun shining on different parts of the Moon.

Interactive 7.2
The path of the Sun

phases of the Moon
changes in the shape of the Moon as seen from Earth

Many scientists believe that a giant collision between two planetary bodies resulted in the formation of Earth and the Moon. Early astronauts collected samples from the surface of the Moon and compared them with the surface of Earth: they are almost identical.

The first scientific description of the Moon was made in 1609 by Italian astronomer and physicist Galileo Galilei (1564–1642), based on his observations through a telescope. At the time it was believed that the Moon had a smooth surface, which explained its ability to reflect light from the Sun. Galileo knew differently. He saw the rough, mountainous terrain and vast craters that we know cover the surface of the Moon. He even described large flat plains that we call 'maria' (pronounced 'MAHR-ee-ah'; Latin for 'seas') because they look like dark oceans. We now know these plains to be solidified lava.

In 2020, NASA's special SOFIA telescope mounted in an aeroplane (the Stratospheric Observatory for Infrared Astronomy) identified small molecules of water on the surface of the Moon for the first time. The amount of water found was very small (100 times less than the Sahara Desert). This will not be enough to supply all the needs of the NASA astronauts that will be landing on the Moon by 2024.

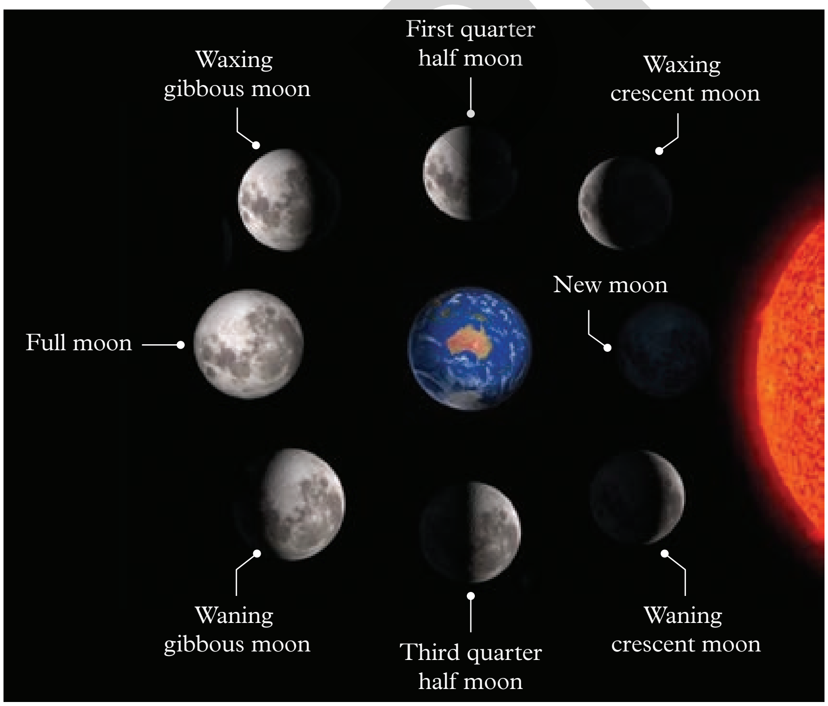


Figure 1 The phases of the Moon as they appear from Australia (the southern hemisphere)

Moonlight

Unlike the Sun, the Moon does not create its own light. Instead, it reflects sunlight. The amount of light reflected varies with the different phases of the Moon, but even the full Moon only provides a faint light that appears bluish to the human eye. We always see the same side of the Moon from Earth because the Moon rotates at the same speed as it orbits. This is just like walking around a person, making sure you always face toward them. The Moon takes 27.3 days to completely orbit the Earth.

Sometimes, only a part of the Moon is visible. You might see half a Moon, a crescent or a fully round Moon. Sometimes the Moon cannot be seen at all, even though it is in the sky. These changes in the shape of the Moon are called the **phases of the Moon** (Figure 1). Of course, the Moon does not change shape – it is always round. What changes is the amount of the Moon that is lit by the Sun, which makes it possible for us to see the Moon from Earth. We are really looking at the 'day' and 'night' parts of the Moon. The Moon rises and sets, just like the Sun. The Moon rises approximately 50 minutes later from one day to the next. The Moon is always in the sky; however, during the day, the sky is usually so light that the Moon is hard to see.

CHALLENGE
7.2: Modelling the phases of the Moon
Go to page **249**.

Figure 3 Australian scientists at the Parkes Observatory played a critical role in the Moon landing.

Exploring the Moon

The Moon is the only body in space on which humans have actually stepped. It has a weak gravitational pull and very little atmosphere; therefore, there is not enough oxygen to breathe. Astronauts must wear space suits fitted with breathing apparatus.

Neil Armstrong and Edwin 'Buzz' Aldrin were the first humans to walk on the Moon in July 1969 as part of the *Apollo 11* mission (Figure 2). They found 'kangaroo hopping' easier than walking on the Moon. The astronauts could jump higher and further because the pull of gravity on them was only about one-sixth of Earth's gravity.

THEIR DAY ON THE MOON

The Sun

EARLY today Neil Armstrong and Edwin Aldrin were dozing in the Eagle after their historic two-hour walk on the moon.

They were due to blast off at 3.55 a.m. to rejoin the Columbia command ship after 21 hours 7 minutes on the Sea of Tranquillity.

Figure 2 The first Moon landing was televised around the world and was front-page news on 21 July 1969.

The surface of the Moon is made of fine grains of dust that stick together like damp sand. The footprints made by the *Apollo 11* astronauts should still be visible in a million years because there is no erosion to destroy them. However, the footprints may be covered with dust from meteor impacts.

It was possible to beam images of the Moon landing around the world because of the satellite dishes located at Honeysuckle Creek in Canberra and Parkes in New South Wales (Figure 3).

Lunar eclipse

In eighteenth-century China, a young scientist called Wang Zhenyi developed a way to model a lunar eclipse. This eclipse occurs when the Earth moves between the Moon and the Sun. The Moon passes into the Earth's shadow and appears dark (Figure 4). Wang modelled this by hanging a lamp from the roof as a Sun, above a circular table that acted like the Earth. She then used a circular mirror that acted like the Moon. By moving the Moon mirror under the 'Earth' table, she was able to model the lunar eclipse.

Figure 4 A time-lapse photograph of a lunar eclipse

7.2 Check your learning

Retrieve

1 **Identify** if these statements are true or false.
   a The Moon creates light.
   b The Moon does not supply light to the Earth.
   c The Moon changes shape during different phases.
   d The Moon is the closest body in space to the Earth.
   e Craters are large indentations on the Moon's surface.
   f Astronomers are pseudoscientists.
   g We can see both sides of the Moon from the Earth.

2 **Recall** why astronauts can jump higher on the Moon than on Earth.

Comprehend

3 Use Figure 1 to **describe** the waxing and waning of the Moon.

Analyse

4 Greek philosopher and scientist Aristotle noticed that, during lunar eclipses, the Earth's shadow was always round. **Consider** how this led him to suggest the Earth was spherical in shape.

Apply

5 **Investigate** an alternative explanation for the phases of the Moon as told by early First Nations Australians. **Explain** how they saw the variation in the appearance of the Moon.

Quiz me
Complete the Quiz me to check how well you've mastered the learning intentions and to be assigned a worksheet at your level.

7.3 The Moon's gravity causes tidal movements

Learning intentions

By the end of this topic, you will be able to:

- explain how the Moon's gravity causes tidal movements
- describe the relationship between the Moon and tides that was recognised by early First Nations Australians.

Key ideas

- The Earth's pull force holds the Moon in orbit.
- The relationship between the Moon and the tides was recognised by early First Nations Australians.
- The pull force of gravity causes high and low tides.

Figure 1 The Moon

The relationship between the Moon and the tides was recognised by early First Nations peoples in Australia. In Yolngu traditions of Arnhem Land, stories describe water filling the Moon-man (Ngalindi) as he rises. When the Moon is full in the sky, the tidal waters are full. As the tide falls, the Moon is left empty for three days before filling once more.

What causes tidal movements?

The Earth's pull force holds the Moon in orbit. The Moon has its own pull force, even though it is far less than the Earth's. The Moon is approximately one-quarter the size and one-eightieth the mass of the Earth, so its pull force is much weaker.

This does not mean the Moon's pull force does not affect the Earth. The pull of the Moon causes the Earth's oceans to bulge toward the Moon. This causes the oceans to cover slightly more land, which we see on the Earth as a **high tide**. The Earth is also being pulled toward the Moon (and away from the water on the opposite side), so another high tide occurs on the opposite side of the Earth. As the Moon travels around the Earth and as both bodies travel around the Sun, the combined pull force from gravity causes the world's oceans to rise to high tides and fall to **low tides**. Because the Earth is rotating while this is happening, two high tides occur each day, approximately 11 hours apart.

high tide
when the ocean covers slightly more land; the highest level that the tide reaches on the shore

low tide
when the ocean covers slightly less land; the lowest level on the shore that the tide recedes to

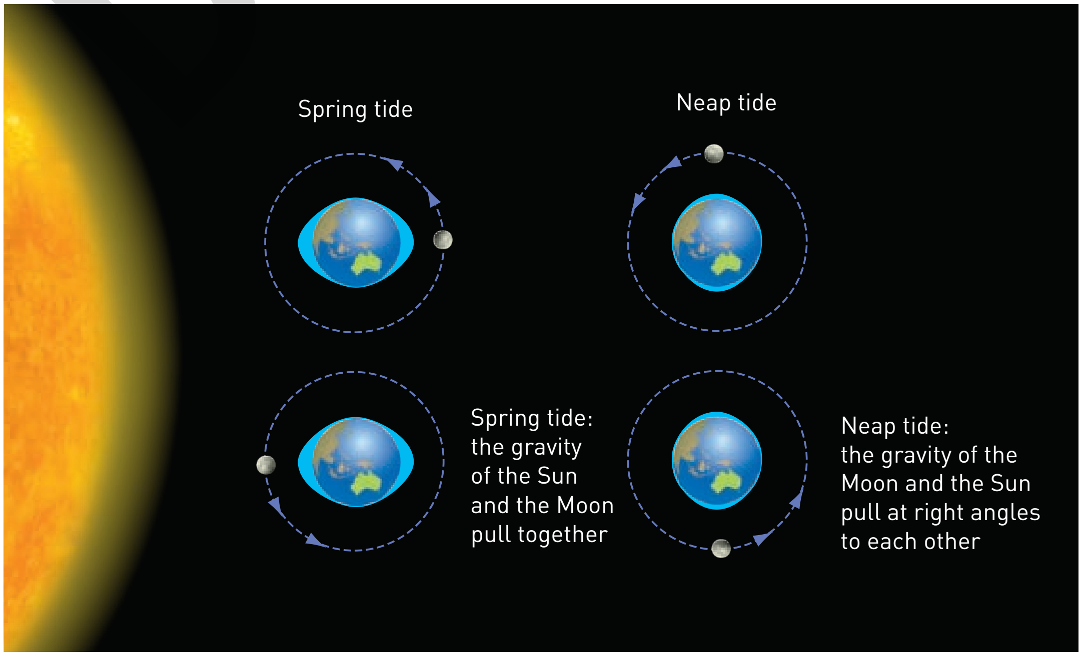


Figure 2 The Moon's pull on the oceans creates spring and neap tides. (The bulges shown here have been exaggerated so that they are easier to see.)

High tides happen when the land is rotated toward the water being pulled in by the Moon or Sun. Low tides happen when the land rotates away from the water bulge.

When the Sun, Moon and Earth are aligned, the combined pull of the Moon and the Sun causes very high tides in some parts of the Earth.

These are known as **spring tides**. Smaller **neap tides** occur during the Moon's quarter phases. At these times, the Sun and Moon are at right angles to the Earth, causing the sea tides to be pulled in both directions at once. Spring and neap tides are shown in Figure 2.

Worked example 7.3 shows how to calculate the difference in height between low and high tide.

spring tide
when there is maximum difference between high and low tides; caused by the combined pull of the Moon and the Sun

neap tide
when the difference between high and low tides is smallest; occurs during the Moon's quarter phase, when the Sun and the Moon pull in different directions

Worked example 7.3: Calculating tides

Table 1 shows the times of high and low tides at Surfers Paradise, in Gold Coast, Queensland, over three days in June 2022. Calculate the difference in height between the two high tides on the Friday.

Solution

One high tide is 1.01 m at 10.17 am and the other high tide is 1.59 m at 10.38 pm.

Subtract the smaller tide from the larger tide:
1.59 – 1.01 = 0.58 m

Table 1 High tides at Surfers Paradise, Gold Coast, in June 2022

Thursday, 2 June 2022		Friday, 3 June 2022		Saturday, 4 June 2022	
Time	Height (m)	Time	Height (m)	Time	Height (m)
4.01 am	0.35	4.42 am	0.38	5.26 am	0.42
9.36 am	1.05	10.17 am	1.01	11.02 am	0.98
3.12 pm	0.33	3.49 pm	0.38	4.31 pm	0.44
9.58 pm	1.64	10.38 pm	1.59	11.21 pm	1.53

7.3 Check your learning

Comprehend

1 **Explain** why the Moon has a greater effect on the tide levels than the Sun.

Analyse

2 Referring to Table 1, **identify** the difference between:
  a the last high tide on Friday and the first one on Saturday
  b the first high tide and the following low tide on Saturday.

Apply

3 Use the data in Table 1 to **predict** the times and heights of the tides for Sunday.

4 For 1 week, graph the high and low tide levels of a beach in your state. **Compare** this against the times of the Moon rise and set. **Discuss** the relationship between the Moon's position and tide levels.

5 Gravity is not considered a force. Instead, gravity is the distortion of space and time caused by a large object. This allows the large object to have a pull force. **Evaluate** the following sentence and rewrite it so that it is correct.
'The force of the Moon's gravity pulls the water on Earth to cause high tides.'

Quiz me
Complete the Quiz me to check how well you've mastered the learning intentions and to be assigned a worksheet at your level.

7.4 Seasons are caused by the tilt of the Earth

Learning intentions

By the end of this topic, you will be able to:

- define the terms 'solstice' and 'equinox'
- explain how seasons are related to the position of the Sun and Earth
- describe the importance of seasons and seasonal calendars to First Nations Australians.

Key ideas

- The Sun travels different paths across the sky at different times of the year.
- During summer, the days are longer and the Sun warms the ground and air.
- During winter, the days are shorter and the ground and air are cooler.
- The equinox occurs when the length of day is equal to the length of night.
- First Nations Australians use regional seasonal calendars which describe the weather, plants and animals that are common in that area at that time of the year.

The Wurdi Youang egg-shaped arrangement of stones shown in Figure 1 was found at Little River, Victoria, by European settlers nearly 200 years ago. The layout of 100 large boulders is thought to have been set out by the Wathaurong people, the Traditional Owners of the area. It is only recently that archaeologists have discovered that the 1 m high rocks at the two ends of the egg shape mark the points where the Sun sets during the middle of winter (the winter **solstice**) and the middle of summer (the summer solstice).

solstice
either of the times when the Sun is furthest from the equator

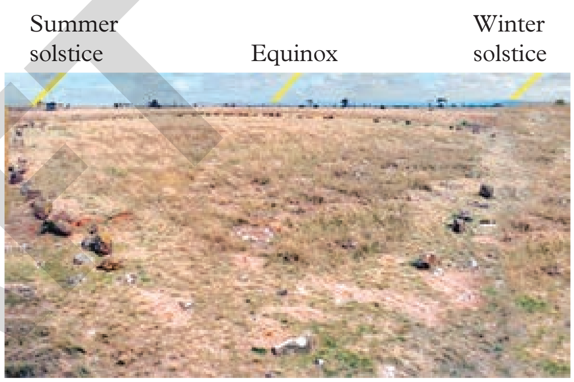


Figure 1 The Wathaurong people who lived between Melbourne and Geelong marked the movement of the Sun with waist-high stones.

Figure 2 Deciduous plants change with the seasons described by Europeans.

CHALLENGE
7.4: Modelling the seasons
Go to page **249**.

Summer

The Earth does not rotate evenly. Rather, the Earth rotates around an imaginary line (the axis) that is on an angle of 23.5 degrees. This means that, for part of the year, the southern hemisphere (including Australia) is tilted towards the Sun (Figure 3). The days are longer and the nights are shorter. The Sun is higher in the sky. This allows more time for the Sun's rays to hit the ground and therefore warm up the air. We experience summer. The Wathaurong people in Victoria knew this, and placed stones that marked the place where the Sun set during the longest day (21 December). This is called the summer solstice.

Equinox

After 21 December, the Earth continues its orbit of the Sun, slowly angling the southern hemisphere away from the Sun. Twice a year (in autumn on 20 March and in spring on 22 September), the position of the Earth allows an equal length of day and night. This is called the **equinox**. The Wathaurong people marked the sunset of these events with the equinox stone.

Winter

In winter, the southern hemisphere is angled away from the Sun. This means the Sun shines lower in our skies and for less time. As a result, there is less time for the Sun to warm up the ground and therefore the air is cooler. We experience winter. The shortest day (21 June), the winter solstice, was also marked by the Wathaurong people.

The Wathaurong people found a way to mark the movement of the Sun, and hence the seasons, without using telescopes or undertaking long sailing trips around the world.

The northern hemisphere's seasons are the opposite of ours in Australia, so during a northern summer there is a southern winter.

The tilt of the Earth is more noticeable in the Antarctic. In the summer, the tilt of the Earth causes the Sun to remain in the sky for five months. The Sun does not set; instead, it sits just above the horizon for the whole time.

The reverse is true for winter in the Antarctic. The angle of the southern hemisphere away from Sun means the Sun sets in May and does not rise again until July.

equinox
a day when day and night are the same length; occurs twice each year

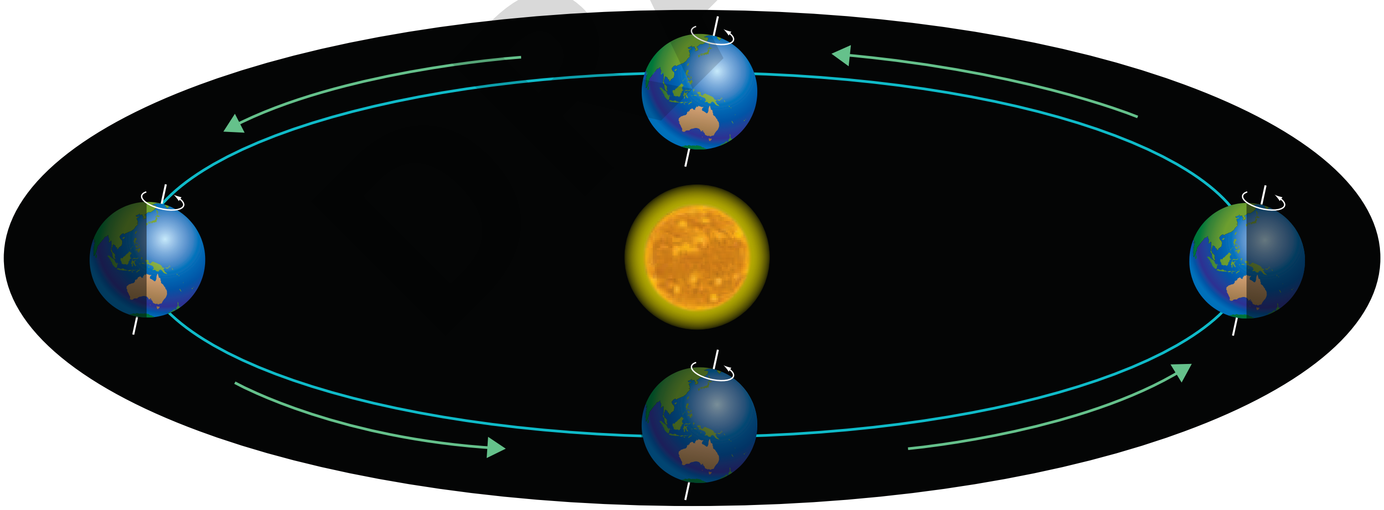


Figure 3 The Earth's rotation and orbit cause day and night, as well as the seasons.

Seasons for First Nations Australians

First Nations Australians have lived in all parts of the Australian landscape for more than 60 000 years. There are over 700 groups and most recognise the different seasons that are unique to their area. First Nations peoples in the Darwin area have seven main seasons in their Gulumoerrgin (Larrakia) year.

These seasons are divided according to the weather and the plants and animals that are common at that time of the year. The rainy season (Balnba) from November to December is when the first rains occur. Gulppula (green tree fog) is said to bring the rain. It is also the time to collect shellfish and the black plum. The monsoon season (Dalay: January–April) is when the saltwater crocodiles are laying their eggs and the barramundi are breeding.

Mayilema season (March–April) overlaps the monsoon season and is when the speargrass flowers appear and the magpie goose eggs can be collected. Damibila (April–June) is the time to collect the barramundi and bush fruit, while heavy dews are on the ground in the Dinidjanggama season (June–August). During Gurrulwa (July–September) there are often big winds that appear to come from all directions at once, while Dalirrgang (September–October) is very hot and humid as the weather slowly builds up to the next rainy season. Figures 4, 5 and 6 show the seaonal calendars unique to Larrakia Country in the Northern Territory, Yirrganydji Country in Far North Queensland and Gariwerd Country in Victoria.

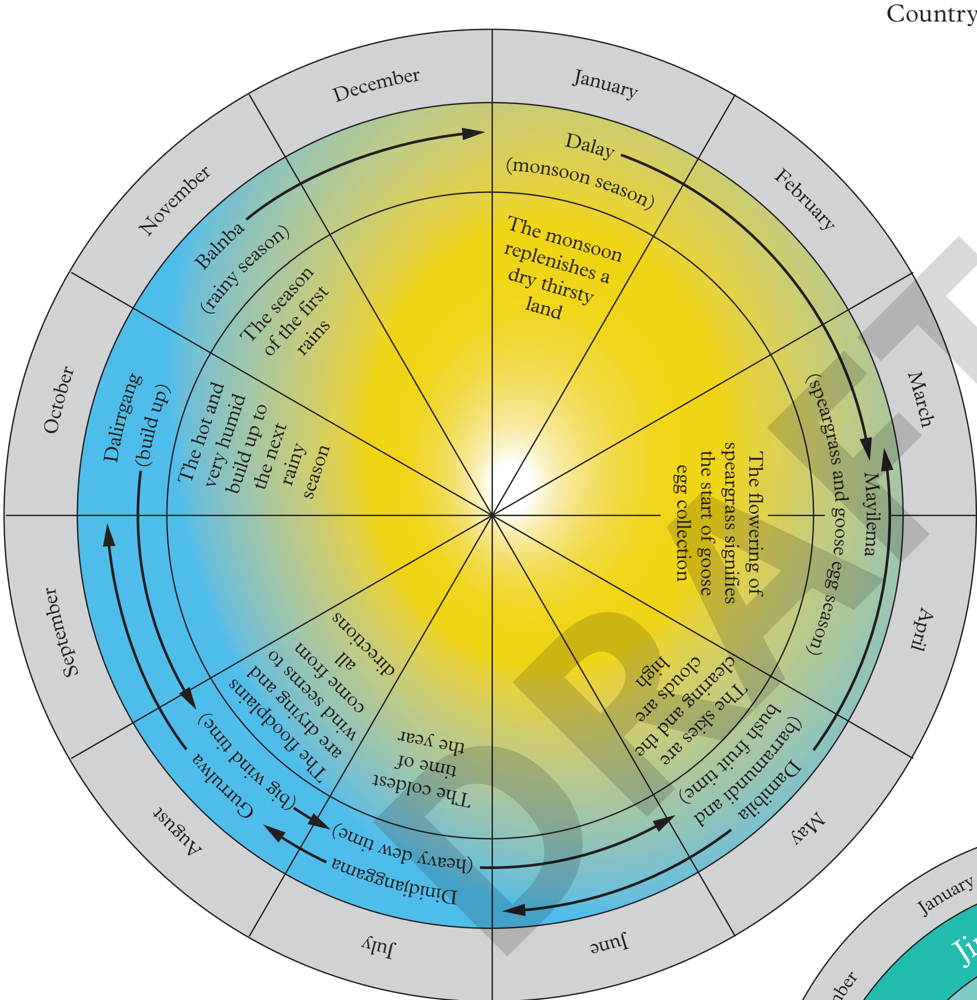
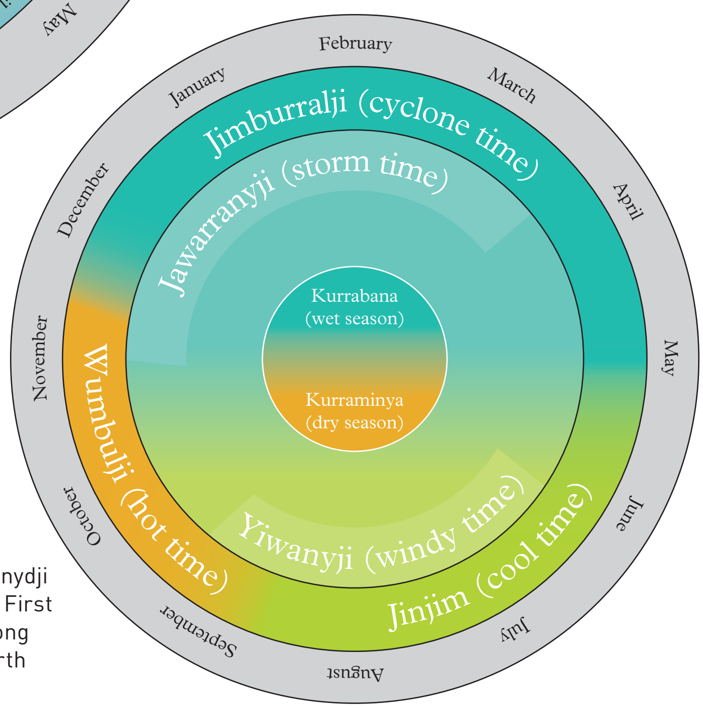


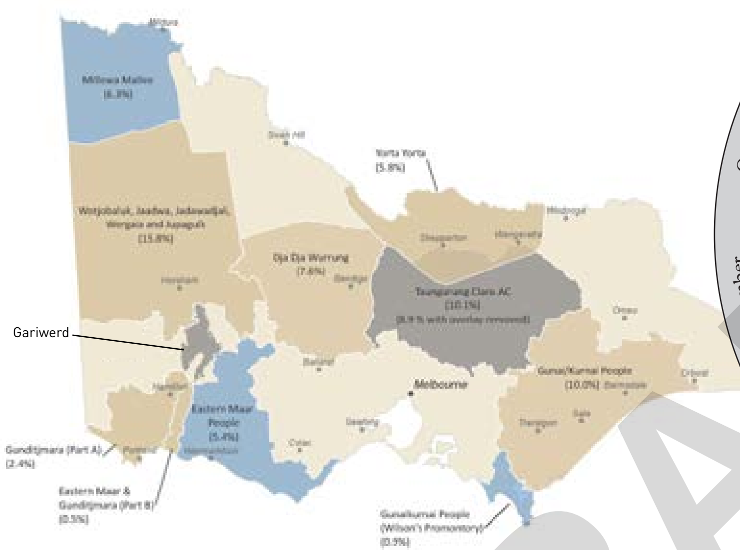
Figure 4 The Gulumoerrgin (Larrakia) calendar is used by First Nations peoples in Darwin.

Figure 5 The Yirrganydji calendar is used by First Nations peoples along the coast of Far North Queensland.



The traditional lands and waters of the Yirrganydji people covers the Queensland coast from Cairns to Port Douglas. Their seasonal calendar shows two major seasons: Kurrabana (wet season) and Kurraminya (dry season). The Kurrabana wet season is divided into a time of storms (Jawarranyji) and a time of cyclones (Jimburralji). The dry season is divided into the cool time (Jinjim), the windy time (Yiwanyji) and the hot time (Wumbulji).

Each of the First Nations peoples used their observations of the local environment to create a unique calendar. This is different to the European approach that recognises the same four seasons in all parts of the world from the Antarctic to the tropics, despite the very different climate and conditions.



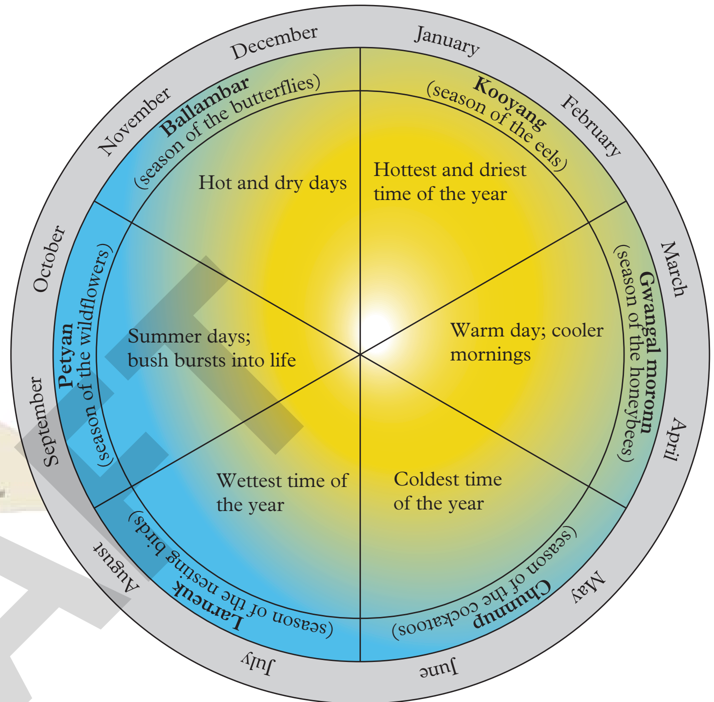


Figure 6 The Gariwerd calendar is used by First Nations peoples in the Gariwerd (Grampians) region in Victoria.

7.4 Check your learning

Retrieve

1 **Identify** the four seasons experienced in Australia, marked with the letters a, b, c and d on Figure 7.

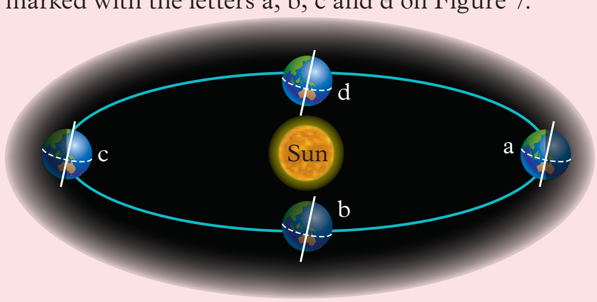


Figure 7 Four seasons in Australia

2 **Recall** the angle of the Earth's rotational tilt away from the Sun.

Comprehend

3 **Represent** the seasons in a table. Draw a table with three columns. In the first column, write the months of the year. In the second column, write the names of the four European seasons next to the appropriate months. In the third column, write the names of the seven Gulumoerrgin (Larrakia) seasons.

Analyse

4 **Compare** the winter solstice with the summer solstice.

5 Use the motion of the Earth around the Sun to **consider** why January is hotter than July in Australia.

6 **Compare** the Gulumoerrgin (Larrakia), Yirrganydji and Gariwerd calendars.

Apply

7 **Create** a paragraph for year five students that discusses how the Wathaurong people gathered and recorded data over many years before placing stones to represent the solstice and equinox.

Quiz me
Complete the Quiz me to check how well you've mastered the learning intentions and to be assigned a worksheet at your level.

//SCIENCE AS A HUMAN ENDEAVOUR//

7.5 Astronomers explore space

Learning intentions

By the end of this topic, you will be able to:

- identify examples that show how advances in technology and scientific knowledge have improved our understanding of the solar system.

It can take many years of travel for a rocket to land on another planet. Scientists therefore need to rely on other methods to learn about space.

Figure 2 The Antennae galaxies are about 45 million light-years away from the Milky Way.

Astronomy

Astronomy is one of the oldest sciences. Ancient astronomers believed that stars were permanently fixed to a heavenly sphere and never changed. Both First Nations and European astronomers tracked the movement of the planets against these heavenly lights, which they grouped into constellations, and used these observations to calculate time and develop calendars. From this they determined the seasons and calculated the best time to plant their crops or gather their foods. They observed solar and lunar eclipses and used the positions of the stars and planets to navigate the oceans.

Figure 1 Emu in the sky, a constellation seen by First Nations Australians in the dark areas of the Milky Way. Depending on its position in the night sky, it informs people about the different behaviours of the bird.

ultraviolet radiation
invisible rays that are part of the energy that comes from the Sun

infrared radiation
invisible light that has longer wavelengths than visible light

telescope
an optical instrument that uses lenses and mirrors to make distant objects appear closer and larger

Telescopes

Telescopes have been used since the seventeenth century to view distant objects. The most common type of telescope used in astronomy is the optical telescope. This works by collecting more light than the human eye can collect and then focusing this light using lenses or mirrors. A distant object viewed through an optical telescope becomes brighter and magnified (Figure 2).

THE HUBBLE AND JAMES WEBB SPACE TELESCOPES

In 1990, NASA launched the Hubble Space Telescope which orbits the Earth at 569 km above our atmosphere. This has given scientists a view of our universe far beyond that of any ground-based telescope because different forms of electromagnetic radiation, such as gamma rays, X-rays and **ultraviolet radiation**, are available for observation.

From the images beamed back to Earth from the Hubble Space Telescope, astronomers have been able to make an enormous number of new observations and have estimated the age of the universe more accurately at around 13–14 billion years. NASA launched the more advanced James Webb Space Telescope on 25 December 2021. It orbits the Earth at 1.5 million km above Earth's atmosphere!

The Webb looks primarily at **infrared radiation**, allowing it to see a greater variety of things than the Hubble. The Webb can see things more clearly than the Hubble because it has a bigger mirror that reflects more light than the Hubble. The newer space telescope will help astronomers build on the knowledge about the universe that they gained from images taken by the Hubble. The first images from the Webb were released to the public in July 2022. Figure 3 shows the difference in the images taken by the Hubble and the Webb.

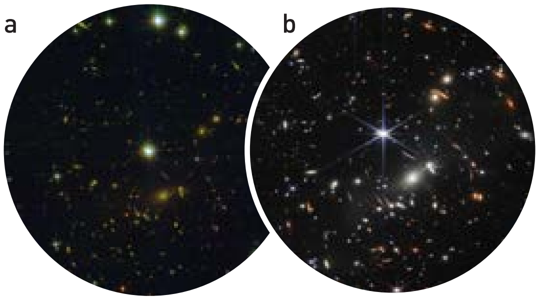


Figure 3 Images of the same galaxy cluster taken by **a** the Hubble Space Telescope and **b** the James Webb Space Telescope

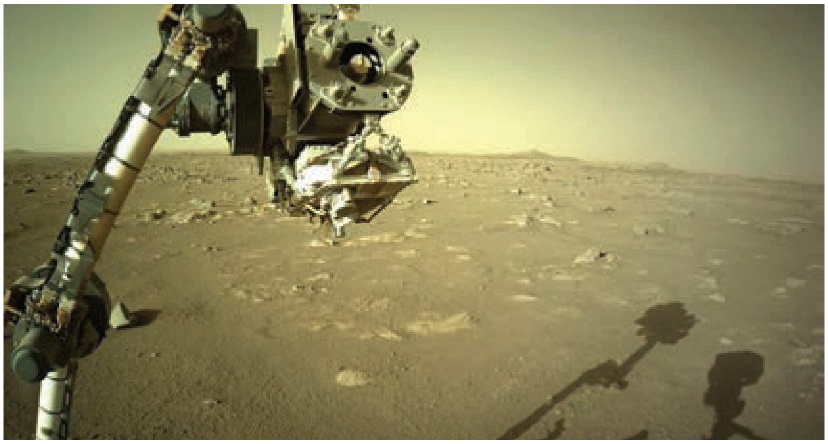


Figure 4 NASA's Mars *Perseverance* rover took this photo using one of its onboard cameras.

Mars mission

NASA is already planning a crewed mission to Mars. But could humans live on Mars? The Mars exploration rovers *Spirit* and *Opportunity* were launched in 2003 and landed on Mars in 2004 to find out more about the 'red planet'.

In 2008, the *Phoenix* Mars lander touched down on an ice sheet on the Martian surface. Operated from Earth, its instruments took photographs of ice that was melting. The lander's robotic arm scooped up soil samples and analysis from the lander's instruments revealed traces of magnesium, sodium, potassium and, importantly, water. NASA scientists described this discovery as a 'huge step forward'.

In 2021, NASA's Mars 2020 Perseverance rover landed on Mars. The rover's mission is to seek signs of ancient life on Mars and to collect rock samples for scientists to study.

The Perseverance rover is taking photos of the surface of Mars (Figure 4) and has even sent back the first audio recordings of Mars.

Space probes

Humans are also able to gather new information about space by using space probes. Typically, space probes are controlled remotely and can be launched into space to measure properties of Earth, the solar system or the universe around us.

The space probe *New Horizons* was launched by NASA in 2006. After a gravity boost from Jupiter in 2007, its six-month flyby of Pluto in 2015 produced an enormous amount of data on the dwarf planet's surface properties, geology and atmosphere, which was still being analysed one year later.

7.5 Test your skills and capabilities

Understanding the impact of science

In 1967 an Outer Space Treaty that offered a series of guidelines for how countries should explore space was signed by countries in the United Nations. After many more years of negotiations, the Agreement Governing the Activities of States on the Moon and Other Celestial Bodies (also called the Moon Treaty) was created by a group of different nations. It sets out a list of rules for all celestial bodies that countries must follow, including ownership and mining. It is yet to be signed by the countries who are currently exploring space.

Science is not just about experiments and making discoveries. Scientists must also develop an understanding of the consequences of their discoveries. Australia is currently building its capacity for space research. **Develop** a set of guidelines for these scientists to follow.

Consider the following to help.

1 **Identify** whether you would own the section of the Moon you land on or explore.

2 **Explain** what you would do if you discovered a valuable metal or mineral on the Moon. (Note: If you do not mine it, how would you pay for the research?)

3 **Describe** what you would do if another country claimed the same section of the Moon.

4 **Describe** the consequences you should face if your rocket crashed into a city in another country.

5 **Compare** your opinions with others in your class.

CHAPTER 7 REVIEW

EARTH, SUN AND MOON

Retrieve

1 **Identify** which of the following best describes the equinox.
  - **A** the longest day of the year
  - **B** a day and night of equal length
  - **C** a lunar eclipse that occurs every year
  - **D** the shortest day of the year

2 **Recall** that a total solar eclipse occurs when:
  - **A** the Moon blocks out the maximum amount of light from the Sun
  - **B** the Earth blocks out the light on the Moon from the Sun
  - **C** the Sun blocks out the view of the Earth from the Moon
  - **D** a comet blocks out light from the Sun.

3 **Identify** which of the following statements is true.
  - **A** The Earth orbits the Sun.
  - **B** The planets orbit the Moon.
  - **C** The Sun orbits the planets.
  - **D** The Earth orbits the Moon.

4 **State** the name for one revolution of the Earth around the Sun.

5 **Identify** the season in Norway when it is summer in Australia.

6 **Recall** the name of the event that occurs when the Moon totally blocks the light from the Sun.

Comprehend

7 **Explain** what causes day and night.

8 **Describe** how the Sun affects day and night and seasons at the Antarctic.

9 **Describe** the seven seasons identified by the Gulumoerrgin (Larrakia) people.

10 **Describe** the phases of the Moon.

11 **Explain** why 29 February only occurs every four years.

12 A student claims that the Moon is a mini Sun that shines at night. **Explain** why they are incorrect.

13 **Explain** the purpose of the Hubble and James Webb Space Telescopes.

Analyse

14 **Compare** a solar eclipse and a lunar eclipse.

15 **Compare** astronomy and astrology.

16 Figure 1 shows how the seasons occur. Answer 'A' or 'B' to each question.
  - **a** **Identify** the drawing that represents summer.
  - **b** If the piece of card was the Earth, **identify** which drawing would represent winter.
  - **c** If the piece of card was the Earth, **identify** which drawing would represent the warmest day.

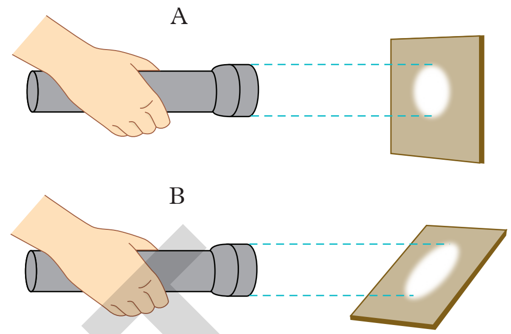


Figure 1 How the seasons occur

17 Figure 2 shows the average number of sunlight hours across Australia in January and June. **Analyse** the two maps and use the data to explain why Australian summers have higher temperatures than Australian winters.

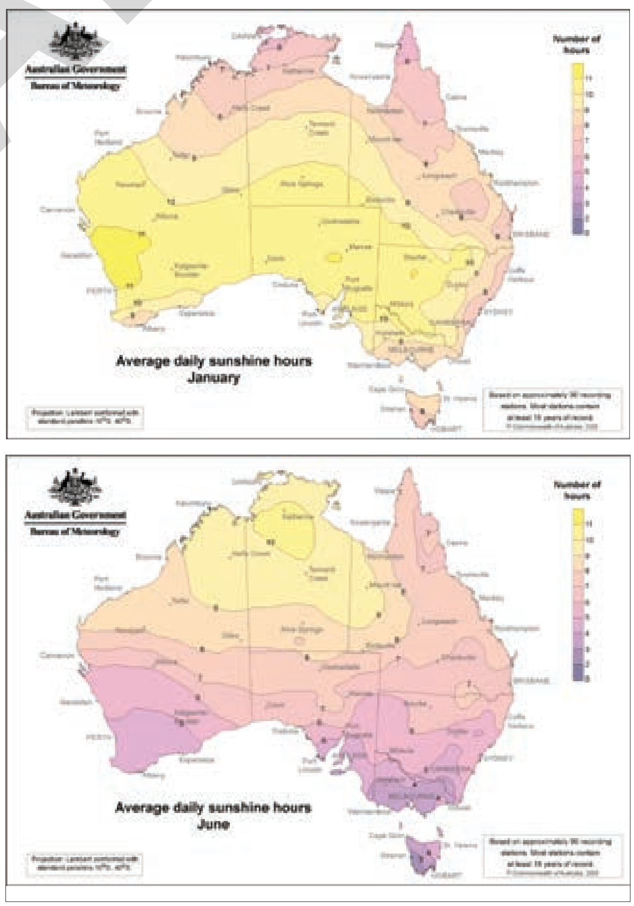


Figure 2 The average amount of sunlight in January and June

18 Study Figure 3 and answer the following questions.

a **Identify** the season that has the longest shadows.

b **Identify** the season that gives the least opportunity for solar heating.

c **Identify** the season where the Sun travels furthest across the sky.

d **Identify** which side of the house is best to grow plants that like sunlight.

e If a plant is growing on the eastern side of a house, **describe** the amount of sunlight it receives in the morning.

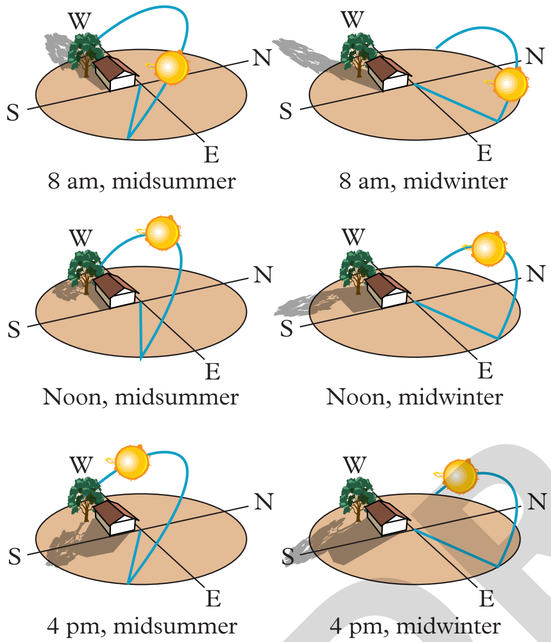


Figure 3 The path of the Sun across the sky in winter and summer

Apply

19 Look at Figure 4, which shows a total eclipse of the Sun as it would be seen in the middle of the day from Earth. **Create** and label a diagram to illustrate a:

a solar eclipse

b lunar eclipse.

Figure 4 Total eclipse of the Sun

20 The Persian calendar celebrates the New Year at the moment the Sun crosses the celestial equator on approximately 21 March each year. In 2014 it was celebrated at 4 am on the east coast of Australia. In 2015 it was celebrated at 10 am. **Discuss** why the exact time of the New Year changes from one year to the next.

21 Visit NASA's website for the 2020 *Perseverance* rover mission (the link is on your obook pro). Navigate to the gallery of 'Raw images' showing recent pictures taken by the rover. Select one image and make five scientific observations about what you can see in the image. **Discuss** what you know about Mars from looking at this image.

22 Gravity is not considered a force. Instead, gravity is the distortion of space and time caused by a large object. This allows the large object to have a pull force. **Evaluate** the following sentence and rewrite it so that it is correct.

'The force of the Moon's gravity pulls the water on Earth to cause high tides.'

Social and ethical thinking

23 Some nations are planning to develop human settlements on the Moon**. Discuss** an argument for and against this decision. **Decide** if you do or do not support this plan. **Justify** your decision (by comparing the arguments for and against this decision and describing why one argument is more important).

24 Many early European settlers claimed that First Nations Australians did not use any of the sciences. **Provide** evidence that refutes this claim.

25 Scientists are continuously exploring space, including Mars. **Discuss** the ethical implications of finding life on one of these planets.

Critical and creative thinking

26 Find data for the sunrise and sunset times over seven days in summer and winter. From this information, **calculate** the length of the day and the length of the night. Present your findings in a table. **Discuss** what you notice about the lengths of the days and nights for each season. **Explain** why this difference occurs.

27 In May 2021 there was a lunar eclipse visible in Australia. The Moon was referred to as a 'supermoon'. **Investigate** what the criteria for a supermoon are, and **explain** why a lunar eclipse may be a supermoon.

Research

28 Choose one of the following topics on which to conduct further research. Present your findings in a format that best fits the information you have found and understandings you have formed.

» Search for extraterrestrial intelligence

Astronomers are involved in a Search for Extraterrestrial Intelligence (SETI).

- Find out what instruments the astronomers are using in this search.
- Describe how these instruments will help them to find extraterrestrial intelligence.
- Describe what they may expect to find.

You, too, can use your computer to become a part of this search.

Figure 5 The Search for Extraterrestrial Intelligence (SETI) Institute is America's only organisation entirely dedicated to searching for life in the universe.

» Science communication

Investigate what it means to be a science communicator.

- Research the work of Wiradjuri astrophysicist and science communicator, Kirsten Banks.
- Describe how she combines First Nations astronomy knowledge with her current work.

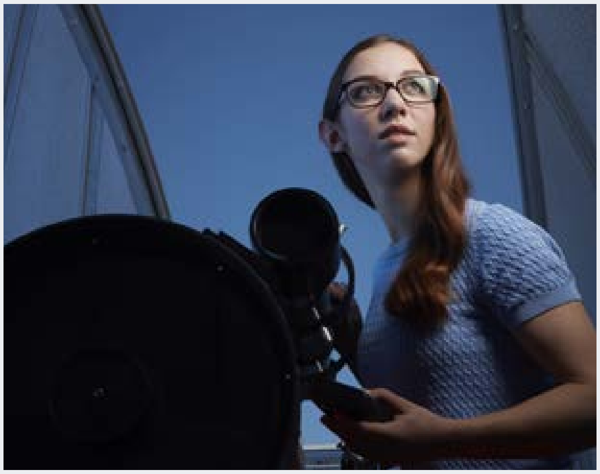


Figure 6 Kirsten Banks

» Mission to the Moon

The huge *Saturn* rocket that took *Apollo 11* to the Moon was an extremely powerful system in its day. The rocket had three 'stages'; each carried its own fuel and dropped off as the rocket went higher into the sky. The rocket carried the 'lunar lander', which was itself a very complicated piece of technology.

- Build a model of the *Saturn* rocket and explain the role of each stage and how it performed.

Figure 7 The launch of the *Saturn* rocket

» The far side of the Moon

The Moon rotates at the same rate as the Earth, so we never see the far side of the Moon from Earth. So what is it like? Is it the same as the near side of the Moon? Some astronauts have flown over the surface of the far side, but only one has landed a ship.

- Identify how many people have seen the far side of the Moon.
- Identify which country landed a probe on the far side and brought back material from the Moon's surface.
- Compare the far side of the Moon to the side that faces Earth.
- Describe the complexities of living on the surface of the Moon.

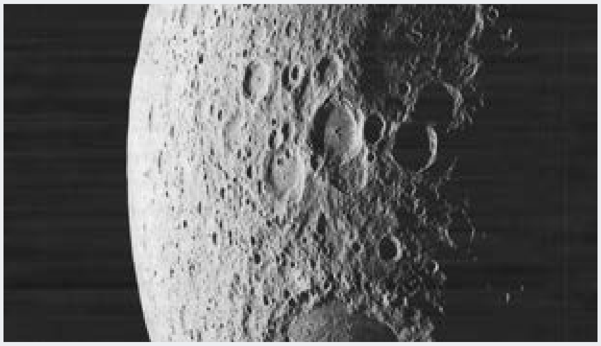


Figure 8 A section of the far side of the Moon

Chapter checklist

Now that you have completed this chapter, reflect on your ability to do the following:

	I can do this.	I cannot do this yet.
• describe the differences between a total and partial solar eclipse • explain how the length of a day and a year relate to the movement of the Earth.	☐	☐ Go back to Topic 7.1 'The Earth, Sun and Moon interact with one another'. Page 4
• identify and describe the phases of the Moon and lunar eclipse • contrast a solar and a lunar eclipse.	☐	☐ Go back to Topic 7.2 'The Moon reflects the Sun's light'. Page 6
• explain how the Moon's gravity causes tidal movements • describe the relationship between the Moon and tides that was recognised by early First Nations Australians.	☐	☐ Go back to Topic 7.3 'The Moon's gravity causes tidal movements'. Page 8
• define the terms 'solstice' and 'equinox' • explain how seasons are related to the position of the Sun and Earth • describe the importance of seasons and seasonal calendars to First Nations Australians.	☐	☐ Go back to Topic 7.4 'Seasons are caused by the tilt of the Earth'. Page 10
• identify examples that show how advances in technology and scientific knowledge have improved our understanding of the solar system.	☐	☐ Go back to Topic 7.5 'Science as a human endeavour: Astronomers explore space'. Page 14

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Play a Quizlet game to test your knowledge.

Chapter quiz
Test your understanding of this chapter with the chapter review quiz.

Check your Teacher obook pro for these digital resources and more:

Quizlet
Launch a live team or individual quiz for your students on key concepts in this chapter.

CHAPTER

8

EXPERIMENTS

7.2 Modelling the phases of the Moon

CHALLENGE

Aim

To model the different phases of the Moon.

What you need:

Torch or lamp with exposed light bulb, globe or basketball, tennis ball, small foam ball, black permanent marker

What to do:

1 In small groups, use a torch or light bulb in a fixed position to represent the Sun. One person should then hold a globe or basketball to represent the Earth, and a second person should hold a tennis ball to represent the Moon.

2 Begin by rotating the Earth as it orbits the Sun. Try to work out how the Moon would orbit the Earth as the Earth orbits the Sun.

3 Use a black permanent marker to colour half of the foam ball. Face the white side of the foam ball towards you. This represents the fully lit face of a full Moon. Slowly rotate the foam ball so that the Moon appears to be getting smaller. (You will gradually see more of the darkened side of the Moon.)

4 Shine the light from a torch on the white section of the Moon. Pass the tennis ball between the light and the foam ball.

Questions

1 Explain why people on Earth only see one side of the Moon.

2 Draw each phase of the Moon as you saw it on the foam ball in step 3.

3 Describe and identify the phenomenon that you modelled in step 4.

4 Explain why the statement ‘the dark side of the Moon’ does not refer to the side of the Moon away from Earth.

7.3 Modelling the seasons

CHALLENGE

Aim

To model how the movement of the Earth can generate different seasons.

What you need:

Torch or lamp with exposed light bulb, globe or basketball

What to do:

1 Use a torch or light bulb in a fixed position to represent the Sun. One person should then hold the globe or basketball to represent the Earth.

2 The Earth is tilted as it orbits the Sun. Hold your model Earth so that it is tilted slightly. Imagine that the axis is tilted to point towards the numbers 1 and 7 on a clock face. Do not change this tilt during the activity.

3 Walk slowly in a circle around the lamp, at the same time rotating the model Earth. Make sure the tilt always points in the same direction. When it is summer in Australia, the Sun is almost overhead. In winter, the sunlight arrives at an angle and is more spread out.

Questions

1 When you have walked half a circle around your Sun, stop and look at the model Earth. Describe which part of the basketball would be experiencing summer.

2 Describe how the seasons changed on one point of the basketball as it moved around the Sun.

3 A student claimed it is hotter in summer because Australia is closer to the Sun. Evaluate the truth of this statement using your model as evidence.

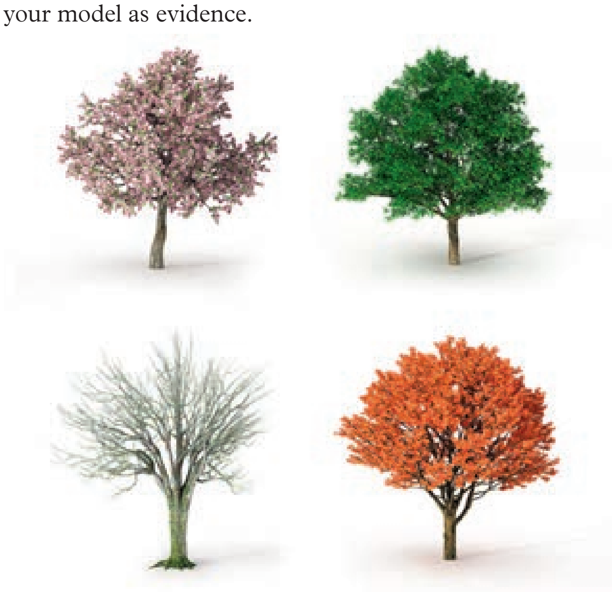

Figure 1 Modelling the seasons

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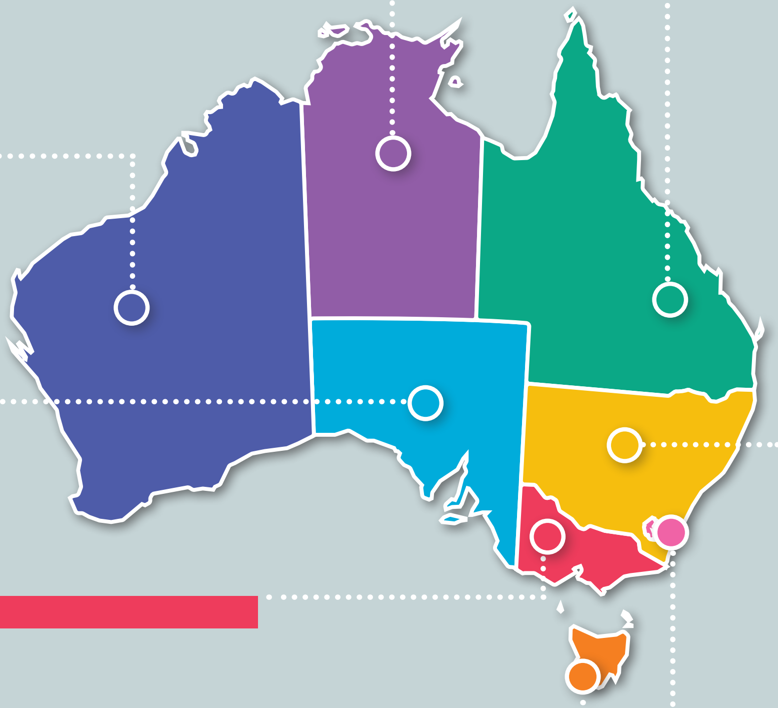

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