PrimaryConnections®
Linking science with literacy

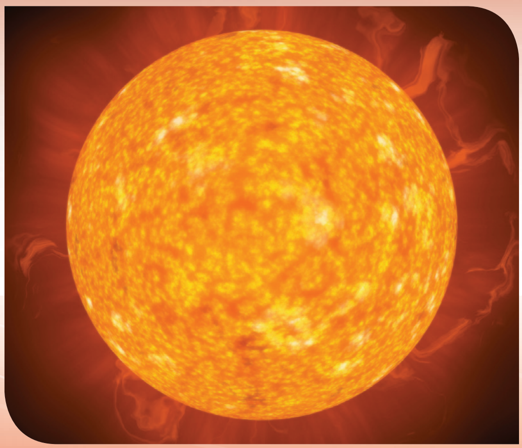
Fully aligned with the Australian Curriculum

The PrimaryConnections program is supported by astronomer, Professor Brian Schmidt, Nobel Laureate

Night and day

Year 3

Earth and space sciences



Primary**Connections** project

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Reference Group	Professor Jenny Graves, AO FAA (Australian Academy of Science) [Chair] Ms Shelley Peers (Australian Academy of Science) ACT Department of Education and Training Australian Council of Deans of Education Australian Curriculum Assessment and Reporting Authority (ACARA) Australian Government Department of Education, Employment and Workplace Relations Australian Literacy Educators' Association Australian Primary Principals Association Australian Science Teachers Association QLD Department of Education, Training and Employment Independent Schools Council of Australia Indigenous Education Consultative Body National Catholic Education Commission NSW Department of Education and Communities NT Department of Education and Training Primary English Teaching Association Australia SA Department for Education and Child Development TAS Department of Education VIC Department of Education and Early Childhood Development WA Department of Education

Australian Academy of Science

Professional learning program

Primary**Connections** comprises a professional learning program supported with exemplary curriculum resources to enhance teaching and learning in science and literacy. Research shows that this combination is more effective than using each in isolation.

Professional Learning Facilitators are available throughout Australia to conduct workshops on the underpinning principles of the program: the Primary**Connections** 5Es teaching and learning model, linking science with literacy, investigating, embedded assessment and collaborative learning.

The Primary**Connections** website has contact details for state and territory Professional Learning Coordinators, as well as additional resources for this unit. Visit the website at: **www.primaryconnections.org.au**

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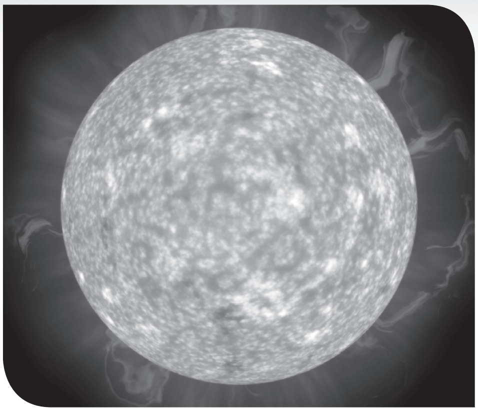

What causes night and day? The rising of the Sun and the Moon are daily reminders of the awe and wonder, beauty and power of the universe. Studying the relationships between the Sun, Earth and Moon helps us understand how we experience day and night on Earth. It also helps us understand directions in terms of North, South, East and West, how time is based on the apparent movement of the Sun across the sky and how time can be determined using a sundial.

The *Night and day* unit is an ideal way to link science with literacy in the classroom. Students explore the sizes, shapes, positions and movements of the Sun, Earth and Moon. They investigate how shadows change throughout the day and link these changes to the Sun's apparent movement across the sky. Students role-play the movements of the Earth in relation to the Sun and Moon. Through investigations, they explain night and day in terms of the Earth spinning on its axis.

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Contents

Foreword

The Australian Academy of Science is proud of its long tradition of supporting and informing science education in Australia. 'Primary**Connections:** linking science with literacy' is its flagship primary school science program, and it is making a real difference to the teaching and learning of science in Australian schools.

The Primary**Connections** approach has been embraced by schools since its inception in 2004, and there is substantial evidence of its effectiveness in helping teachers transform their practice. It builds teacher confidence and competence in this important area, and helps teachers use their professional skills to incorporate elements of the approach into other areas of the curriculum. Beginning and pre-service teachers find the approach do-able and sustainable. Primary**Connections** students enjoy science more than in comparison classes, and Indigenous students, in particular, show significant increases in learning using the approach.

The project has several components: professional learning, curriculum resources, research and evaluation, and Indigenous perspectives. With the development of an Australian curriculum in the sciences by ACARA in December 2010, it is an exciting time for schools to engage with science, and to raise the profile of primary science education.

Students are naturally curious. Primary**Connections** provides an inquiry-based approach that helps students develop deep learning, and guides them to find scientific ways to answer their questions. The lessons include key science background information, and further science information is included on the Primary**Connections** website (www.primaryconnections.org.au).

Science education provides a foundation for a scientifically literate society, which is so important for engagement in key community debates, such as climate change, carbon emissions, and immunisation, as well as for personal decisions about health and well-being. The inquiry approach in Primary**Connections** prepares students well to participate in evidence-based discussions of these and other issues.

Primary**Connections** has been developed with the financial support of the Australian Government and has been endorsed by education authorities across the country. The Steering Committee, comprising the Department of Education, Employment and Workplace Relations and Academy representatives, and the Reference Group, which includes representatives from all stakeholder bodies including states and territories, have provided invaluable guidance and support. Before publication, the teacher background information on science is reviewed by a Fellow of the Academy. All these inputs have ensured an award-winning, quality program.

The Fellows of the Academy are committed to ongoing support for teachers of science at all levels. I commend Primary**Connections** to you and wish you well in your teaching.

Professor Suzanne Cory, AC PresAA FRS
President (2010–2013)
Australian Academy of Science

The PrimaryConnections program

Primary**Connections** is an innovative program that links the teaching of science and literacy in the primary years of schooling. It is an exciting and rewarding approach for teachers and students, with a professional learning program and supporting curriculum resources. Further information about professional learning and other curriculum support can be found on the Primary**Connections** website: (www.primaryconnections.org.au)

The PrimaryConnections teaching and learning model

This unit is one of a series designed to exemplify the Primary**Connections** teaching and learning approach, which embeds inquiry-based learning into a modified 5Es instructional model with the five phases: *Engage, Explore, Explain, Elaborate* and *Evaluate* (Bybee, 1997). The relationship between the 5Es phases, investigations, literacy products and assessment is illustrated below:

Primary**Connections 5Es teaching and learning model**

Phase	Focus	Assessment focus
ENGAGE	Engage students and elicit prior knowledge	**Diagnostic assessment**
EXPLORE	Provide hands-on experience of the phenomenon	**Formative assessment**
EXPLAIN	Develop scientific explanations for observations and represent developing conceptual understanding Consider current scientific explanations	**Formative assessment**
ELABORATE	Extend understanding to a new context or make connections to additional concepts through a student-planned investigation	**Summative assessment** of the Science Inquiry Skills
EVALUATE	Students re-represent their understanding and reflect on their learning journey, and teachers collect evidence about the achievement of outcomes	**Summative assessment** of the Science Understanding

More information on Primary**Connections** 5Es teaching and learning model can be found at: www.primaryconnections.org.au

Developing students' scientific literacy

The learning outcomes in Primary**Connections** contribute to developing students' scientific literacy. Scientific literacy is considered the main purpose of school science education and has been described as an individual's:

- scientific knowledge and use of that knowledge to identify questions, acquire new knowledge, explain scientific phenomena and draw evidence-based conclusions about science-related issues
- understanding of the characteristic features of science as a form of human knowledge and enquiry
- awareness of how science and technology shape our material, intellectual and cultural environments
- willingness to engage in science-related issues, and with the ideas of science, as a reflective citizen (Programme for International Student Assessment & Organisation for Economic Co-operation and Development [PISA & OECD], 2009).

Linking science with literacy

Primary**Connections** has an explicit focus on developing students' knowledge, skills, understanding and capacities in science and literacy. Units employ a range of strategies to encourage students to think about and to represent science.

Primary**Connections** develops the literacies of science that students need to learn and to represent their understanding of science concepts, processes and skills. Representations in Primary**Connections** are multi-modal and include text, tables, graphs, models, drawings and embodied forms, such as gesture and role-play. Students use their everyday literacies to learn the new literacies of science. Science provides authentic contexts and meaningful purposes for literacy learning, and also provides opportunities to develop a wider range of literacies. Teaching science with literacy improves learning outcomes in both areas.

Assessment

Assessment against the year level achievement standards of the Australian Curriculum: Science (ACARA, 2014) is ongoing and embedded in Primary**Connections** units. Assessment is linked to the development of literacy practices and products. Relevant understandings and skills are highlighted at the beginning of each lesson. Different types of assessment are emphasised in different phases:

Diagnostic assessment occurs in the *Engage* phase. This assessment is to elicit students' prior knowledge so that the teacher can take account of this when planning how the *Explore* and *Explain* lessons will be implemented.

Formative assessment occurs in the *Explore and Explain* phases. This enables the teacher to monitor students' developing understanding and provide feedback that can extend and deepen students' learning.

Summative assessment of the students' achievement developed throughout the unit occurs in the *Elaborate* phase for the Science Inquiry Skills, and in the *Evaluate* phase for the Science Understanding.

Alignment with the Australian Curriculum: Science

The Australian Curriculum: Science has three interrelated strands—Science Understanding, Science as a Human Endeavour and Science Inquiry Skills—that together 'provide students with understanding, knowledge and skills through which they can develop a scientific view of the world' (ACARA, 2014).

The content of these strands is described by the Australian Curriculum as:

Science Understanding	
Biological sciences	Understanding living things
Chemical sciences	Understanding the composition and behaviour of substances
Earth and space sciences	Understanding Earth's dynamic structure and its place in the cosmos
Physical sciences	Understanding the nature of forces and motion, and matter and energy
Science as a Human Endeavour	
Nature and development of science	An appreciation of the unique nature of science and scientific knowledge.
Use and influence of science	How science knowledge and applications affect people's lives and how science is influenced by society and can be used to inform decisions and actions
Science Inquiry Skills	
Questioning and predicting	Identifying and constructing questions, proposing hypotheses and suggesting possible outcomes
Planning and conducting	Making decisions regarding how to investigate or solve a problem and carrying out an investigation, including the collection of data
Processing and analysing data and information	Representing data in meaningful and useful ways; identifying trends, patterns and relationships in data, and using evidence to justify conclusions
Evaluating	Considering the quality of available evidence and the merit or significance of a claim, proposition or conclusion with reference to that evidence
Communicating	Conveying information or ideas to others through appropriate representations, text types and modes

AC All the material in this table is sourced from the Australian Curriculum.

There will be a minimum of four Primary**Connections** units for each year of primary school from Foundation to Year 6—at least one for each Science Understanding sub-strand of the Australian Curriculum. Each unit contains detailed information about its alignment with all aspects of the Australian Curriculum: Science and its links to the Australian Curriculum: English and Mathematics.

Safety

Learning to use materials and equipment safely is central to working scientifically. It is important, however, for teachers to review each lesson before teaching to identify and manage safety issues specific to a group of students. A safety icon is included in lessons where there is a need to pay particular attention to potential safety hazards. The following guidelines will help minimise risks:

- Be aware of the school's policy on safety in the classroom and for excursions.
- Check students' health records for allergies or other health issues.
- Be aware of potential dangers by trying out activities before students do them.
- Caution students about potential dangers before they begin an activity.
- Clean up spills immediately as slippery floors are dangerous.
- Instruct students never to taste, smell or eat anything unless they are given permission.
- Discuss and display a list of safe practices for science activities.

References

Australian Curriculum Assessment and Reporting Authority (ACARA). (2013). *Australian Curriculum: Science.* www.australiancurriculum.edu.au

Bybee, R.W. (1997). *Achieving scientific literacy: from purposes to practical action.* Portsmouth, NH: Heinemann.

Programme for International Student Assessment & Organisation for Economic Co-operation and Development. (2009). *PISA 2009 assessment framework: key competencies in reading, mathematics and science.* Paris: OECD Publishing.

Unit at a glance *Night and day*

Phase	Lesson	At a glance
ENGAGE	**Lesson 1** Night and day notions	To capture students' interest and find out what they think they know about how the Earth's rotation on its axis causes regular changes, including night and day. To elicit students' questions about what causes night and day.
EXPLORE	**Lesson 2** Shapes and sizes	To provide students with hands-on, shared experiences of the shapes, relative sizes and positions of the Sun, Earth and Moon.
	Lesson 3 Shadows at play	To provide students with hands-on, shared experiences of shadows and light.
EXPLAIN	**Lesson 4** In a spin	To support students to represent and explain their understanding of how Earth's rotation on its axis causes night and day, and to introduce current scientific views.
ELABORATE	**Lesson 5** Investigating shadows ***Session 1*** Planning it out ***Session 2*** One o'clock, two o'clock	To support students to plan and conduct an investigation of the length and direction of shadows during one day.
EVALUATE	**Lesson 6** Spinning in space	To provide opportunities for students to represent what they know about how the Earth's rotation on its axis causes regular changes, including night and day, and to reflect on their learning during the unit.

Note: It is recommended that this unit is taught in Term 4 due to the difficulty of the concepts that are covered.

A unit overview can be found in Appendix 8, page 64.

Alignment with the Australian Curriculum: Science

This *Night and day* unit embeds all three strands of the Australian Curriculum: Science.
The table below lists sub-strands and their content for Year 3. This unit is designed to be taught in conjunction with other Year 3 units to cover the full range of the Australian Curriculum: Science content for Year 3.

For ease of assessment the table below outlines the sub-strands and their aligned lessons.

Strand	Sub-strand	Code	Year 3 content descriptions	Lessons
Science Understanding	**Earth and space sciences**	ACSSU048	Earth's rotation on its axis causes regular changes, including night and day	1–6
Science as a Human Endeavour	**Nature and development of science**	ACSHE050	Science involves making predictions and describing patterns and relationships	2, 5
	Use and influence of science	ACSHE051	Science knowledge helps people to understand the effect of their actions	3
Science Inquiry Skills	**Questioning and predicting**	ACSIS053	With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge	2, 3, 5
	Planning and conducting	ACSIS054	Suggest ways to plan and conduct investigations to find answers to questions	5
		ACSIS055	Safely use appropriate materials, tools or equipment to make and record observations, using formal measurements and digital technologies as appropriate	3, 4, 5, 6
	Processing and analysing data and information	ACSIS057	Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends	5
		ACSIS215	Compare results with predictions, suggesting possible reasons for findings	3, 4, 5
	Evaluating	ACSIS058	Reflect on the investigation, including whether a test was fair or not	5
	Communicating	ACSIS060	Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports	1–6

AC All the material in the first four columns of this table is sourced from the Australian Curriculum.

Interrelationship of the science strands

The interrelationship between the three strands—Science Understanding, Science as a Human Endeavour and Science Inquiry Skills—and their sub-strands is shown below. Sub-strands covered in this unit are in bold.

Year 3

Science Understanding | **Science as a Human Endeavour** | **Science Inquiry Skills**

Science Understanding:
- Biological sciences
- Chemical sciences
- **Earth and space sciences**
- Physical sciences

Science as a Human Endeavour:
- **Nature and development of science**
- **Use and influence of science**

Science Inquiry Skills:
- **Questioning and predicting**
- **Planning and conducting**
- **Processing and analysing data and information**
- **Evaluating**
- **Communicating**

AC All the terms in this diagram are sourced from the Australian Curriculum.

Relationship to overarching ideas

In the Australian Curriculum: Science, six overarching ideas support the coherence and developmental sequence of science knowledge within and across year levels. In *Night and day* these overarching ideas are represented by:

Overarching idea	Incorporation in *Night and day*
Patterns, order and organisation	Students observe and identify patterns in the changing length and directions of shadows over the duration of a day as the Sun rises and sets.
Form and function	Students describe and compare the spherical shapes and sizes of the Earth, Sun and Moon.
Stability and change	Students identify the predictable occurrence of night and day. They observe changes in the position of the Sun in the sky during the day and the regular pattern of the Sun rising in the East and setting in the West.
Scale and measurement	Students explore the differences in size of the Sun, Moon and Earth and select scaled-down 3-D versions of each. They investigate why the Sun and Moon can appear to be the same size.
Matter and energy	Students role-play the spinning of the Earth on its axis and the observable effects of sunrise and sunset. They explore how the Sun provides light energy to one side of the Earth at a time, causing night and day as the Earth spins.
Systems	Students investigate the relationship between the Sun, Earth and Moon and how they interact to cause regular events, such as night and day.

Curriculum focus

The Australian Curriculum: Science is described by year level, but provides advice across four year groupings on the nature of learners. Each year grouping has a relevant curriculum focus.

Curriculum focus Years 3–6	Incorporation in *Night and day*
Recognising questions that can be investigated scientifically and investigating them	Students explore how the spinning of the Earth on its axis causes night and day through observations, models and role-play. They investigate changing shadows throughout the day, observing the change to the length and direction of shadows using a shadow stick.

Achievement standards

The achievement standards of the Australian Curriculum: Science indicate the quality of learning that students typically demonstrate by a particular point in their schooling, for example, at the end of a year level. These standards will be reviewed regularly by ACARA and are available from the ACARA website.

By the end of this unit, teachers will be able to make evidence-based judgments on whether the students are achieving below, at or above the Australian Curriculum: Science Year 3 achievement standard.

General capabilities

The skills, behaviours and attributes that students need to succeed in life and work in the 21st century have been identified in the Australian Curriculum as general capabilities. There are seven general capabilities and they are embedded throughout the units. For further information see: www.australiancurriculum.edu.au

For examples of our unit-specific general capabilities information see the next page.

Night and day—Australian Curriculum general capabilities

General capabilities	Australian Curriculum description	*Night and day* examples
Literacy	Literacy knowledge specific to the study of science develops along with scientific understanding and skills. Primary**Connections** learning activities explicitly introduce literacy focuses and provide students with the opportunity to use them as they think about, reason and represent their understanding of science.	In *Night and day* the literacy focuses are: • T-charts • science journals • annotated drawings • word walls • labelled diagrams • role-plays • tables • graphs.
Numeracy	Elements of numeracy are particularly evident in Science Inquiry Skills. These include practical measurement and the collection, representation and interpretation of data.	Students: • select spheres to represent the Earth, Sun and Moon to scale • measure the changing length and direction of shadows • collect and represent data in tables and simple column graphs.
Information and communication technology (ICT) competence	ICT competence is particularly evident in Science Inquiry Skills. Students use digital technologies to investigate, create, communicate, and share ideas and results.	Students are given optional opportunities to: • use interactive technology to view the interaction between the Earth and Sun that causes night and day • use a digital camera to record observations.
Critical and creative thinking	Students develop critical and creative thinking as they speculate and solve problems through investigations, make evidence-based decisions, and analyse and evaluate information sources to draw conclusions. They develop creative questions and suggest novel solutions.	Students: • formulate, pose and respond to questions • develop evidence-based claims • use reasoning to explain how evidence supports a claim.
Ethical behaviour	Students develop ethical behaviour as they explore principles and guidelines in gathering evidence and consider the implications of their investigations on others and the environment.	Students: • ask questions of others, respecting each other's point of view.
Personal and social competence	Students develop personal and social competence as they learn to work effectively in teams, develop collaborative methods of inquiry, work safely, and use their scientific knowledge to make informed choices.	Students: • work collaboratively in teams • participate in discussions.
Intercultural understanding	Intercultural understanding is particularly evident in Science as a Human Endeavour. Students learn about the influence of people from a variety of cultures on the development of scientific understanding.	• Cultural perspectives opportunities are highlighted where relevant • Important contributions made to science by people from a range of cultures are highlighted where relevant.

AC All the material in the first two columns of this table is sourced from the Australian Curriculum.

Cross-curriculum priorities

There are three cross-curriculum priorities identified by the Australian Curriculum:

- Aboriginal and Torres Strait Islander histories and cultures
- Asia and Australia's engagement with Asia
- Sustainability.

For further information see: www.australiancurriculum.edu.au

Aboriginal and Torres Strait Islander histories and cultures

The Primary**Connections** Indigenous perspectives framework supports teachers' implementation of Aboriginal and Torres Strait Islander histories and cultures in science. The framework can be accessed at: www.primaryconnections.org.au

Night and day focuses on the Western science way of making evidence-based claims about how the Earth's rotation on its axis causes regular changes, including night and day.

Aboriginal and Torres Strait Islander Peoples might have other explanations for the observed phenomenon of night and day. For information and activities see:

- *Astronomy and Australian Indigenous People* written by Adele Pring from the Astronomical Association of South Australia. See http://www.assa.org.au/media/2912/aaaip.pdf

Other useful sites on Indigenous astronomy include:

- http://www.questacon.edu.au/starlab/aboriginal_astronomy.html
- http://www.atnf.csiro.au/research/AboriginalAstronomy/whatis.htm
- http://members.optusnet.com.au/virgothomas/space/abobeliefs2.html
- http://www.abc.net.au/science/articles/2009/07/27/2632463.htm

Primary**Connections** recommends working with Aboriginal and Torres Strait Islander community members to access local and relevant cultural perspectives. Protocols for engaging with Aboriginal and Torres Strait Islander community members are provided in state and territory education guidelines. Links to these are provided on the Primary**Connections** website.

Alignment with the Australian Curriculum: English and Mathematics

Strand	Sub-strand	Code	Year 3 content descriptions	Lessons
English–Language	**Language for interaction**	ACELA1476	Understand that successful cooperation with others depends on shared use of social conventions, including turn-taking patterns, and forms of address that vary according to the degree of formality in social situations	1–6
English–Literacy	**Interacting with others**	ACELY1676	Listen to and contribute to conversations and discussions to share information and ideas and negotiate in collaborative situations	1, 3, 5, 6
		ACELY1792	Use interaction skills, including active listening behaviours and communicate in a clear, coherent manner using a variety of everyday and learned vocabulary and appropriate tone, pace, pitch and volume	1, 3, 4, 5, 6
		ACELY1677	Plan and deliver short presentations, providing some key details in logical sequence	4, 5, 6
	Creating texts	ACELY1682	Plan, draft and publish imaginative, informative and persuasive texts demonstrating increasing control over text structures and language features and selecting print, and multimodal elements appropriate to the audience and purpose	1, 6
Mathematics–Measurement and Geometry	**Using units of measurement**	ACMMG061	Measure, order and compare objects using familiar metric units of length, mass and capacity	2, 5
	Shape	ACMMG063	Make models of three-dimensional objects and describe key features	2
Mathematics–Statistics and Probability	**Data representation and interpretation**	ACMSP068	Identify questions or issues for categorical variables. Identify data sources and plan methods of data collection and recording	5
		ACMSP069	Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies	5
		ACMSP070	Interpret and compare data displays	5

AC All the material in the first four columns of this table is sourced from the Australian Curriculum.

Other links are highlighted at the end of lessons where possible. These links will be revised and updated on the website (www.primaryconnections.org.au).

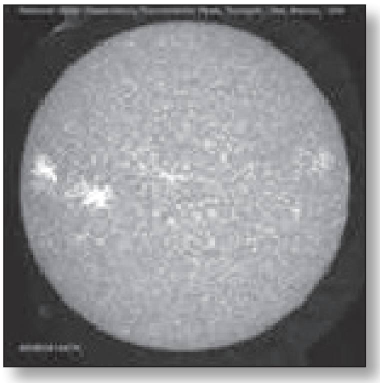
Teacher background information

Introduction to the Sun, Earth and Moon

The Sun, Earth and Moon belong to the Solar System, which includes all the planets, moons, comets and particles of dust that are in orbit around the Sun. Our Solar System is part of the Milky Way Galaxy, which contains tens of billions of stars. The universe comprises billions of galaxies.

The Sun is the largest object in the Solar System, containing 99 per cent of the total mass of the system. The Sun and the whole Solar System are moving at great speed through the Galaxy. Because the Sun is so massive, everything else in the Solar System is attracted to it by the Sun’s gravity and everything revolves in orbit around it.

The Sun is a medium-sized star. The Earth is much closer to the Sun than it is to any other star. That is why the Sun seems much larger and brighter than other stars. Light from the Sun reaches the Earth in eight minutes, whereas the light from the next nearest star takes more than four years to reach us.



The Sun

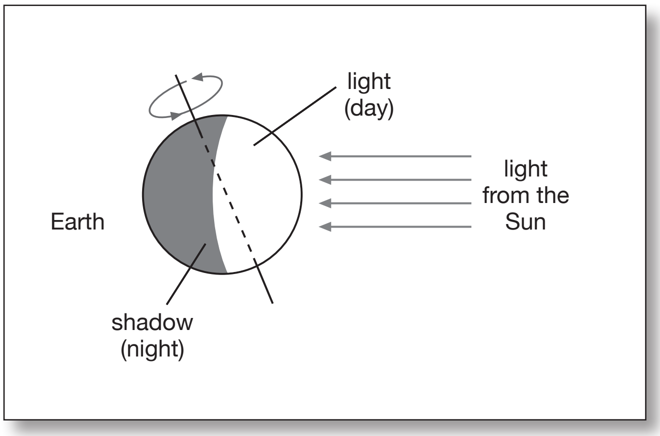
Image from the PrimaryConnections Science Background CD
(courtesy of Victorian Department of Education and Training)

The Earth is a planet in orbit around the Sun. This orbit takes slightly more than one year—365¼ days—so we add an extra day to our calendar, 29 February, in every fourth year, which we call a leap year.

The Earth

Image from the PrimaryConnections Science Background CD
(courtesy of Victorian Department of Education and Training)

The Sun is always heating and lighting the Earth, but only the side of the Earth facing the Sun experiences daylight. The rest is in shadow. The reason we experience alternating night and day, or the apparent rising and setting of the Sun, is that the Earth is spinning on its axis, once every 24 hours.



The Earth spins on its axis, giving us night and day

The Moon is a satellite of the Earth. It is held in orbit by the Earth's gravity and goes around the Earth relatively quickly because it is close to the Earth. The Moon's gravitational pull on the Earth is not nearly as strong as the Sun's, because the Moon is less massive, but it is enough to draw the Earth's oceans towards it and cause the tides. The tilt of the Earth's axis does not change as it goes around the Sun – that is, the north pole of the earth is always pointing towards the same place in space. This causes the seasons. (This concept is not considered in this unit.)

The Moon

Image from the Primary**Connections** Science Background CD
(courtesy of Victorian Department of Education and Training)

We always see the same face of the Moon from Earth, because the Moon spins on its axis once each time it goes around the Earth. We see the Moon from the Earth because the Moon reflects light from the Sun. The Moon itself does not emit light.

Further information about the Sun, Earth and Moon can be found on the Primary**Connections** Science Background CD and the following websites:

- Astronomy Picture of the Day: www.apodaustralia.com
- Melbourne Planetarium: www.museum.vic.gov.au/planetarium

- NASA Kids' Club: www.nasa.gov/audience/forkids/home/index.html
- StarChild: A Learning Centre for Young Astronomers: http://starchild.gsfc.nasa.gov
- The Nine Planets: A Multimedia Tour of the Solar System: www.nineplanets.org

Students' conceptions

Taking account of students' existing ideas is important in planning effective teaching approaches that help students learn science. Students develop their own ideas during their experiences in everyday life and might hold more than one idea about an event or phenomenon.

Students might have a range of non-scientific ideas about the Sun, Earth and Moon as it is not obvious that we are on a spinning, spherical planet that is orbiting the Sun.

Students might say that they think the Earth is round, or spherical, but when they respond to questions their answers will often indicate that they believe it is flat like a plate.

Students might have a range of alternative conceptions about how night and day occur. These might include beliefs that:

- the Sun is too far away at night for its light to be seen
- the Sun goes behind a hill at night
- clouds cover the Sun at night
- the Moon covers the Sun at night
- the Sun goes around the Earth once a day
- the Earth goes around the Sun once a day.

References

Skamp, K. (Ed.) (2012). *Teaching primary science constructively* (4th Edn). South Melbourne: Cengage Learning Australia.

To access more in-depth science information in the form of text, diagrams and animations, refer to the Primary**Connections** Science Background Resource which has now been loaded on the Primary**Connections** website: www.primaryconnections.org.au/science-background-resource/.

Note: This background information is intended for the teacher only.

Lesson 1 Night and day notions

AT A GLANCE

To capture students' interest and find out what they think they know about how the Earth's rotation on its axis causes regular changes, including night and day.

To elicit students' questions about what causes night and day.

Students:

- brainstorm ideas about night and day
- choose reasons for why it is dark at night
- draw the Sun, Earth and Moon showing how night and day happens.

Lesson focus

The focus of the *Engage* phase is to spark students' interest, stimulate their curiosity, raise questions for inquiry and elicit their existing beliefs about the topic. These existing ideas can then be taken account of in future lessons.

Assessment focus

Diagnostic assessment is an important aspect of the *Engage* phase. In this lesson you will elicit what students already know and understand about:

- how the Earth's rotation on its axis causes regular changes, including night and day.

Key lesson outcomes

Science

Students will be able to represent their current understanding as they:

- describe the difference between night and day
- describe the cause of night
- describe the movements of the Sun, Earth and Moon to cause night and day.

Literacy

Students will be able to:

- contribute to discussions about night and day
- create an annotated drawing to show the movements of the Sun, Earth and Moon to cause night and day
- describe the purpose and features of an annotated drawing
- contribute to the beginning of a word wall.

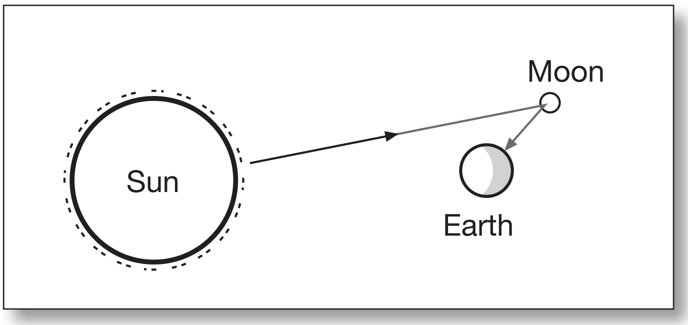
This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

The Sun is approximately 70 per cent hydrogen gas, which undergoes constant nuclear fusion to produce helium at its core and release energy as visible light and heat.

The Earth is the only habitable planet in the Solar System and, as far as we know, in the universe. The Earth's atmosphere contains oxygen, which is necessary to support life. It also contains carbon dioxide, which acts like a blanket, keeping the Earth at a temperature that will support life. Earth is also the only planet in the Solar System with liquid water on its surface.

The Moon is made of rock and has virtually no atmosphere. The Moon itself does not produce light; we can see it from the Earth only because the Moon reflects light from the Sun.



An observer on Earth at night sees the Moon by reflected sunlight

Equipment

FOR THE CLASS	FOR EACH STUDENT
• class science journal • word wall • images of night and day scenes • 1 enlarged copy of 'Where's the Sun?' (Resource sheet 1)	• student science journal • 1 copy of 'Where's the Sun?' (Resource sheet 1)

Preparation

- Prepare an enlarged copy of 'Where's the Sun?' (Resource sheet 1).
- Read 'How to use a science journal' (Appendix 2).
- Read 'How to use a word wall' (Appendix 3).
- Prepare a T-chart in the class science journal:

What we know about night and day

Night	Day

ENGAGE

- *Optional:* Display the class science journal, T-chart and 'Where's the Sun?' (Resource sheet 1) on an interactive whiteboard or a computer connected to a projector. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.primaryconnections.org.au

Lesson steps

1 Introduce the unit by showing images of night and day scenes. For example, images of a city at night and during the day.

Brainstorm and discuss ideas about the differences between night and day and record them on a T-chart. Discuss the purpose and features of a T-chart.

Literacy focus

Why do we use a T-chart?

We use a **T-chart** to organise information so that we can understand it more easily.

What does a T-chart include?

A **T-chart** includes two columns with headings. Information is put into the columns based on the headings.

What we know about night and day

Night	Day
It is dark	It is very light
We can see the stars	We can see the Sun
The Moon is in the sky	We can see clouds
We need lights to see	We can see shadows

A work sample of night and day T-chart

ENGAGE

2 Ask students questions, such as:

- How do we know it is day? What might we see if it is day?
- How do we know it is night? What might we see if it is night?

Note: In the *Engage* phase, do not provide any formal definitions or correct answers as the purpose is to elicit students' prior knowledge.

3 Introduce an enlarged copy of 'Where's the Sun?' (Resource sheet 1). Read through and discuss with students.

Provide students with time to complete 'Where's the Sun?' (Resource sheet 1).

4 Read each question one at a time and ask students to form groups with others who chose the same response and discuss why they chose that answer. Choose some students from each group to explain their ideas to the whole class. Encourage students to provide reasons for their ideas. Repeat the process for each question.

5 Introduce the class science journal and explain the purpose and features of a science journal.

Literacy focus

Why do we use a science journal?

We use a **science journal** to record what we see, hear, feel and think so that we can look at it later.

What does a science journal include?

A **science journal** includes dates and times. It might include written text, drawings, measurements, labelled diagrams, photographs, tables and graphs.

6 Explain that students will create an annotated drawing with the title 'Night and day' in their science journals to record their ideas about how night and day happen, showing the Sun, Moon and Earth. Discuss the purpose and features of an annotated drawing.

Literacy focus

Why do we use an annotated drawing?

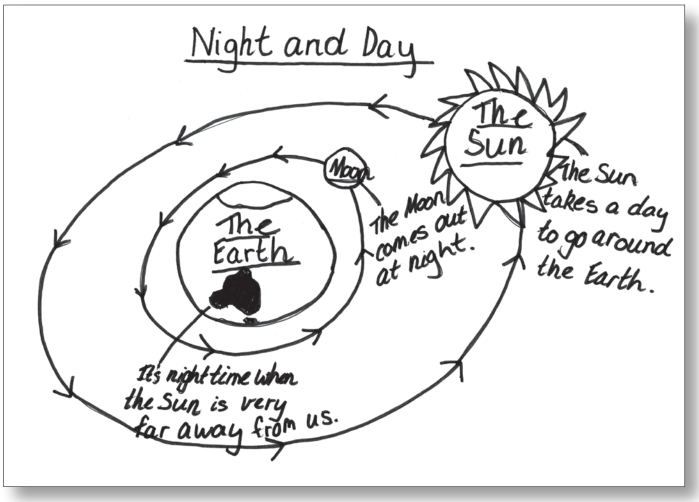
We use an **annotated drawing** to show an idea or an object.

What does an annotated drawing include?

An **annotated drawing** includes a picture and words or descriptions about the idea or object.

Discuss how movements might be indicated by lines with arrows or turning arrows.

7 Provide students with time to create annotated drawings. Ask students to discuss and share their drawings with a partner.



Work sample of annotated drawing of night and day

ENGAGE

Note: Students will review and modify their annotated drawing throughout the unit, as their ideas are challenged.

8 Ask students what words from today's lesson might be put on the word wall. Discuss the purpose and features of a word wall.

Literacy focus

Why do we use a word wall?

We use a **word wall** to record words we know or learn about a topic. We display the **word wall** in the classroom so that we can look up words we are learning about and see how they are spelled.

What does a word wall include?

A **word wall** includes a topic title or picture and words that we have seen or heard about the topic.

9 Add words and images to the word wall.

Curriculum links

Studies of Society and the Environment

- Research other representations, myths and legends that humans have used throughout time to explain night and day.

The Arts

- Use *Starry night* by Vincent Van Gogh as a stimulus for creating artwork to represent day-time and night-time scenes.

Where's the Sun?

Name: ______________________________ **Date:** ______________

Why is it dark at night?	True or false?
We need to sleep.	
The Sun goes too far away at night.	
The Sun goes behind a hill at night.	
The Sun is still shining but we are on the shadow side of the Earth.	
The Sun goes to the other side of the world.	
Clouds cover the Sun at night.	

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Lesson 2 Shapes and sizes

AT A GLANCE

To provide students with hands-on, shared experiences of the shapes, relative sizes and positions of the Sun, Earth and Moon.

Students:

- view images of the Sun, Earth and Moon
- investigate the relative sizes of the Sun, Earth and Moon
- use spherical objects to explore why the Sun and Moon appear to be the same size when viewed from Earth.

EXPLORE

Lesson focus

The *Explore* phase is designed to provide students with hands-on experiences of the science phenomenon. Students explore ideas, collect evidence, discuss their observations and keep records, such as science journal entries. The *Explore* phase ensures all students have a shared experience that can be discussed and explained in the *Explain* phase.

Assessment focus

Formative assessment is an ongoing aspect of the *Explore* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of:

- the shape and relative sizes of the Sun, Moon and Earth.

You will also monitor their developing science inquiry skills (see page 2).

Key lesson outcomes

Science

Students will be able to:

- describe the spherical shapes of the Sun, Earth and Moon
- compare the relative sizes of the Sun, Earth and Moon
- explain why the Sun looks the same size as the Moon when viewed from Earth.

Literacy

Students will be able to:

- contribute to discussions on the shapes and sizes of the Sun, Earth and Moon
- use 3-D models to develop understanding of the shapes and sizes of the Sun, Earth and Moon
- demonstrate their understanding of scale in relation to representing the sizes of the Sun, Earth and Moon.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

The Sun, Earth and Moon are all spheres. The Sun is the largest object in the Solar System. It is gigantic compared with the Earth, which is larger than the Moon. The Moon's diameter is one-quarter that of the Earth's. Although the Moon is much smaller than the Sun, when viewed from the Earth, they appear to be about the same size in the sky because the Moon is much closer to the Earth than the Sun.

The distances between the major objects in the Solar System can be difficult to imagine because they are so large. Light, which is the fastest thing in the Universe, takes about eight minutes to travel from the Sun to Earth, and just more than one second to travel between the Moon and Earth.

Table 3 represents the diameters of the Sun, Earth and Moon and the distances of the Sun and Moon from Earth in actual measurements (kilometres) and scaled-down measurements (metres, centimetres, millimetres). The scale measurements are based on the Sun's diameter being equivalent to one metre.

Body	Diameter	Distance from Earth
Sun	1,392,000 km (1 m)	149,574,000 km (106 m)
Earth	12,756 km (9 mm)	
Moon	3,476 km (2½ mm)	384,400 km (27 cm)

For a long time, the Earth was thought to be flat, because that is how it appears to an observer standing on the ground. Because of the Earth's immense size, it curves over large distances, which makes it nearly impossible to observe its curvature with the naked eye.

In the fourth century BC, Aristotle proposed that the Earth was round, based on three observations. Firstly, ships sailing away from land appeared to vanish hull-first into the ocean as they sailed into the distance (if the Earth was flat they would just get smaller and smaller until they disappeared). Secondly, the further south a person travelled, the higher the southern constellations rose in the night sky, meaning the person's angle of view was changing, which is not possible on a flat disc. And thirdly, the shadow of the Earth on the Moon during a lunar eclipse was always a circle, and only a sphere always casts a circular shadow.

Equipment

FOR THE CLASS

- class science journal
- team roles chart
- team skills chart
- word wall
- objects to represent the Sun, Earth and Moon (eg, basketball, marble, peppercorn)
- pictures, posters, video or internet images of the Sun, Earth and Moon

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 tennis ball
- 1 basketball

Preparation

- Read 'How to organise collaborative learning teams (Year 3–Year 6)' (Appendix 1). Display an enlarged copy of the team skills chart and the team roles chart in the classroom. Prepare role wristbands or badges for Directors, Managers and Speakers, and the equipment table.
- Find a suitable location for outdoor activities.
- Review websites that demonstrate shapes, sizes and positions of the Sun, Earth and Moon (see Primary**Connections** website for suggestions).

Lesson steps

1. Review the previous lesson. Invite students to share ideas or experiences of how people travel around the Earth, such as by flying or sailing. Where possible, draw on students' experiences of travelling to other parts of the Earth. This might help students appreciate that the Earth is a sphere and not flat, as it appears.
2. Ask students to suggest objects that they think are the same shape as the Earth, for example, a basketball. Ask students the name of the shape (a sphere) and discuss how a sphere is different from a circle or a disc. Discuss the shapes of the Sun and Moon.

   Add 'sphere' to the word wall.

3 Discuss what students know about the sizes of the Sun, Earth and Moon, particularly in comparison with each other.

4 Introduce three spherical objects, such as a basketball, a marble and a peppercorn. Ask students to match each spherical object to the Sun, Earth or Moon to indicate their size, for example, basketball—Sun, marble—Earth, peppercorn—Moon, and give reasons for their match.

5 Discuss a common observation that the Moon appears to be similar in size to the Sun. You could introduce this activity using students' drawings from Lesson 1, which will often represent the Sun and the Moon as being about the same size.

6 Explain that students will be working in collaborative learning teams to find out more about the sizes and positions of the Sun, Earth and Moon.

If students are using collaborative learning teams for the first time, introduce and explain the team skills chart and the team roles chart. Explain that students will wear role wristbands or badges to help them (and you) know which role each team member has.

Draw students' attention to the equipment table and discuss its use. Explain that this table is where Managers will collect and return equipment.

7 Explain that for the following activity teams will use a basketball to represent the Sun and a tennis ball to represent the Moon. (For this activity, using a tennis ball to represent the Moon is more practical than the peppercorn that was used earlier.)

8 Form teams and allocate roles. Ask Managers to collect team equipment.

9 Take students out into the playground. Explain that one team member will hold the tennis ball, while another will hold the basketball. The third team member will stand in front and be able to view both balls. Ask students to imagine that the observing student is standing on the Earth and looking at the Sun and Moon.

10 The student with the basketball will move backwards until the student viewing the balls observes that the basketball appears to be the same size as the tennis ball. Students swap positions so that each team member has a turn to be the observer. In teams, students discuss their observations and relate them to the sizes of the Sun and Moon.

This activity demonstrates that two different-sized objects can appear to be the same size if they are different distances from the observer.

11 When you return to the classroom, view images, such as photographs or internet images, or show video footage, for example, using the internet or video/DVD, that illustrates the spherical shapes of the Sun, Earth and Moon.

12 Ask students to review their annotated drawing of the Sun, Earth and Moon from Lesson 1 to make adjustments (or begin another drawing) based on their experiences in this lesson.

13 Provide students with time to reflect and record their ideas about the lesson activities in their science journals. You might like to provide students with prompts, such as:

- Something new I learned today was…
- Something that interested me today was…
- Something I wonder about is…

14 Update the word wall with words and images.

Curriculum links

English

- Send postcards from the Moon.

Mathematics

- Study 2-D and 3-D shapes.

Studies of Society and Environment

- Research and read about space flights and Moon landings.

Indigenous perspectives

Indigenous people have been observing the Sun, Moon and their cycles of movement for thousands of years. Certain stars and constellations, representing various spirits, are like celestial noticeboards acting as a reminder of the social rules of the group. Most Australian Indigenous legends represent the Sun as a woman and the Moon as a man, unlike other Indigenous cultures.

The Aboriginal people of northern Australia explain why there is night and day in their story, *Wuriunpranilli, the Sun Woman*. See www.questacon.edu.au/starlab/the_sun.html

EXPLORE

Lesson 3 Shadows at play

EXPLORE

AT A GLANCE

To provide students with hands-on, shared experiences of shadows and light.

Students:

- play shadow tag
- observe and discuss changes in shadows around the school.

Lesson focus

The *Explore* phase is designed to provide students with hands-on experiences of the science phenomenon. Students explore ideas, collect evidence, discuss their observations and keep records, such as science journal entries. The *Explore* phase ensures all students have a shared experience that can be discussed and explained in the *Explain* phase.

Assessment focus

Formative assessment is an ongoing aspect of the *Explore* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of:

- how shadows are formed and how they change.

You will also monitor their developing science inquiry skills (see page 2).

Key lesson outcomes

Science

Students will be able to:

- describe changes in size and direction of shadows during a day
- describe apparent movement of the Sun across the sky from East to West each day
- describe how shadows are made
- observe light and shaded sides of objects in sunlight.

Literacy

Students will be able to:

- discuss observations of light and shadows
- draw a labelled diagram of own shadow
- record ideas about light and shadows.

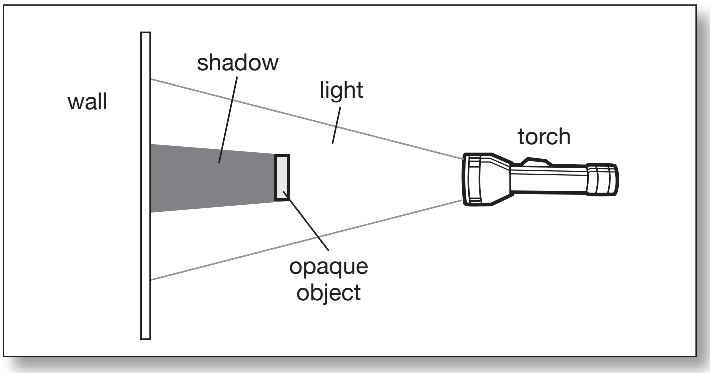
This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

Shadows are formed when the path of light is blocked by an object. Light travels in approximately straight lines. Light passing a sharp edge will diffract a little bit (i.e. bend into the shadow region). This effect is negligible in terms of everyday perception. Through investigating shadows, we can use this concept to provide information about the positions and movements of the Sun, Earth and Moon.

Materials that block light are opaque, while materials that allow light to pass through them are transparent. The shape of a shadow is affected by:

- the shape of the object blocking the light
- how close the object is to the light source, and
- the position of the light source relative to the object, for example, whether it is above or at the same level as the object.



Casting shadows

When the position of the light source is right above the object, the object will cast a short shadow on the ground. As the light source moves downwards, the object will cast a longer shadow. This is why when the Sun is directly overhead, people and objects cast very small, short shadows. In the morning and afternoon, however, when the Sun is low on the horizon, they cast very long shadows. As the position of the Sun in the sky changes from East in the morning to West in the afternoon, the direction of shadows changes. The change in the position of a shadow throughout the day is what allows shadows to be used when telling the time using sundials.

Students' conceptions

Students might confuse features of a shadow with those of a reflection, for example, by representing facial features in a drawing of their shadow. Although the Sun appears to move across the sky from East to West during the day, almost all of the Sun's apparent motion across the sky comes from the rotation of the Earth. It is the spinning of the Earth on its axis that causes the shadows to move and creates the impression of the Sun moving across the sky.

This lesson provides an opportunity to challenge students' common conception that the Sun moves around the Earth while the Earth stays still. Students will observe that while the movement of shadows can be attributed to the movement of the light source, for example, the torch, which represents the Sun, it can also be attributed to the movement of the ball, for example, the Earth.

Equipment

FOR THE CLASS

- class science journal
- team roles chart
- team skills chart
- word wall
- T-chart from Lesson 1
- 1 ruler or shadow puppet
- strong light or torch
- 1 popstick
- 1 piece of plasticine or clay
- *optional:* digital camera

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal

EXPLORE

Lesson steps

1 Review the T-chart from Lesson 1 on night and day differences and focus attention on answers that referred to light and shadows. Explain that in this lesson, students will be exploring the formation and features of shadows. Elicit students' understanding of shadows by asking questions, such as:

- What is a shadow?
- What is needed to make a shadow?
- How do shadows change?

2 On a sunny morning, take students outside for a game of 'shadow tag'. Students work in pairs, where one partner is 'it' and tries to tag their partner's shadow, and the other partner becomes 'it' after being tagged.

SAFETY

Looking at the Sun can cause permanent eye damage, and in rare cases this can occur without any pain. Warn students against looking directly at the Sun at any time.

3 After each pair of students has had a few turns, ask students what they noticed about their shadows this early in the morning, using questions, such as:

- Does your shadow move in the same direction as you do?
- Are you and your shadow joined together?
- How can you make your shadow smaller or larger?
- Where is the Sun in relation to your shadow?
- What do you think causes a shadow?

4 Walk around the school to observe sunny and shady places. Also look for objects where one side is in shadow while the other side is in light. Repeat this activity at least once more during the day, keeping a record of observations of how shadows change.

Optional: take photos of shadows as they change throughout the day.

5 Discuss students' experiences of sunny and shady places in the school. Ask questions, such as:

- Are places or objects, for example, the flagpole, always in sunlight or shade throughout the day?

- Do buildings or objects always cast a shadow? What do you notice about the shape of their shadows?
- Does the length of shadows change during the day? Why do you think that happens?
- Why do you think one side of an object, for example, a tree, is light and the other side is dark?

Record students' ideas in the class science journal.

6 Discuss with students where the Sun is located, and how this might change during the course of the day as they repeat the shadow observation activities.

7 Ask students to draw a labelled diagram in their science journals of themselves, their shadow and the position of the Sun in relation to their shadow as they observed from the game of shadow tag and other observations of shadows. Discuss the purpose and features of a labelled diagram.

Literacy focus

Why do we use a labelled diagram?

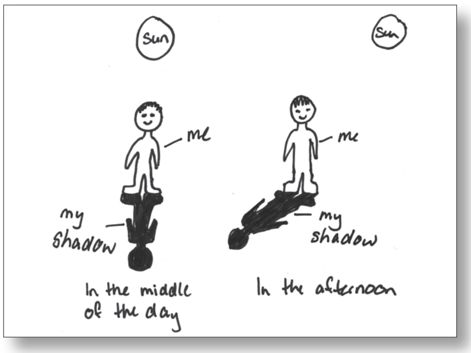
We use a **labelled** diagram to show the shape, size and features of an object.

What does a labelled diagram include?

A **labelled diagram** might include a title, an accurate drawing, a scale to show the object's size and labels showing the main features. A line or arrow connects the label to the feature.

EXPLORE

8 Ask students to share and discuss their labelled diagrams with a partner, providing reasons for their ideas.



Work sample of a labelled diagram

9 Shine a torch on a vertical ruler or shadow puppet to demonstrate the way light travels in straight lines and forms a shadow behind an opaque object that blocks the light.

Ask students to note that the shadow is formed where the ruler/puppet stops the light. The shadow is behind the ruler/puppet directly in line with the light source.

10 Discuss students' observations with questions such as:

- How is the shadow formed?
- How can you tell that light travels in straight lines?

11 Demonstrate that movement of the shadow can occur when the torch moves and also when the ruler/puppet moves. Challenge students to identify different ways in which the shadow behind the ruler/puppet could be made to move, for example:

- What will make the shadow longer or shorter?
- What happens to the shadow when the light is above the ruler/puppet?

12 Ask students to predict what will happen when a torch is shone onto a popstick stuck on a ball, for example, a netball, a basketball, with a piece of plasticine or clay.

13 Show that the shadow can be moved by rotating the ball when the torch is held still. Discuss students' observations, by asking questions such as:

- What could the ball represent? For example, the Earth.
- What could the torch represent? For example, the Sun.
- What could the popstick represent? For example, a person, a flag pole, a tree.
- What does this show about the shadows formed about the school?
- Why do shadows move during the day?

14 Record students' ideas and observations about shadows in the class science journal, noting that shadows can change when either the light source or an object moves.

15 Update the word wall with words and images.

EXPLORE

Curriculum links

English

- Write or adapt a story that can be used to develop a script for a shadow puppet play.

Mathematics

- Make shadow profiles of students or students' heads and calculate the areas of the shadows.
- Measure the perimeter of a shadow, for example, using string.

Studies of Society and Environment

- Research and read about Indonesian shadow puppets.
- Study map reading using magnetic compasses.

The Arts

- Create props and puppets for use in a shadow puppet play.
- Rehearse and perform a shadow puppet play.

Indigenous perspectives

Indigenous people recognise that there are dark areas or shadows in the sky and they include them when they are describing their constellations or patterns of stars. Astronomers now realise these are large areas of gases which create shadows. They are called dark nebulae.

- Explore the *Emu in the sky* constellation and its significance for Indigenous people. See www.questacon.edu.au/starlab/the_emu.html www.atnf.csiro.au/research/AboriginalAstronomy/about.htm

Lesson 4 In a spin

AT A GLANCE

To support students to represent and explain their understanding of how Earth's rotation on its axis causes night and day, and to introduce current scientific views.

Students:

- use models to explain their ideas of how the Earth and Sun cause night and day
- participate in role-plays to explain how the spinning of the Earth on its axis as it orbits the Sun causes night and day
- represent their new understanding of night and day in a labelled diagram.

Lesson focus

In the *Explain* phase students develop a literacy product to represent their developing understanding. They discuss and identify patterns and relationships within their observations. Students consider the current views of scientists and deepen their own understanding.

EXPLAIN

Assessment focus

Formative assessment is an ongoing aspect of the *Explain* phase. It involves monitoring students' developing understanding and giving feedback that extends their learning. In this lesson you will monitor students' developing understanding of:

- how Earth's rotation on its axis causes regular changes, including night and day.

Key lesson outcomes

Science

Students will be able to:

- demonstrate through role-play that the spinning of the Earth on its axis causes night and day
- demonstrate through role-play that the Earth orbits the Sun and the Moon orbits the Earth.

Literacy

Students will be able to:

- use oral language and role-play to represent their understanding of the rotation of the Earth
- complete a labelled diagram to represent how night and day are caused by Earth's rotation
- identify the limitations of models in showing how the Earth rotates.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

Night and day are the result of the Earth spinning on its axis; the Earth makes one complete rotation on its axis approximately every 24 hours. The side of the Earth facing the Sun is in daylight, while the side facing away is in the Earth's own shadow (night). Although the Sun appears to move across the sky during the day, it is not movement by the Sun but the Earth's rotation that causes the apparent movement of the Sun across the sky. The Earth spins in an anti-clockwise direction when viewed from the North Pole, so that the east coast of Australia moves into the sunlight first in the morning and sunrise is experienced two or three hours later (depending on daylight saving) on the west coast.

Equipment

FOR THE CLASS

- class science journal
- team roles chart
- team skills chart
- word wall
- 1 light source (eg, lamp, torch, data projector or overhead projector)
- 1 world globe or ball (eg, netball or basketball)
- labels with 'Sun', Earth' and Moon
- 1 enlarged copy of 'The spinning Earth' (Resource sheet 2)

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- props to represent Earth and Sun (eg, different-sized balls or spheres, plasticine, torches)
- 1 copy of 'The spinning Earth' (Resource sheet 2) per team member

Preparation

- Organise a darkened area or room for the Earth rotation exercise.
- Organise resources for students' role-play.
- Prepare an enlarged copy of 'The spinning Earth' (Resource sheet 2).
- *Optional:* Display 'The spinning Earth' (Resource sheet 2) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

Lesson steps

1 Review the activities from the previous lessons, using the class science journal and the word wall. Lead a discussion with review questions, such as:

- What do we know about the Sun and the Earth?
- What do changing shadows tell us about the movement of the Earth?

2 Explain that students will be working in collaborative learning teams to represent their ideas about the movement of the Earth to create night and day.

Explain that the teams will use props to represent the Sun and Earth. Discuss with students their observations of how objects in sunlight have a light side and a shadow side, and how that might help them to show night and day on Earth. Encourage students to review their science journals and to use other resources to check their ideas.

3 Form teams and allocate roles. Ask Managers to collect team equipment.

4 Provide teams with time to share ideas and develop their explanations and commentary. Ask two teams to join together so the teams can demonstrate their ideas to each other.

5 Bring students together and review the key ideas of their explanations, asking students to provide reasons for their ideas.

Explain why scientists use models, for example, to help them explain how things work. Discuss how models have limitations (eg. they might not be a 'complete' or accurate representation). Assist students to identify the limitations of their models.

6 Explain that students will be participating in a class role-play to represent the movement of the Earth, demonstrating how we experience night and day. Discuss the purpose and features of a role-play.

Literacy focus

Why do we use a role-play?

We use a **role-play** to show how something works by acting it out.

What does a role-play include?

A **role-play** might include speech, actions and props.

7 Darken the room or move to a dark room. Ask one student to stand in front of the class, in front of the light source and turn slowly in an anti-clockwise direction. Ask questions, such as:

- What could the student represent? (The Earth.)
- What could the light source represent? (The Sun.)
- What does this show? (That the Earth at any one time is half in light and half in shadow.)
- What does it tell us about the light and the shadow (night and day)?
- Why can't we see the Sun at night?

8 Ask four students to stand in front of the class, in front of the light source, in a circle facing outwards. Ask students to move their circle slowly in an anti-clockwise direction.

EXPLAIN

Ask them to stop, and then ask the audience to identify who in the circle is in daylight and who is in the shadow of the Earth and, therefore, experiencing night.

Discuss that as the students approach the light source the light on them becomes brighter. Discuss how this compares with what happens on the Earth as it rotates and people experience sunrise.

9 Ask the students in the circle to call out when they experience sunrise, the middle of the day (midday), sunset and the middle of the night (midnight). Ask students to explain their decisions.

10 Using a globe or ball, explain that the Earth spins around an imaginary line called its axis. Mark the spot on the globe in front of a light source to show where the students live, then spin the globe to show the spot moving from light (day) into shadow (night).

11 Explain that the role-play shows only part of what is happening, that is, while the Earth spins on its axis it also goes around the Sun.

12 Ask one student to stand in the centre of an open space. Provide the student with a label, 'Sun'. Ask another student to spin anti-clockwise on his/her axis (when viewed from above) while slowly moving in orbit around the Sun. Provide this student with a label, 'Earth'. Ask questions, such as:

- How is spinning different from orbiting? (Orbiting means to travel around another object.)
- How long will it take for the Earth to spin once on its axis? (One day.)

EXPLAIN

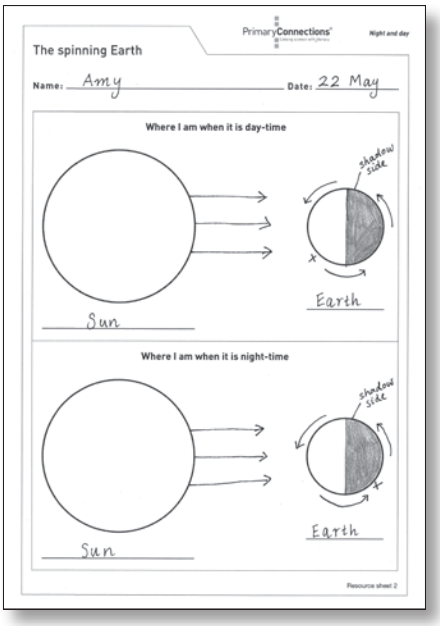
13 Introduce the enlarged copy of 'The spinning Earth' (Resource sheet 2). Discuss with students asking the following questions:

- Which is the Sun and which is the Earth? Why do you think that? (The Sun is larger than the Earth.) Label the Sun and Earth.
- Are the Sun and Earth that close together? Why is it represented this way?
- How do light rays travel from the Sun to the Earth? (In straight lines). Model how to draw the Sun's rays.
- How can we show that the Earth spins? (Draw curved arrows.) Which way does the Earth spin? (Anti-clockwise.) Model how to draw arrows to show the Earth spinning in an anti-clockwise direction.
- Which part of the Earth is having day-time? (The side facing the Sun.)
- Which part of the Earth is having night-time? (The side facing away from the Sun, which is in shadow.) Model how to shade the other side of the Earth to represent the shadow side.
- Where are we if we are having day-time? (On the side facing the Sun.) Model how to draw a cross on that side.

14 Explain to students that they will complete their own copy of 'The spinning Earth' (Resource sheet 2), including the second part showing where they are at night-time.

15 Provide time for students to complete 'The spinning Earth' (Resource sheet 2). Ask students to discuss and share their drawings with a partner providing reasons for their thinking.

16 Update the word wall with words and images.



Work sample of 'The spinning Earth' (Resource sheet 2)

Curriculum links

Studies of Society and the Environment

- Read and compare traditional stories about the Sun, Earth and Moon from a range of cultures, including Australia's Indigenous culture.
- Research and discuss the use of Sun and Moon symbols on national flags. For example, the Sun is used as part of the Australian Aboriginal flag and the Japanese flag, while the crescent moon features on the national flags of Malaysia and Pakistan.

Information and Communication Technology

Earth rotation: merry-go-round, L1129 (www.scootle.edu.au)

By comparing views from a moving merry-go-round to views from stationary positions around the merry-go-round, students are introduced to the idea that apparent movement of objects may depend on the viewing frame of reference. Students then use the Earth rotation model to compare views from Earth to views of Earth from a stationary point in space.

Note: Students might require support with this learning object as it is designed for Year 7–8 students.

Indigenous perspectives

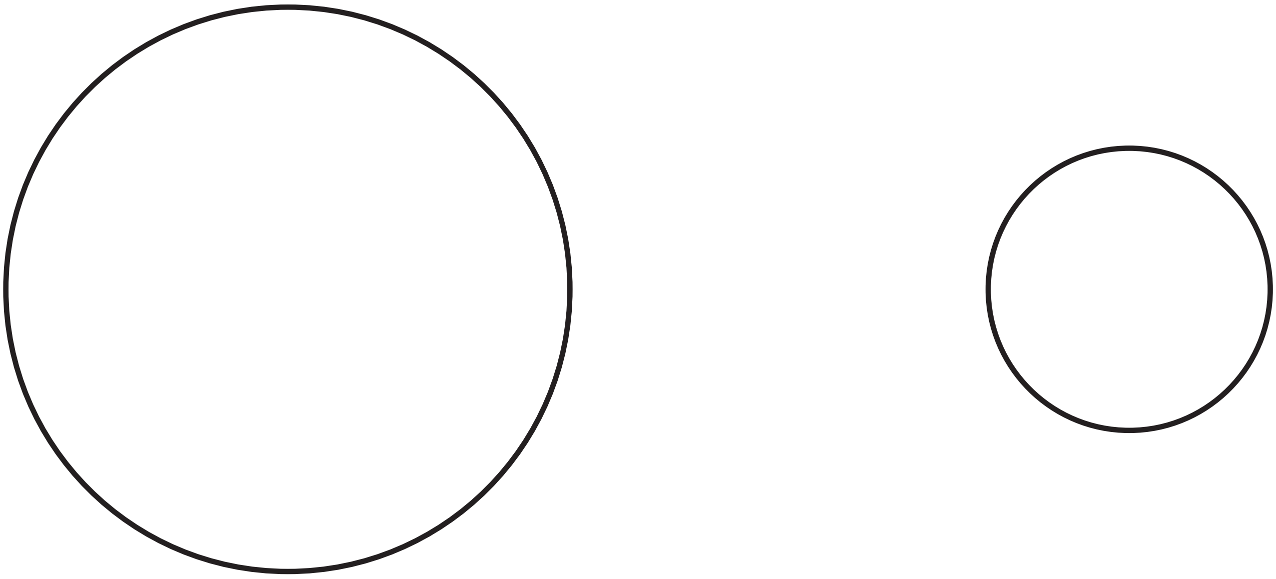
- Western scientists seek to understand the relationships between the Earth, Sun and Moon and the causes of regular occurrences such as night and day. Indigenous people might have their own way of explaining regular occurrences in the sky (see page 7).
- Primary**Connections** recommends working with Aboriginal and Torres Strait Islander community members to access local and relevant cultural perspectives. Protocols for engaging with Aboriginal and Torres Strait Islander community members are provided in state and territory education guidelines. Links to these are provided on the Primary**Connections** website (www.primaryconnections.org.au).

EXPLAIN

The spinning Earth

Name: ______________________ **Date:** ____________

Where I am when it is day-time



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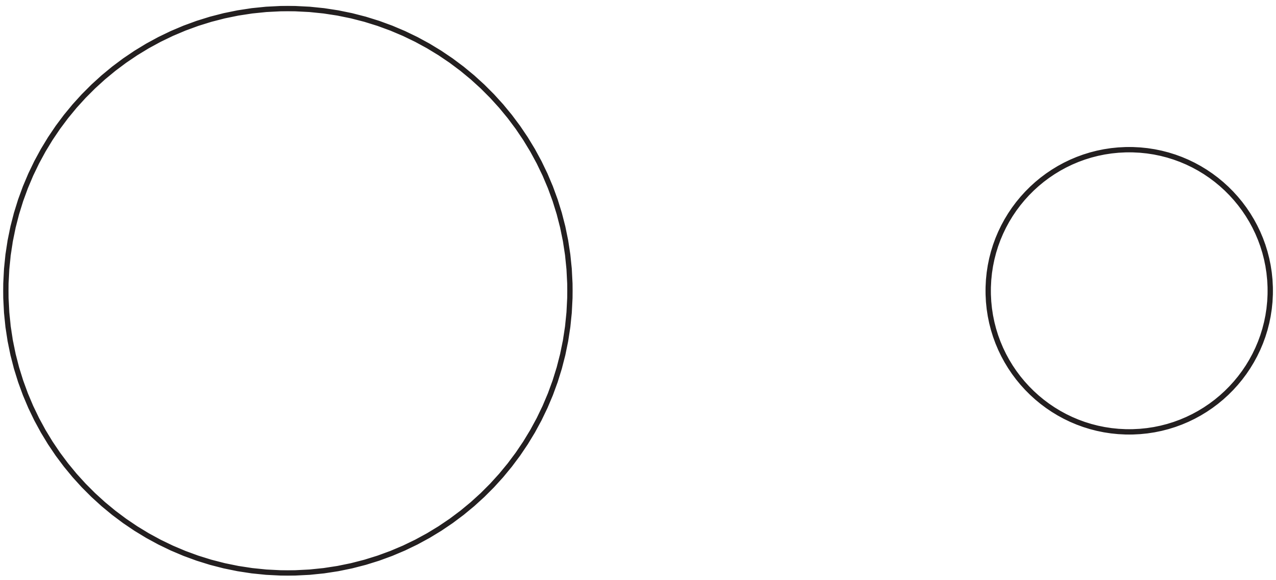
Where I am when it is night-time



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 ISBN 978 0 85847 313 3

Lesson 5 Investigating shadows

AT A GLANCE

To support students to plan and conduct an investigation of the length and direction of shadows during one day.

Session 1 Planning it out

Students:

- plan an investigation
- select variables to be changed, measured or kept the same.

Session 2 One o'clock, two o'clock ...

Students:

- conduct an investigation
- observe and record results.

Session 3 Shadows rock!

Students:

- create a table with measurements of shadows
- create a column graph to represent and compare measurements
- discuss and summarise results of investigation.

ELABORATE

Lesson focus

In the *Elaborate* phase students plan and conduct an open investigation to apply and extend their new conceptual understanding in a new context. It is designed to challenge and extend students' science understanding and science inquiry skills.

Assessment focus

Summative assessment of the Science Inquiry Skills is an important focus of the *Elaborate* phase (see page 2).

Key lesson outcomes

Science

Students will be able to:

- plan and conduct an investigation of the effect of time of day on length and direction of shadows
- record observations and measurements
- construct a graph to represent their results.

Literacy

Students will be able to:

- discuss and compare ideas about how shadows change during a day
- use a table and a column graph to represent findings
- describe the features of fair testing
- summarise results of an investigation.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Teacher background information

The Sun appears to rise in the East and set in the West because the Earth rotates anti- clockwise on its axis when viewed from the North Pole. The Sun remains stationary relative to the Earth, however, the Sun and the whole Solar System are moving at great speed through the Galaxy. From Earth, the Sun appears to travel in an arc across the sky, and the height of the arc varies depending on where the observer is on the Earth and what time of year it is.

A shadow stick can be any tall, narrow object that can be set up vertically. In the early morning, as the Sun rises in the East, the stick will cast a long shadow towards the West. In the late afternoon, as the Sun sets in the West, a long shadow will point eastwards.

If the length and direction of the shadow are marked at regular intervals throughout the day, the shortest shadow can be determined; this occurs at solar noon. Solar noon is the time of day, halfway between sunrise and sunset, when the Sun is at its highest point in the sky. This might not be at 12 noon as solar noon is usually different from clock noon because of artificial time zones and daylight saving arrangements.

Session 1 Planning it out

Equipment

FOR THE CLASS

- class science journal
- team roles chart
- team skills chart
- word wall
- 1 enlarged copy of 'Shadow stick investigation planner' (Resource sheet 3)
- selection of 'shadow sticks' (eg, rulers, sticks) (see 'Preparation')
- self-adhesive notes

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Shadow stick investigation planner' (Resource sheet 3) for each team member

Preparation

- Read 'How to conduct a fair test' (Appendix 4).
- Locate an area that will be sunny throughout the school day.
- Prepare an enlarged copy of 'Shadow stick investigation planner' (Resource sheet 3).

Note: The longer the stick, the longer the shadow will be. This will affect the size of paper needed for recording the shadows. You might like to try this activity beforehand to check that the large sheets of paper (see Session 2 'Equipment') will be wide enough to record the full length of the morning and afternoon shadows.

Lesson steps

1. Review the previous lessons and discuss what students have observed and learned about the spinning of the Earth. Review what they have observed about shadows and changes to shadows over time.
2. Explain that students will be working in collaborative learning teams to investigate the questions:
   - What happens to the length and direction of shadows during the day?
   - When are shadows at their longest and shortest?
3. Introduce an enlarged copy of the 'Shadow stick investigation planner' (Resource sheet 3) and record the questions for investigation.

   Ask students to make predictions and provide reasons for their predictions. Record predictions in the class science journal.
4. Discuss the use of a stick in this investigation and introduce the shadow sticks you have selected for the teams to use. Discuss how students could record their observations, for example, place a large sheet of paper under their shadow sticks and mark out length and position of the shadow.

ELABORATE

5 Ask students what could affect the length and direction of the shadow, and record suggestions, for example, on self-adhesive notes, to make a list of factors that might affect the length and direction of shadows. Suggestions might include the time of day, the position of the Sun, the height of the shadow stick, the location of the shadow stick and the position of the paper.

Ask students what they will need to observe and record as part of the investigation, for example, the length and direction of shadows.

6 Introduce the term 'variables' as things that can be changed, measured or kept the same in an investigation. Ask students why it is important to keep some things the same when you are measuring changes (to make the test fair and so we know what caused the observed changes).

Review their understanding of using fair testing in science investigations.

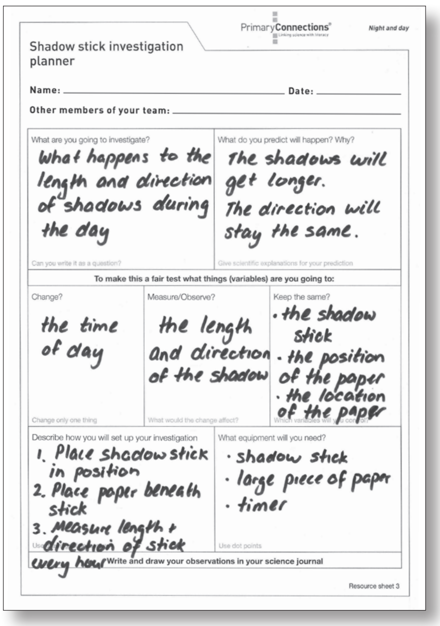
7 Discuss and model how students will complete their investigation planner by organising the self-adhesive notes on the enlarged investigation planner. For example, discuss what they will:

- **change**: for this investigation, the time of day will change (if using self-adhesive notes, this note can be moved to the 'change' section on the planner)
- **measure/observe**: record the length and direction of the shadow (if using self-adhesive notes, this note can be moved to the 'measure or observe' section on the planner)
- **keep the same**: the shadow stick, the shadow stick's position on the paper, the position of the paper, the location of the paper (if using self-adhesive notes, these notes can be moved to the 'keep the same' section on the planner).

8 Explain that in this session students will complete the first page of the investigation planner in preparation for observing and measuring shadows in the next session.

9 Form teams and allocate roles. Ask Managers to collect team equipment.

Provide teams with time to complete the first page of the investigation planner and to organise their shadow stick in preparation for carrying out the investigation on the next sunny day.


PrimaryConnections
Linking science with literacy
Night and day

Shadow stick investigation planner

Name: ______ Date: ______

Other members of your team: ______

What are you going to investigate?	What do you predict will happen? Why?
What happens to the length and direction of shadows during the day Can you write it as a question?	The shadows will get longer. The direction will stay the same. Give scientific explanations for your prediction

To make this a fair test what things (variables) are you going to:

Change?	Measure/Observe?	Keep the same?
the time of day Change only one thing	the length and direction of the shadow What would the change affect?	· the shadow stick · the position of the paper · the location of the paper Which variables will you control?

Describe how you will set up your investigation	What equipment will you need?
1. Place shadow stick in position 2. Place paper beneath stick 3. Measure length + direction of stick every hour	· shadow stick · large piece of paper · timer Use dot points

Write and draw your observations in your science journal

Resource sheet 3

Shadow stick investigation planner (Resource sheet 3)

ELABORATE

Shadow stick investigation planner

Name: ______________________________ **Date:** ______________

Other members of your team: ______________________________

What are you going to investigate?	What do you predict will happen? Why?
Can you write it as a question?	Give scientific explanations for your prediction

To make this a fair test what things (variables) are you going to:

Change?	Measure/Observe?	Keep the same?
Change only one thing	What would the change affect?	Which variables will you control?

Describe how you will set up your investigation	What equipment will you need?
Use drawings if necessary	Use dot points

Write and draw your observations in your science journal

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Recording and presenting results

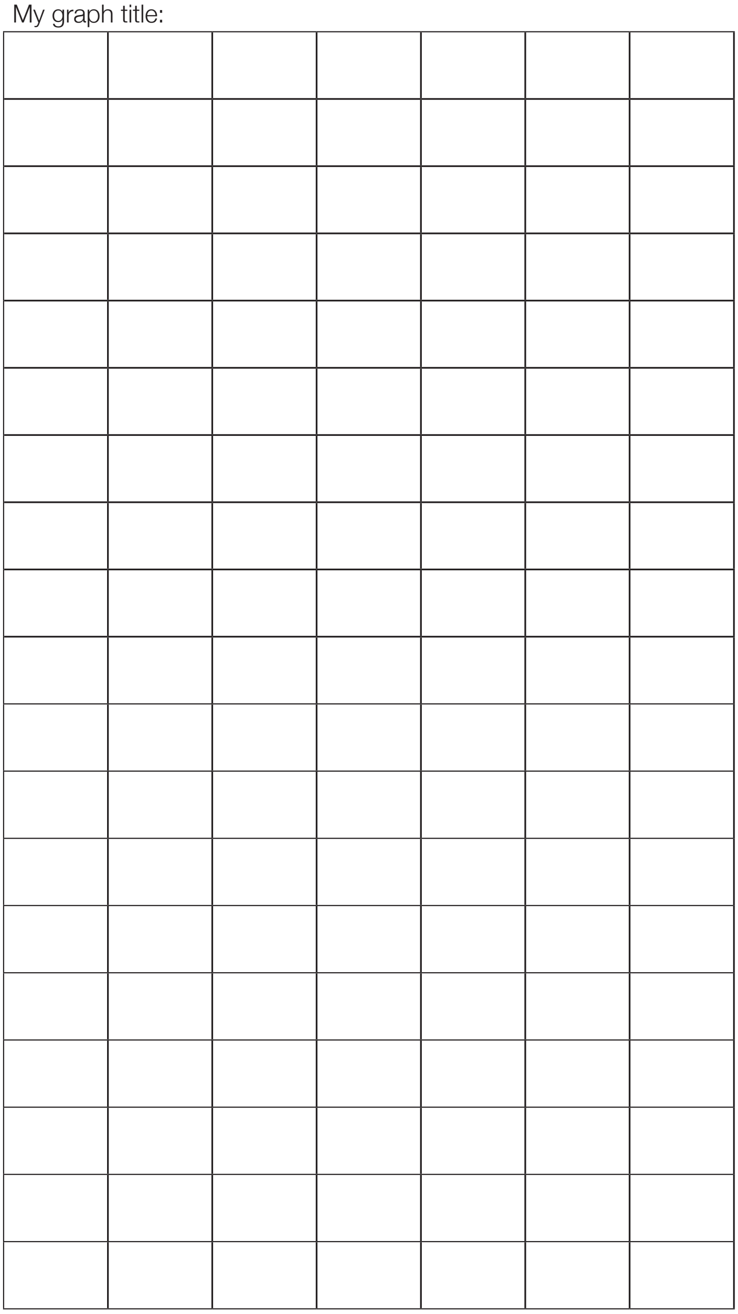
Record your results in a table.

Length of shadows at different times

Time of observation	Length of shadow (cm)

Present your results in a graph.

My graph title:



Length of shadow (cm)

Time of day

 ISBN 978 0 85847 313 3

Explaining results

Review the results of your investigation to answer the following questions.

What happened to the length of the shadow during the day?
When was the shadow the shortest? When was it the longest?
Why did the length of the shadow change?
What happened to the direction of the shadow during the day?
What happened to the position of the Sun during the day?
Why did the direction of the shadow change during the day?

Evaluating the investigation

What challenges did you experience doing this investigation?
How did you, or how could you, overcome them?
How could you improve this investigation (fairness, accuracy)?

Session 2 One o'clock, two o'clock ...

Equipment

FOR THE CLASS

- class science journal
- team roles chart
- team skills chart
- word wall
- magnetic compass

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's journal
- each team member's copy of 'Shadow stick investigation planner' (Resource sheet 3)
- shadow stick (eg, a stick weighted with a ball of clay or plasticine)
- large sheet of paper for recording shadows
- *optional:* digital camera

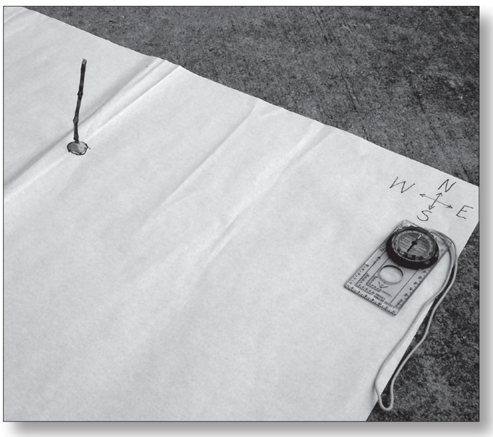
Preparation

- Select a day for this activity when it will be possible to take hourly readings of the shadow stick.
- Locate an area that will be sunny throughout the school day.
- Find out where north is, so you can assist students to place their sheet for recording shadows at a suitable orientation in step 3 (otherwise shadows could fall outside of the recording sheet).

ELABORATE

Lesson steps

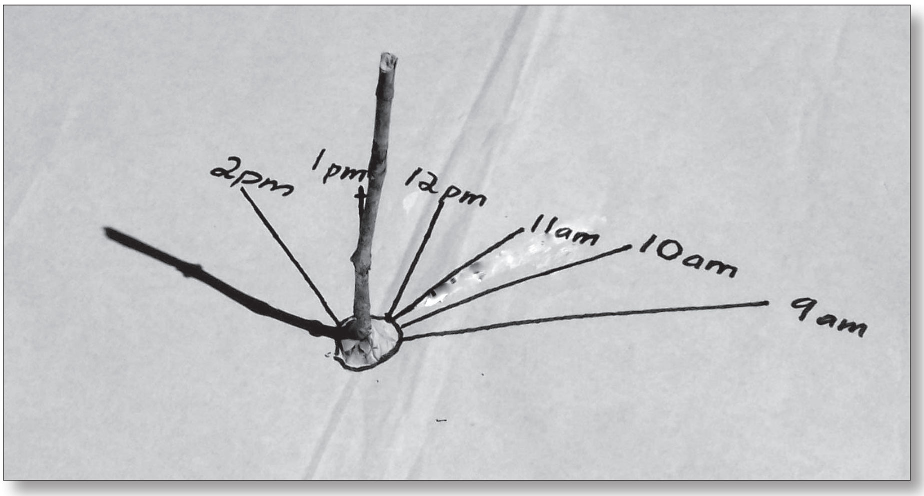
1. Review the investigation planning from the previous session.
2. Re-form teams and allocate roles. Ask Managers to collect team equipment.
3. Ask students to anchor the sheet of paper that needs to be oriented on the East–West axis, so that the top edge of the paper faces North and the bottom edge of the paper faces South (see 'Preparation').



Shadow stick investigation set-up

4 Ask students to use the plasticine or clay to make a base for the shadow stick and place it in the middle of the North-facing side of the sheet of paper. Draw a circle around the base to mark its position and remind students of the need to keep the stick in the same place in order to keep the investigation fair.

5 Arrange for teams to mark shadow length and direction throughout the day (preferably on the hour, and definitely including noon). Students can begin making observations at the start of the school day as they organised their investigation planner and shadow stick in the previous session. Remind students to record the time on each shadow marked.



Recording shadow length and direction using a shadow stick

Session 3 Shadows rock!

Equipment

FOR THE CLASS	FOR EACH TEAM
• class science journal • team roles chart • team skills chart • word wall	• role wristbands or badges for Director, Manager and Speaker • each team member's journal • each team member's copy of 'Shadow stick investigation planner' (Resource sheet 3)

Preparation

- Read 'How to construct and use a graph' (Appendix 6).
- Read 'How to facilitate evidence-based discussions (Appendix 5).

ELABORATE

Lesson steps

1 Review teams' records of their shadow observations from the previous session by asking questions, such as:

- What happened to the length of the shadow during the day?
- When was the shadow the shortest? When was it the longest?
- Why did the length of the shadow change?
- What happened to the position of the Sun during the day?
- Why did the direction of the shadow change during the day?

2 Discuss the table 'Length of shadows at different times' on the investigation planner and model how students will add their shadow stick measurements to the table. Discuss the purpose and features of a table.

Literacy focus

Why do we use a table?

We use a **table** to organise information so that we can understand it more easily.

What does a table include?

A **table** includes a title, columns with headings and information organised under each heading.

Length of shadows at different times

Time of observation	Length of shadow (cm)

3 After students have constructed their 'Length of shadows at different times' table, model how to construct a graph to represent the information from the table. Discuss the purpose and features of a graph.

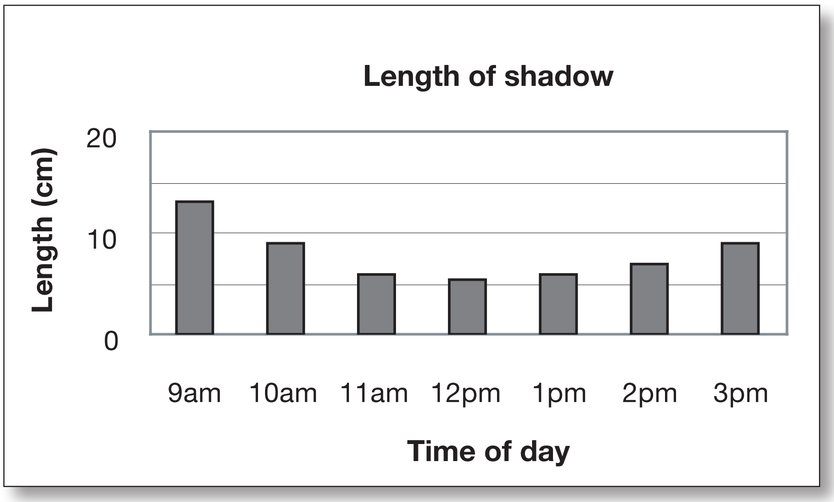
Literacy focus

Why do we use a graph?

We use a **graph** to organise information so we can look for patterns. We sue different types of graphs, such as picture, column or line graphs, for different purposes.

What does a graph include?

A **graph** includes a title, axes with labels on them and the units of measurement.



Example of a column graph

Discuss with students the conventions of constructing a scientific graph. The vertical axis (Y axis) usually represents the thing (variable) we measure and the horizontal axis (X axis) the thing (variable) we change.

Note: As the data for both variables are continuous, a line graph would be the conventional method to represent the findings from this investigation. It is suggested, however, that students construct a column graph, as this is appropriate for Year 3 students.

Allow time for students to construct their graphs.

4 After students have constructed their graphs, analyse the graphs and look for patterns and relationships, asking questions, such as:

- What is the story of your graph?
- When was the shadow longest and shortest?
- Do the data in your graph reveal any patterns?

5 Discuss team answers to the questions. Encourage students to use the science questions starters in ‘How to facilitate evidence-based discussions’ in Appendix 5.

6 Ask students to reflect on their shadow observations in Lesson 3, where the movement of either the torch or the ball changed the shadows. Discuss how these observations relate to the result of this investigation, which shows that if the Sun is still, the Earth must be spinning for the shadows to change length and direction during the day.

7 Provide students with time to reflect on the shadow stick investigation on their investigation planner and respond to the questions:
- What challenges did you experience doing this investigation?
- How could you overcome them?
- How could you improve the investigation?

The completed investigation planner provides a work sample for summative assessment of the investigation outcomes.

8 Update the word wall with words and images

Curriculum links

Mathematics

- Construct and study different types of graphs.

Studies of Society and Environment

- Research the use of sundials in other cultures, such as ancient Egyptian, Greek, Roman and Chinese civilisations.

Information and Communication Technology (ICT)

- Compile tables and construct graphs using computer applications.

Light and shadows: casting shadows, L1126 (www.scootle.edu.au)

After an introduction that carefully explains the reasons why and how shadows are created, students examine the way different shapes can generate different shadows. With the ability to move the Sun, students can see the different shadows cast at different times of the day.

Light and shadows: matching shadows, L1127 (www.scootle.edu.au)

To extend their understanding, students are asked to match either the shadow that is displayed on the screen to an object, or to make a shadow to match a given object. Students are then asked to move the Sun to the correct position in the sky to generate the shadow that is being displayed by a given object.

Indigenous perspectives

Indigenous peoples' traditional shelters were constructed to take advantage of the Sun and its seasonal path.

- Construct a model of a traditional shelter and conduct an investigation into the amount of shadow within the shelter during a day. See House design which takes advantage of the Sun in:
  www.aboriginaleducation.sa.edu.au/files/links/The_Sun_and_Moon_Aborigin_1.pdf

Lesson 6 Spinning in space

AT A GLANCE

To provide opportunities for students to represent what they know about how the Earth's rotation on its axis causes regular changes, including night and day, and to reflect on their learning during the unit.

Students:

- review and discuss the unit
- review ideas on night and day from Lesson 1
- create an annotated drawing to represent their knowledge and understanding of the movements of the Sun, Earth and Moon to cause night and day
- reflect on their learning during the unit.
- represent their new understanding of night and day in a labelled diagram.

Lesson focus

In the *Evaluate* phase students reflect on their learning journey and create a literacy product to re-represent their conceptual understanding.

Assessment focus

Summative assessment of the Science Understanding descriptions is an important aspect of the *Evaluate* phase. In this lesson you will be looking for evidence of the extent to which students understand:

- how Earth's rotation on its axis causes regular changes, including night and day.

EVALUATE

Key lesson outcomes

Science

Students will be able to:

- describe the shapes and relative sizes of the Sun, Earth and Moon
- explain how night and day are caused by the Earth rotating on its axis.

Literacy

Students will be able to:

- use written, oral and visual language to describe their understanding of the Sun, Earth and Moon moving in space
- construct an annotated drawing to represent and communicate what they learned about the Sun, Earth and Moon, and night and day
- reflect on their learning using a science journal entry.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 5).

Equipment

FOR THE CLASS

- class science journal
- word wall

FOR EACH STUDENT

- student science journal
- 1 copy of 'Where's the Sun?' (Resource sheet 1)
- their completed copy of 'Where's the Sun?' (Resource sheet 1) from Lesson 1
- 1 x A3 sheet of paper

Lesson steps

EVALUATE

1. Review the unit using the class science journal, the word wall and other resources developed during the unit.
2. Remind students of the 'Where's the Sun?' (Resource sheet 1) task completed at the beginning of the unit. Explain that they will revisit the task to see how their ideas have changed as a result of the evidence they collected in their investigations throughout the unit.
3. Provide students with time to complete a second copy of 'Where's the Sun?' (Resource sheet 1). After students have completed the resource sheet, return the sheet they completed in Lesson 1 for comparison. Ask students to share with a partner how their ideas have changed since the beginning of the unit.

4 Explain to students that they will complete a new annotated drawing to communicate what they have learned during this unit about what causes night and day. Discuss that the drawing might look very different to the one that they did at the start of the unit as they might have new ideas and understandings about night and day. Review the purpose and features of an annotated drawing.

5 Discuss what type of information students could include in their annotated drawings, such as:

- the sizes and shapes of the Sun, Earth and Moon
- the positions and movements of the Sun, Earth and Moon, and
- why we have night and day.

6 Distribute the A3 sheets of paper and provide students with time to plan and complete their annotated drawings. Encourage students to refer to the annotated drawings they have recorded in their science journals during the unit and the word wall for support.

7 Ask students to share their annotated drawings with a partner, and explain how their ideas have changed.

8 Ask students to reflect on the *Night and day* unit.

Ask questions, such as:

- What have you learned?
- Which activity did you enjoy the most?
- Which activity or lesson helped you to answer a question or change your ideas?
- How did your ideas change during the unit?
- Which activity was the least enjoyable?
- Is there anything you still find difficult to understand?
- Is there something interesting you have learned, done or would like to find out more about?
- Is there somewhere or someone you might like to visit as a result of studying this unit?

Curriculum links

Information and Communication Technology (ICT)

Earth rotation: night and day, L696 (www.scootle.edu.au)

Using an animated model of the Earth, students explore how rotation is related to night and day, and time of day. Students investigate how the Sun shines on one side of the Earth while the other side is in darkness. They are challenged to answer a series of questions by experimenting with the model. For example, when the Sun rises in New Zealand, what is the approximate time in Sydney?

Note: Students might require support with this learning object as it is designed for Year 7–8 students.

EVALUATE

Appendix 1
How to organise collaborative learning teams (Year 3–Year 6)

Introduction

Students working in collaborative teams is a key feature of the Primary**Connections** inquiry-based program. By working in collaborative teams students are able to:

- communicate and compare their ideas with one another
- build on one another's ideas
- discuss and debate these ideas
- revise and rethink their reasoning
- present their final team understanding through multi-modal representations.

Opportunities for working in collaborative learning teams are highlighted throughout the unit.

Students need to be taught how to work collaboratively. They need to work together regularly to develop effective group learning skills.

The development of these collaborative skills aligns to descriptions in the Australian Curriculum: English. See page 7.

Team structure

The first step towards teaching students to work collaboratively is to organise the team composition, roles and skills. Use the following ideas when planning collaborative learning with your class:

- Assign students to teams rather than allowing them to choose partners.
- Vary the composition of each team. Give students opportunities to work with others who might be of a different ability level, gender or cultural background.
- Keep teams together for two or more lessons so that students have enough time to learn to work together successfully.
- If you cannot divide the students in your class into teams of three, form two teams of two students rather than one team of four. It is difficult for students to work together effectively in larger groups.
- Keep a record of the students who have worked together as a team so that by the end of the year each student has worked with as many others as possible.

Team roles

Students are assigned roles within their team (see below). Each team member has a specific role but all members share leadership responsibilities. Each member is accountable for the performance of the team and should be able to explain how the team obtained its results. Students must therefore be concerned with the performance of all team members. It is important to rotate team jobs each time a team works together so that all students have an opportunity to perform different roles.

For Year 3–Year 6, the teams consist of three students—Director, Manager and Speaker. (For Foundation–Year 2, teams consist of two students—Manager and Speaker.)

Each member of the team should wear something that identifies them as belonging to that role, such as a wristband, badge, or colour-coded peg. This makes it easier for you to identify which role each student is doing and it is easier for the students to remember what they and their team mates should be doing.

Manager
The Manager is responsible for collecting and returning the team's equipment. The Manager also tells the teacher if any equipment is damaged or broken. All team members are responsible for clearing up after an activity and getting the equipment ready to return to the equipment table.

Speaker
The Speaker is responsible for asking the teacher or another team's Speaker for help. If the team cannot resolve a question or decide how to follow a procedure, the Speaker is the only person who may leave the team and seek help. The Speaker shares any information they obtain with team members. The teacher may speak to all team members, not just to the Speaker. The Speaker is not the only person who reports to the class; each team member should be able to report on the team's results.

Director (Year 3–Year 6)
The Director is responsible for making sure that the team understands the team investigation and helps team members focus on each step. The Director is also responsible for offering encouragement and support. When the team has finished, the Director helps team members check that they have accomplished the investigation successfully. The Director provides guidance but is not the team leader.

Team skills

Primary**Connections** focuses on social skills that will help students work in collaborative teams and communicate more effectively.

Students will practise the following team skills throughout the year:

- Move into your teams quickly and quietly
- Speak softly
- Stay with your team
- Take turns
- Perform your role.

To help reinforce these skills, display enlarged copies of the team skills chart (see the end of this Appendix) in a prominent place in the classroom.

Supporting equity

In science lessons, there can be a tendency for boys to manipulate materials and girls to record results. Primary**Connections** tries to avoid traditional social stereotyping by encouraging all students, irrespective of their gender, to maximise their learning potential. Collaborative learning encourages each student to participate in all aspects of team activities, including handling the equipment and taking intellectual risks.

Observe students when they are working in their collaborative teams and ensure that both girls and boys are participating in the hands-on activities.

TEAM ROLES

Manager

Collects and returns all materials the team needs

Speaker

Asks the teacher and other team speakers for help

Director

Make sure that the team understands the team investigation and completes each step

TEAM SKILLS

1 Move into your teams quickly and quietly

2 Speak softly

3 Stay with your team

4 Take turns

5 Perform your role

Appendix 2
How to use a science journal

Introduction

A science journal is a record of observations, experiences and reflections. It contains a series of dated, chronological entries. It can include written text, drawings, labelled diagrams, photographs, tables and graphs.

Using a science journal provides an opportunity for students to be engaged in a real science situation as they keep a record of their observations, ideas and thoughts about science activities. Students can use their science journals as a useful self-assessment tool as they reflect on their learning and how their ideas have changed and developed during a unit.

Monitoring students' journals allows you to identify students' alternative conceptions, find evidence of students' learning and plan future learning activities in science and literacy.

Keeping a science journal aligns to descriptions in the Australian Curriculum: Science and English. See pages 2 and 7.

Using a science journal

1. At the start of the year, or before starting a science unit, provide each student with a notebook or exercise book for their science journal or use an electronic format. Tailor the type of journal to fit the needs of your classroom. Explain to students that they will use their journals to keep a record of their observations, ideas and thoughts about science activities. Emphasise the importance of including pictorial representations as well as written entries.
2. Use a large project book or A3 paper to make a class science journal. This can be used at all year levels to model journal entries. With younger students, the class science journal can be used more frequently than individual journals and can take the place of individual journals.
3. Make time to use the science journal. Provide opportunities for students to plan procedures and record predictions, and their reasons for predictions, before an activity. Use the journal to record observations during an activity and reflect afterwards, including comparing ideas and findings with initial predictions and reasons. It is important to encourage students to provide evidence that supports their ideas, reasons and reflections.
4. Provide guidelines in the form of questions and headings and facilitate discussion about recording strategies, such as note-making, lists, tables and concept maps. Use the class science journal to show students how they can modify and improve their recording strategies.
5. Science journal entries can include narrative, poetry and prose as students represent their ideas in a range of styles and forms.
6. In science journal work, you can refer students to display charts, pictures, diagrams, word walls and phrases about the topic displayed around the classroom. Revisit and revise this material during the unit. Explore the vocabulary, visual texts and ideas that have developed from the science unit, and encourage students to use them in their science journals.

7 Combine the use of resource sheets with journal entries. After students have pasted their completed resource sheets in their journal, they might like to add their own drawings and reflections.

8 Use the science journal to assess student learning in both science and literacy. For example, during the *Engage* phase, use journal entries for diagnostic assessment as you determine students' prior knowledge.

9 Discuss the importance of entries in the science journal during the *Explain* and *Evaluate* phases. Demonstrate how the information in the journal will help students develop literacy products, such as posters, brochures, letters and oral or written presentations.

***Night and day* science journal**

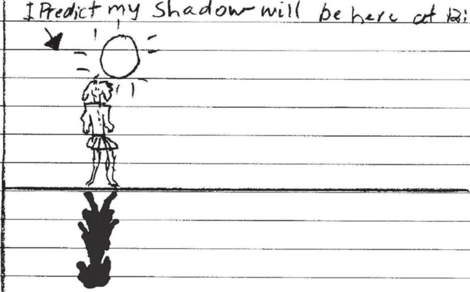
October

The role play helped me understand how day and
night happen. Using human bodies for the models
of the Sun and the Earth and Moon was fun.
Mrs Jones told the story and some of the students
acted it out. When we are facing the Sun it is
day and when we are not facing the Sun it is
dark and night time. The Earth spins around
the Sun and the Moon spins around the Earth

October

Shadow play

We went outside on a sunny day at 11:20 AM
To play a game of shadow tag and
We observed the length and angle of our
shadows. We were standing with our
backs to the sun. Our shadows were
dark because we blocked the sun
to form our shadows.
My shadow was longer than me
and it was straight a head
of me.
I Predict my shadow will be here at 12:40



Appendix 3
How to use a word wall

Introduction

A word wall is an organised collection of words and images displayed in the classroom. It supports the development of vocabulary related to a particular topic and provides a reference for students. The content of the word wall can be words that students see, hear and use in their reading, writing, speaking, listening and viewing.

Creating a class word wall, including words from regional dialects and languages, aligns to descriptions in the Australian Curriculum: English. See page 7.

Goals in using a word wall

A word wall can be used to:

- support science and literacy experiences of reading, viewing, writing and speaking
- provide support for students during literacy activities across all key learning areas
- promote independence in students as they develop their literacy skills
- provide a visual representation to help students see patterns in words and decode them
- develop a growing bank of words that students can spell, read and/or use in writing tasks
- provide ongoing support for the various levels of academic ability in the class
- teach the strategy of using word sources as a real-life strategy.

Organisation

Position the word wall so that students have easy access to the words. They need to be able to see, remove and return word cards to the wall. A classroom could have one main word wall and two or three smaller ones, each with a different focus, for example, high-frequency words.

Choose robust material for the word cards. Write or type words on cardboard and perhaps laminate them. Consider covering the wall with felt-type material and backing each word card with a self-adhesive dot to make it easy for students to remove and replace word cards.

Word walls do not need to be confined to a wall. Use a portable wall, display screen, shower curtain or window curtain. Consider a cardboard shape that fits with the unit, for example, a sphere shape for a unit on night and day.

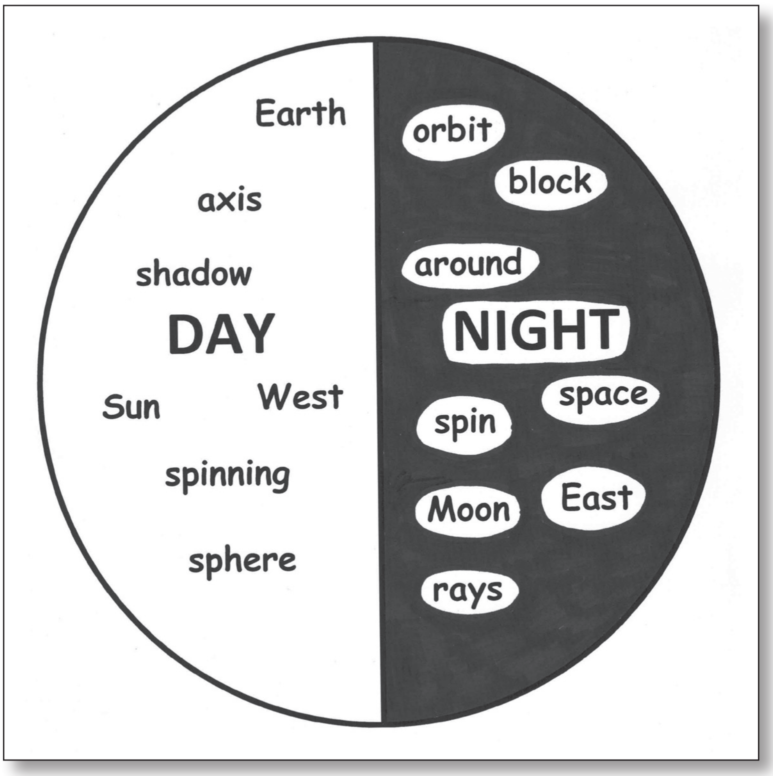
The purpose is for students to be exposed to a print-rich environment that supports their science and literacy experiences.

Organise the words on the wall in a variety of ways. Place them alphabetically, or put them in word groups or groups suggested by the unit topic, for example, words for a *Night and day* unit might be organised using headings, such as ‘Night’ and ‘Day’.

Invite students to contribute different words from different languages to the word wall. Group words about the same thing, for example, ‘Earth’, ‘Sun’ and ‘Moon’, on the word wall so that the students can make the connections. Identify the different languages used, for example, by using different-coloured cards or pens to record the words.

Using a word wall

1. Limit the number of words to those needed to support the science and literacy experiences in the classroom.
2. Add words gradually, and include images where possible, such as drawings, diagrams or photographs. Build up the number of words on the word wall as students are introduced to the scientific vocabulary of the unit.
3. Encourage students to interact with the word wall. Practise using the words with students by reading them and playing word games. Refer to the words during science and literacy experiences and direct students to the wall when they need a word for writing. Encourage students to use the word wall to spell words correctly.
4. Use the word wall with the whole class, small groups and individually during literacy experiences. Organise multi-level activities to cater for the individual needs of students.



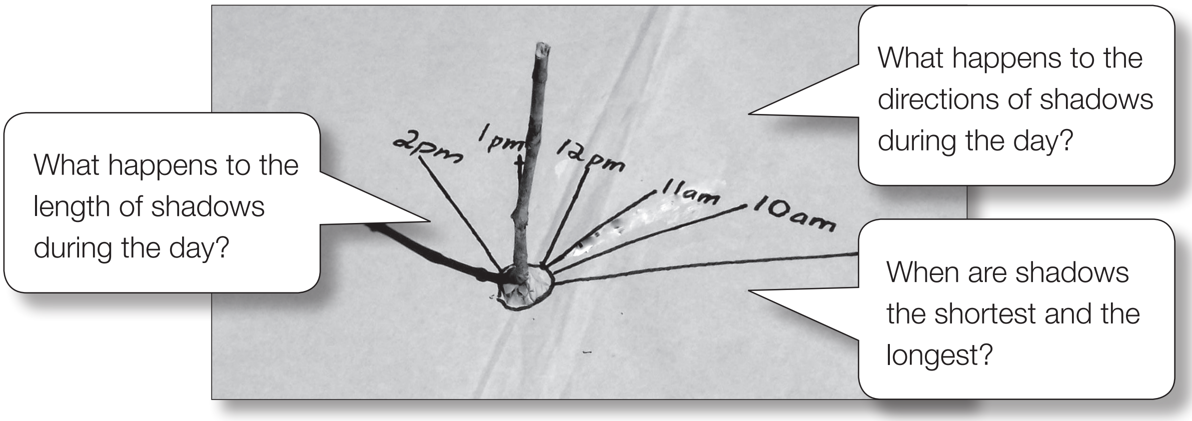
Night and day **word wall**

Appendix 4
How to conduct a fair test

Introduction

Scientific investigations involve posing questions, testing predictions, collecting and interpreting evidence and drawing conclusions and communicating findings.

Planning a fair test



All scientific investigations involve *variables*. Variables are things that can be changed (independent), measured/observed (dependent) or kept the same (controlled) in an investigation. When planning an investigation, to make it a fair test, we need to identify the variables.

It is only by conducting a fair test that students can be sure that what they have changed in their investigation has affected what is being measured/observed.

'**C**ows **M**oo **S**oftly' is a useful scaffold to remind students how to plan a fair test:

Cows: **Change** one thing (independent variable)

Moo: **Measure/Observe** another thing (dependent variable) and

Softly: keep the other things (controlled variables) the **Same.**

To investigate whether the time of day affects shadow length, students could:

CHANGE	time of day	Independent variable
MEASURE	shadow length	Dependent variable
KEEP THE **SAME**	the shadow stick, the shadow stick's position on the paper, the position of the paper, the location of the paper	Controlled variables

Appendix 5
How to facilitate evidence-based discussions

Introduction

Argumentation is at the heart of what scientists do; they pose questions, make claims, collect evidence, debate with other scientists and compare their ideas with others in the field.

In the primary science classroom, argumentation is about students:

- articulating and communicating their thinking and understanding to others
- sharing information and insights
- presenting their ideas and evidence
- receiving feedback (and giving feedback to others)
- finding flaws in their own and others' reasoning
- reflecting on how their ideas have changed.

It is through articulating, communicating and debating their ideas and arguments that students are able to develop a deep understanding of science content.

Establish norms

Introduce norms before starting a science discussion activity. For example,

- Listen when others speak.
- Ask questions of each other.
- Criticise ideas not people.
- Listen to and discuss all ideas before selecting one.

Question, Claim, Evidence and Reasoning

In science, arguments that make claims are supported by evidence. Sophisticated arguments follow the QCER process:

Q What **question** are you trying to answer? For example, 'What causes night and day?'

C The **claim**, for example, 'The length and direction of the shadow changes during the day as the Sun's position changes during the day.'

E The **evidence**, for example, 'We measured the length of the shadow every hour from 9am to 3pm. Our results were: at 9 am the length of the shadow was 12 cm, at 10 am—9 cm, 11 am—6 cm, 12 pm—5 cm, 1 pm—6 cm, 2 pm—7 cm, 3 pm—9 cm.'

R The **reasoning**, saying how the evidence supports the claim, for example, 'Shadows change in length and direction according to the position of the Sun. As the Earth spins the Sun's position in the sky moves from East to West and then it sets and night falls.'

Students need to be encouraged to move from making claims only, to citing evidence to support their claims. Older students develop full conclusions that include a claim, evidence and reasoning. This is an important characteristic of the nature of science and an aspect of scientific literacy. Using science question starters (see next section) helps to promote evidence-based discussion in the classroom.

Science question starters

Science question starters can be used to model the way to discuss a claim and evidence for students. Teachers encourage team members to ask these questions of each other when preparing their claim and evidence. They might also be used by audience members when a team is presenting its results. (See Primary**Connections** 5Es DVD, Chapter 5).

Science question starters

Question type	Question starter
Asking for evidence	I have a question about ______________________________. How does your evidence support your claim____________? What other evidence do you have to support your claim ____?
Agreeing	I agree with __________ because ______________________.
Disagreeing	I disagree with _______________ because ______________. One difference between my idea and yours is _____________.
Questioning further	I wonder what would happen if _______________________? I have a question about ______________________________. I wonder why _____________________________________? What caused ______________________________________? How would it be different if ___________________________? What do you think will happen if _______________________?
Clarifying	I'm not sure what you meant there. Could you explain your thinking to me again?

Appendix 6
How to construct and use a graph

Introduction

A graph organises, represents and summarises information so that patterns and relationships can be identified. Understanding the conventions of constructing and using graphs is an important aspect of scientific literacy.

During a scientific investigation, observations and measurements are made and measurements are usually recorded in a table. Graphs can be used to organise the data to identify patterns, which help answer the research question and communicate findings from the investigation.

The Australian Curriculum: Mathematics Statistics and Probability ‘Data representation and interpretation’ content descriptions for Year 3 are:

- Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies
- Interpret and compare data displays

Once you have decided to construct a graph, two decisions need to be made:

- What type of graph? and
- Which variable goes on each axis of the graph?

What type of graph?

The type of graph used depends on the type of data to be represented. Many investigations explore the effect of changing one variable while another is measured or observed.

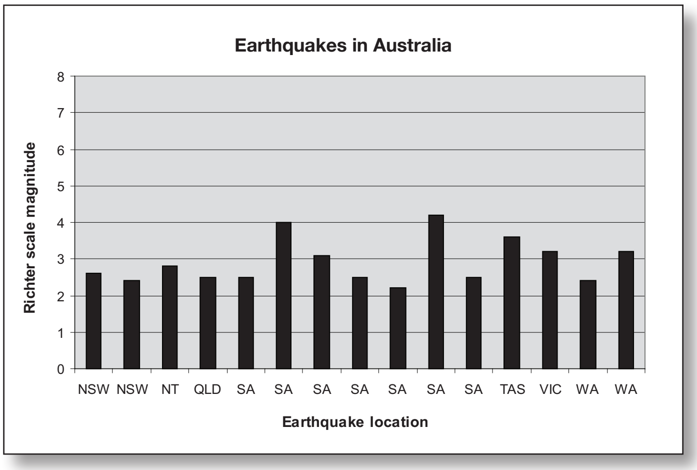
Column graph

Where data for one of the variables are in **categories** (that is, we use **words** to describe it, for example, earthquake location) a **column graph** is used. In *Earthquake explorers*, students analyse and compare secondary data. Students use their understanding of earthquakes to explain the patterns in the data. Graph A below shows the magnitude of earthquakes in Australian states and territories **(data in categories)** and is presented as a **column graph**.

Table A: Earthquake magnitude recorded in Australian states and territories from October 2008 to November 2008.

Earthquake magnitude (Richter scale)	Australia
2.6	Australia (NSW)
2.4	Australia (NSW)
2.8	Australia (NT)
2.5	Australia (QLD)
2.5	Australia (SA)
4.0	Australia (SA)
3.1	Australia (SA)
2.5	Australia (SA)
2.2	Australia (SA)

Graph A: Earthquake magnitude recorded in Australian states and territories from October 2008 to November 2008.



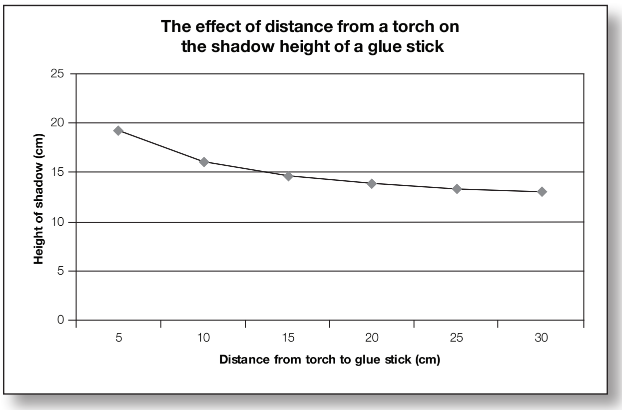
Line graph

Where the data for both variables are **continuous** (that is, we use **numbers** that can be recorded on a measurement scale, such as length in centimetres or mass in grams), a **line graph** is usually constructed. Graph B below shows how the results from an investigation of the effect of distance from a light source **(continuous data)** on the shadow height of an object **(continuous data)** have been constructed as a **line graph.**

Table B: The effect of distance from a torch on the shadow height of a glue stick

Distance from torch to glue stick (cm)	Height of shadow (cm)
5	19.3
10	16.1
15	14.7
20	13.9
25	13.3
30	13

Graph B: The effect of distance from a torch on the shadow height of a glue stick



Which variable goes on each axis?

It is conventional in science to plot the variable that has been changed on the horizontal axis (X axis) and the variable that has been measured/observed on the vertical axis (Y axis) of the graph.

Graph titles and labels

Graphs have a title and each variable is labelled on the graph axes, including the units of measurement. The title of the graph is usually in the form of 'The effect of one variable on the other variable'. For example, 'The effect of distance from a torch on the shadow height of a glue stick' (Graph B).

Steps in analysing and interpreting data

Step 1 – Organise the data (for example, construct a graph) so you can see the pattern in data or the relationship between data for the variables (things that we change, measure/observe, or keep the same).

Step 2 – Identify and describe the pattern or relationship in the data.

Step 3 – Explain the pattern or relationship using science concepts.

Questioning for analysis

Teachers use effective questioning to assist students to develop skills in interrogating and analysing data represented in graphs. For example:

- What is the story of your graph?
- Do data in your graph reveal any patterns?
- Is this what you expected? Why?
- Can you explain the pattern? Why did this happen?
- What do you think the pattern would be if you continued the line of the graph?
- How certain are you of your results?

Analysis

Analysis of Graph B shows that the further the distance from the torch the shorter the height of the glue stick's shadow. This is because as light travels in straight lines, the closer the object is to a light source the more light it blocks out and, therefore, the bigger the shadow.

Appendix 7
Night and day **equipment list**

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	3	4	5	5	5	6
		SESSION					1	2	3	
Equipment and materials										
basketball	1 per team			●						
chalk	1 per class				●					
chalk *optional*	1 per team				●					
images of night and day scenes	1 set per class		●							
labels with ‘Sun’, ‘Earth’ and ‘Moon’	1 set per class					●				
light source (eg, lamp, torch, data projector or overhead projector)	1 per class					●				
magnetic compass	1 per class				●					
magnetic compass *optional*	1 per team				●					
objects to represent the Sun, Earth and Moon (eg, basketball, marble, peppercorn)	1 per class			●						
paper, A3	1 per student									●
paper, large sheet for recording shadows	1 per team							●		
pictures, posters, video or internet images of the Sun, Earth and Moon	1 set per class			●						
props to represent the Earth and Sun (eg, different-sized balls or spheres, plasticine, torches)	1 set per team					●				
selection of ‘shadow sticks’ (eg, rulers, sticks)	1 per class						●			
self-adhesive notes	1 set per class						●			
shadow stick (eg, a stick weighted with a ball of clay or plasticine)	1 per team							●		
T-chart from Lesson 1	1 per class				●					
tennis ball	1 per team			●						
world globe or ball (eg, netball or basketball)	1 per class					●				

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	3	4	5	5	5	6
		SESSION					1	2	3	
Resource sheets										
‘Where’s the Sun?’ (RS1)	1 per student		•							•
‘Where’s the Sun?’ (RS1), enlarged	1 per class		•							
‘The spinning Earth’ (RS2)	1 per student					•				
‘The spinning Earth’ (RS2), enlarged	1 per class					•				
‘Shadow stick investigation planner’ (RS3)	1 per student						•	•	•	
‘Shadow stick investigation planner’ (RS3), enlarged	1 per class						•			
Teaching tools										
class science journal	1 per class		•	•	•	•	•	•	•	•
role wristbands or badges for Director, Manager and Speaker	1 set per team			•	•	•	•	•	•	
student science journal	1 per student		•	•	•	•	•	•	•	•
team roles chart	1 per class			•	•	•	•	•	•	
team skills chart	1 per class			•	•	•	•	•	•	
word wall	1 per class		•	•	•	•	•	•	•	•
Multimedia										
digital camera *optional*	1 per class				•					
digital camera *optional*	1 per team							•		

Appendix 8
Night and day unit overview

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to represent their current understanding as they:	Students will be able to:	Students:	
ENGAGE	**Lesson 1** Night and day thoughts	• describe the difference between night and day • describe the cause of night • describe the movements of the Sun, Earth and Moon to cause night and day.	• contribute to discussions about night and day • create an annotated drawing to show the movements of the Sun, Earth and Moon to cause night and day • contribute to the beginning of a word wall.	• brainstorm ideas about night and day • choose reasons for why it is dark at night • draw the Sun, Earth and Moon showing how night and day happens.	**Diagnostic assessment** • Where's the Sun? (Resource sheet 1) • T-chart • Annotated drawings • Science journal entries • Class discussions • Word wall contributions
EXPLORE	**Lesson 2** Shapes and sizes	• describe the spherical shapes of the Sun, Earth and Moon • compare the relative sizes of the Sun, Earth and Moon • explain why the Sun looks the same size as the Moon when viewed from Earth.	• contribute to discussions on the shapes and sizes of the Sun, Earth and Moon • use 3-D models to develop understanding of the shapes and sizes of the Sun, Earth and Moon • demonstrate their understanding of scale in relation to representing the sizes of the Sun, Earth and Moon.	• view images of the Sun, Earth and Moon • investigate the relative sizes of the Sun, Earth and Moon • use spherical objects to explore why the Sun and Moon appear to be the same size when viewed from Earth.	**Formative assessment** • Annotated drawings • Science journal entries • Class discussions • Word wall contributions

* These lesson outcomes are aligned to relevant descriptions of the Australian Curriculum. See page 2 for Science and page 7 for English and Mathematics.

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students will be able to:	
EXPLORE	**Lesson 3** Shadows at play	• describe changes in size and direction of shadows during a day • describe how shadows are made • observe light and shaded sides of objects in sunlight.	• discuss observations of light and shadows • draw a labelled diagram of own shadow • record ideas about light and shadows.	• play shadow tag • observe and discuss changes in shadows around the school.	**Formative assessment** • Science journal entries • Labelled diagrams • Class discussions • Word wall contributions
EXPLAIN	**Lesson 4** In a spin	• demonstrate through role-play that the spinning of the Earth on its axis causes night and day • demonstrate through role-play that the Earth orbits the Sun and the Moon orbits the Earth.	• use oral language and role-play to represent their understanding of the rotation of the Earth • complete a labelled diagram to represent how night and day are caused by Earth's rotation.	• use models to explain their ideas of how the Earth and Sun cause night and day • participate in role-plays to explain how the spinning of the Earth on its axis as it orbits the Sun causes night and day • represent their new understanding of night and day in a labelled diagram.	**Formative assessment** • Role-plays • Labelled diagrams • Science journal entries • Class discussions • Word wall contributions • 'The spinning Earth' (Resource sheet 2)

* These lesson outcomes are aligned to relevant descriptions of the Australian Curriculum. See page 2 for Science and page 7 for English and Mathematics.

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students will be able to:	
ELABORATE	**Lesson 5** Investigating shadows ***Session 1*** Planning it out ***Session 2*** One o'clock, two o'clock ... ***Session 3*** Shadows rock!	• plan and conduct an investigation of the effect of time of day on length and direction of shadows • record observations and measurements • construct a graph to represent their results.	• discuss and compare ideas about how shadows change during a day • use a table and a column graph to represent findings • describe the features of fair testing • summarise results of an investigation.	***Session 1*** Planning it out • plan an investigation • select variables to be changed, measured or kept the same. ***Session 2*** One o'clock, two o'clock ... • conduct an investigation • observe and record results. ***Session 3*** Shadows rock! • create a table with measurements of shadows • create a column graph to represent and compare measurements • discuss and summarise results of investigation.	**Summative assessment** of Science Inquiry Skills • 'Shadow stick investigation planner' (Resource sheet 3) • Science journal entries • Class discussions • Word wall contributions
EVALUATE	**Lesson 6** Night and day notions	• describe the shapes and relative sizes of the Sun, Earth and Moon • explain how night and day are caused by the Earth rotating on its axis.	• use written, oral and visual language to describe their understanding of the Sun, Earth and Moon moving in space • construct an annotated drawing to represent and communicate their ideas and what they learned about the Sun, Earth and Moon, and night and day • reflect on their learning through a science journal entry.	• review and discuss the unit • rethink ideas on night and day from Lesson 1 • create an annotated drawing to represent their knowledge and understanding of the Sun, Earth and Moon, and night and day • reflect on their learning during the unit.	**Summative assessment** of Science Understanding • 'Where's the Sun?' (Resource sheet 1) • Annotated drawings • Science journal entries • Class discussions • Word wall contributions

* These lesson outcomes are aligned to relevant descriptions of the Australian Curriculum. See page 2 for Science and page 7 for English and Mathematics.

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Year	Biological sciences	Chemical sciences	Earth and space sciences	Physical sciences
F	*Staying alive*	*What's it made of?*	*Weather in my world*	*On the move*
1	*Schoolyard safari*	*Spot the difference*	*Up, down and all around*	*Look! Listen!*
2	*Watch it grow!*	*All mixed up*	*Water works*	*Push pull*
3	*Feathers, fur or leaves?*	*Melting moments*	*Night and day*	*Heating up*
4	*Plants in action*	*Material world*	*Beneath our feet*	*Smooth moves*
	Friends and foes	*Package it better*		
5	*Desert survivors*	*What's the matter?*	*Earth's place in space*	*Light shows*
6	*Marvellous micro-organisms*	*Change detectives*	*Earthquake explorers*	*It's electrifying*
				Essential energy

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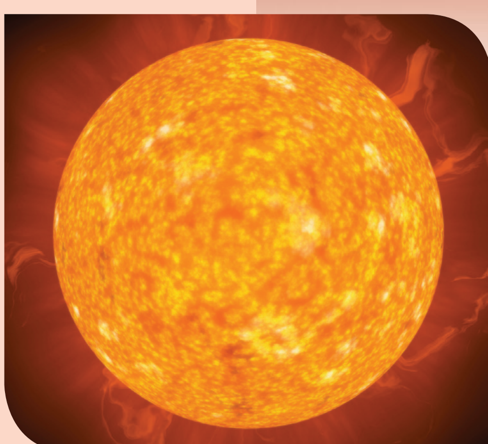

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