PrimaryConnections®
Linking science with literacy

Fully aligned with the Australian Curriculum

Melting moments

Year 3

Chemical sciences

A partnership between the Australian Academy of Science (the Academy) and the Australian Government Department of Education, Employment and Workplace Relations (DEEWR), Primary**Connections:** linking science with literacy is an innovative program linking the teaching of science with the teaching of literacy in primary schools. The program includes a professional learning component and curriculum units aligned to the Australian Curriculum, which span all years of primary school. Each unit may be used individually or as part of the full suite of Primary**Connections** materials.

Research shows that the professional-learning component of our program significantly enhances the implementation of the curriculum units. Our 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 cooperative learning.

Please visit our website www.science.org.au/primaryconnections for more information and additional curriculum resources.

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Melting moments

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Every day we see or use things that have been melted or frozen, heated or cooled. All around us are items that we find both useful and attractive that have been moulded into different shapes using heating and cooling. These can range from cast iron frying pans and plastic rubbish bins to chocolate bilbies. Understanding the properties of materials and how they change state under different conditions can help materials scientists to develop even more extraordinary products to help improve our quality of life.

The *Melting moments* unit is an ideal way to link science with literacy in the classroom. While exploring how solids or liquids are influenced by temperature, students experience the way items from their everyday lives can change. Through hands-on investigations, students investigate how the size of the pieces affects the melting time of chocolate.

Australian Government

Australian Academy of Science

Published by the Australian Academy of Science.

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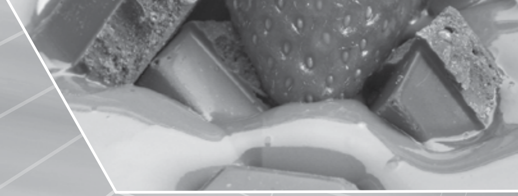
Font: Helvetica Neue, DIN
Cover images: www.istockphoto.com. Stock.xchng. www.sxc.hu.

ISBN 978 0 85847 299 0

Acknowledgments

Primary**Connections** is supported by the Australian Government.

Thanks to the trial teachers and students of the trial schools Australia-wide and Fellows of the Australian Academy of Science who contributed to this unit.



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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 doable 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 CD that accompanies the units.

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, comprised of 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 over the last seven years. Before publication, the science teacher background information on science is reviewed by a Fellow of the Academy of Science. 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
Australian Academy of Science
2010 – 2013

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.science.org.au/primaryconnections

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).

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 (Bybee, 1997), with the five phases: *Engage, Explore, Explain, Elaborate* and *Evaluate.* The relationship between the 5Es phases, investigations, literacy products and assessment are 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.science.org.au/primaryconnections/teaching-and-learning/

Assessment

Assessment against the year level Achievement standards of the Australian Curriculum: Science (ACARA, 2010) is ongoing and embedded in Primary**Connections** units. Assessment is linked to the development of literacy practices and products. Relevant understandings and skills for each lesson 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 of the Science Inquiry Skills and of the Science Understanding in the *Evaluate* phase.

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.

Alignment with the Australian Curriculum: Science

The Australian Curriculum: Science (2010) 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.'

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 affects peoples' 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.

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

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 (SAFETY) 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). (2010). *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

Melting moments

Phase	Lesson	At a glance
ENGAGE	**Lesson 1** Sunken shapes	To capture students' interest and find out what they think they know about the way a change of state between solid and liquid can be caused by adding or removing heat. To elicit students' questions about how to change the shape of objects by adding or removing heat.
EXPLORE	**Lesson 2** Heat it up	To provide hands-on, shared experiences of heating different materials.
	Lesson 3 Cool customers	To provide hands-on, shared experiences of cooling different materials.
	Lesson 4 Freeze it!	To provide hands-on, shared experiences of freezing different materials.
EXPLAIN	**Lesson 5** Sometimes solid	To support students to represent and explain their understanding of the way different materials change from solid to liquid at different temperatures, and to introduce current scientific views.
ELABORATE	**Lesson 6** Break it up	To support students to plan and conduct an investigation of the way shape affects the melting rate of chocolate.
EVALUATE	**Lesson 7** Ready to set	To provide opportunities for students to represent what they know about the way a change of state between solid and liquid can be caused by adding or removing heat, and to reflect on their learning during the unit.

A unit overview can be found in Appendix 9, page 72.

Alignment with the Australian Curriculum: Science

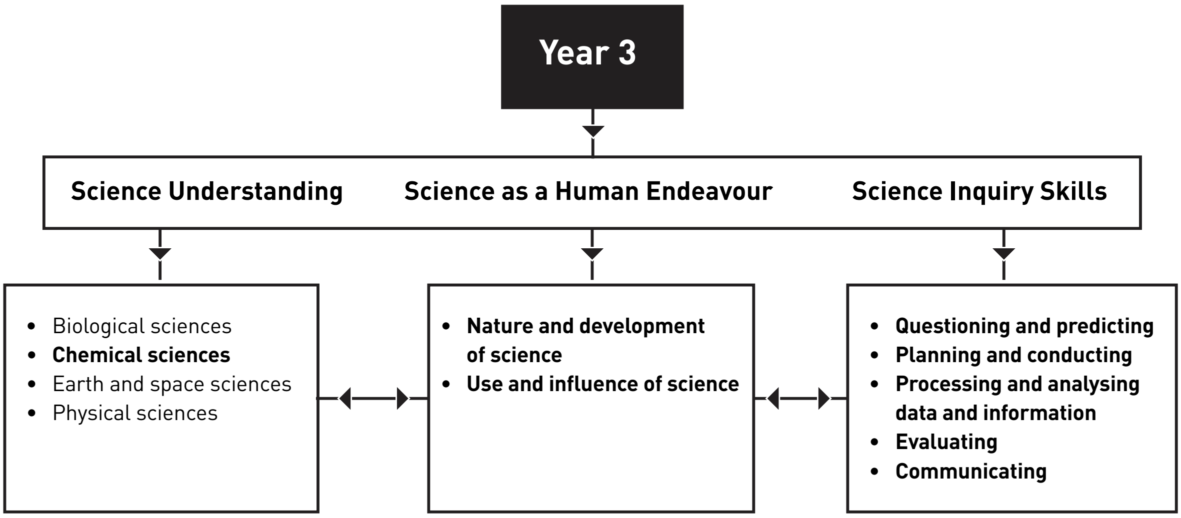
Melting moments embeds the three strands of the Australian Curriculum: Science. The particular sub-strands and their content for Year 3 that are relevant to this unit are shown below.

Strand	Sub-strand	Code	Year 3 content descriptions	Lessons
Science Understanding (SU)	**Chemical sciences**	ACSSU046	A change of state between solid and liquid can be caused by adding or removing heat	1–7
Science as a Human Endeavour (SHE)	**Nature and development of science**	ACSHE050	Science involves making predictions and describing patterns and relationships	2, 3, 4, 5
	Use and influence of science	ACSHE051	Science knowledge helps people to understand the effect of their actions	7
Science Inquiry Skills (SIS)	**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	1, 2, 3, 4, 6
	Planning and conducting	ACSIS054	Suggest ways to plan and conduct investigations to find answers to questions	2, 6
		ACSIS055	Safely use appropriate materials, tools or equipment to make and record observations, using formal measurements and digital technologies as appropriate	2, 3, 4, 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, 6, 7
		ACSIS215	Compare results with predictions, suggesting possible reasons for findings	2, 3, 4, 6
	Evaluating	ACSIS058	Reflect on the investigation, including whether a test was fair or not	6
	Communicating	ACSIS060	Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports	2, 3, 4, 5, 7

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.



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 *Melting moments*, these overarching ideas are represented by:

Overarching idea	Incorporation in *Melting moments*
Patterns, order and organisation	Students describe solids and liquids by identifying similarities and differences in a range of materials. They identify patterns in the rates of melting and freezing of substances.
Form and function	Students observe that liquids and solids have different properties which determine their use. They explore the way a solid can be changed to a liquid and then be moulded by cooling to have different uses.
Stability and change	Students explore the way materials can change from solid to liquid or vice-versa depending on the temperature. They observe that the freezing point of a substance under the same conditions is always the same.
Scale and measurement	Students are introduced to a simple measurement scale of melting points. They explore how the rate of change of state can be influenced by the size of the surface area.
Matter and energy	Students investigate the effect of adding or removing heat on the change of state of materials.
Systems	Students discuss simple systems of materials changing state with a change of external temperature.

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 *Melting moments*
Recognising questions that can be investigated scientifically and investigating them	Students generate inquiry questions about changing solids to liquids and visa-versa by adding or removing heat. They discuss and formulate plans of action to answer these questions, including completing scientific investigations, and generating new claims to answer their questions.

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 the unit, teachers will be able to make evidence-based judgements on whether the students are achieving below, at or above the Australian Curriculum: Science Year 3 achievement standard. Rubrics to help teachers make these judgements are available on the website:
www.science.org.au/primaryconnections/curriculum-resources

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 units. For unit specific information see the next page. For further information see:
www.australiancurriculum.edu.au/Generalcapabilities

'Melting moments' - Australian Curriculum General capabilities

General capabilities	Australian Curriculum description	*Melting moments* 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 *Melting moments* the literacy focuses are • science journals • word walls • line drawings • storyboards • role-plays • tables • procedural texts • 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 • collect, interpret and represent data through tables and 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 Resource technology to view, record and analyse information • use ICT to create multimedia presentations.
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 • use reasoning to develop questions for inquiry • formulate, pose and respond to questions • develop evidence-based claims.
Ethical behaviour	Students develop ethical behaviour as they explore ethical principles and guidelines in gathering evidence and consider the ethical implications of their investigations on others and the environment.	Students • ask questions 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 • follow a procedural text for working safely • 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.

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.

Two of these are embedded within this unit as described below. For further information see: www.australiancurriculum.edu.au/CrossCurriculumPriorities

Aboriginal and Torres Strait Islander histories and cultures

Primary**Connections** has developed an Indigenous perspective framework which has informed practical reflections on intercultural understanding. It can be accessed at: www.science.org.au/primaryconnections/indigenous

Melting moments focuses on the Western science way of making evidence-based claims about the way materials might change state by adding or removing heat.

Indigenous cultures might have different explanations for the observed phenomenon of materials changing from liquids to solids or vice versa.

Primary**Connections** recommends working with Indigenous community members to access contextualised, relevant Indigenous perspectives. Protocols on seeking out and engaging Indigenous community members are discussed in state and territory Indigenous education policy documents and can be found on the Primary**Connections** website.

Sustainability

The *Melting moments* unit provides opportunities for students to understand that some common materials are heated at high temperatures to become liquids that are more easily moulded. This has direct applications in understanding the ways materials such as plastic are recycled and the amount of energy necessary to change their shape.

Alignment with the Australian Curriculum: English and Maths

Strand	Sub-strand	Code	Year 3 content descriptions	Lessons
English - Language	**Language variation and change**	ACELA1475	Understand that languages have different written and visual communication systems, different oral traditions and different ways of constructing meaning.	1, 2, 5
	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.	2, 3, 4, 6
	Text structure and organisation	ACELA1478	Understand how different types of texts vary in use of language choices, depending on their function and purpose, for example, tense, mood, and types of sentences.	1, 2, 3, 6
	Expressing and developing ideas	ACELA1484	Learn extended and technical vocabulary and ways of expressing opinion including modal verbs and adverbs.	7
English - Literature	**Responding to literature**	ACELT1596	Draw connections between personal experiences and the worlds of texts, and share responses with others.	5, 7
	Creating literature	ACELT1791	Create texts that adapt language features and patterns encountered in literacy texts, for example, characterisation, rhyme, rhythm, mood, music, sound effects and dialogue.	5
English - Literacy	**Interaction with others**	ACELY1676	Listen to and contribute to conversations and discussions to share information and ideas and negotiate in collaborative situations.	1, 5, 7
		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.	1–7
	Interpreting, analysing, evaluating	ACELY1679	Read an increasing range of different types of texts by combining contextual, semantic, grammatical and phonic knowledge, using text processing strategies, for example, monitoring, predicting, confirming, rereading, reading on and self-correcting.	6
Mathematics - Measurement and Geometry	**Using units of measurement**	ACMMG061	Measure, order and compare objects using familiar metric units of length, mass and capacity.	6
Mathematics - Statistics and Probability	**Data representation and interpretation**	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.	3, 4 ,6
		ACMSP070	Interpret and compare data displays.	6

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.science.org.au/primaryconnections/curriculum-resources/

Introduction to changing state

Teacher background information

Matter

All matter is made up of very small particles called atoms. These atoms can join with other atoms to form molecules. Every type of material contains specific types of atoms or molecules resulting in different materials having different properties. For example, gold is made up of gold atoms only. Water is made up of water molecules, a combination of hydrogen and oxygen atoms. The way the atoms or molecules are arranged in a material will affect its state of matter.

States of matter

A material might be found in different states. The most familiar states are solid, liquid or gas. Other states of matter are now recognised, for example, plasma and liquid crystal but these will not be dealt with in this unit.

The amount of energy the atoms or molecules of a material possesses determines its state of matter, for example, the molecules in solid chocolate have less energy than those in melted chocolate.

- Solids have atoms or molecules that are held together with rigid bonds. The atoms vibrate in place but they do not change position. This means that a solid holds its shape and does not flow, nor can it be significantly compressed.
- Liquids have atoms or molecules that are held together with weaker bonds. They stay close together and so occupy a constant volume of space. Thus a liquid can only be compressed a little bit, if at all. However the bonds are loose enough to let atoms or molecules slide past each other. Due to the force of gravity a liquid flows and takes the shape of the container into which it is poured.

Gases are not considered in this unit. They are not included in the ACARA Year 3 Science Understanding description. For students of this age the properties of gases are considered conceptually difficult to understand.

Changing states

Materials exist as particular states of matter at particular temperature and pressure conditions. These are specific to the material. For example, at room temperature and normal air pressure water exists as a liquid and iron exists as a solid. Increasing the temperature eventually changes solids to liquids (the iron will melt) and liquids to gases (the water will become a gas). The temperature at which a liquid changes to a gas is called the boiling point; the temperature at which a liquid changes to a solid is called the freezing point.

Differences in pressure change the boiling and freezing points of materials. The boiling point of water at atmospheric pressure of 1 bar (sea level) is 100°C. However at lower pressures, for example, on a mountain top, the boiling point of water decreases (1°C for every 285m in elevation). Early explorers used to judge their altitude by measuring the boiling point of water. Water boils at 69°C on the top of Mt Everest.

Viscosity is a measure of the ability of a liquid to flow. Some liquids (more viscous) such as oil or honey do not flow as easily as other liquids (less viscous) such as water or alcohol.

Students' conceptions

Taking account of students' existing ideas is important in planning effective teaching approaches that help students develop understandings in 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 are strongly influenced by everyday language, and can use the term 'solid' to denote something as hard or large. They tend to use it as an adjective rather than to describe a set of substances. They might have difficulty understanding that the same material can be solid or liquid depending on the temperature.

Some students identify all liquids with water, and the most common liquids identified by students are water-based, including dishwashing liquid, milk, seawater, cordial and lemonade. More viscous liquids such as oil, paraffin and honey are less commonly identified as liquid. Students might also assume that all liquids contain water and that melting involves a substance turning to water.

References

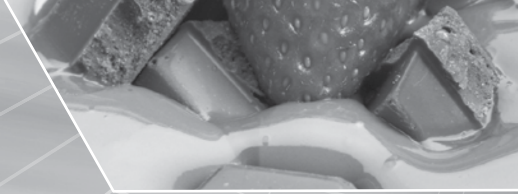
Cakicki, Y., & Yavuz, G. (2010). The effect of constructive science teaching on 4th grade students' understanding of matter. *Asia-Pacific Forum on Science Learning and Teaching*, 11(2). Retrieved from www.ied.edu.hk/apfslt/download/v11_issue2_files/cakici.pdf

Hapkiewicz, A. (1992). *Finding a list of Science Misconceptions*. MSTA Newsletter, 38 (Winter '92), 11-14.

Krnel, D., Watson, R., & Glazar, S. (1998). Survey of research related to the development of the concept of matter. *International Journal of Science Education*, 257-289.

Skamp, K. (Ed.). (2012). *Teaching Primary Science Constructively* (4th Ed.). South Melbourne: Cengage Learning Australia.

Use the accompanying Science Background CD to access more in-depth science information in the form of text, diagrams and animations. Note that this background information is intended for the teacher only.



Lesson 1 Sunken shapes

ENGAGE

AT A GLANCE

To capture students' interest and find out what they think they know about the way a change of state between solid and liquid can be caused by adding or removing heat.

To elicit students' questions about the way to change the shape of objects by adding or removing heat.

Students

- observe objects that have changed shape due to melting and re-freezing
- brainstorm ideas about what happens when materials are warmed or cooled.

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 materials change state when heated or cooled.

Key lesson outcomes

Students will be able to represent their current understanding as they:
• contribute to discussions about objects and materials and what happens when things are warmed or cooled
• identify the purpose and features of a science journal
• use scientific vocabulary appropriately
• brainstorm the reasons everyday objects might have changed shape
• identify possible questions for investigation.

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

Teacher background information

Context

In this lesson the class is going to examine an object that has changed shape because of the process of heating and then cooling. Establish a context for the unit that is relevant to students, for example, chocolate melted in the sun, items melted in a fire, ice cream melted in a hot car.

Objects and materials

ENGAGE

In this unit, the term 'material' refers to the what objects are made of, for example, a window (object) is made from glass (material); a soft drink bottle (object) is made from plastic (material); a kitchen sink (object) is made from stainless steel (material).The properties of an object depend on the materials from which it is made. For example, a statue made of ice water will be solid at temperatures below 0°C but will melt at higher temperatures due to a property of water, its melting point 0°C. Some properties of the object, however, do not depend on the materials it is made of, for example, the shape and size of a statue.

Students' conceptions

Students might know a range of meanings for the word 'material', for example, fabric or written information, and for the term 'property', such as, land, real estate or possessions. For this unit, the term 'material' refers what an object is made of, and 'properties' are qualities or attributes.

Many students might be unaware that the properties of a material determine how useful it is for particular purposes. For example, they might just accept that aluminium is used to make saucepans without considering the properties which makes it suitable for that use, including the ability to stay solid at high temperatures and to distribute heat effectively.

Equipment

FOR THE CLASS

- class science journal
- word wall
- 2 identical solid objects that melt (see 'Preparation')
- enlarged copy of 'Information note for families' (Resource sheet 1)
- enlarged copy of 'Run, run, runny' (Resource sheet 2)
- *Optional:* additional pairs of objects that melt

FOR EACH STUDENT

- science journal
- 'Run, run, runny' folder or journal (eg, manila folder, book)
- 'Information note for families' (Resource sheet 1)
- 'Run, run, runny' (Resource sheet 2)

Preparation

- Read 'How to use a science journal' (Appendix 2).
- Read 'How to use a word wall' (Appendix 3) and prepare a word wall for the class.
- Establish a context for the unit (see 'Teacher background information').
- Find two identical objects, for example, two candles or two hollow chocolate shapes:
  - Keep one object unchanged
  - Heat the other object so that it melts and changes shape, for example, in an oven at low heat. Cool it down so that it is solid again before presenting to the class.

  Optional: provide several pairs of melted and un-melted objects for the class.
- Decide when students will be presenting the information that they collect (see Lesson step 9) and write this information on the 'Information note for families' (Resource sheet 1)
- Make a 'Changes at home' folder or journal for each student, including 'Information note for families' (Resource sheet 1) and 'Run, run, runny' (Resource sheet 2).
- Enlarge a copy of 'Information note for parents' (Resource sheet 1) and 'Run, run, runny' (Resource sheet 2).
- *Optional:* Display the science journal, word wall, 'Information note for parents' (Resource sheet 1) and pictures of melted and un-melted objects on an interactive whiteboard or on a computer connected to a projector. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

1 Introduce the melted object(s) (see 'Preparation') and the context (see 'Teacher background information'). Ask questions such as:
- What do you think this is?
- Do you think this always looked like this?
- Why do you think it looks like this now?

2 Introduced the un-melted object(s) and ask students to compare with the melted object(s).

Optional: If you have melted several different objects, ask students to identify which melted object corresponds with which un-melted objects.

3 Ask questions such as:
- In what ways are they similar?
- In what ways are they different?

Record students' answers in the class science journal.

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

4 Introduce the class science journal and discuss its purpose and features.

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** might include dates and times, written text, drawings, measurements, labelled diagrams, photographs, tables and graphs.

Record a summary of students' responses in the class science journal.

5 Write the terms 'melt' and 'freeze' on cards for the class word wall and ask students to describe what they think the terms might mean. Ask questions such as:

- What things have you seen melting/freezing?
- Why do things melt/freeze?
- What is happening when things melt/freeze?
- When do you/don't you want things to melt/freeze?
- Do you have any questions about melting and freezing?

Record students' answers in the class science journal. Explain that these are the ideas they have now and throughout the unit they will be working like scientists to investigate these ideas/claims and develop new claims.

Optional: Ask students to record their ideas in their science journal

Note: If there is an interesting and relevant question that leads to a suitable investigation, consider adding an *Explore* lesson to investigate it.

6 Introduce the word wall and discuss its purpose and features.

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 the way they are spelt.

What does a word wall include?

A **word wall** might include a topic title or picture and words which we have seen or heard about the topic.

7 Ask students to suggest words from today's lesson that would be useful to place on the word wall.

Invite students to contribute words from different languages to the word wall, including local Indigenous names of materials if possible, and discuss.

8 Introduce the enlarged copy of 'Information note for families' (Resource sheet 1). Read through and discuss with students.

9 Introduce the enlarged copy of 'Run, run, runny' (Resource sheet 2). Explain that students can write and draw their answers and model how to complete an entry.

10 Explain that students will give presentations of what they discover either as the unit progresses or at the end of the unit.

Australian curriculum links

English

- While working on the word wall, discuss different communication systems of different languages.

Information note for families

Introducing the 'Run, run, runny' project

This term our class is studying how a change of state between solid and liquid can be caused by adding or removing heat.

As part of the science unit *Melting moments*, we would like students to think about when melting is commonly seen in the home.

Tasks to do

Each student will have a 'Run, run, runny' folder or journal to record information, including a sheet for drawing and writing about when melting was observed in the home. Students are asked to record what melted and the reasons why it melted, for example,

What melted?	Why did it melt?
butter	The pan was hot when we cooked the eggs.
ice blocks	My toast was warm when I put the butter on it.
ice blocks	My drink was warm.
candle	It melted when we lit it. The flame was hot.

Students are encouraged to take photographs if possible.

Students will be asked to share their observations with their classmates on ___________.

Class teacher ___________________________

Run, run, runny

Name: ______________________ **Date:** ______________________

What melted?	Why did it melt?

Lesson 2 Heat it up

EXPLORE

AT A GLANCE

To provide hands-on, shared experiences of heating different materials.

Students

- predict what will happen when different materials are heated
- work in teams to observe what happens when different materials are heated
- record their observations using line drawings and descriptive words.

Lesson focus

The *Explore* phase provides students with hands-on experiences of the topic's science phenomenon while building their science inquiry skills. 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. In this lesson you will monitor students' developing understanding of:

- the way materials change state when heated.

Key lesson outcomes

Students will be able to:
• predict what will happen when different materials are heated and compare results with predictions
• work in teams to safely use appropriate equipment to investigate what happens when different materials are warmed
• record findings using a line drawing
• discuss and compare results to form common understandings using appropriate vocabulary including 'solid' and 'liquid'
• identify solid materials that melt when warmed.

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

Teacher background information

Solids and liquids

Scientists classify materials as solids, liquids and gases at given temperature and pressure conditions. Water is a liquid while iron is a solid at room temperature and pressure. (Other states of matter are now recognised, for example, plasma and liquid crystal but these will not be dealt with in this unit).

Solids have a fixed shape and volume. For example, an ice cube has a certain shape and takes up a certain space. The atoms or molecules of solids are all tightly packed together; however, the atoms or molecules vibrate about a fixed point.

Liquids have a fixed volume but their shape depends on their container. One litre of water takes up the same amount of space in any container, but will take the shape of its container (for example, the shape of a bottle, glass or bowl). The atoms or molecules of liquids are packed together but can slide over each other enabling liquids to change their shape.

Gases will not be considered in this unit.

Changing state

Materials change state when they gain or lose heat energy. This is a physical change because there is no chemical reaction or chemical change occurring. For example, ice is still water but in a frozen state. When most solids gain enough heat energy they normally melt and become liquid. When liquids lose enough heat energy they 'freeze' and become solid. When a material changes state, the atoms or molecules do not change. It is the way the atoms or molecules are spaced and held together that changes. Physical changes of state are easily reversible when the materials are 'pure' (only containing one type of atom or molecule).

When a non-pure solid (a physical mixture of substances) melts and becomes liquid, sometimes the components can separate. Therefore when the liquids are put back into the freezer, the original solid might not be re-created. For example, melted and refrozen ice cream becomes two separate solids: ice and frozen cream.

Some solids undergo chemical reactions when heated where the atoms or molecules react and produce new substances. These reactions are called chemical changes and are not examples of changes of state. For example, wood, does not melt when heated but burns (combines with oxygen) instead. Some complex liquids, such as egg white, cook and become solid when they are heated. The nature of the egg white is chemically changed where proteins are broken up, recombine and form new proteins. Cooked egg white cannot return to its original state.

Students' samples

Material/object	**State after warming enough to melt chocolate buttons** (see 'Preparation')
Water-based liquids such as water, cordial or milk	Still liquid
Viscous liquids such as honey or oil	Still liquid, may have become less viscous (easier to stir)
Alcohol-based liquid such as rubbing alcohol	Still liquid
Solids that easily melt such as chocolate buttons	Changed state to liquid and has therefore lost its shape
Solids that don't easily melt such as plastic or metal spoons	Still solid unless the heat source was very warm and the plastic has a low melting point

Students' conceptions

The word 'solid' is used differently in everyday language to the way it is used in science. This might cause some confusion for students. For example, in everyday language 'solid' is often used to mean the opposite of 'hollow', however, hollow objects such as tennis balls are classified as solids by scientists. Similarly, some students might believe that solids must be rigid and hard whereas scientists classify softer materials such as paper and sponges as solids. This is because 'solid' describes properties at the molecular level.

Some students refer to the size or shape of an object when deciding if something is a solid or a liquid. Size and shape might describe an object but do not depend on the material from which it is made. A wooden table can be large and round or small and rectangular; a ball can be the same shape and size irrespective of whether it is made from lead or leather.

Students often find granular substances such as sand and sugar difficult to classify particularly since they rarely examine individual grains. Powders are made from solid materials, however the objects themselves (the grains of powder) are very small. Each grain of powder keeps its shape, however as a group they behave rather like liquids because they can pour and fill containers.

Students might think that all liquids are water or contain water. Many common liquids such as cordials and milk are suspensions of molecules in water and behave in a similar way to water. However the term 'liquid' applies to all materials that flow while keeping a specific volume, therefore oil, paraffin and honey are classified by scientists as liquids.

Some students might associate melting with 'turning to water'. When an ice cube melts it is not turning into water, it is solid water changing into liquid water. The water is changing state. Any molten substance has the same chemical composition as its solid substance, just in a different state of matter.

Equipment

FOR THE CLASS

- class science journal
- word wall
- team roles chart
- team skills chart
- enlarged copy of 'Before and after' (Resource sheet 3)
- water-based liquid for some teams to heat (see 'Preparation')
- viscous liquid for some teams to heat (see 'Preparation')
- heat-resistant solids for some teams to heat (see 'Preparation')
- hat or bowl
- timing device eg a watch or stopwatch
- access to a refrigerator
- paper for list (see 'Preparation')
- *Optional:* heat sources (see 'Preparation')

FOR EACH TEAM

- role wristbands or badges for Director, Manager, Speaker
- each team member's science journal
- 1 copy of 'Before and after' (Resource sheet 3)
- 2 large chocolate buttons, eg 5cm wide
- 3 plastic resealable bags with areas to record information on, eg 20cm wide
- marker to label bags

EXPLORE

Preparation

- Read 'How to organise collaborative learning teams' (Appendix 1). Display an enlarged copy of the team skills chart and the team roles chart in the classroom. Prepare team role wristbands or badges.
- Read 'How to facilitate evidence-based discussions' (Appendix 4).
- Ensure students have choices of warm places to put their samples, for example, in direct sunlight, near a heater or in an oven at low heat (<60°C). Do not put samples in a microwave as microwaves heat some types of molecules faster than others which can bias results.
- Do not provide students with access to naked flames.

SAFETY

- Time how long it takes for chocolate buttons to melt in the warm places.
- Collect materials for teams to place in their resealable bags, including:
  - chocolate buttons
  - a water-based liquid, for example, water, cordial or milk
  - a viscous liquid, for example, honey or oil
  - a solid that does not melt at temperatures under 50°C, for example, a plastic or metal spoon

Ensure materials are provided in easy to pour containers and are labelled so students can identify them.

SAFETY

- Check for student allergies or intolerance to the liquids and solids collected. Remind students not to eat or drink any of the samples.
- Create a list of materials for teams to collect in their bags. Include chocolate buttons in one bag for each team. For example,
  - chocolate buttons, cordial, oil
  - chocolate buttons, plastic spoon, water
  - chocolate buttons, oil, metal spoon
  - chocolate buttons, metal spoon, cordial

  Write one list for each team on a small piece of paper and place in a hat. Ensure that each type of material is represented in the lists for teams. Place the completed lists in the hat for teams to draw out.
- Enlarge a copy of 'Before and after' (Resource sheet 3).
- *Optional:* Display 'Before and after' (Resource sheet 3) on an interactive whiteboard or on a computer connected to a projector. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

1. Review the previous lesson using the class science journal and word wall, focusing students' thoughts on what happens when different materials are heated.
2. Introduce the collected materials and explain that students are going to work in collaborative learning teams to explore what happens when the materials are put in a hot place.

   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 use wristbands or badges to help them (and you) know which role each member has.
3. Ask students to predict what might happen when each material is heated. Ask why they think that. Record students' predictions and reasons in the class science journal.

   Optional: Use a PROE (Predict, Reason, Observe, Explain) format in the class science journal to record students' thoughts and observations.
4. Introduce the plastic bags and explain that students will put a different sample in each bag. Introduce the hat and explain that each team will draw out a list of materials that they will put in their bags.
5. Model writing the team names and sample name on each bag, filling the bag with one material and sealing it.

6 Discuss where to put the bags so that the materials are heated, for example, in direct sunlight or near a heat source (see 'Preparation').

7 Form teams and allocate roles. Ask Managers to collect team equipment and allow time for teams to label and fill their bags and examine their materials at room temperature.

SAFETY

8 Remind students not to taste or eat any of the materials for allergy and hygiene reasons. Ask students to clean up any spills immediately.

9 Ask students what words they might use to describe the materials. Brainstorm descriptive words that students might use, for example, hot, cold, hard, runny, sticky and soft. Discuss how the descriptive words can be made comparative, for example, 'hotter', 'colder', 'harder', 'runnier', 'stickier' and 'softer'. Record on the class word wall.

10 Ask students whether they would use the words 'solid' and 'liquid' to describe their materials. Ask questions such as:

- What do you think solid means? Why do you think this material is solid? How can you tell?
- What do you think liquid means? Why do you think this material is solid? How can you tell?

Explain that scientists call all things that are runny 'liquids' (for example, water, milk, cordial) and things that keep their shape 'solids' (for example, chair, cup, pencil). Record an agreed description of the words in the class science journal and add to the word wall.

Note: In some recognised Aboriginal English dialects, 'solid' is used as an adjective to describe something that is 'good' or 'great'. Discuss how different people can use language differently and in this unit of work the word 'solid' will be used as scientists use it.

11 Introduce the enlarged copy of 'Before and after' (Resource sheet 3) and explain that teams will be drawing line drawings of their materials before and after they are warmed. Discuss the purpose and features of a line drawing.

Literacy focus

Why do we use a line drawing?

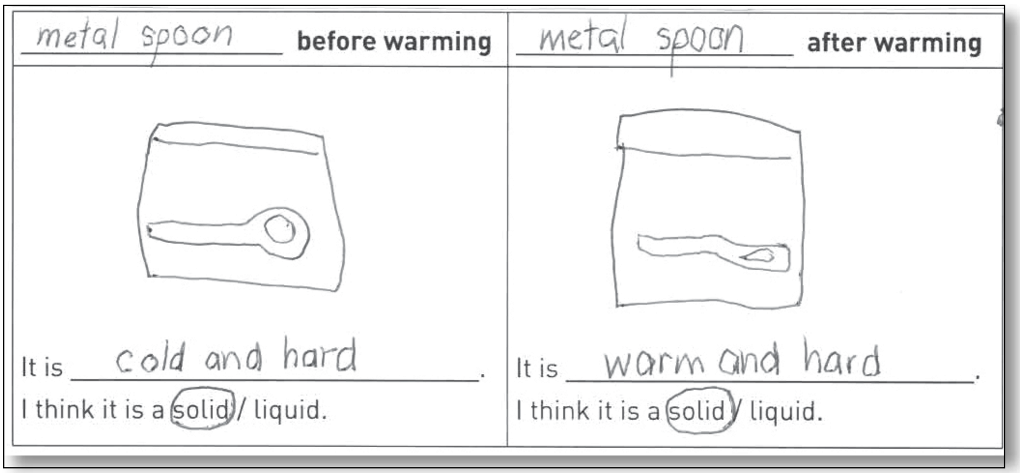
We use a line **drawing** to show what an object looks like without lots of detail.

What does a line drawing include?

A **line drawing** includes simple lines usually using a pencil.

12 Model completing an entry on the enlarged copy of 'Before and after' (Resource sheet 3), including indicating if a material is solid or liquid.

EXPLORE



Work sample of 'Before and after'

13 Allow time for teams to record their 'Before' observations on their copies of 'Before and after' (Resource sheet 3) before placing the materials in a warm place.

14 Ask teams to warm their materials. Allow enough time for the chocolate buttons to melt (see 'Preparation').

15 Ask teams to collect their materials and complete their 'After' sections on their copies of 'Before and after' (Resource sheet 3).

Note: The completed sheets of 'Before and after' (Resource sheet 3) will be cut up in Lesson 3. Do not paste into students science journals.

16 Invite each team to share their observations of their materials. Encourage them to use descriptive and comparative language. Ask questions such as:

- What changed after the material had been warmed?
- What stayed the same? (It is still chocolate, the colour is the same)
- Does anyone else have the same observation?
- Is the result the same as our prediction? Why/Why not?
- Why do you think it changed/didn't change?

17 Ask students in the audience to use the 'Science question starters' (see Appendix 4) to ask each team about their investigation.

Record class results of their observations in the science journal next to the original predictions of what would happen to different materials.

18 Ask students to predict what will happen to the materials in their bags if they are now put in a refrigerator. Record students' predictions in the class science journal.

Optional: Use a new PROE format.

19 Explain that the samples will be placed in a refrigerator and they will examine them in the next lesson.

20 Update the word wall with words and images.

Australian curriculum links

Mathematics

- Measure the volume and mass of the different samples students were provided with.

Before and after

Name:________________________________ **Date:**____________________________

____________________ **before warming**	____________________ **after warming**
It is ________________________________. I think it is a solid / liquid.	It is ________________________________. I think it is a solid / liquid.

____________________ **before warming**	____________________ **after warming**
It is ________________________________. I think it is a solid / liquid.	It is ________________________________. I think it is a solid / liquid.

____________________ **before warming**	____________________ **after warming**
It is ________________________________. I think it is a solid / liquid.	It is ________________________________. I think it is a solid / liquid.

Lesson 3 Cool customers

AT A GLANCE

To provide hands-on, shared experiences of cooling different materials.

Students

- work in teams to observe what happens when different materials are cooled
- create a storyboard to explain what has been happening to their materials.

EXPLORE

Lesson focus

The *Explore* phase provides students with hands-on experiences of the topic's science phenomenon while building their science inquiry skills. 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. In this lesson you will monitor students' developing understanding of:

- how materials change state when cooled.

Key lesson outcomes

Students will be able to:
• predict what will happen when different materials are cooled in a refrigerator and compare results with predictions
• work in teams to safely use appropriate equipment to investigate what happens when different materials are cooled in a refrigerator
• record findings using a storyboard
• discuss and compare results to form common understandings using appropriate vocabulary
• identify liquid materials that solidify when placed in a refrigerator.

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

Teacher background information

Changing shape

Because solid materials have atoms or molecules that are held together rigidly, materials keep their shape at the molecular level. Objects made of these materials will not change shape, unless external forces are applied, such as tearing or hammering. In that case the object changes shape but the material remains solid.

The objects will also change shape if the material they are made of melts and becomes liquid. When a material becomes liquid, it starts to flow and take the shape of its container. Not all areas of material melt at the same time which can cause some interesting shape changes before it becomes completely liquid. It is only possible to restore the original shape of the object by placing the material in a mould of the original shape and cooling it until it becomes solid again.

Students' samples

In this lesson, students will be exploring what has happened to their materials that they put in the refrigerator. The table below indicates the changes they are expected to see.

Material/object	State after being in the refrigerator
Water-based liquids such as water, cordial or milk	Still liquid
Viscous liquids such as honey or oil	Still liquid, may have become very viscous (hard to stir)
Alcohol-based liquids such as rubbing alcohol	Still liquid
Solids that easily melt such as chocolate buttons	Changed state from liquid to solid, shape is that of the liquid when placed in refrigerator
Solids that don't easily melt such as a plastic or metal spoon	Still solid

EXPLORE

Equipment

FOR THE CLASS	FOR EACH TEAM
• class science journal • word wall • team skills chart • team roles chart • enlarged copy of 'Before and after' (Resource sheet 3) from Lesson 2 • large sheet of paper • access to a freezer • alcohol-based liquid in bags to freeze (see 'Preparation' for quantity) • *Optional:* Cooler bag to transport bags of materials (see 'Preparation')	• role wristbands or badges for Director, Manager, Speaker • each team member's science journal • teams' refrigerated materials from Lesson 2 • teams' copies of 'Before and after' (Resource sheet 3) from Lesson 2 • 1 A3 sized sheet of paper to create storyboards

Preparation

- Ensure teams can collect their bags of material at approximately the temperature of the refrigerator, for example, by removing them during the lesson if the refrigerator is close by or by stocking them in a cooler bag.
- Identify an alcohol that can be placed in the freezer with students' samples, for example rubbing alcohol. Decide how many bags you will create in order for students to be able to study them under your supervision.

  SAFETY

  Create labelled samples for the class containing 100mL of the alcohol. 'Double bag' these samples for safety: tape the re-sealable bag closed and place in a second bag. Tape this bag closed also. Follow the risk assessment procedures for your sector and consult the MSDS (Material Safety Data Sheet) on the product.
- *Optional:* Create storyboards on an interactive whiteboard or on a computer connected to a projector. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

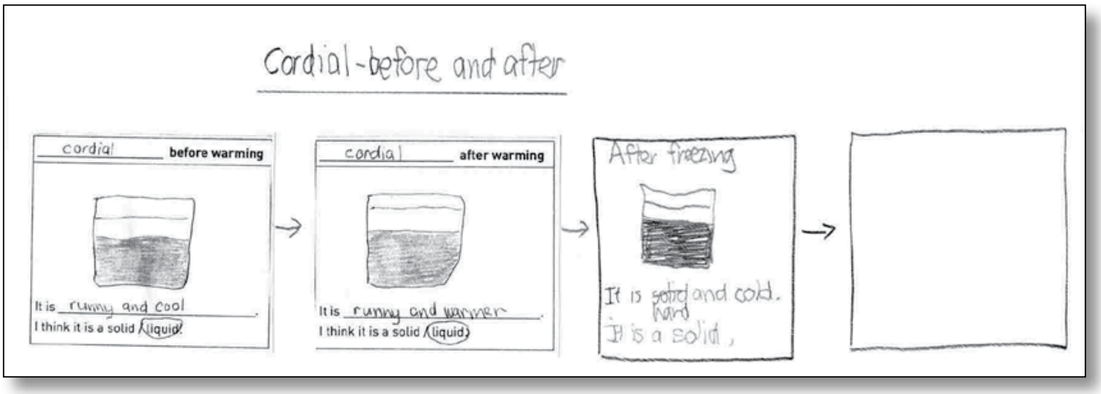
1. Review the previous lesson using the class science journal and the word wall. Remind students of their predictions about what might happen to the different materials if they were put into a refrigerator.
2. Explain that students will be working in collaborative learning teams to explore what happened to the materials in their bags after they were placed in the refrigerator.

   Optional: If students have studied the unit *Heating up* discuss how a refrigerator removes heat from objects because the objects are warmer than the air in the refrigerator.

3 Explain that students are going to make observations and use the information they have recorded to create a storyboard about each material showing what happened before and after warming and then after cooling in the refrigerator. Discuss the purpose and features of a storyboard.

> ### Literacy focus
>
> **Why do we use a storyboard?**
>
> We use a **storyboard** to show important steps of a process in the order they happen.
>
> **What does a storyboard include?**
>
> A **storyboard** includes a title. Each step in the storyboard is numbered and includes a picture and a caption describing the step.

4 Model creating a storyboard on the large sheet of paper by writing a title and cutting out the 'Before' and 'After' squares on the enlarged copy of 'Before and after' (Resource sheet 3). Paste the squares in a row and draw a third square labelled 'After freezing'. Join each of the sections with an arrow. Discuss with students what the arrow represents (For example, add heat, put in freezer). Ask students to leave space for a fourth square.



Work sample of 'Before and after' storyboard

5 Ask students to predict what might happen if the material is then placed in a freezer, and record their prediction under their storyboard.

6 Form teams. Ask managers to collect their teams' bags.

7 Allow time for students to observe their materials and create their storyboards.

8 Invite each team to share their storyboards. Ask questions such as:

- Did you notice anything else?
- Did your results match your predictions? Why/Why not?
- What happened between each stage of your storyboard? (We added heat, we removed heat)

Ask students in the audience to use the 'Science question starters' (see Appendix 4) to ask each team about the information in the storyboards.

9 As a class, review results, and ask questions such as:

- What happened to the chocolate when it was heated? (It became a liquid but stayed the same colour)
- Why do you think it no longer had the same shape? (Because liquids take the shape of their containers)
- What happened when the chocolate was cooled again? (It became solid but kept the same shape as the liquid had been)
- How could you create chocolates in the shape that you want?
- Why didn’t this spoon change shape like the chocolate? (Because it didn’t melt when it was heated)

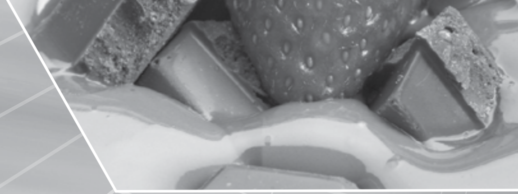
10 Record class predictions of what will happen to each material when placed in the freezer in the class science journal.

11 Introduce the alcohol-based liquid in bags (see ‘Preparation’). Ask students to describe it (runny, clear, like water). Explain it is rubbing alcohol and discuss its use. Explain that you will be putting this liquid in the freezer for students to compare with their own samples. Ask students to predict what they think will happen to the alcohol in the freezer and record students’ predictions in the class science journal.

SAFETY

If students handle the bags containing rubbing alcohol to look at the liquid, ensure they are supervised by an adult at all times.

12 Update the word wall with words and images.



Lesson 4 Freeze it!

AT A GLANCE

To provide hands-on, shared experiences of freezing different materials.

Students

- work in teams to observe what happens when different materials are placed in a freezer
- play a game of 'freeze' and discuss the terms 'freeze' and 'melt'
- review and complete their storyboards from Lesson 3.

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. In this lesson you will monitor students' developing understanding of:

- how materials change state when frozen.

Key lesson outcomes

Students will be able to:	Science*	English	Maths
• predict what will happen when different materials are placed in a freezer and compare results with predictions	AC**SIS**053 AC**SIS**215		
• work in teams to safely use appropriate equipment to conduct their investigation	AC**SIS**055	ACELA1476	
• record findings in a storyboard	AC**SIS**060		ACMSP069
• discuss and compare results to form common understandings using appropriate vocabulary including 'melt' and 'freeze'	AC**SIS**215 AC**SU**046 AC**SHE**050	ACELY1792 ACELA1676 ACELA1483	ACMP070
• identify liquid materials that 'freeze' in a freezer.	AC**SU**046		
***SU** – Science Understanding, **SHE** – Science as a Human Endeavour, **SIS** – Science Inquiry Skills			

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

Teacher background information

Freezing and melting

When a material changes from the solid state to the liquid state, it is called 'melting'. When it changes from the liquid state to the solid state it is called 'freezing'. For each material there is a specific temperature at which this change of state occurs. This is called the 'melting point' or 'freezing point' of the material depending on which way the state of matter is changing. The temperature of the freezing and melting point for a pure substance is identical. For water it is 0°C (at sea level atmospheric pressure). We therefore associate 'freezing' with low temperatures since this is the most common change of state that we observe in our everyday lives.

Iron has a very high melting point of 1,530°C and will therefore 'freeze' (change from liquid to solid) at temperatures below 1,530°C.

Students' samples

In this lesson, students will be exploring what has happened to their materials that they put in the freezer. The table below indicates the changes they are expected to see.

Material/object	State after being in the freezer
Water-based liquids such as water, cordial or milk	Changed to solid (has frozen)
Viscous liquids such as honey or oil	Changed to solid (has frozen)
Alcohol-based liquid such as rubbing alcohol	Still liquid
Solids that easily melt such as chocolate buttons	Still solid in the same shape as it was after being in the refrigerator
Solids that don't easily melt such as a plastic or metal spoon	Still solid

Students' conceptions

Some students might think that 'ice' is a different material to liquid water. However it is the same material but in a different state. Other liquids might also freeze in the freezer, for example, oil, but they do not turn into the same solid as water does even if they are formed under the same conditions.

Equipment

FOR THE CLASS

- class science journal
- word wall
- team skills chart
- team roles chart
- alcohol-based liquid in bags from Lesson 3
- *Optional:* Cooler bag and ice to transport bags of materials (see 'Preparation')

FOR EACH TEAM

- role wristbands or badges for Director, Manager, Speaker
- each team member's science journal
- teams' frozen materials from Lesson 2
- teams' storyboards from Lesson 3

Preparation

- Organise an area for the class game.
- Ensure teams can collect their bags of material at approximately the temperature of the freezer, for example, by removing them during the lesson if the freezer is close by or by stocking them in a cooler bag surrounded by ice.

Lesson steps

1. Review the previous lesson using the class science journal and the word wall. Remind students that their samples are in the freezer.
2. Explain that students will be working in collaborative learning teams to explore what happened to the materials in their bags after they were placed in the freezer.
3. Ask students to create a fourth panel for their storyboards started in Lesson 3.
4. Form teams. Ask Managers to collect their teams' bags.
5. Allow time for students to examine their materials and extent their storyboards.
6. Introduce the alcohol-based liquid in bags from the freezer and review what the material is. Ask students to compare what happened to that liquid with the liquids in their own samples.
7. As a class discuss the results, ask questions such as:
    - Which materials become solids?
    - Which materials stayed liquid?
    - Did your results match your predictions? Why/Why not?
    - What else did you notice?
8. Ask students what they think the term 'frozen' means and which materials they think were frozen.

9 Ask students if they have heard of the ‘Freeze’ game. Explain the rules:

- Students move around until you call ‘Freeze’.
- When you call ‘Freeze’ they have to stay still in the position that they are in.
- They don’t move again until you call ‘Melt’.

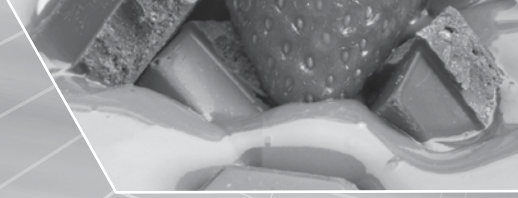
10 Take the class to the area to play the game. Play several rounds with students.

11 As a class discuss the game they have just played. Ask questions such as:

- What kinds of materials did being ‘frozen’ remind you of? What about when you were not frozen?
- Does the game remind you of anything you have observed? How are they similar?

Explain that scientists say that materials ‘freeze’ when they change from liquid to solid. We call things ‘freezers’ because water-based liquids freeze at that temperature.

12 Update the word wall with words and images.



Lesson 5 Sometimes solid

AT A GLANCE

To support students to represent and explain their understanding of the way different materials change from solid to liquid at different temperatures, and introduce current scientific views.

Students

- role-play materials freezing and melting
- create a table identifying when materials are either solid or liquid
- identify that adding heat can change solid materials to liquids and removing heat can change liquid materials to solids.

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.

Assessment focus

Formative assessment is an important aspect of the *Explain* phase. It involves monitoring students' developing understanding that:

- a change of state between solids and liquids can be caused by adding or removing heat.

This allows you to provide feedback to help students further develop their understanding.

Key lesson outcomes

Students will be able to:
• contribute to discussions about solids and liquids materials and what causes them to change state
• role-play materials changing state between solid and liquid
• *(optional)* read information texts to research information
• organise information about materials in a table and interpret their findings
• identify that adding heat can change solid materials to liquids and removing heat can change liquid materials to solids.

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

Teacher background information

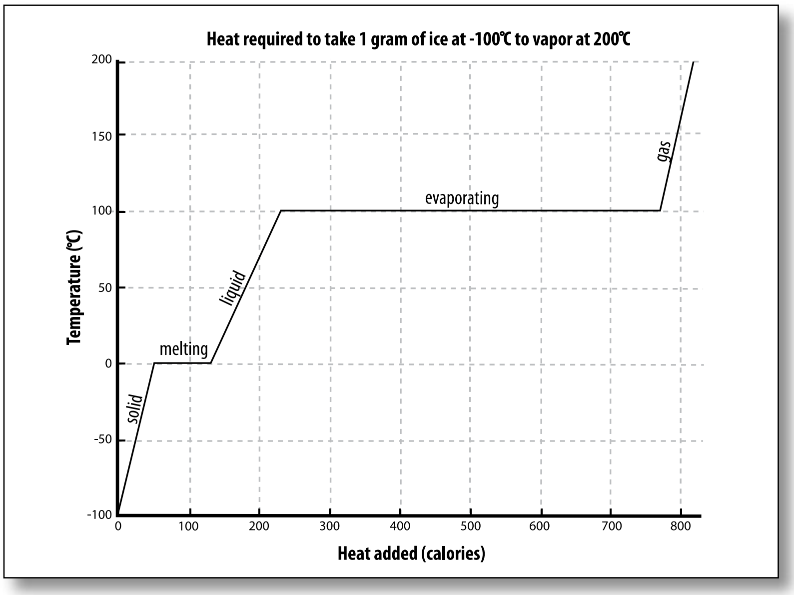
The difference between a material in a solid or liquid state is due to the arrangement of its atoms or molecules. In solids, they are linked by rigid bonds, which means the material keeps its shape. In liquids the bonds are weaker, allowing atoms or molecules to slide past each other due to the force of gravity or external pressures.

The amount of heat a material possesses is a measure of the vibration of its atoms or molecules. The more heat they have, the faster the atoms or molecules vibrate. The bonds between the atoms or molecules can only withstand a certain amount of vibration. When the atoms or molecules of a solid begin to vibrate at a certain speed the bonds between them begin to change and the solid changes to liquid.

For example, at -20°C water is a solid (ice). When heat is applied to it, the water molecules move faster and the temperature of the ice increases. However when the temperature reaches 0°C the molecules cannot vibrate any faster while linked together with rigid bonds. At this point the temperature stops increasing and the heat provides the energy to change the bonds between the molecules and the ice melts to liquid water. When all of the ice has melted, the continuing heat now causes the water molecules to start vibrating more and the temperature once again increases.

A similar phenomenon occurs at the 'boiling point' of water. At 100°C, the temperature of the water stops increasing and the heat provides energy to change the bonds between the molecules of liquid water as it evaporates to a gas (steam). When all of the water has evaporated, the continuing heat now causes the steam molecules to start vibrating more and the temperature once again increases.

This is shown in the graph below.



The temperature at which a solid changes to a liquid (melts) if further heat is applied or a liquid changes to a solid (freezes) if heat is removed, is known as the freezing or melting point. This temperature is specific to materials, and depends on the atmospheric pressure. Many substances have melting and boiling points that are not commonly experienced in the natural environment. For example, copper has a melting point of over 1000°C; students will not experience copper in liquid form in the classroom or at home. However they might see things such as copper pipes that have melted during bushfires and refrozen in new shapes.

Some particularly complex materials, such as wood, do not melt. When they are heated they can start to burn instead (they have a specific 'burning point'). Other complex materials, such as eggs, are liquid at room temperature and become solid both when put in the freezer and when heated (cooked), for example, in hot water or a frypan. The change that occurs when the egg is cooked is not a change of state but rather a change of alignment of the molecules within the egg that is non-reversible.

In this lesson, the class will construct a table to represent this at a level appropriate to their conceptual understanding:

Material	Freezer	Refrigerator	Room temperature	Warm place
rubbing alcohol	liquid	liquid	liquid	SAFETY
water	solid	liquid	liquid	liquid
cordial	solid	liquid	liquid	liquid
milk	solid	liquid	liquid	liquid
oil	solid	liquid	liquid	liquid
honey	solid	liquid	liquid	liquid
chocolate	solid	solid	solid	liquid
metal	solid	solid	solid	solid
plastic	solid	solid	solid	solid

EXPLAIN

Equipment

FOR THE CLASS

- class science journal
- word wall
- blank poster paper
- 4m piece of rope
- factual texts about creating solids with particular shapes by melting and cooling materials

FOR EACH STUDENT

- science journal
- storyboard from Lesson 4

Preparation

- Organise an area for the role-play.
- On a large sheet of poster paper, write the heading 'Solid or liquid?' and prepare a six-column chart below with the following headings:

Material	Freezer	Refrigerator	Room temperature	Warm place

  Leave space next to the 'Warm place' column for additional notes.
- Source multimodal texts on materials that have melted at high temperatures, for example, melted metals or glass, and on materials that have frozen at very cold temperatures, for example, petrol freezing in Siberian winters.
- *Optional:* Source activities on materials heating and cooling, for example,
  - www.bbc.co.uk/schools/scienceclips/ages/8_9/solid_liquids.shtml
- *Optional:* Create the table and display multimodal texts and activities on an interactive whiteboard or on a computer connected to a projector. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

1 Review previous lessons using the class science journal and word wall. Ask students to review their storyboards of different materials.

2 Explain that students are going to represent what they have learned by using a role-play. Discuss the purpose and features of a role-play.

Literacy focus

Why do we use a role-play?
We use a **role-play** as a physical representation of a system, process or situation.

What does a role-play include?
A **role-play** might include speech, gestures, actions and props.

Ask each student to choose one of their team's materials to represent in the role-play.

3 Take students to the area for the role-play and split the area in two using the rope (see 'Preparation'). Explain that students will stand on one side of the rope when the material that they are representing is solid and on the other side when the material that they are representing is liquid.

4 Discuss the difference between solids and liquids that they have observed and review their agreed descriptions in the class science journal. Brainstorm how students should act on either side of the rope, for example, stay still on the solid side and moving around with flowing gestures on the liquid side.

5 Explain that you will call out situations for example, 'In the freezer', 'In a warm place' or 'In the refrigerator'. Ask students to place themselves on the correct side of the rope depending on the situation. Role-play different situations as a class.

6 As a class, review the role-play, asking questions such as:

- When were there the most students being solids?
- When were there the most students being liquids?

7 Introduce the 'Solid or liquid?' table (see 'Preparation') and 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.

8 Ask students what they think 'room temperature' means. Add 'room temperature' to the word wall.

EXPLAIN

9 As a class complete the columns 'Freezer', 'Refrigerator', 'Room temperature' and 'Warm place' for each material examined by the class. Mark when different materials become liquids (see 'Teacher background information'). Do not fill in the column for the alcohol-based liquid at a warm temperature as students do not have direct evidence for it (and it might turn to gas).

10 Discuss the table, asking questions such as:
- Where are the materials the hottest?
- Where are the materials the coldest?
- When are most materials liquids?
- When are most materials solids?
- What can this tell us about what happens when we add heat to a material? (most solids become liquids)
- What can this tell us about what happens when we remove heat (cool) from a material? (most liquids become solids)

Record students' answers in the class science journal.

11 Ask students if the metal and plastic materials can become liquid. Introduce the multimodal text and activities (see 'Preparation') and discuss what happens at high temperatures and low temperatures. Add notes to the class table about metals and plastics become liquids at high temperatures.

12 Discuss that scientists explain that almost all solid materials become liquids when they have received enough heat but different materials become liquids at different times. Explain that alcohol can become solid at extremely low temperatures, and add a note to the class table.

13 Review class description of 'solid', 'liquid', 'melt' and 'freeze' in the class science journal and update if needed. Discuss how scientists review their ideas in the light of new information and evidence.

14 Discuss how the changing of materials from solid to liquid affects the shape of objects, since liquids are runny and do not hold their shape.

Optional: Ask students to complete activities on solids and liquids (see 'Preparation').

15 Explain that some plastic bottles and glass bottles are recycled into new shapes by heating their materials to a very, very hot temperature until they melt and can be poured into new shapes.

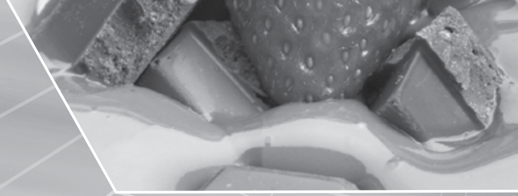
16 Update the word wall with words and images.

EXPLAIN

Australian curriculum links

Indigenous perspectives

- The classification of materials into states such as solid and liquid is one way to organise the world. Indigenous people might have their own way of understanding the world around them (see page xii). Contact local Indigenous community members and/or Indigenous Education Officers to access relevant, local Indigenous knowledge. Protocols are available on the website: www.science.org.au/primaryconnections/indigenous



Lesson 6 Break it up

AT A GLANCE

To support students to plan and conduct an investigation of the way shape affects the melting rate of chocolate.

Students

- work in teams to investigate the way shape affects the melting rate of chocolate
  identify variables to change and keep the same in an investigation
- record and discuss observations
- present investigation results in a column graph
- make claims based on evidence about their results.

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' understanding and skills.

Assessment focus

Summative assessment of the Science Inquiry Skills is an important focus of the *Elaborate* phase. Rubrics are available on the website to help you monitor students' inquiry skills.

Key lesson outcomes

Students will be able to:
• identify questions about the factors affecting the melting rate of chocolate and predict the outcomes of their investigation
• work in teams to safely use appropriate equipment to investigate whether different shapes affect the melting rate of chocolate
• record findings, present them as a graph and identify patterns or trends
• discuss and compare results with predictions to form common understandings
• make claims based on evidence about whether different shapes affect the melting rate of chocolate
• reflect on the investigation including whether the test was fair.

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

Teacher background information

Variables that affect melting

Heat is the transfer of energy within or between materials due to differences in their temperatures. Heat transfers from the material with the higher temperature, ie the heat source, to the material with the lower temperature, ie the heat sink. Heat is transferred between materials through the zone of contact between them: the more contact they have the more heat is transferred per unit of time. Therefore objects of different temperatures with more surface area in contact with each other will transfer more heat over the same amount of time compared with objects with less contact surface area.

When melting chocolate we break the block into smaller blocks to increase the amount of surface area available for heat transfer. The largest amount of surface area is available when the object is very thin, for example, a hollow object.

Equipment

FOR THE CLASS

- class science journal
- word wall
- team skills chart
- team roles chart
- 1 enlarged copy of ‘Melting investigation planner’ (Resource sheet 4)
- timing device, eg, clock or timer
- *Optional:* heat sources (see ‘Preparation’)

FOR EACH TEAM

- role wristbands or badges for Director, Manager, Speaker
- each team member’s science journal
- 3 copies of ‘Melting investigation planner’ (Resource sheet 4)
- 2 chocolate frogs or large chocolate buttons
- 2 plastic resealable bags with areas to write on
- marker
- *Optional:* timing device, eg, clock or timer

Preparation

- Read ‘How to write questions for investigations’ (Appendix 5).
- Read ‘How to conduct a fair test’ (Appendix 6).
- Read ‘How to construct and use a graph’ (Appendix 7).
- Enlarge a copy of ‘Melting investigation planner’ (Resource sheet 4).
- Ensure students have some choices of warm places to put their samples, for example, in direct sunlight, or near a heater or in an oven at low heat (<60°C) or by using a hair dryer or placing the bags in warm water. Do not put samples in a microwave as microwaves heat some types of molecules faster than others, which can bias results.
- Test how long it takes for the mass of chocolate that you have chosen to melt. If necessary, adjust how long students wait between checking their bags (see Lesson step 11).
- *Optional:* Source multimodal texts on different shaped materials that are melting, for example: vimeo.com/27412785
- *Optional:* Display the ‘Melting investigation planner’ (Resource sheet 4) on an interactive whiteboard or on a computer connected to a projector. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

ELABORATE

Lesson steps

1 Review the previous lessons using the class science journal and the word wall, focusing students' attention on their observations of things melting. Ask questions such as:

- Do all materials melt at the same temperature? What did you observe?
- Does a particular material melt all at once? What did you observe?
- What happens to the shape of a material as it melts?
- How can we tell when all of the material has melted?

2 Introduce the object made from chocolate material for the investigation (see 'Preparation'). Ask students to predict how long it might take for the object to melt.

3 Explain that students will work in collaborative learning teams to investigate the time it takes for a chocolate object to melt.

4 Ask students what things might affect the time it takes for the chocolate object to melt. Record students' suggestions in the class science journal. Suggestions might include the amount of chocolate (mass), the shape of the chocolate, the size of the pieces, how heat is added.

5 Explain that they will investigate whether changing the size of the pieces of chocolate (by breaking one up into smaller pieces) will affect the time it takes to melt. Discuss how we know when the chocolate has all melted (For example, poke or squish the chocolate).

6 Introduce the enlarged copy of 'Melting investigation planner' (Resource sheet 4). Read the 'What are you going to investigate? Section. Assist students to complete the investigation question 'What happens to the melting time when we change the size of the pieces of the chocolate?'

7 Discuss and record on the 'Melting investigation planner' (Resource sheet 4) what teams will:

- **change:** the size of the pieces of chocolate
- **measure:** the time to melt
- keep the **same:** the mass of the chocolate, the heat source, the type of bag in which the chocolate is melted

8 Discuss why it is important to change only one thing at a time to keep the investigation fair (so we know what caused the changes we observe). Ask questions such as:

- What if we put them next to different heat sources?
- What if one chocolate had more mass than the other?
- What if we used two different types of chocolate?

9 Read through the equipment list on the enlarged copy of 'Melting investigation planner' (Resource sheet 4). Explain that each team will receive two identical pieces of chocolate and that students will break one of the pieces into many smaller pieces.

SAFETY

Note: Remind students not to eat any of the chocolate. You might consider sharing some fresh chocolate to eat at the end of the investigation with the class. Be aware of food allergies.

ELABORATE

10 Read through the procedural text on the enlarged copy of 'Melting investigation planner' (Resource sheet 4). Discuss the features and purpose of a procedural text.

> **Literacy focus**
>
> **Why do we use a procedural text?**
>
> We use a **procedural text** to find out how something is done.
>
> **What does a procedural text include?**
>
> A **procedural text** includes a title, a list of materials that we need to do a task and a sequence of steps to follow. It might include labelled diagrams.

Model completing the steps of the procedural text.

11 Explain that you will call out every ten minutes for teams to check if all their chocolate has melted.

Optional: If students have been introduced to keeping time, allow them to monitor when to check on their chocolate.

Optional: Ask students to present their home activity (see Lesson 1) during the ten-minute wait time between checking samples.

12 Discuss the 'Recording results' section of the enlarged copy of the 'Melting investigation planner' (Resource sheet 4). Model completing the sentences.

13 Form teams and allocate roles. Ask managers to collect team equipment.

14 Allow time for teams to conduct their investigations. Students might take digital photographs as the investigation proceeds to use as a record of their findings.

15 After teams have recorded their results, discuss the 'Displaying results' section of the enlarged copy of the 'Melting investigation planner' (Resource sheet 4). Explain that this is where each team will complete a column graph of their results so it is easier to see the patterns in results. Discuss the purpose and features of a graph.

> **Literacy focus**
>
> **Why do we use a graph?**
>
> We use a **graph** to show information so we can look for patterns. We use different types of graphs, such as column, picture of line graphs, for different situations.
>
> **What does a graph include?**
>
> A **graph** includes a title, axes with labels on them and the units of measurement.

Model how to complete the graph.

16 Allow teams time to complete their graphs. Invite each team to share their results with the class.

17 Use guided questioning to help students think about what happened to their chocolate objects as they melted, for example:

- Which pieces melted most quickly/least quickly?
- What did you notice about the times that it took the chocolate to melt (The faster it takes to melt the less time recorded)

ELABORATE

- What was different about the chocolate that melted most quickly/least quickly?
- What is happening when material melts?
- Where is the heat coming from?
- How does heat get into the chocolate material?
- How do you know when the chocolate has completely melted?

18 As a class discuss what claim they can make to answer the original question for investigation, for example smaller pieces melt faster. Record the claim on the enlarged copy of 'Melting investigation planner' (Resource sheet 4) in the 'Discussing results' sections.

19 Discuss the evidence students have for their claims and record this on their planner (We observed them with a fair test. The broken up chocolate melted in a shorter time than the full piece of chocolate)

20 Ask students why they think the chocolate broken into smaller pieces melts faster. Explain that heat enters a material through its surface and therefore the more surface an object has in contact directly with the heat source, the faster heat enters into the material. Discuss how the broken chocolate pieces have more surfaces for the heat to enter than the single piece of chocolate. (see 'Teacher background information').

21 Review the investigation as a class, asking questions such as:

- What went well with our investigation?
- What didn't go well? How could we have done it better?
- What ideas do you have for another investigation about the melting or freezing of materials?

Record students' answers in the class science journal.

Optional: Provide opportunities for further investigation of their questions or suggest they explore their questions at home and report to the class.

22 Update the word wall with words and images.

ELABORATE

Melting investigation planner

Name:________________________________ **Date:**________________________

Other members of your team:____

What are you going to investigate?	**What do you think will happen? Explain why.**
What happens to ______________________________ when we change ______________________________?	

To make the test fair, what things (variables) are you going to:

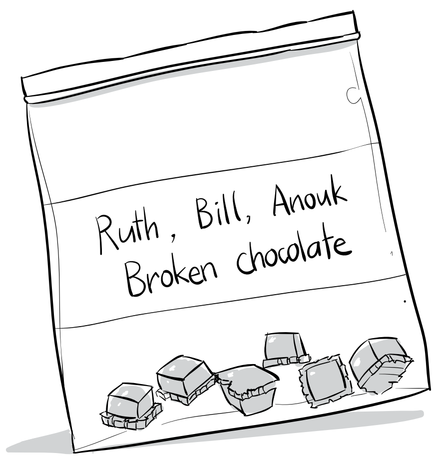
Change?	**Measure /Observe?**	**Keep the same?**

What equipment does the team need?

- role wristbands or badges for Director, Manager, Speaker
- each team member's science journal
- ______g of the full piece of chocolate
- ______g of the broken chocolate
- 2 plastic resealable bags
- pen
- access to a warm place or heat source

What will the team do?

1 Break one piece of chocolate into many smaller pieces.
2 Draw each piece of chocolate on recording results section of the planner.
3 Write which chocolate you will put in the bag.
4 Put the chocolate in the labelled bags.
5 Put the bags in a warm place.
6 Check the bags every 10 minutes.
7 Record how long it takes for each chocolate to melt.



Melting investigation planner

Recording results

Draw the full piece of chocolate:	Draw the broken pieces of chocolate:
It took ________________ minutes to melt.	It took ________________ minutes to melt.

Displaying results Present your results in a graph

Title of graph: ____

Discussing results What did our whole class find?

Question: What happens to the melting time when we change the size of the pieces of the chocolate?

Claim: ____

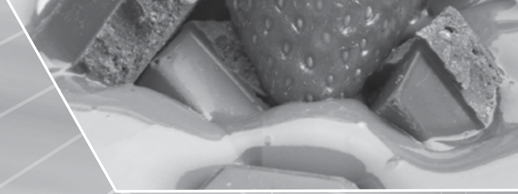
____

____

Evidence: ____

____

____



Lesson 7 Ready to set

AT A GLANCE

To provide opportunities for students to represent what they know about the way a change of state between solid and liquid can be caused by adding or removing heat, and to reflect on their learning during the unit.

Students

- create a storyboard to explain how the present in Lesson 1 changed shape
- make claims about the way materials change with temperature change
- participate in a class discussion to reflect on their learning during the unit.

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 that:

- a change of state between solid and liquid can be caused by adding or removing heat.

Literacy products in this lesson provide useful work samples for assessment using the rubrics provided on the Primary**Connections** website.

Key lesson outcomes

Students will be able to:
• identify that materials can change state between solid and liquid when heat is added or removed and that this affects objects in their everyday lives
• share responses and opinions with others through creating a storyboard
• contribute to discussions and express their opinions about their learning journey.

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
- the objects from Lesson 1
- 1 enlarged copy of ‘Too hot!’ (Resource sheet 5)

FOR EACH STUDENT

- science journal
- 1 copy of ‘Too hot!’ (Resource sheet 5)
- *Optional:* material to create multimedia presentations

Preparation

- Enlarge a copy of ‘Too hot!’ (Resource sheet 5).
- *Optional:* Display ‘Too hot!’ and create the class storyboard on an interactive whiteboard or on a computer connected to a projector. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.science.org.au/primaryconnections

Lesson steps

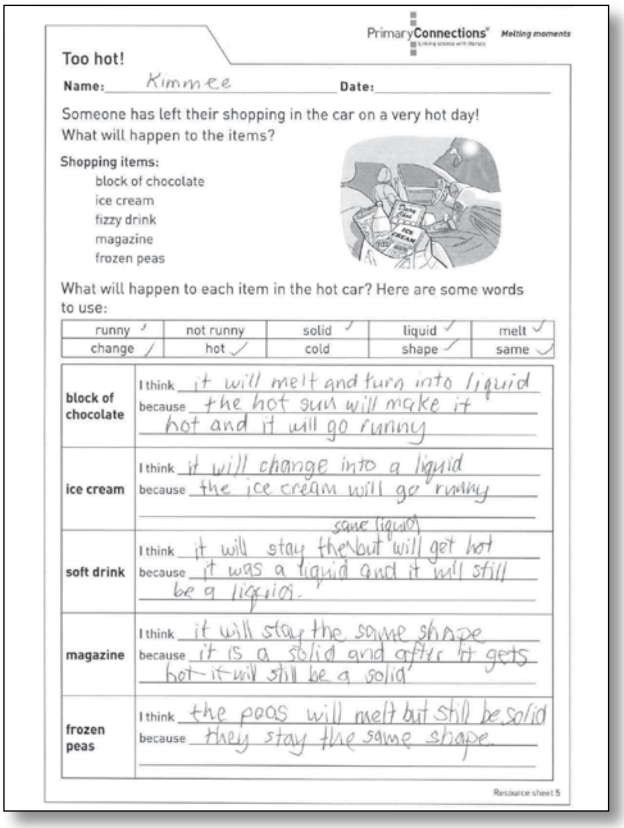
1 Review the previous lessons using the class science journal and word wall.

2 Remind students of the objects introduced in Lesson 1. Ask students to think about how they changed shape and share their ideas with a partner.

3 As a class, create a storyboard in the class science journal to explain what happened to the objects that changed shape. Ask students to use appropriate scientific words when expressing their ideas. Ask questions such as:

- Why do you think…?
- That’s interesting, can you tell me more about…?
- How would a scientist describe that?

4 Introduce the enlarged copy of ‘Too hot!’ (Resource sheet 5). Read through with students and model how to record their thinking. For example, ‘The ice cream will become a liquid because it will melt and go runny and will not be an ice cream shape anymore’.



PrimaryConnections Melting moments

Too hot!

Name: Kimmee Date:

Someone has left their shopping in the car on a very hot day!
What will happen to the items?

Shopping items:
block of chocolate
ice cream
fizzy drink
magazine
frozen peas

What will happen to each item in the hot car? Here are some words to use:

runny ✓	not runny	solid ✓	liquid ✓	melt ✓
change ✓	hot ✓	cold	shape ✓	same ✓

block of chocolate	I think it will melt and turn into liquid because the hot sun will make it hot and it will go runny
ice cream	I think it will change into a liquid because the ice cream will go runny
soft drink	I think it will stay the same liquid but will get hot because it was a liquid and it will still be a liquid.
magazine	I think it will stay the same shape because it is a solid and after it gets hot it will still be a solid
frozen peas	I think the peas will melt but still be solid because they stay the same shape.

Resource sheet 5

Work sample of 'Too hot'

5 Allow time for students to complete their copy of 'Too hot!' (Resource sheet 5). Ask students questions such as:

- Can that become liquid? What will it look like?
- How can we make the liquid solid?
- What would happen if we put it in the refrigerator/freezer?

Optional: Allow students to create multimedia presentations to explain what they think will happen, including techniques such as Claymation.

6 Ask students to share their ideas about what would happen if all the items were then put in the refrigerator/freezer.

7 Ask students to reflect on their learning during the unit using their science journals, the class science journal and the word wall. Ask questions such as:

- What did you think about solids and liquids at the start of the unit?
- What did we want to find out about…?
- What have you learned about...? Why do you think that now?
- How did you find out about…?
- What activity did you enjoy most of all? Why?
- What activity did you find the most challenging? Why?
- What are you still wondering about?
- What did you learn about working in teams?

EVALUATE

Too hot!

Name: ______________________ **Date:** ______________________

Someone has left their shopping in the car on a very hot day!
What will happen to the items?

Shopping items:

- block of chocolate
- ice cream
- fizzy drink
- magazine
- frozen peas

What will happen to each item in the hot car? Here are some words to use:

runny	not runny	solid	liquid	melt
change	hot	cold	shape	same

block of chocolate	I think ______________________ because ______________________ ______________________
ice cream	I think ______________________ because ______________________ ______________________
soft drink	I think ______________________ because ______________________ ______________________
magazine	I think ______________________ because ______________________ ______________________
frozen peas	I think ______________________ because ______________________ ______________________

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.

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 F-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, for example, a colour-coded peg, badge or wristband. 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.

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

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 SKILLS

1. Move into your teams quickly and quietly
2. Speak softly
3. Stay with your team
4. Take turns
5. Perform your role

TEAM ROLES

Manager

Collects and returns all materials the team needs

Speaker

Asks the teacher and other team speakers for help

Director

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

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.

Representing their ideas in a science journal gives students a purposeful task for writing and reading in English. For additional information on how to help students who are learners of English as an additional language or dialect, please see the Australian Curriculum resources.

Using a science journal

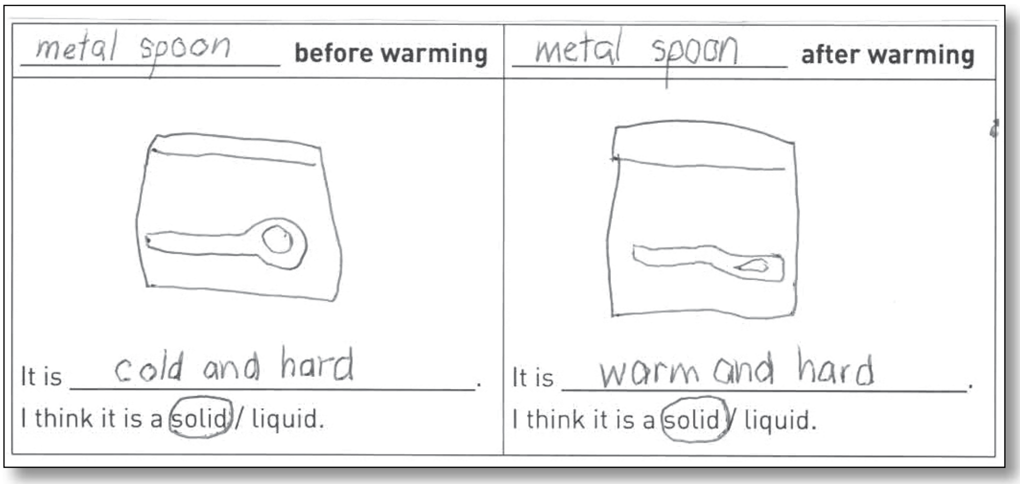
1. At the start of the year, or before starting a science unit, provide each student with a notebook or exercise book for their science journal or use an electronic format. Tailor the type of journal to fit the needs of your classroom. Explain to students that they will use their journals to keep a record 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 Stages 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, for example, 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.

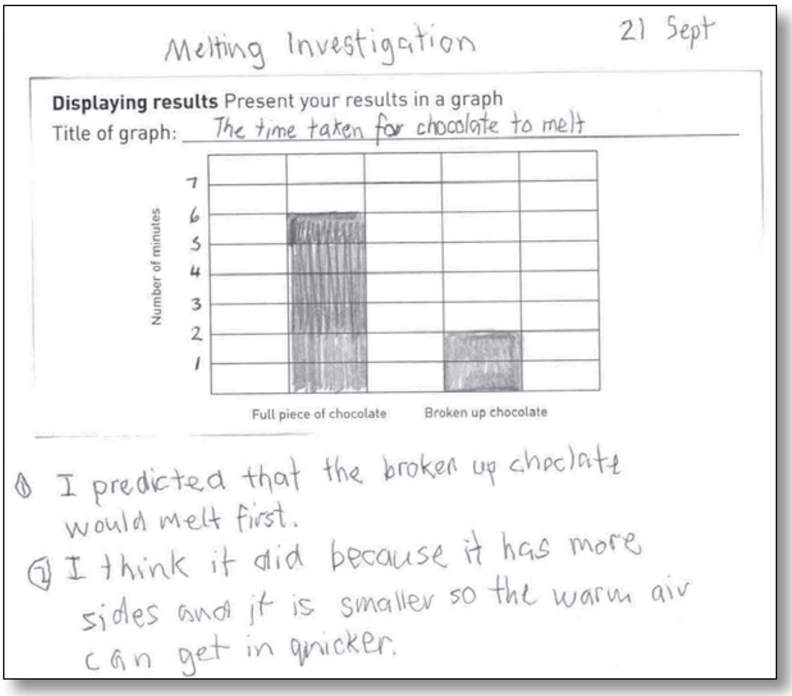
7 Combine the use of resource sheets with journal entries. After students have pasted their completed resource sheets in their journal, they might like to add their own drawings and reflections.

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.

Melting moments science journal entries





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.

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

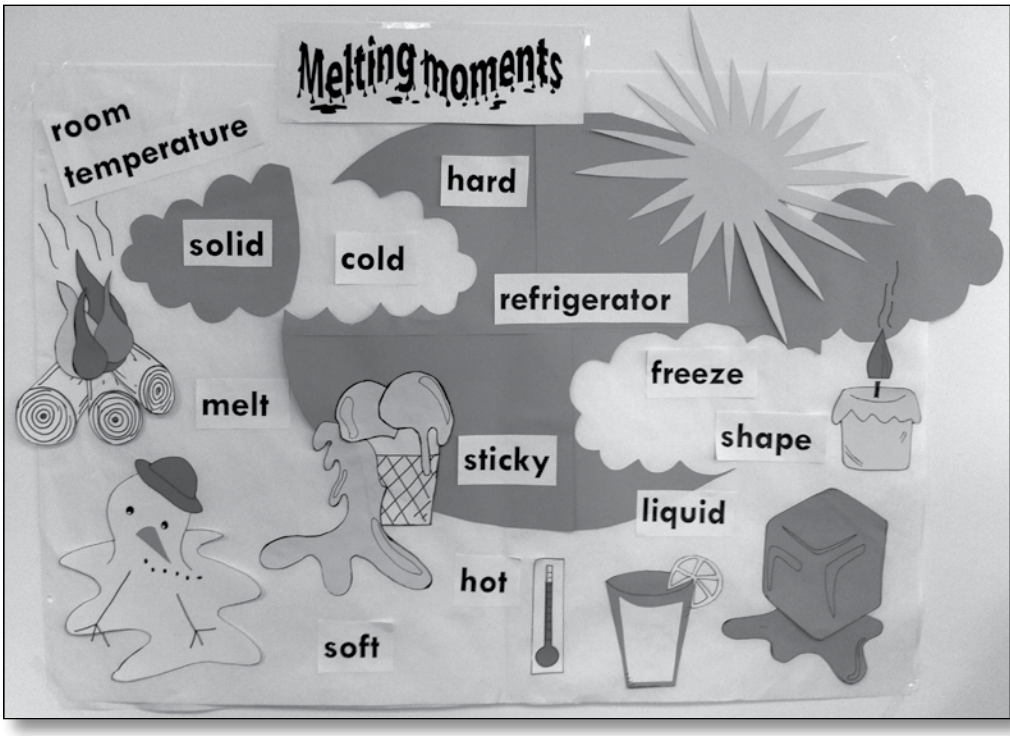
Position the word wall so that students have easy access to the words. They need to be able to see, remove and return word cards to the wall. A classroom could have one main word wall and two or three smaller ones, each with a different focus, for example, high-frequency words.

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-fastening 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, an animal silhouette for an animal characteristics unit. 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 *Melting moments* unit might be organised using headings, such as ‘Solids’, ‘Liquids’ and ‘Melted and Frozen’.

Invite students to contribute words from different languages to the word wall. Group words about the same thing, for example, different names of the same animal, on the word wall so that students can make the connections. Identify the different languages used, for example, by using different coloured cards or pens to record the words.



Melting moments word wall

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.

Appendix 4
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 other's 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
- 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? 'What happens to the melting time when we change the size of the pieces of chocolate?'

C - The **claim**. For example, 'A piece of chocolate melts faster when it is broken into lots of pieces than one piece only.'

E - The **evidence**. For example, 'One piece of chocolate took _ minutes to melt. The same size piece of chocolate took _ minutes when it was broken into smaller pieces.'

R - The **reasoning**. How the evidence supports the claim. In this unit, students are required to make claims and collect evidence only.

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 how 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 *The Primary**Connections** 5Es DVD,* Chapter 5).

Science question starters

Question type	Question starter
Asking for evidence	I have a question about...? What is your evidence to support your claim? Do you have any other evidence to support your claim?
Agreeing	I agree with ___________ because ______________________.
Disagreeing	I disagree with ________________ because _______________. One difference between my idea and yours is _____________.
Questioning more	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?

DISCUSSION SKILLS

1 Listen when others speak

2 Ask questions of each other

3 Criticise ideas not people

4 Discuss all ideas before selecting one

Appendix 5
How to write questions for investigation

Introduction

Scientific inquiry and investigation are focused on and driven by questions. Some questions are open to scientific investigation, while others are not. Students often experience difficulty in developing their own questions for investigation.

This appendix explains the structure of questions and how they are related to variables in a scientific investigation. It describes an approach to developing questions for investigation and provides a guide for constructing investigable questions with your students. Developing their own questions for investigation helps students to have ownership of their investigation and is an important component of scientific literacy.

The structure of questions for investigation

The way that a question is posed in a scientific investigation affects the type of investigation that is carried out and the way information is collected. Examples of different types of questions for investigation include:

- How does/do…?
- What effect does…?
- Which type of…?
- What happens to…?

All science investigations involve *variables*. Variables are things that can be changed, measured or kept the same (controlled) in an investigation.

- The **independent variable** is the thing that is changed during the investigation.
- The **dependent variable** is the thing that is affected by the independent variable, and is measured or observed.
- **Controlled variables** are all the other things in an investigation that could change but are kept the same to make it a fair test.

An example of the way students can structure questions for investigation is:

What happens to ____________________ when we change ____________________?

dependent variable **independent variable**

The type of question for investigation in *Smooth moves* refers to two variables and the relationship between them, for example, an investigation of the variables that affect how far a matchbox moves. The question for investigation could be:

Q1: What happens to the distance the matchbox moves when we change the size of the force acting on it?

In this question, *the distance the matchbox moves* depends on *the size of the force acting on it*. The size of the force acting on it is the thing that is **changed** (independent variable) and the distance the matchbox moves is the thing that is **measured or observed** (dependent variable).

Q2: What happens to the distance the matchbox moves when we change the surface of the table?

In this question, *the distance the matchbox moves* depends on *the surface of the table*. The angle of the surface is the thing that is **changed** (independent variable) and the distance the matchbox moves is the thing that is **measured or observed** (dependent variable).

Possible questions for investigation in *Marvellous micro-organisms* are:

Q1: What happens to mould growth when we change the amount of moisture?

In this question, *mould growth* depends on *moisture*. The amount of moisture is the thing that is **changed** (independent variable) and mould growth is the thing that is **measured or observed** (dependent variable).

Q2: What happens to mould growth when we change the temperature?

In this question, *mould growth* depends on *temperature*. Temperature is the thing that is **changed** (independent variable) and mould growth is the thing that is **measured or observed** (dependent variable).

Developing questions for investigation

The process of developing questions for investigation is to:

- Provide a context and reason for investigating.
- Pose a general focus question in the form of: 'What things might affect __________ (**dependent variable**)?'.

  For example, 'What things might affect the speed of the reaction?'.
- Use questioning to elicit the things (**independent variables**) students think might affect the **dependent variable**, for example, the surface area of the tablet, the temperature of the liquid, the type of liquid, the amount of liquid, the type of tablet.

  Each of the **independent variables** can be developed into a question for investigation, for example, the temperature of the liquid. These are the things that might be changed (**independent variables**), which students think will affect the thing that is measured or observed (**dependent variable**).
- Use the scaffold 'What happens to __________ when we change __________?' to help students develop specific questions for their investigation, for example, 'What happens to the speed of the reaction when you change the temperature of the liquid?'.
- Ask students to review their question for investigation after they have conducted their investigation and collected and analysed their information.

  Encouraging students to review their question will help them to understand the relationship between what was changed and what was measured in their investigation. It also helps students to see how the information they collected relates to their prediction.

Appendix 6
How to conduct a fair test

Introduction

Scientific investigations involve posing questions, testing predictions, planning and conducting tests, interpreting and representing evidence, drawing conclusions and communicating findings.

Planning a fair test

In *Melting moments* students investigate things that affect how quickly a material melts.

All of these investigations are used to answer questions for inquiry about solids and liquids and the way they change state when heat is added or removed.

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 answer the question of inquiry 'Does the shape of an object affect how quickly its materials melt?' students could investigate whether a solid block of chocolate melts more quickly or slowly than a block broken into pieces. Students could:

CHANGE	the shape of the chocolate	Independent variable
MEASURE/OBSERVE	the time to melt	Dependent variable
KEEP THE **SAME**	the type of chocolate, the mass of chocolate, the amount of heat added to the chocolate, the container or bag the chocolate is in, the temperature in the room	Controlled variables

Appendix 7
How to construct and use a graph (Year 3)

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.

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 Australian Curriculum: Mathematics describes data representation and interpretation for Year 3 as follows:

- 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.

Picture graph

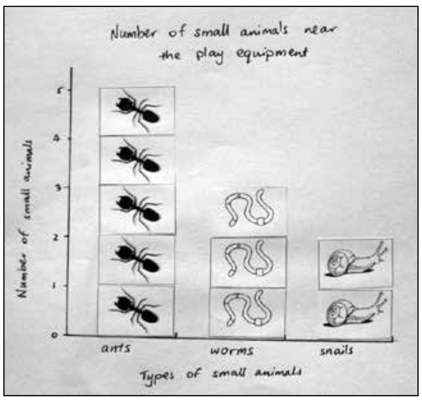
Picture graphs support students in the transition from using physical representations to representing information using symbols or pictures in columns. The symbols or pictures must be the same size.

Table A shows the results recorded for an investigation of the types of small animals found in different environments. This information is represented in Graph A by using one small picture for each animal in Table A.

Table A: Number of small animals near the play equipment

Types of small animals	Number of small animals
ant	5
worm	3
snail	2

Graph A: Number of small animals near the play equipment



Column graph

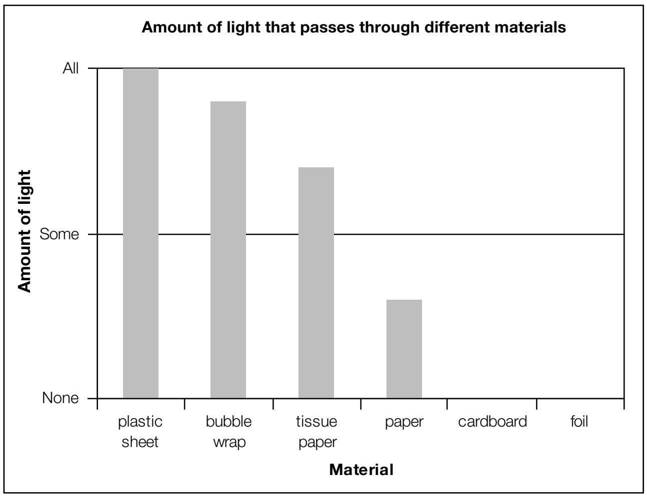
Where data for one of the variables are in **categories** (that is, we use **words** to describe it, for example, earthquake location) a **column graph** is used.

Graph B below shows how the results of an investigation of the effect of material type on the amount of light that passes through it **(data in categories)** have been constructed as a **column graph**.

Table B: The effect of material on the amount of light that passes through

Material	Amount of light
plastic sheet	all
bubble wrap	almost all
tissue paper	most
paper	not much
cardboard	none
foil	none

Graph B: The effect of material on the amount of light that passes through



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 titles 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 material on the amount of light that passes through.'

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 the 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 different numbers of small animals were found near the play equipment. Students could compare graphs of different environments to determine which environments suit which animals. For example, if lots of ants were found in the garden, near the play equipment and in the lunch area students might conclude that ants can live in lots of places in the schoolyard. If ants were only found in the garden, students might conclude that the ants prefer a garden habitat because they aren't found in other places.

Appendix 8
Melting moments equipment list

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	3	4	5	6	7
		SESSION							
Equipment and materials									
A3 paper	1 per class, 1 per team				•				
A4 paper	1 per class			•					
access to refrigerator (with freezer compartment)	1 per class			•	•	•			
alcohol based liquid	Per class			•					
bags (small, plastic, re-sealable, with label)	3 per team			•					
bags (small, plastic, re-sealable, with label)	2 per team							•	
blank poster paper	1 per class						•		
card or paper for labels	Ongoing			•					
chocolate buttons	2 per team			•					
chocolate frog or buttons	2 per team							•	
cooler bag *optional*	1 per class				•	•			
factual texts about creating solids with particular shapes by melting and cooling	1 set per class						•		
heat resistant solids	Per team			•					
hat	1 per class			•					
heat sources *optional*	1 per class			•				•	
marker	1 per team			•				•	
material to create multimedia presentation	1 per team								•
objects that melt (similar objects)	2 per class		•						•
rope (4m)	1 per class						•		
timing device	1 per class			•				•	
timing device *optional*	1 per team							•	
viscous liquid	Per team			•					
water-based liquid	Per team			•					

Resource sheets									
– ‘Information note for families’ (RS1)	3 per team		•						
– ‘Information note for families’ (RS1), enlarged	1 per class		•						
– ‘Run, run, runny’ (RS2)	3 per team		•						
– ‘Run, run, runny’ (RS2), enlarged	1 per class		•						
– ‘Before and after’ (RS3))	3 per team			•	•				
– 'Before and after’ (RS3), enlarged	1 per class			•	•				
– 'Melting investigation planner’ (RS4)	3 per team							•	
– ‘Melting investigation planner’ (RS4), enlarged	1 per class							•	
– ‘Too hot’ (RS5)	3 per team								•
– ‘Too hot’ (RS5), enlarged	1 per class								•
Teaching tools									
class science journal	1 per class		•	•	•	•	•	•	•
collaborative learning role badges	1 set per team			•		•	•	•	•
collaborative learning team roles chart	1 per class			•		•	•	•	•
collaborative learning team skills chart	1 per class			•		•	•	•	•
student science journal	1 per student		•	•	•	•	•	•	•
word wall	1 per class		•	•	•	•	•	•	•
Multimedia									
Digital camera *optional*								•	

Appendix 9
Melting moments unit overview

		LESSON SUMMARY	LESSON OUTCOMES*	ASSESSMENT OPPORTUNITIES
		Students	Students will be able to	
ENGAGE	**Lesson 1** Sunken shapes	• observe objects that have changed shape due to melting and cooling • brainstorm ideas about melting and cooling of materials.	represent their current understanding as they: • contribute to discussions about the objects and materials and what happens when they are heated or cooled • identify the purpose and features of a science journal • use scientific vocabulary appropriately • brainstorm the reasons everyday objects might have changed shape • identify possible questions for investigation.	**Diagnostic assessment** • Science journal entries • Class discussions • Word wall contributions • 'Run, run, runny' (Resource sheet 2)
EXPLORE	**Lesson 2** Heat it up	• predict what will happen when different materials are heated • work in teams to observe what happens when different materials are heated • record their observations using line drawings and adjectives.	• predict what will happen when different materials are heated and compare results with predictions • work in teams to safely use appropriate equipment to investigate what happens when different materials are warmed • record findings using a line drawing • discuss and compare results to form common understandings using appropriate vocabulary including 'solid' and 'liquid' • identify solid materials that melt when warmed.	**Formative assessment** • Science journal entries • Class discussions • Word wall contributions • 'Before and after' (Resource sheet 3)

* These outcomes are aligned to relevant descriptions of the Australian Curriculum: Science and are provided at the beginning of each lesson.

		LESSON SUMMARY	LESSON OUTCOMES*	ASSESSMENT OPPORTUNITIES
		Students	Students will be able to	
EXPLORE	**Lesson 3** Cool customers	• work in teams to observe what happens when different materials are cooled • create a storyboard to explain what has been happening to their materials.	• predict what will happen when different materials are cooled in a refrigerator and compare results with predictions • work in teams to safely use appropriate equipment to investigate what happens when different materials are cooled in a refrigerator • record findings using a storyboard • discuss and compare results to form common understandings using appropriate vocabulary • identify liquid materials that solidify when placed in a refrigerator.	**Formative assessment** • Science journal entries • Class discussions • Word wall contributions • Storyboards
EXPLORE	**Lesson 4** Freeze it!	• work in teams to observe what happens when different materials are placed in a freezer • play a game of ‘freeze’ and discuss the terms ‘freeze’ and ‘melt’ • review and complete their storyboards from Lesson 3.	• predict what will happen when different materials are placed in a freezer and compare results with predictions • work in teams to safely use appropriate equipment to conduct their investigation • record findings in a storyboard • discuss and compare results to form common understandings using appropriate vocabulary including ‘melt’ and ‘freeze’ • identify liquid materials that ‘freeze’ in a freezer.	**Formative assessment** • Science journal entries • Class discussions • Word wall contributions • Storyboards

* These outcomes are aligned to relevant descriptions of the Australian Curriculum: Science and are provided at the beginning of each lesson.

		LESSON SUMMARY	LESSON OUTCOMES*	ASSESSMENT OPPORTUNITIES
		Students	Students will be able to	
EXPLAIN	**Lesson 5** Sometimes solid	• role-play materials freezing and melting • create a table identifying when materials are either solid or liquid • identify that adding heat can change solid materials to liquids and removing heat can change liquid materials to solids.	• contribute to discussions about solid and liquid materials and what causes them to change state • role-play materials changing state between solid and liquid • *(optional)* read informative texts to research information • organise information about materials in a table and interpret their findings • identify that adding heat can change solid materials to liquids and removing heat can change liquid materials to solids.	**Formative assessment** • Science journal entries • Class discussions • Word wall contributions • Role-play

* These outcomes are aligned to relevant descriptions of the Australian Curriculum: Science and are provided at the beginning of each lesson.

		LESSON SUMMARY	LESSON OUTCOMES*	ASSESSMENT OPPORTUNITIES
		Students	Students will be able to	
ELABORATE	**Lesson 6** Break it up	• role-play materials freezing and melting • create a table identifying when materials are either solid or liquid • identify that adding heat can change solid materials to liquids and removing heat can change liquid materials to solids.	• work in teams to investigate the way shape affects the melting rate of chocolate • identify variables to change and keep the same in an investigation • record and discuss observations • present investigation results in a column graph • make claims based on evidence about their results.	**Summative assessment** of the Science Inquiry Skills • Science journal entries • Class discussions • Word wall contributions • 'Melting investigation planner' (Resource sheet 4)
EVALUATE	**Lesson 7** Ready to set	• create a storyboard to explain how the objects present in Engage changed shape • make claims about the way materials change with temperature change • participate in a class discussion to reflect on their learning during the unit.	• identify that materials can change state between solid and liquid when the temperature changes and that this affects objects in their everyday lives • share responses and opinions with others through creating a storyboard • contribute to discussions and express their opinions about their learning journey.	**Summative assessment** of the Science Understanding • Science journal entries • Class discussions • Word wall contributions • Storyboards • 'Too hot! (Resource sheet 5)

* These outcomes are aligned to relevant descriptions of the Australian Curriculum: Science and are provided at the beginning of each lesson.

Professional learning

*Primary**Connections:** linking science with literacy* is an innovative program linking the teaching of science with the teaching of literacy in primary schools. The program includes a professional learning component and curriculum units aligned to the Australian Curriculum: Science.

Research has shown that the professional learning component of the Primary**Connections** program significantly enhances the implementation of the curriculum units. Professional Learning Facilitators are available throughout Australia to conduct a variety of workshops. At the heart of the professional learning program is the Curriculum Leader Training Program.

Primary**Connections Curriculum Leader Training Program**

Held annually, this two-day workshop develops a comprehensive understanding of the Primary**Connections** program. Participants receive professional learning resources that can be used to train others in Primary**Connections**.

Primary**Connections one-day Introduction to** Primary**Connections Program**

This workshop develops knowledge and understanding of Primary**Connections**, and the benefits to enhance the teaching and learning of science and literacy.

The professional learning calendar, other workshops and booking forms can be found on the website: www.science.org.au/primaryconnections

PrimaryConnections®
Linking science with literacy

Order your next unit at
www.science.org.au/primaryconnections

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

PrimaryConnections®
Linking science with literacy

Primary**Connections**: Linking science with literacy is an innovative program linking the teaching of science with the teaching of literacy in primary schools.

The program combines a sophisticated professional learning program with exemplary curriculum resources.

Primary**Connections** features an inquiry-based approach, embedded assessment and incorporates Indigenous perspectives.

The Primary**Connections** curriculum resources span Years F-6 of primary school.

www.science.org.au/primaryconnections

Australian Government

Australian Academy of Science