PrimaryConnections®
Linking science with literacy

Fully aligned with the Australian Curriculum

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

What's the matter?

Year 5

Chemical sciences



Primary**Connections project**

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Australian Academy of Science

Professional learning program

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

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

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

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What's the matter?

Year 5

Chemical sciences

Matter is all around us. It can be as small as the particles that make up the tiniest cell in our skin or as large as the whole galaxy. Anything that takes up space and has mass is called matter. The matter that we experience every day and the matter that we are made of is only a tiny fraction of the matter that exists in the universe. By investigating and understanding matter, scientists are able to find out more about the universe and its possibilities.

The *What's the matter?* unit is an ideal way to link science with literacy in the classroom. Through hands-on investigations, students explore the properties of solids, liquids and gases, and plan and conduct an investigation of how the properties of materials change with temperature.

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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 do-able and sustainable. Primary**Connections** students enjoy science more than in comparison classes, and Indigenous students, in particular, show significant increases in learning using the approach.

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

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

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

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

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

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

The PrimaryConnections program

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

The PrimaryConnections teaching and learning model

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

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

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

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

Developing students' scientific literacy

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

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

Linking science with literacy

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

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

Assessment

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

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

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

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

Alignment with the Australian Curriculum: Science

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

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

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

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

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

Safety

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

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

References

Australian Curriculum Assessment and Reporting Authority (ACARA). (2012). *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

What's the matter?

Phase	Lesson	At a glance
ENGAGE	**Lesson 1** Mysterious matter	To capture students' interest and find out what they think they know about how solids, liquids and gases have different observable properties and behave in different ways. To elicit students' questions about how to identify solids, liquids and gases.
EXPLORE	**Lesson 2** See how they run! ***Session 1*** Looking at liquids ***Session 2*** *(Optional)* Runny races	To provide students with hands-on, shared experiences of the observable properties of liquids.
	Lesson 3 Solid studies	To provide students with hands-on, shared experiences of the observable properties of solids.
	Lesson 4 What a gas!	To provide students with hands-on, shared experiences of the observable properties of gases.
EXPLAIN	**Lesson 5** Sort it out	To support students to represent and explain their understanding of the observable properties of solids, liquids and gases, and how they behave in different ways. To introduce current scientific views.
ELABORATE	**Lesson 6** Hot stuff	To support students to plan and conduct an investigation of whether the observable properties of materials change with temperature.
EVALUATE	**Lesson 7** Mind your matters	To provide opportunities for students to represent what they know about how solids, liquids and gases have different observable properties and behave in different ways, and to reflect on their learning during the unit.

A unit overview can be found in Appendix 8, page 68.

Alignment with the Australian Curriculum: Science

This *What's the matter?* unit embeds all three strands of the Australian Curriculum: Science. The table below lists sub-strands and their content for Year 5. This unit is designed to be taught in conjunction with other Year 5 units to cover the full range of the Australian Curriculum: Science content for Year 5.

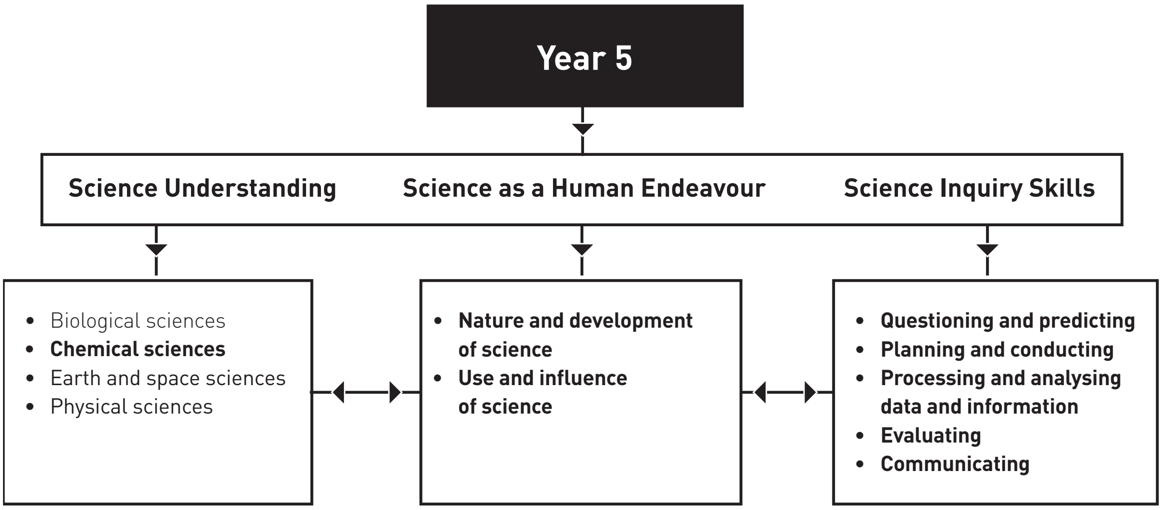
For ease of assessment the table below outlines the sub-strands and their aligned lessons.

Strand	Sub-strand	Code	Year 5 content descriptions	Lessons
Science Understanding	**Chemical sciences**	ACSSU077	Solids, liquids and gases have different observable properties and behave in different ways	1–7
Science as a Human Endeavour	**Nature and development of science**	ACSHE081	Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena	1–7
	Use and influence of science	ACSHE083	Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples lives	7
Science Inquiry Skills	**Questioning and predicting**	ACSIS231	With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be	1–6
	Planning and conducting	ACSIS086	With guidance, plan appropriate investigation methods to answer questions or solve problems	4, 6
		ACSIS087	Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate	4, 6
		ACSIS088	Use equipment and materials safely, identifying potential risks	2–6
	Processing and analysing data and information	ACSIS090	Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate	2, 3
		ACSIS218	Compare data with predictions and use evidence in developing explanations	3–7
	Evaluating	ACSIS091	Suggest improvements to the methods used to investigate a question or solve a problem	6, 7
	Communicating	ACSIS093	Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts	3–7

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 *What's the matter?* these overarching ideas are represented by:

Overarching idea	Incorporation in *What's the matter?*
Patterns, order and organisation	Students develop criteria for identifying and classifying materials as solids, liquids or gases based on their observable properties.
Form and function	Students explore properties of materials and relate them to their use or function.
Stability and change	Students investigate whether properties of materials change at different times and review how materials change state.
Scale and measurement	Students use formal measurement to quantify properties such as density.
Matter and energy	Students investigate how increasing thermal energy (temperature) of materials affects their properties and what state they are in.
Systems	Students explore how materials interact to form composite materials and objects with particular properties.

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 *What's the matter?*
Recognising questions that can be investigated scientifically and investigating them	Students discuss properties of materials that can be investigated scientifically and pose questions for investigation. They use science inquiry skills to conduct fair tests of how properties of materials can vary.

Achievement standards

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

By the end of this unit, teachers will be able to make evidence-based judgments on whether the students are achieving below, at or above the Australian Curriculum: Science Year 5 achievement standard.

General capabilities

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

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

What's the matter?—Australian Curriculum general capabilities

General capabilities	Australian Curriculum description	*What's the matter?* 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 *What's the matter?* the literacy focuses are: • word walls • science chat-boards • science journals • tables • annotated drawings • factual texts.
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 • use measurement in their fair tests.
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: • create tables using software • design and produce cards for team games using software.
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 • consider different ways of thinking about solids, liquids and gases • develop evidence-based claims about how the properties of materials can differ.
Ethical behaviour	Students develop ethical behaviour as they explore principles and guidelines in gathering evidence and consider the implications of their investigations on others and the environment.	Students: • ask questions of others respecting each other's point of view.
Personal and social competence	Students develop personal and social competence as they learn to work effectively in teams, develop collaborative methods of inquiry, work safely, and use their scientific knowledge to make informed choices.	Students: • work collaboratively in teams • 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.

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

Aboriginal and Torres Strait Islander histories and cultures

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

What's the matter? focuses on the Western science way of distinguishing different states for the same material, for example, water can be a solid (ice), a liquid or a gas (steam). Scientists recognise each state by properties that define it, such as fluidity and compressibility.

Aboriginal and Torres Strait Islander Peoples might have other ways of understanding the world around them and the relationships between things. They might order the world according to holistic principles from the Dreamtime.

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

Sustainability

The *What's the matter?* 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 Mathematics

Strand	Sub-strand	Code	Year 5 content descriptions	Lessons
English–Language	**Language variation and change**	ACELA1500	Understand that the pronunciation, spelling and meaning of words have histories and change over time	1
	Language for interaction	ACELA1502	Understand how to move beyond making bare assertions and take account of differing perspectives and points of view	3, 4, 5, 6, 7
	Text structure and organisation	ACELA1504	Understand how texts vary in purpose, structure and topic as well as the degree of formality	1, 2, 3, 4, 5, 6, 7
	Expressing and developing ideas	ACELA1512	Understand the use of vocabulary to express greater precision of meaning, and know that words can have different meanings in different contexts	1, 7
English–Literacy	**Interacting with others**	ACELY1699	Clarify understanding of content as it unfolds in formal and informal situations, connecting ideas to students' own experiences and present and justify a point of view	1, 3, 4, 5, 6
		ACELY1796	Use interaction skills, for example paraphrasing, questioning and interpreting non-verbal cues and choose vocabulary and vocal effects appropriate for different audiences and purposes	1, 3, 4, 5, 6, 7
	Interpreting, analysing, evaluating	ACELY1703	Use comprehension strategies to analyse information, integrating and linking ideas from a variety of print and digital sources	1, 2, 3, 4, 5, 6
	Creating texts	ACELY1704	Plan, draft and publish imaginative, informative and persuasive print and multimodal texts, choosing text structures, language features, images and sound appropriate to purpose and audience	7
		ACELY1707	Use a range of software including word processing programs with fluency to construct, edit and publish written text, and select, edit and place visual, print and audio elements	7
Mathematics–Number and Algebra	**Number and place value**	ACMNA291	Use efficient mental and written strategies and apply appropriate digital technologies to solve problems	1, 2, 3, 5, 6
Mathematics–Measurement and Geometry	**Using units of measurement**	ACMMG108	Choose appropriate units of measurement for length, area, volume, capacity and mass	2, 3, 5, 6
Mathematics–Statistics and Probability	**Data representation and interpretation**	ACMSP118	Pose questions and collect categorical or numerical data by observation or survey	1, 6
		ACMSP119	Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies	2, 3, 5, 6
		ACMSP120	Describe and interpret different data sets in context	3, 5, 6

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

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

Teacher background information

Introduction to states of matter

Matter

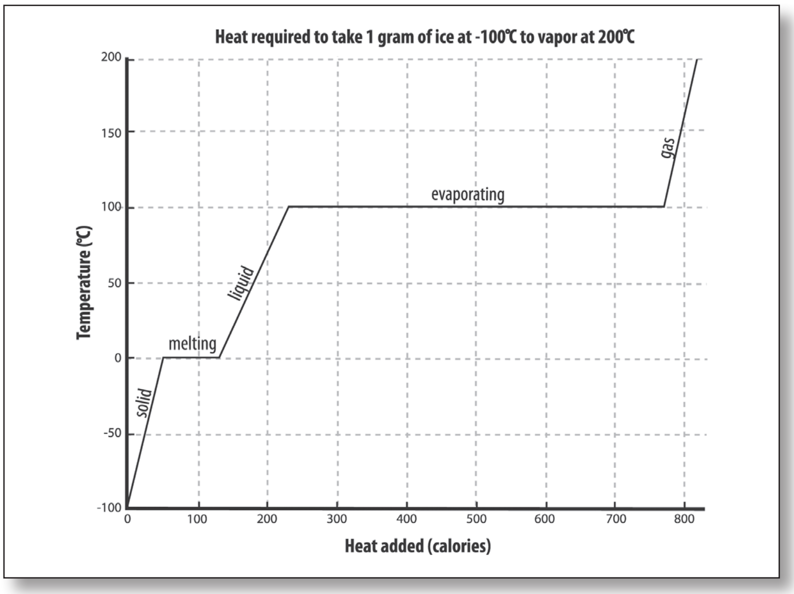
All matter is made up of very small particles called atoms. These atoms can join with other atoms to form molecules. While some atoms, such as silver, gold and metals, exist as material entities, the overwhelming components of matter are molecules. Water is made up of water molecules, a combination of 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, such as 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 possess determines its state of matter. A substance will exist as a particular state of matter in particular temperature and pressure conditions. These are specific to the substance, for example, at room temperature and normal air pressure water can be found as a liquid and iron is found as a solid. Increasing the temperature eventually changes solids to liquids (the iron will melt) and liquids to gas (the water will become vapour).

- **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 looser bonds that allow atoms or molecules to slide past each other. 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. Due to the force of gravity a liquid flows and takes the shape of the container into which it is poured.
- **Gases** have particles that are not held together with bonds. In the right conditions they can spread out and fill any available container. They can also be compressed.



Properties of materials

The Australian Curriculum: Science defines 'material' as a substance with particular qualities or that is used for specific purposes. As such, the term 'material' will be used in this unit to define what substances objects are made of. For example, a window (object) is made from glass (material) and a soft drink bottle (object) is made from plastic (material).

Materials have properties that can be used to describe and classify them. The properties of materials come from the chemical and physical nature of the molecules that are used to make them. Scientists use properties such as fluidity and compressibility to distinguish between solids, liquids and gases, however there are many other properties that can be studied, such as the absorbency, elasticity, strength and transparency of solid materials or the viscosity of liquids.

Some materials are composite materials, that is they are made of several different substances or materials. For example, foam rubber is made of polyurethane (a solid material) which is wrapped around pockets of air (a gas). The composite materials might have properties that come from their different materials, for example, foam rubber keeps its shape like a solid and is elastic (returns to its original shape after deformation) because of the polyurethane and it is compressible because of the gas trapped inside it.

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 a rubber ball or a thin plastic sheet is solid in terms of how scientists use this word. 'Solid' is also recognised as an adjective denoting something 'good' or 'great' in some Australian English dialects.

Students might have difficulty recognising crushed or powdered solids as being solids, particularly since they might identify liquids through their ability to pour. Pouring is a consequence of flowing, which is the property of a fluid, but it is also possible to 'pour' small solids (beans) or powders. The difference is that when powders are poured they land in a heap and need to be shaken to settle, whereas liquids flow under the effect of gravity to take on the shape of the container.

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. 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.

Students might not have many conceptions about gas. When asked about gases they might provide examples of uses of gas, for example, 'gas flame', rather than examples of gases, for example, methane. Some students identify gas as dangerous or flammable and do not recognise that air is a gas.

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, Volume 11(2), Article 13.

Hapkiewicz, A. (1992). 'Finding a List of Science Misconceptions', MSTA Newsletter, 38 (Winter'92), pp. 11–14.

Krnel, D., Watson, R., and Glazar, S. (1998). 'Survey of research related to the development of the concept of matter', International Journal of Science Education, 20 pp. 257–289.

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

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

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

Lesson 1 Mysterious matter

ENGAGE

AT A GLANCE

To capture students' interest and find out what they think they know about how solids, liquids and gases have different observable properties and behave in different ways.

To elicit students' questions about how to identify solids, liquids and gases.

Students:

- explore different materials
- vote and explain their ideas on whether they think the materials are solids, liquids or gases
- contribute to the start of a class science chat-board.

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 solids, liquids and gases have different observable properties and behave in different ways.

You will also monitor their developing science inquiry skills (see page 3).

Key lesson outcomes

Science

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

- vote on whether they think materials are solids, liquids and/or gases
- explain what they think solids, liquids and gases are
- contribute to discussions about solids, liquids and gases
- identify questions about solids, liquids and gases and how they are classified.

Literacy

Students will be able to:

- identify the purpose and features of a science chat-board and word wall
- record their reasoning about solids, liquids and gases
- review the results of tallies
- understand the purpose and features of the class science chat-board and word wall.

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

Teacher background information

In this lesson students are asked to vote on whether they think each of the substances in the containers are solids, liquids or gases. The following is for teachers' information only:

- Container 1: stones = Solid (hard solid)
- Container 2: icing sugar = Solid (powdered solid)
- Container 3: play-doh = Solid (soft solid)
- Container 4: elastic bands = Solid (stretchy solid)
- Container 5: cooking oil = Liquid
- Container 6: honey = Liquid
- Container 7: air = Gas
- Container 8: psyllium gel = has properties of both a Solid and a Liquid

Psyllium

Psyllium is a plant from the grass family. When its seed husks are mixed with water, they form a gel which can swell up to ten times the original volume. Psyllium husks are often used medicinally to assist with weight loss and to improve bowel health, and can be purchased from health food shops and some supermarkets in the cereal or health food section.

Equipment

FOR THE CLASS

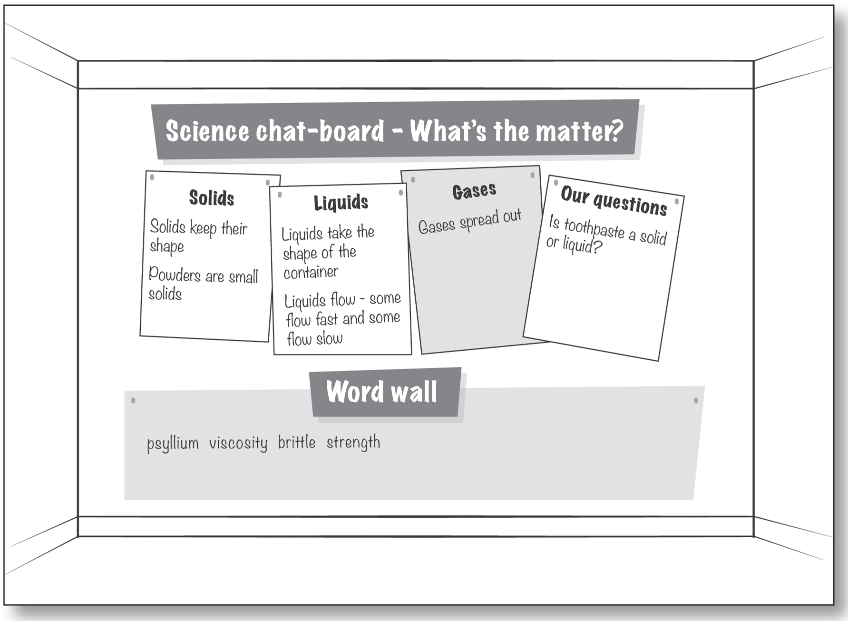
- class science journal
- word wall
- 5 large sheets of paper
- science chat-board (see 'Preparation')
- 8 transparent containers with lids
- materials to place in containers: stones, icing sugar, play-doh, elastic bands, cooking oil, honey
- 200 g of psyllium husks
- 200 mL water
- 1 enlarged copy of 'Voting matters' (Resource sheet 1)
- self-adhesive notes

FOR EACH STUDENT

- science journal
- 1 copy of 'Voting matters' (Resource sheet 1)

Preparation

- Prepare an enlarged copy of 'Voting matters' (Resource sheet 1).
- *Optional:* Display 'Voting matters' (Resource sheet 1) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).
- Read 'How to use a word wall' (Appendix 3).
- Prepare five large sheets of paper (join two A3 sheets together or use butcher's paper). Write the titles 'Solid', 'Liquid', 'Gas', 'Our questions' and 'Word wall' on the top of the sheets.



Science chat-board sample

To support students to organise their ideas, display these charts so that you and your students can record keywords, pictures, questions, ideas and reflections on each chart using self-adhesive notes. Collectively, these charts are the science chat-board for this unit.

Note: These sheets will represent students' understanding about states of matter at the beginning of the unit. As the unit progresses, students will collect evidence and information about solids, liquids and gases. Encourage students to use this evidence to change, confirm and provide reasons for their understanding by adding their thoughts to the science chat-board. For example, students might use different-coloured paper or self-adhesive notes to cover their initial thoughts about solids, liquids and gases.

- *Optional:* The questions and self-adhesive notes could be colour coded to identify the different sections of the science chat-board or different colours could be used to represent questions, key words, ideas and thoughts.
- Prepare psyllium gel for the class by mixing the husks (200 g) with water (200 mL) and allowing the mixture to thicken.
- *Optional:* Add colour to the psyllium gel using non-allergenic food colouring.
- SAFETY: Check for any students' allergies to psyllium.
- Create eight transparent containers with lids containing the following:
    - Container 1: stones
    - Container 2: icing sugar
    - Container 3: play-doh
    - Container 4: elastic bands
    - Container 5: cooking oil
    - Container 6: honey
    - Container 7: air
    - Container 8: psyllium gel
- *Optional:* Display the class science journal and class science chat-board on an interactive whiteboard or on a computer connected to a projector. If you have a whiteboard that has a voting system, use it to collect students' votes.

Lesson steps

1. Introduce the containers (see 'Preparation') and explain that you will be asking students to investigate the contents of each container and vote on whether they think each one is a solid, liquid or gas.
2. Introduce an enlarged copy of 'Voting matters' (Resource sheet 1) and model how to vote by placing a tally in the appropriate column. Discuss the second section of the resource sheet and explain that students will write and/or draw the properties or what helps them to decide if something is a solid, a liquid or a gas.
3. Allow time for students to examine each container, vote for whether they think each is a solid, liquid or gas, and then write the properties that help them determine each state.

SAFETY

Remind students not to smell or eat things without permission. Explain that it is safe to smell these things. Ask students not to taste them for hygiene reasons.

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

4 Ask students to reveal their vote for the material in each container. Tally students' votes in the class science journal.

Solid, liquid or gas?	Solid	Liquid	Gas
Container 1	卌 卌 卌 卌		
Container 2	卌 卌 卌	卌	
Container 3	卌	卌 卌 卌	

Class tally of students' votes sample

5 As a class, discuss the results. Discuss challenges they encountered. Explain to students that as they learn more about solids, liquids and gases they might wish to change their vote and will be able to do so at the end of the unit.

6 As a class, discuss the properties of the contents of each container that helped students decide if it is a solid, liquid or gas. Introduce the large sheets of paper titled 'Solid', 'Liquid' and 'Gas' on the class science chat-board. Discuss the purpose and features of a science chat-board.

Literacy focus

Why do we use a science chat-board?

A **science chat-board** is a display area where we share our changing questions, ideas, thoughts and findings about a science topic.

What does a science chat-board include?

A **science chat-board** might include dates and times, written text, drawings, measurements, labelled diagrams, photographs, tables and graphs.

7 Write descriptive words on cards or paper strips. Place words on the word wall section of the class science chat-board (see 'Preparation'). Discuss the purpose and features of a word wall.

Literacy focus

Why do we use a word wall?

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

What does a word wall include?

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

Invite students to contribute words from different languages to the word wall, reminding them that Standard Australian English is one of many social dialects used in Australia.

8 Introduce the 'Our questions' section of the class science chat-board. Ask students to record any questions they have about solids, liquids and gases on this section of the science chat-board, for example, using self-adhesive notes so they can be grouped.

9 Ask students if they have any further words for the word wall section of the class science chat-board.

Voting matters

Name: ______________________________ **Date:** ____________

Container	Solid?	Liquid?	Gas?
1: stones			
2: icing sugar			
3: play-doh			
4: elastic bands			
5: cooking oil			
6: honey			
7: air			
8: mystery material			

How would you describe solids, liquids and gases? Write and/or draw your thoughts.

Solids are:
Liquids are:
Gases are:

I had trouble describing ______________________ **because** ______________________

____

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Lesson 2 See how they run!

EXPLORE

AT A GLANCE

To provide students with hands-on, shared experiences of the observable properties of liquids.

Session 1 Looking at liquids

Students:

- explore and record in a table the properties of different liquids
- identify properties that are shared by liquids
- discuss how liquids flow and take the shape of their containers.

Session 2 *(Optional)* Runny races

Students:

- discuss how to set up an investigation of the viscosity of liquids
- work in teams to explore the viscosity of materials.

Lesson focus

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

Assessment focus

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

- how liquids have observable properties that distinguish them from solids and gas, as well as properties that vary between liquids.

Key lesson outcomes

Science

Students will be able to:

- observe the properties of liquids
- identify that liquid materials flow and take the shape of their container
- identify the features of a fair test and predict which liquid is the most viscous
- work in teams to explore the viscosity of liquid materials
- review the investigation.

Literacy

Students will be able to:

- understand the purpose and features of a science journal
- record their observations of the properties in a table
- discuss and compare results to form common understandings.

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

Teacher background information

Properties of liquids

All liquids flow; under the influence of gravity they will spread out and take the shape of the container that they are in or spread out on a flat surface. However, not all liquids flow the same way. The viscosity of a liquid is a measure of its resistance to flowing. A liquid with a high viscosity, for example, cold honey will flow slowly. A liquid with low viscosity, for example, cooking oil will flow quickly and easily. How easily a liquid flows is related to its chemical structure, including the size and shape of the atoms or molecules and the strength of the bonds between them. The viscosity of a liquid is also affected by the temperature. Most liquids will flow more easily at higher temperatures than lower temperatures.

All liquids occupy a definite volume of space. The density of atoms can vary and therefore liquids have different weights for the same volume (density). Oil is less dense than water, which is why it floats on the surface of the ocean during oil spills.

Students' conceptions

Students might think that all liquids are water or contain water. Many common liquids, such as cordials and milk are suspensions of particles in water and behave similarly 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.

EXPLORE

Session 1 Looking at liquids

Equipment

FOR THE CLASS

- class science journal
- class science chat-board
- team skills chart
- team roles chart
- word wall

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- ½ cup of liquids (eg, lemonade, fruit juice, water, milk, washing up liquid) (see 'Preparation')
- ½ cup of powdered laundry detergent
- 1 spoon
- 10 plastic transparent cups
- 1 timing device (eg, a stopwatch or a watch with a second hand)

Preparation

- Read 'How to use a science journal' (Appendix 2).
- 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 role wristbands or badges and the equipment table.
- Read 'How to facilitate evidence-based discussions' (Appendix 4).
- Collect a selection of liquids, enough of each for each team to have approximately 2 tablespoons each. For example, lemonade, milk, water, fruit juice, cooking oil, vinegar, washing up liquid.

Lesson steps

1 Review the previous lessons using the class science journal and class science chat-board. Focus students' attention on their ideas about liquids.

2 Ask students to brainstorm as many liquids as possible. List responses in the class science journal. Discuss the purpose and features of a science journal.

Literacy focus

Why do we use a science journal?

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

What does a science journal include?

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

3 Ask students to think of words to describe the properties of the liquids. Ask students questions, such as:

- Are there any liquids that don't have water in them? Name them.
- What are some liquids that are thick, and some that are thin?

Record students' responses in the class science journal.

4 Introduce the collected liquids and powdered laundry detergent (see 'Preparation'). Explain that students will be working in collaborative learning teams to explore all of the substances to decide which are liquids. Ask teams to think of three or more things that help them decide which are not liquids (the powdered laundry detergent is the only one that is not a liquid).

5 Discuss the types of things that students might look at or do to help make their decision, such as: turning the container upside down; shaking the container; using a magnifying glass to look carefully at each material; tipping the container and seeing how long the substance takes to flow to the other end; pouring the substances into a new cup and observing what happens as they flow into the cup.

6 Form teams and allocate roles. Ask Managers to collect team equipment. If students are using collaborative learning teams for the first time, introduce and explain the team skills chart and the team roles chart.

7 Allow time for students to conduct the investigation and record their results.

8 Ask Speakers to share their team findings, as follows:

Our claim is that ________________is not a liquid. Our evidence is: ________________.

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

10 Ask students to help write a conclusion in the class science journal of what they have found out about liquids. For example:

The common properties of liquids that we found are: ______________________.

Some of the things that are different between liquids are: _________________.

We had difficulty describing _________________ because _________________.

11 Update the 'Liquids' section of the class science chat-board with what students have learned.

12 Review the 'Our questions' section of the class science chat-board and answer any questions that can be answered. Record what students have learned next to the question and how they came to that conclusion.

13 Update the word wall section of the class science chat-board with words and images.

EXPLORE

Session 2 Runny races *(Optional)*

Equipment

FOR THE CLASS

- class science journal
- class science chat-board
- team skills chart
- team roles chart
- word wall
- 1 enlarged copy of 'Runny investigation planner' (Resource sheet 2)'
- containers of cooking oil and honey from Lesson 1
- container of water

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- 1 copy of 'Runny investigation planner' (Resource sheet 2)
- 2 tablespoons cooking oil
- 2 tablespoons water
- 2 tablespoons honey
- 3 tablespoons
- 3 cups
- 1 timing device (eg, a stopwatch or a watch with a second hand)

Preparation

- Prepare an enlarged copy of 'Runny investigation planner' (Resource sheet 2).
- *Optional:* Display 'Runny investigation planner' (Resource sheet 2) 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.primaryconnections.org.au).

Lesson steps

1. Review the previous lessons using the class science journal and class science chat-board. Focus students' attention on their ideas about liquids.
2. Introduce the containers of cooking oil, water and honey. Ask students to observe the liquids in the three jars. Ask questions, such as:
   - What is the same about the liquids?
   - What is different about the liquids?
3. Introduce the term 'viscosity' and discuss what it means (a liquid's resistance to flowing). Records students' ideas in the class science journal on whether all liquids have the same viscosity.
4. Brainstorm with students how we might measure the viscosity of the liquids. Record students' ideas in the class science journal. For example:
   - Put a hole in the bottom of a polystyrene cup and time how long it takes the liquid to run out.

- Time how long it takes for the liquids to run down an incline.
- Turn the bottles upside down and time how long it takes for the liquids to run the length of the bottles.

5 Ask students to order the liquids from the least viscous to the most viscous. Record ideas in the class science journal.

6 Ask teams to choose how to investigate the viscosity of liquids. Discuss how to keep the investigation fair.

7 Discuss with students how they could record their results, for example, in a table. Model drawing a table in the class science journal and discuss headings. Ask students to draw a table in their science journal to record results.

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

9 Allow time for students to conduct the investigation and record their results.

10 Ask Speakers to share their team findings with the class. Ask students in the audience to use the 'Science question starters' (see Appendix 4) to ask each team about their investigation.

11 As a class, discuss what conclusions can be drawn from the collected results. Ask students if we can compare the results. Why/Why not?

12 Update the 'Liquids' section of the class science chat-board with what students have learned.

13 Review the 'Our questions' section of the class science chat-board and answer any questions that can be answered. Record what students have learned next to the question and how they came to that conclusion.

14 Update the word wall section of the class science chat-board with words and images.

Curriculum links

Information and Communication Technology (ICT)

- Video the flow of each of the liquids and observe similarities and differences.

Runny investigation planner

Name: ______________________ **Date:** ______________

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

To make this a fair test what things (variables) are you going to:		
Change? Change only one thing	Measure? What would the change affect?	Keep the same? Which variables will you control?

What equipment will you need? Use dot points	What are you going to do? Use drawings if necessary

Lesson 3 Solid studies

AT A GLANCE

To provide students with hands-on, shared experiences of the observable properties of solids.

Students:

- explore the properties of different solid materials
- record their observations in a table
- identify properties that are shared by solids
- identify that powders are solids based on their observable properties.

EXPLORE

Lesson focus

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

Assessment focus

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

- how solids have observable properties that distinguish them from liquids and gas, as well as properties that vary between solids.

Key lesson outcomes

Science

Students will be able to:

- observe the properties of solids
- review the investigation and identify further questions for investigation
- work in teams to safely use appropriate equipment
- identify that powders are solids using evidence-based claims.

Literacy

Students will be able to:

- record their observations of the properties of solids in a table
- discuss and compare results.

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

Teacher background information

Properties of solid materials

In this lesson, students will be examine the materials from which several different objects are made. These materials are all classified as solids by scientists. Students will subject the objects to some tests in order to explore the properties (physical characteristics or attributes) of the solid materials. Properties that students might explore include:

Strength: a material's ability to resist forces applied to it. The more force a material can resist, the stronger it is. Tensile strength refers to a material's ability to withstand being pulled end from end, while compressive strength refers to a material's ability to withstand being compressed or squashed. Examples of strong materials include: steel, concrete.

Hardness: how easily the substance is worn away or scratched. Diamond is the hardest naturally occurring substance known, and can only be scratched by another diamond. Examples of hard materials include: diamonds, ceramic, concrete, steel, tusks, teeth.

Brittleness: a material is brittle if it is hard but breaks easily (like glass). Examples of brittle materials include: polystyrene, glass, ceramic, crystal.

Elasticity: a material is elastic if it changes shape when a force is applied to it and recovers its original shape when the force is removed. Rubber and many types of plastics are very elastic.

Malleability: how easily a material can be bent or shaped. A material that can be deformed or reshaped easily is said to be malleable. Examples of malleable materials include: gold, aluminium foil, play-doh, clay, brass.

Note: These terms are for teacher information only. Students are only required to use descriptions, such as squash, scratch, break, stretch, reshape.

Powders

Scientists classify materials as solids or liquids, not objects. Size is a characteristic of an object; it does not depend on the material that it was made from. For example, a ball can be the same shape and size irrespective of whether it is made from lead or leather.

Powders are made from solid materials; however, the objects themselves (the grains of powder) are very small. Each grain of powder keeps its shape, but as a group they behave like liquids because they can pour and fill containers. Powders do not spread out under the force of gravity; when poured they form heaps and often have to be shaken to take on the form of the container they are in.

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

Students' conceptions

The word 'solid' is used differently in everyday language from 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, for example, tennis balls, are classified as solids by scientists. Similarly, some students might believe that solids must be rigid and hard whereas scientists classify materials, such as paper and sponges, as solids. This is because 'solid' describes properties at the molecular level.

Students often find granular substances, such as sand and sugar, difficult to classify, particularly since they rarely examine individual grains. Some students refer to the size of the object when deciding if something is a solid or a liquid.

Equipment

FOR THE CLASS

- class science journal
- class science chat-board
- team skills chart
- team roles chart
- word wall
- 1 enlarged copy of 'Solid science' (Resource sheet 3)

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- 1 copy of 'Solid science' (Resource sheet 3)
- magnifying glass
- selection of solids (eg, soap, chalk, play-doh, a stone, a block of wood, a sponge, jelly snake, elastic band, marbles, flour, laundry powder, rice) (see 'Preparation')

Preparation

- Collect a selection of solids, such as soap, chalk, play-doh, a stone, a block of wood, a sponge, jelly snake, elastic band, marbles, flour, laundry powder, rice.
- Prepare an enlarged copy of 'Solid science' (Resource sheet 3).
- *Optional:* Display 'Solid science' (Resource sheet 3) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

Lesson steps

1 Review the previous lesson using the class science journal and class science chat-board. Focus students' attention on their ideas about the properties of materials.

2 Introduce the display of solid materials (see 'Preparation'). Ask students to describe some of the properties of the samples.

3 Introduce the enlarged copy of 'Solid science' (Resource sheet 3). Explain that students will be working in collaborative learning teams to explore some of the properties of the materials that the objects are made from and compare them with properties of liquids. Explain that students will be filling out a table to record what happened to each material for each test. Discuss the purpose and features of a table.

4 Brainstorm other tests that students might perform. Discuss what students could look at to help gather evidence on whether powders are a solid or a liquid (use a magnifying glass).

5 Model how to complete an entry for one of the materials.

6 Discuss with students what they think the word 'hard' means. Discuss that scientists consider hard to mean how easily a substance is scratched or worn away. For example, the hardest substance in the world is a diamond, and it can only be scratched by another diamond. Explain that in this investigation students will use the scientific definition of hard.

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

8 Allow time for teams to complete their investigations and record their results.

9 Ask Speakers to share their team's findings. Ask students in the audience to use the 'Science question starters' (see Appendix 4) to ask each team about their investigation. Record an agreed class results table on the enlarged copy of 'Solid science' (Resource sheet 3).

10 As a class, discuss the investigation, asking questions, such as:

- What do the different solids have in common?
- What is different about them?
- Are powders solids? How do we know? What properties do they have in common with other solids?

11 Update the 'Solids' section of the class science chat-board.

EXPLORE

12 Review the 'Our questions' section of the class science chat-board and answer any questions that can be answered. Record what students have learned next to the question and how they came to that conclusion.

13 Update the word wall section of the class science chat-board with words and images.

Curriculum links

Technology

- Use computer software to create tables.

EXPLORE

Solid science

Team members' names: ______________________________ **Date:** __________

	Liquids	**Solids**					
Test	Water						
Is it hard? (Can it be scratched?)							
Is it runny?							
Does its shape change easily?							
Does it pour easily?							
Does its shape depend on the container it's in?							
Can it be stirred?							
Is it easy to squash?							
Can it be stretched?							

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Lesson 4 What a gas!

AT A GLANCE

To provide students with hands-on, shared experiences of the observable properties of gases.

Students:

- identify that air is made up of gases and that it takes up space
- work in collaborative learning teams to change one variable in a fair test investigation about air
- compare air and water and discuss how gases spread out to fill their container.

EXPLORE

Lesson focus

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

Assessment focus

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

- how gases have observable properties that distinguish them from liquids and solids.

EXPLORE

Key lesson outcomes

Science

Students will be able to:

- make predictions, provide evidence for their predictions and compare them with results
- identify the features of a fair test and choose which variable to change
- work in teams to safely use appropriate equipment to complete an investigation
- identify that gases take up space and fill the container they are in using evidence-based claims.

Literacy

Students will be able to:

- discuss and compare results to form common understandings.

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

Teacher background information

Gases

When a liquid is heated sufficiently, its atoms or molecules are so energised that they separate from each other and only have weak interactions. Gases have much more space between their atoms or molecules and are therefore generally hard to see, although a few can have a slight coloured tinge. It is easier to see the effects of a gas, for example, by looking at the movements of tiny ash particles in smoke as they float in the air.

Because the atoms or molecules are not bound strongly together, gases spread out and fill the container that they are in. They have comparably low viscosity and density and can be compressed, unlike solids and liquids. Gases vary in how much they can be compressed, the property of compressibility. If the compression from external pressure is strong enough and/or the temperature is low enough, gases will revert to liquid form.

Air

Air is the name we give to gases that surround the Earth and are kept close to the surface by Earth's gravity. Air primarily contains nitrogen (78.1%), oxygen (20.9%) and argon (0.9%). It also contains trace amounts if other gases, such as water vapour, carbon dioxide, methane and ozone, which are gases that contribute significantly to the greenhouse effect (keeping some of the heat from Earth from dissipating into space). There might also be trace elements from industrial manufacturing, such as chlorine and fluorine compounds, mercury or sulphur dioxide. The relative concentrations of these pollutants determine air quality. There might also be fine particle of solids floating in the air, such as dust or pollen.

Gases have mass and weight. However, it is hard to demonstrate this in the classroom since air surrounds all the measurement devices, just as a fish couldn't use scales to measure the weight of water when it is surrounded by water.

Students' conceptions

Students might not associate gases with matter. They might not think that gases take up space or have mass and weight. They also might not associate air with gases.

Equipment

FOR THE CLASS

- class science journal
- class science chat-board
- team skills chart
- team roles chart
- word wall
- 1 enlarged copy of 'Tissues in a cup' (Resource sheet 4)
- 1 plastic transparent cup
- 1 balloon filled with air
- 1 balloon filled with water

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- 1 copy of 'Tissues in a cup' (Resource sheet 4)
- 2 plastic transparent cups
- 2 tissues
- 1 deep container
- water to fill the container

Preparation

- This activity involves water; if possible identify an outdoor area for students to conduct their investigations.
- Fill balloons with water and air.
- *Optional:* Ask students to fill the balloons themselves if you have the time and support to help them tie ends without squirting water everywhere.
- Prepare an enlarged copy of 'Tissues in a cup' (Resource sheet 4).
- *Optional:* Display 'Tissues in a cup' (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.primaryconnections.org.au).

Lesson steps

1 Review the previous lessons using the class science journal and class science chat-board. Focus students' attention on their ideas about gases.

2 Ask students if they can give examples of any common gases. Introduce the balloons filled with air (see 'Preparation'). Discuss what is in the balloons (air) and how it is a combination of several different gases including nitrogen, oxygen and carbon dioxide (see 'Teacher background information').

3 Ask students if the balloon is a solid or a liquid and why they think that. Discuss how the gas in the balloon is bounded by the balloon, which is a solid. Ask students if they can think of other examples where a gas is bounded by a solid (eg. Gases in an exhaust pipe; air in a basketball; air in a bicycle tube).

4 Introduce the transparent cup and ask students if they think there is anything inside it. Tip the cup upside down and repeat the question.

5 Explain that students are going to work in collaborative learning teams to explore the properties of gas.

6 Introduce the enlarged copy of 'Tissues in a cup' (Resource sheet 4). Read through with students and model how to complete if necessary. Remind students to provide reasons for their predictions.

7 Ask students to complete an annotated drawing to show what happened. Discuss the purpose and features of an annotated drawing.

EXPLORE

Literacy focus

Why do we use an annotated drawing?

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

What does an annotated drawing include?

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

8 Form teams and allocate roles. Ask teams to complete their planning for their investigation in their copy of 'Tissues in a cup' (Resource sheet 4).

9 Ask Managers to collect team equipment. Allow time for students to conduct the investigation and record their results.

10 Ask Speakers to share their team's findings with the class. Ask students in the audience to use the 'Science question starters' (see Appendix 4) to ask each team about their investigation.

11 As a class, discuss what conclusions can be drawn from the investigation. For example: 'The tissue stayed dry because air takes up the space between it and the water'.

12 After teams have shared their ideas with the class, discuss how air takes up space and fills the container it is in. Ask questions, such as:

- Where would the air go if I opened this balloon?
- Where would the water go?

13 Update the 'Gases' and Liquids' sections of the class science chat-board.

14 Review the 'Our questions' section of the class science chat-board and answer any questions that can be answered. Record what students have learned next to the question and how they came to that conclusion.

15 Update the word wall section of the class science chat-board with words and images.

Tissues in a cup

Team members' names: ______________________ **Date:** __________

What do you need?

- one deep container
- two tissues
- water to fill the container
- two plastic, transparent cups

Investigation 1

What are you going to do?	Draw an annotated drawing to explain what happened.
1. Fill the container with water. 2. Place one tissue in the bottom of a plastic cup. 3. Turn the cup upside down and place the lip of the cup as flat as possible on the surface of the water and press the cup down into the water. 4. Remove the cup from the water and examine the tissue. **What do you predict will happen?**	

Investigation 2

What are you going to do?	Draw an annotated drawing to explain what happened.
1. Repeat steps 1 and 2 above. 2. Slowly tilt the cup and observe. 3. Remove the cup from the water and examine the tissue. **What do you predict will happen?**	

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Lesson 5 Sort it out

AT A GLANCE

To support students to represent and explain their understanding of the observable properties of solids, liquids and gases, and how they behave in different ways. To introduce current scientific views.

Students:

- discuss claims about solids, liquids and gases
- work in teams to sort materials according to what they have learned about solids, liquids and gases
- read and discuss a text about solids, liquids and gases.

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

- how solids, liquids and gases have different observable properties and behave in different ways.

You will also monitor their developing science inquiry skills (see page 3).

You are also able to look for evidence of students' use of appropriate ways to represent what they know and understand about solids, liquids and gases, and give them feedback on how they can improve their representations.

Key lesson outcomes

Science

Students will be able to:

- make and discuss evidence-based claims about solids, liquids and gases
- work in teams to sort materials according to their properties
- identify how to distinguish solids, liquids and gases.

Literacy

Students will be able to:

- discuss and compare results
- read and discuss a text about solids, liquids and gases
- discuss how to find answers to questions that they might have.

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
- class science chat-board
- team skills chart
- team roles chart
- word wall

FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- 1 copy of 'States of matter' (Resource sheet 5)

Preparation

- Read 'States of matter' (Resource sheet 5) and decide how you will use it with your class. It might be used as an independent reading task, in teams or in guided reading groups.

Lesson steps

1. Review the previous lessons using the class science journal and word wall. Focus students' attention on what they recorded about solids, liquids and gases.
2. Ask students to think of a description of each of the terms – solid, liquid and gas. Ask students to write each description on one piece of paper. Encourage students to think about what they have learned about solids, liquids and gases so far in this unit.
3. Explain that students will work in collaborative learning teams to devise a description of each of the terms – solid, liquid and gas – by using each team member's ideas.
4. Form teams and allocate roles.
5. Ask Speakers to share their teams' description of a solid, liquid and gas with the class.

6 Introduce the description ‘Solids hold their shape and do not flow’. Discuss how this compares with each teams’ definition. Discuss whether the collected evidence supports this claim. Record the claim and evidence to support it in the class science journal.

7 Introduce the description ‘Liquids are runny and flow to take the shape of the container’ and discuss whether the collected evidence supports this concept. Record the claim and evidence to support it in the class science journal. Discuss how it is not the speed at which something flows but the fact that it does flow that defines a liquid.

8 Introduce the description ‘Gases take up space and fill up the container that they are in’ and discuss whether the collected evidence supports this concept. Record the claim and evidence to support it in the class science journal.

9 Explain that students will read a factual text about states of matter: solids, liquids and gases. They will use what they learn to help them to classify the samples of materials from Lesson 1. Discuss the purpose and features of a factual text.

Literacy focus

Why do we use a factual text?

We use a **factual text** to inform, teach or persuade someone reading it. We can read a factual text to collect information.

What does a factual text include?

A **factual text** includes a title, text and pictures.

EXPLAIN

10 Arrange for students to read ‘States of matter’ (Resource sheet 5) individually, in teams or in guided reading groups (see ‘Preparation’).

11 After students have read the text, ask them to brainstorm the key points and record them in their science journal.

12 Discuss the text as a class, asking questions, such as:

- What have we learned about materials?
- Does this change your ideas about solids, liquids and gases? Why?

13 Discuss the eight containers in Lesson 1 where students voted on whether they thought each was a solid, liquid or gas. Explain that students are going to work in collaborative learning teams to classify the eight containers from Lesson 1 as solids, liquids or gases and to provide reasons for their classification.

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

15 Allow time for students to complete the activity. Ask questions, such as:

- Why do you think that powder is a solid and not a liquid?
- What test did you do to decide that honey is a liquid?

16 Ask Speakers to share their team’s classifications with the class. Ask students to say if they have changed their original vote and if so, why. For example, ‘At first I thought honey was a solid because it wasn’t runny like water which is a liquid. Now I know that honey is a very viscous liquid.

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

18 As a class, discuss what properties about the collected materials made it more difficult to identify whether the materials were solids, liquids or gases.

19 Update the 'Gases' and Liquids' sections of the class science chat-board.

20 Review the 'Our questions' section of the class science chat-board and answer any questions that can be answered. Record what students have learned next to the question and how they came to that conclusion.

Optional: For each unanswered question on the class science chat-board, discuss with students whether the question is relevant to the topic and feasible to investigate. If it is, discuss a plan of action for how to find that information, for example, through secondary sources, such as credible books or websites.

21 Update the word wall section of the class science chat-board with words and images.

Curriculum links

Information and Communication Technology (ICT)

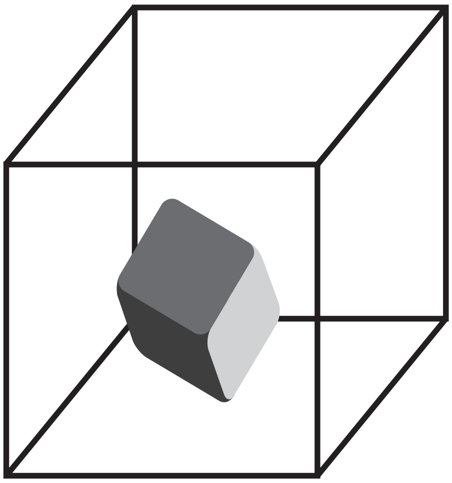
- View interactive videos about solids, liquids and gases. For example: http://www.bbc.co.uk/schools/scienceclips/ages/8_9/solid_liquids.shtml

Indigenous perspectives

- The sorting and classifying of materials according to properties that reflect their atomic state as described by scientists is one way to organise the world. Indigenous people might have their own way of understanding the world around them (see page 6).
- Primary**Connections** recommends working with Aboriginal and Torres Strait Islander community members to access local and relevant cultural perspectives. Protocols for engaging with Aboriginal and Torres Strait Islander community members are provided in state and territory education guidelines. Links to these are provided on the Primary**Connections** website (www.primaryconnections.org.au).

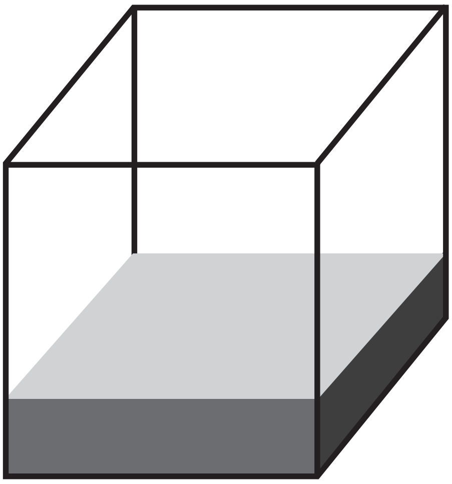
States of matter

Everything around us that takes up space is called matter. 'States of matter' means the form that matter takes. The states of matter that we mostly come across are solids, liquids and gases. Another state of matter is plasma. The Sun is mostly made of plasma.



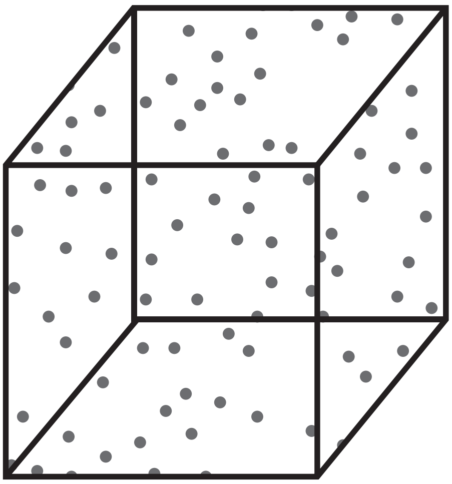
Solids

Some solids are **hard**, such as stone and wood, some are **soft**, such as sponges and wool, and others are **powders**, such as flour and coffee, where each particle is a tiny solid. Solids keep their shape. In a solid, it is the particles that maintain its rigid structure. Heating some solids can turn them into liquids. For example, heating butter turns it into a liquid.



Liquids

Liquids flow and will spread out when poured. The shape of a liquid depends on the container it is in. Even when liquids change their shape, they always take up the same amount of space. Heating a liquid can turn it into a gas, for example, boiling water turns it into water vapour. Cooling a liquid can turn it into a solid, for example, freezing water turns it into ice.



Gases

Gases can be compressed. They are floating around us or are trapped inside a solid. They spread out and fill up the size or shape of the container they are in. Gases are often invisible. Cooling a gas can turn it into a liquid, for example, water vapour turns into water as it cools.

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Lesson 6 Hot stuff

AT A GLANCE

To support students to plan and conduct an investigation of whether the observable properties of gas change with temperature.

Students:

- identify that air is a gas and that it takes up space
- work in collaborative learning teams to change one variable in a fair test investigation about air
- discuss how the volume of a gas depends on the temperature.

Lesson focus

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

Assessment focus

Summative assessment of the Science Inquiry Skills is an important focus of the *Elaborate* phase (see page 3).

Key lesson outcomes

Science

Students will be able to:

- make predictions, provide evidence for their predictions and compare them with results
- identify the features of a fair test and choose which variable to change
- work in teams to safely use appropriate equipment to complete an investigation
- review the investigation and identify further questions for investigation
- identify that the volume of gases depends on their temperature.

Literacy

Students will be able to:

- discuss and compare results.

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

Teacher background information

Hot solids

Many materials become weaker at high temperatures, that is they become less resistant to forces exerted on them. They might also become more malleable and less elastic (less able to return to their original form after a deformation). Materials which retain their strength at high temperatures, in particular despite repeated and quick temperature changes, are useful for many purposes; for example, glass-ceramics have become extremely useful in the home.

Metallic materials that conduct electricity are better conductors at cooler temperatures. Some materials can become superconductors at low temperatures, for example, tin and aluminium, having almost no resistance to electrical current below their critical temperatures.

Solids can expand when heated and contract when cooled. This is one of the reasons houses creak in the evening. Different materials expand to different extents under the same temperature, which is why running hot water over a glass container can help loosen the metal lid (metal expands more than glass).

Hot liquids

When most liquids are heated their viscosity (flow) can change. Warm honey is much easier to spread on bread than cold honey, because the heat has decreased its viscosity. This effect is most noticeable on liquids that are very viscous at room temperature, such as honey or syrup. Liquids expand slightly as they heat and contract slightly as they cool. A notable exception to that rule is liquid water between 0 and 4°C.

Hot air

Gases expand when heated and spread out far more than liquids or solids since the interactions between their atoms or molecules are far weaker. This means that the density (mass per unit of volume) of a gas at a certain pressure can vary significantly depending on the temperature.

Hot air balloons use this principle to rise above the ground. The air they contain is much less dense than the surrounding air, which is therefore pushed upwards. This is the same principle as when objects less dense than water are pushed to the surface of bodies of water (Archimedes' principle).

Hot changes

When most solid materials are heated sufficiently they reach their melting point and change into liquid materials. The material has the same atoms or molecules, but their interactions are different and so the properties of the material change significantly. When most liquids are heated sufficiently their atoms or molecules separate from each other and form a gas. These are known as physical changes.

Some solids, liquids or gases, when heated to a specific temperature, reach their burning point and might combust under certain conditions. This is a chemical change. In this lesson students are testing heat-dependent variations in the properties of solids, liquids or gases. They explore physical and chemical changes to materials in other units.

Equipment

FOR THE CLASS

- class science journal
- class science chat-board
- team skills chart
- team roles chart
- word wall
- 1 enlarged copy of 'Balloon investigation planner' (Resource sheet 6)
- 2 x 500 mL bottles
- 2 balloons
- 1 bucket
- water (~50°C) to ¾ fill the bucket
- extra equipment for conducting fair tests (eg, different-sized bottles, different-shaped balloons, different-shaped containers) (see 'Preparation')

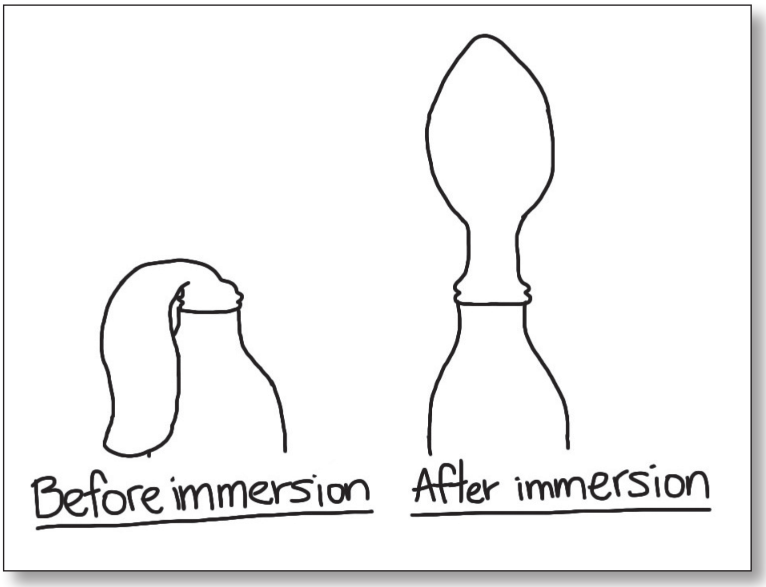
FOR EACH TEAM

- each team member's science journal
- role wristbands or badges for Director, Manager and Speaker
- 1 copy of 'Balloon investigation planner' (Resource sheet 6)
- 2 x 250 mL bottles
- 2 balloons
- 1 container deep enough to submerge a 250 mL bottle
- water (~50°C) to ¾ fill the container

ELABORATE

Preparation

- **Note:** This activity involves hot water. If possible, arrange for parents/carers to help supervise teams during the investigation.
- Identify an outdoor area for students to conduct their investigations.
- Place a balloon over the top of each bottle for the class. Trial submerging the bottle to see if the balloon inflates. The important variable is the difference between the original temperature of the air in the bottle and the temperature of the water in which it is submerged. If your classroom is too hot, consider keeping the bottles somewhere cool, for example, in an esky with ice blocks in it.



Balloon before and after immersion of the bottle in hot water

- Collect materials for students to vary the variables of the investigation (see Step 5), such as containers and bottles of different sizes, water at different temperatures and balloons of different shapes.
- Set up a 'safety zone' where you can prepare hot water (~50°C). Work out a safety procedure for students to collect warm water.
- Prepare an enlarged copy of 'Balloon investigation planner' (Resource sheet 6).
- *Optional:* Display 'Balloon investigation planner' (Resource sheet 6) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

Lesson steps

1 Review the previous lessons using the class science journal and class science chat-board. Ask students questions, such as:

- What have we learned about the properties of solids/liquids/gases?
- Do you think those properties always stay the same? Why/Why not?
- How do you think you could change the properties of a material?

2 Introduce the bottles with balloons on top. Ask what is inside the bottle (air). Ask students to predict what will happen when you submerge a bottle in hot water, providing reasons for their prediction.

3 Submerge one bottle and ask students to compare it with the non-submerged bottle. Ask students to compare their predictions with their observations. Ask them to explain why they think the balloon inflated.

4 Discuss why you had a non-submerged bottle (to be able to see what would have happened if you had not submerged the bottle, to check that the balloon really inflates due to submersion). Explain that this is known as a 'control' in science, and that the bottle which is submerged is the 'test'.

5 Ask students what things might affect whether the balloon inflates. Brainstorm variables that students could change, such as the size of the bottle, the temperature of the water, the shape of the balloon, the size of the container, the amount of water it is pushed into.

6 Explain that students are going to work in collaborative learning teams to conduct a fair test. Introduce the enlarged copy of 'Balloon investigation planner' (Resource sheet 6) and read through with students. Ask students what variable they are going to change, and to write the question for investigation. Identify the variables they will need to keep the same to make it a fair test. Remind students to provide reasons for their predictions and to ensure they have a 'control'.

7 Form teams and allocate roles. Ask teams to complete their planning for their investigation on their copy of 'Balloon investigation planner' (Resource sheet 6).

8 Discuss with students how they could record their results, such as by taking photos, drawing labelled diagrams or measuring the height and circumference of the balloon. Ask students to record their results in their science journal.

9 Ask Managers to collect team equipment. Allow time for students to conduct the investigation and record their results.

10 Ask Speakers to share their team's findings with the class. Ask students in the audience to use the 'Science question starters' (see Appendix 4) to ask each team about their investigation.

11 As a class, discuss what conclusions can be drawn from the collected results, asking questions, such as:

- Did your results match your predictions? Why do you think that happened?
- What variables changed what happened to the balloon? Why do you think that is?
- Does our evidence support the claim that 'the balloon inflated because air takes up more space when it is heated'?

12 Explain that the amount of space that a gas takes up depends on its temperature: it is a property that changes with the temperature. Explain that this is why balloons can shrink if put in the freezer or bottles with fizz can explode in hot weather.

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

- What have we learned about the properties of gaseous materials?
- What challenges did you experience doing this investigation?
- How might you overcome them next time?
- Can you think of ways to change or improve the investigation next time?
- Do you have any ideas for other investigations about the how the properties of gases, liquids or solids change with temperature?

14 Record students' ideas in the class science journal.

15 Update the 'Gases' section of the class science chat-board with what students have learned.

16 Update the word wall section of the class science chat-board with words and images.

Curriculum links

Science

- Research how hot air balloons work.

Mathematics

- Measure the circumference of objects and order them according to size.

Balloon investigation planner

Team members' names: ______________________ **Date:** __________

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

To make this a fair test what things (variables) are you going to:		
Change? Change only one thing	Measure? What would the change affect?	Keep the same? Which variables will you control?

What equipment will you need? Use dot points	What are you going to do? Use drawings if necessary

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Lesson 7 Mind your matters

AT A GLANCE

To provide opportunities for students to represent what they know about how solids, liquids and gases have different observable properties and behave in different ways, and to reflect on their learning during the unit.

Students:

- create cards to use in a card game about solids, liquids and gases
- 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:

- how solids, liquids and gases have different observable properties and behave in different ways.

EVALUATE

Key lesson outcomes

Science

Students will be able to:

- participate in a class discussion about the properties of solids, liquids and gases
- identify the observable properties of chosen solids, liquids and gases.

Literacy

Students will be able to:

- create game cards about solids, liquids and gases using text and illustrations
- express their thoughts 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
- class science chat-board
- word wall
- 1 enlarged copy of 'Matter cards' (Resource sheet 7)

FOR EACH STUDENT

- science journal
- 2 copies of 'Matter cards' (Resource sheet 7)
- optional: 2 A4 cardboard sheets to paste 'Matter cards' onto

Preparation

- Prepare an enlarged copy of 'Matter cards' (Resource sheet 6).

Lesson steps

1. Review previous lessons using the class science journal and class science chat-board, asking questions, such as:
   - What are the properties of solids/liquids/gases?
   - What are similar about powders and liquids?
   - What happens to gas when it is heated?
2. Introduce the enlarged copy of 'Matter cards' (Resource sheet 6). Discuss with students that they will be creating cards to show what they have learned about solids, liquids and gases to join with other students' cards to play a game.
3. Explain that one card will have an illustration of a solid, liquid or gas, and its matching card a description of whether it is a solid, liquid or gas and three properties of the object, material or substance. Model how to complete two cards.

EVALUATE

A soccer ball

It is a <u>solid with gas inside</u>

1. It can be squashed a bit, but it keeps its shape.

2. If you put it into a box, it would still keep its shape.

3. If it didn't have gas inside, it would go flat.

Sample of two cards for 'Matter cards' game

4 Explain that students will complete illustrations and text on two solids, two liquids and two gases. Discuss that students might choose materials that they have investigated during the unit or other materials that they might think of.

5 Provide students with time to complete their cards, then join with others to play a game.

Optional: Students create cards using computer software.

6 Ask students to reflect on their learning journey through the unit. Ask questions, such as:

- What did you think about … 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 about 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?

7 Ask students to record their answers to the questions in the science journals.

8 Allow time for students to join with other class members to use their cards to play card games, such as 'Concentration' and 'Snap'.

EVALUATE

Matter cards

Name: ______________________ **Date:** ____________

______________________	**It is a** ______________________. **1.** **2.** **3.**
______________________	**It is a** ______________________. **1.** **2.** **3.**
______________________	**It is a** ______________________. **1.** **2.** **3.**

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

Introduction

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

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

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

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

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

Team structure

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

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

Team roles

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

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

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

Manager

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

Speaker

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

Director (Year 3–Year 6)

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

Team skills

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

Students will practise the following team skills throughout the year:

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

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

Supporting equity

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

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

TEAM ROLES

Manager

Collects and returns all materials the team needs

Speaker

Asks the teacher and other team speakers for help

Director

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

TEAM SKILLS

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

Appendix 2
How to use a science journal

Introduction

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

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

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

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

Using a science journal

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

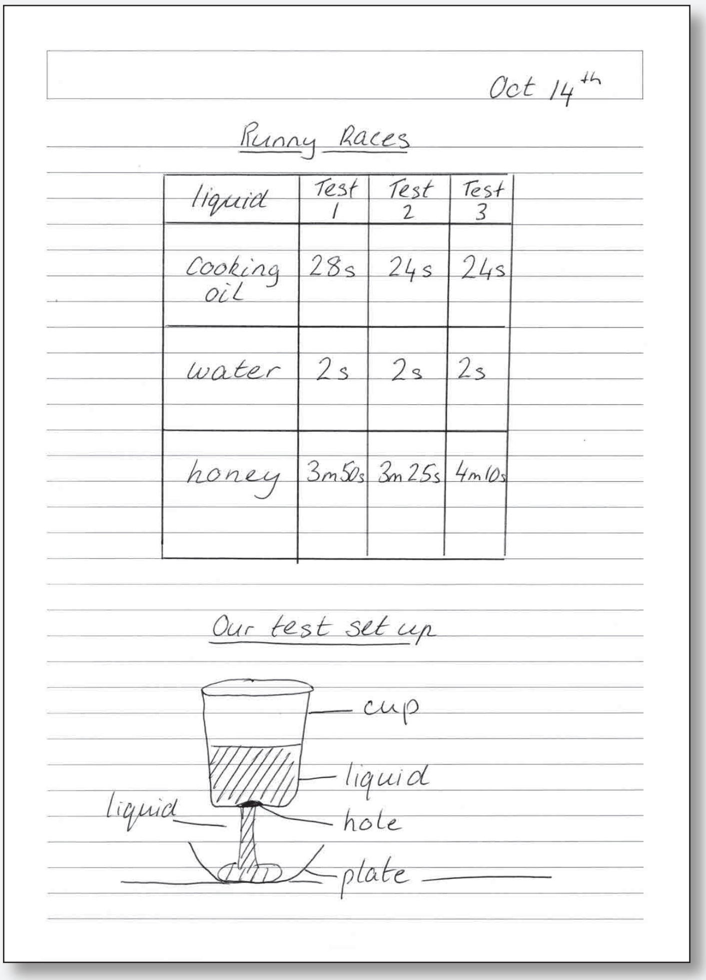
6 In science journal work, you can refer students to display charts, pictures, diagrams, word walls and phrases about the topic displayed around the classroom. Revisit and revise this material during the unit. Explore the vocabulary, visual texts and ideas that have developed from the science unit, and encourage students to use them in their science journals.

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

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

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

***What's the matter?* science journal**


Oct 14th

Runny Races

liquid	Test 1	Test 2	Test 3
cooking oil	28s	24s	24s
water	2s	2s	2s
honey	3m50s	3m25s	4m10s

Our test set up

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.

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

Goals in using a word wall

A word wall can be used to:

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

Organisation

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

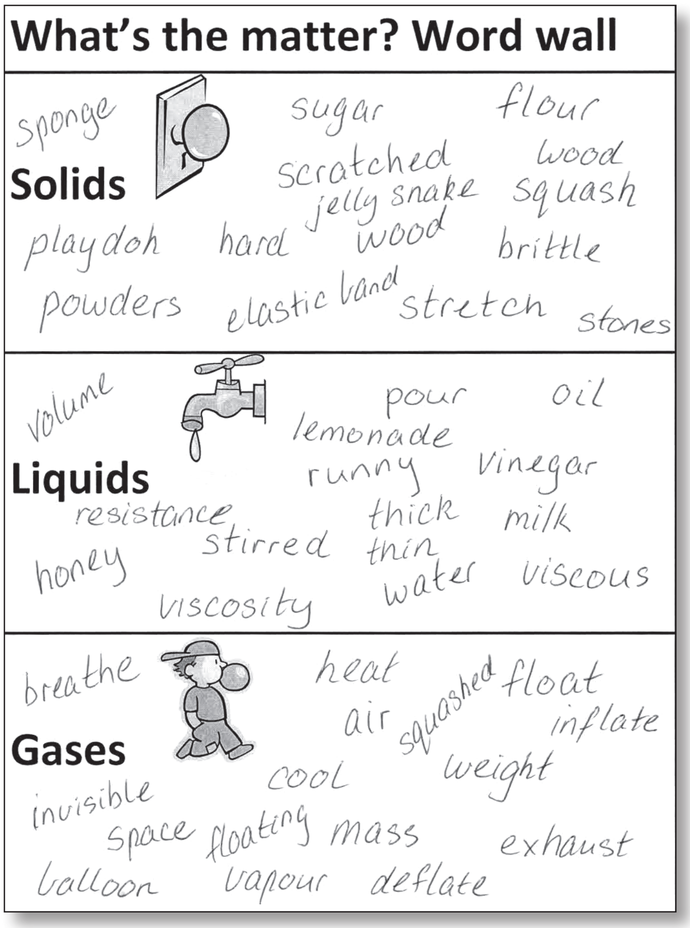
Choose robust material for the word cards. Write or type words on cardboard and perhaps laminate them. Consider covering the wall with felt-type material and backing each word card with a self-adhesive dot to make it easy for students to remove and replace word cards.

Word walls do not need to be confined to a wall. Use a portable wall, display screen, shower curtain or window curtain. Consider a cardboard shape that fits with the unit, for example, an apple for a needs 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 *What's the matter?* unit might be organised using headings, such as 'Solids', 'Liquids' and 'Gases'.

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



What's the matter? **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 individual students 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 others' reasoning
- reflecting on how their ideas have changed.

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

Establish norms

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

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

Question, Claim, Evidence and Reasoning

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

Q What **question** are you trying to answer? For example, 'What happens to the size a balloon inflates to when we change the temperature of the water?'

C The **claim**. For example, 'A balloon inflates less when the water is at a lower temperature.'

E The **evidence**. For example, 'When the water temperature was 50 degrees the balloon inflated to a diameter of 30 cm. When the water temperature was 20 degrees the balloon didn't inflate.'

R The **reasoning**. How the evidence supports the claim. When gas in a balloon is heated it expands and causes the balloon to inflate.

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

Science question starters

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

Science question starters

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

Appendix 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 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 in 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 in *What's the matter?* 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 size to which the balloon inflates?'.

  - Use questioning to elicit the things (**independent variables**) students think might affect the **dependent variable**, such as the size of the balloon, the shape of the balloon, the temperature of the water.

  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 size the balloon inflates to when you change the temperature of the water?'.
- 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.

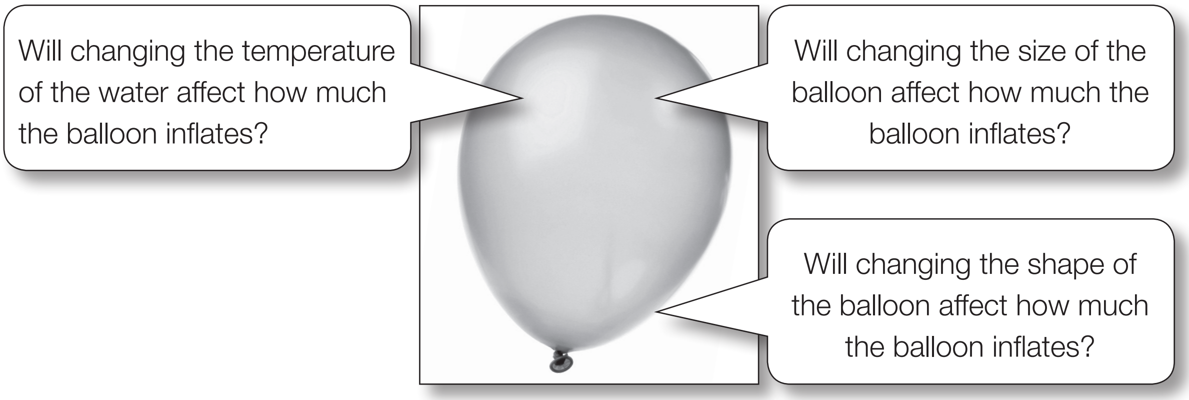
Appendix 6
How to conduct a fair test

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 *What's the matter?* students investigate things that affect the size to which a balloon inflates.



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

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

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

Cows: **Change** one thing (independent variable)
Moo: **Measure/Observe** another thing (dependent variable) and
Softly: keep the other things (controlled variables) the **Same**.

To investigate whether the water temperature affects how far the balloon inflates, students could:

CHANGE	the water temperature	Independent variable
MEASURE/OBSERVE	how much the balloon inflated	Dependent variable
KEEP THE **SAME**	the size of the balloon, the brand of the balloon, the size of the bottle, the temperature of the bottle	Controlled variable

Appendix 7
What's the matter? equipment list

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	4	5	6	7
		SESSION		1	2					
Equipment and materials										
balloon, filled with air	1 per team						●			
balloon, filled with water	1 per team						●			
balloons	2 per class								●	
balloons	2 per team								●	
bottles, 250 mL	2 per team								●	
bottles, 500 mL	2 per class								●	
bucket	1 per class								●	
cardboard, A4 (optional)	2 sheets per student									●
container, deep	1 per team						●			
container, deep enough to submerge a 250 mL bottle	1 per team								●	
containers, transparent with lids	8 per class		●					●		
containers of honey and cooking oil from Lesson 1	1 per class				●					
container of water	1 per class				●					
cooking oil	2 tbs per team				●					
cups	3 per team				●					
cups, plastic transparent	2 per team						●			
cups, plastic transparent	10 per team			●						
cup, plastic transparent	1 per class						●			

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	4	5	6	7
		SESSION		1	2					
Equipment and materials										
extra equipment for conducting fair tests (eg, different-sized bottles, different-shaped balloons, different-sized containers)	per class								•	
honey	2 tbs per team				•					
liquids (eg, lemonade, fruit juice, water, milk, washing up liquid)	½ cup per team			•						
magnifying glass	1 per team					•				
materials to place in containers: stones, icing sugar, play-doh, elastic bands, cooking oil, honey	per class		•							
paper, large sheets	5 per class		•							
tissues	2 per team						•			
powdered laundry detergent	½ cup per team			•						
psyllium husks	200 g per class		•							
selection of solids (eg, soap, chalk, play-doh, a stone, a block of wood, a sponge, jelly snake, elastic band, marbles, flour, laundry powder, rice)	1 or 1 cup per class					•				
self-adhesive notes	1 set per class		•							
spoon	1 per team			•						
tablespoons	3 per team				•					
timing device (eg, a stopwatch or a watch with a second hand)	1 per team			•	•					
water	200 mL per class		•							
water	2 tbs per team				•					
water, to fill deep container	per team						•			
water, ~50°C to ¾ fill a bucket	per class								•	
water, ~50°C to ¾ fill an ice cream container	per team								•	

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	4	5	6	7
		SESSION		1	2					
Resource sheets										
'Voting matters' (RS1), enlarged	1 per class		●							
'Voting matters' (RS1)	1 per student		●							
'Runny investigation planner' (RS2), enlarged	1 per class				●					
'Runny investigation planner' (RS2)	1 per team				●					
'Solid science' (RS3), enlarged	1 per class					●				
'Solid science' (RS3)	1 per team					●				
'Tissues in a cup' (RS4), enlarged	1 per class						●			
'Tissues in a cup' (RS4)	1 per team						●			
'States of matter' (RS5),	1 per team							●		
'Balloon investigation planner' (RS6), enlarged	1 per class								●	
'Balloon investigation planner' (RS6)	1 per team								●	
'Matter cards' (RS7), enlarged	1 per class									●
'Matter cards' (RS7)	2 per student									●
Teaching tools										
class science journal	1 per class		●	●	●	●	●	●	●	●
role wristbands or badges for Director, Manager and Speaker	1 set per team			●	●	●	●	●	●	
student science journal	1 per student		●	●	●	●	●	●	●	●
team roles chart	1 per class			●	●	●	●	●	●	
team skills chart	1 per class			●	●	●	●	●	●	
science chat-board	1 per class		●	●	●	●	●	●	●	●
word wall	1 per class		●	●	●	●	●	●	●	●

Appendix 8
What's the matter? unit overview

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to represent their current understanding as they:	Students will be able to:	Students:	
ENGAGE	**Lesson 1** Mysterious matter	• vote on whether they think materials are solids, liquids and/or gases • explain what they think solids, liquids and gases are • contribute to discussions about solids, liquids and gases • identify questions about solids, liquids and gases and how they are classified.	• identify the purpose and features of a science journal and word wall • record their reasoning about solids, liquids and gases • review the results of tallies • understand the purpose and features of the class science chat-board and word wall.	• explore different materials • vote and explain their ideas on whether they think the materials are solids, liquids or gases • contribute to the start of a class science chat-board.	**Diagnostic assessment** • Voting matters (Resource sheet 1) • Class discussions • Science chat-board contributions

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

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLORE	**Lesson 2** See how they run! ***Session 1*** Looking at liquids ***Session 2*** *(Optional)*Runny races	• observe the properties of liquids • identify that liquid materials flow and take the shape of their container • identify the features of a fair test and predict which liquid is the most viscous • work in teams to explore the viscosity of liquid materials • review the investigation.	• understand the purpose and features of a science journal • record their observations of the properties in a table • discuss and compare results to form common understandings.	***Session 1*** Looking at liquids • explore and record in a table the properties of different liquids • identify properties that are shared by liquids • discuss how liquids flow and take the shape of their containers. ***Session 2*** *(Optional)* Runny races • discuss how to set up an investigation of the viscosity of liquids • work in teams to explore the viscosity of materials.	**Formative assessment** • Science journal entries • Class discussions • Science chat-board contributions • 'Runny investigation planner' (Resource sheet 2)

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

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLORE	**Lesson 3** Solid studies	• observe the properties of solids • review the investigation and identify further questions for investigation • work in teams to safely use appropriate equipment • identify that powders are solids using evidence-based claims.	• record their observations of the properties of solids in a table • discuss and compare results.	• explore the properties of different solid materials • record their observations in a table • identify properties that are shared by solids • identify that powders are solids based on their observable properties.	**Formative assessment** • Science journal entries • Class discussions • Science chat-board contributions • 'Solid science' (Resource sheet 3)
	Lesson 4 What a gas!	• make predictions, provide evidence for their predictions and compare them with results • identify the features of a fair test and choose which variable to change • work in teams to safely use appropriate equipment to complete an investigation • identify that gases take up space and fill the container they are in using evidence-based claims.	• discuss and compare results to form common understandings.	• identify that air is a gas and that it takes up space • work in collaborative learning teams to change one variable in a fair test investigation about air • compare air and water and discuss how gases spread out to fill their container.	**Formative assessment** • Science journal entries • Class discussions • Science chat-board contributions • 'Tissues in a cup' (Resource sheet 4)

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

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLAIN	**Lesson 5** Sort it out	• make and discuss evidence-based claims about solids, liquids and gases • work in teams to sort materials according to their properties • identify how to distinguish solids, liquids and gases.	• discuss and compare results • read and discuss a text about solids, liquids and gases • discuss how to find answers to questions that they might have.	• discuss claims about solids, liquids and gases • work in teams to sort materials according to what they have learned about solids, liquids and gases • read and discuss a text about solids, liquids and gases.	**Formative assessment** • Science journal entries • Class discussions • Science chat-board contributions • 'States of matter' (Resource sheet 5)
ELABORATE	**Lesson 6** Hot stuff	• make predictions, provide evidence for their predictions and compare them with results • identify the features of a fair test and choose which variable to change • work in teams to safely use appropriate equipment to complete an investigation • review the investigation and identify further questions for investigation • identify that the volume of gases depends on their temperature.	• discuss and compare results.	• identify that air is a gas and that it takes up space • work in collaborative learning teams to change one variable in a fair test investigation about air • discuss how the volume of a gas depends on the temperature.	**Summative assessment** of Science Inquiry Skills • Science journal entries • Class discussions • Science chat-board contributions • 'Balloon investigation planner' (Resource sheet 6)

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

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EVALUATE	**Lesson 7** Mind your matters	• participate in a class discussion about the properties of solids, liquids and gases • identify the observable properties of chosen solids, liquids and gases.	• create game cards about solids, liquids and gases using text and illustrations • express their thoughts about their learning journey.	• create cards to use in a card game about solids, liquids and gases • reflect on their learning during the unit.	**Summative assessment** of Science Understanding • Science journal entries • Class discussions • Science chat-board contributions • 'Matter cards' (Resource sheet 7)

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

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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*
4	*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*
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