Primary**Connections**®
Linking science with literacy

Fully aligned with the Australian Curriculum

The Primary**Connections** program is supported by astronomer, Professor Brian Schmidt, Nobel Laureate

Change detectives

Year 6

Chemical sciences

PrimaryConnections project

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Australian Council of Deans of Education
Australian Curriculum Assessment and Reporting Authority (ACARA)
Australian Government Department of Education, Employment and Workplace Relations
Australian Literacy Educators' Association
Australian Primary Principals Association
Australian Science Teachers Association
QLD Department of Education, Training and Employment
Independent Schools Council of Australia
Indigenous Education Consultative Body
National Catholic Education Commission
NSW Department of Education and Communities
NT Department of Education and Training
Primary English Teaching Association Australia
SA Department for Education and Child Development
TAS Department of Education
VIC Department of Education and Early Childhood Development
WA Department of Education

Australian Academy of Science

Professional learning program

PrimaryConnections 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 PrimaryConnections 5Es teaching and learning model, linking science with literacy, investigating, embedded assessment and collaborative learning.

The PrimaryConnections 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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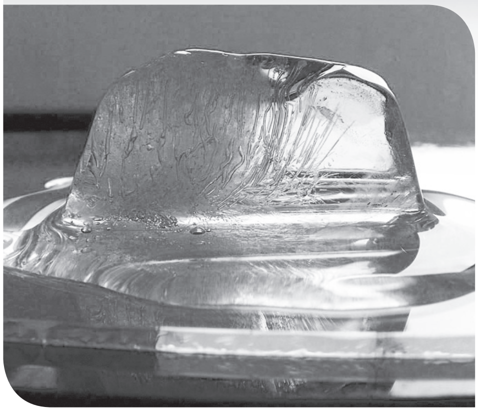

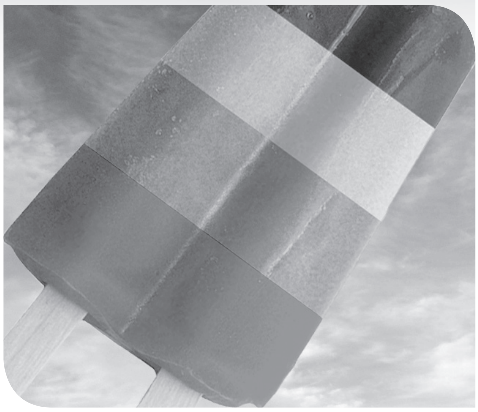

What makes things change and what affects how fast they change? Why do some things burn more fiercely, rust more quickly or smell more strongly? The whole world is made up of particles that are constantly moving and reacting with one another in fascinating ways. Science seeks to understand why and how substances change, and this has led to advances in everything from food preservation to fire control.

The *Change detectives* unit is an ideal way to link science with literacy in the classroom. It provides opportunities for students to explore melting, evaporating, dissolving, burning and chemical reactions. Students' understanding of the factors that influence the rate of change will be developed through hands-on activities and student-planned investigations. Students become detectives who identify and explain physical and chemical changes in everyday materials.

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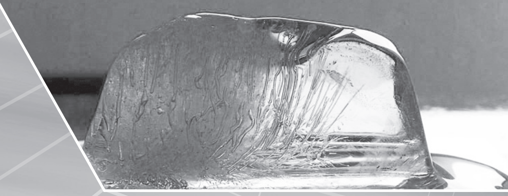


Contents

Foreword

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

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

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

Students are naturally curious. Primary**Connections** provides an inquiry-based approach that helps students develop deep learning, and guides them to find scientific ways to answer their questions. The lessons include key science background information, and further science information is included on the 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, comprised of 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 science teacher background information on science is reviewed by a Fellow of the Academy of Science. All these inputs have ensured an award-winning, quality program.

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

Professor Suzanne Cory, AC PresAA FRS
President (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, 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 for each lesson are highlighted at the beginning of each lesson. Different types of assessment are emphasised in different phases:

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

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

Summative assessment of the students' achievement developed throughout the unit occurs in the *Elaborate* phase of the Science Inquiry Skills and 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 ⚠ SAFETY is included in lessons where there is a need to pay particular attention to potential safety hazards.

The following guidelines will help minimise risks:

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

References

Australian Curriculum Assessment and Reporting Authority (ACARA). (2010). *Australian Curriculum: Science*. www.australiancurriculum.edu.au

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

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

Unit at a glance

Change detectives

Phase	Lesson	At a glance
ENGAGE	**Lesson 1** Mess scene investigation	To capture students' interest and find out what they think they know about changes that occur to materials in their everyday lives. To elicit students' questions about why certain changes occur and whether or not they are easily reversible.
EXPLORE	**Lesson 2** Purely physical ***Session 1*** Mostly melting ***Session 2*** Playing particles ***Session 3*** Evocative evaporation	To provide students with hands-on, shared experiences of melting and evaporation, and a model used to represent them.
	Lesson 3 Slippery solutions ***Session 1*** Delightful dissolving ***Session 2*** Gas bags	To provide students with hands-on, shared experiences of dissolving and a chemical reaction in water.
	Lesson 4 Candle capers	To provide students with hands-on, shared experiences of burning candles.
EXPLAIN	**Lesson 5** Classifying changes	To support students to represent and explain their understanding and observations of physical and chemical changes. To introduce current scientific views about physical and chemical changes.
ELABORATE	**Lesson 6** Fizz whiz	To support students to plan and conduct an investigation of the factors that affect the rate of reactions.
EVALUATE	**Lesson 7** Intrepid reporters	To provide opportunities for students to represent what they know about physical and chemical changes and to reflect on their learning during the unit.

A unit overview can be found in Appendix 8, page 80.

Alignment with the Australian Curriculum: Science

This *Change detectives* unit embeds all three strands of the Australian Curriculum: Science. The table below lists sub-strands and their content for Year 6. This unit is designed to be taught in conjunction with other Year 6 units to cover the full range of the Australian Curriculum: Science content for Year 6.

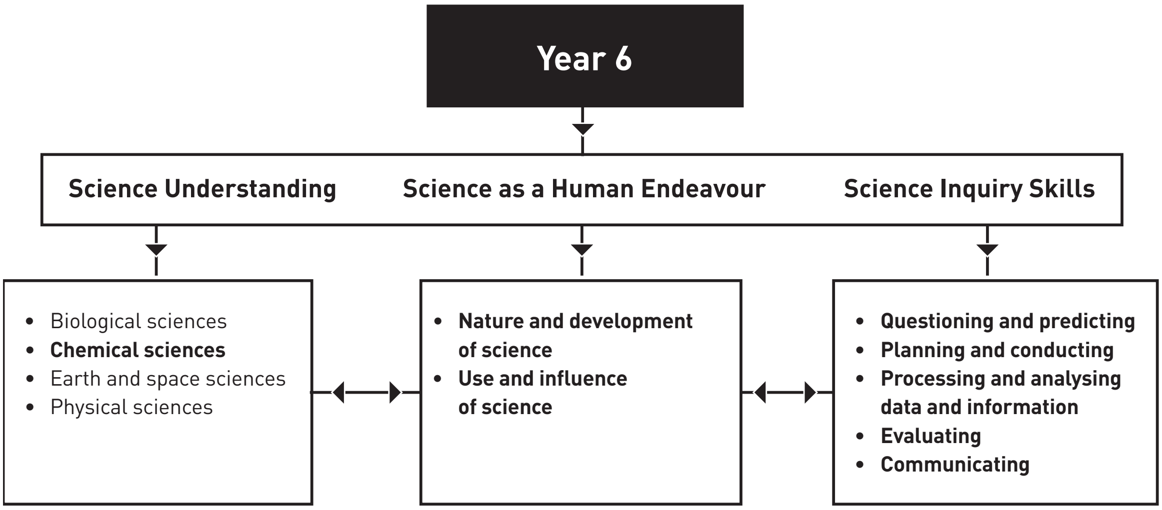
For ease of assessment the table below outlines the sub-strands and their aligned lessons.

Strand	Sub-strand	Code	Year 6 content descriptions	Lessons
Science Understanding (SU)	**Chemical sciences**	ACSSU095	Changes to materials can be reversible, such as melting, freezing, evaporating; or irreversible, such as burning and rusting	1, 2, 3, 4, 5, 7
Science as a Human Endeavour (SHE)	**Use and influence of science**	ACSHE100	Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives	5, 7
Science Inquiry Skills (SIS)	**Questioning and predicting**	ACSIS232	With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be	2, 3, 6
		ACSIS103	With guidance, plan appropriate investigation methods to answer questions or solve problems	6
		ACSIS104	Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate	3, 6
		ACSIS105	Use equipment and materials safely, identifying potential risks	3, 4, 6
	Processing and analysing data and information	ACSIS107	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, 4, 6
		ACSIS221	Compare data with predictions and use as evidence in developing explanations	3, 6
	Evaluating	ACSIS108	Suggest improvements to the methods used to investigate a question or solve a problem	6
	Communicating	ACSIS110	Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts	1, 7

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

Interrelationship of the science strands

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



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 *Change detectives*, these overarching ideas are represented by:

Overarching idea	Incorporation in *Change detectives*
Patterns, order and organisation	Students investigate and classify physical and chemical changes to materials. They develop explanations for the patterns they observe, drawing on evidence.
Form and function	Students role-play the movement of particles to represent their understanding of the effect of temperature on phase changes. They explore the usefulness of materials as related to their state, for example, a solid or a liquid form at room temperature.
Stability and change	Students investigate how heating or cooling causes change. They identify reversible and irreversible changes through hands-on activities. They investigate factors that influence the rate of change of a reaction.
Scale and measurement	Students make observations and represent their findings about changes using line graphs. They consider how materials are composed at a particle level using marbles to represent particles in a model of a substance.
Matter and energy	Students describe reversible and irreversible changes and the factors that affect such changes, for example, the addition or removal of heat energy.
Systems	Students explore the interrelationship between the production of new substances and the consumption of original substances during a chemical change.

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 *Change detectives*
Recognising questions that can be investigated scientifically and investigating them	Students formulate a testable question with guidance and make predictions about what factors affect the speed of a chemical reaction. They plan and conduct a fair test of a chemical reaction and identify patterns in their findings.

Achievement standards

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

By the end of the unit, teachers will be able to make evidence-based judgements on whether the students are achieving below, at or above the Australian Curriculum: Science Year 6 achievement standard. Rubrics to help teachers make these judgements will be available on the website (www.primaryconnections.org.au).

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.

Change detectives—Australian Curriculum general capabilities

General capabilities	Australian Curriculum description	*Change detectives* 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 *Change detectives* the literacy focuses are: • science journal • summaries • reports • word walls • tables • role-plays • procedural texts • graphs • Venn diagrams.
Numeracy	Elements of numeracy are particularly evident in Science Inquiry Skills. These include practical measurement and the collection, representation and interpretation of data.	Students: • Use measurement (volume, capacity and time) • calculate averages • collect, interpret and represent data through tables and graphs • use measurement equipment appropriately (timer, cup measure, teaspoon measure).
Information and communication technology (ICT) competence	ICT competence is particularly evident in Science Inquiry Skills. Students use digital technologies to investigate, create, communicate, and share ideas and results.	Students are given optional opportunities to: • use a digital camera to record the mess scene images • use online digital resources to explore dissolving • create a digital Venn diagram • create a digital report.
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: • brainstorm variables for investigations • devise testable questions • respond to teacher questions • discuss initial ideas • create classification groupings.
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: • respect each other's ideas during discussions.
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: • identify ways to reduce risk and follow safety rules in the classroom during investigations • work in collaborative learning teams performing a role and practising team skills • discuss individual results with other team members • role-play science phenomena with other members of the class.
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

Change Detectives focuses on the Western science way of making evidence-based claims about the way objects change, whether physically, chemically or through the gaining or losing of heat energy to cause a change of state.

Aboriginal and Torres Strait Islander Peoples might have other explanations for the observed phenomenon of materials changing from liquids to solids or vice versa.

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

In the *Change detectives* unit students learn about how changes to materials can be reversible or irreversible. This provides opportunities for students to understand why and how substances change and how the world is made up of constantly moving particles. A deeper understanding of the composition of everyday materials and the factors that influence change can assist them to develop knowledge, skills and values for making decisions about individual and community actions that contribute to sustainable patterns of use of the Earth's natural resources.

Alignment with the Australian Curriculum: English and Mathematics

Strand	Sub-strand	Code	Year 6 content descriptions	Lessons
English–Language	**Language for interaction**	ACELA1516	Understand that strategies for interaction become more complex and demanding as levels of formality and social distance increase	1, 5, 7
		ACELA1517	Understand the uses of objective and subjective language and bias	7
	Expressing and developing ideas	ACELA1524	Identify and explain how analytical images like figures, tables, diagrams, maps and graphs contribute to our understanding of verbal information in factual and persuasive texts	2, 3, 4, 5, 7
		ACLEA1526	Understand how to use banks of known words, word origins, base words, suffixes and prefixes, morphemes, spelling patterns and generalisations to learn and spell new words, for example technical words and words adopted from other languages	1, 7
English–Literature	**Literature and context**	ACELT1613	Make connections between students' own experiences and those of characters and events represented in texts drawn from different historical, social and cultural contexts	1
	Creating literature	ACELT1618	Create literary texts that adapt or combine aspects of text students have experienced in innovative ways	1
		ACELT1800	Experiment with text structures and language features and their effects in creating literary texts, for example, using imagery, sentence variation, metaphor and word choice	1
English–Literacy	**Interacting with others**	ACELY1709	Participate in and contribute to discussions, clarifying and interrogating ideas, developing and supporting arguments, sharing and evaluating information, experiences and opinions	2, 3, 4, 5, 6, 7
		ACELY1816	Use interaction skills, varying conventions of spoken interactions such as voice volume, tone, pitch and pace, according to group size, formality of interaction and needs and expertise of the audience	2, 3, 4, 5, 6, 7
	Interpreting, analysing, evaluating	ACELY1711	Analyse how text structures and language features work together to meet the purpose of a text	1, 7
		ACELY1801	Analyse strategies authors use to influence readers	7

Strand	Sub-strand	Code	Year 6 content descriptions	Lessons
English–Literacy (continued)	**Creating texts**	ACELY1714	Plan, draft and publish imaginative, informative and persuasive texts, choosing and experimenting with text structures, language features, images and digital resources appropriate to purpose and audience	7
		ACELY1715	Reread and edit students' own and others' work using agreed criteria and explaining editing choices	7
		ACELY1716	Develop a handwriting style that is legible, fluent and automatic and varies according to audience and purpose	7
		ACELY1717	Use a range of software, including word processing programs, learning new functions as required to create texts	7
Mathematics–Measurement and Geometry	**Using units of measurement**	ACMMG138	Connect volume and capacity and their units of measurement	3, 4
Mathematics–Statistics and Probability	**Data representation and interpretation**	ACMSP147	Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables	3, 4
		ACMSP148	Interpret data presented in digital media and elsewhere	3, 4
	Chance	ACMSP146	Compare observed frequencies across experiments with expected frequencies	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 physical and chemical change

Changes to objects can include changes to the size, shape, smell and appearance. For example, a rock crumbles, a teapot breaks, and a steak changes colour, odour and texture when cooked.

Objects have characteristics such as size, weight and appearance, which are determined by the materials that are used to make them. Materials can be made of several different substances, for example, air is a material made of many different gases. Substances are made of particles, atoms or ions.

Physical change is a change to the physical properties of an object or material where the substances remain the same. The object itself might not remain the same, such as, a rock could be ground to powder or a mug be smashed to pieces, but the substances are still present. There is still rock and porcelain. Physical change occurs when an object receives or loses energy. This might be from a force, for example, by being hit, or when a substance gains or loses heat energy, such as, when an ice cube melts or liquid water freezes.

A chemical change is where a substance is transformed into a new substance (or substances) at the molecular level. The new chemical substances might be in the form of a gas, liquid or solid. For example, it is easily seen that charcoal is created when toast burns, but the combustion of the cellulose in the bread also produces invisible carbon dioxide and gaseous water. When a substance undergoes a physical change, however, its chemical composition does not change—water is H_2O whether it is in the form of a gas (steam), liquid (water), or solid (ice). Common salt—solid sodium chloride—can be recovered from salty water by evaporation and dissolved again to form salty water in which the two components of salt are still present. Sugar crystals can similarly be recovered from sugar-sweetened water without chemical change.

When some substances undergo physical changes, there can also be some minute chemical changes occurring at the molecular level. These changes are only detectable through scientific testing. For example, when sodium bicarbonate dissolves in water the majority of the change is physical. At the molecular level, some of the sodium bicarbonate and water react to produce a slightly alkaline solution.

Students' conceptions

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

Many students might hold non-scientific conceptions about physical and chemical changes because the changes that occur at a particle level are not observable. In physical changes such as freezing, melting, evaporation and boiling that bring about a change of state, students might believe that substances which evaporate simply disappear and no longer exist and that heat and cold are actual substances involved in these changes.

Students might not realise that the substances produced by a chemical reaction are new substances, different from the original substances. For example, rust is not iron—it is something new created when iron reacts with oxygen in the presence of water. Students might think that the same materials or substances are still present after a chemical change. A chemical change produces new substances by consuming the original ones.

Many students do not believe that mass is conserved in a chemical change, that is, the mass of substances before and after the change is the same. Many students believe that the mass of exhaust gases is less than the mass of liquid petrol burnt in the car's engine. This is related to the misconception that gases have no weight. Many students also believe that air or oxygen plays no active role in combustion reactions.

Students sometimes confuse substances and energy. For example, they might think that heat and light are substances made of particles, whereas they are forms of energy.

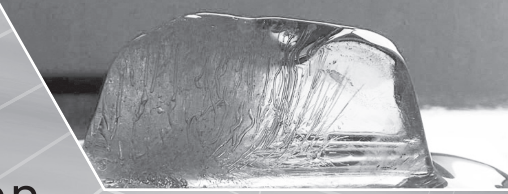
Safety

This unit uses some common household items and chemicals. Each Australian state and territory has specific health and safety requirements. You need to comply with any requirements of your state and school regarding health and safety in the classroom, particularly with restrictions on using aspirin and aspirin derivatives in the classroom.

Check local jurisdiction requirements before teaching this unit.

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

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



Lesson 1 Mess scene investigation

AT A GLANCE

To capture students' interest and find out what they think they know about changes that occur to materials in their everyday lives.

To elicit students' questions about why certain changes occur and whether or not they are easily reversible.

Students:

- observe and record information about some common changes to materials
- share and discuss observations.

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:

- reversible and irreversible changes to everyday materials, and how to summarise team observations about common changes to materials.

Key lesson outcomes

Science

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

- identify evidence of changes that occur
- describe their existing ideas of what causes change
- explain why they think changes can or cannot be reversed.

Literacy

Students will be able to:

- contribute to discussions about changes to common materials
- identify the purpose and features of a science journal
- make predictions and record observations in the class science journal
- understand the purpose and features of a summary and a report.

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

Equipment

FOR THE CLASS	FOR EACH TEAM
• class science journal • word wall • 'Mess scene' (see 'Preparation') • *optional:* digital camera	• role wristbands or badges for Director, Manager and Speaker • each team member's science journal

Preparation

- Read 'How to organise collaborative learning teams' (Appendix 1). Display an enlarged copy of the team skills chart and the team roles chart in the classroom. Prepare role badges or wristbands and the equipment table.
- Read 'How to use a science journal' (Appendix 2).
- Read 'How to use a word wall' (Appendix 3).
- Create a 'Mess scene' for students to examine using the following:
  - salt in a glass of water with open salt container beside it
  - melted chocolate
  - burnt chocolate (heat the chocolate beyond melting point until it takes on a crusty texture, burnt appearance and stronger smell)
  - ice-poles melting in their clear wrappers
  - a glass full of bubbles from sodium bicarbonate and tartaric acid reacting together in water, with a packet of sodium bicarbonate and tartaric acid next to it
  - frozen milk in the carton
  - a burning candle
  - a perfume bottle tipped over (or vinegar if students have allergies)
  - glass of water with a fizzing tablet, for example, antacid tablets (which will also be used in the *Elaborate* lesson).

  For example, set up stations around the room during a break or in the morning, with the different changes. As an alternative, before and after photos are available on the Primary**Connections** website (www.primaryconnections.org.au) however, the 'Mess scene' set up is highly recommended.
- Decide on how the unit will be conducted, for example, as a 'whodunnit' where a perpetrator and time of crime is identified by students based on their observations and investigations as the unit progresses. Decide the audience for the report, such as, the principal, the science-coordinator, a chief investigator of the 'Mess scene'. This gives a context and clear purpose for the report, which assists students in deciding what to include (see Lesson 7).
- Prepare a page in the class science journal with the title 'First thoughts'.

- Begin collecting sets of different sized glass jars for Lesson 4, such as:
  - 120 ml, for example, baby food jars
  - 250 ml, for example, tartare sauce jars
  - 330 ml, for example, salsa jars
  - 500 ml, for example, pasta sauce jars.

Lesson steps

1 Introduce the 'Mess scene' (see 'Preparation') and invite students to become 'Change detectives'. Discuss the role and skills of a 'Change detective', such as, observing the scene and using evidence to investigate what they think has happened.

Optional: If a real 'Mess scene' was prepared, allow students to take pictures of the 'evidence' with a digital camera. These can be used at the beginning of each Explore lesson and in the Evaluate lesson.

2 Allow students to explore the 'Mess scene' and ask questions, such as:

- What can you observe about each example?
- What changes have occurred to the original objects and materials?
- Do you think the changes can be reversed? Why? How? Why not?

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

> ### Literacy focus
>
> **Why do we use a science journal?**
>
> We use a **science journal** to record what we see, hear, feel, and think so that we can look at it later to help us with our claims and evidence.
>
> **What does a science journal include?**
>
> A **science journal** include dates and times. It might include written text, drawings, measurements, labelled diagrams, photographs, tables and graphs.

Record students' responses from Lesson step 2 in the class science journal.

4 Explain that students will be working in collaborative learning teams to share their observations, discuss what they think has happened at the scene and create a team summary of their ideas in each team member's science journal.

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

5 Discuss the purpose and features of a summary.

> **Literacy focus**
>
> **Why do we use a summary?**
>
> We use a **summary** to present the main points of a topic or text.
>
> **What does a summary include?**
>
> A **summary** includes a concise description of the main points of a topic or text.

ENGAGE

6 Form teams and allocate roles. Allow time for students to complete the task.

7 Ask each team Speaker to share some key points from each team's summary. Record key points under the title 'First thoughts' in the class science journal (see 'Preparation').

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

8 Explain that students will use their detective skills and gather information about the scene to present an end-of-unit report. Discuss the purpose and features of a report.

> **Literacy focus**
>
> **Why do we use a report?**
>
> We use a **report** to present information in written form. It might be used to teach or influence the audience.
>
> **What does a report include?**
>
> A **report** includes an introduction, a body and a conclusion. It might include charts, tables, graphs and images.

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

> **Literacy focus**
>
> **Why do we use a word wall?**
>
> We use a **word wall** to record words we know or learn about a topic. We display the word wall in the classroom so that we can look up words we are learning about and see 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.

10 Commence the word wall with words and images from the lesson.

Curriculum links

English

- Read a class novel about crime scenes.
- Create a class story based on the mess scene that describes what students think might have happened.

Studies of Society and Environment

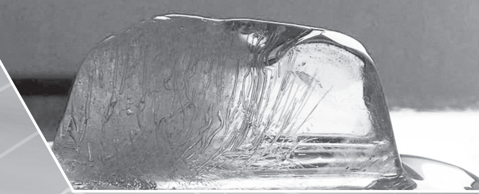
- Explore the work of detectives and forensic scientists.

The Arts

- Explore the difference between taking photographs for information and taking photographs for artistic expression, such as, photographic competitions, images in magazines, space photographs. Students explore taking photographs that are aesthetically pleasing (artistic) and informative, such as, astrographs, crystals through a microscope, leaves, insects. The photographic display could be labelled 'Science as art'.
- Use observational skills to look at photographic art work.

Indigenous perspectives

- 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).



Lesson 2 Purely physical

EXPLORE

AT A GLANCE

To provide students with hands-on, shared experiences of melting and evaporation, and a model used to represent them.

Session 1 Mostly melting

Students:

- test whether melted or frozen objects can be returned to their original state
- observe and record the factors that make an ice cube melt the fastest.

Session 2 Playing particles

Students:

- represent what happens when a solid melts.

Session 3 Evocative evaporation

Students:

- discuss why they can smell evaporated liquids
- observe and record the factors that make a liquid evaporate the fastest
- describe what happens when a liquid evaporates.

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:

- reversible changes to materials, such as melting, freezing and evaporating. You will also monitor their developing science inquiry skills (see page 2).

Key lesson outcomes

Science

Students will be able to:

- plan an investigation, with teacher support
- make predictions about what factors will make an ice cube melt fastest and a liquid evaporate fastest
- observe, record and interpret the results of their investigation
- describe the effect of temperature on phase change
- explain that the same substance can change state and be a liquid, a solid, or a gas
- explain why they can smell evaporated liquids.

Literacy

Students will be able to:

- understand the purpose and features of a table
- use oral, written and visual language to record and discuss investigation results
- engage in a discussion to compare ideas, and use evidence from an investigation to explain that temperature has an effect on phase change
- role-play their understanding of the effect of temperature on phase change by using representational models of particles.

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

Teacher background information

An object can be changed by external forces, such as, it can be dented, scratched or broken. An object can also change because the substances the object is made of change. For example, a full, sealed bottle of water placed in the freezer can change shape, or even explode, because the water in the bottle expands as it freezes. A chocolate rabbit left in the Sun will change shape because the heat from the Sun melts the chocolate.

States of matter

All substances are made of particles. A substance might be found in different states.

The traditional ones are solid, liquid and gas. The difference between them is the amount of energy the particles of the substance have, for example, the difference between solid chocolate and melted chocolate is the amount of energy their particles have. Other states of matter are now often recognised, such as, plasma and liquid crystal.

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

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

Gases have no fixed shape or volume, and assume the shape of the space in which they are contained. The particles of gases bounce around, into each other and off the sides of the container. The gases of the atmosphere are retained around the Earth because of the Earth's gravity.

Changing states

Substances change state when they gain or lose heat energy. For example, frozen water that gains heat energy will start changing into liquid water at 0°C, and liquid water will start changing into water vapour (gas) at 100°C. When a saucepan of water is placed on a stove, the heat energy initially goes into warming the water. When all the water has reached 100°C then the heat energy will go into turning the water into vapour (rather than heating the water). The liquid water will remain at 100°C and bubbles of water vapour will form. The heat energy makes the particles vibrate and move more energetically. Some particles move so fast they escape from the surface of the liquid water and become water vapour.

Whether a substance is a solid, a liquid or a gas depends on the pressure and temperature of the substance's environment. Pressure tends to keep particles together. When heat provides energy causing a substance to change state, adding pressure can prevent this from occurring. For example, the liquid water in a pressure cooker can reach temperatures above 100°C.

When melting a solid or evaporating a liquid, the faster heat is gained by the substance, the quicker it will change state. Heat enters through the surface, therefore the larger the surface available, the faster heat will be absorbed. Heating an ice cube in a frying pan only warms one side and takes longer than immersing an ice cube in hot water. Smashing an ice cube increases the available surface area, and so it will melt faster.

When a substance changes state, the particles do not change, it is the way the particles are spaced that changes. This is known as a physical change, and it is easily reversible. However, when a non-pure solid (mixture) melts and becomes liquid, sometimes the components can separate. Therefore when the liquids are put back into the freezer, the original solid might not be re-created. For example, melted and refrozen ice-cream becomes two separate solids: ice and frozen cream.

Students' conceptions

Students have difficulty classifying soft, malleable and granular solids as solids in the way they are defined by scientists. This is reinforced by the common use of 'solid' as an adjective meaning hard, heavy, not flexible or in one big piece. Granular solids, such as powders, might behave like liquids because they take the shape of the container they are in. However, the particles in each grain of a powder have a definite shape and volume, and powders can form mounds when poured whereas liquids can not. Some solids such as jelly are considered to be non-rigid solids to distinguish them from solids that are rigid and have a fixed shape.

Some students might associate melting with 'turning to water'. When an ice cube melts it is not turning into water, it is solid water changing into liquid water. The water is changing state. All substances remain the same substance when they melt.

Students might think that aluminium foil or a thick cloth will melt an ice cube, because they associate these materials with warmth. These materials help keep our body (or food) warm because they are effective insulators—they insulate the warmth produced by our bodies. However, they will also slow the rate at which heat energy moves from the surfaces or surrounding air to the ice cube.

Most students might not have the conception that substances are made of particles. This notion is introduced in the unit to help students conceptualise how an object can change observable properties while still made of the same substance (for example, a chocolate block becomes runny with heat but is still made of chocolate). Research suggests that the use of different representational forms (drawing, acting, manipulating and writing) helps students engage with the idea of particles.

Session 1 Mostly melting

Equipment

FOR THE CLASS

- class science journal
- word wall
- 1 enlarged copy of ‘PROE record: Purely physical’ (Resource sheet 1)
- 1 non-melted chocolate button
- 1 glass of milk

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member’s science journal
- 1 copy of ‘PROE record: Purely physical’ (Resource sheet 1) per each team member
- 1 frozen milk cube in a container (see ‘Preparation’)
- 1 melted chocolate button (see ‘Preparation’)
- 3 ice cubes in separate containers
- 1 timing device (eg, a stopwatch or a watch with a second hand)
- equipment to investigate melting an ice cube (eg, towel, aluminium foil, glass of hot water)

Preparation

- Freeze 1 milk and 3 water cubes for each team. Ensure the size of the water cube is small enough to fit into a student’s mouth.
- Melt one chocolate button for each team, such as, placing them in an oven or by placing chocolate buttons on pieces of grease proof paper and microwaving them.
- *Optional:* Organise adults to assist students in this lesson.

Lesson steps

1 Review Lesson 1, focusing students' attention on the melted chocolate and the frozen milk. Review students' first thoughts recorded in the class science journal.

2 Introduce the non-melted chocolate button and the glass of milk to the class and ask students to describe the chocolate button and the milk.

3 Explain that students will be working in collaborative learning teams to test their ideas about how the melted chocolate and the frozen milk can be returned to their original state that the students observed in Lesson step 2.

4 Draw students' attention to the equipment table and discuss its use. Explain that this table is where Managers will collect and return team equipment. Explain that Managers will collect a melted chocolate button and a frozen milk cube for each team member.

SAFETY

Remind students not to taste the chocolate button or milk cube for allergy and hygiene reasons.

Optional: Each team investigates either the chocolate or the frozen milk.

5 Form teams and allocate roles. Allow time for teams to discuss how to return the melted chocolate bud and the frozen milk to their original state.

6 Ask Managers to collect team equipment. Ask teams to perform their tests and record their observations in their science journals.

Note: The investigations might take some time. Continue the session, allowing students to return and check on the state of their chocolate and/or milk at regular intervals.

7 Explain that students will continue to work in their collaborative learning teams to explore how they can make an ice cube melt as fast as possible.

8 Invite teams to brainstorm ways to quickly melt an ice cube, such as, wrap it in a towel or blanket, put it in the Sun or put it in their mouth.

9 Ask each team Speaker to share their team's ideas. Record the ideas in the class science journal, tallying the number of times each idea is suggested. Select the three most suggested ideas and explain that each cooperative learning team member will investigate one of the ideas and discuss the results with their team members.

10 Model how to use the Predict, Reason, Observe, Explain (PROE) strategy. Record the investigation question 'How can we make the ice cube melt the fastest?'. Model an entry in the class science journal.

Predict: Record one of the predicted ways the ice cube might melt the fastest, such as, wrap it in a towel or blanket.

Reason: Ask for reasons to support the predictions and record in the class science journal, for example, a blanket makes things warm so I think it will melt the ice cube fastest.

Observe: Explain that teams will observe an ice cube melting for each prediction and record their results for each prediction in their science journal. Such as:

- Wrapped in a towel—after 30 minutes the ice cube still hadn't melted much.
- In the Sun—the ice cube melted in 10 minutes.
- In their mouth—the ice cube melted in 5 minutes.

Explain: Ask teams to compare their predictions with their observations, and explain why the results did or did not match their predictions, for example, 'My results did not match my predictions because the blanket stopped the ice cube from melting. This might be because it stopped warm air getting on the ice cube. Melting it in my mouth was more efficient than putting it in the Sun. This might be because I could suck away the melted water and allow more of the ice cube to touch my warm mouth.'

Note: Do not correct predictions or reasons as the purpose is for the students to record their predictions and challenge these with the observed results.

11 Ask teams to discuss how they can keep the test fair, asking questions such as:

- What will each team measure?
- When will each team start recording?

Ask teams to complete the 'Predict' and 'Reason' sections of the PROE strategy.

12 Ask Managers to collect team equipment. Ask teams to observe and time how long it takes the ice cube to melt and record their results using Resource sheet 1. Allow time for students to complete the 'Observe' and 'Explain' sections of the PROE strategy.

13 Invite team Speakers to share their team's results with the class. During the discussion, focus students' attention on the fact that heat energy makes solids melt.

Optional: Discuss other substances that melt, such as, butter melting on hot toast and metals melting in very hot fires, as in a bushfire. Discuss how different substances melt at different temperatures.

14 Ask teams to discuss what has happened to their melted chocolate button and their milk cube. Compare them with the chocolate button and glass of milk in Lesson step 2, describing what has happened to each item and if it has changed back to the original state which students observed in Lesson step 2.

15 Ask students to summarise what they have learned about melted chocolate, frozen milk and ice cubes in their original and melted states in their science journal. Review the features and purpose of summaries (see Lesson 1). Support their writing with sentence beginnings, such as:

- What I have learned about changes is …
- I know this because …
- I want to know more about …
- My final report might include information about …

16 Update the word wall with words and images.

PROE record: Purely physical

Name: ______________________ **Date:** ______________

Other members of your team: ______________________

Your team's task is to explore how you can make an ice cube melt as fast as possible. Each team member will investigate one of the three methods the class have decided upon. You then need to draw or write your predictions and then record your reasons, observations and explanations in the table below using writing and drawings.

Predict Draw or write a description of how you will make your ice cube melt the fastest.	
Reason Why do you think this method will be the fastest?	
Observe Carry out your test, taking special care to time accurately. What happened? What was your time?	
Explain Compare your results with your team members'. Did the results fit your prediction? Why do you think that is?	

Session 2 Playing particles

Equipment

FOR THE CLASS

- class science journal
- word wall
- 1 melted ice pole in a clear wrapper
- 1 frozen ice pole in a clear wrapper

FOR EACH TEAM

- science journal
- tray of marbles or small beads for each team
- *optional:* length of rope

Preparation

- Collect props for students to use in particle representations, such as, marbles or small beads.
- Prepare a table in the class science journal with the title ‘Icy observations’.

Icy observations

Similarities	Differences

Lesson steps

1 Review Lesson 1, focusing students’ attention on the frozen milk, melted chocolate and melted ice poles. Review students’ first thoughts in the class science journal.

2 Introduce the frozen ice pole and the melted ice pole. Ask questions, such as:
- Are these the same object? Why/Why not?
- Are these made of the same things?
- How do we get one from the other?
- What are the similarities between these items?
- What are the differences between these items?

3 Record answers in the table in the class science journal (see ‘Preparation’). Discuss the features and purpose of a table.

EXPLORE

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.

4 Introduce the terms 'substance' and 'particle'. Ask students to describe what they think substances and particles are. Explain that scientists think that substances are made of particles (see 'Teacher background information').

5 Explain that scientists think that particles in a solid like a frozen ice pole are all packed together and only wobble around a fixed position, whereas in a liquid, they have more energy and can move more freely and slide over each other. When the particles gain heat energy they move more energetically.

6 Ask students to use the idea of particles to represent what they think is happening when an ice cube melts. Several different modes of representation can be used, such as:

- Students participate in a whole-class role-play to represent what happens to the particles in a melting ice pole. Particles that were very tightly packed together in the solid state start to move faster and move past each other. Discuss the features and purpose of a role-play.

Literacy focus

Why do we use a role-play?

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

What does a role-play include?

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

- Explain that students are all going to role-play being particles of water. Explain that they are low in energy and so are not moving much and are all packed together. Ask students to stand close to each other, not moving from the spot, swaying backwards and forwards. Discuss what name could be given to the students now, such as, an ice pole, a solid.
- Explain that you will 'add heat energy' to students by tapping them on the shoulder. Ask students that have become heated particles to sway backwards and forwards more energetically and to start moving slowly near the other students while staying close. Walk around the group of students, adding heat to the students at the outside first. When all students are moving slowly together, discuss what name could be given to the students as whole, such as, a puddle of water, a liquid.

  Optional: Use a rope on the ground to mark out the shape of a bowl. When students are behaving like a liquid, they move to fit the shape of the bowl.

- Introduce a tray filled with marbles or small beads. Discuss what the marbles represent (particles of water). Give a tray to each cooperative learning team and ask them to arrange the marbles to represent a block of ice, for example, by compacting them in a corner of the container. Ask teams to give reasons for their representation. Ask teams to arrange the marbles to represent a puddle of water, for example, by spreading the marbles out in the container, and give reasons for their representation.

7 Discuss the limits of the models used to represent solids and liquids, for example, particles might not look or act like marbles or people. Particles are much smaller—too small to see even with a microscope. Explain that using models also helps scientists explore ideas.

8 Discuss ways of representing chocolate melting, for example, label the marbles or themselves 'chocolate particles' instead of 'water particles'.

9 Ask students to summarise what they have learned in their science journal. Update the word wall with words and images.

Session 3 Evocative evaporation

Equipment

FOR THE CLASS

- class science journal
- word wall
- a small bottle of perfume, vinegar or essence
- 1 sheet of plastic (eg, an overhead transparency)
- 1 glass of water
- 1 straw
- heating equipment, such as: electric hot plate, hairdryer

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 10 ml water
- a clock

Preparation

SAFETY

- Remind students to be aware of inhaling unknown substances.
- Remind students to be cautious around heat sources.

Lesson steps

1 Review Lesson 1, focusing students' attention on the perfume bottle and review students' first thoughts recorded in the class science journal. Review Sessions 1 and 2, focusing students' attention on the representations they used to describe melting and particles.

2 Produce a small, sealed bottle of perfume, vinegar or an essence. Explain that you are going to open the bottle and pour some out onto a surface. Ask students to spread out around the room.

3 Open the bottle and pour a very small puddle (about half the size of your palm) on a sheet of plastic on a flat surface. Quickly draw a line around the puddle.

4 Ask students to raise their hand when they smell the perfume. Wait for all students to be able to smell the perfume. Ask questions, such as:
- Why couldn't we smell it when the bottle was sealed?
- Which people in the room could smell the perfume first? Why do you think they smelled it first?
- Where is the smell coming from?
- What do you think is happening?

5 Discuss students' ideas of how the smell gets to their noses. Ask questions, such as:
- Could you tell me more about that?
- Well, if that is right, what about …?
- Do others agree with that idea?
- Scientists think that smell is particles getting into our nose. What do you think?
- Remember that you would find it difficult to smell if your nose is blocked or the container is sealed shut. How does that fit with your idea? How does that fit with the ideas that scientists have about smell?
- Discuss food smells, odours at home, natural body odours and outdoor smells, for example, gum leaves.

6 *Optional:* Look at the liquid on the plastic. Ask questions such as:
- Is the puddle the same size as it was before?
- Where are the perfume/essence particles that used to be there?
- Where do you think the perfume/essence particles are going?
- What size do you think the puddle will be in an hour?

Ask students to draw a picture of what they think they would see if they looked at the edge of the puddle through an (imaginary) super-strong microscope. Record in their science journals.

7 Explain that students will be working in their collaborative learning teams to explore how they can make 10 ml of water evaporate as fast as possible.

8 Review the PROE strategy from Lesson 2, Session 1. Record the investigation question 'How can we evaporate the water the fastest?' and review each step of the PROE strategy.

9 Form teams and allocate roles.

10 Ask teams to complete the 'Predict' and 'Reason' sections of the PROE strategy in their science journal. Discuss ways they could measure and record the water evaporating. Refer to Resource sheet 1 for an example of how to record this investigation using this strategy.

11 Ask Managers to collect team equipment. Ask teams to observe the water evaporating over time and record their results. Allow time for students to complete the 'Observe' and 'Explain' sections of the PROE strategy.

EXPLORE

12 Ask Speakers to share their team's results with the class and record findings in the class science journal. Discuss the similarities of things melting and things evaporating. Focus the students' attention on the fact that heat makes liquids evaporate. Ask students why they think evaporation occurs, referring them to the role-play in Session 2.

13 Blow bubbles with a straw into a glass of water. Ask students what they think is inside the bubbles (air). Ask students what they think a gas is. Explain that scientists think a gas is made of particles (such as water, oxygen, carbon dioxide) that have lots of energy and are bouncing off each other all the time.

14 *Optional:* Students create a role-play representation like that used in Session 2, Lesson step 6, to represent a puddle of water drying up in the Sun.

15 Ask students to summarise what they have learned in their science journal. Update the word wall with words and images.

EXPLORE

Curriculum links

Science

- Explore condensation. Ask teams to think of where the water comes from on cold objects exposed to air, such as a can of soft drink from the fridge (from water vapour in the air condensing on the cold surface).

Health and Physical Education

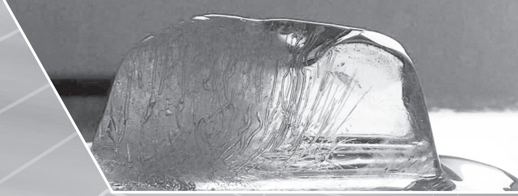
- Discuss the need to replace the water that evaporates from our skin when we sweat.

Indigenous perspectives

Some Indigenous people use native plants for medicinal purposes, treating ailments such as headaches and stomach aches. Crushing the leaves of the melaleuca, eucalyptus and prostanthera (mint) species releases the vapours of the essential oils.

- Use tea tree oil or eucalyptus oil as demonstration essence in this lesson.
- Research the medicinal use of plants by Indigenous people.
  See www.bri.net.au/medicine.html

  Note: Permission is needed to collect plants from public bushlands and national parks.
- 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).



Lesson 3 Slippery solutions

AT A GLANCE

To provide students with hands-on, shared experiences of dissolving and a chemical reaction in water.

Session 1 Delightful dissolving

Students:

- observe salt dissolving in water
- devise and conduct tests to retrieve the salt in its original form.

Session 2 Gas bags

Students:

- observe and record what happens when a sodium bicarbonate solution mixes with a tartaric acid solution.

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, for example, 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:

- changes to materials from dissolving and through a chemical reaction. You will also monitor their developing science inquiry skills (see page 2).

Key lesson outcomes

Science

Students will be able to:

- make predictions about the results from an investigation of the effect of the quantity of water on the amount of salt dissolved
- plan and conduct an investigation follow directions to investigate a chemical reaction that produces the gas carbon dioxide
- observe, record and interpret the results of their investigations
- identify the features that made their investigation a fair test
- explain that chemical change only occurs when all the necessary substances are present.

Literacy

Students will be able to:

- identify the features and purpose of a procedural text
- follow a procedural text to complete an investigation
- use oral, written and visual language to describe, record and discuss investigation results
- engage in discussion to compare ideas and relate evidence from an investigation to explanations about dissolving and reacting and to prior predictions
- demonstrate understanding of dissolving and reacting using science journal entries.

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

EXPLORE

Session 1 Delightful dissolving

Teacher background information

Dissolving

When a solid, for example, in a powder form, is added to a liquid, it might dissolve. When this happens the particles of the solid completely disperse in the liquid so that they are no longer visible (not to be confused with a suspension of a solid in a liquid). For example, when table salt is dissolved in water, a liquid solution is formed that contains a dissolved salt. The salt is not changed into another chemical substance: the salt remains as salt but is now dissolved in water.

Not all substances will dissolve in water, for example, nail polish dissolves in acetone. Some solids will dissolve in water but not in other liquids, for example, aspirin tablets will not dissolve in oil. Whether or not things dissolve depends on the properties of the liquids and the solids, for example, fats will not dissolve in water.

If the powdered solid does not dissolve in the liquid, the liquid will appear cloudy when it is stirred (and will become clear again when the powder resettles at the bottom). This is because the solid particles block light more effectively than the liquid does. After adding a soluble powder, a liquid might become cloudy when it is first mixed. This is because it takes time for solids to dissolve. Stirring helps the process by allowing the water to reach as much of the solid as possible.

Liquids such as liquid water can only dissolve a certain amount of a solid at room temperature and pressure. That is why some solid might remain undissolved if too much of a solid is added to the water. The salt or sugar dissolves until the 'solution is saturated'. You can increase the amount of substance that dissolves in a liquid by increasing the temperature or pressure. Water can dissolve more sugar crystals when it is hot. If the sugar solution is 'saturated' when it is hot, sugar will crystallise from the solution when it cools.

Gases can also dissolve in liquids. 'Carbonated water' used for soft drinks, is water in which carbon dioxide gas has been dissolved. The water and gas are put under pressure so more gas is dissolved in the water than would be the case under normal atmospheric conditions. When the pressure is released by opening a bottle or can, the excess carbon dioxide escapes from the water as bubbles.

Students' conceptions

Students might confuse dissolving with melting. Melting is a change of state—a solid substance becomes liquid through a change of pressure or heat. Dissolving is when one substance (solid or gas) combines with a liquid substance.

Students might say that the 'sugar has disappeared' when sugar has dissolved in water. This statement might mean that students believe that the sugar is no longer present, or it might mean that they are simply remarking that they can no longer see the sugar. The sugar is still present, although it is no longer visible, and can be retrieved if the water evaporates from the solution.

Students might think that the taste of the dissolved substance remains, but not the actual substance. The taste sensation is caused by particles interacting with our taste buds (similar to the way in which our smell receptors interact with perfume particles). Therefore the presence of the taste indicates the actual substance is still there.

Equipment

FOR THE CLASS

- class science journal
- word wall
- 1 enlarged copy of 'Salt dissolving table' (Resource sheet 2)
- 1 x 300 ml measuring jug

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Salt dissolving table' (Resource sheet 2)
- 1 x 100 ml transparent container
- 1 x 200 ml transparent container
- 300 ml of water
- 3 tablespoons of salt
- 1 x ½ teaspoon measuring spoon

Preparation

- Prepare an enlarged copy of 'Salt dissolving table' (Resource Sheet 2).
- Prepare a table in the class science journal for Lesson step 8, for example:

Team	Number of half teaspoons of salt that dissolved in:	
	100 ml water	200 ml water
1		
2		
...		
Average		

EXPLORE

Lesson steps

1. Review Lesson 1, focusing students' attention on the salt container in the bucket of water. Review students' first thoughts recorded in the class science journal.
2. Explain that students will be working in collaborative learning teams to investigate how much salt can be dissolved in 100 ml and 200 ml of water.
3. Discuss how students will measure how much salt will dissolve, for example, by measuring with half teaspoons. Ask students how they will know if the salt is no longer dissolving and discuss the importance of proceeding slowly in stirring and waiting for the salt to dissolve.
4. Introduce the enlarged copy of 'Salt dissolving table' (Resource sheet 2). Review the purpose and features of a table (see Lesson 2, Session 2). Discuss how to complete the table to record observations.
5. Ask students to give reasoned predictions about how much salt can be dissolved in each glass of water and record their predictions and reasons in their science journals.
6. Form teams and allocate roles. Ask Managers to collect team equipment.
7. Allow time for students to dissolve the salt, and complete the resource sheet.
   Ask teams to reflect on questions, such as:
   - Is the salt still there when you dissolve it? How do you know? (You can taste it, if you evaporate the water again you can see it.)
   - Where do the salt crystals go? (The salt particles go in between the water particles.)
   - How do you know when the salt is no longer dissolving? (It remains on the bottom of the container.)

   SAFETY

   Remind students that they should only taste things that you indicate are safe.
8. Ask Speakers to share their team's results and thoughts about the questions asked. Record each team's results in the table in the class science journal (see 'Preparation'). Model how to calculate the average values for each volume of water. Ask questions such as:

- What advantage is there in analysing the results from all groups? (Comparing groups allows us to know if the result is consistent.)
- Why are the different groups' results not all the same? (Some sources of error might be sampling error, such as, small difference in the amount of salt per half teaspoon or slightly different water quality, or observation error, for example, one group didn't notice that the salt had stopped dissolving.)
- How does the average help us? (It should provide us with a value that is closer to the real value.)
- How do the results differ from the predictions made before the investigation?

9 Ask students to explain what they think is happening. Ask questions such as:

- Why does the salt stop dissolving? (The water cannot hold any more salt particles.)
- Why is it cloudy when you mix the final solution instead of clear like before? (Because there are solid particles of salt being swirled around.)
- Which holds more salt, 200 ml of water or 100 ml of water? Why?

10 Ask students to suggest ways to get the salt (and/or water) back.

11 *Optional:* Students can further explore dissolving and reversible and irreversible changes on online digital resources such as http://www.bbc.co.uk/schools/scienceclips/ages/10_11/rev_irrev_changes.shtml

12 *Optional:* Ask students to conduct fair tests of their suggestions. (see Appendix 4)

13 Ask students to represent what they think is happening when the salt dissolves in the water, by representing particles as in Lesson 2, Session 2, lesson step 6. For example, half the class moves slowly around in a designated space (representing particles of water in a container). The other students represent particles of salt that disperse among the water particles when added.

14 Ask students to summarise what they have learned in their science journal. Update the word wall with words and images.

EXPLORE

Salt dissolving table

Name: ______________________ **Date:** ______________________

Number of half teaspoons	Observation of the 100mL transparent container of water	Observation of the 200mL transparent container of water

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Session 2 Gas bags

Teacher background information

Sodium bicarbonate ($NaHCO_3$) is a common chemical used in the kitchen. It has many other common names, including sodium hydrogen carbonate, sodium bicarb, baking soda, bread soda, cooking soda, bicarbonate soda or bicarbonate of soda. It is used in baking because when it comes in contact with an acid, carbon dioxide gas is formed. When the gas is produced it is trapped in bubbles in the material. Gases expand when they are heated, so the cake mixture (with bubbles of gas trapped in it) rises.

When tartaric acid and sodium bicarbonate are mixed in powder form the particles are not free to react with each other, so there is no chemical reaction. When each is dissolved in water separately there is no carbon dioxide gas formed since only one of the necessary particles is present each time. It is only when the substances are combined in their dissolved form that the reaction takes place. The two original substances sodium bicarbonate and tartaric acid (the reactants) react with each other and are changed into new substances that are formed by the chemical reaction (carbon dioxide, water and sodium tartrate).

EXPLORE

Sodium bicarbonate is a chemical salt, which means it is a solid made of two particles (Na^+ and HCO_3^-). These two particles separate in the water. Acids such as tartaric acid are substances that release particles of hydrogen (H^+) when they are dissolved.

The reaction occurs between the HCO_3^- particles from the sodium bicarbonate and the hydrogen (H^+) particles from an acid. These react together and form carbon dioxide (CO_2) and water (H_2O). The carbon dioxide produced is a gas at room temperature so it forms bubbles in the solution.

Sodium bicarbonate will react with any acid to produce the gas carbon dioxide.

Because the reaction changes the acid, sodium bicarbonate is often used to neutralise acids. For example, it is sometimes prescribed to patients with acid indigestion.

Students' conceptions

Students might think that a chemical reaction is not an interaction of ingredients, but one ingredient that plays an active role. For example, when presented with bicarbonate reacting with vinegar (a weak acid in water), they might ascribe the cause of the reaction to be the sodium bicarbonate dissolving in a liquid. Using tartaric acid instead of vinegar will allow students to compare dissolving and reacting.

Most students are familiar with 'fizzy' drinks. Therefore the appearance of bubbles is not necessarily seen as something that needs to be explained. See the 'Teacher background information' in Lesson 3, Session 1 for an explanation of why carbonated drinks have bubbles of carbon dioxide in them. Students might have the misconception that the bubbles formed by a chemical reaction (a chemical change) is the same process by which bubbles are released from solution when the cap is removed from a bottle of fizzy drink (a physical change).

Students might not believe that the sodium bicarbonate and tartaric acid are converted by the reaction until there is none present in their original form. Encouraging students to think about why the reaction stops and whether the amount of substances dissolved affects the result, can help challenge these ideas.

Equipment

FOR THE CLASS

- class science journal
- word wall
- 1 enlarged copy of 'Fizzing investigation' (Resource sheet 3)
- *optional:* digital camera to record students' findings

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Fizzing investigation' (Resource sheet 3)
- 6 teaspoons of sodium bicarbonate
- 6 teaspoons of tartaric acid
- 3 cups of non-acidic water (see 'Preparation')
- 1 cup measure
- 1 teaspoon
- 4 transparent bottles of the same size (350–400 ml approximately)
- 4 balloons
- 1 labelling pen
- 1 funnel
- adhesive tape
- 4 pieces of paper towel

EXPLORE

Preparation

- Prepare an enlarged copy of 'Fizzing investigation' (Resource Sheet 3).
- Buy tartaric acid powder (or citric acid powder) and sodium bicarbonate (also known as bicarbonate of soda) from your supermarket.
- Check if your local tap water is acidic. Pour a glass of water and add some sodium bicarbonate. If it fizzes the water is acidic and the reaction is already starting.
- If this is the case, try again using some bottled water (the best is distilled water).
- SAFETY Check your school's safety procedures for chemicals. Sodium bicarbonate and tartaric acid are both listed as harmless substances that might be disposed of down the sink. However some students might be allergic and this lesson is an opportunity to discuss safety precautions for unknown chemicals.
- Read 'How to conduct a fair test' (Appendix 4).

Lesson steps

1. Review Lesson 1, focusing students' attention on the glass full of bubbles in the 'Mess scene'. Review students' first thoughts recorded in the class science journal.
2. Ask students when they have seen bubbles in liquids, for example, soft drinks.
3. Explain that students will be working in collaborative learning teams to investigate the glass full of bubbles, by investigating what happens when combinations of water, sodium bicarbonate and tartaric acid are mixed.

4 Ask students to predict what they think would happen if they combine water, sodium bicarbonate and tartaric acid. Discuss how students can test their predictions and how they can keep the test fair while investigating.

5 Introduce an enlarged copy of the 'Fizzing investigation' (Resource sheet 3) and discuss the purpose and features of procedural texts.

Literacy focus

Why do we use a procedural text?

We use a **procedural text** to describe how something is done. We can read a procedural text to find out how to do things.

What does a procedural text include?

A **procedural text** includes a list of materials needed to do the task and a description of the sequence of steps used. It might include annotated diagrams.

Read through the enlarged copy of 'Fizzing investigation' (Resource sheet 3).

6 Encourage students to reflect on the procedure by asking questions, such as:

- Why do you label the bottles? (To keep track of each since the solutions are all clear and colourless.)
- Why do you label the balloons? (To keep track of each since the powders are both white.)
- Why do you put the powder in the balloons? (To make sure that the powders are added at the same time, after the balloon is upended.)
- Why do you wipe the funnel each time? (So you don't accidentally add some powder into the wrong bottle.)
- Why do you discard the paper towel? (To make sure you don't accidentally wipe powder onto the funnel.)

Optional: Ask students to devise their own procedure rather than 'Fizzing investigation' (Resource sheet 3).

7 Discuss the different combinations listed and ask why such a variety is needed. Introduce the idea of a fair test and the need for a control. Ask students what things they might need to keep the same to ensure that it is a fair test, such as, the same size bottle and amount of ingredients in each bottle.

8 Ask students to write their predictions for each bottle in their science journals. Discuss predictions as a class.

9 Explain that students are going to use observation (focusing carefully on one aspect of an event to be able to notice precisely what is happening) and record the results.

10 Draw students' attention to the sodium bicarbonate, the tartaric acid powder and the water on the equipment table.

SAFETY

Remind students to be careful when handling unknown chemicals. Ask students for suggestions of safety measures to take in these circumstances.

Remind students not to ingest or inhale the sodium bicarbonate and tartaric acid powders or get them in their eyes.

11 Form teams and allocate roles. Ask Managers to collect team equipment and allow time for students to complete their investigations.

12 Ask teams to record their observations and discuss their findings. Remind students to use note-taking to record the information.

13 Ask Speakers to share their team's findings and conclusions. Encourage students to think about the bubbles created in Bottle 4, by asking questions, such as:

- What are the bubbles? (A gas.)
- Do the bubbles come from the sodium bicarbonate? Why do you think that? (No, because then they would appear when the sodium bicarbonate dissolved.)
- Do the bubbles come from the tartaric acid? Why do you think that? (No, because then they would appear when the tartaric acid dissolved.)
- When do the bubbles appear? (When both solutions are mixed together.)
- Why do you think that they only appear then? (Because all three substances are needed for the reaction.)
- *Optional:* Predict what will happen if you mix Bottle 2 and Bottle 3.

Record answers in the class science journal.

Ask students what they think has inflated the balloon. Explain that the bubbles are a gas called carbon dioxide and discuss what students might already know about carbon dioxide (such as, fizzy drinks have carbon dioxide bubbles, and animals breathe out carbon dioxide). Explain that the gas is mixing with the air at the top of the bottle and is taking up space which is why the balloon is inflating.

14 Ask students to summarise what they have learned in their science journal. Update the word wall with words and images.

EXPLORE

Curriculum links

Science

- Make crystals with white sugar, salt, alum.
- Explore other activities that use sodium bicarbonate and an acid, for example, canister rockets.

Mathematics

- Measure the volume of solids, liquids and gases.

Indigenous perspectives

Many bush foods are potentially poisonous if ingested and need to be prepared with specific techniques before they are safe to eat. Over thousands of years, Indigenous people have developed a knowledge of which bush foods are poisonous and how they need to be treated to remove toxins.

- Create a poster illustrating different techniques Indigenous people used to remove toxins from bush foods.
- 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).

Fizzing investigation

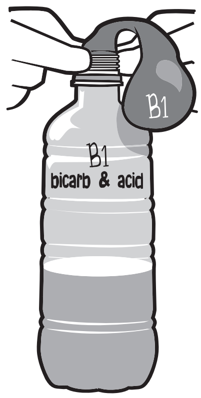
Aim

To find out what happens when combinations of water, sodium bicarbonate and tartaric acid are mixed.

Equipment

- role badges for director, manager and speaker
- each team member's science journal
- 6 teaspoons of sodium bicarbonate
- 6 teaspoons of tartaric acid
- 3 cups of non-acidic water
- 1 cup measure
- 1 teaspoon
- 4 pieces of paper towel
- 4 transparent bottles of the same size (350–400mL approximately)
- 4 balloons
- 1 labelling pen
- 1 funnel
- masking tape

Activity steps



1 Label the 4 bottles with the following information:

- Bottle 1: bicarb + acid
- Bottle 2: bicarb + water
- Bottle 3: acid + water
- Bottle 4: bicarb + acid + water

Label the balloons 1, 2, 3 and 4.

2 Add 2 teaspoons of sodium bicarbonate to balloons 1, 2 and 4 by placing the funnel into the opening of each balloon.

3 Wipe funnel carefully with a piece of paper towel. Discard paper towel.

4 Add 2 teaspoons of tartaric acid to balloons 1, 3 and 4 by placing the funnel into the opening of each balloon.

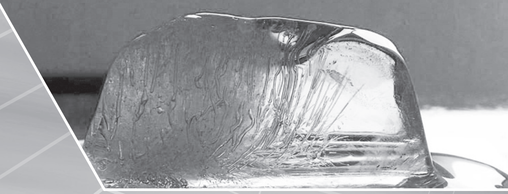
5 Wipe funnel carefully with the second piece of paper towel. Discard paper towel.

6 Add 1 cup of water to bottles 2, 3 and 4 by placing the funnel into the mouth of each bottle.

7 Have one team member carefully fit the opening of each balloon over the mouth of their corresponding bottle while another holds the balloon so that no powder falls in. Pull the stem part of the balloon down so that it will not come off easily. If it is loose, stick it down with a piece of masking tape to make it airtight.

8 Carefully upend Balloon 1 so that its contents fall into Bottle 1. Mix the contents gently. Observe the bottle carefully, and record your observations in your science journal.

9 Repeat step 8 for each of the bottles.



Lesson 4 Candle capers

AT A GLANCE

To provide students with hands-on, shared experiences of burning candles.

Students:

- observe candles and their separate parts
- investigate how candles need air (oxygen) to keep burning.

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 changes to materials can be irreversible, such as burning. You will also monitor their developing science inquiry skills (see page 2).

Key lesson outcomes

Science

Students will be able to:

- observe and discuss the features of a candle
- make predictions about which features of candles allow them to burn
- with teacher support, plan an investigation of how a burning candle is affected by the amount of air available
- identify how to conduct the investigation safely
- observe, record and interpret the results of their investigation
- describe the conditions that are necessary for a candle to burn.

Literacy

Students will be able to:

- use oral, written and visual language to report observations of candles
- identify the purpose and features of a graph
- engage in discussion to compare ideas and develop understanding about conditions that are necessary for a candle to burn
- demonstrate understanding of candles and burning through science journal entries.

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

Teacher background information

Fire is what we see in the chemical reaction of combustion. This reaction requires three things: heat, fuel and oxygen. 'Getting the fire started' literally means creating enough heat for the fire to sustain itself while there is fuel and oxygen available. Once started, the reaction produces heat energy.

The fuel provides the chemical energy for the reaction. It is generally carbon-based, such as, wood, coal, natural gas, oil or wax.

Oxygen (from the air) reacts with the fuel in the heat of the reaction. Combustion reactions usually produce carbon dioxide gas and water vapour, for example:

$$\text{candle wax} + \text{oxygen} \longrightarrow \text{carbon dioxide} + \text{water}$$

Wax and oxygen are combined in the chemical reaction to form carbon dioxide and water vapour as new substances.

Fire blankets are designed to stop oxygen reaching the fuel and therefore stop the reaction. A candle goes out when covered by a jar because the oxygen in the jar is consumed and the flame becomes surrounded with carbon dioxide which does not support combustion.

When a fuel receives enough heat and oxygen it will burst into flame. The temperature at which this occurs is known as the ignition point, and each fuel has its own ignition point. Substances with low ignition points are more likely to burn when heated by a fire and are known as flammable, such as, certain fabrics and paper. Fire starters have a low ignition point, they are therefore easy to light and the heat produced by their burning can cause logs to ignite.

If the temperature drops below ignition point the combustion reaction can no longer occur. Fire fighters douse flames with water because the water absorbs the heat energy to change the liquid water into water vapour, dropping the temperature of the fire. For the same reason, logs that are full of moisture will not burn easily since the initial heat put on them will go into turning the liquid water to water vapour rather than bringing the wood to its ignition point.

The wick of a candle burns long enough for the wax to start melting. The liquid wax is drawn up the wick to the flame where it becomes a gas. As a gas it reacts with the oxygen and creates carbon dioxide and water. This reaction releases energy in the form of heat. The carbon dioxide and water produced are gases; however, the water vapour will condense once away from the heat of the candle. Some wax particles begin to react with the oxygen but leave the candle before they are completely changed; these particles create a black smear where they land.

Students' conceptions

Students might not think that gaseous substances, for example, oxygen, are actively involved in the burning process. Therefore they might not realise that such substances are consumed during the reaction.

Many students think that during burning, a substance called heat is formed and no other substances are formed. Heat is not a substance; it is a form of energy. The two new substances formed (carbon dioxide and water) are both colourless gases.

Students might believe that the wax slows the wick down or holds it up, rather than realising its role as fuel. Similarly students might believe that a candle simply melts or changes to vapour in the air, rather than being consumed by the flames and producing new substances.

Equipment

FOR THE CLASS

- class science journal
- word wall
- 3 identical candles (see 'Preparation')
- matches
- lump of wax on a metal skewer
- length of wick
- 1 foil tray
- 1 tea-light candle
- 1 glass jar (eg, 250 ml)

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 4 tea-light candles
- 4 glass jars of different sizes (see 'Preparation')
- matches
- 1 timing device (eg, a stopwatch or a watch with a second hand)

Preparation

- Read 'How to conduct a fair test' (Appendix 4).
- Read 'How to construct and use a graph' (Appendix 5).
- Find three identical candles for the class, such as, tea-light candles, birthday candles, table candles. Keep one intact, burn one until it is only a stub and melt one, for example, by putting it in an oven in a foil tray.
- Check your school safety procedures for fire. Locate the fire blanket and extinguisher.
- Collect 4 glass jars of different sizes for each team, for example:
  - 120 ml, for example, baby food jar
  - 250 ml, for example, tartare sauce jar
  - 330 ml, for example, salsa jar
  - 500 ml, for example, pasta sauce jar.
- **Note:** Ensure that all used and unused matches are placed in the box and returned at the end of the lesson.

Lesson steps

1. Review Lesson 1, focusing students' attention on the burnt chocolate. Review students' first thoughts recorded in the class science journal. Ask questions, such as:
   - Is the chocolate melted? What makes you say that?
   - How do you know the chocolate has been burnt? (It now has black charcoal.)
2. Introduce the intact candle, the melted candle and the candle stub (see 'Preparation'). Explain that all three candles were originally identical. Ask questions such as:
   - What has happened to this candle? Why do you think that?
   - Why is there only a stub left? Where has the wax gone?
   - What do I need to light the intact candle?

   Record answers in the class science journal.
3. Introduce the intact candle to the class and ask questions such as:
   - What do you need for a candle to burn?
   - Where does the wax go when the candle is burning?
   - What happens when a candle is burning?

   Write the questions on the board or in the class science journal.

   Remind students that fire is a potential hazard. Ask students to suggest safety measures to be put in place to avoid danger.
4. Light the candle and ask students to carefully observe the candle burning and discuss possible answers to the questions in Lesson step 3.
5. Introduce the separate wick, the wax, a candle and a jar and ask students to record, in their science journal, their predictions and supporting reasons about:
   - What will happen if I light this wick?
   - What will happen if I light this wax?
   - What will happen if I put a jar over a lighted candle?

6 Ask students to observe closely as you:

- Light the wick without wax.
- Light the wax without a wick.
- Place a lighted candle under an inverted glass jar.

Ask students to record their observations in their science journals.

7 Pose the question: 'What things will affect the time the candle stays alight?'. Record students' suggestions in the class science journal. Introduce the term 'variables' as things that can be changed, measured or kept the same in an investigation.

8 Explain that students will be working in collaborative learning teams to conduct an investigation into the effect of the amount of air on the time the candle stays alight. Discuss and record in the class science journal what teams will:

- Change: the size of the jar
- Measure/Observe: how long the candle stays alight
- Keep the same: the size of the candle, the wax of the candle, the air around.

Discuss how to make it a fair test, by only changing one variable and keeping all others the same.

Optional: Ask teams to plan their own investigation if they are familiar with the process.

9 Discuss how to measure how much air is contained in each jar, for example, by measuring the amount of water each jar holds.

10 Draw attention to the equipment available for each team. Ask teams to wipe the inside of the jars clean before beginning the investigation. This is important to remove any water residue that might be inside the jar.

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

12 *Optional:* Ask students to conduct replication trials and calculate the average time it takes for the candle to go out. Discuss why conducting replication trials helps provide more reliable results (see Lesson 6, 'Teacher background information'). The jars need to be flushed after each trial to remove the carbon dioxide.

13 Allow time for students to complete the investigation. Ask teams to observe their jars carefully and draw and describe what they see in their science journal.

14 Ask team Speakers to share their findings with the class. Discuss the purpose and features of a line graph. Create a class line graph using the data from the teams and record in the class science journal.

Literacy focus

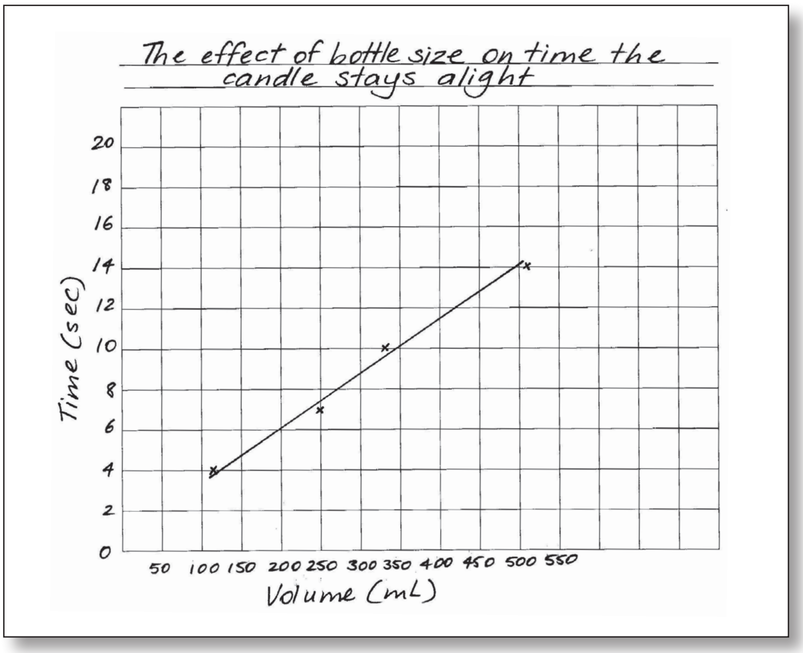
Why do we use a graph?

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

What does a graph include?

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

EXPLORE



Candle capers student work sample

EXPLORE

Ask students to use the graph to predict how long a candle will burn under a 400 ml jar.

Note: In order to use the graph to make this prediction the intervals on the x axis need to be equal (see the sample graph). It is best to have at least three experimental data points to make an accurate prediction (see Appendix 5).

15 Discuss why the candle goes out under the jar, and why the candle takes longer when the jar is bigger. Ask questions, such as:

- Why do you think that?
- Tell me more about the word 'air'.
- Well, if that is right, what about …?
- Scientists say that fires use oxygen in the air as fuel. How does that fit with your idea?

16 Discuss where the wax might have gone (changed into carbon dioxide and water). Ask students to describe what they found inside the jar after burning candles in them (water droplets). Ask questions, such as:

- I hadn't thought about it like that before. Where did you get that idea?
- What do you mean by that?
- I wonder what would happen if …?
- Here's another idea about that: scientists think that the wax turns into a gas and combines with the oxygen when there is heat, and that this becomes water and carbon dioxide (this reaction produces more heat). What do you think?

17 Ask students to summarise what they have learned in their science journal.

Update the word wall with words and images.

Curriculum links

Mathematics

- Explore how to measure the volume of the jars.
- Measure the burning times of flames of different sized candles.

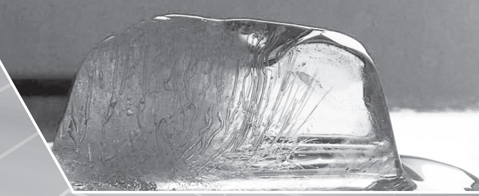
Studies of Society and Environment

- Research fire safety, bushfires and bushfire controls.

Indigenous perspectives

Charcoal is used by some Indigenous people as a pigment for painting.

- Research the use of charcoal in traditional and contemporary Indigenous art. See www.aboriginalartstore.com.au/aboriginal-art-culture/aboriginal-art-paintings
- 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).



Lesson 5 Classifying changes

AT A GLANCE

To support students to represent and explain their understanding of physical and chemical changes.

To introduce current scientific views about physical and chemical changes.

Students:

- discuss descriptions of physical and chemical change
- classify changes as physical or chemical changes.

EXPLAIN

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:

- the classification of physical and chemical changes to materials, such as melting and burning. How scientific understandings, such as classification, are used to help people all over the world communicate through a shared discourse. You will also monitor their developing science inquiry skills (see page 2).

You are also able to look for evidence of students' use of appropriate ways to represent what they know and understand about physical and chemical changes to materials, and give them feedback on their representations.

Key lesson outcomes

Science

Students will be able to:

- recognise a need for scientific classification
- create categories to group different changes
- explain the difference between physical and chemical change
- describe reactions as physical or chemical change, and give reasons for their choice.

Literacy

Students will be able to:

- demonstrate understanding of the difficulties of classification systems through discussions
- engage in discussion to compare ideas about how to classify changes and provide relevant arguments to support their conclusions
- use scientific vocabulary appropriately in their writing and talking
- create a Venn diagram to present information.

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

Teacher background information

Developing categories helps scientists to organise and make sense of the world around them. Everything in the world is unique, and categories help to identify the similarities and differences between things. Things might be grouped in different ways for different purposes, such as, scientists studying food webs might group animals as herbivores or carnivores whereas an ecologist studying a community of native animals might want to distinguish kangaroos from wallabies.

The following descriptions are used for this unit:

Physical change is a change in which no new substance is formed.

Chemical change is a change that results in the conversion of the original substances to form new substances.

In this unit a 'new substance' means the formation of new types of particles. Therefore water melting and salt dissolving are physical changes, whereas burning and the sodium bicarbonate reaction are chemical changes. These descriptions are very simple, and some changes seem to fit into both categories. For example, when a candle burns, the wax melts (physical change) and then burns (chemical change). The important thing is for students to give a reasoned argument as to why they chose to classify the changes as physical or chemical.

In this unit students investigate reversible physical changes (melting, evaporating and dissolving) and irreversible chemical changes (burning and the formation of gas). However, some chemical changes are reversible, for example, the chemical reaction which drives rechargeable batteries. Some physical changes are also irreversible, for example, grinding a log into sawdust.

Some other common changes are:

- Rusting iron, which is caused by the iron particles reacting with water and oxygen to form a new substance (rust). The original metal is changed into a new substance. This is a chemical change.
- Cutting wood is a physical change since the wood changes form. However, if the friction of the chainsaw produces enough heat some of the wood might reach ignition point, in which case some sawdust might burn and undergo a chemical change.
- Bending wire is a physical change, since the object only changes form.
- A glowing tungsten filament in an incandescent light bulb is not a chemical change. The heat and light produced are forms of energy, not new substances. The filament is heated to its ignition point but as there is no oxygen, the wire does not burn—it glows.
- Bubbles appearing in carbonated drinks is a physical change. Carbon dioxide gas was dissolved in the drink at high pressure, and when the pressure was released, the particles come out of solution, become a gas again, and leave the drink.

Equipment

FOR THE CLASS

- class science journal
- word wall
- 1 enlarged copy of 'Changes card sort' (Resource sheet 4)

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Changes card sort' (Resource sheet 4)
- A3 sheet of paper or butcher's paper

Preparation

- Prepare an enlarged copy of 'Changes card sort' (Resource sheet 4) and cut it into the separate cards.
- *Optional:* Organise a guest speaker who uses classification (such as, a librarian, a geologist, a chemist, a biologist, a lawyer) to visit the class. Ask them to prepare a brief presentation about the importance and difficulties of classifying in their jobs.

Lesson steps

1. Review the unit using the class science journal. Discuss the different changes that students have investigated.
2. Discuss why categorisation is important in science. Ask questions, such as:
   - Why classify things? (To help us make sense of the world, and recognise the similarities and differences between things.)
   - What if we didn't classify things? (We would have difficulty communicating, since simple words like 'tree' are a classification.)

3 Explain that as 'Change detectives' students will group the changes they have investigated. Explain that students will be working in collaborative learning teams to group the different changes using a card sort.

4 Introduce the set of cards produced from the enlarged copy of 'Changes card sort' (Resource sheet 4, see 'Preparation'). Discuss how to represent classification, for example, by placing the cards in a Venn diagram. Discuss the purpose and features of a Venn diagram.

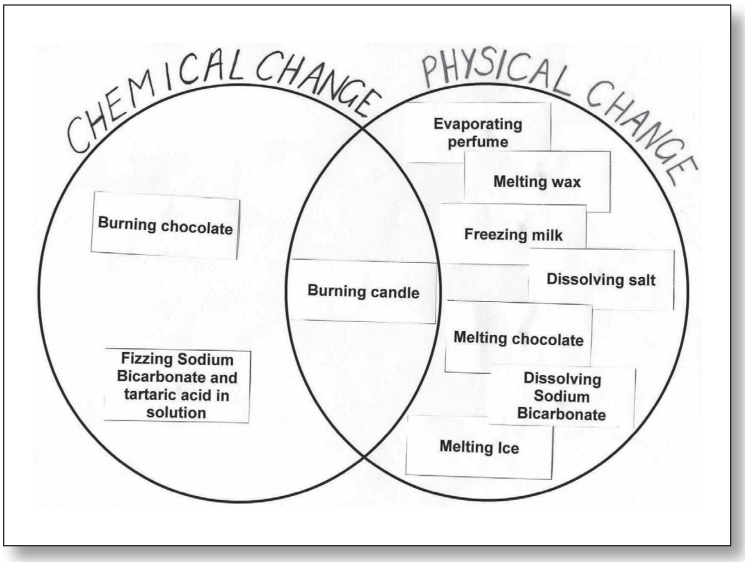
Literacy focus

Why do we use a Venn diagram?

We use a **Venn diagram** to show how the properties of different things are similar and different.

What does a Venn diagram include?

A **Venn diagram** includes overlapping circles. Things with a particular property are placed in a particular circle. Things with more than one of the properties are placed in the area where the circles overlap.



Team work sample of a Venn diagram

5 Form teams and allocate roles. Ask students to decide on categories, for example, students might decide to put all changes producing gas into one group, and all the non-gas producing changes in another group. As teams are deciding on their categories ask questions, such as:

- Could you tell me more about that?
- I hadn't thought about it like that before. Where did you get that idea?
- Well, if that is right, what about …?

Note: It is important to allow students to select their own category titles and to give reasons for their choices.

6 *Optional:* Students can create a Microsoft Powerpoint slide with animation to present their Venn diagram.

7 Ask Speakers to share their team's categorisations with the class.

8 Discuss how classifying all things into categories can be difficult. For example, if a librarian had a section called 'History' and another called 'Science', where would they put a book called 'History of Science'?

9 *Optional:* Ask a guest speaker to talk to the class about the importance and difficulties of classifying in their jobs (see 'Preparation').

10 Explain that some scientists group changes into physical and chemical changes.

Explain the common generalisation used to differentiate these two changes (see 'Teacher background information'). Add the words to the word wall.

11 Explain that students are going to work in their teams to classify the changes on the cards using these new categories. Ask students to provide reasons and evidence for their choices.

12 Re-form teams and ask students to complete the card sort using the new categories.

13 As a class, discuss each team's classifications. Discuss whether the descriptions of physical and chemical change are adequate to reflect the real world.

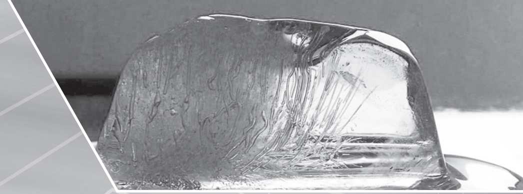
14 *Optional:* Students search their houses for other changes, and report on whether they are physical or chemical.

15 Ask students to summarise what they have learned in their science journal.
Update the word wall with words and images.

EXPLAIN

Changes card sort

Melting ice	**Dissolving sodium bicarbonate**
Burning chocolate	**Freezing milk**
Melting wax	**Burning candle**
Dissolving salt	**Evaporating perfume**
Fizzing sodium bicarbonate and tartaric acid in solution	**Melting chocolate**



Lesson 6 Fizz whiz

AT A GLANCE

To support students to plan and conduct an investigation of the factors that affect the rate of reactions.

Students:

- formulate a question for investigation
- plan and set up an investigation to determine factors that affect the rate of reactions
- observe, record and share results.

Lesson focus

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

Assessment focus

Summative assessment of the Science Inquiry Skills is an important focus of the *Elaborate* phase (see page 2). Rubrics will be available on the website to help you monitor students' inquiry skills.

Key lesson outcomes

Science

Students will be able to:

- formulate a question and make predictions about what factors affect the speed of a chemical reaction
- plan and conduct fair tests of different factors to see if they affect the speed of a chemical reaction
- use equipment and materials safely
- make and record observations
- construct and identify patterns in a graph
- provide evidence to support their conclusions and suggest improvements to their investigation methods.

Literacy

Students will be able to:

- represent results to decide what factors affect the speed of a chemical reaction
- summarise their findings about what factors affect the speed of a chemical reaction
- engage in discussion to compare ideas and provide relevant arguments to support their conclusions.

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

Teacher background information

Most fizzy tablets contain sodium bicarbonate and an acid powder, for example, citric acid. As seen in Lesson 3, these two chemicals react when in water together forming bubbles of carbon dioxide. This is a chemical reaction since new substances are formed (water and carbon dioxide) and the original substances are changed. Like most chemical reactions, the speed of this reaction increases at higher temperatures and decreases at lower temperatures. As the reaction depends on the substances being in water, the faster the water has access to the particles, the faster they dissolve and can react with each other. Breaking the tablet in half or crumbling will increase the surface area exposed to water which will increase the speed of the reaction.

Tablets might contain the ingredients to create bubbles for several reasons. It might help increase the rate at which the tablet breaks up and dissolves. Also, fizzy liquids are absorbed by the intestines faster than other liquids. The bubbles tickle the exit valve in your stomach, and it opens. For example, this is why champagne tends to make people more tipsy (the alcohol reaches the bloodstream faster).

Replication and repeat trials

In this investigation, students will focus on variables that influence the speed of the chemical reaction that produces the fizzing effect. The time taken to complete fizzing is a measure of the reaction rate or speed of the reaction.

The speed of the reaction might vary slightly from tablet to tablet because the tablets are not identical (sampling error). Also there might be other sources of error, for example, observation error (for example, a timing error) and manipulation error (for example, the tablets might not all be inserted in the same way). It is best to repeat the test several times to be sure that the average result is a good approximation of the actual time it takes for the reaction to take place. Scientists conduct repeat trials whenever possible. The more sources of error, the more trials are needed to be sure that the results are reliable.

Since each test involves a different tablet this investigation is known as a replication trial. A repeat trial would involve the same object, for example, bouncing the same ball over and over to check what height it bounces to.

Equipment

FOR THE CLASS

- class science journal
- word wall
- 1 enlarged copy of 'Tablet investigation planner' (Resource sheet 5)
- 1 fizzy tablet
- 1 glass of water
- 1 jug
- 1 timing device (eg, a stopwatch or a watch with a second hand)

FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Tablet investigation planner' (Resource sheet 5), A4 or A3 sized, for each student
- 3 fizzy tablets
- 3 plastic cups
- ½ cup measure
- spoon
- 1 timing device (eg, a stopwatch or a watch with a second hand)
- hot water (see 'Preparation')
- room temperature water
- ice-cold water

Preparation

- Prepare an enlarged copy of 'Tablet investigation planner' (Resource sheet 5).
- Set up a 'Safety zone' where you can prepare hot (from the tap), room temperature and ice-cold water. Decide on a safety procedure for students to collect hot, room temperature and ice-cold water.
- Draw a blank 'Fizz whiz variables grid' in the class science journal and complete the centre square (see Lesson step 5).
- Read 'How to write questions for investigation' (Appendix 6).
- Read the safety precautions on the tablets carefully.

SAFETY

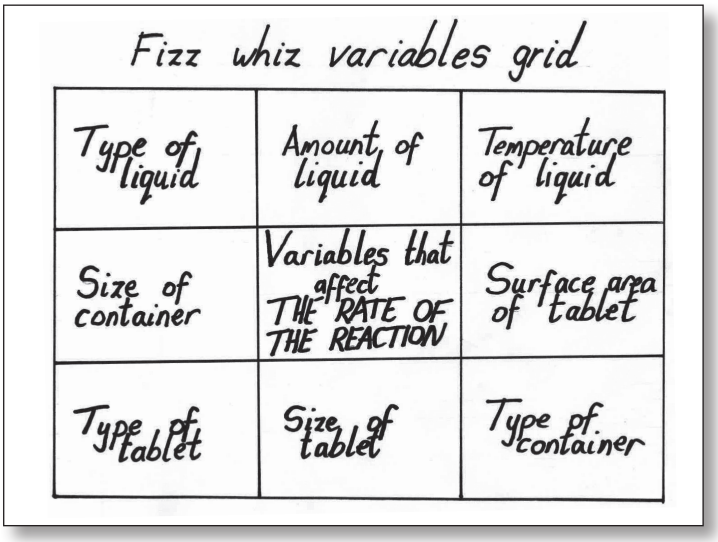
ELABORATE

Lesson steps

1. Review Lesson 1, focusing students' attention on the glass of water with a tablet fizzing in it. Ask if any students have ever taken a medicine or vitamin supplement that fizzed in water.
2. Discuss what kind of change a tablet fizzing in water is. Discuss why the tablets are designed to fizz.
3. Explain that as 'Change detectives' students have been asked to provide some additional evidence for the 'Mess scene' investigation. Crime detectives need to know whether the state of the tablet (fully dissolved, half dissolved or not dissolved) can be used as a reliable indicator of when the crime was committed.
4. Explain that students will be working in collaborative learning teams to investigate the rate of reaction of a tablet fizzing in water.
5. Ask students to brainstorm what things (variables) might affect the rate of this reaction, such as:

- size of the tablet
- surface area of the tablet
- type of tablet
- temperature of the liquid the tablet is in
- amount of liquid.

Record the students' answers in the variables grid (see 'Preparation').



Sample of a completed variables grid

6 Model how to use the variables grid to plan a fair test by only changing one variable and keeping all others the same. For example, if they investigate the effect of water temperature on the rate of the reaction, students might:

- Change: the temperature of the liquid
- Measure/Observe: how long the tablet fizzes
- Keep the same: the size of the tablet, the amount of liquid, the type of liquid, the type of tablet, the type of container, the size of the container and the surface area of the tablet.

Display this information in the classroom for easy student reference.

7 Discuss why replication is necessary to produce reliable results and list possible reasons for variation (for example, the tablets are not identical). Ask questions, such as:

- Do you think it will happen the same way every time?
- How will that affect the result?
- How will that affect what we think?

8 Introduce students to the process of writing questions for investigation (see 'Preparation'). Model the development of a question, for example 'What happens to the rate of the reaction when we change the temperature of the liquid?' Ask questions, such as:

- What do we want to know?
- How can we find this out?

9 Introduce the enlarged copy of 'Tablet investigation planner' (Resource sheet 5). Discuss the 'Results' section of the planner and explain that each team will conduct a test using

ELABORATE

liquids of each temperature. Each team will then join with two other teams to discuss their results and calculate and plot their averages on the graph in the 'Presenting results' section of the 'Tablet investigation planner' (Resource sheet 5). Review the purpose and features of a graph (see Lesson 4) and how to construct a line graph (see Appendix 5).

10 Form teams and allocate roles. Ask Managers to collect a role badge and a copy of 'Tablet investigation planner' (Resource sheet 5) for each team member.

11 Ask teams to plan their investigation on the 'Tablet investigation planner'(Resource sheet 5).

12 Ask Managers to collect team equipment and allow time for students to conduct the investigation, record their results, discuss them with two other teams and present them in the 'Presenting results' section of the 'Tablet investigation planner' (Resource sheet 5).

SAFETY

Remind students of the safety precautions for handling hot water and unknown chemicals. Ask the students to clarify the need for safety precautions.

13 Analyse and compare graphs as a class and look for patterns and relationships, asking questions such as:

- What is the story of your graph?
- Do the data in your graph reveal any patterns?
- When did the tablet fizz for the shortest time?
- At which temperature did the chemical reaction go fastest?
- Can you use the graph to make predictions?

14 Ask students to reflect on the investigation and respond to the questions in the 'Explaining results' and 'Evaluating the investigation' sections of the 'Tablet investigation planner' (Resource sheet 5).

15 Review the 'Mess scene' and ask students to use their understanding of the tablet fizzing to discuss what they know about the scene. Ask questions, such as:

- What did you observe about the tablet in the 'Mess scene'?
- What do you think the tablet can tell us about when the perpetrator left the scene?
- Why do you think that? What reasons and evidence can you give to support your ideas?

16 Ask students to summarise what they have learned in their science journal. Update the word wall with words and images.

ELABORATE

Curriculum links

Science

- Compare the chemical ingredients of different fizzing tablets recorded on packaging, noting similarities and differences. Identify the acid in each product.

Mathematics

- Explore averages and grids in conjunction with replicating and reporting results.

Indigenous perspectives

- 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).

Tablet investigation planner

Name: ______________________________ **Date:** ____________

Other members of your team: ______________________________

What are you going to investigate? Can you write it as a question?	What do you think will happen? Explain why. Give scientific explanations for your prediction

To make the test fair, 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?

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

 ISBN 978 0 85847 325 6

Tablet investigation planner

Results

Trial	Time in seconds			
	Team 1	Team 2	Team 3	Average
cold water				
room temperature water				
hot water				

Presenting results

Can you show your results in a graph?

 ISBN 978 0 85847 325 6

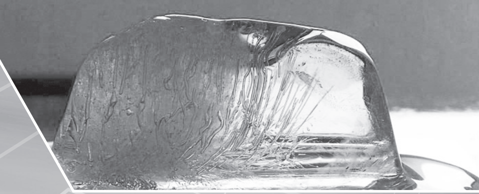
Tablet investigation planner

Explaining results

When you changed ……………...…….................... what happened to the speed of the reaction?
Did the result match your prediction? Explain why and how it was different.

Evaluating the investigation

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



Lesson 7 Intrepid reporters

AT A GLANCE

To provide opportunities for students to represent what they know about physical and chemical changes and reflect on their learning during the unit.

Students:

- create a final report of their ‘Mess scene’ findings
- reflect on their learning during the unit.

Lesson focus

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

Assessment focus

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

- that changes to materials can be reversible, such as melting, freezing and evaporating; or irreversible, such as burning, and how scientific understandings are used to solve problems that directly affect people’s lives.

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

EVALUATE

Key lesson outcomes

Science

Students will be able to:

- describe different changes and why they have occurred
- identify changes as physical or chemical changes
- identify changes as reversible and irreversible
- describe investigations and support conclusions with evidence.

Literacy

Students will be able to:

- prepare an analytical report of their investigations which demonstrates understanding of physical and chemical changes
- summarise their findings concisely
- use language to clarify their understanding and reflect on their experiences
- use language and visual representation to communicate their ideas in a report.

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

Equipment

FOR THE CLASS	FOR EACH STUDENT
• class science journal • word wall	• science journal

Lesson steps

1 Remind students that their final role as 'Change detectives' will be to present a comprehensive yet concise report on the 'Mess scene' for a selected audience (see Lesson 1, 'Preparation'). Review the purpose and features of a report (see Lesson 1), for example, the need to include the evidence from their investigations that led them to their conclusions.

2 Explain that the report will have two sections. The first section includes information on each change present in the original 'Mess scene', such as:

- whether the change was chemical or physical, and reasons supporting this conclusion
- a brief description of why the change might have occurred
- whether the original object is recoverable or not. If it is recoverable, how can this be achieved? If it is not, why not?

The second section includes a brief summary of investigations completed and the conclusions reached, for example, how long ago the mess was made.

3 Describe the features you will be looking for to assess the quality of students' reports:

- well-organised information
- clear, concise communication
- evidence of knowledge of the topic
- use of evidence and reasoning to support conclusions
- quality/creativity of the presentation.

4 Provide students with time to plan, prepare and publish their reports. Allow time for students to discuss the mode of their report, for example, a printed report, a PowerPoint presentation, a Kahootz presentation or a poster.

5 *Optional:* Invite an audience, such as, another class, parents or a scientist to view the reports and discuss the 'Mess scene' investigation.

6 Ask students to conduct a self-assessment of learning by completing sentences in their science journal such as:

- I really enjoyed …
- I learned a lot about …
- I could improve …
- I'm still wondering about …
- Next time we work in teams I will …
- In the future I would like to …

EVALUATE

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

Introduction

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

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

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

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

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

Team structure

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

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

Team roles

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

For Year 3–Year 6, the teams consist of three students—Director, Manager and Speaker. (For Foundation–Year 2, teams consist of two students—Manager and Speaker.) Each member of the team should wear something that identifies them as belonging to that role, such as, a wristband, badge, or colour-coded peg. This makes it easier for you to identify which role each student is doing and it is easier for the students to remember what they and their team mates should be doing.

Manager

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

Speaker

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

Director (Year 3–Year 6)

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

Team skills

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

Students will practise the following team skills throughout the year:

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

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

Supporting equity

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

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

TEAM ROLES

Manager
Collects and returns all materials the team needs

Speaker
Asks the teacher and other team speakers for help

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

TEAM SKILLS

1 Move into your teams quickly and quietly

2 Speak softly

3 Stay with your team

4 Take turns

5 Perform your role

Appendix 2
How to use a science journal

Introduction

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

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

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

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

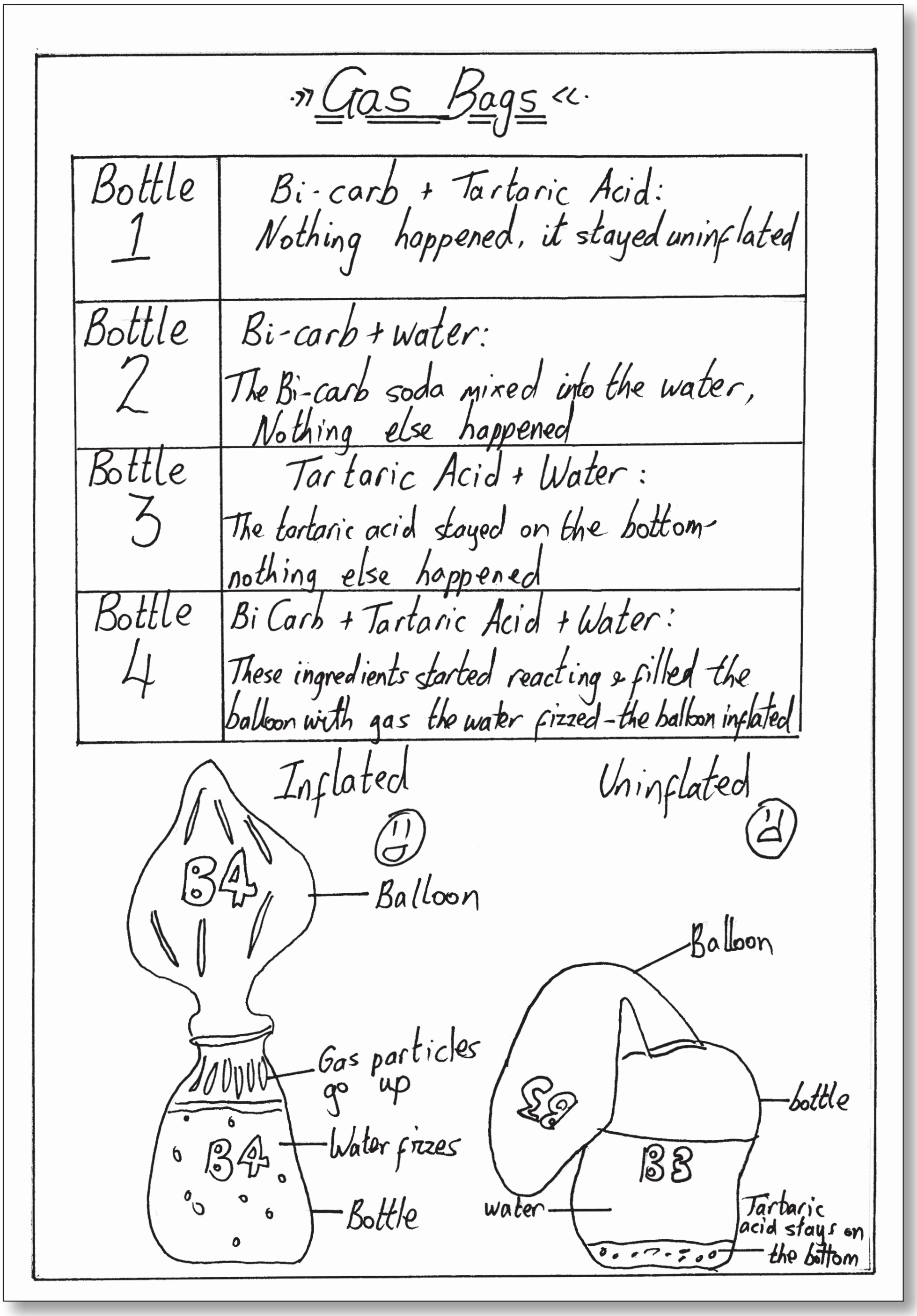
Using a science journal

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

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

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

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



Gas Bags

Bottle 1	Bi-carb + Tartaric Acid: Nothing happened, it stayed uninflated
Bottle 2	Bi-carb + water: The Bi-carb soda mixed into the water, Nothing else happened
Bottle 3	Tartaric Acid + Water: The tartaric acid stayed on the bottom - nothing else happened
Bottle 4	Bi Carb + Tartaric Acid + Water: These ingredients started reacting & filled the balloon with gas the water fizzed - the balloon inflated

Change detectives **science journal**

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.

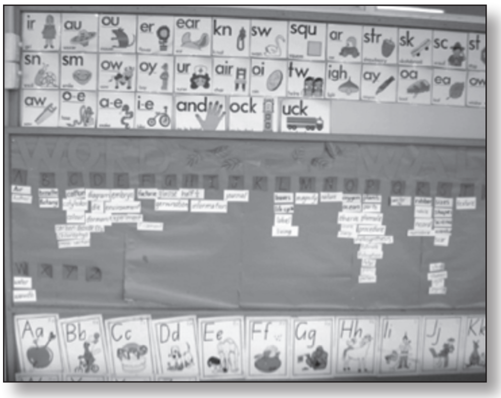
Choose robust material for the word cards. Write or type words on cardboard and perhaps laminate them. Consider covering the wall with felt-type material and backing each word card with a self-fastening dot to make it easy for students to remove and replace word cards.

Word walls do not need to be confined to a wall. Use a portable wall, display screen, shower curtain or window curtain. Consider a cardboard shape that fits with the unit, for example, an apple for a needs unit.

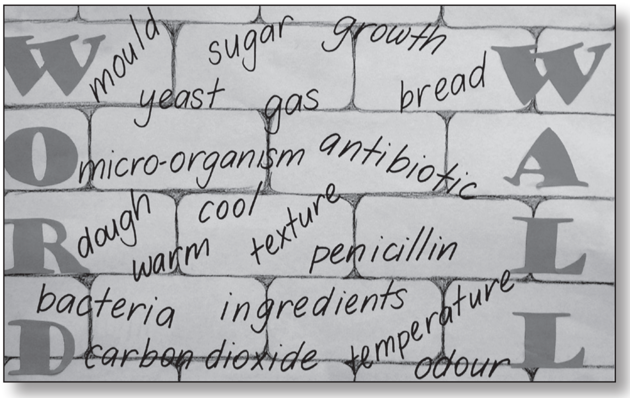
The purpose is for students to be exposed to a print-rich environment that supports their science and literacy experiences.

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 *Change detectives* unit might be organised using headings, such as ‘types of changes’, ‘materials’ and ‘investigation words’.

Invite students to contribute different words from different languages to the word wall. Group words about the same thing, for example, different names of the same substance, 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.



Plants in action **word wall**



Marvellous micro-organisms **word wall**

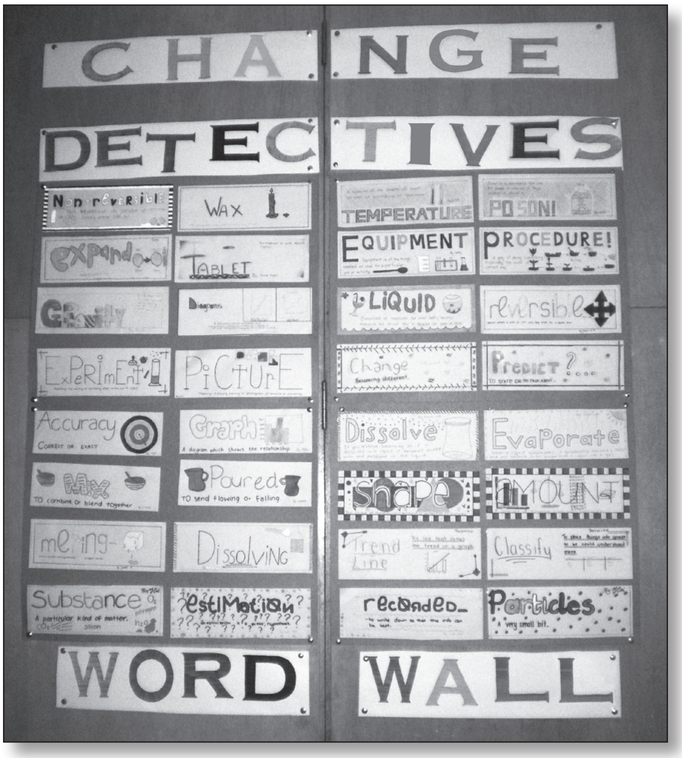
Using a word wall

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.



Change detectives **word wall**

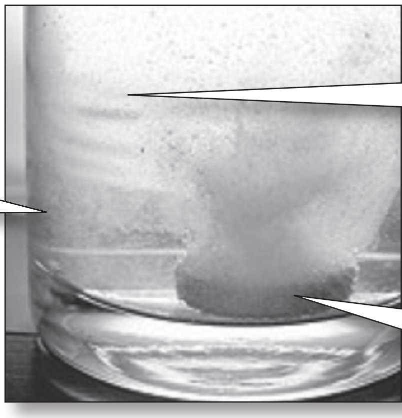
Appendix 4
How to conduct a fair test

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 *Change detectives*, students investigate things that affect the rate of reaction (of a tablet fizzing in water).



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)

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

To investigate whether temperature of the liquid has an effect on reaction time, students could:

To investigate whether moisture has an effect on mould growth, students could:

CHANGE	the temperature of the liquid	Independent variable
MEASURE/ OBSERVE	how long the tablet fizzes	Dependent variable
KEEP THE **SAME**	the size of the tablet, the amount of liquid, the type of liquid, the type of tablet, the type of container, the temperature of the liquid, the size of the container and the surface area of the tablet	Controlled variables

Appendix 5
How to construct and use a graph

Introduction

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

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

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

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

What type of graph?

The Australian Curriculum: Mathematics describes data representation and interpretation for Year 6 as follows:

- Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables.
- Interpret secondary data presented in digital media and elsewhere.

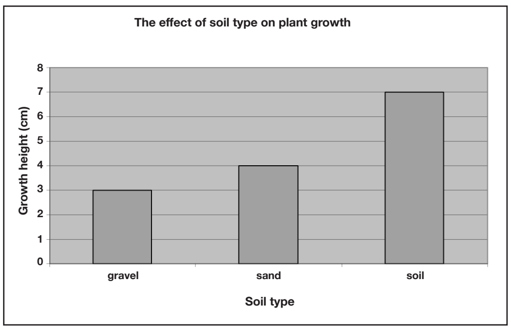
Column graph

Where data for one of the variables are in **categories** (that is, we use **words** to describe it, for example, soil type), a **column graph** is used. Graph A below shows how the results for an investigation on the effect of soil type **(data in categories)** on plant growth have been constructed as a **column graph**.

Table A: The effect of soil type on plant growth

Soil type	Growth height (cm)
gravel	3
sand	4
soil	7

Graph A: The effect of soil type on plant growth



Line graph

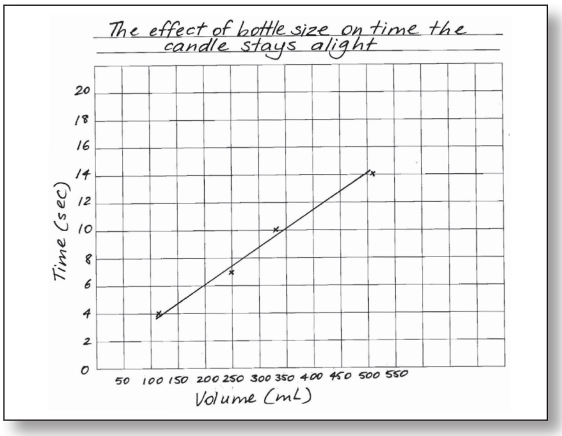
Where the data for both variables are **continuous** (that is, we use **numbers** that can be recorded on a measurement scale, such as length in centimetres or mass in grams), a **line graph** is usually constructed. Graph B below shows how the results from an investigation of the size of the jar (available oxygen) **(continuous data)** on the time the candle stays alight **(continuous data)** have been constructed as a **line graph**.

There is often a difference between the theoretical data and the experimental data (which is subject to a number of sources of error). After plotting experimental data in a graph, a 'line of best fit' is drawn to represent the pattern in the data. The line is drawn so that the sum of the distances of the points above the line are approximately equal to the sum of the distances below the line.

Table B: Relationship between the size of a container and the time the candle stays alight

Volume of container (mL)	Time (sec)
120	4
250	7
330	10
500	14

Graph B: Relationship between the size of a container and the time the candle stays alight



Which variable goes on each axis?

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

Graph titles and labels

Graphs have titles and each variable is labelled on the graph axes, including the units of measurement. The title of the graph is usually in the form of 'The effect of one variable on the other variable'. For example, 'The effect of material on the amount of light that passes through.'

Steps in analysing and interpreting data

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

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

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

Questioning for analysis

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

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

Analysis

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

Analysis of Graph C shows that the amount of light that passes through materials changes according to the type of material. This is because the more transparent or translucent a material is the more light that can pass through it.

Appendix 6
How to write questions for investigation

Introduction

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

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

The structure of questions for investigation

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

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

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

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

The type of question for investigation in *Change detectives* refers to two variables and the relationship between them, for example, an investigation of the variables that affect the rate of a reaction. The question for the investigation might be:

Q1: What happens to the rate of the reaction when we change the temperature of the liquid (water)?

In this question, *the rate of the reaction* depends on *the temperature of the liquid (water).* The temperature of the liquid is the thing that is changed (independent variable) and the speed of the reaction is the thing that is measured or observed (dependent variable).

Q2: What happens to the rate of the reaction when we change the surface area of the tablet?

In this question, *the rate of the reaction* depends on *the surface area of the tablet.* The surface area of the tablet is the thing that is changed (independent variable) and the speed of the reaction is the thing that is measured or observed (dependent variable).

An example of the way students can structure questions for investigation in *Change detectives* is:

What happens to ______________________when we change _______________________?

dependent variable **independent variable**

Developing questions for investigation

The process of developing questions for investigation in *Change detectives* is to:

- Provide a context and reason for investigating.
- Pose a general focus question in the form of:
  'What things might affect ___________ (**dependent variable**)?'.
  For example, 'What things might affect the speed of the reaction?'.
- Use questioning to elicit the things **(independent variables**) students think might affect the **dependent variable** (for example, the surface area of the tablet, the temperature of the liquid, the type of liquid, the amount of liquid, the type of tablet).
  By using questions, elicit the things that students can investigate, such as the temperature of the liquid or the surface area of the tablet. These are the things that could be changed (independent variables), which students predict will affect the thing that is measured or observed (dependent variable).
  Each of the independent variables can be developed into a question for investigation.
- Use the scaffold 'What happens to _____________ when we change _____________?' to help students develop specific questions for their investigation.
  For example, 'What happens to the rate of the reaction when we change the temperature of the liquid (water)?' or 'What happens to the rate of the reaction when we change the surface area of the tablet?'.
- 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 7
Change detectives equipment list

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	2	3	3	4	5	6	7
		SESSION		1	2	3	1	2				
Equipment and materials												
balloons	4 per team							●				
candles, identical	3 per class								●			
chocolate button, melted	1 per team			●								
chocolate button, non-melted	1 per class			●								
containers, transparent glass or plastic												
– 100 ml container	1 per team						●					
– 200 ml container	1 per team						●					
cups, plastic	3 per team										●	
equipment to investigate melting an ice cube (towel, aluminium foil, glass of hot water)	1 collection per team			●								
foil tray	1 per class								●			
frozen milk cube, in container	1 per team			●								
funnel	1 per team							●				
heating equipment (eg, electric hot plate, fry pan, stove)	1 per class					●						
ice cubes, 3 in containers	1 set per team			●								
ice pole, frozen in a clear wrapper	1 per class				●							
ice pole, melted in a clear wrapper	1 per class				●							
jars												
– glass (eg, 200 ml jar)	1 per class								●			
– different sizes (eg, 100 ml, 250 ml and 500 ml)	4 per team								●			
labelling pen	1 per team							●				

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	2	3	3	4	5	6	7
		SESSION		1	2	3	1	2				
Equipment and materials (continued)												
marbles or small beads	1 tray per team				●							
adhesive tape	1 per team							●				
matches	1 per class and 1 per team								●			
measure, cup	1 per team							●				
measure, half cup	1 per team										●	
measuring jug, 300 ml	1 per class						●				●	
measuring spoons	1 set per team											
– ½ teaspoon	1 per team						●					
– 1 teaspoon	1 per team							●				
'Mess scene' equipment	1 collection per class		●									
– burning candle			●									
– burnt chocolate			●									
– frozen milk in the carton			●									
– glass full of bubbles from bicarbonate and tartaric acid reacting together in water, with a packet of sodium bicarbonate and tartaric acid next to it			●									
– glass with a fizzing tablet (eg, antacid tablets)			●									
– ice poles melted in their clear wrappers			●									
– melted chocolate			●									
– open salt container fallen in a bucket of water			●									
– perfume bottle tipped over (or vinegar if students have allergies)			●									
milk, 1 glass	1 per class			●								
paper, A3 sheet or butcher's	1 per team									●		
paper towel	4 pieces per team							●				

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	2	3	3	4	5	6	7
		SESSION		1	2	3	1	2				
Equipment and materials (continued)												
perfume, vinegar or essence, small bottle	1 per class					●						
plastic sheet (eg, overhead transparency)	1 per class					●						
props for particle representations (eg, marbles or small beads)	1 set per team				●							
rope, 1 length	1 per team				●							
salt	3 tablespoons per team						●					
sodium bicarbonate	6 teaspoons per team							●				
spoon	1 per team										●	
straw	1 per class					●						
tablet, fizzy	1 per class and 3 per team										●	
tartaric acid	6 teaspoons per team							●				
tea-light candle	1 per class and 4 per team								●			
timing device (eg, stopwatch or watch with a second hand)	1 per team			●					●		●	
transparent bottles, all the same size (350–400 ml approximately)	4 per team							●				
water												
– 10 ml	1 per team					●						
– 1 glass	1 per class					●					●	
– 300 ml	1 per team						●					
– 3 cups, non-acidic	1 per team							●				
– hot, enough to fill a plastic cup	1 quantity per team										●	
– ice-cold, enough to fill a plastic cup	1 quantity per team										●	
– room temperature, enough to fill a plastic cup	1 quantity per team										●	
wax, on a metal skewer	1 per class								●			
wick, 1 length	1 per class								●			
transparent containers, 200 ml or more	2 per team						●					

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	2	3	3	4	5	6	7
		SESSION		1	2	3	1	2				
Resource sheets												
‘PROE record: Purely physical’ (RS1), enlarged	1 per class			•								
‘PROE record: Purely physical’ (RS1), enlarged	1 per student			•								
‘Salt dissolving table’ (RS2), enlarged	1 per class						•					
‘Salt dissolving table’ (RS2)	1 per team						•					
‘Fizzing investigation’ (RS3), enlarged	1 per class							•				
‘Fizzing investigation’ (RS3)	1 per team							•				
‘Changes card sort’ (RS4), enlarged	1 per class									•		
‘Changes card sort’ (RS4)	1 per team									•		
‘Tablet investigation planner’ (RS5), enlarged	1 per class										•	
‘Tablet investigation planner’ (RS5), A4 or A3 sized	1 per student										•	
Teaching Tools												
class science journal	1 per class		•	•	•	•	•	•	•	•	•	•
cooperative learning wristbands	1 set per team		•	•		•	•	•	•	•	•	
cooperative learning team roles chart	1 per class											
cooperative learning team skills chart	1 per class											
student science journal	1 per student		•	•	•	•	•	•	•	•	•	•
word wall	1 per class		•	•	•	•	•	•	•	•	•	•
Multimedia												
digital camera *optional*	1 per class		•					•				

Appendix 8
Change detectives unit overview

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to represent their current understandings as they:	Students will be able to:	Students:	
ENGAGE	**Lesson 1** Mess scene investigation	• identify evidence of changes that occur • describe their existing ideas of what causes change • explain why they think changes can or cannot be reversed.	• contribute to discussions about changes to common materials • identify the purpose and features of science journal • make predictions and record observations in the class science journal • understand the purpose and features of summary and a report.	• observe and record information about some common changes to materials • share and discuss observations.	**Diagnostic assessment** • Through discussion share ideas and questions about changes to materials • Science journal entries • Class discussion • Team summary • Word wall contribution

* 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** Purely physical ***Session 1*** Mostly melting ***Session 2*** Playing particles ***Session 3*** Evocative evaporation	• plan an investigation, with teacher support • make predictions about what factors will make an ice cube melt fastest and a liquid evaporate fastest • observe, record and interpret the results of their investigation • describe the effect of temperature on phase change • explain that the same substance can change state and be a liquid, a solid, or a gas • explain why they can smell evaporated liquids.	• understand the purpose and features of a table • use oral, written and visual language to record and discuss investigation results • engage in a discussion to compare ideas, and use evidence from an investigation to explain that temperature has an effect on phase change • role-play their understanding of the effect of temperature on phase change by using representational models of particles.	***Session 1*** **Mostly melting** • test whether melted or frozen objects can be returned to their original state • observe and record the factors that make an ice cube melt the fastest. ***Session 2*** **Playing particles** • represent what happens when a solid melts. ***Session 3*** **Evocative evaporation** • discuss why they can smell evaporated liquids • observe and record the factors that make a liquid evaporate the fastest • describe what happens when a liquid evaporates.	**Formative assessment** • Science journal entries • Class discussion • PROE responses • 'PROE record: Purely physical' (Resource sheet 1) • Role-play representation

* 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** Slippery solutions ***Session 1*** Delightful dissolving ***Session 2*** Gas bags	• make predictions of the results from an investigation of the effect of the quantity of water on the amount of salt dissolved • plan and conduct an investigation follow directions to investigate a chemical reaction that produces the gas carbon dioxide • observe, record and interpret the results of their investigations • identify the features that made their investigation a fair test • explain that chemical change only occurs when all the necessary substances are present.	• identify the features and purpose of a procedural text • follow a procedural text to complete an investigation • use oral, written and visual language to record and discuss investigation results • engage in discussion to compare ideas and relate evidence from an investigation to explanations about dissolving and reacting and to prior predictions • demonstrate understanding of dissolving and reacting using science journal entries.	***Session 1*** **Delightful dissolving** • observe salt dissolving in water • devise and conduct tests to retrieve the salt in its original form. ***Session 2*** **Gas bags** • observe and record what happens when a bicarbonate soda solution mixes with a tartaric acid solution.	**Formative assessment** • Science journal entries • Class discussion about safety • Class discussion about predictions • 'Salt dissolving table' (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 4** Candle capers	• observe and discuss the features of a candle • make predictions about which features of candles allow them to burn • with teacher support, plan an investigation of how a burning candle is affected by the amount of air available • identify how to conduct the investigation safely • observe, record and interpret the results of their investigation • describe the conditions that are necessary for a candle to burn.	• use oral, written and visual language to report observations of candles • identify the purpose and features of a graph • engage in discussion to compare ideas and develop understanding about conditions that are necessary for a candle to burn • demonstrate understanding of candles and burning through science journal entries.	• observe candles and their separate parts • investigate how candles need air to keep burning.	**Formative assessment** • Science journal entries • Class discussion • ‘Candle capers’ graph

* 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** Classifying changes	• recognise a need for scientific classification • create categories to group different changes • explain the difference between physical and chemical change • describe reactions as physical or chemical change, and give reasons for their choice.	• demonstrate the understanding of the difficulties of classification systems through discussions • engage in discussion to compare ideas about how to classify changes and provide relevant arguments to support their conclusions • use scientific vocabulary appropriately in their writing and talking • create a Venn diagram to present information.	• discuss descriptions of physical and chemical change • classify changes as physical or chemical changes.	**Formative assessment** • Science journal entries • Class discussion • Venn diagram • 'Changes card sort' (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:	
ELABORATE	**Lesson 6** Fizz wizz	• formulate a question and make predictions about what factors affect the speed of a chemical reaction • plan and conduct fair tests of different factors to see if they affect the speed of a chemical reaction • use equipment and materials safely • make and record observations • construct and identify patterns in a graph • provide evidence to support their conclusions and suggest improvements to their investigation methods.	• represent results to decide what factors affect the speed of a chemical reaction • summarise their findings about what factors affect the speed of a chemical reaction • engage in discussion to compare ideas and provide relevant arguments to support their conclusions.	• formulate a question for investigation • plan and set up an investigation to determine factors that affect the rate of reactions • observe, record and share results.	**Summative assessment** of Science Inquiry Skills • Science journal entries • Questions for investigation • Class discussion about safety • 'Tablet investigation planner' (Resource sheet 5)

* 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** Intrepid reporters	• describe different changes and why they have occurred • identify changes as physical or chemical changes • identify changes as reversible and irreversible • describe investigations and support conclusions with evidence.	• prepare an analytical report of their investigations which demonstrates understanding of physical and chemical changes • summarise their findings concisely • use language to clarify their understanding and reflect on their experiences • use language and visual representation to communicate their ideas in a report.	• create a final report of their 'Mess scene' findings • reflect on their learning during the unit.	**Summative assessment** of Science Understanding • Science journal entries • Class discussion • 'Mess scene' investigation report

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

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

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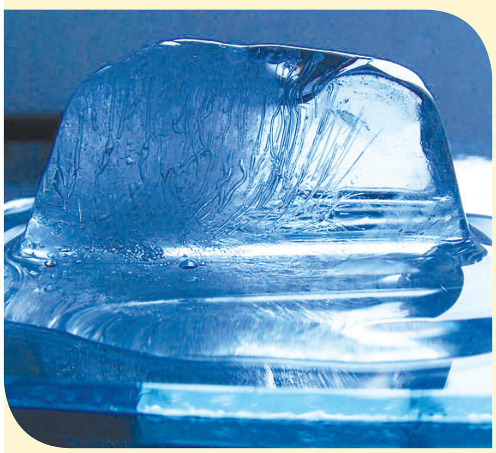

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