PrimaryConnections®
Linking science with literacy

Fully aligned with the Australian Curriculum

The PrimaryConnections program is supported by astronomer, Professor Brian Schmidt, 2011 Nobel Laureate

Push-pull

Year 2

Physical sciences

Primary**Connections project**

Professional learning program

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

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

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

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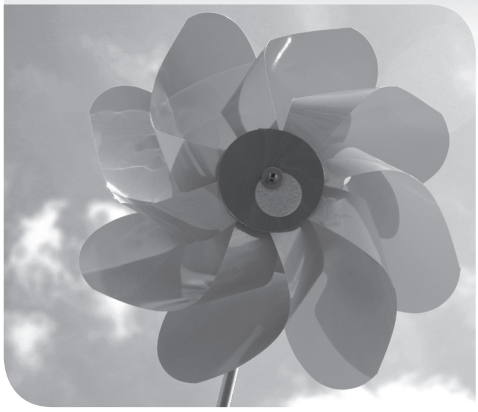

Forces are at work in everything we do—we push to open doors, and pull to tie ropes. Gravity pulls on things to make them fall down or to keep them down. Scientists and engineers study forces to design better bridges and faster aeroplanes, and to reduce the forces that affect people in car accidents.

The *Push-pull* unit is an ideal way to link science with literacy in the classroom. The unit provides the opportunity for students to explore pushes and pulls. Through investigations, students observe and gather evidence about how these forces act in air and water, and on the ground. Students identify the effect of the pull of gravity and learn that both air and water can 'push'.

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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. 'PrimaryConnections: 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 PrimaryConnections 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. PrimaryConnections 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. PrimaryConnections 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 PrimaryConnections 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 PrimaryConnections prepares students well to participate in evidence-based discussions of these and other issues.

PrimaryConnections 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 PrimaryConnections to you and wish you well in your teaching.

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

The Primary**Connections 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 Primary**Connections 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 

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 *Push-pull*

Phase	Lesson	At a glance
ENGAGE	**Lesson 1** Moving toys	To capture students' interest and find out what they think about how a push or a pull affects how an object moves or changes shape To elicit students' questions about how toys move
EXPLORE	**Lesson 2** Investigating pushes and pulls at home (optional) ***Session 1*** Push-pull pursuit ***Session 2*** Guessing game	To provide students with hands-on, shared experiences of pushes and pulls around the home
	Lesson 3 Water, water everywhere	To provide students with hands-on, shared experiences of the push of water on floating objects
	Lesson 4 What sinks? What floats? (optional)	To provide students with hands-on, shared experiences of how to change an object that sinks into one that floats
	Lesson 5 Floating on air	To provide students with hands-on, shared experiences of the push of air
EXPLAIN	**Lesson 6** Push meets pull	To support students to represent and explain their understanding of how a push or pull affects how toys move or change shape, and to introduce current scientific views
ELABORATE	**Lesson 7** Helicopter test flights	To support students to plan and conduct an investigation of the factors that affect a paper helicopter's fall through air
EVALUATE	**Lesson 8** Pulling it all together	To provide opportunities for students to represent what they know about how a push or a pull affects how an object moves or changes shape, and to reflect on their learning during the unit

A unit overview can be found in Appendix 6, page 62

Alignment with the Australian Curriculum: Science

This *Push-pull* unit embeds all three strands of the Australian Curriculum: Science. The table below lists sub-strands and their content for Year 2. This unit is designed to be taught in conjunction with other Year 2 units to cover the full range of the Australian Curriculum: Science content for Year 2.

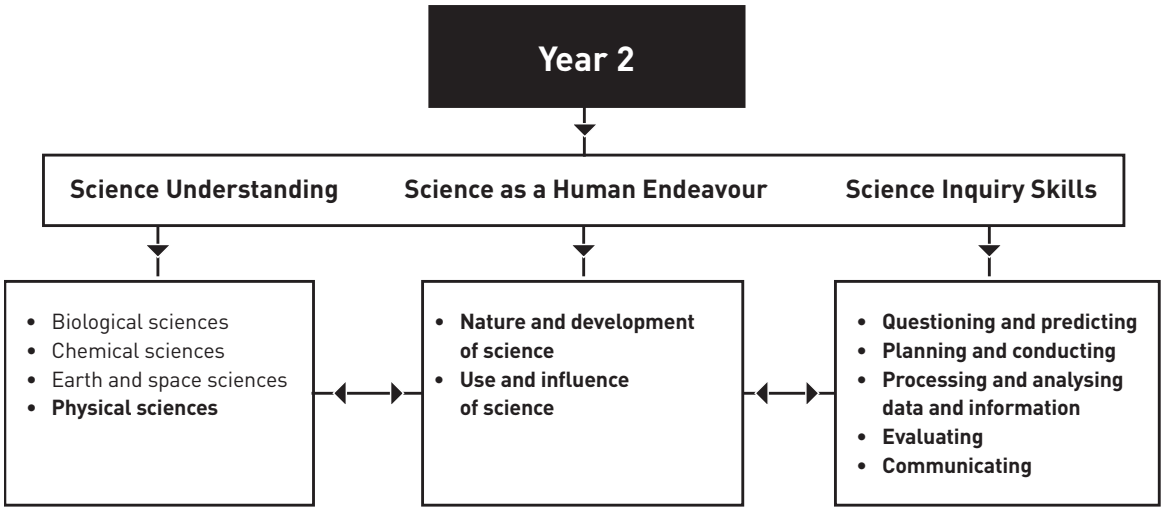
For ease of assessment the table below outlines the sub-strands and their aligned lessons.

Strand	Sub-strand	Code	Year 2 content descriptions	Lessons
Science Understanding (SU)	**Physical sciences**	ACSU033	A push or a pull affects how an object moves or changes shape	1–8
Science as a Human Endeavour (SHE)	**Nature and development of science**	ACSHE034	Science involves asking questions about, and describing changes in, objects and events	3
	Use and influence of science	ACSHE035	People use science in their daily lives, including when caring for their environment and living things	1,2,3
Science Inquiry Skills (SIS)	**Questioning and predicting**	ACSIS037	Respond to and pose questions, and make predictions about familiar objects and events	3
	Planning and conducting	ACSIS038	Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas, and accessing information sources	3,7
		ACSIS039	Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate	7
	Processing and analysing data and information	ACSIS040	Use a range of methods to sort information, including drawings and provided tables	1,2
		ACSIS214	Through discussion, compare observations with predictions	4,5
	Evaluating	ACSIS041	Compare observations with those of others	1,2,3,4,5
	Communicating	ACSIS042	Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play	1,6,8

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.



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

Relationship to overarching ideas

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

Overarching idea	Incorporation in *Push-pull*
Patterns, order and organisation	Students explore how different strengths of pushes and pulls affect the movement of objects in predictable ways.
Form and function	Students explore how an object's form can affect how it moves in water, air and on the ground, and therefore influence its use.
Stability and change	Students investigate how objects float, fall slowly or stay still because of the forces acting on them. They explore how a stable object has balanced forces acting on it.
Scale and measurement	Students experience how some large objects float and smaller ones can sink. They use force-arrow diagrams to represent push and pull forces of different sizes and the direction in which they are acting.
Matter and energy	Students investigate the effect of the pull of gravity and explore how both air and water can 'push'.
Systems	Students investigate and compare floatation in both air and water, and recognise the opposing forces at work in a system.

Curriculum focus

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

Curriculum focus Years F–2	Incorporation in *Push-pull*
Awareness of self and the local world	Students identify the forces they use in their daily lives to play and work and live. They observe and discuss the effects of gravity and how forces work in water, air and on the ground. They use science inquiry skills to conduct a test of fall time for paper helicopters.

Achievement standards

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

By the end of this unit, teachers will be able to make evidence-based judgements on whether the students are achieving below, at or above the Australian Curriculum: Science Year 2 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 unit-specific information see the next page. For further information see: www.australiancurriculum.edu.au

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

Push-pull—Australian Curriculum general capabilities

General capabilities	Australian Curriculum description	*Push-pull* 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 *Push-pull* the literacy focuses are: • word walls • tables • science journals • force-arrow diagrams • factual texts.
Numeracy	Elements of numeracy are particularly evident in Science Inquiry Skills. These include practical measurement and the collection, representation and interpretation of data.	Students: • complete provided data tables • observe and report on differences using comparison vocabulary (such as heavy, light, faster, slower).
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 Learning Objects about forces • use a digital camera to take photographs of an investigation.
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: • discuss their ideas and reasoning • predict and explain their observations • solve to a sink/float problem challenge • reflect on questions and share answers with a partner • consider investigation variables • contemplate an observed phenomenon.
Ethical behaviour	Students develop ethical behaviour as they explore principles and guidelines in gathering evidence and consider the implications of their investigations on others and the environment.	Students: • ask questions respecting each other's point of view.
Personal and social competence	Students develop personal and social competence as they learn to work effectively in teams, develop collaborative methods of inquiry, work safely, and use their scientific knowledge to make informed choices.	Students: • work with a partner to manipulate materials • follow safety rules during investigations.
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 • Important contributions made to science by people from a range of cultures are highlighted.

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

Cross-curriculum priorities

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

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

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

Aboriginal and Torres Strait Islander histories and cultures

The Primary**Connections** Indigenous perspective 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

Push-pull focuses on the Western science way of making evidence-based claims about the way objects move and change shape.

Aboriginal and Torres Strait Islander Peoples might have other explanations for the observed phenomenon of the effects of forces.

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 guidelines. Links to these are provided on the Primary**Connections** website.

Sustainability

In the *Push-pull* unit, students explore ways that objects move on land, through water and in the air. This privdes opportunities to develop an understanding of how forces can be harnessed to do useful things. This can assist them to develop knowledge, skills and values for making decisions about individual and community actions that contribute to sustainable patterns of energy use.

Alignment with the Australian Curriculum: English and Mathematics

Strand	Sub-strand	Code	Year 2 content descriptions	Lesson
English–Language	**Language variation and change**	ACELA1461	Understand that language varies when people take on different roles in social and classroom interactions and how the use of key interpersonal language resources varies depending on context	1,3,5,7
	Text structure and organisation	ACELA1466	Know some features of text organisation including page and screen layouts, alphabetical order, and different types of diagrams, for example timelines	1,2,3,5,6,8
	Expressing and developing ideas	ACELA1470	Understand the use of vocabulary about familiar and new topics and experiment with and begin to make conscious choices of vocabulary to suit audience and purpose	1–8
English–Literacy	**Literature and Context**	ACELT1587	Discuss how depictions of characters in print, sound and images reflect the contexts in which they were created	1,3,4
	Responding to literature	ACELT1589	Compare opinions about characters, events and settings in and between texts	1,3,4
		ACELT1590	Identify aspects of different types of literary texts that entertain, and give reasons for personal preferences	1,3,4
English–Literacy	**Interacting with others**	ACELY1666	Listen for specific purposes and information, including instructions, and extend students' own and others' ideas in discussions	1,2,3,5,7
		ACELY1789	Use interaction skills including initiating topics, making positive statements and voicing disagreement in an appropriate manner, speaking clearly and varying tone, volume and pace appropriately	1,3,5,7
	Interpreting, analysing, evaluating	ACELY1669	Read less predictable texts with phrasing and fluency by combining contextual, semantic, grammatical and phonic knowledge using text processing strategies, for example monitoring meaning, predicting, rereading and self-correcting	6
Mathematics–Statistics and Probability	**Data representation and interpretation**	ACMSP049	Collect, check and classify data	1,2,4
		ACMSP050	Create displays of data using lists, table and picture graphs and interpret them	1,2,4

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 forces

Forces change the way things move. Forces can make stationary objects move and moving objects speed up, slow down or stop. They can change the direction an object is moving in, and can even change its shape. It is not possible to 'see' a force—it is only possible to feel or observe its effects. Forces come in pairs—one force is an action while the second force is a reaction. For example, when you push on something, it pushes back on you. Forces can be harnessed to do useful things, such as, transport people from one place to another or construct tall buildings.

The balance between opposing forces determines whether objects float or sink in water, and whether objects in air fall quickly like a stone, slowly like a feather, or float like a hot air balloon. The balance between opposing forces determines how quickly a ball rolls down a hill, how long it takes a moving car to stop, and the behaviour of many other everyday objects. A stationary object has forces acting on it, but it is stationary because those forces are balanced.

Humans are constantly moving things. Nature is also constantly exerting forces. Air can push, water can push, and gravity is always pulling things towards the centre of the Earth. We observe the effects when moisture falls from the sky under the force of gravity.

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.

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 Moving toys

AT A GLANCE

To capture students' interest and find out what they think about how a push or a pull affects how an object moves or changes shape.

To elicit students' questions about how toys move.

Students:

- work in teams to explore how toys move
- share questions about how toys move or change shape
- use arrows to show pushes and pulls
- create a list of push and pull words to develop a word wall.

Lesson focus

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

Assessment focus

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

- a push or a pull affects how an object moves or changes shape.

Key lesson outcomes

Science

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

- describe pushes and pulls that make toys move or change shape
- observe and describe ways of moving toys
- contribute to the development of a class table.

Literacy

Students will be able to:

- contribute to discussions about pushes and pulls in our daily lives
- understand the purpose and features of a table
- use a table to record observations about pushes and pulls.

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

Teacher background information

Students use many combinations of pushes and pulls when playing with toys. An object moves when a push or a pull (a force) is applied to it. The motion is opposed by a force called friction. Moving objects slow down because the force of friction pushes against the object and slows it to a stop.

Marbles roll when pushed and a toy car rolls down a slope if the pull of gravity is greater than the force of friction that opposes its movement. As the car can't move straight down towards the pull of gravity, because of the friction it accelerates down the slope more slowly than if it were dropped from the same height. The steeper the slope, the faster the car will roll down it.

Paper planes will glide through air with the air pushing them up, opposing the pull of gravity, until they are slowly pulled down to the ground. Toy boats and balls will float on water that pushes on them from below, opposing the pull of gravity.

Diagrams can be drawn to show the pushes and pulls acting on an object. The pull of gravity is shown as an arrow going down from the centre of mass of the object while a push is shown as an arrow going towards the object.

Students' conceptions

Many students have non-scientific ideas about forces and gravity. They might associate forces with movement, and movement with living things, and therefore believe that only living things exert forces. Many students think that a force has to be continuously applied to an object to keep it moving because they don't recognise that it is the opposing force of friction that slows an object. Many students think that forces are acting only when an object moves and that gravity acts only on falling objects. Although a book sitting on a table is pulled down by gravity, the table pushes back up against the book. It is still because these two forces are balanced, there is no net force acting on the book and so the book does not move.

Equipment

FOR THE CLASS

- class science journal
- word wall
- 1 large toy with wheels
- 1 large sheet of paper or cardboard for the 'Making things move' table (see 'Preparation')

FOR EACH TEAM

- role wristbands or badges for Manager and Speaker
- toys that demonstrate different types of push and pull movement on the ground, in water and in air (eg, marbles, car, wagon, ball, boat, rubber duck, paper airplane, balloon, pinwheel, playdough)
- 2 pieces of paper approximately 10 cm x 15 cm (eg, an A4 sheet of paper cut into quarters)
- 2 copies of 'Push and pull pictures' (Resource sheet 1)

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 wristbands and the equipment table.
- Read 'How to use a science journal' (Appendix 2).
- Read 'How to use a word wall' (Appendix 3).
- Collect toys that demonstrate different types of movement on the ground, in water and in air.
- Prepare a large three-column table, with the following headings:

Making things move

on the ground	in water	in air

Lesson steps

1 Place the large toy with wheels in front of the class. Invite students to suggest a way the toy could be moved, for example, 'push it' and then ask a student to demonstrate how to move the toy. Ask students to suggest another way to move the toy, for example, 'pull it' and then ask another student to demonstrate how to move the toy. Explore other ways to move the toy and discuss how these might be 'pushes' or 'pulls'. Discuss students' ideas about how and why the toy moves. Ask students if any of the toys change shape when they are pushed or pulled.

2 During the discussion, record push and pull words on cards. Commence a word wall. Discuss the purposes and features of a word wall.

Literacy focus

Why do we use a word wall?

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

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.

3 Explain that students will work in collaborative learning teams to explore how toys move or change shape when they are pushed or pulled. If students are using these teams for the first time, introduce and explain the team skills chart and the team roles chart. Explain that students will wear wristbands to help them (and you) know which role each team member has.

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

5 Form pairs and allocate Manager and Speaker roles. Ask Managers to collect team equipment, including wristbands.

6 Explain that each team will have a collection of toys to play with to explore how they can make them move or change shape. Allow time for play. Move around the room and ask questions such as:

- How did the toy move?
- Did the toy move the same way each time?
- What made the toy move?
- Why do you think that?
- Did the toy change its shape? What happened? What did it look like?

Note: This activity is used for diagnostic assessment. Collect anecdotal records of students' existing ideas, for example, some students might have the misconception that all moving objects have an inbuilt ability to move. Encourage students, but avoid providing correct answers at this stage.

7 Ask Managers to collect two pieces of paper for their team. Ask students to choose one toy and draw a picture on a piece of paper. Ask them to write under the picture what they did (or could do) to make the toy move or change shape, such as, 'I pulled the car', 'I blew the pinwheel', 'I can push the boat', I squashed the playdough'.

8 Introduce the 'Making things move' table (see 'Preparation') and discuss its purpose and features with the class.

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.

Ask students to attach their pictures to the appropriate column of the 'Making things move' table, grouping them according to whether the toy moves 'on the ground', 'in water' or 'in air'. Ask several students to explain why they placed their drawing in that column and read their caption about how they made the toy move.

9 Introduce an enlarged copy of 'Push and pull pictures' (Resource sheet 1). Discuss how there are pushes and pulls all around us and that science helps us to understand how things move and change shape because of pushes and pulls.

Distribute students' sheets and ask students to use arrows to show where pushes and pulls occur in the pictures. Avoid providing correct answers at this stage as the aim of the activity is to find out what students already know about pushes and pulls, and how arrows are used to represent forces.

10 After students have completed the activity, collect the sheets for assessment. Students will repeat this activity in the last lesson of the unit.

11 Model a science journal entry about the lesson's activities using the class science journal. Discuss the purpose and features of a science journal with the class.

Literacy focus

Why do we use a science journal?

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

What does a science journal include?

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

12 Update the word wall and add any significant vocabulary that has been used in the lesson.

Curriculum links

English

- Choose a narrative text that includes children playing with toys, such as, kites, balls, boats or things that are pushed or pulled. Discuss the text to highlight how the toys move or are used. Write a condensed version of the text on large blank pages and ask pairs of students to provide illustrations.

Health and Physical Education

- Engage in gross motor activities such as bat and ball games, tug-o-war and tunnel ball. Discuss the forces used to play the games and how the work done by our bodies to move the equipment helps to keep us fit.

The Arts

- Engage in dramatic play as kites or balls.

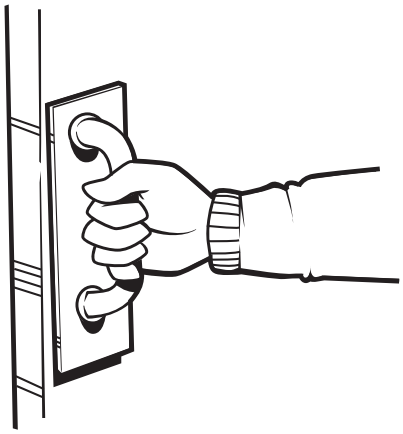
Indigenous perspectives

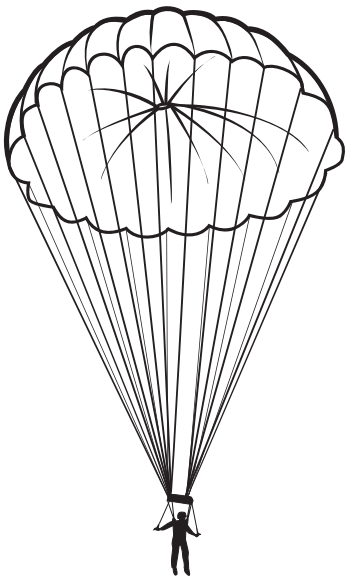
- Include traditional indigenous toys and games See: http://www.ausport.gov.au/participating/indigenous/resources/games_and_activities/full_resource
- Indigenous people might have their own way of understanding the world around them (see page 6). Contact local Indigenous community members and/or Indigenous Education Officers to access relevant, local Indigenous knowledge. Protocols are available on the website (www.primaryconnections.org.au).

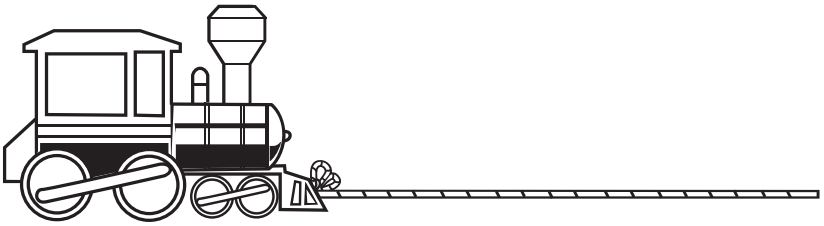
Push and pull pictures

Name: _____ **Date:** _____

Draw arrows to show the pushes and pulls in these pictures.







 ISBN 978 0 85847 308 9

Lesson 2 Investigating pushes and pulls at home (optional)

AT A GLANCE

To provide students with hands-on, shared experiences of pushes and pulls around the home.

Session 1 Push-pull pursuit

Students:

- review the pushes and pulls investigated in Lesson 1
- investigate pushes and pulls at home

Session 2 Guessing game

Students:

- play a guessing game about pushes and pulls found at home.

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:

- how a push or pull affects how objects move.

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

Key lesson outcomes

Science

Students will be able to:

- describe pushes and pulls that make objects move or change shape
- investigate ways to move objects and record their ideas.

Literacy

Students will be able to:

- use oral, written and visual language to report observations and reflect on experiences of pushes and pulls in their daily lives at home
- record information in a table
- retrieve information from a table.

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

EXPLORE

Session 1 Push-pull pursuit

Equipment

FOR THE CLASS

- 1 enlarged copy of 'Push-pull pursuit' (Resource sheet 2)

FOR EACH STUDENT

- 1 copy of 'Push-pull pursuit' (Resource sheet 2)

Lesson steps

1 Review the previous activity where students investigated pushes and pulls using toys. Explain that they are going to investigate pushes and pulls in their homes because they can use science in their daily lives at home as well as at school. Introduce an enlarged copy of 'Push-pull pursuit' (Resource sheet 2) and read it to students.

2 Review the purpose and features of a table and explain where students should write the name of the places they investigate. Explain that they can write and/or draw as they record their findings in the 'push' and 'pull' columns.

3 Brainstorm places that students might investigate at home, such as, the kitchen, the backyard, the living room. Discuss the need for them to be careful while they are investigating, such as, not try to push or pull things that are fragile, too heavy or dangerous, including chemical containers, tools or appliances.

4 Tell students when the sheet 'Push-pull pursuit' (Resource sheet 2) needs to be returned and ask them to write this date in the space provided.

Push-pull pursuit

Name: _____ **Date:** _____

In our science classes we have been investigating push and pull forces. We know that pushes and pulls can make things move. We have found pushes and pulls on land, in water and in air.

We are going to investigate two places at home and draw and write about any pushes or pulls we can find there.

This sheet needs to be back at school on _____

Place (for example, kitchen, backyard)	**Push**	**Pull**

 ISBN 978 0 85847 308 9

Session 2 Guessing game

Equipment

FOR EACH STUDENT

- the completed table 'Push-pull pursuit' (Resource sheet 2) from Session 1

Lesson steps

1 Ask students to sit with their completed table 'Push-pull pursuit' (Resource sheet 2) face down in front of them. Explain that they are going to play a guessing game with the information they have collected. Without saying the name of the place, they will read the pushes and pulls found in that place to a partner. The partner's task will be to guess the place where the pushes and pulls were found. Each partner will take a turn to describe one place at a time. For example:

Student: 'I pushed buttons on the microwave and the telephone, and I pulled open the drawers. I pulled and pushed the cupboard doors and the fridge door.'

Partner: 'I think that was in the kitchen.'

2 Organise students into pairs and allow time to play the game.

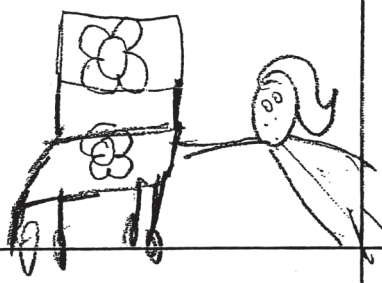
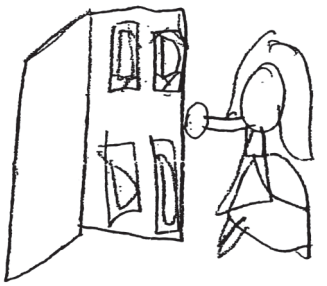
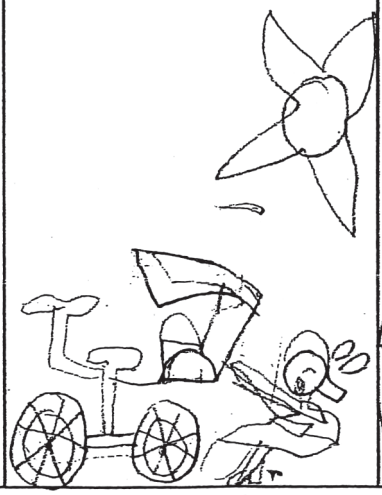
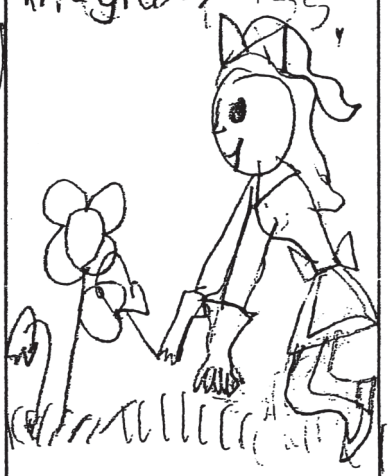
Push-pull pursuit

Name: Rebecca **Date:** 15 March

In our science classes, we have been investigating push and pull forces. We know that pushes and pulls can make things move and make things stop. We have found pushes and pulls on land, in water and in the air.

We are going to investigate two areas at home and draw and write about any pushes or pulls we can find there!

This sheet needs to be back at school on Thursday

Area (for example, kitchen, backyard)	**Push**	**Pull**
Study room	I push a flower chair. 	I pull a door 
garden	I push a bike 	mum pull the grass 

Student work sample describing pushes and pulls at home

Lesson 3 Water, water eveywhere

EXPLORE

AT A GLANCE

To provide students with hands-on, shared experiences of the push of water on floating objects.

Students:

- discuss and reflect on experiences with water
- push air-filled objects (balls) under water to experience the push of water
- feel the difference between a heavy object suspended in air and then in water
- create a labelled force-arrow diagram to indicate push or pull forces.

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:

- a push or pull affects how objects move in water.

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

Key lesson outcomes

Science

Students will be able to:

- identify that gravity pulls down on objects
- explain that water can push up on objects in water
- discuss how scientific knowledge of pushes and pulls in water can be useful in their daily lives.

Literacy

Students will be able to:

- contribute to discussions about why objects sink or float
- create force-arrow diagrams to indicate push and pull forces.

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

Teacher background information

Whether an object floats or sinks is determined by the balance between the downward pull of gravity on an object (also called weight) and the upward push of water. If the weight of an object is greater than the upward push of water on the object, it will sink. If the weight of an object and the upward push of water are in balance, the object will float.

The weight of an object is determined by how much mass an object has; objects with lots of mass experience a stronger pull of gravity. They are called heavy objects. Objects with small mass experience a weaker pull of gravity. They are called light objects.

The upward push of water is determined by the volume of water that the object pushes aside (displaces). The larger the volume of the object, the more water it has to displace, and the greater the force of the water pushing back against it.

Archimedes (287–212 BC) was an Ancient Greek mathematician and philosopher who discovered, while bathing, that 'when an object is immersed in a liquid the upthrust is equal to the weight of liquid displaced by the object'. There is a legend that he was so excited by his findings that he leapt from his bath and ran naked through the town exclaiming 'Eureka!' which means 'I have found it!'.

Equipment

FOR THE CLASS

- class science journal
- word wall
- paper towels to dry hands and mop up spills
- range of different sized balls (eg, table tennis balls, small rubber balls, basketballs).

FOR EACH TEAM

- role wristbands or badges for Manager and Speaker
- each team member's science journal
- 1 bucket or medium-sized container filled with water
- a heavy object with thick string tied around it (eg, 1L plastic bottle filled with water)
- paper towel for mopping up spills.

Preparation

- Depending on the availability of resources and space, you might consider doing this lesson as a rotation activity so that you can supervise it closely or joining teams together to halve the number of water containers needed, or organise this activity as a whole class activity.
- Plan where students will work with water, such as, in a wet area or on a verandah. Ensure that it is away from sources of electricity.

SAFETY

- Fill containers with water.
- Tie string around each heavy object and test them in a medium-sized container of water. If you are using a plastic bottle as your heavy object, fill it up to the brim with water so that the bottle contains no air.

EXPLORE

Lesson steps

1. Discuss students' experiences with water, such as, playing in a pool, swimming or having a bath. Discuss what they think happens to different objects when placed in water.
2. Explain that in this lesson students are going to work in collaborative learning teams to investigate water.
3. Form pairs and allocate roles.
4. Take students to the wet area you have prepared and discuss safe behaviour around water, for example, drying up, Managers alerting you to any large spills of water, not splashing. Explain that they are going to push the balls under water to feel what happens when the balls get pushed under.

   The different sized balls will allow them to feel the differences in the upward force provided by the water, and learn that the larger the ball, the greater the force.
5. Ask Managers to collect team equipment and allow teams time to investigate pushing different balls under the water.

Pushing a basketball under water

Releasing a basketball that has been pushed under water

6 Discuss what students feel when they push the balls under the water and what happens when they release them. Ask them to give reasons why they think this might be happening.

7 Show students one of the heavy objects with string attached. Ask them to predict how it would feel to hold the object in water and in air. Explain that they will investigate this in teams.

SAFETY

Explain that students need to take care when lifting or moving the heavy object.

8 Re-form teams and distribute heavy objects. Ask students to pull up on the string and lift the object into the air. Ask teams to describe what they feel, using questions, such as:

- What does it feel like?
- What would happen if you let go?
- Why do you think this would happen?

Discuss the downward pull of gravity and how it makes things fall to the ground. (Gravity is a complex concept but it is easy for students to recognise its effects.)

9 Ask teams to lower the heavy object into the water, wait a moment, and then pull on the string to lift the object out of the water. Ask students to describe what they feel, using questions, such as:

- Does it feel the same in water as it does in air?
- Why do you think it feels lighter in water?
- Could something be pushing the heavy object up to make it feel lighter?

Students should notice that the heavy object feels lighter in the water. This is because it is supported by the upward push of water.

10 Record students' findings in the class science journal by drawing a simple outline of an object, for example, a ball sitting on or under the water line. Explain the purpose and features of a force-arrow diagram with the class.

Lowering a weighted object into water

Literacy focus

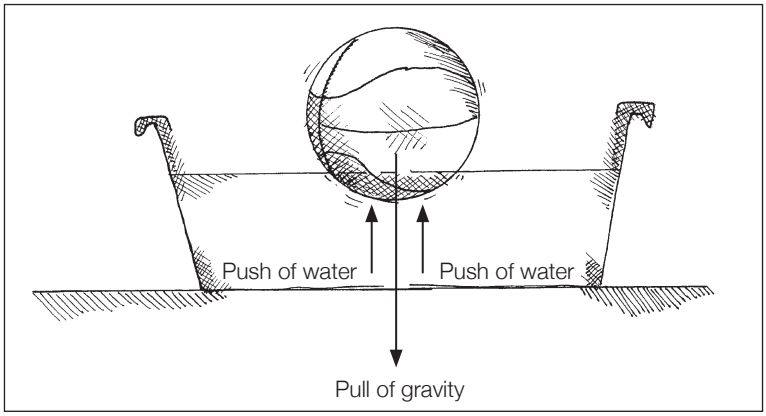
Why do we use a force-arrow diagram?

We use a **force-arrow diagram** to show push and pull forces.

What does a force-arrow diagram include?

A **force-arrow diagram** uses arrows to show the direction of forces. A pull is shown by an arrow pointing away from the object. A push is shown by an arrow pointing towards the object.

Note: Arrows used to represent forces have a different meaning to arrows used to label objects.



Force-arrow diagram

EXPLORE

Model drawing force-arrows to show the downward pull of gravity and the upward push of water. Ask students: 'Why does a ball thrown up in the air land on the ground?' and 'What pulls a rock down when it sinks?'. Remind them that it is gravity that pulls things down to the Earth. Ask them: 'Why did the ball move upwards when you released it?'.

11 Ask students to use force-arrow diagrams to record their findings in their science journal about the push of water on the objects investigated in this lesson.

12 After students have recorded their findings, discuss their force-arrow diagrams.

13 Ask students when the knowledge of an object's ability to float might be useful, such as, weighted hooks on a fishing line, an anchor on a boat, floatation devices for young children and in water rescue situations.

14 Update the word wall.

Curriculum links

English

- Read and discuss ideas in a narrative text such as *Who sank the boat?* By Pamela Allen.

Studies of Society and Environment

- Research transport by land, sea and air.

Lesson 4 What sinks? What floats? (optional)

AT A GLANCE

To provide students with hands-on, shared experiences of how to change an object that sinks into one that floats.

Students:

- work in teams to investigate objects that sink or float in water
- investigate how to change an object that sinks into one that floats.

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:

- a push or pull affects how an object behaves in water.

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

Key lesson outcomes

Science

Students will be able to:

- make observations about objects that sink or float in water and record their findings
- identify ways to change an object that sinks into one that floats
- recognise that the shape of an object influences whether it will sink or float.

Literacy

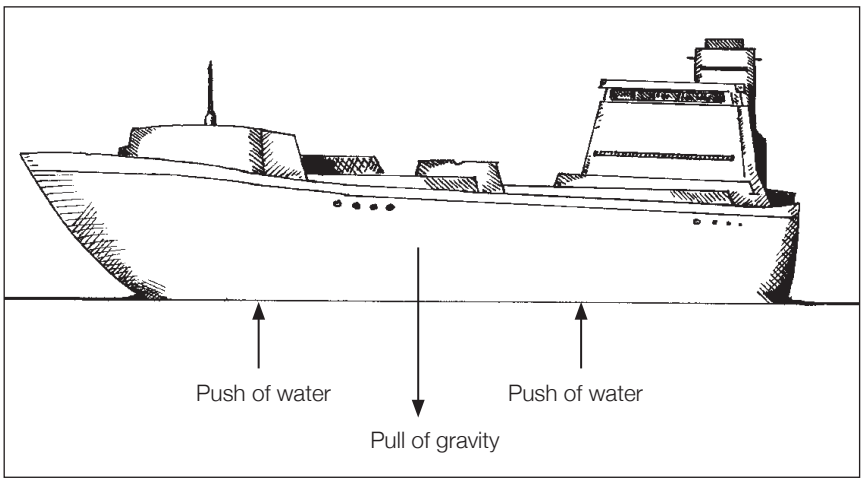
Students will be able to:

- contribute to discussions about the push of water and how to change an object that sinks into one that floats
- use language and visual representations to record their ideas about sinking and floating
- use a table to record predictions, observations and explanations.

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

Teacher background information

Things sink or float in water depending on their shape and the material they are made from. This is why very heavy objects (such as an ocean liner) can float, while very light objects (such as a paper clip) sink. While an ocean liner is massive, heavy and takes up a lot of space, it is mostly hollow inside, and therefore can displace more than its weight in water. A paper clip is solid metal, and although it is very light, it displaces less than its weight in water. The diagram shows the balance between push and pull forces on an ocean liner.



Water supports the weight of a boat

Adding to an object's weight or altering its shape can change whether it floats or sinks. Some objects that float can be made to sink by adding weight to it, for example, if a boat or ship is overloaded it will sink as the added weight overcomes the upward push of water. Some objects that sink can be made to float by changing their shape to something that displaces more water, for example, turning a piece of iron into a boat.

This can be demonstrated by filling or emptying a water bottle—to sink the bottle it needs to displace less than its weight in water. The more air in the bottle, the lighter it is and the better it will float, as it is much lighter than the weight of the water it displaces, and vice versa. A plastic bottle filled with air will float while the same bottle filled with water will sink. The bottle's shape has stayed the same, but the bottle and its contents are heavier.

Floating objects will sink if they have no additional weight and their shape is changed. For example, plasticine moulded into the shape of a boat that displaces enough water will float, but if the plasticine is squashed into a ball shape that displaces less water, but is the same weight, it will sink.

The reverse is also true. A tonne of steel would sink if it displaced too small an amount of water, but if changed into a different shape, for example, a boat shape, it will float.

Students' conceptions

Many students have non-scientific ideas about sinking and floating, believing that objects sink because they are big or heavy and float because they are small or light. This is because they have not recognised that whether an object sinks or floats is determined by two factors; the weight of the object, and the upwards force of buoyancy, or the balance between push and pull forces.

Equipment

FOR THE CLASS

- class science journal
- word wall
- paper towels to dry hands and mop up spills
- 1 enlarged copy of 'What sinks? What floats?' (Resource sheet 3)
- an object that floats (eg, an empty plastic bottle)
- a large, clear plastic tub filled with water

FOR EACH TEAM

- role wristbands or badges for Manager and Speaker
- each team member's science journal
- 1 bucket or medium-sized container filled with water
- 2 copies of 'What sinks? What floats?' (Resource sheet 3)
- 3 objects that sink or float from the following range:
  - big and light (eg, polystyrene tray, air-filled ball, empty plastic bottle)
  - small and light (eg, paper clip, elastic band, cork, bottle top or lid)
  - big and heavy (eg, metal tools, a rock, a plastic bottle filled with water)
  - small and heavy (eg, a sinker, nuts and bolts, a ball of plasticine)
- 1 ball of plasticine

Preparation

- Depending on the availability of resources and space, you might consider doing this lesson as a rotation activity or joining teams together to halve the number of water containers needed.
- Plan where students will work with water, such as, in a wet area or on a veranda. Ensure that it is away from sources of electricity.

SAFETY

- Fill the containers with water.

Lesson steps

1 Explain that students will investigate a range of objects to learn about what items sink in water, and what objects float. Explain that each team will have their own container of water and equipment.

2 Introduce the enlarged copy of 'What sinks? What floats?' (Resource sheet 3) and review the purpose and features of a table.

3 Model how to use the Predict, Observe, Explain (POE) strategy. Ask 'What do we mean by float?'. Explain that objects which float sit on or near the surface of the water. Choose an object such as an empty bottle and record it in the first column.

Predict: Ask students to predict whether the bottle will sink or float and circle the word in the 'predict' column. Ask them why they think this. Use this as an opportunity to elicit their existing ideas about sinking and floating, and identify misconceptions.

Observe: Place the empty bottle in the water and ask students to observe and describe what happens. Circle the appropriate word in the 'observe' column for whether it floats or sinks.

Explain: Ask students to compare their predictions with their observations. Ask them to explain why they think the object sinks or floats and attempt to reconcile any differences with their original reasons. Record their ideas in the 'explain' column.

4 Explain that students will investigate other objects to see if the class can find out what is similar about things that float and things that sink.

5 Form pairs (consider keeping the same groups as in the last lesson) and allocate roles. Ask Managers to collect team equipment.

Note: Do not allow students to move to the buckets of water at this stage.

6 Ask students to record the names of the team's three items in the first column of 'What sinks? What floats?' (Resource sheet 3). A list of objects on the board might provide a reference for students. Ask students to complete the 'predict' column for each object.

7 Ask teams to move to their water buckets. As teams conduct their investigations, support them to work through the 'Observe' and 'Explain' process. Ask students questions, such as:

- Why did you think it would float?
- Was your prediction correct?
- Why do you think it doesn't float?

8 Students record their ideas on 'What sinks? What floats?' (Resource sheet 3).

9 Ask several teams to share one of their investigations with the class and describe whether the object they investigated floated or sank.

10 Review the objects that floated. Ask students what is similar about these objects. Do the same for the objects that sank.

Students might start to describe reasons why things sink or float. Many students will focus on only one characteristic of an object that causes it to sink or float, such as, 'it's heavy' or 'it's small'. Prompt students to think about more than one characteristic of the object that made it sink or float, for example, 'it's big and it's light'. Help students to develop the idea that things that float are 'light for their size' and things that sink are 'heavy for their size'.

11 Explain to teams that they are now going to investigate how they can change an object that sinks into an object that floats. Ask Managers to collect a ball of plasticine for their team.

12 Allow time for teams to play with the plasticine in the water. Ask students to try different ways of pushing or pulling the plasticine to see what shapes they can make and if those shapes sink or float. Discuss students' attempts to make the plasticine float and any successes. Help to develop their understanding by explaining that objects that are 'heavy for their size' sink and objects that are 'light for their size' float. For example, changing the shape of the plasticine ball into a boat will make it float because its size has increased with no change to its weight.

EXPLORE

Ball of plasticine

Floating plasticine

13 Ask students to write and draw in their science journal about things that sink and float and how they changed a sinker into a floater.

Review how to use force-arrows to represent a push or a pull. Help students to use force-arrows appropriately (the arrows show the direction in which the force is acting, that is, towards the object for pushes and away from the object for pulls). Each force-arrow should be labelled correctly, for example, 'the push of water'.

14 Update the word wall with words and images.

Curriculum links

English

- Share a narrative text such as *Mr Archimedes' bath* by Pamela Allen. Compare the characters and settings to other Pamela Allen books.

What sinks? What floats?

Name: _____ **Date:** _____

1 Choose three objects.

2 Predict whether they will sink or float by circling the word.

3 Circle what you observed—did they sink or float?

4 Explain why you think these objects sink or float.

Object	Predict	Observe	Explain – Why?
	sink or **float**	**sink** or **float**	
	sink or **float**	**sink** or **float**	
	sink or **float**	**sink** or **float**	

Lesson 5 Floating on air

AT A GLANCE

To provide students with hands-on, shared experiences of the push of air.

Students:

- explore where air can be found
- observe and discuss the result of placing a glass containing a tissue upside down in a container of water
- observe and discuss the differences in the fall of a crumpled sheet of paper and a flat sheet.

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:

- a push or pull affects how objects move in the air.

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

Key lesson outcomes

Science

Students will be able to:

- identify that air is a substance that takes up space
- explain that air pushes up against falling objects
- explain that gravity pulls things down
- recognise that the shape and orientation of an object can influence how it falls
- identify things to keep the same in a fair test.

Literacy

Students will be able to:

- contribute to discussions about how air can push
- create a force-arrow diagram to record their ideas about how air can push on a falling object.

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

Teacher background information

Air is a mixture of gases. Like other materials it has mass and takes up space. An object falling through the air is being pulled towards the Earth by gravity. Acting in the opposite direction is the push of air (air resistance) which slows the fall of the object. The balance between these two forces determines how quickly an object will fall.

A ball-bearing has a small volume but a large mass when compared to a feather. If both objects are dropped in air from the same height, the ball-bearing will hit the ground first. The feather has a smaller mass and therefore a smaller gravitational pull, or weight, than the ball bearing. The feather has a larger surface for air to push against and therefore experiences more air resistance than the ball bearing.

The principles of flotation are the same for gases as they are for liquids. If the upward push of air or water equals the downward pull of gravity on an object, the two forces balance and the object will float. Hot air balloons and helium balloons float in air because the push of the air upwards against the balloon equals the pull of gravity down to the Earth.

Equipment

FOR THE CLASS

- class science journal
- word wall
- 2 sheets of A4 paper
- 1 transparent plastic container
- 1 transparent cup
- 1 tissue

FOR EACH TEAM

- role wristbands or badges for Manager and Speaker
- each team member's science journal
- 2 plastic bags
- 2 sheets of A4 paper

Preparation

- Prepare a page in the class science journal with the title 'Collecting air: our predictions and findings'.
- Fill the transparent plastic container with at least 10 centimetres of water.

Lesson steps

1 Review previous investigations of pushes and pulls, including those acting in water. Explain that in this lesson students are going to work in teams to investigate air.

2 Form teams and allocate roles.

3 Ask teams to consider the questions: 'What is air?' and 'Where is air?'.
Use the Think-Pair-Share strategy:

Think: Students individually consider the questions: What is air? Where is air?

Pair: Each team discusses their ideas.

Share: Teams share their partner's ideas with the class.

4 After teams have shared their ideas with the class, explain that they are going to collect air. Ask teams to predict where they might find air and record predictions on the 'Collecting air: our predictions and findings' page in the class science journal.

Discuss with students the safe use of plastic bags, for example, keeping them away from their faces.

5 Ask Managers to collect two plastic bags for the team. Ask teams to collect as much air as they can, in any way they can think of.

6 After teams have had an opportunity to collect air, arrange for them to share examples of where they found air. As locations are shared, tick them off on the list of predictions in the class science journal or add them to the bottom of the list.

7 Discuss teams' findings. Help them to develop their understanding by explaining that air is real; it is everywhere. Depending on where students report they have found air, you might need to ask further questions to help them understand that air is everywhere.

Such as, 'Is there air under the table? In the drawer? In the cupboard?'.

8 Organise students so that they can all see the container of water. Introduce the transparent cup and ask them if they think there is air inside it. Tip the cup upside down and repeat the question.

9 Push a dry tissue tightly into the bottom of the cup. Review the Predict, Observe, Explain (POE) strategy used in Lesson 4 and use it for the following activity.

Predict: Ask students to predict what will happen to the tissue if the cup is placed upside down in the container of water, and provide reasons for their prediction.

Observe: Place the cup upside down in the water. Take the cup out of the water and select a student to remove the tissue from the cup and describe what they feel, for example, 'The tissue is dry!'. Pass the tissue around the class.

Explain: Ask students to compare their predictions with their observations. Ask them to explain why they think the tissue stayed dry.

10 Lead a discussion about the idea that the tissue stayed dry because the air in the cup took up space and stopped the water getting in. Review what students have found out about air and make a record in the class science journal, such as:

- 'Air is everywhere.'
- 'Air takes up space.'

11 Hold a sheet of A4 paper horizontally. Ask students to predict what will happen if you drop the paper. Let the paper fall to the ground and ask them to describe what they saw.

Discuss why students think that the paper fell to the ground, and compare it to their earlier experiences. For example, 'Gravity is pulling the paper down'.

12 Explain that teams are going to investigate how changing the shape or orientation of the paper affects the way it falls. For example, model how teams will crumple one piece of paper into a ball and keep the other piece flat. Explain that they are going to drop both pieces of paper at the same time, with the flat sheet held horizontally.

Ask students to predict which piece of paper will reach the floor first, and provide reasons for their prediction.

13 Hold the two pieces of paper at different heights and ask:

- Will it be fair if I drop them like this?
- Would it be fair if I let one go before the other?
- Would it be fair if I threw one hard and let the other drop?

Reinforce that for a test to be fair, some things have to be kept the same.

14 Re-form teams and ask Managers to collect two pieces of paper for their team and crumple one piece into a ball. Ask teams to drop both sheets of paper at the same time and discuss why one piece of paper fell faster than the other.

15 Lead a discussion about why there was a difference in the time it took for each piece of paper to reach the floor. Encourage discussion about air, and how air slows down falling objects. Explain that the flat sheet of paper has a greater surface for the air to push up against so it falls more slowly than the crumpled piece of paper.

Note: Some students might think the crumpled sheet is heavier than the flat sheet. Compactness is sometimes confused with weight so an explicit discussion might benefit these students. Flatten out the crumpled sheet and show that it is the same as the flat sheet, only the shape had been changed.

16 *Optional:* Test dropping two flat pieces of paper, one held vertically and one held horizontally.

17 Review the features of a force-arrow diagram. Model adding force-arrows to a drawing of a horizontal sheet of paper. Ask students to record their ideas from the lesson in their science journal, for example, by drawing a force-arrow diagram of the paper falling. You might like to provide students with prompts, such as:

- Something I found out about air is …
- Something I found out about things falling in air is …
- Something I'm not sure about/a question I have is …
- I wonder …

Lesson 6 Push meets pull

AT A GLANCE

To support students to represent and explain their understanding of how a push or pull affects how toys move or change shape, and to introduce current scientific views.

Students:

- reflect on their observations and experiences of pushes and pulls
- discuss the terms 'force' and 'gravity'
- represent push and pull forces using force-arrow diagrams.

Lesson focus

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

Assessment focus

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

- a push or pull affects how toys move or change shape.

You are also able to look for evidence in students' drawings and oral language to represent what they know about pushes and pulls, and to give students feedback about how they can improve their representations.

Key lesson outcomes

Science

Students will be able to:

- describe their understanding of 'push', 'pull', 'float' and 'sink'
- understand that the upward push of water or air on objects causes them to float in water or air
- understand that the downward pull of gravity on objects causes them to sink or fall to the ground.

Literacy

Students will be able to:

- contribute to discussions about forces
- create force-arrow diagrams to indicate push-pull forces
- complete a cloze activity using the terms 'force' and 'gravity'
- use subject-specific vocabulary appropriately in their writing.

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

Equipment

FOR THE CLASS

- class science journal
- word wall
- 1 enlarged copy of 'Fantastic forces' (Resource sheet 4)
- factual texts about forces including gravity (see Primary**Connections** website for suggestions)

FOR EACH STUDENT

- science journal
- 1 copy of 'Fantastic forces' (Resource sheet 4)

Lesson steps

1 Review the class science journal, the word wall and activities from the previous lessons. Ask students questions, such as:

- Where have we been investigating different types of pushes and pulls? Such as, in the classroom, at home, on the ground, in water and in air.
- What did you feel when you pushed the objects under the water? What was doing the pushing?
- How did the object feel when you held it in the air? What was doing the pulling?
- What did the object feel like when you lowered it into the water? Why?
- What happened when you dropped pieces of paper? Did the shape of the paper affect what happened when you dropped it?

Lead the discussion to help students understand that there are pushes and pulls acting all around them.

2 Ask students to act out a 'push' and a 'pull'. Ask them to act out pushes and pulls of different sizes, such as, 'Show me a small pull', 'Show me a big push'.

Record in the class science journal that pushes and pulls can be different sizes.

3 Introduce the term 'force' as a push or a pull that can make an object move, change direction, or change shape. Discuss how students can use the word 'force' to describe pushes and pulls they have experienced, such as, 'I use a push force to type on the keyboard', 'I use a pull force to open the door'. Ask them to share a sentence with a partner using the word 'force' in relation to the pushes and pulls they have investigated.

4 Remind students of previous activities in the unit and ask the name of the pull that makes things fall to the ground. Explain that the pull of gravity is also a force.

Model using the term 'gravity' in a sentence, for example, 'A ball falls to the ground because of the force of gravity'. Ask students to share a sentence about gravity in relation to an investigation they have made or an experience they have had, for example, 'The force of gravity pulled the paper to the ground'.

5 Explain that students are going to use force-arrow diagrams to show what they have investigated and learned about pushes and pulls. Review their use of force-arrow diagrams in Lesson 3, and review the purpose and features of such a diagram.

Introduce an enlarged copy of 'Fantastic forces' (Resource sheet 4) and explain that students will complete the sentences about pushes and pulls using words provided and draw a force-arrow diagram. Model how students need to complete the sentences by selecting words from the box.

6 After students have completed their resource sheets, arrange for them to share their completed sentences with a partner. Then bring the class together to share the completed sentences. Create a class list of examples of what push and pull forces can do.

7 Use factual texts to help students deepen their understanding of the concepts of force and gravity. Explain the purpose and features of a factual text.

Literacy focus

Why do we use a factual text?

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

What does a factual text include?

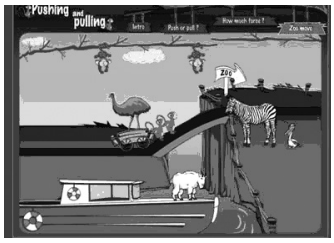
A **factual text** includes a title, text and pictures. It might include labels, diagrams, maps and photographs.

8 *Optional:* Undertake sentence-building activities with 'push' and 'pull' on strips of paper card.

Curriculum links

Information and Communication Technology (ICT)

- The Learning Federation: Students could use the learning objects listed below to explore the difference between pushes and pulls, and the use of different amounts of force.



Pushing and pulling: push or pull?, L1120 (www.scootle.edu.au)

Students discover the difference between 'push' and 'pull' as they are asked to move four small animals, of similar mass across the bridge using 'monkey power'. Monkeys are selected from their perch in the tree. If the student is asked to push the animal, they must place the monkey behind the cart. To pull the animal across, they need to place the monkey in front of the cart.

Pushing and pulling: how much force?, L1121 (www.scootle.edu.au)

The animals to be moved are of different sizes and therefore different masses. To move them will require different amounts of force! Students need to move the animals using the correct number of monkeys – too few and the cart can't be moved, too many monkeys leads to a crash! Luckily the number of monkeys available is more than will ever be needed.

Pushing and pulling: zoo move, L1122 (www.scootle.edu.au)

There is a finite pool of monkeys available. Using too few monkeys will mean that the cart will not be pushed across successfully. Using too many will mean that the cart will crash and there won't be enough monkeys to get all the animals across. A challenging puzzle about force and mass.

EXPLAIN

Fantastic forces

Name: _____ **Date:** _____

1 Use the words in the box to complete the sentences.

gravity	**pushes**	**forces**	**pull**

Pushes and pulls are_____. I use a_____force to take out the plug.

Water _____ up on things that float. _____ pulls things to the ground.

2 Complete these sentences:

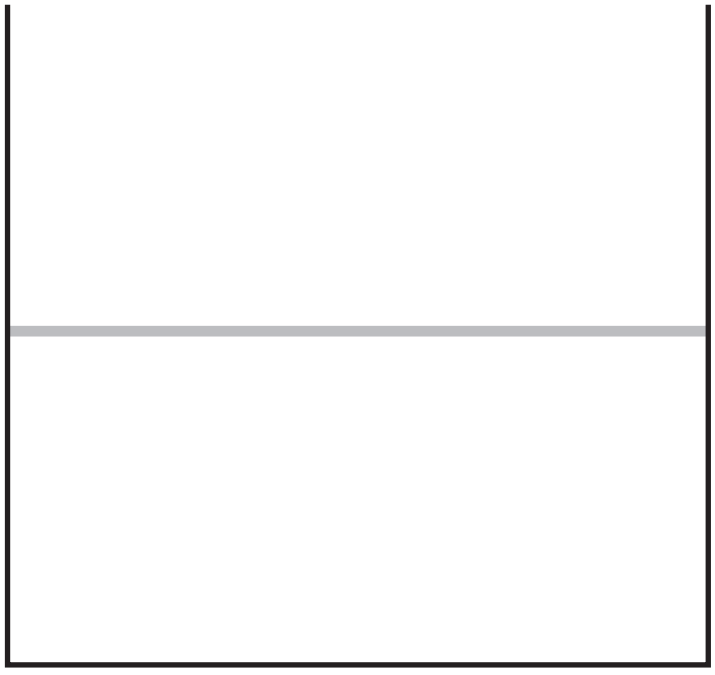
I can use a push force to _____

_____

I can use a pull force to_____

_____

3 Draw something floating in the tub of water and use force-arrows to show pushes and pulls.



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Lesson 7 Helicopter test flights

AT A GLANCE

To support students to plan and conduct an investigation of the factors that affect a paper helicopter's fall through air.

Students:

- work in teams to investigate what factors affect the fall of a paper helicopter
- identify things (variables) to change and keep the same in an investigation
- record and discuss observations
- show on a diagram where pushes and pulls act on a falling paper helicopter.

Lesson focus

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

Assessment focus

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

Key lesson outcomes

Science

Students will be able to:

- explain that air pushes up against falling objects
- identify the push of air and the pull of gravity acting on a falling object
- test a variable in an investigation.

Literacy

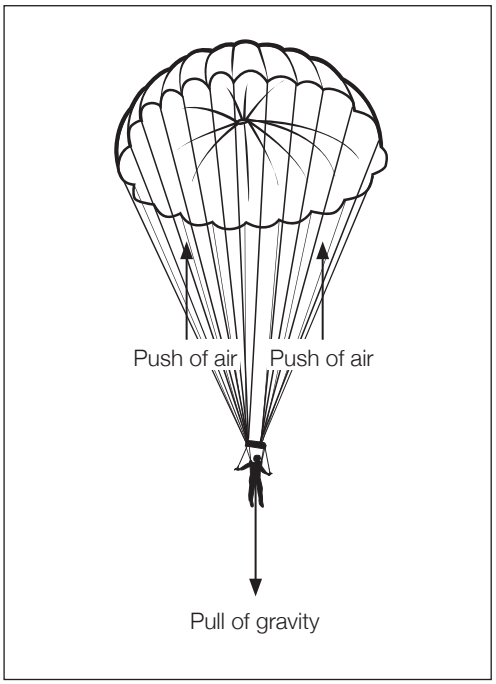
Students will be able to:

- contribute to discussions about the factors that affect the fall of a paper helicopter through air
- record and report on an investigation into the factors that affect the fall of a paper helicopter through air.

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

Teacher background information

When objects fall through air, they accelerate due to the pull of gravity before reaching a constant rate of fall called terminal velocity. Terminal velocity is reached when the gravitational force pulling an object downwards is equal and opposite to the air resistance pushing it upwards and there is no more acceleration.



A parachute catches the air and supports the weight of the parachutist

Parachutes increase a skydiver's air resistance, or the upward push they receive from the air. This reduces their terminal velocity to a safe level.

The same forces affect a paper helicopter—the larger the wings and the lighter the helicopter, the slower it will fall. Adding weight, such as, adding paper clips to the stem, or using heavier paper will make the helicopter fall faster because of the increased pull of gravity. Increasing its wing size will make it fall more slowly because of increased air resistance on the larger surface area.

As air moves past the falling paper helicopter, it creates a spinning effect. The air pushes up each wing separately, which causes the helicopter to spin.

Real helicopters can land safely if their engines fail as they are capable of a form of flight called 'autorotation', which can be described as a form of gliding. If a helicopter's engine fails, the pilot changes the angle of the blades to allow the airflow to keep them spinning at an appropriate speed. To achieve this, the helicopter must be in a descent so a landing area must be found quickly, but the pilot still has some control over the rate of descent. When the helicopter is close to the ground, the pilot 'flares' the helicopter to 'wash off' forward speed. This also increases the speed of the spinning rotors. Before the touchdown, the speed of the spinning rotors is sacrificed by the pilot who changes the angle of the blades once more to cushion the touchdown.

(This teacher background information about real helicopters was provided by a helicopter instructor with the Australian Army in Townsville, Queensland.)

Equipment

FOR THE CLASS

- class science journal
- word wall
- 1 copy of 'Paper helicopters' (Resource sheet 5)
- 'Making things move' class table
- *optional:* self-adhesive notes
- *optional:* digital camera

FOR EACH TEAM

- role wristbands or badges for Manager and Speaker
- each team member's science journal
- 2 copies of 'Paper helicopters' (Resource sheet 5)
- scissors

Preparation

- Make a paper helicopter using 'Paper helicopters' (Resource sheet 5).
- Read 'How to conduct a fair test' (Appendix 4).
- Draw an investigation planner in the class science journal, allowing sufficient space for your recording method, for example:

Investigation planner

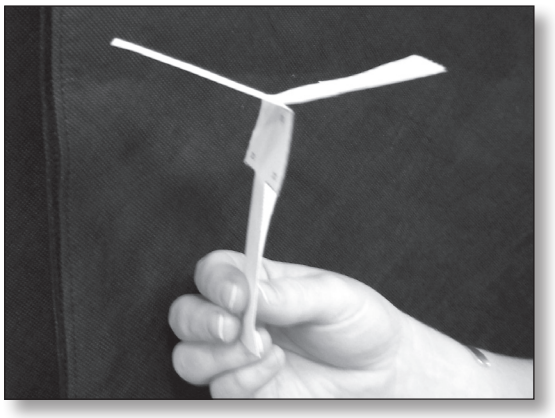
Question: What happens to the helicopter fall time when we change the wing size?		
We will **change**		
We will **observe** which helicopter hits the ground first		
We will keep the **same**		

- Consider how you will organise activities with your class to provide scaffolding where necessary. Such as:
  - Use a classroom helper to assist students to construct the helicopters.
  - Use self-adhesive notes to record students' suggestions about what can affect how fast the helicopter falls (in step 5 of the lesson). The notes can then be easily placed on the large investigation planner and moved as needed.
  - Conduct class discussions away from investigation materials to focus students' thinking.
  - If students have previous experience with planning investigations, ask teams or individuals to complete an investigation planner.

Lesson steps

1 Introduce the paper helicopter you have made. Ask students to predict what will happen when you release the helicopter and explain their prediction. Release the helicopter and discuss how students' observations compared with their predictions.

Note: Having the wings angled slightly upwards increases the chances of the helicopter successfully spinning.



Paper helicopter

2 Explain that students will work in teams to explore how paper helicopters fall. Introduce a copy of 'Paper helicopters' (Resource sheet 5) and model how students cut and fold the paper to make their helicopters.

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

4 After teams have made and played with their first helicopter, review the idea that gravity pulls things to the ground. Lead a discussion about how the upward push of air on the helicopter wings causes the helicopter to spin.

5 Pose the question: 'What things will affect how quickly the helicopter falls to the ground?' Look at each part of the helicopter in turn and record students' suggestions, for example, on self-adhesive notes to make a list of factors that might affect the helicopter's fall. Suggestions might include the size of the wings, shape of the wings, angle of the wings, length of the stem, height it is dropped from, weight of the helicopter, and paper it is made from.

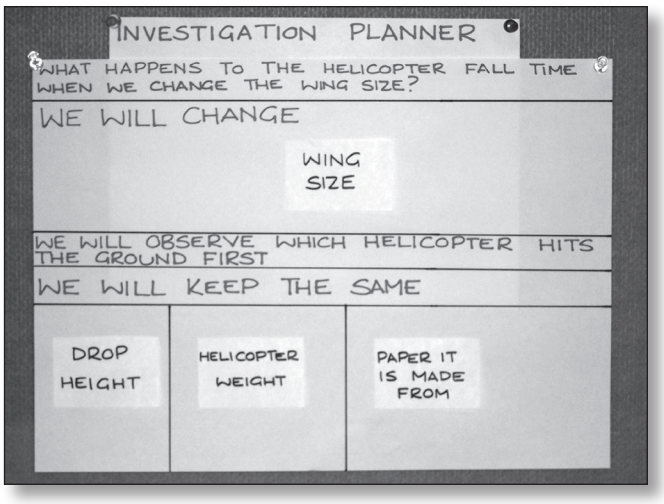
6 Explain that the focus of the team investigation will be to investigate how changing the size of the wings affects how fast the helicopter falls.

7 Introduce the investigation planner in the class science journal and read the question for investigation: 'What happens to the helicopter fall time when we change the wing size?'

Discuss and record on the investigation planner in the class science journal what teams will:

- **change:** the size of the wings (if using self-adhesive notes, this can be moved to the 'We will change' section on the planner)
- **observe:** which helicopter hits the ground first
- keep the **same:** the shape of the wings, angle of the wings, stem length, helicopter weight, release height (if using self-adhesive notes, these can be placed in the 'We will keep the same' section on the planner).

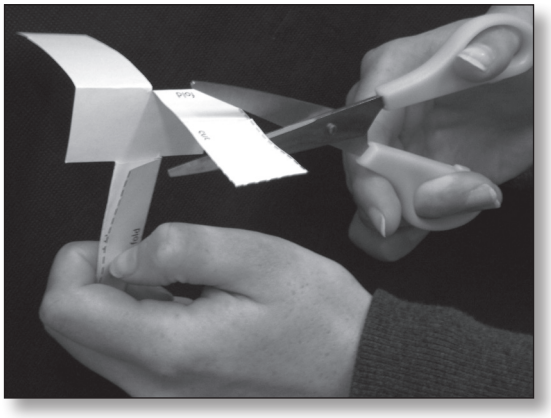
For students with limited experience of planning investigations, provide the information for the investigation question and the 'We will observe' section, as these are the hardest part of the planner to complete.



Using the investigation planner

8 Discuss why it is important to change only one thing at a time to keep the investigation fair.

9 Model how teams will modify one member's helicopter by cutting the wings to reduce their length.



Cutting the helicopter's wings

Explain that only one team member, for example, the Manager will change the wing size of the helicopter, and discuss why it is important to keep the other team member's helicopter the same for comparison. Explain how students can use the lines on the helicopters as a guide to make sure they cut the same amount from each wing.

10 Allow time for teams to modify one of their helicopters. As teams compare dropping both their paper helicopters, you, or students, might take a digital photograph of their investigation to use as a record of their findings.

11 Use guided questioning to help students think about what is happening to their paper helicopter, such as:

- What pulls the helicopter down?
- How does it move?
- What pushes up against the wings of the helicopter?

ELABORATE

- How do you know?
- Have you seen examples of this anywhere else, such as, real helicopters or parachutes?
- Why does the helicopter with bigger/smaller wings fall more slowly/more quickly?

12 Ask students to write and draw about their results in their science journals. You could provide students with prompts such as:

- The thing I changed about my helicopter was … For example, the size of the wings.
- The thing I observed about my helicopter was … Such as, the helicopter with bigger wings fell more slowly/the helicopter with smaller wings fell more quickly.
- The things I kept the same about my helicopter were …

13 Encourage students to make connections to their earlier investigations with items in water:

- How are these results similar to our investigation of objects in water? Such as, 'the helicopter is sinking' or 'gravity is pulling it down'.
- How are these results different from our investigation of objects in water? For example, 'there is no water pushing, air is pushing'.

14 Update the word wall. Attach copies of digital photographs of the paper helicopter tests, or copies of the students' results to the 'Making things move' class table to show the use of pushes and pulls in air.

15 *Optional:* Investigate what effect changing other factors has on the helicopter's fall see suggestions in step 5.

16 *Optional:* Explore the use of comparative language to describe the investigation findings, such as, smaller/bigger; faster/slower; first/last.

Curriculum links

Studies of Society and Environment

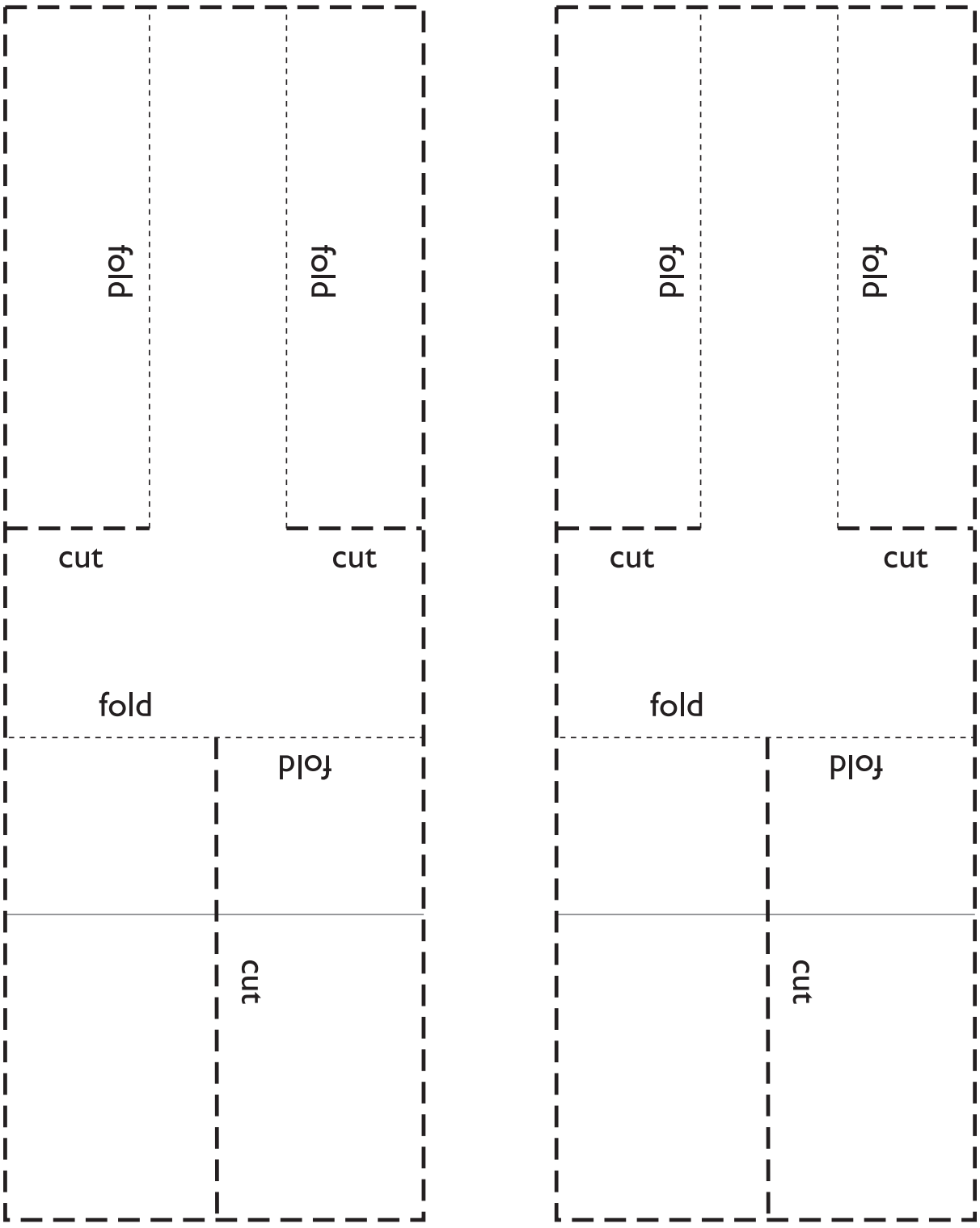
- Reflect on the use of helicopters in disaster relief and rescue missions.

Indigenous perspectives

- The Australian Indigenous scientist and inventor, David Unaipon, anticipated the helicopter in early drawings based on the principle of the boomerang. The boomerang is a wooden implement of Indigenous design that has a number of uses, mainly for hunting and fighting, but also as digging sticks and as clapsticks to make music.
  - Explore activities with boomerangs.
  - See http://members.ozemail.com.au/~mmichie/engag_t&w.htm
  - Watch the videoclip, Number seven boomerang.
  - See www.australianscreen.com.au/titles/karli-jalangu-boomerang-today/clip1
  - Find out more about the inventor David Unaipon.
  - See www.questacon.edu.au/indepth/clever/aboriginal_technology.html
- Indigenous people might have their own way of understanding the world around them (see page 6). Contact local Indigenous community members and/or Indigenous Education Officers to access relevant, local Indigenous knowledge. Protocols are available on the website (www.primaryconnections.org.au).

Paper helicopters

Name: _____ **Date:** _____



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Lesson 8 Pulling it together

AT A GLANCE

To provide opportunities for students to represent what they know about how a push or a pull affects how an object moves or changes shape, and to reflect on their learning about pushes and pulls.

Students:

- review this unit by using the class science journal, word wall, and 'Making things move' class table
- repeat 'Push and pull pictures' assessment task (Resource sheet 1)
- reflect on their learning during the unit.

Lesson focus

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

Assessment focus

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

- a push or a pull affects how an object moves or changes shape.

Key lesson outcomes

Science

Students will be able to:

- identify and describe the effects of push and pull forces in different situations in their daily lives
- explain that air and water push against objects
- explain that gravity pulls objects to the ground.

Literacy

Students will be able to:

- contribute to discussions about push and pull forces
- represent push and pull forces using labelled force-arrow diagrams
- use oral, written and visual language to clarify understanding, describe the effects of push and pull forces, and reflect on their own learning.

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

Equipment

FOR THE CLASS

- class science journal
- word wall
- 'Making things move' class table
- 1 enlarged copy of 'Push and pull pictures' (Resource sheet 1)
- 1 enlarged copy of each of the 6 images on 'Push and pull pictures' (Resource sheet 1)

FOR EACH STUDENT

- science journal
- 1 copy of 'Push and pull pictures' (Resource sheet 1)
- completed 'Push and pull pictures' (Resource sheet 1) collected from students in Lesson 1

Preparation

- Locate copies of 'Push and pull pictures' (Resource sheet 1) that students completed as a diagnostic assessment task in Lesson 1.

Lesson steps

1. Review the class science journal, word wall and 'Making things move' class table.
2. Remind students of the 'Push and pull pictures' task they did at the beginning of the unit. Explain that they are going to repeat the activity to see if they have changed any of their ideas as a result of their investigations throughout the unit.

   Explain that it is also an opportunity for students to show themselves—and you—how much they have learned about pushes and pulls, and about the way to represent them, for example, using force-arrow diagrams during the unit.

   Review the use of labelled force-arrow diagrams.

3 Provide students with time to complete 'Push and pull pictures' (Resource sheet 1). After they have completed the resource sheet, return their sheet from Lesson 1 to review how their ideas have changed since the beginning of the unit. To help students compare their two sheets, you might like to ask them questions, such as:

- What ideas have you changed?
- What new ideas have you developed?
- What objects/toys change shape when you push or pull them?
- What activity or activities helped you to learn these new ideas?

4 Bring the class together and, using enlarged copies of the pictures on 'Push and pull pictures' (Resource sheet 1), invite students to share how they labelled the pictures. Annotate the enlarged copies with the students' contributions.

5 Review the Push-pull unit with the class, asking questions, such as:

- Which activity helped you to learn something new?
- Which activity did you enjoy? Why?
- What did you learn about working with a partner?

6 Record students' responses in the class science journal.

Appendix 1
How to organise collaborative learning teams (F–Year 2)

Introduction

Students working in collaborative teams is a key feature of the PrimaryConnections 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.

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

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
- Stay with your team
- Take turns.

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

TEAM SKILLS

1. Move into your teams quickly and quietly

2. Stay with your team

3. Take turns

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.

Using a science journal

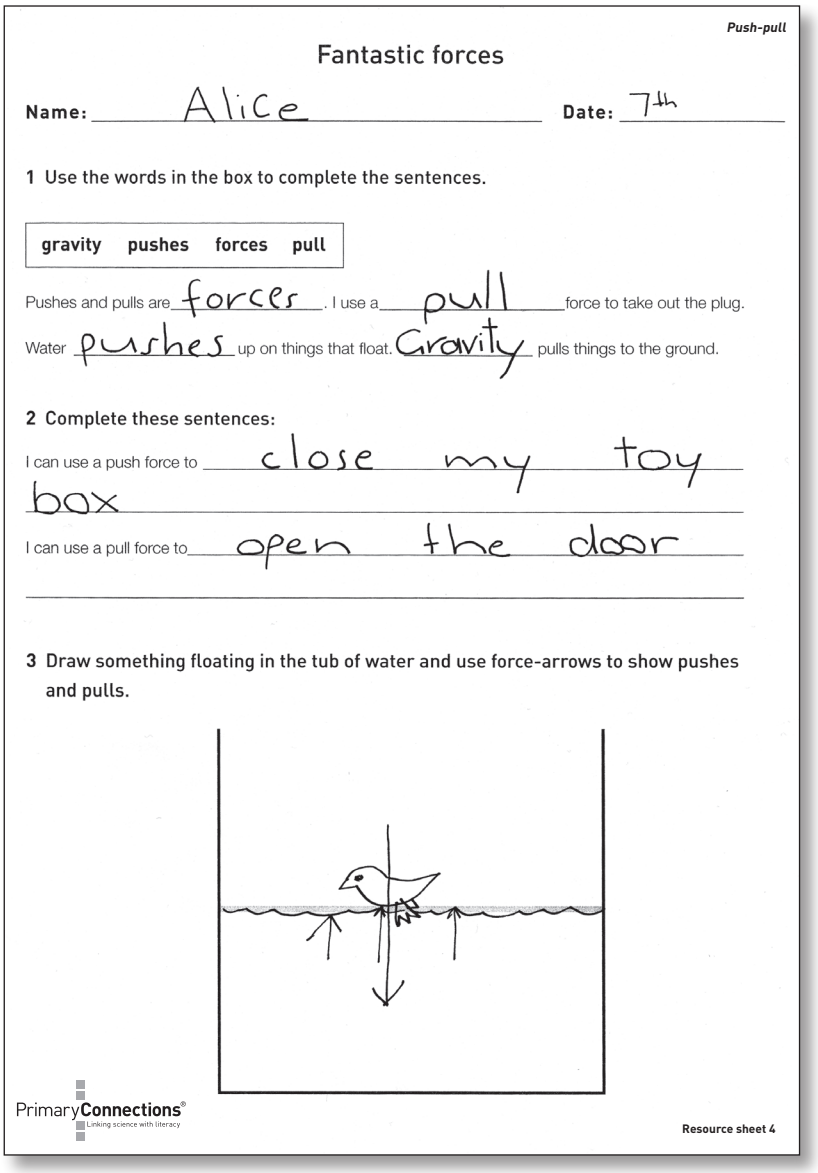
1. At the start of the year, or before starting a science unit, provide each student with a notebook or exercise book for their science journal or use an electronic format. Tailor the type of journal to fit the needs of your classroom. Explain to students that they will use their journals to keep a record 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, such as, note-making, lists, tables and concept maps. Use the class science journal to show students how they can modify and improve their recording strategies.
5. Science journal entries can include narrative, poetry and prose as students represent their ideas in a range of styles and forms.

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

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

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

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



Push-pull

Fantastic forces

Name: Alice Date: 7th

1 Use the words in the box to complete the sentences.

gravity	pushes	forces	pull

Pushes and pulls are forces. I use a pull force to take out the plug.

Water pushes up on things that float. Gravity pulls things to the ground.

2 Complete these sentences:

I can use a push force to close my toy box

I can use a pull force to open the door

3 Draw something floating in the tub of water and use force-arrows to show pushes and pulls.

PrimaryConnections® Linking science with literacy

Resource sheet 4

***Push-pull* 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.

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.

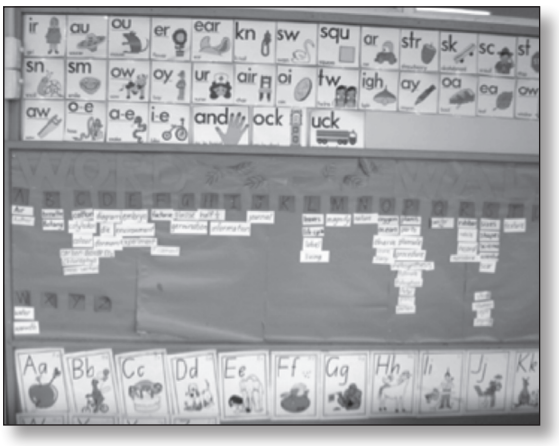
Choose robust material for the word cards. Write or type words on cardboard and perhaps laminate them. Consider covering the wall with felt-type material and backing each word card with a self-fastening dot to make it easy for students to remove and replace word cards.

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.

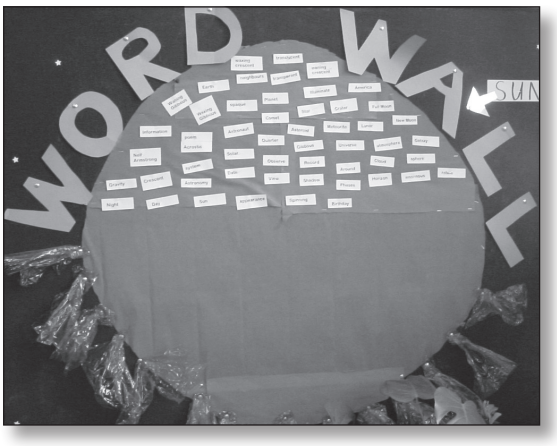
The purpose is for students to be exposed to a print-rich environment that supports their science and literacy experiences.

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 *Push-pull* unit might be organised using headings, such as, ‘Push and pull words’, ‘Floating and sinking words’ 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 object that floats 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.



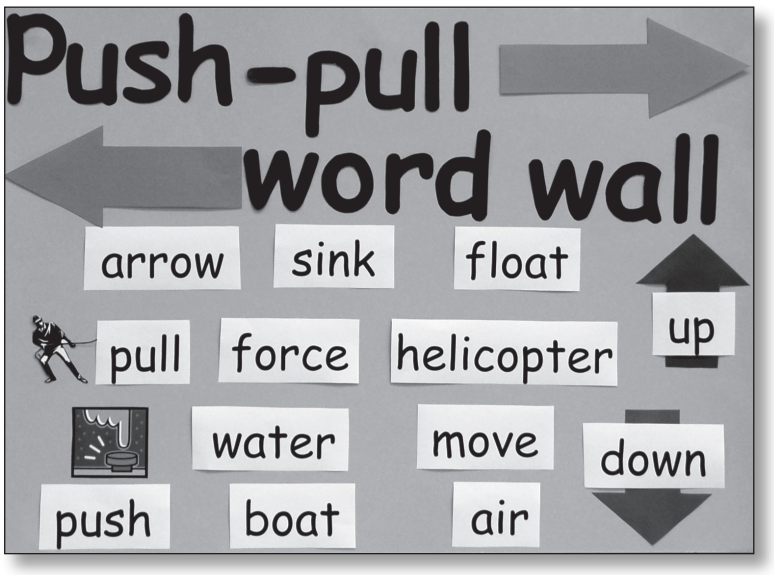
***Plants in action* word wall**



***Spinning in space* 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.



***Push-pull* word wall**

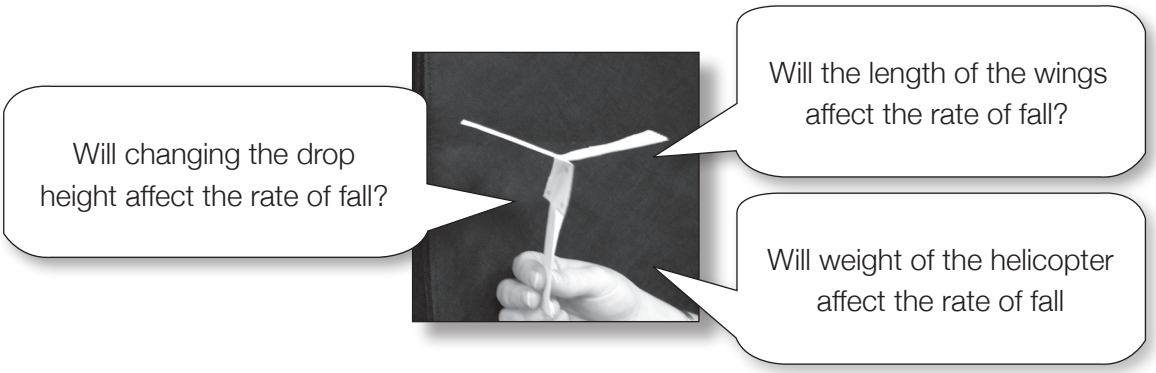
Appendix 4
How to conduct a fair test

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 *Push-pull*, students investigate things that affect the rate of fall of a paper helicopter.



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.

Note: It is not intended that Year 2 students be introduced to the word 'variable'.

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 moisture has an effect on mould growth, students could:

CHANGE	the length of the wings	Independent variable
MEASURE/ OBSERVE	how quickly it falls	Dependent variable
KEEP THE **SAME**	the shape of the wings, angle of the wings, stem length, helicopter weight, release height	Controlled variables

Appendix 5
Push-pull equipment list

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	4	5	6	7	8
				1	2						
Equipment and materials											
balls, range of different sizes (eg, table tennis balls, small rubber balls, basketballs)	collection per class					•					
containers											
– bucket or medium-sized container filled with water	1 per team					•	•				
– clear plastic tub, large, filled with water	1 per class						•				
– transparent cup	1 per class							•			
– transparent plastic container	1 per class							•			
factual text	collection per class								•		
heavy object with thick string tied around it (eg, 1L plastic bottle filled with water)	1 per team					•					
objects that sink or float from the following range:											
– big and light (eg, polystyrene tray, air-filled ball, empty plastic bottle)	set of 3 per team						•				
– small and light (eg, paper clip, elastic band, cork, bottle top or lid)	set of 3 per team						•				
– big and heavy (eg, metal tools, a rock, a plastic bottle filled with water)	set of 3 per team						•				
– big and heavy (eg, metal tools, a rock, a plastic bottle filled with water)	set of 3 per team						•				
– small and heavy (eg, a sinker, nuts and bolts, a ball of plasticine)	set of 3 per team						•				
object that floats (eg, an empty plastic bottle)	1 per class						•				
paper											
– A4 paper	2 sheets per class							•			
– A4 paper	2 sheets per team							•			
– piece of paper approximately 10cm x 15cm (eg, an A4 sheet of paper cut into quarters)	2 per team		•								

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	4	5	6	7	8
				1	2						
– piece of tissue	1 per class							●			

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	4	5	6	7	8
				1	2						
Equipment and materials (continued)											
– self-adhesive notes optional	collection per class									●	
– very large sheet of paper or cardboard	1 per class		●								
paper towel for whole class						●	●				
plastic bags	2 per team							●			
plasticine	1 ball per team						●				
scissors	1 pair per team									●	
toy, large with wheels	1 per class		●								
toys that demonstrate different types of push and pull movement (see Lesson 1 for examples)			●								
Resource sheets											
Push and pull pictures' (RS1)	2 per team		●								
Push and pull pictures' (RS1), enlarged images	1 of each of the 6 images per class										●
'Push-pull pursuit' (RS2)	1 per student			●							
'Push-pull pursuit' (RS2), completed	1 per student				●						
'Push-pull pursuit' (RS2), enlarged	1 per class			●							

'What sinks? What floats?' (RS3)	2 per team						●				
'What sinks? What floats?' (RS3), enlarged	1 per class						●				
'Fantastic forces' (RS4)	1 per student								●		
'Fantastic forces' (RS4), enlarged	1 per class								●		
'Paper helicopters' (RS5)	1 per class									●	
'Paper helicopters' (RS5)	2 per team									●	

EQUIPMENT ITEM	QUANTITIES	LESSON	1	2	2	3	4	5	6	7	8
				1	2						
Teaching tools											
class science journal	1 per class		●			●	●	●	●	●	●
'Making things move' class table	1 per class									●	●
collaborative learning wristbands	1 set per team		●			●	●	●		●	
collaborative learning team roles chart	1 per class		●			●	●	●		●	
collaborative learning team skills chart	1 per class		●			●	●	●		●	
student science journal	1 per student					●	●	●	●	●	●
word wall	1 per class		●			●	●	●	●	●	●
Multimedia											
digital camera and appropriate software and hardware for printing photos	1 per class									●	

Appendix 6
Push-pull 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** Moving toys	• describe pushes and pulls that make toys move or change shape • observe and describe ways of moving toys • contribute to the development of a class table.	• contribute to discussions about pushes and pulls in our daily lives • understand the purpose and features of a table • use a table to record observations about pushes and pulls.	• work in teams to explore how toys move or change shape • share questions about how toys move or change shape • use arrows to show pushes and pulls • create a list of push and pull words to develop a word wall.	**Diagnostic assessment** • Discussion • 'Push and pull pictures' (Resource sheet 1)
EXPLORE	**Lesson 2** Investigating pushes and pulls at home (optional) ***Session 1*** Push-pull pursuit ***Session 2*** Guessing game	• describe pushes and pulls that make objects move or change shape • investigate ways to move objects and record their ideas.	• use oral, written and visual language to report observations and reflect on experiences of pushes and pulls in their daily lives at home • record information in a table • retrieve information from a table.	***Session 1*** **Push-pull pursuit** • review the pushes and pulls investigated in Lesson 1 • investigate pushes and pulls at home. ***Session 2*** **Guessing game** • play a guessing game about pushes and pulls found at home.	**Formative assessment** • 'Push-pull pursuit' (Resource sheet 2)

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

		SCIENCE OUTCOMES*	LITERACY OUTCOMES*	LESSON SUMMARY	ASSESSMENT OPPORTUNITIES
		Students will be able to:	Students will be able to:	Students:	
EXPLORE	**Lesson 3** Water, water everywhere	• identify that gravity pulls down on objects • explain that water can push up on objects in water • discuss how scientific knowledge of pushes and pulls in water can be useful in their daily lives.	• contribute to discussions about why objects sink or float • create force-arrow diagrams to indicate push and pull forces.	• discuss and reflect on experiences with water • push air-filled objects (balls) under water to experience the push of water • feel the difference between a heavy object suspended in air and then in water • create a labelled force-arrow diagram to indicate push or pull forces.	**Formative assessment** • Science journal entries
	Lesson 4 What sinks? What floats? (optional)	• make observations about objects that sink or float in water and record their findings • identify ways to change an object that sinks into one that floats • recognise that the shape of an object influences whether it will sink or float.	• contribute to discussions about the push of water and how to change an object that sinks into one that floats • use language and visual representations to record their ideas about sinking and floating • use a table to record predictions, observations and explanations.	• work in teams to investigate objects that sink or float in water • investigate how to change an object that sinks into one that floats.	**Formative assessment** • Science journal entries • 'What sinks? What floats?' (Resource sheet 3)

* 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 5** Floating on air	• identify that air is a substance that takes up space • explain that air pushes up against falling objects • explain that gravity pulls things down • recognise that the shape and orientation of an object can influence how it falls • identify things to keep the same in a fair test.	• contribute to discussions about how air can push • create a force-arrow diagram to record their ideas about how air can push on a falling object.	• explore where air can be found • observe and discuss the result of placing a glass containing a tissue upside down in a container of water • observe and discuss the differences in the fall of a crumpled sheet of paper and a flat sheet.	**Formative assessment** • Science journal entries
EXPLAIN	**Lesson 6** Push meets pull	• describe their understanding of 'push', 'pull', 'float' and 'sink' • understand that the upward push of water and air on objects causes them to float in water or air • understand that the downward pull of gravity on objects causes them to sink or fall to the ground.	• contribute to discussions about forces • create force-arrow diagrams to indicate push-pull forces • complete a cloze activity using the terms 'force' and 'gravity' • use subject-specific vocabulary appropriately in their writing.	• reflect on their observations and experiences of pushes and pulls • discuss the terms 'force' and 'gravity' • represent push and pull forces using force-arrow diagrams.	**Formative assessment** • 'Fantastic forces' (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 7** Helicopter test flights	• explain that air pushes up against falling objects • identify the push of air and the pull of gravity acting on a falling object • test a variable in an Investigation.	• contribute to discussions about the factors that affect the fall of a paper helicopter through air • record and report on an investigation into the factors that affect the fall of a paper helicopter through air.	• work in teams to investigate what factors affect the fall of a paper helicopter • identify things (variables) to change and keep the same in an investigation • record and discuss observations • show on a diagram where pushes and pulls act on a falling paper helicopter.	**Summative assessment** of Science Inquiry Skills • Science journal records of investigation • 'Paper helicopters' (Resource sheet 5)
EVALUATE	**Lesson 8** Pulling it all together	• identify and describe the effects of push and pull forces in different situations in their daily lives • explain that air and water push against objects • explain that gravity pulls objects to the ground.	• contribute to discussions about push and pull forces • represent push and pull forces using labelled force-arrow diagrams. • use oral, written and visual language to clarify understanding, describe the effects of push and pull forces, and reflect on their own learning.	• review this unit by using the class science journal, word wall and 'Making things move' class table • repeat 'Push and pull pictures' assessment task (Resource sheet 1) • reflect on their learning during the unit.	**Summative assessment** of Science Understandings and Science as a Human Endeavour • 'Push and pull pictures' (Resource sheet 1)

* 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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