PrimaryConnections®
Linking science with literacy

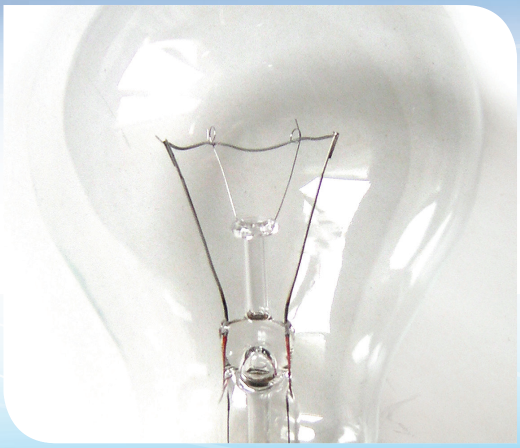
Fully aligned with the Australian Curriculum

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

# It's electrifying

## Year 6

***Physical sciences***



## Primary**Connections** project

| | |
|---|---|
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Australian Academy of Science

## Professional learning program

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

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

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

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# It's electrifying

## Year 6

### *Physical sciences*

Electrical energy is part of our everyday lives at home, at work and at school. We use it for refrigeration, machines and lighting. Portable devices, such as mobile phones, watches and many toys, rely on batteries for electrical energy. Electric circuits are needed to allow energy to be transferred from a battery to light bulbs, motors and buzzers, where it is changed into light, movement or sound.

The *It's electrifying* unit is an ideal way to link science with literacy in the classroom. Students develop their understanding through hands-on activities that explore the role of electrons in transferring energy in electric circuits. Through investigating batteries, light bulbs, switches, conductors and insulators, they explain how battery-operated devices, for example, a torch, work.

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# Contents

# Foreword

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

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

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

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

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

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

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

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

# The 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<br>Consider current scientific explanations | **Formative assessment** |
| **ELABORATE** | Extend understanding to a new context or make connections to additional concepts through a student-planned investigation | **Summative assessment** of the Science Inquiry Skills |
| **EVALUATE** | Students re-represent their understanding and reflect on their learning journey, and teachers collect evidence about the achievement of outcomes | **Summative assessment** of the Science Understanding |

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

## Developing students' scientific literacy

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

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

## Linking science with literacy

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

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

## Assessment

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

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

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

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

## Alignment with the Australian Curriculum: Science

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

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

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

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

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

## Safety

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

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

## References

Australian Curriculum Assessment and Reporting Authority (ACARA). (2012). *Australian Curriculum: Science*. www.australiancurriculum.edu.au

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

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

## Unit at a glance *It's electrifying*

| Phase | Lesson | At a glance |
|---|---|---|
| **ENGAGE** | **Lesson 1**<br>What makes it go? | To capture students' interest and find out what they think they know about how electrical circuits provide a means of transferring and transforming electrical energy<br>To elicit students' questions about how electric circuits work |
| **EXPLORE** | **Lesson 2**<br>Light up my life | To provide students with hands-on, shared experiences of constructing and representing electric circuits |
| | **Lesson 3**<br>Light bulb explorers | To provide students with hands-on, shared experiences of the structure of a light bulb |
| | **Lesson 4**<br>Alessandro Volta: Battery maker | To provide students with hands-on, shared experiences of exploring the role of Alessandro Volta in the development of the first battery |
| **EXPLAIN** | **Lesson 5**<br>Enacting electrons | To support students to represent and explain their understanding of electric circuits, and to introduce current scientific views |
| **ELABORATE** | **Lesson 6**<br>Problem solvers: What's it all about? | To support students to plan and conduct an investigation of conductors and insulators |
| | **Lesson 7**<br>Switched on | To support students to plan and conduct an investigation of the function of switches in an electric circuit |
| **EVALUATE** | **Lesson 8**<br>Bright sparks: Sharing what we know | To provide opportunities for students to represent what they know about how electrical circuits provide a means of transferring and transforming electrical energy, and to reflect on their learning during the unit |

A unit overview can be found in Appendix 8, page 96.

# Alignment with the Australian Curriculum: Science

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

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

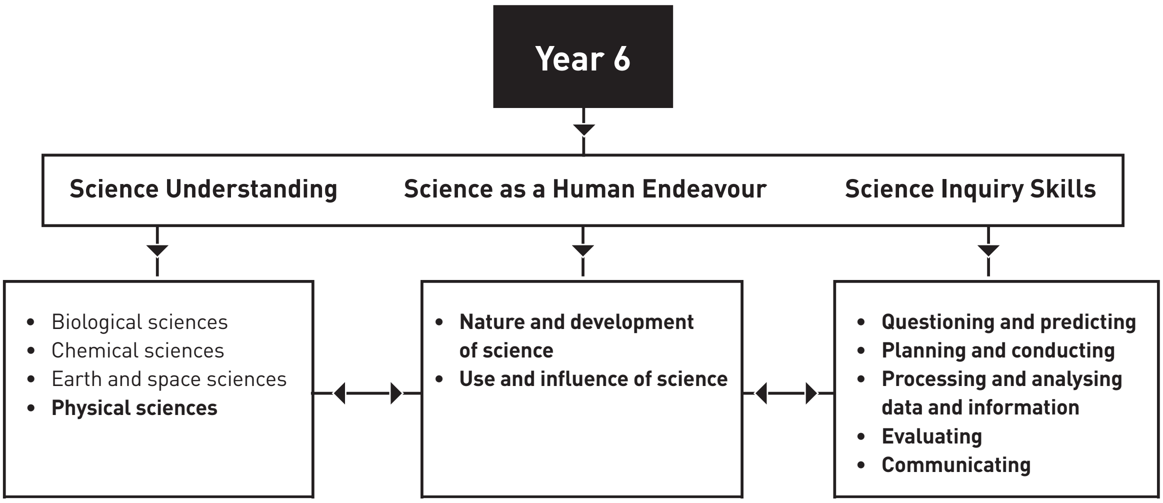
| Strand | Sub-strand | Code | Year 6 content descriptions | Lessons |
|---|---|---|---|---|
| **Science Understanding** | **Physical sciences** | ACSSU097 | Electrical circuits provide a means of transferring and transforming electricity | 1, 2, 3, 5, 7, 8 |
| **Science as a Human Endeavour** | **Nature and development of science** | ACSHE098 | Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena | 1–7 |
| | | ACSHE099 | Important contributions to the advancement of science have been made by people from a range of cultures | 4 |
| | **Use and influence of science** | ACSHE100 | Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples' lives | 1, 3–5, 8 |
| | | ACSHE220 | Scientific knowledge is used to inform personal and community decisions | 7 |
| **Science Inquiry Skills** | **Questioning and predicting** | ACSIS232 | With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be | 6 |
| | **Planning and conducting** | ACSIS103 | With guidance, plan appropriate investigation methods to answer questions or solve problems | 6 |
| | | ACSIS104 | Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate | 6 |
| | | ACSIS105 | Use equipment and materials safely, identifying potential risks | 1–4, 6–8 |

| Strand | Sub-strand | Code | Year 6 content descriptions | Lessons |
|---|---|---|---|---|
| **Science Inquiry Skills (SIS)** (continued) | **Processing and analysing data and information** | ACSIS107 | Construct and use a range of representations, including tables and graphs, to represent and describe observations, patterns or relationships in data using digital technologies as appropriate | 1–3, 5, 6, 8 |
| | | ACSIS221 | Compare data with predictions and use as evidence in developing explanations | 2, 6 |
| | **Evaluating** | ACSIS108 | Suggest improvements to the methods used to investigate a question or solve a problem | 6 |
| | **Communicating** | ACSIS110 | Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts | 1–8 |

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 *It's electrifying* these overarching ideas are represented by:

| Overarching idea | Incorporation in ***It's electrifying*** |
|---|---|
| **Patterns, order and organisation** | Students explore, describe and sequence the components of an electric circuit to allow electrons to flow. They investigate the properties of conductors and insulators and organise them into categories based on the patterns in their findings. |
| **Form and function** | Students investigate the form and function of batteries, light bulbs and switches, investigating their components and their function when placed in an electric circuit. For example, the store of energy in a compact battery is a form which allows it to be used in a highly portable object such as a torch. |
| **Stability and change** | Students recognise that the conductive properties of a material and its suitability for use remain stable. They investigate how the flow of electrons along a circuit can be altered by using switches, insulators or resistant components, for example, a light bulb. |
| **Scale and measurement** | Students identify volts as the unit of measurement for the amount of 'push' a battery provides to the electrons in a circuit. They use an appropriate scale in their labelled diagrams to show the relative size of objects in their representations. |
| **Matter and energy** | Students investigate the transformation of energy from chemical reactions in batteries to electrical energy. This energy is transferred along the wires of the electric circuit to devices such as light bulbs that transform it into other energy types, such as light and heat. |
| **Systems** | Students investigate closed electric circuits as systems providing a pathway for the continuous flow of electrons. They represent their understanding of electric circuit systems and the interdependence of its various components. |

## Curriculum focus

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

| Curriculum focus Years 3–6 | Incorporation in *It's electrifying* |
|---|---|
| **Recognising questions that can be investigated scientifically and investigating them** | Students generate inquiry questions about electric circuits and their components. They discuss and formulate plans of action to answer these questions, including completing scientific investigations and generating new claims based on evidence to answer their questions. Investigations might include the form and function of circuit components, building a simple electric circuit and conducting a fair test about the electrical conductivity of materials. |

## Achievement standards

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

By the end of this unit, teachers will be able to make evidence-based judgments on whether the students are achieving below, at or above the Australian Curriculum: Science Year 6 achievement standard.

## General capabilities

The skills, behaviours and attributes that students need to succeed in life and work in the 21st century have been identified in the Australian Curriculum as general capabilities. There are seven general capabilities and they are embedded throughout the units.

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

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

## *It's electrifying*—Australian Curriculum general capabilities

| General capabilities | Australian Curriculum description | *It's electrifying* examples |
|---|---|---|
| **Literacy** | Literacy knowledge specific to the study of science develops along with scientific understanding and skills.<br>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 *It's electrifying* the literacy focuses are:<br>• science journals<br>• cutaway diagrams<br>• word walls<br>• circuit diagrams<br>• labelled diagrams<br>• biographies<br>• chronological lists<br>• role-plays<br>• annotated diagrams<br>• tables<br>• procedural 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:<br>• collect, represent and interpret data through tables and diagrams. |
| **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:<br>• use interactive resource technology to view, record and discuss information. |
| **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:<br>• use reasoning to develop questions for inquiry<br>• formulate, pose and respond to questions about electric circuits<br>• give reasons to justify their responses to questions. |
| **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:<br>• 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:<br>• work collaboratively in teams<br>• conduct role-play and word loop exercises appropriately<br>• follow procedural texts for working safely<br>• participate in discussions. |
| **Intercultural understanding** | Intercultural understanding is particularly evident in Science as a Human Endeavour. Students learn about the influence of people from a variety of cultures on the development of scientific understanding. | • 'Cultural perspectives' opportunities are highlighted where relevant.<br>• Important contributions made to science by people from a range of cultures are highlighted where relevant. |

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

## Cross-curriculum priorities

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

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

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

## Aboriginal and Torres Strait Islander histories and cultures

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

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

## Sustainability

In *It's electrifying* students discuss sources of electrical energy and investigate the ways electrical energy can be transferred and transformed in an electric circuit to operate devices which are useful to humans.

This provides opportunities for students to develop an understanding that energy is neither created nor destroyed; that it can be stored and transformed to other forms of energy; that the amount of energy required to operate components such as light bulbs in a simple circuit varies; and that energy flow can be changed by using materials which help or prevent the flow of electrons. This can assist them to develop knowledge, skills and values for making decisions about individual and community actions that contribute to sustainable patterns of use of the Earth's energy resources.

# Alignment with the Australian Curriculum: English and Mathematics

| Strand | Sub-strand | Code | Year 6 content descriptions | Lessons |
|---|---|---|---|---|
| **English–Language** | **Language variation and change** | ACELA1515 | Understand that different social and geographical dialects or accents are used in Australia in addition to Standard Australian English | 1–8 |
| | **Language for interaction** | ACELA1516 | Understand that strategies for interaction become more complex and demanding as levels of formality and social distance increase | 1–8 |
| | | ACELA1517 | Understand the uses of objective and subjective language and bias | 1, 2, 4, 6–8 |
| | **Expressing and developing ideas** | ACELA1524 | Identify and explain how analytical images like figures, tables, diagrams, maps and graphs contribute to our understanding of verbal information in factual and persuasive texts | 1–7 |
| | | ACELA1526 | Understand how to use banks of known words, word origins, base words, suffixes and prefixes, morphemes, spelling patterns and generalisations to learn and spell new words, for example technical words and words adopted from other languages | 1–8 |
| **English–Literature** | **Literature and context** | ACELT1613 | Make connections between students' own experiences and those of characters and events represented in texts drawn from different historical, social and cultural contexts | 4 |
| **English–Literacy** | **Interacting with others** | ACELY1709 | Participate in and contribute to discussions, clarifying and interrogating ideas, developing and supporting arguments, sharing and evaluating information, experiences and opinions | 1–8 |
| | | ACELY1816 | Use interaction skills, varying conventions of spoken interactions such as voice volume, tone, pitch and pace, according to group size, formality of interaction and needs and expertise of the audience | 1–8 |
| | | ACELY1710 | Plan, rehearse and deliver presentations, selecting and sequencing appropriate content and multimodal elements for defined audiences and purposes, making appropriate choices for modality and emphasis | 4, 8 |

| Strand | Sub-strand | Code | Year 6 content descriptions | Lessons |
|---|---|---|---|---|
| **English–Literacy** (Continued) | **Interpreting, analysing and evaluating** | ACELY1711 | Analyse how text structures and language features work together to meet the purpose of a text | 3, 4 |
| | | ACELY1712 | Select, navigate and read texts for a range of purposes, applying appropriate text processing strategies and interpreting structural features, for example table of contents, glossary, chapters, headings and subheadings | 3, 4, 7 |
| | | ACELY1713 | Use comprehension strategies to interpret and analyse information and ideas, comparing content from a variety of textual sources including media and digital texts | 3, 4 |
| | **Creating texts** | ACELY1714 | Plan, draft and publish imaginative, informative and persuasive texts, choosing and experimenting with text structures, language features, images and digital resources appropriate to purpose and audience | 4, 8 |
| | | ACELY1715 | Reread and edit students' own and others' work using agreed criteria and explaining editing choices | 7, 8 |
| **Mathematics–Statistics and probability** | **Data representation and interpretation** | ACMSP147 | Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables | 6 |

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

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

# Teacher background information

## Introduction to electrical energy

When things happen or change, energy is involved. Energy is abstract: you cannot see or feel energy—you can see only evidence of its effects. Movement, emission of light, sound or heat and changes to the shape of objects are all evidence that energy is acting. The Sun, fossil fuels, wind and hydro-electric schemes are all important sources of energy that are used to generate electrical energy. We use electrical energy to do things for us.

Energy can be stored. A battery is a store of chemical energy. Before and after a battery is connected to a circuit, the chemicals in the battery react with each other releasing their energy which is given to tiny particles called electrons. Electrons have a property that is fundamental to electricity and it is called electric charge. Charges come in two forms—positive and negative—and electrons are negatively charged.

All materials are made of atoms. Electrons are very small, negatively charged particles that form the outside of atoms. When the chemicals in a battery react, electrons are transferred from one chemical to another to make a new chemical. However, the arrangement of the battery is such that the electrons cannot move freely from one chemical to the other unless a path is provided. This is why the chemical reaction happens only when the battery is in a circuit. The energy released by the chemical reaction causes the electrons in the wire of the complete circuit to move. Electrons move in a copper wire at the very slow rate of approximately 1 cm an hour. However, as soon as they start moving at one end of the wire they move all along the wire, even at the other end of the wire. Electrical energy is carried around the circuit by the electrons.

An electric circuit is the pathway along which the electrons flow. The electrons can move only when there is a complete circuit. The electrons flow in only one direction: from the negative to the positive terminal of the battery. This unit will highlight this concept by using arrows in diagrams that represent electron flow. Conventional circuit diagrams, however, have arrows that represent current, which is marked as flowing in the opposite direction to the electrons. This unit focuses on electron flow, as it is easier for this age group to understand than the notion of current.

Electric circuits transfer energy from the source, which is often a battery, to devices, such as light bulbs or buzzers, which transform the energy into other forms, such as light and sound. Energy is neither created nor used up in electric circuits. It is moved to other places (transferred) and then changed into other forms (transformed).

**Note:** In this unit, the terms ‘battery’ and ‘cell’ are used with the same meaning, as the term ‘battery’ is now in common usage. Technically, a 1.5 V ‘battery’ is a cell, whereas a ‘battery’, such as a car battery, is made of a set of cells.

## Students’ conceptions

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

Many students have non-scientific ideas about batteries, circuits and electricity. The everyday meanings given to terms such as 'electricity', 'power', 'current' and 'energy' are often different to the way the scientific community uses them and this can cause confusion.

Electricity is not 'current' or 'power' or 'energy'; it is a field of science like 'chemistry'. Hence, in this unit, the focus will be on electrical energy carried by a flow of electrons and how electrons move in a circuit.

Some students might believe that the battery is a store of electrical energy ('electricity', 'power', 'energy', 'amps') that flows out of the battery to the light bulb, where it is used up. In fact, the battery does store something: it stores chemicals, which, when they react together, release chemical energy. This chemical energy is converted to electrical energy when it pushes the electrons around a circuit. This energy is not 'used up' by devices in the circuit, for example, a light bulb, it is transformed or changed. There is less electrical energy after an incandescent light bulb has been powered but there is more light and heat energy in the room.

Students might think that the battery goes 'flat' when all the electrical energy has been used up. Rather, it is when the chemicals inside the battery (for example, the zinc in ordinary batteries) have finished reacting with each other that the battery is exhausted and can no longer provide a 'push' to the electrons.

In rechargeable batteries, the two chemicals can be separated again by passing an electric current through them in the opposite direction.

To access more in-depth science information in the form of text, diagrams and animations, refer to the Primary**Connections** Science Background Resource, now available on the Primary**Connections** website: (www.primaryconnections.org.au).

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

# Lesson 1 What makes it go?

ENGAGE

**AT A GLANCE**

To capture students' interest and find out what they think they know about how electrical circuits provide a means of transferring and transforming electrical energy.

To elicit students' questions about how electric circuits work.

Students:

- observe and record information about the working of different battery-operated devices
- draw a cutaway diagram of how they think a torch works
- share and discuss observations.

## Lesson focus

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

## Assessment focus

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

- how electrical circuits provide a means of transferring and transforming electricity.

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

## Key lesson outcomes

**Science**

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

- identify evidence that shows that a battery is working
- explain their existing ideas of how a battery works
- describe how they think a battery-operated device works
- explain their existing ideas of how a torch works
- explain what they know about how electric circuits work.

**Literacy**

Students will be able to:

- record information and ideas about battery-operated devices
- represent what they think they know about how a torch works in a cutaway diagram
- contribute to the class science chat-board to represent their understanding of how electric circuits work, including further questions to investigate.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

## Teacher background information

A battery contains chemicals. When these chemicals react, they release energy, which is used to push the electrons within the battery from the positive to the negative terminal. This creates an imbalance, with the negative terminal having many electrons and the positive terminal having few. When these two terminals are connected, a circuit is complete. The electrons of the negative terminal of the battery are pushed into the wire until they reach a device in the circuit, such as a light bulb, motor or buzzer. From here, they travel to the positive terminal and back to the negative terminal. The circuit can be repeated over and over as long as the chemical reaction continues. By this process, the chemical energy of the battery is transformed into electrical energy, which is carried around the circuit by the electrons to the light bulb, bell, buzzer or motor, where the electrical energy is changed into another form of energy, such as light, sound, heat or movement.

As the chemicals react, the rate at which they push the electrons diminishes. The push diminishes over time until it is no longer detectable. Energy is not produced from nothing, nor is it consumed, nor does it disappear into nothing. In this case, the chemical energy is transformed into electrical energy, which is in turn transformed into light, heat, sound or movement energy.

In a torch, the chemical energy of the battery or batteries gives the electrons in the circuit a 'push', and they carry electrical energy from the battery to the light bulb. The light bulb transforms the electrical energy into heat and light energy, which is the light given out by the torch when it is switched on. An incandescent light bulb transforms the electrical energy into mostly heat and some light; an energy-efficient fluorescent light bulb transforms the electrical energy directly into light.

A torch will not work until the switch is turned on. When a switch is turned on, it completes the electric circuit, making a complete path for the electrons to flow around. A torch works by having a fully connected path from the battery (or batteries) to the light bulb and back to the battery. In some torches, the torch case is part of the path or circuit.

**Note:** The focus for this unit will be on alkaline batteries.



## Equipment

### FOR THE CLASS

- class science journal
- class science chat-board
- team roles chart
- team skills chart
- 3 or 4 torches
- collection of battery-operated devices (eg, toy, music player, doorbell, handheld computer game, mobile phone, walkie-talkies, megaphone)
- large sheets of paper for class science chat-board (see 'Preparation')

### FOR EACH TEAM

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

## Preparation

- Read 'How to organise collaborative learning teams (Year 3—Year 6)' (Appendix 1). Display an enlarged copy of the team skills chart and team roles chart in the classroom. Prepare role wristbands or badges and the equipment table.
- Read 'How to use a science journal' (Appendix 2).
- Read 'How to use a word wall' (Appendix 3). In this unit, the word wall will be known as the keywords section of the class science chat-board.
- Prepare a place in the classroom for the class science chat-board. This area is for you and your students to record words, pictures, questions, ideas and reflections about the unit as it progresses. Write keywords or questions on a sheet of paper (you can add more during the unit) to support the students to organise their ideas, such as 'Keywords', 'Our questions' and 'Aha! Light bulb moments'.
- *Optional:* Display the class science journal and class scientists' chat-board on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

## Lesson steps

1 Introduce the collection of battery-operated devices, including torches.

2 Explain that students will be working in collaborative learning teams to explore different

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

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

**4** Explain that students will be recording in their science journals, observations about what the devices do and what makes them work. Discuss the purpose and features of a science journal.



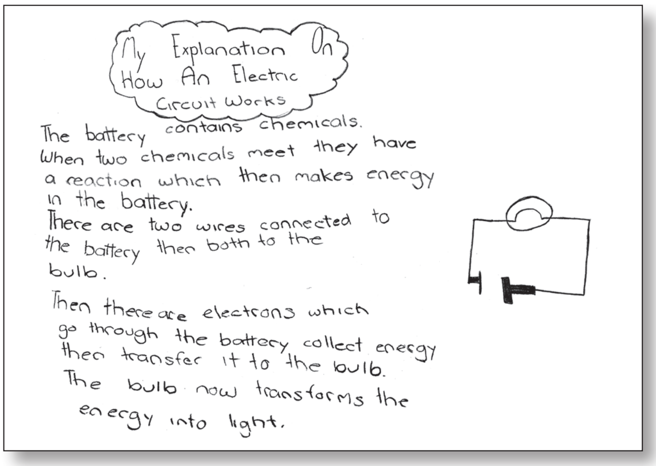
### Literacy focus

**Why do we use a science journal?**

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

**What does a science journal include?**

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




**Student work sample of a science journal entry**

**5** Explain that each team will explore and record observations about a total of three devices, one of which will be a torch. Explain that Managers will collect the devices one at a time, and return them to the equipment table before taking another device.

Ask students to record responses to questions, such as:

- What does the device do? (For example, lights up, makes a sound.)
- What makes it go? (For example, a switch, a button, a battery.)
- How does the device work?

In the *Engage* phase, do not provide any formal definitions or correct answers as the purpose is to elicit students' prior knowledge. Having an insight into what students think allows you to address and build on their existing knowledge base throughout the unit.

Ask students to also record their ideas about how a battery works.

SAFETY

Discuss the need to be careful when exploring the devices and their components. For example, small batteries should be kept away from the mouth as they can accidentally be ingested. Explain to what extent students can go to deconstruct their devices. Remind students never to deconstruct devices that are still connected to a power source, especially if they are connected to mains power.

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

7 Ask teams to explore the devices and record their observations in their science journals.

8 Introduce the class science chat-board and explain that it is designed for students to record words, pictures, questions, ideas and reflections about the unit as it progresses.

Discuss students' observations about the devices. Record their ideas on the class science chat-board, for example, under a heading, 'What battery-operated devices can do'.

9 Explain that students are going to draw a cutaway diagram of the torch they explored to show how they think it works (that is, how it makes the light bulb glow). Ask students to imagine that they can see inside the torch and draw in their science journal a cutaway diagram of what they think they would see.

Discuss the features and purpose of a cutaway diagram. Ask students to list things that the diagrams cannot show, for example, in a cutaway diagram of a torch, you cannot show the gases in the light bulb or the inside workings of the switch.

ENGAGE

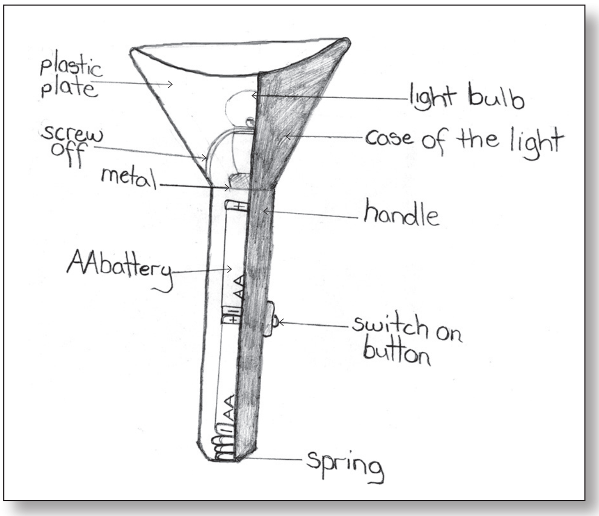
## Literacy focus

**Why do we use a cutaway diagram?**

We use a **cutaway diagram** to show the inside and outside parts of an object.

**What does a cutaway diagram include?**

A **cutaway diagram** includes a title and a drawing showing what the inside of the object looks like. It includes labels with lines or arrows to indicate the feature.




**Student work sample of a cutaway diagram of a torch**

Reassure students that they need not be anxious if they are unsure about how the torch works or what it looks like inside. Encourage them to record everything they think of. Explain that in this unit they will learn more about the torch and how devices like it work.

This is an opportunity to probe students' thinking by asking questions, such as:

- Tell me about your diagram.
- Why do you think that?
- What if…?
- Explain this piece to me.

The purpose in the *Engage* phase is to elicit students' existing questions and conceptions so you can take account of their ideas in the following lessons. Do not correct alternative conceptions at this stage.

Encourage students to prepare for the next lessons by asking questions, such as:

- How could we test that idea?
- What do you think would happen if…?
- I wonder…

**10** Brainstorm the role of electrical energy in students' lives. Record lists of the battery-operated devices used by students and their families at school, at home and in the community. Add to the class science chat-board.

**11** Discuss the advantages and disadvantages of batteries and battery-operated devices. For example, they allow things to be portable, such as torches, music players and mobile telephones. Batteries go 'flat' and are a more expensive source of electrical energy than mains electricity.

**12** Ask students to share their ideas about how batteries work. Record their ideas on the class science chat-board under a heading, such as 'How we think a battery works'.

**13** Record key vocabulary about battery-operated devices that has been used, such as battery, button, movement, light and sound on the keywords section of the class science chat-board. The keywords section of the class science chat-board is a form of word wall.

### Literacy focus

**Why do we use a word wall?**

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

**What does a word wall include?**

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

Discuss the keywords and record students' suggestions about how to describe them. These descriptions can be modified and adapted during the unit.

Invite students to contribute words from different languages to the word wall, as well as words used in different social and geographical dialects and accents used in Australia in addition to Standard Australian English.

**Note:** It is important to use the word 'describe' rather than 'define'. 'Definitions' are often viewed as fixed and unchangeable, whereas 'descriptions' support students to see that ideas can change as their understanding develops. Similarly, scientists' ideas develop as they find more evidence or think creatively about existing information.

**14** Review the role of the class science chat-board as a place for students to record their pictures, questions, ideas, findings and reflections, and new words during the unit. Explain that students might like to write or draw their contributions, and that they are able to respond to or build on someone else's contribution.

**15** Focus on the 'Our questions' section and ask students for suggestions. Model recording these on the class science chat-board. Explain that during the next week (or other period) each student should add a question to the wall.

*Optional:* Organise a schedule for students to add to the class science chat-board to ensure that all students have time and the opportunity to make regular contributions.

*Optional:* Ask the students to reflect on extension questions, such as:

- Does the physical size of a battery affect how long it lasts?
- Do AA batteries last longer than AAA batteries?
- Do different brands of the same size battery last the same length of time?

These questions encourage students to plan investigations that help develop their conceptual understanding of batteries. Remind students to consider aspects of fair testing (see 'How to conduct a fair test', Appendix 4).

ENGAGE

## Curriculum links

### Mathematics

- Compare the cost-effectiveness of standard and heavy-duty batteries in the same type of toy.

### Studies of Society and Environment

- Explore the effect of harnessing electricity for society, such as lighting appliances, industry and farm machinery.

### Indigenous perspectives

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

# Lesson 2 Light up my life

## AT A GLANCE

To provide students with hands-on, shared experiences of constructing and representing electric circuits.

Students:

- construct and test circuits
- represent a functioning circuit.

EXPLORE

## Lesson focus

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

## Assessment focus

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

- the components of electric circuits and how to connect them to form a working circuit.
- how energy from batteries can be used to generate electrical energy.
- the fact that science involves testing predictions to develop explanations.
- how electrical circuits function.

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

## Key lesson outcomes

### Science

Students will be able to:

- make predictions about circuits that will light a light bulb
- construct and test circuits and record their observations
- compare their representations of circuits.

### Literacy

Students will be able to:

- record predictions, observations and explanations about circuits
- use writing, drawing and modelling to clarify ideas about designs of circuits
- represent a circuit diagram using circuit symbols.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

## Teacher background information

For a battery to be able to change its chemical energy into electrical energy, it needs to be connected to a completed path so that the electrons can move along the wire. This path—with at least a battery, wires and a device (to which the energy is transferred, such as a buzzer or a light bulb)—is called an electric circuit.

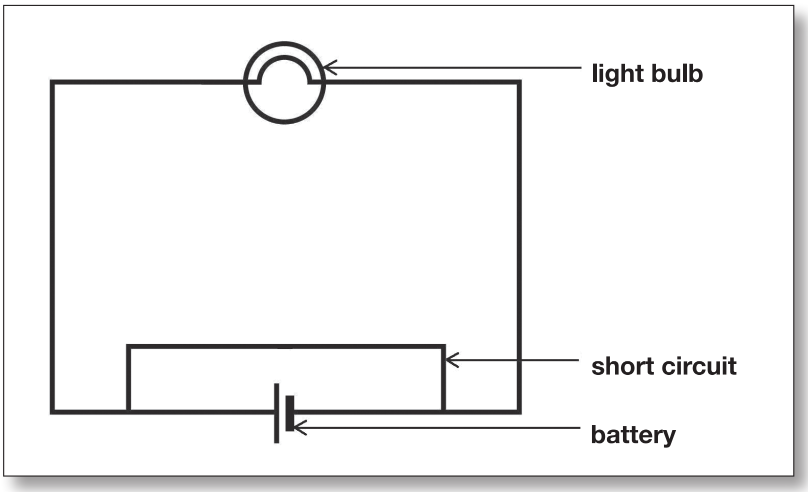
In a completed circuit, the electrons flow continuously in one direction from one point of the battery (the negative terminal) to another (the positive terminal). The flow of the electrons from the battery, along the wires and around the circuit, is what carries the electrical energy. Electrons move at about only 1 cm an hour in copper wire. There is no delay, however, as the electrons of the wire close to the positive terminal flow into that terminal and are replaced by electrons next to them (all the electrons in the wire move forward at the same time).

A device, such as a light bulb or motor, can be placed in the circuit or path. As the electrons flow through the device, the energy that they carry is changed (transformed) into other forms of energy, such as movement, light, heat or sound. The energy is not used up but is changed into another form. Students need to be able to trace this continuous connected path through all the devices in the circuit.

The electrons carrying the energy from the negative terminal to the positive terminal of the battery will travel along the path of least resistance in a circuit. A short circuit is where a very easy path is available for the electrons to flow along. This path is said to have low resistance compared with the rest of the circuit. When a light bulb or buzzer is included in a circuit, it provides greater resistance to the flow of electrons than plain wire.

If a battery is connected to a circuit that includes a light bulb, but there is another wire present—which allows the electrons to go directly back to the battery—the electrons will take this easy path, creating a short circuit. When the electrons follow this easy path, the chemicals in the battery will quickly react and be consumed, and so cannot produce any more electrical energy for the electrons and the battery soon becomes 'flat'.

**Note:** You will need to monitor the circuits trialled by students because if they inadvertently create a short circuit they will quickly flatten the batteries.

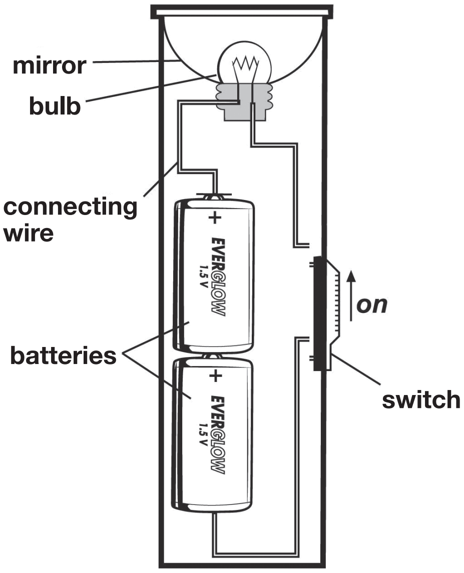



**A diagram of a circuit that has a short circuit**

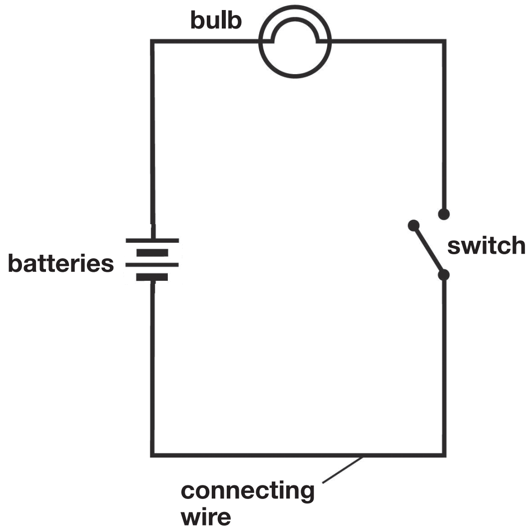
EXPLORE

## The circuit in a torch

The main components of a torch circuit include a battery (or batteries), connecting wires, a switch and a light bulb. A circuit is formed with these components and, when the switch is closed and there is a completed path or loop that electrons can move around, the torch will operate.




**Labelled diagram of the parts of a torch**




**Circuit diagram of a torch**

## Students' conceptions

When students draw diagrams of how an electric circuit can be connected to light up a light bulb, they are influenced by their beliefs about circuits and about electric current. Many students do not understand that there needs to be two connection points on the battery and two connection points on the light bulb for there to be a continuous pathway for the flow of electrons around the circuit and through the light bulb and through the battery. Many students believe that electric current is consumed by the light bulb. Scientists explain that the electrons flow through the light bulb and are not consumed. It is the electrical energy they carry that is changed into other forms of energy, such as heat and light; nothing is used up or consumed.

Students' explanations for how the circuits work could reveal some non-scientific ideas. There are four common ways that students can represent and explain how circuits work. Only one of these—the fourth explanation below—matches the scientific explanation. Students might use terms, such as 'electricity', 'power', 'energy', 'juice' or 'amps' rather than 'current' when explaining their model.

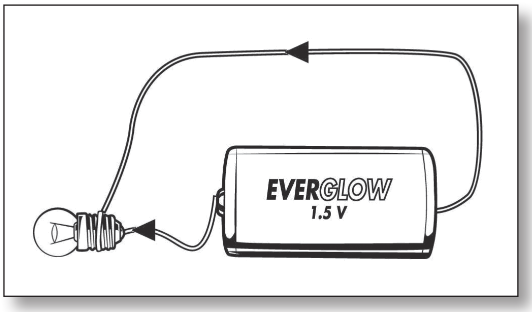
**Note:** The arrows in the models in this unit represent electron flow. Arrows in conventional circuit diagrams represent current, which is marked as flowing in the opposite direction. This unit focuses on electron flow, as it is easier for this age group to understand than the notion of current.

EXPLORE

**Type 1: Clashing currents model (non-scientific idea)**

*Two connection points on the light bulb and two connection points on the battery.*

While this circuit will light the light bulb, students might explain that the light bulb lights because something flows from each end of the battery and collides in the light bulb, causing it to light up. They might also suggest that this uses up whatever is moving in the wires. This is referred to as the 'clashing currents' model and is a non-scientific idea.



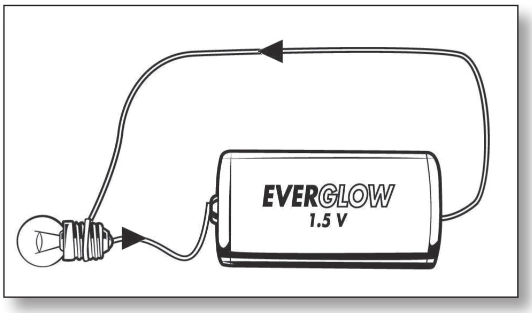

In the scientists' model, the electrons flow in only one direction from the negative terminal of the battery to the light bulb and then from the light bulb to the positive terminal of the battery. The light bulb lights up because the electrical energy carried by the electrons is changed into light by the light bulb. The electrons are not used up.



**Type 2: Consumption model (non-scientific idea)**

*Two connection points on the light bulb and two connection points on the battery.*

While this circuit will light the light bulb, some students might believe that something comes out of the battery and when it lights the light bulb, some of it is used up or lost in the light bulb, so there is less of it returning to the battery in the other wire. This non-scientific idea is referred to as the 'consumption' model.

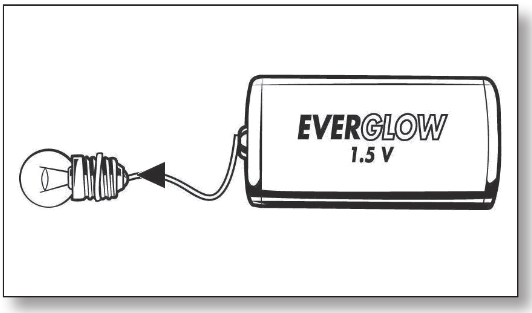



In the scientists' model, the electrons flowing in the wires are not used up; rather, it is the chemical reaction in the battery that is exhausted.

**Type 3: Source-sink model (non-scientific idea)**

*One connection point on the light bulb and one connection point on the battery.*

Students might think that this circuit will light the light bulb because they believe that something flows from the battery and is used up in the light bulb to make it light. Therefore, students believe only one wire is needed, while any other wires are unnecessary. Students might believe that a single wire connected from a battery to a device will work because that is how it appears in home appliances. This is referred to as the 'source-sink' model.



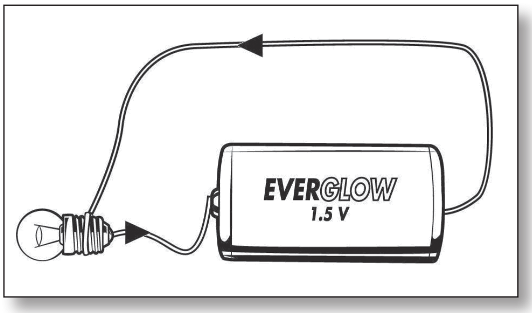

In the scientists' model, the electrons will not flow to the light bulb unless there is a return wire from the light bulb to the battery to allow the electrons to flow around the circuit. If there is not a complete path for the electrons to flow around in a circuit, they will not be able to carry the energy from the battery to the light bulb.

**Type 4: Scientists' model**

*Two connection points on the light bulb and two connection points on the battery.*

This model is how scientists understand electron flow in a circuit.

When this circuit is connected, it lights the light bulb. Electrons flow from one end of the battery (negative terminal) through one wire and pass through the light bulb, which lights up by transforming the energy carried by the electrons from electrical to light energy. The electrons continue to move in the second wire to return to the other end of the battery (positive terminal) and they are not used up.




Reference for models: Osborne, R. & Freyberg, P. (Eds). (1985). *Learning in Science, the implications of children's science*. Auckland, New Zealand: Heinemann Education, 23–4.

EXPLORE

## Equipment

### FOR THE CLASS

- class science journal
- class science chat-board
- team roles chart
- team skills chart
- 1 enlarged copy of 'PROE record: Lighting up my life' (Resource sheet 1)
- stripping pliers or knife
- spare light bulbs and batteries for replacements, if necessary

### FOR EACH TEAM

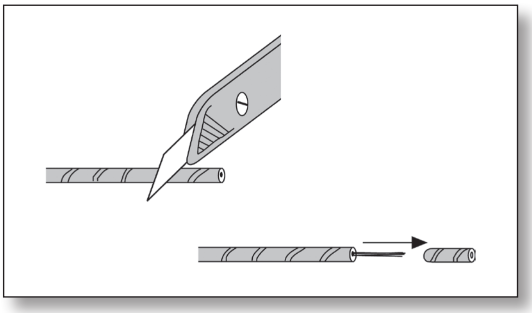
- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'PROE record: Lighting up my life' (Resource sheet 1) per team member
- 1 battery (size C or D)
- 1 light bulb (1.5 V)
- 2 pieces of insulated wire (15 cm long), with ends stripped of insulation; or folded foil wires (see 'Folded foil wires', Resource sheet 2 and 'Preparation')
- *optional:* 1 copy of 'Folded foil wires' (Resource sheet 2)

**Note:** While equipment such as light bulb holders and battery holders is available, using it can prevent students from seeing the connection points on a light bulb and a battery. Students might therefore believe that the holders themselves play some part in the circuit. During *Explore* activities in this unit, it is preferable that students do not use light bulb or battery holders.

## Preparation

- Prepare an enlarged copy of 'PROE record: Lighting up my life' (Resource sheet 1).
- Using stripping pliers or a knife, strip the insulation from the ends of the wire, as shown.
- This needs to be done by the teacher or another adult, not by students.

SAFETY



**Stripping insulation from the ends of the wire**

Alternatively, make circuit 'wires' by using folded aluminium foil (see 'Folded foil wires', Resource sheet 2). The use of foil can be problematic as it tears easily. If possible, the use of electrical wires is recommended.

- *Optional:* Display the enlarged copy of 'PROE record: Lighting up my life' (Resource sheet 1) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.primaryconnections.org.au

## Lesson steps

1 Review students' exploration of battery-operated devices from the previous lesson—in particular, their ideas of how a torch works.

Review the class science chat-board and discuss some of the ideas or questions that have been contributed.

2 Explain that students will be working in collaborative learning teams to explore how they can light up a light bulb using a battery and one or two wires. Show students a set of the resources available for each team.

**Note:** Connecting one point of the battery with one point on the light bulb with a wire will not light up a light bulb. This method allows students to question the source-sink model (see 'Teacher background information' in this lesson).

3 Introduce the Predict, Reason, Observe, Explain (PROE) strategy to the class using the enlarged copy of 'PROE record: Lighting up my life' (Resource sheet 1) in the class science journal. Explain each step of the PROE strategy.

**Predict:** Explain that students predict, by writing or drawing ways to connect the equipment that will make the bulb light up, and record their prediction in the first box of the 'PROE record: Lighting up my life' (Resource sheet 1).

EXPLORE

**Reason:** Students record reasons to support their predictions in the second box of the 'PROE record: Lighting up my life' (Resource sheet 1).

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

**Observe:** Explain that students will construct and test their equipment, recording everything that they observe in the 'Observe' box of the 'PROE record: Lighting up my life' (Resource sheet 1) using writing and drawings.

**Explain:** Explain that in this section of the 'PROE record: Lighting up my life' (Resource sheet 1) students compare their predictions with their observations. Ask students to explain in the last box of the 'PROE record: Lighting up my life' (Resource sheet 1) why the result did or did not match their prediction.

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

**5** Ask each team member to complete the 'P' and 'R' sections of the 'PROE record: Lighting up my life' (Resource sheet 1) then paste it into their science journal. Ask students to share their predictions and reasons with their team and the class.

EXPLORE

**6** Ask teams to construct and test circuits and to complete the 'O' and 'E' sections of the 'PROE record: Lighting up my life' (Resource sheet 1) using writing and drawings.

SAFETY

Explain that when using low-voltage batteries, for example, 9 V or less, in their investigation, it is safe for students to touch bare wire because there is only a small amount of electrical energy coming from the battery. Any bare wires carrying mains electricity or high voltage (electrical energy) are extremely dangerous.

SAFETY

Connecting a wire from one end of the battery terminal directly to the other terminal will cause the wire to become very hot (and flatten the battery). Explain that students should always have a device, for example, a light bulb, between the wire that goes from one terminal of the battery to the other terminal.

To complete a functioning circuit, students will need to make connections with both (the positive and negative) terminals of the battery and two points on the light bulb.

**7** As teams are engaged in their investigation, ask students questions, such as:

- What happens if you put the wire on other parts of the light bulb?
- What happens if you put the wire on other parts of the battery?
- Which parts of the light bulb/battery seem to be the same?
- Which parts of the light bulb/battery seem to be different?

**8** Remind students to record, in their science journal, the 'O' and 'E' steps on the 'PROE record: Lighting up my life' (Resource sheet 1) as they test their predictions.

**9** Challenge students who have quickly created a functional circuit using two wires to create a functional circuit using only one wire (which they can do if they connect the remaining connection point on the light bulb directly with the remaining connection point on the battery).

**Completing a functioning circuit**
**(The wire needs to touch the base and the side of the light bulb.)**

**10** After teams have completed their investigation and Managers have returned the equipment to the equipment table, lead a class discussion for students to share their 'Observations' and 'Explanations'. During this discussion attempt to reconcile any differences students might have experienced compared to their predictions and former reasoning.

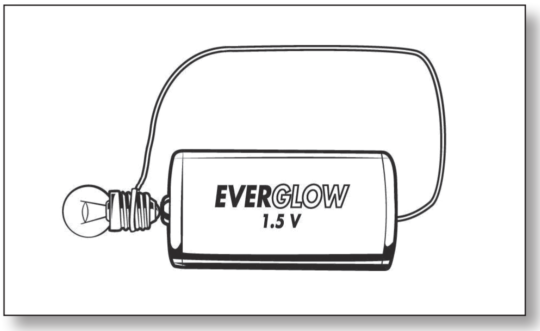



**Diagram of a functional circuit using only one wire**

**11** Ask Speakers to create a drawing on the board to show how their team made the light bulb light up and also a way that did not make it light up. Compare the drawings and discuss questions, such as:

- How do you think the light bulb needs to be connected to make it work?
- Why did this arrangement work/not work? How would you change it to make it work and why?

Review the times when the light bulb didn't light up. Discuss questions, such as:

- If the light did not turn on, what would you need to check?

**12** Introduce the term 'circuit' and discuss what it means in relation to the class exploration of lighting a light bulb. Discuss other meanings of the word 'circuit' that students know, such as a fitness circuit, or a course or track used in racing.

Add a class-generated description of 'electric circuit' to the class science chat-board, for example, 'Electrical components organised to create a circular path for electrical energy to flow through'.

EXPLORE

**13** Review the drawings on the board and discuss similarities and differences in the way students have represented equipment or electric circuits. Discuss the confusion that could occur when using different ways to represent equipment, for example, some people draw different pictures to represent the same thing.

**14** Explain that a way to show an electrical system is by using a circuit diagram. Standard electrical symbols are used in circuit diagrams to represent how a circuit is connected.

Introduce and discuss the symbols used to represent the equipment students have already used, such as wire, battery [cell] and light bulb.

**15** Model drawing a circuit diagram on the board.

### Literacy focus

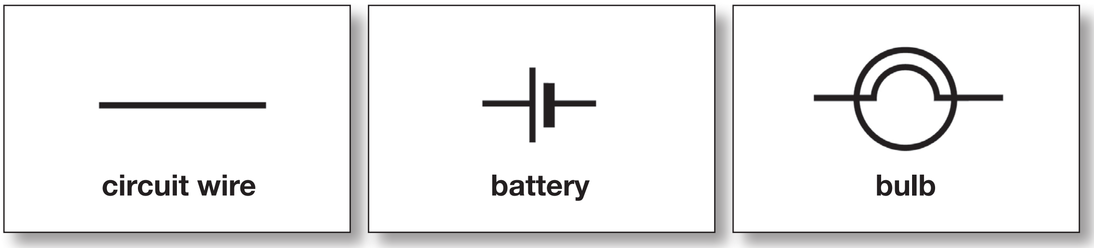
**Why do we use a circuit diagram?**

We use a **circuit diagram** to represent an electric circuit as a picture.

**What does a circuit diagram include?**

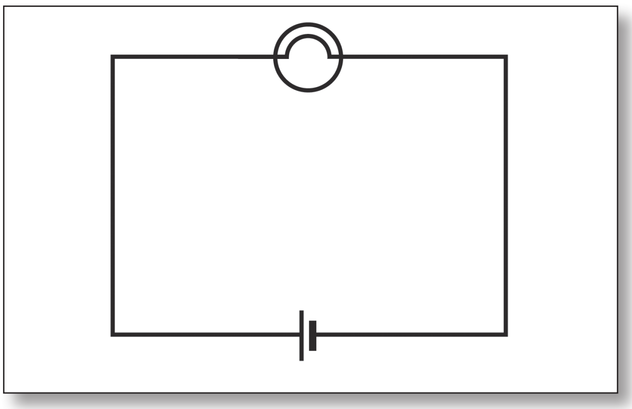
A **circuit diagram** includes standard symbols to represent the components of the electrical circuit and shows their position in the circuit.






**Standard electrical symbols**

**16** Ask students to select one of the drawings of a circuit that they recorded in the 'PROE record: Lighting up my life' (Resource sheet 1) and represent it in their science journals as a circuit diagram using electrical symbols. Ask students to include a record of their ideas about the path of electrical energy as it travels around the circuit and through each of the components of the circuit.



**Sample circuit diagram (wire, battery, light bulb)**

**17** Ask students to review their cutaway diagram of how a torch could work from Lesson 1 and update or redraw this diagram to include what they now know, such as names/symbols of parts and the need for a complete circuit for the torch to light.

If students still hold non-scientific ideas of how a circuit works (see 'Teacher background information'), ask questions, such as:

- Why do you think that?
- Well, if that is right, what about…?
- What do you think about…?
- Could you tell me more about…?

**18** Update the class science chat-board by adding pictures, questions, ideas, findings and reflections including electrical symbols, and add new words to the keywords section.

## Curriculum links

**Mathematics**

- Systematically explore how to increase the brightness of the bulb. Generalise the relationship between the number of batteries and the brightness.

**Technology**

- Invite an electrician to visit the class to talk about how circuit diagrams are used in the workplace.

**Information and Communication Technology (ICT)**

- Use an interactive whiteboard or online web resources to construct circuit diagrams.

**Indigenous perspectives**

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

EXPLORE

# PROE record: Lighting up my life

**Name:** ______________________ **Date:** ______________

**Other members of your team:** ______________________________

Your team's task is to explore how to light up a light bulb using a battery and one or two wires. Draw your predictions and then record your reasons, observations and explanations on this record sheet using writing and drawings.

| | |
|---|---|
| **Predict**<br>Draw how you could connect the equipment. | |
| **Reason**<br>Why do you think it will work? | |
| **Observe**<br>What happened? What did you see? | |
| **Explain**<br>Did the results fit the prediction? Why do you think that is? | |

# Folded foil wires

**Team members' names:**________________________________ **Date:**____________________

Folded strips of aluminium foil can replace wires, switches, light bulb contacts and connecting points for batteries. Folded foil wires can be used easily to form right-angle turns that can lie flat, making it easier to follow the path of the electrical current.

Foil can bend and tear easily and is difficult to handle when trying to make contact with a battery. It can also break if bent too often in the one place.

## Aim

To make folded strips of aluminium foil to use as wires, switches, light bulb contacts and connecting points for batteries.

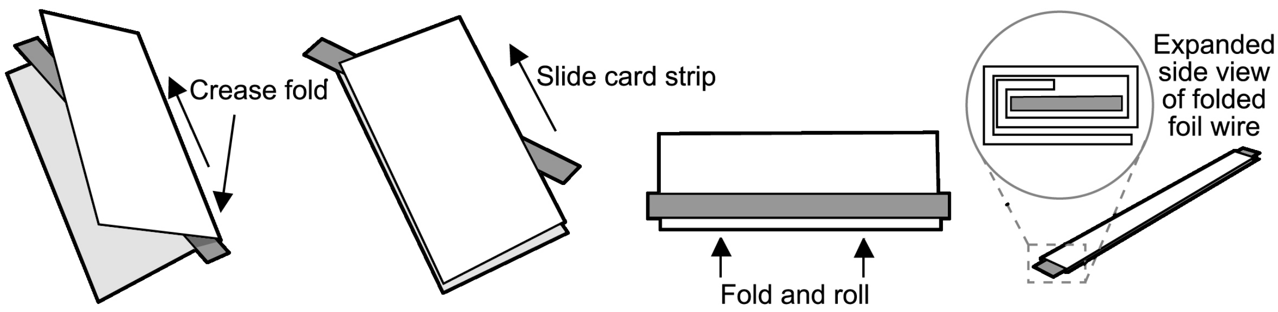
## Equipment

- thin cardboard strips (1 cm x 30 cm)
- foil pieces (8 cm x 30 cm)

## Procedure

Follow the instructions below to fold the foil wires. The cardboard strip can act as a foil cutter and a rolling guide.

1. Lie the cardboard strip along the long edge of a piece of foil.
2. Fold the foil around the strip forming a flat ribbon.
3. Pull out the cardboard strip. Repeat with the other pieces of foil.




The 30 cm-long folded foil wires can be cut or torn to size. Shorter pieces can be used to make battery-connecting points and switches.

# Lesson 3 Light bulb explorers

**AT A GLANCE**

To provide students with hands-on, shared experiences of the structure of a light bulb.

Students:

- draw a light bulb from memory
- draw a light bulb from observation
- read about and complete a labelled diagram of a light bulb.

EXPLORE

## Lesson focus

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

## Assessment focus

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

- the structure and function of a light bulb and how it connects to an electric circuit.
- scientific understandings that can solve problems that directly affect peoples lives, for example, the light bulb.

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

# Key lesson outcomes

### Science

Students will be able to:

- describe the structure of a light bulb
- label the parts of a light bulb
- explain the function of each part of a light bulb.

### Literacy

Students will be able to:

- create a labelled diagram of a light bulb
- interpret a factual text about light bulbs
- use oral language to represent scientific ideas about electrical energy
- contribute to the construction of a class diagram of how a light bulb works.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).



# Teacher background information

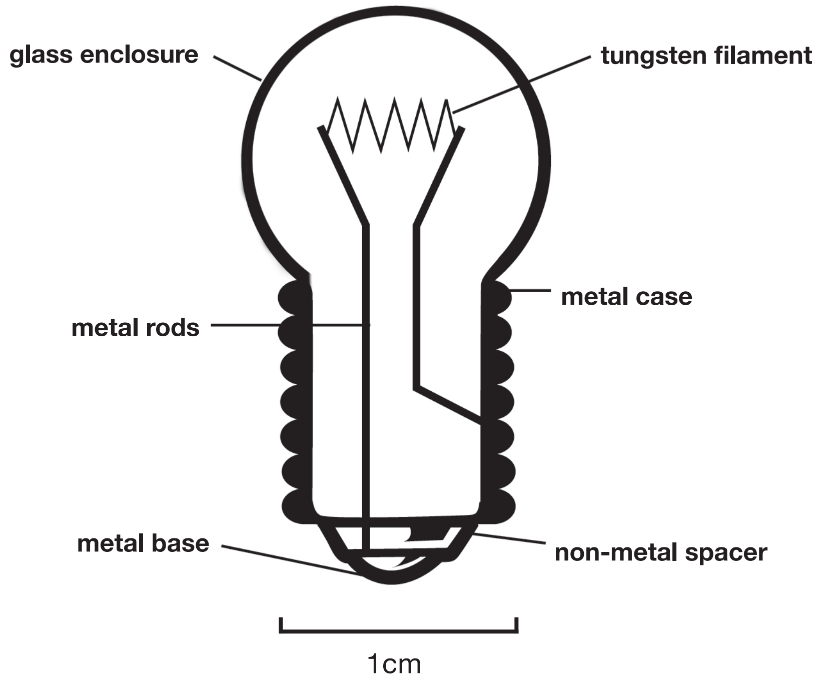
The student resource sheet in this lesson provides useful teacher background information about the structure of incandescent light bulbs. Incandescent light bulbs generate light by heating a tungsten filament. Fluorescent light bulbs generate light by exciting a gas present in the tube, hence, students will not see how they work by examining them with a hand lens. Fluorescent light bulbs are called energy-saving bulbs because they use less energy than incandescent bulbs. This is because more of the electrical energy entering a fluorescent light bulb is converted into light, whereas incandescent light bulbs convert most of the electrical energy into heat.

**Note:** Household incandescent light bulbs are being phased out of home use. Many other forms of incandescent light bulbs will remain available, such as car light bulbs and torch light bulbs.

## Students' conceptions

Students might have non-scientific ideas about the connection points on light bulbs and batteries. They might not understand that there must be two different connection points on the light bulb. This is necessary to make a circuit that works, as in the last lesson. There needs to be a continuous path or circuit for electrons to move along.

To understand why a light bulb needs two connection points, students can examine the diagram of a light bulb. The electrons flow into the wire from the side of the light bulb, through the wire to the tungsten filament and then down and out of the base of the light bulb.




**A light bulb**

## Equipment

### FOR THE CLASS

- class science journal
- class science chat-board
- team roles chart
- team skills chart
- *optional:* collection of light bulbs of different sizes and shapes
- 1 enlarged copy of 'Inside a light bulb' (Resource sheet 3)
- dictionaries (eg, hardcopy or online)

### FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 light bulb (eg, 1.5 V bulb)
- 1 magnifying glass or hand lens
- 1 copy of 'Inside a light bulb' (Resource sheet 3) for each team member

## Preparation

- Prepare an enlarged copy of 'Inside a light bulb' (Resource sheet 3).
- *Optional:* Display the enlarged copy of 'Inside a light bulb' (Resource sheet 3) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

## Lesson steps

1 Review the last lesson and remind students of what they learned about electric circuits and how to draw and label an electric circuit.

Review the class science chat-board and discuss interesting ideas or questions that have been contributed.

2 Explain that this lesson will focus on exploring light bulbs. Brainstorm places and items that use light bulbs. For example, household room lighting, streetlights, vehicle indicator lights, traffic lights and airport runway lights.

3 Ask students to imagine and draw a light bulb in their science journals. Ask them to label it with any information they currently know, such as the names of different parts and the materials used. Discuss the features and purpose of a labelled diagram.

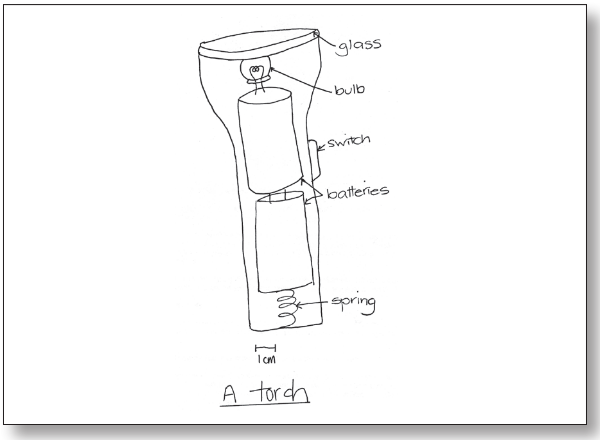
### Literacy focus

**Why do we use a labelled diagram?**

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

**What does a labelled diagram include?**

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




**Student work sample of a labelled diagram**

Model how to draw a scale that is a horizontal line with a bar at each end, placed under the diagram with the size, for example, 1cm, written under the line.

4 After students have completed their initial diagram, explain that they will be working in teams to explore and record observations of a light bulb. Explain that students might like to add to or change their first diagram using a different colour, or they might like to start a new diagram.

**Note:** Do not use fluorescent light bulbs as they do not have a filament. Do not put the bulbs in holders as the students will not be able to see where the connections occur on the bulb.

Model how to use a magnifying glass or hand lens to look closely at the inside of a light bulb.

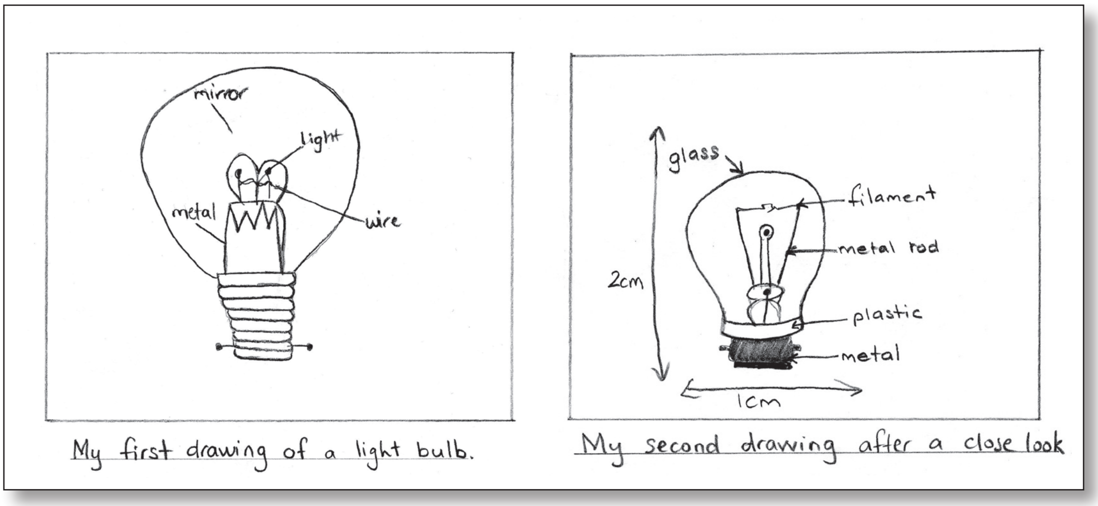
**Note:** When using a hand lens, hold it close to the eye without touching the face. Then hold the object in front of the lens and move the object forwards and backwards until there is a clear, focused image.

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

**6** After teams have completed their observations and drawings, ask them to share their findings about the light bulb. Ask students to compare the drawing of the light bulb they did from memory with the one they did from observation, and discuss the differences. Discuss the importance of observation in scientists' work.

Encourage students to discuss some of their findings by asking questions, such as:

- What have you noticed about the light bulb?
- Why do you think the filament is that shape?
- What do you think the filament is made of?
- Where do you think the light bulb connects to the circuit?




**Student work sample before a close look and after a close look at a light bulb**

**7** Introduce an enlarged copy of 'Inside a light bulb' (Resource sheet 3). Explain that students will read it with their teams and complete the labelling activity. Ask students to mark, for example, highlight or underline, any interesting or unfamiliar vocabulary as they are reading the text.

**8** After teams have read the text and labelled the diagram of the light bulb, use student suggestions to label the diagram on an enlarged copy of 'Inside a light bulb' (Resource sheet 3) in the class science journal. Ask students to check that they have labelled their diagram correctly.

**9** Compile a class list of the interesting or unfamiliar words that students marked in the text of 'Inside a light bulb' (Resource sheet 3).

Discuss the words and record students' suggestions about how to describe them.

Organise for teams or individual students to use student dictionaries to locate the meaning of the marked vocabulary. Share meanings and record the new words and descriptions on the keywords section of the class science chat-board.

10 Discuss the students' ideas in relation to their findings. Ask questions, such as:

- Why does the filament have the shape it does? (To increase the length of the filament. This increases resistance, which causes the filament to heat and produce light.)
- What is the filament made of? (Tungsten.)
- Why are there two different connection points? (For electrons to enter and leave the bulb, to create a circuit.)

11 Update the class science chat-board by adding pictures, questions, ideas, findings and reflections and add new words to the keywords section.

## Curriculum links

**Science**

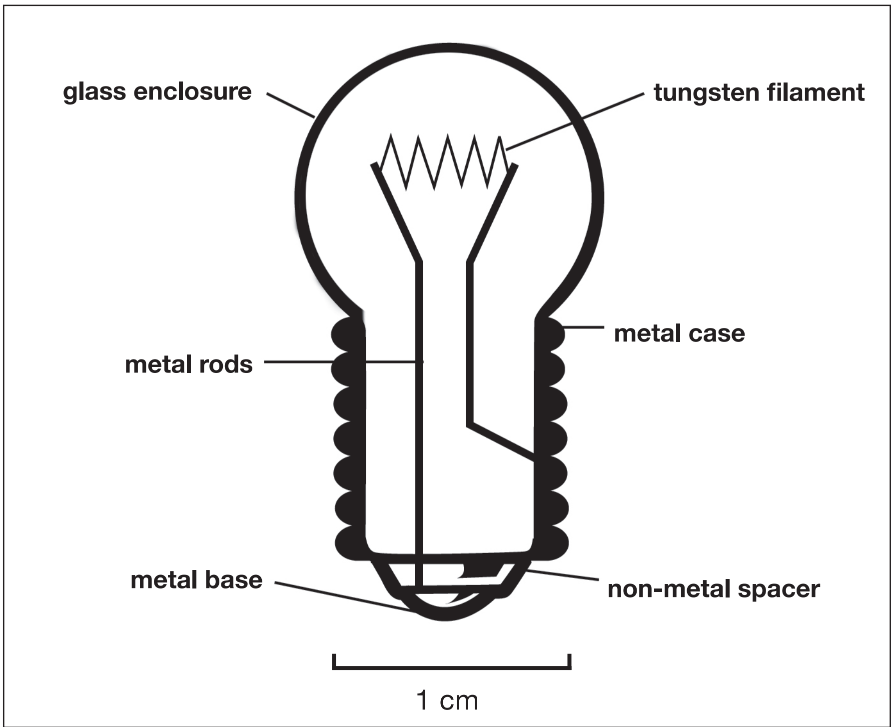
- Obtain a set of different-shaped bulbs. Draw diagrams of these bulbs and establish the similarities and differences between the bulbs. For example, do all bulbs have the same components? Are the components in the same location?

**Indigenous perspectives**

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

# Inside a light bulb

**Name:** ______________________ **Date:** ______________________




**A light bulb**

Inside a light bulb, there is a wire filament, which is often made of the metal tungsten. The filament looks like a spring. It is attached to two metal rods.

One of these rods is connected to the threaded outer metal case. The other rod is connected to the shiny metal part on the base of the light bulb. A non-metal spacer, which does not conduct electricity, separates the two connection points.

When electrical energy flows through it, the filament heats up to more than 2,000° C. The flow of electrical energy through the filament heats the wire and causes it to glow white-hot and give out a bright light. The heat from the filament warms the light bulb's glass to temperatures that can burn a hand brought too close.

You'd think that being so hot the metal would burn up, however, fire needs oxygen—that's why you can smother some fires and they go out. The bulbs are filled with nitrogen or neon gas, which means there is no oxygen in the bulb. This allows the filament to glow, without burning, for hundreds of hours.

SAFETY

**SAFETY NOTE:** In this activity, the light bulbs are low-voltage bulbs that are safe to touch. Never touch household light bulbs when they are switched on as they are very hot.

**Complete the labelled diagram of a light bulb with the following labels:**

| | | |
|---|---|---|
| **glass enclosure** | **metal case** | **non-metal spacer** |
| **metal base** | **tungsten filament** | **metal rods** |

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# Lesson 4 Alessandro Volta: Battery maker



**AT A GLANCE**

To provide students with hands-on, shared experiences of exploring the role of Alessandro Volta in the development of the first battery.

Students:

- read and discuss a biography of Alessandro Volta
- discuss the way scientists develop and change their ideas
- represent their ideas about the biography.

## Lesson focus

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

## Assessment focus

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

- how electrical circuits provide a means of transferring electricity.
- the historical development of batteries based on the work of Alessandro Volta.
- how scientists pose questions and gather evidence to develop explanations.

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

# Key lesson outcomes

**Science**

Students will be able to:

- identify some ways that scientists think and work
- understand that scientific explanations develop historically through the contribution of ideas from many scientists
- understand that scientific explanations are revised as new evidence emerges.

**Literacy**

Students will be able to:

- understand the purpose and features of a biography
- discuss how scientific knowledge develops
- represent an understanding of this biography in a chronological list, role-play or researched multimedia presentation.



This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

# Teacher background information

## How scientists think and work

Scientific knowledge is a set of explanations made by scientists based on observations and evidence. These explanations have been built up over time in an attempt to explain how the world works and continue to be revised as new evidence emerges.

Scientists conduct experiments in order to test ideas and find evidence; however, the conclusions and explanations drawn from the evidence can be influenced by the life experiences and beliefs of the scientists. Scientists are a part of the world they study and their ideas can be influenced by it.

When scientists disagree, they first check the available information. In scientific publications, the authors highlight their experimental procedure so that the experiments can be replicated. Scientific debate is, however, generally about what conclusions can be drawn from the available evidence. The example given in this unit is the debate between Luigi Galvani (1737–1798) and Alessandro Volta (1745–1827) about the existence and nature of 'animal electricity' (see 'Resource sheet 4'). Galvani made a frog's leg twitch with static electricity. When he saw a leg twitch under his scalpel without applying electricity, he concluded that frogs' legs must produce electricity. Volta correctly pointed out that the dismembered frog's leg did not produce electricity, and conducted experiments that showed that the electricity was produced due to the contact of two different metals in solution. Volta's refusal to believe in animal electricity was, however, incorrect. The nerves of a living animal produce electric current to make muscles contract—that is why the legs were contracting when a weak current went through them. The disagreement between Galvani and Volta led their followers to design very different experiments, leading to the advancement of knowledge of electricity and nerve fibres.

## Batteries

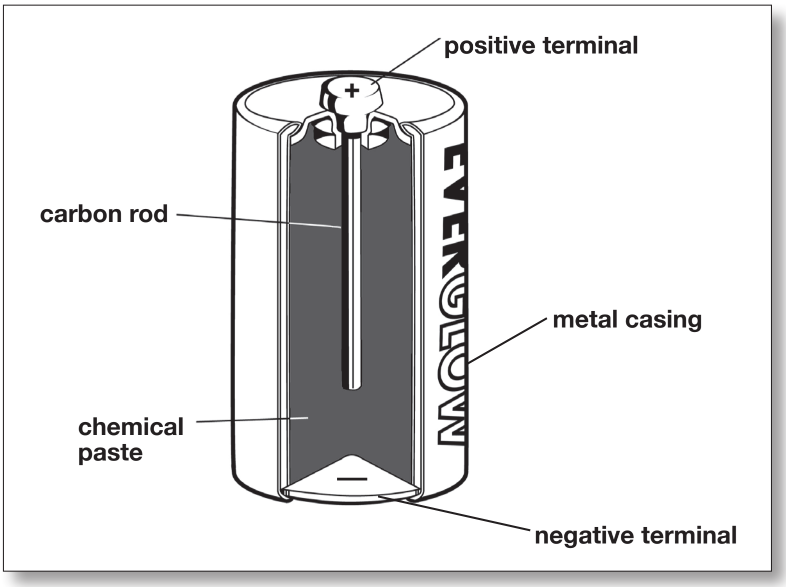
A battery is a device that stores chemical energy and makes it available in electrical form. Alessandro Volta's original cell battery, the voltaic pile, was developed in 1799. A voltaic pile is made of discs of two different metals, for example, copper and zinc, separated with cloth soaked in a chemical solution. Volta's battery was the first continuous and reproducible source of an electrical current.

Modern torch batteries are similar to Volta's original battery. They are called 'dry-cell' batteries. Dry-cell batteries are made from two materials separated by a moist chemical paste—so they are not really dry! One of the materials forms the positive terminal of the battery; the negative terminal is made from the other material and the moist paste fills the space between the two.

The chemicals in the paste take the electrons from the positive terminal—the carbon rod—and give them to the negative terminal, which is made out of a metal called zinc. When the battery is connected to a complete circuit, the electrons flow from the negative terminal through the wires of the circuit outside the battery and back to the positive terminal.

Energy in the battery chemicals is used to move the electrons to the negative terminal of the battery when there is a circuit. This energy pushes the electrons around the circuit by giving them electrical energy. The electrical energy is carried by the electrons to the bulb in the circuit. The bulb transforms the electrical energy into light and heat energy.






**Cutaway diagram of a battery**

As the chemicals (mainly the zinc in the negative terminal) are used up, there is less energy available and the push given to the electrons decreases. When the push becomes too low, there is no longer enough electrical energy transported and the bulb doesn't light. When this happens, we say the battery is flat.

The voltage of the battery is the amount of energy (or 'push') that the battery can generate and give to the electrons. The larger the voltage or the number of volts, the larger the capacity to energise electrons in a circuit.

SAFETY

Do not cut up lithium, alkaline or hydride batteries as this can be quite dangerous.

# Equipment

## FOR THE CLASS

- class science journal
- class science chat-board
- collection of batteries of different sizes and voltages (eg, 1.5 V battery, watch battery, large torch battery such as a D size)
- 1 enlarged copy of 'Alessandro Volta: Battery maker' (Resource sheet 4)

## FOR EACH STUDENT

- science journal
- 1 copy of 'Alessandro Volta: Battery maker' (Resource sheet 4)
- *optional:* 1 copy of 'Chronological list: Alessandro Volta' (Resource sheet 5)

# Preparation

- Prepare an enlarged copy of 'Alessandro Volta: Battery maker' (Resource sheet 4).
- Read the biography of 'Alessandro Volta: Battery maker' (Resource sheet 4) and decide how it will be read by your class, for example, as an independent reading task, in teams or in guided reading groups (see Lesson step 5).
- Select an activity or provide students with the opportunity to select an activity from the options listed in Lesson step 9 for the use of the biography of 'Alessandro Volta: Battery maker' (Resource sheet 4).
- *Optional:* Display the enlarged copy of 'Alessandro Volta: Battery maker' (Resource sheet 4) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.primaryconnections.org.au

# Lesson steps

1. Review students' exploration of battery-operated devices from Lesson 1, and their exploration of electric circuits in the other previous lessons.

   Review the class science chat-board and discuss some of the ideas or questions that have been contributed.

2. Introduce various batteries and ask students to identify differences in the battery sizes and labelled voltages. Ask students to suggest what 'V' or 'volts' could represent, and record students' ideas in the class science journal. Ask students if they know any information about the history of the battery, and record it in the class science journal.

   *Optional:* Record the characteristics of each of these batteries in a table.

3. Explain that students will read a biography to find out about a person who made an important contribution to the development of the battery. Introduce an enlarged copy of the biography of 'Alessandro Volta: Battery maker' (Resource sheet 4).

   Ask students to share their ideas about biographies and what they are used for.
   Ask questions, such as:

- What features could we find in this biography? (For example, dates, people's names, use of past tense.)
- Who usually writes such texts? (For example, adventure writers, historians.)
- What evidence does the author have to show that this is a true representation of the person's life? (For example, are they a friend, a relative or a historian?)
- Why are such texts written? (For example, to create a record of someone's life.)
- Why has the author used a cartoon for this biography? (For example, to make it more appealing, to give us images to help us understand what we are reading.)
- Does the cartoon make the biography more or less believable? (For example, many cartoons are used for entertainment not for information.)

Discuss the purpose and features of a biography.

### Literacy focus

**Why do we use a biography?**

We use a **biography** to describe events in a person's life. We can read a **biography** to find out about what a person did.

**What does a biography include?**

A **biography** includes a title, dates and descriptions of the person's achievements. The events are usually listed in the order they occurred and include the person's contribution to society.



**4** Ask students to predict vocabulary that they could read in the text, such as 'Volta', 'battery' or 'history'. Record suggestions in the class science journal.

**5** Organise students to read the biography of 'Alessandro Volta: Battery maker' (Resource sheet 4) (see 'Preparation' for suggestions of how to organise the reading task).

**6** After reading the biography of 'Alessandro Volta: Battery maker' (Resource sheet 4), review students' predictions about the vocabulary and language features of the text. Review any predictions about the use of the word 'volt' in the history of the battery.

**Note:** Explanation of the word 'volt' will occur in the *Explain* lesson. At this stage, focus discussion on Volta's life history.

**7** Discuss what the biography of 'Alessandro Volta: Battery maker' (Resource sheet 4) suggests about the ways that scientists make or change their ideas. Ask questions, such as:

- Why did the scientists disagree?
- What was the first thing Volta did when he disagreed with Galvani? Why?
- Did either of them change their ideas? Did they change other people's ideas?
- What could have happened if Volta had agreed with Galvani?

**8** Support students to reflect critically on the biography, using questions, such as:

- Do you think this cartoon is reliable?
- Can we trust the information? Why?
- Who do you think could have written it? Why?

EXPLORE

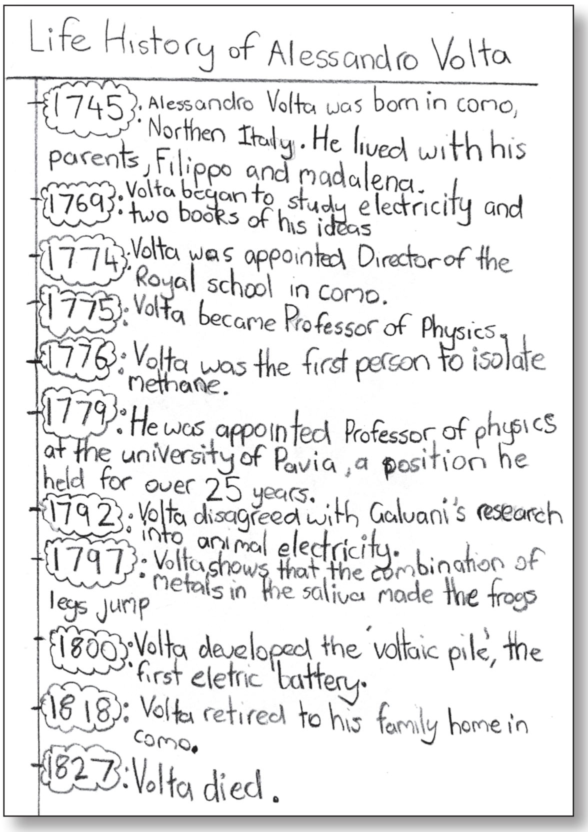
**9** Organise students to complete one or more of the suggestions below for using the biography of 'Alessandro Volta: Battery maker' (Resource sheet 4).

- Create a chronological list to represent significant events in Volta's life, for example, using 'Chronological list: Alessandro Volta' (Resource sheet 5).

Ask students to consider why the events are significant.

> ### Literacy focus
>
> **Why do we use a chronological list?**
>
> We use a **chronological list** to summarise a series of events in the order they happened.
>
> **What does a chronological list include?**
>
> A **chronological list** includes a title, the date of each event and a description of each event.

- Work in teams to role-play an interview with Volta, for example, with one student in character as Volta and others as interviewers.
- Ask students to play the role of Galvani or Volta in a debate about who is correct.



Life History of Alessandro Volta

1745: Alessandro Volta was born in como, Northen Italy. He lived with his parents, Filippo and madalena.

1769: Volta began to study electricity and two books of his ideas

1774: Volta was appointed Director of the Royal school in como.

1775: Volta became Professor of Physics.

1776: Volta was the first person to isolate methane.

1779: He was appointed Professor of physics at the university of Pavia, a position he held for over 25 years.

1792: Volta disagreed with Galvani's research into animal electricity.

1797: Volta shows that the combination of metals in the saliva made the frogs legs jump

1800: Volta developed the 'voltaic pile', the first eletric battery.

1818: Volta retired to his family home in como.

1827: Volta died.

**Student work sample of a chronological list**

- Explore perceptions of scientists and their contributions to the development of ideas in science. Explain that students have only four words to describe a scientist, for example, Alessandro Volta. Ask them to draw a scientist and record four words in their science journals. Use the Think/Pair/Share strategy:

**Think/Pair/Share**

**Think:** Students think individually about four words they would use to describe a scientist.

**Pair:** Each student discusses their ideas with a partner.

**Share:** Each pair shares their ideas with the class.

- Ask students to use their science journals to record their ideas about the importance of Volta in the history of science and electricity.
- Research further information about Volta and create a multimedia presentation about his life and research.

**10** Update the class science chat-board by adding pictures, questions, ideas, findings and reflections and add new words to the keywords section.

**11** Introduce a new heading on the class science chat-board—'Batteries'—and ask students to explore their homes to identify battery-operated devices. Ask students to add their findings, including images of devices and batteries from catalogues or magazines, to the class science chat-board.



## Curriculum links

**Science**

- Research and read about other scientists who have contributed to the history of electricity, such as Luigi Galvani and Thomas Edison (inventor of the light bulb).

**English**

- Critically analyse texts to determine their reliability and veracity. Use a variety of texts on the same topic. Include recounts/reports from newspapers, science magazines and the internet. Ask different groups to review different texts on the same topic. Students then determine criteria for considering the reliability of the text, such as source type, author/reporter, depth of data, tone of language, bibliography, well-supported opinions, illustration type and clarity.

**Mathematics**

- Create timelines taking time scale into account. For example, the distance between two dates 10 years apart should be 10 times that between two dates one year apart.

**Visual Arts**

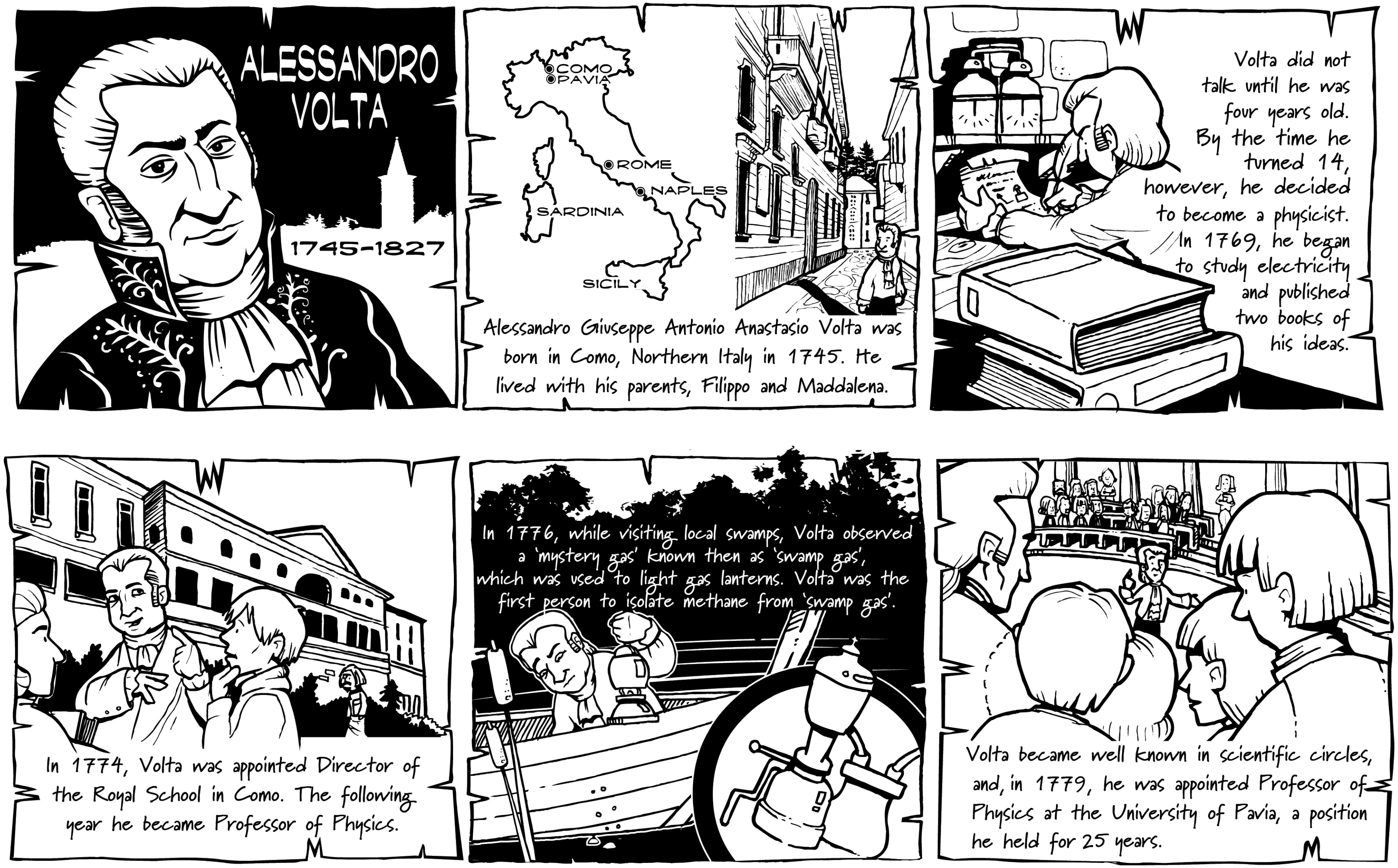
- Create cartoons, such as 'Electrifying Energy' or 'Circuit Capers', to convey messages about how scientists work.

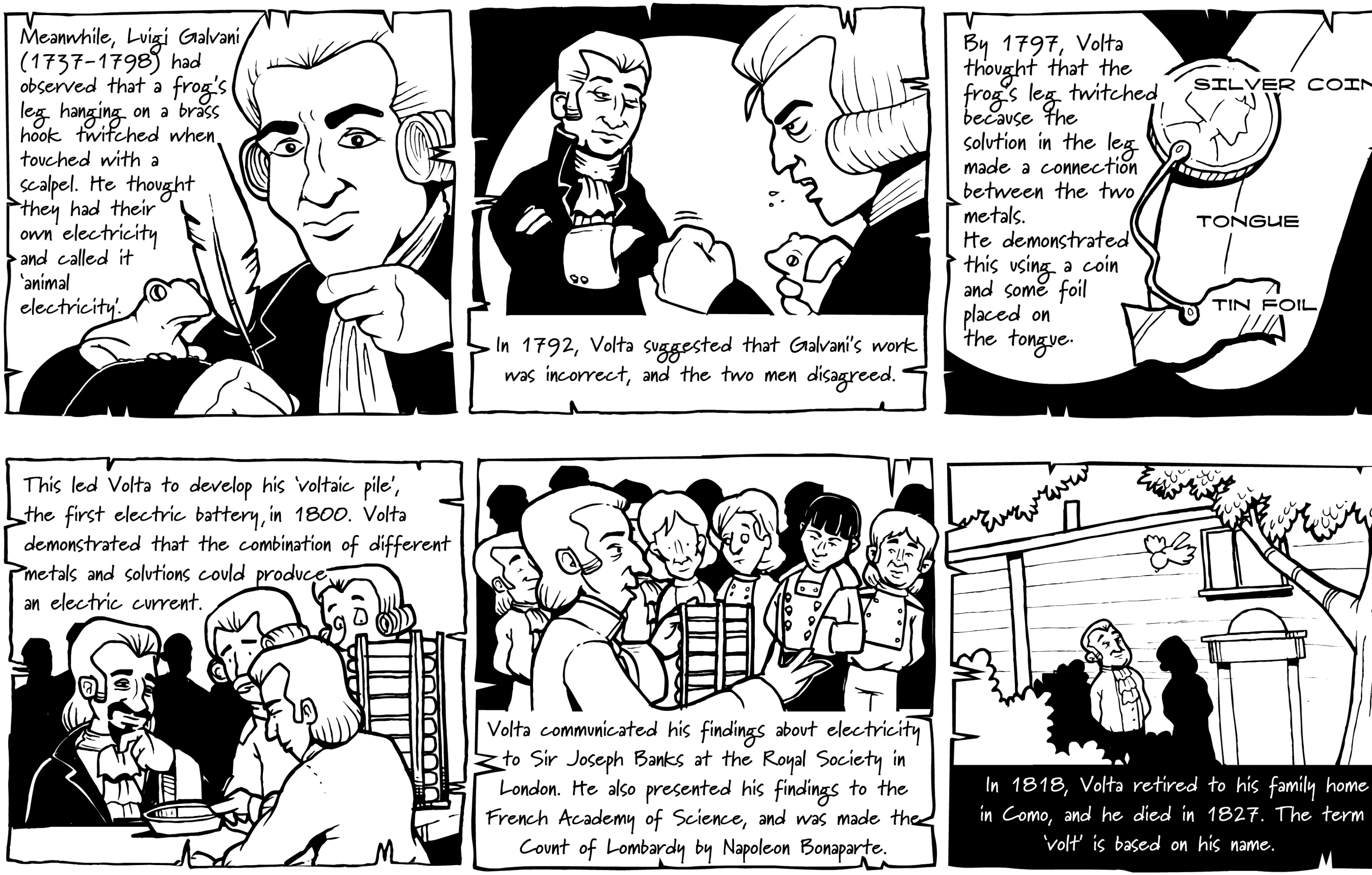
**Indigenous perspectives**

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

# Alessandro Volta: Battery maker

**Name:** ______________________ **Date:** ____________



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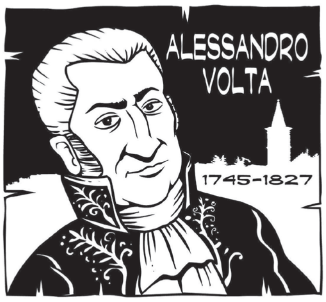
# Chronological list: Alessandro Volta

**Name:** ______________________ **Date:** ______________________




## Life history of Alessandro Volta

Use the information from 'Alessandro Volta: Battery maker' (Resource sheet 4) to record the significant events in Volta's life in a chronological list.

**Alessandro Volta lived from 1745 to 1827. The term 'volt' was based on his name.**

**1745**

**1769**

**1774**

**1776**

**1779**

**1797**

**1800**

**1818**

**1827**

 ISBN 978 0 85847 317 1

# Lesson 5 Enacting electrons

## AT A GLANCE

To support students to represent and explain their understanding of electric circuits, and to introduce current scientific views.

Students:

- participate in a whole-class role-play of an electric circuit
- discuss the role of the components of an electric circuit
- represent their understanding using a circuit diagram.

## Lesson focus

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

EXPLAIN

## Assessment focus

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

- how electrical circuits provide a means of transferring electrical energy to devices that then transform it.
- that energy stored in batteries can be used to generate electrical energy in a circuit.

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

# Key lesson outcomes

**Science**

Students will be able to:

- describe the components of a complete circuit
- identify the source of electrical energy in a circuit
- explain the role of electrons in carrying electrical energy around a circuit
- explain that electrical energy is changed into light energy by the bulb.

**Literacy**

Students will be able to:

- show understanding of how a circuit works through participation in a role-play and discussion
- represent their understanding through drawing an annotated diagram of a circuit
- use scientific vocabulary appropriately in writing and talking.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

# Teacher background information

All materials are made of atoms and electrons. Electrons are very small, negatively charged particles that form the outside part of atoms. The battery provides the push that makes the electrons move around a circuit. The battery voltage is the measure of the ability of the battery to push the electrons around a circuit. The electrons are already in the wire and the other components of the circuit, and are free to move in the copper and some other metals. A battery contains chemicals. When these chemicals react, they release energy, which is used to push many electrons to the negative terminal of the battery. From here, they are pushed around the circuit to a device, such as a light bulb, bell, buzzer or motor, to the positive terminal of the battery and back to the negative terminal. By this process, the chemical energy of the battery is changed (transformed) into electrical energy, which is carried around the circuit by the electrons to the light bulb, bell, buzzer or motor. When it gets to the device, the electrical energy is changed into another form of energy, such as light, sound, heat or movement. When all the chemicals in the battery have reacted, the battery loses its ability to generate electrical energy, the rate of electron flow is greatly reduced and the battery is called 'flat'. Energy is not produced from nothing, nor is it consumed, nor does it disappear into nothing. In this case, the chemical energy is transformed into electrical energy, which is in turn transformed into light, heat, sound or movement energy.

The chemical energy of the battery can be released as electrical energy only when the battery is connected into a circuit. In a completed circuit, the electrons flow continuously in one direction from one point of the battery (the negative terminal) to another (the positive terminal). The chemical reaction occurs—rather slowly—even when a circuit is not connected. This accounts for the indefinite 'shelf life' of batteries.

## Equipment

| FOR THE CLASS | FOR EACH STUDENT |
|---|---|
| • class science journal<br>• class science chat-board<br>• 1 decorated container (eg, a bucket decorated with tinsel, cellophane or crepe paper) for the 'bulb'<br>• 50–60 (twice as many as the number of students) packets of energy (eg, pegs, counters) | • science journal |

## Preparation

- Locate an area with enough space for students to move around safely during the role-play activity. This might need to be outside the classroom.

EXPLAIN

## Lesson steps

1 Review the unit using the class science journal and the class science chat-board. Discuss what students have investigated about electric circuits.

2 Explain that in this lesson students will participate in a whole-class role-play to represent what happens in an electric circuit. Brainstorm what will be represented in the role-play, for example, battery, bulb, wires, and what equipment would help the representation. Explain that each student will take part in the simulation of the circuit.

Explain the purpose and features of a role-play and discuss the equipment that could be used to show this, such as:

- The decorated bucket could represent… (The light bulb.)
- What formation will we need to make? (An oval or circle.)
- To represent the battery and the bulb, one student could… (Sit on a chair.)

### Literacy focus

**Why do we use a role-play?**

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

**What does a role-play include?**

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

Ask the students to organise themselves into an oval shape.

*Optional:* Mark out an oval using chalk or a long rope.

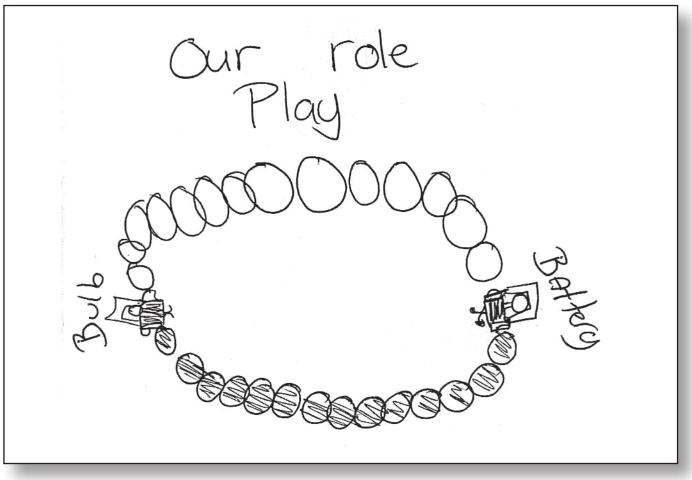
Place a chair at each end of the oval. Position the same number of students between the chairs on each side of the oval. An even distribution of numbers will help students see that the electric current is constant around the circuit.

Ask two students to be seated in the chairs, and explain that one seated student represents a 'battery' and the other represents a 'bulb'.

*Optional:* Provide the battery student with a hat labelled 'battery' and the bulb student with a hat labelled 'bulb'.

**3** Discuss what name could be given to the path to be taken by the students who are standing in the circuit representing the wire, which has the electrons in it, for example, 'wires'. Explain that within the wires, there are particles called 'electrons' and the role of each of the standing students is to be an 'electron'.

Explain that the electrons can carry electrical energy around the circuit. Discuss where the electrical energy will be sourced from (the battery) and where it will travel to (the bulb). Give the decorated container to the bulb student.




**Student representation of the role-play**

**4** Introduce the packets of energy, such as pegs or counters, that the 'battery' will provide to the 'electrons'. Discuss how the 'electrons' will carry the packets of energy to the 'bulb' and how the 'bulb' will transform the energy into heat and light when the 'electrons' drop the energy packets into the 'bulb's' container.

SAFETY

Discuss the need for the electron students to walk slowly around the circuit without pushing or overtaking other 'electrons'.

**5** Begin the simulation by asking the 'battery' to give the first 'electron' a packet of energy and signalling to all of the 'electrons' to start moving in a clockwise direction. All the 'electrons' move at once. Provide the 'battery' with enough packets of energy so that each 'electron' can complete two laps of the circuit.

**6** As the 'electrons' pass by the 'battery', the 'electrons' take one packet of energy, which they carry to the 'bulb'. As they pass the 'bulb', the 'electrons' drop their energy packets into the 'bulb's' container. The student simulating the bulb can then shake the decorated container to represent energy being transformed into light and heat as the packets of energy are dropped in.



EXPLAIN

7 After dropping off their energy packets, the 'electrons' continue to move and return to the 'battery' to pick up another energy packet. When the last packet of energy has been given to an 'electron', ask the 'electrons' to stop moving and sit down where they are. Without further energy from the battery to 'push' the electrons around the circuit, they all stop moving.

8 Discuss the simulation and each of the roles of the battery, electrons and bulb, for example:

- The **battery** contains chemicals, which possess chemical energy. When the chemicals react with each other, they generate electrical energy. The battery is the source of electrical energy and provides the 'push' to make the electrons move.
- The **electrons** carry the electrical energy from the battery to the bulb—this is energy transfer.
- The **bulb** changes the electrical energy into light and heat energy—this is energy transformation.

Review students' observations of the 'V' symbol on batteries and the biography of Alessandro Volta. Explain that 'voltage' is a measure of the push and is recorded in 'volts', which are represented by the letter 'V'. The larger the number of volts, the larger is the push the battery can provide.

Discuss the terms 'transfer' and 'transform'.

Discuss the way that the electrons move in a stream and are not used up.

Ask students to note that there is the same number of electrons (students) at the beginning as there is at the end of the simulation.

9 Discuss what happened when the battery used up all its packets of energy, for example, the chemicals in the battery were used up and could not generate any more electrical energy or 'push', so the battery ran out of energy packets to give to the electrons and the electrons stopped moving. No electrons flowed through the bulb to provide energy, so the bulb did not light up.

10 Discuss the limitations of this role-play, for example, the packets of energy do not accumulate in the bulb, but are changed (transformed) into light and heat, which travel away from the bulb. Discuss that it can be difficult to represent all the elements of a phenomenon through a role-play.

11 Count the number of energy packets given to the battery and then repeat the simulation and discuss questions, such as:

- How many connection points are there on the bulb? (Two.) Why? (One for electrons to enter and one for electrons to leave the bulb.)
- How many connection points are there on the battery? (Two.) Why? (One for electrons to leave the battery and one for them to re-enter.)
- Why are there two wires? (To connect the connection points of the battery and bulb, creating a circuit.) A circuit can be created with just one wire, as seen in Lesson 2.
- What is the energy source? (The battery.)

- Where does the ‘push’ come from to move the electrons? (A chemical reaction in the battery.)
- What happens to the electrical energy when it gets to the bulb? (It is transformed into light and heat.)

**12** Count the number of energy packets at the end of the simulation and note that the number is the same as that given to the battery at the beginning. Explain that no electrons have been used up; rather, the chemical energy of the battery has been transformed into electrical energy, which moves the electrons. The electrons move through the circuit, lighting the bulb before returning to the battery. Eventually, the chemicals in the battery will be used up and the bulb will not glow because there is no more chemical reaction to make the electrons move.

**13** Model how to draw an annotated diagram and explain the purpose and features of an annotated diagram.

## Literacy focus

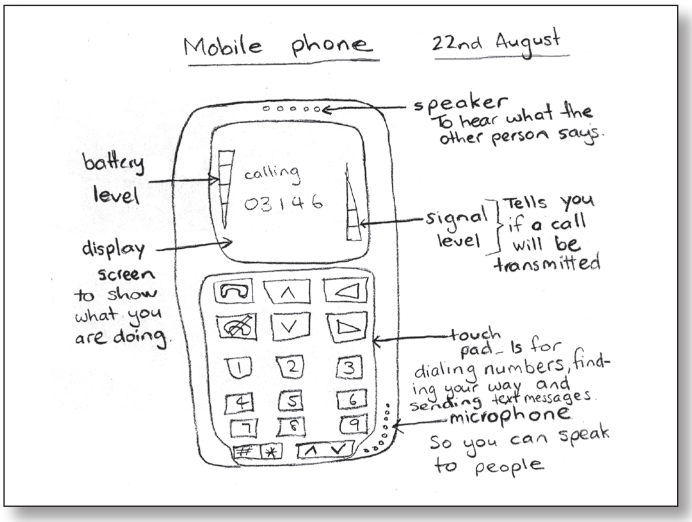
**Why do we use an annotated diagram?**

We use an **annotated diagram** to show the parts of an object and what they do.

**What does an annotated diagram include?**

An **annotated diagram** might include an accurate drawing, a title, a date and a few words about each of the parts. A line or arrow joins the words to the part.






**Sample annotated diagram**

**14** Ask students to draw an annotated diagram of the role-play in their science journals and to annotate their representation of the role-play to explain what happens in each part of the circuit.

Carefully monitor students’ diagrams and annotations. Challenge students who have retained non-scientific ideas with probing questions, such as:

- Could you tell me more about that?
- What do you mean by that?

- Tell me more about your description of the word… (circuit)?
- What about when we…?
- Scientists have found that… How does that fit with your idea?

**15** When students have completed their diagrams and annotations, ask them to share their representations and develop a class circuit diagram with annotations. Ask students to review their diagrams and discuss ways of improving them. Students could then make their changes using a different-coloured pencil.

**16** Update the class science chat-board by adding pictures, questions, ideas, findings and reflections and add new words to the keywords section.

## Curriculum links

### Science

- Draw a series of action diagrams of the role-play, for example, depicting the bulb unlit, then lit.

### Indigenous perspectives

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

# Lesson 6 Problem solvers: What's it all about?

**AT A GLANCE**

To support students to plan and conduct an investigation of conductors and insulators.

Students:

- formulate a question for investigation
- construct a circuit and test their question for investigation
- observe, record and share results
- discuss materials that conduct electrical energy.

## 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 skills.

## Assessment focus

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

ELABORATE

## Key lesson outcomes

**Science**

Students will be able to:

- formulate a question and make predictions about whether or not various materials will conduct an electric current
- conduct fair tests of materials to see if they are conductors or insulators
- identify and describe the types of materials that are conductors and insulators
- provide evidence to support their description.

**Literacy**

Students will be able to:

- plan, conduct and represent a fair test to decide if materials are conductors or insulators
- summarise their findings about materials investigated
- participate in cooperative learning teams and class discussion.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

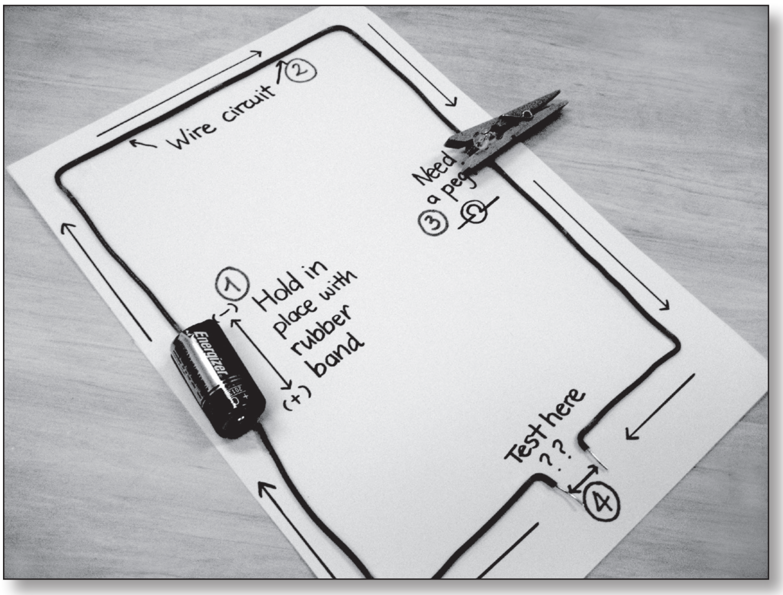
## Teacher background information

All materials are made of atoms and electrons. Electrons are small, negatively charged particles that form the outside part of atoms. Materials that contain free electrons—that is, electrons that are free to move—are called conductors. Free electrons are not strongly connected to their atoms and are therefore free to move within the material. Different materials have different levels of free electrons. Materials with many free electrons, for example, metals, are good conductors.

Materials such as glass or plastic have electrons that are not free to move. Therefore, they do not allow electrons to flow through them and are called insulators. Common insulators include plastics, rubber, wood and glass. A plastic insulator is used on electric switches and wires to prevent shock or electrical injury to a person using them. The insulators prevent the electrons carrying electrical energy escaping from conductors, for example, the wires, and therefore stop them burning people or giving them a shock.

When electrons travel through a conductor, they encounter resistance to their flow. Generally, thin wires do not conduct as effectively as thick wires of the same material (thin wires present higher resistance to the flow of electrons). This can be likened to a thin pipe which provides more resistance to the flow of water than a thick pipe. This resistance causes the electrons to release some of their energy as heat and the conductor (the wire) heats up. If the purpose of an electrical circuit is to produce light or heat, it contains conductors with high resistance, for example, the thin tungsten wires in a light bulb. The thin tungsten wires in the bulb provide high resistance so that heat and some light are produced. The interconnecting wires in a circuit should be thick to provide the least amount of resistance to the circuit. Therefore, the energy from the source (a battery) goes to the device with high resistance (a bulb) and is carried by the wires which present very low resistance.

## Teacher information on the completed investigation




**Investigation set up**

This investigation is designed for students to test materials to establish which are conductors of electrical energy. This diagram shows what we believe the scientists in the lesson scenario intended. The clue areas are:

1. The positive and negative signs indicate a source of electrical energy (a battery) and show the battery orientation.
2. The direction of electron flow is shown in the circuit using arrows to indicate the flow of electrons from negative to positive.
3. Position 3 indicates where the bulb is to be placed. The peg acts as a bulb holder and can clip one wire to the side of the metal case. To complete the circuit, the other wire needs to touch the base of the bulb.
4. The question marks indicate that a test of some sort is to be carried out. The question to be investigated relates to ‘sorting the materials’ in the ‘Scientists’ materials box’. Students place materials across the two ends of stripped wire at ‘4’. If the material is a conductor, for example, a metal, the circuit will be completed and the bulb will light up. If the material is an insulator, such as plastic, rubber or paper, the circuit will not be completed and the bulb will not light up.

When working scientifically in this lesson, measurements are made using observations. Students will measure the materials’ ability to conduct electrons by observing whether or not the light bulb lights up.

# Equipment

### FOR THE CLASS

- class science journal
- class science chat-board
- 1 enlarged copy of 'Lab notes: What's this all about?' (Resource sheet 6)
- 1 enlarged copy of 'Problem solvers: Investigation planner' (Resource sheet 7)
- team roles chart
- team skills chart

### FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Lab notes: What's this all about?' (Resource sheet 6)
- 1 copy of 'Problem solvers: Investigation planner' (Resource sheet 7) per team member
- 'Essentials for the investigation':
  - 1 battery (size C or D)
  - 1 light bulb (1.5 V)
  - 2 pieces of insulated wire (15 cm long), with ends stripped of insulation; or folded foil wires (see 'Folded foil wires', Resource sheet 2 and 'Preparation')
  - self-adhesive tape
  - 1 clothes peg
  - 1 piece A4 card
- 1 'Scientists' materials box' containing:
  - wood (eg, popsticks, toothpicks)
  - plastic (eg, straws, plastic cutlery)
  - rubber (eg, balloons, rubber bands)
  - metal (eg, paperclips, cutlery)
  - paper and/or cardboard
  - pencils (sharpened at both ends)
  - gardening wire or twist-ties
  - insulated copper wire with the ends stripped



# Preparation

- Prepare an enlarged copy of 'Lab notes: What's this all about?' (Resource sheet 6) and 'Problem solvers: Investigation planner' (Resource sheet 7).
- Prepare an equipment table labelled 'Essentials for the investigation' and another table labelled 'Scientists' materials box'.
- Read 'Teacher information on the completed investigation' (see 'Teacher background information').
- Read 'How to conduct a fair test' (Appendix 4).
- *Optional:* Display the enlarged copies of 'Lab notes: What's this all about?' (Resource sheet 6) and 'Problem solvers: Investigation planner' (Resource sheet 7) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

# Lesson steps

1 Review the class science chat-board, the class science journal and the role-play students experienced in Lesson 5.

2 Explain that in this lesson students will be working in teams to solve a mystery. Introduce an enlarged copy of 'Lab notes: What's this all about?' (Resource sheet 6). Read through the resource sheet with the class and introduce one set of the 'Essentials for the investigation' and the 'Scientists' materials box' equipment.

3 Explain that each team will be constructing its own version of the circuit set-up on 'Lab notes: What's this all about?' (Resource sheet 6), and will use the 'Essentials for the investigation' and the 'Scientists' materials box' equipment to solve the problem presented by the missing scientists.

4 Explain that the first task for the teams is to discuss the problem to establish what the scientists could have been investigating and what their question for investigation was.

5 Form teams and allocate roles. Ask Managers to collect a team copy of 'Lab notes: What's this all about?' (Resource sheet 6), to facilitate team discussions about the question for investigation.

6 Invite teams to share their ideas about what they thought the scientists could have been investigating. Record the ideas in the class science journal. For example, the scientists wanted to know which materials could be placed across the gap to complete the circuit, and their question could have been: 'Which materials allow electrons to flow so that the bulb lights up?'.

7 Explain that the students are now going to take the place of the scientists. Introduce an enlarged copy of 'Problem solvers: Investigation planner' (Resource sheet 7). As a class, discuss the investigation process and decide on the investigation question. Record the question on the enlarged copy of 'Problem solvers: Investigation planner' (Resource sheet 7) in the class science journal.

8 Discuss and check materials that might be needed to investigate the question. For example:

- Check that all the connection points are well connected.
- Check that the battery is not flat.
- Check that the light is not broken.

9 Ask students to record their question for investigation and their prediction of what will happen as well as what they plan to change, measure/observe and keep the same on their copy of 'Problem solvers: Investigation planner' (Resource sheet 7).

10 Ask students to make a list of available materials and to draw a diagram for setting up the equipment on their 'Problem solvers: Investigation planner' (Resource sheet 7).

11 Explain that students will record the results of their investigation in a table. Discuss the purpose and features of a table.

## Literacy focus

**Why do we use a table?**

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

**What does a table include?**

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

**Example of a table**

| Materials tested | Result |
|---|---|
| | |
| | |
| | |
| | |

**12** Provide teams with time to construct their circuits, test the materials and record their findings in the 'Recording results' table of their 'Problem solvers: Investigation planner' (Resource sheet 7). As a class, discuss the investigations. Ask students to explain which materials electrons passed through and which materials electrons didn't pass through.

**13** Discuss the words the students could use to describe and label the two groups of materials. For example, students could call the materials that did not allow electrons to pass through 'blockers', 'stoppers' or 'preventers', while materials that did allow electrons to pass through could be called 'flowers', 'passers' or 'allowers'.

**14** Introduce the terms 'conductors' and 'insulators' as scientific words that are used to describe the two groups of materials.

**15** Ask students to summarise and record their findings and evaluate their investigation in the 'Explaining results' and 'Evaluating the investigation' sections of 'Problem solvers: Investigation planner' (Resource sheet 7).

**16** Share and discuss students' ideas recorded in the 'Explaining results' section of 'Problem solvers: Investigation planner' (Resource sheet 7). Review the table discussed in Lesson step 11 and develop descriptions for the terms 'conductors' and 'insulators'.

Record descriptions in the class science journal. Discuss questions, such as:

- How is electrical energy carried around a circuit? (By electrons flowing through the wire.)
- Why do some materials allow electrons to pass through them, while others don't? (Conductors have electrons that can move around, allowing electrical energy to flow through them, while insulators do not.)

ELABORATE

17 Ask students to share their ideas recorded in the 'Evaluating the investigation' section of 'Problem solvers: Investigation planner' (Resource sheet 7) and discuss improvements that could be made to their investigation. Some students could recognise the value of testing a wider range of materials. Some students could recognise the value of testing more samples of each type of material. For example, testing more plastics to determine whether all plastics are insulators.

18 Add pictures, questions, ideas and reflections to the class science chat-board and new words to the keywords section.

## Curriculum links

### Mathematics

- Estimate and measure the length of wires used in the investigation.

### Indigenous perspectives

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

# Lab notes:
# What's this all about?

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

Imagine that you are a scientist who works in a research laboratory. Your team has been given the task of completing an investigation that was left incomplete by a team of scientists that has been assigned to a top-secret investigation. Due to security restrictions, the original team cannot be contacted. The only details available are contained in the following email:

Message List | Delete    Previous | Next    Forward | Forward as Attachment | Reply | Reply All

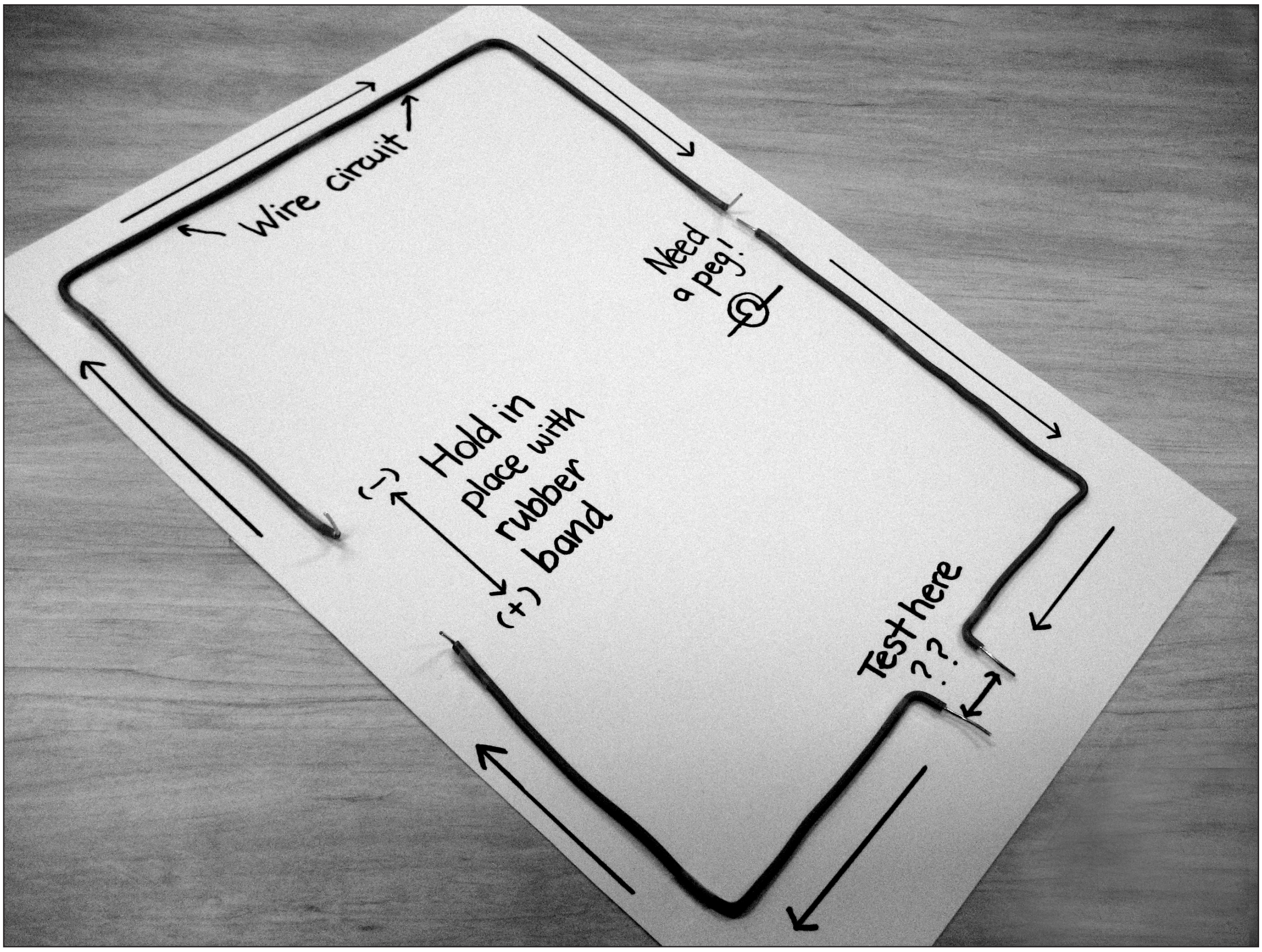
**From:** "Investigation Team" <originalteam@science.org.au>
**To:** "New Team" <newteam@school.edu.au>
**Subject:** Electric circuit problem

**Attachments:** Electric circuit photograph (3 MB)
**Options:** View printable version | Download this as a file

Dear Team,

We had to rush off but we are leaving this circuit problem in your capable hands. Everything you need to complete the investigation can be found in this photograph, the 'Scientists' material box' and the 'Essentials for the investigation' equipment.

Good luck!
Your research colleagues

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# Problem solvers: Investigation planner

**Name:** ______________________________ **Date:** ______________

**Other members of your team:** ______________________________

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

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

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

| Describe how you will set up your investigation?<br><br>Use drawings if necessary | What equipment will you need?<br><br>Use dot points |
|---|---|

**Write and draw your observations in your science journal**

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## Recording results

Record your results in a table.

| Materials tested | Result |
|---|---|
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |
| | |

## Explaining results

Write a statement to summarise your findings about the materials investigated.

## Evaluating the investigation

| What challenges did you have doing this investigation? | How could you improve this investigation? (fairness, accuracy) |
|---|---|
| | |

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# Lesson 7 Switched on

## AT A GLANCE

To support students to plan and conduct an investigation of the function of switches in an electric circuit.

Students:

- discuss the role of switches in an electric circuit
- create a circuit diagram including the switch symbol.

## Lesson focus

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

## Assessment focus

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

ELABORATE

## Key lesson outcomes

### Science

Students will be able to:

- construct two types of electrical switch
- explain how switches are used to control the flow of electrical energy around a circuit.

### Literacy

Students will be able to:

- interpret a procedural text to construct two types of electrical switch
- represent their understanding of how switches control the flow of electrical energy in a circuit using a circuit diagram
- develop scientific vocabulary about switches.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

## Teacher background information

A switch is a device in a circuit that can be opened and closed. For electrons to flow, there needs to be a continuous, conducting path between the negative battery terminal and the positive battery terminal. By placing a switch in a circuit, the flow of electrons in the circuit can be started or stopped. This prevents the waste of electrical energy and avoids the battery going flat when the light or the heat is not wanted.

Switches are made of materials that allow electrons to flow through them: that is, conductors. When the switch is 'on', the circuit is closed (it has no gaps in it) and the bulb lights up. A closed circuit allows a continuous flow of electrons from the negative terminal through the wire to the bulb, back to the positive terminal of the battery and so on until the chemical reaction in the battery ceases.

When the switch is 'off' or open, it is called an open circuit. There is a break in the circuit and the electrons are unable to flow in the circuit as the circuit is incomplete. A broken wire or an open switch leaves a gap in the circuit, preventing a flow of electrons from one side of the battery to the other.

## Equipment

### FOR THE CLASS

- class science journal
- class science chat-board
- 1 enlarged copy of 'Making switches' (Resource sheet 8)
- collection of battery-operated devices from Lesson 1
- team roles chart
- team skills chart

### FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 copy of 'Making switches' (Resource sheet 8)
- 1 battery (1.5 V)
- 1 light bulb (1.5 V)
- *optional:* light bulb holder and battery holder
- *optional:* a small electric buzzer or motor for the bulb
- 3 pieces of insulated wire (15 cm long), with ends stripped of insulation; or folded foil wires (see 'Folded foil wires', Resource sheet 2 and 'Preparation')
- Electrical switch 1
  - 1 piece of A4 card
  - 1 metal paperclip
  - 2 metal split pins or thumbtacks
  - self-adhesive tape
- Electrical switch 2
  - 3 corrugated-card squares (10 cm x 10 cm)
  - aluminium foil A4 sheet

ELABORATE

## Preparation

- Prepare an enlarged copy of 'Making switches' (Resource sheet 8).
- *Optional:* Display the enlarged copy of 'Making switches' (Resource sheet 8) on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed (www.primaryconnections.org.au).

## Lesson steps

**1** Review the different battery-operated devices that students explored in Lesson 1.

Discuss the ways the devices were made to work, such as a button or a switch.

Discuss the circuits that students constructed in Lesson 2 and any difficulties that were encountered in making the circuit complete so that the electrons could flow, for example, the need to hold the wire to the other components to complete the circuit.

**2** Brainstorm examples of switches that students have used, such as light switches, power point switches and switches on electrical appliances.

**3** Explain that students will be working in teams to construct two different types of switch and investigate the role of a switch in an electrical circuit.

*Optional:* Conduct this lesson as an open investigation by asking the teams: 'How can we make a switch?'.

**4** Read through an enlarged copy of 'Making switches' (Resource sheet 8) and explain the purpose and features of procedural texts.

### Literacy focus

**Why do we use a procedural text?**

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

**What does a procedural text include?**

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

Explain that the teams will make both types of switch, shown on 'Making switches' (Resource sheet 8), one at a time.

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

*Optional:* Students could substitute an electric buzzer, electric motor or mini-fan for the bulb.

**6** After teams have constructed and tested the two switches, revise the need for a circuit to be complete in order for a bulb to light up. Lead a discussion about why a switch is a useful component in an electrical circuit, using questions, such as:

- What did the switch do in the circuit? (When it was not connected, it stopped the path of the electrons. When it was connected, the electrons travelled through it.)
- Why do we use a switch in a circuit? (To have more control over when the electrical energy is flowing; so that energy isn't wasted; so that the battery doesn't go flat.)

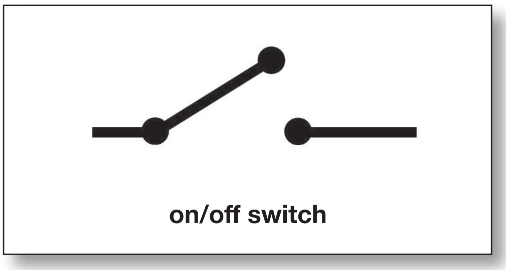
ELABORATE

Discuss how the switches constructed by the teams reflect switches that are used in devices and in households. For example, the paperclip switch is similar to power points and on–off switches, while the pressure switch is similar to the function of buttons and keys used in remote controls and keyboards.

Discuss the materials used to make the switches and how this links to the students' investigation in the previous lesson. For example, the switch materials were made from metal because metal is a conductor of electrical energy; and the base was made from card because it is an insulating material that prevents the electrical energy escaping from the circuit.

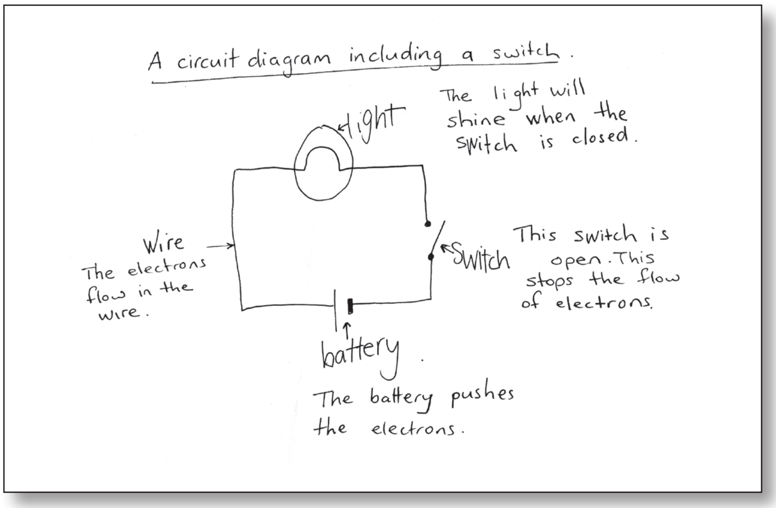
7 Review symbols already used in circuit diagrams and introduce the circuit symbol for a switch.

8 Ask students to draw in their science journals a circuit diagram that includes a switch, using electrical symbols. Ask them to annotate the diagram to describe the role of the switch in a circuit.




**Electrical symbol for a switch in the 'off' position**

*Optional:* Repeat the role-play from Lesson 5 and add a switch to the circuit. For example, two students standing together are the switch. When they join arms or hands, the electron students can pass by them but when they are not connected, the electron students need to stop until the switch connection is made.




**Student work sample of an annotated circuit diagram including a switch**

9 Update the class science chat-board by adding pictures, ideas, findings and reflections, including the circuit symbol for a switch, and add new vocabulary to the keywords section.

# Making switches

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

## Electrical switch 1

### Aim

To make a paperclip switch.

### Equipment

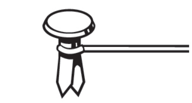
**FOR EACH TEAM**

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 piece of A4 card
- 1 battery (1.5 V)
- 1 light bulb (1.5 V)
- 3 insulated copper wires, stripped of insulation at each end; or folded foil wires (see 'Folded foil wires', Resource sheet 2)
- 2 metal split pins or thumbtacks
- 1 metal paperclip
- self-adhesive tape

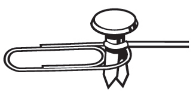
### Activity steps

1 Make a circuit using a battery, a bulb and insulated copper wire and place it on top of the piece of A4 card.

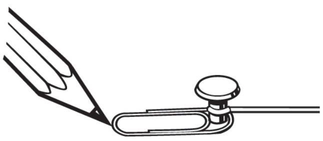
2 Assemble the switch materials on the card as shown below:

**a** 

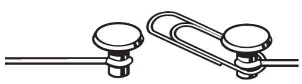
Wrap one end of a piece of wire around a split pin.

**b** 

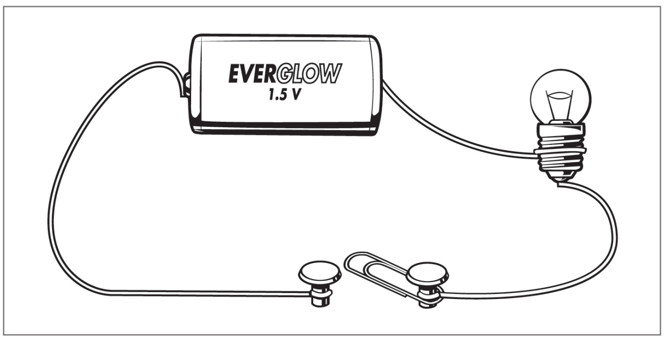
Place the paperclip around its base and anchor it in the card.

**c** 

Wrap a second piece of wire around a second split pin. Use a pencil to mark on the card where the pin needs to go and insert it.

**d** 

Complete the circuit using a battery bulb and the third piece of wire. Move the paperclip so that it touches the second pin. This will complete the circuit and the bulb will light.




**Paperclip switch**

# Electrical switch 2

## Aim

To make a pressure switch.

## Equipment

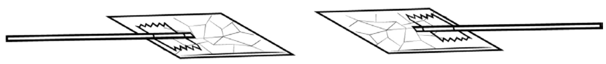
**FOR EACH TEAM**

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- 1 battery (1.5 V)
- 1 light bulb (1.5 V)
- 3 insulated copper wires, stripped of insulation at each end; or folded foil wires (see 'Folded foil wires', Resource sheet 2)
- 3 corrugated-card squares (10 cm x 10 cm)
- aluminium foil
- self-adhesive tape
- scissors

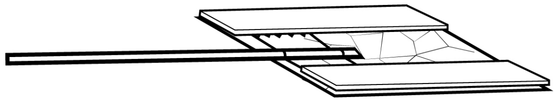
## Activity steps

1. Cover two of the 10 cm x 10 cm cards with aluminium foil.

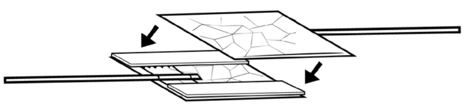
2. Tape 3 cm of insulated copper wire to the left-hand side of a card square and 3 cm to the right-hand side of another card square.

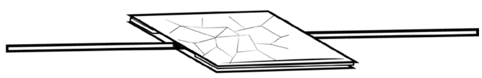


3. To make spacers, cut two 3 cm strips from the remaining piece of cardboard. Glue these pieces to one of the foil-covered cards.



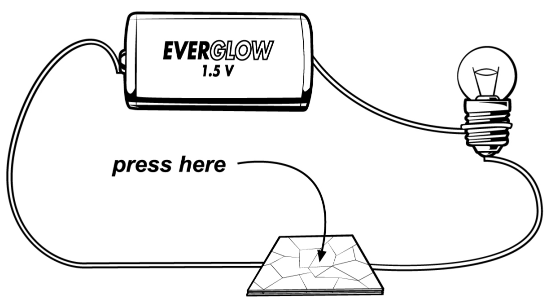
4. Place the other foil-covered card on top of the spacers. Tape these together to make a stack. It will look like this:





5. Connect the wires to the circuit.

6. When you press the switch, the two foil surfaces make contact to complete the circuit and the bulb will light. When you stop pressing, the circuit is broken and the bulb will not light. This is called a pressure switch.




**Pressure switch**

 ISBN 978 0 85847 317 1

# Lesson 8 Bright sparks: Sharing what we know

## AT A GLANCE

To provide opportunities for students to represent what they know about how electrical circuits provide a means of transferring and transforming electrical energy, and to reflect on their learning during the unit.

Students:

- participate in a word loop activity
- work in collaborative learning teams to prepare a model of a torch
- prepare a description that communicates the main ideas of their model and how an electric circuit works
- share models and descriptions with an audience
- reflect on their learning during the unit.

## Lesson focus

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

## Assessment focus

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

- that electric circuits provide a means of transferring and transforming electricity.
- scientific understandings can solve problems that directly affect people's lives, for example, the light bulb (see page 2).

Literacy products in this lesson provide useful work samples for assessment.

EVALUATE

# Key lesson outcomes

**Science**

Students will be able to:

- describe a circuit in terms of components that form a continuous path for the flow of electrons
- describe how energy is transferred within an electric circuit
- explain the characteristics of conductors and insulators in terms of categories of materials.

**Literacy**

Students will be able to:

- make a labelled model to represent how an electric circuit works
- make a presentation to communicate their understanding of electric circuits
- use a checklist to reflect on their learning in the unit
- list, group and label ideas about their learning in the unit.

This lesson also provides opportunities to monitor the development of students' general capabilities (highlighted through icons, see page 6).

# Equipment

## FOR THE CLASS

- class science journal
- class science chat-board
- team roles chart
- team skills chart
- '*It's electrifying* Word loop cards' (Resource sheet 9)
- 1 large sheet of paper for affinity diagram

## FOR EACH TEAM

- role wristbands or badges for Director, Manager and Speaker
- each team member's science journal
- *optional:* 1 copy of 'Torch template' (Resource sheet 10)
- 1 battery (1.5 V)
- 1 bulb (1.5 V)
- *optional:* 1 sheet of cellophane
- *optional:* light bulb holder and battery holder
- 3 pieces of insulated wire (15 cm long), with ends stripped of insulation; or folded foil wires (see 'Folded foil wires', Resource sheet 2 and 'Preparation')
- 1 metal paperclip
- 2 metal split pins or thumbtacks
- self-adhesive tape
- materials for circuit description (see Lesson step 2)
- 1 copy of 'Bright sparks: Reflecting on my learning' (Resource sheet 11) per team member
- several self-adhesive notes per team member

EVALUATE

## Preparation

- Read 'How to use word loops' (Appendix 5) which includes an answer sheet.
- Cut out word loop cards.
- Read 'How to use an affinity diagram' (Appendix 6).
- *Optional:* 'Torch template' (Resource sheet 10) has been provided for use in this *Evaluate* activity. You might like to use this template or ask students to develop their model based on their own ideas of an item/place that uses an electric circuit and light, such as a lighthouse, a room or a house.
- *Optional:* Display the affinity diagram on an interactive whiteboard. Check the Primary**Connections** website to see if an accompanying interactive resource has been developed: www.primaryconnections.org.au

## Lesson steps

**1** Introduce the word loop activity and organise the class to complete the activity that uses the scientific vocabulary of the unit. After your class has completed the word loop, organise the completed word loop cards for display on the class science chat-board.

**Note:** It is important that symbols are used only when requested. Similarly, if a symbol is not requested only use words.

Use the class science chat-board to review the unit and how students' ideas have changed and developed during the unit.

**2** Explain that students will be working in teams to construct a model of a torch to show what they know and have learned about electric circuits.

Explain that students will also prepare a description of how the model works and introduce or discuss the ways in which the students could do this. For example, students could:

- write a procedure for constructing an electric circuit
- create a mini-dictionary of key terms and ideas associated with the model
- create a mini-poster that can be displayed with the model
- make a computer-based presentation.

*Optional:* Students work on the model in teams and prepare their descriptions individually.

**3** Review the activities students have completed during the unit and discuss what type of information students could include in their description, for example:

- what an electric circuit is
- the components of an electric circuit, and their roles
- the role of conductors and insulators in an electric circuit
- what happens to energy in the circuit.

**4** Brainstorm presentation ideas, such as:

- share the models with an audience, for example, another class or parents
- develop a multimedia presentation

- videotape the students providing an explanation of their model.

Discuss how the form of presentation and the audience for the presentation affects students' labelled models, for example, the language used.

*Optional:* Provide the students with a design brief that involves the students designing, constructing and testing their own product involving an electric circuit rather than them following a template.

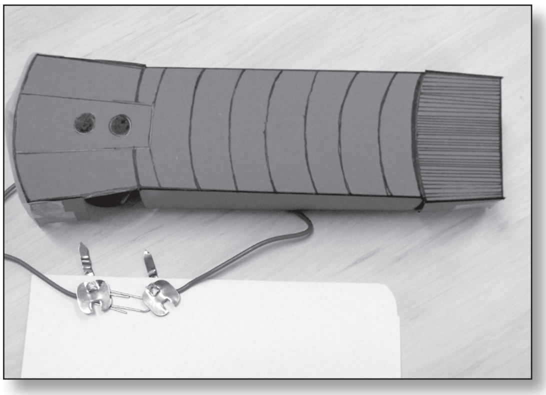
**5** Introduce an enlarged copy of 'Torch template' (Resource sheet 10) and explain how the students will use it to build their model. For example, teams can construct a circuit and place the cut-out template over the top to represent a torch.

When they lift the template up, it will resemble the cutaway diagrams they have drawn during the unit.

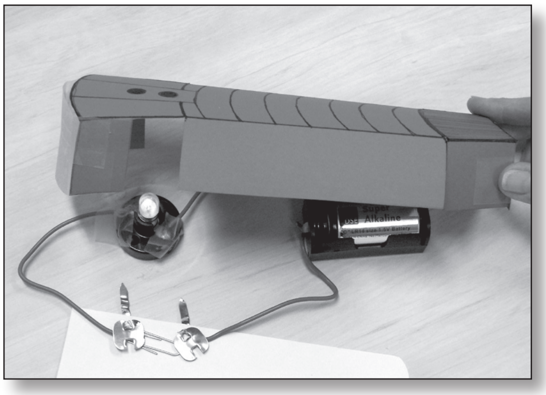
**Note:** Students could use a paperclip switch or a pressure switch in their models.

**6** Discuss the information that you will be looking for to assess students' models and descriptions:

- evidence of electric circuits, conductors and insulators and what happens to



**Model of a torch**



**Cutaway showing electric circuit**

energy
in a circuit

- well-organised information
- effective written and oral communication.

**7** Form teams and allocate roles. Ask Managers to collect the equipment their team needs.

**8** Provide students with time to plan and construct their models and descriptions.

**9** Organise students to share their models and descriptions with an audience.

**10** Introduce the affinity diagram activity. Organise the class to complete the activity as a reflection of what they have learned.

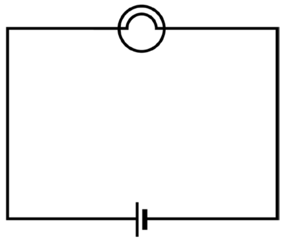
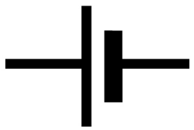
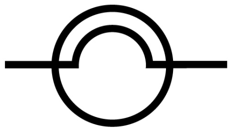
**11** Add pictures, questions, ideas and reflections to the class science chat-board and new words to the keywords section.

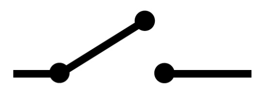
**12** Introduce an enlarged copy of 'Bright sparks: Reflecting on my learning' (Resource sheet 11) and read it through with the class. Explain that students should tick or write comments in the appropriate boxes. They could also include examples of how they have demonstrated the outcome, for example, 'My model worked…'.

**13** Provide students with time to reflect on their learning in the unit and complete their copy of 'Bright sparks: Reflecting on my learning' (Resource sheet 11).

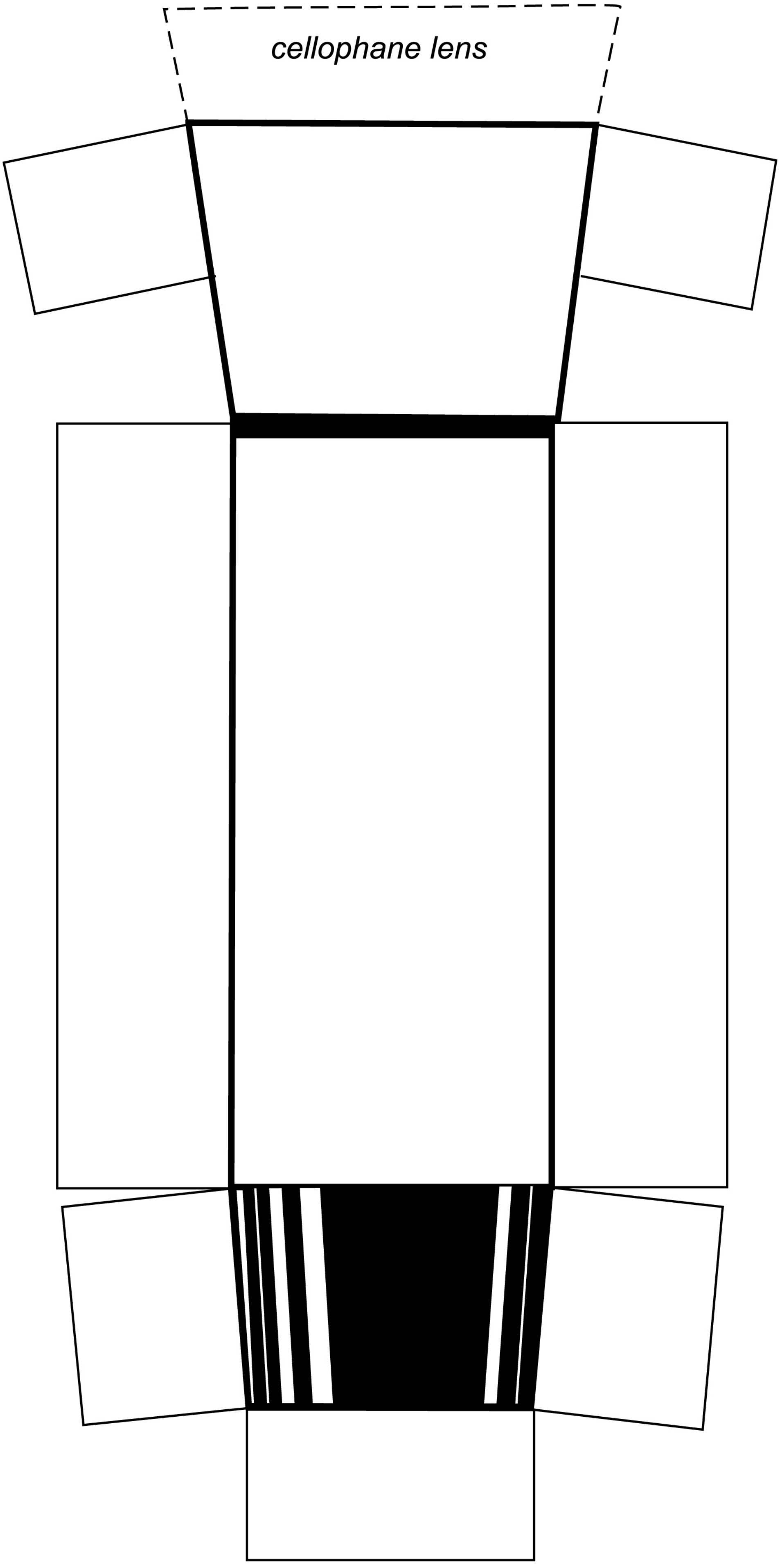
# *It's electrifying* word loop cards

| | | | |
|---|---|---|---|
| **Torch** | Particles that carry energy around a circuit | **Bulb** | A scientist who explored electricity at the same time as Alessandro Volta |
| **Battery** | Materials that allow the flow of electrons | **Tungsten** | The switch is 'off' and there is a gap in the circuit |
| **Volta** | Where electrons enter and leave a battery or bulb | **Filament** | The symbol for 'volts' |
| **Galvani** | The change in energy from one type to another | **Electric circuit** | Materials that do not allow the flow of electrons |

| | | | |
|---|---|---|---|
|  | A device that can be used to open or close a circuit | **Electrons** | Spring-like wire inside a light bulb |
|  | Electrical symbol for a switch | **Connection points** | Standard symbol for a bulb |
|  | The switch is 'on' and there are no gaps in the circuit | **Energy transfer** | Standard symbol for a battery |
|  | The amount of 'push' provided by the battery; named after Alessandro Volta | **Transformation** | A pictorial representation of an electric circuit |

| | | | |
|---|---|---|---|
| **Volt** | A pathway that electrical energy goes around | **Switch** | The movement of energy from one place to another |
| **V** | Standard symbol for a circuit wire |  | The scientist who designed the first battery |
| **Conductors** | A type of metal used to make a light bulb filament | **Closed circuit** | A source of energy |
| **Insulators** | Transforms electrical energy to light (and heat) energy | **Open circuit** | Battery-operated device that produces light |

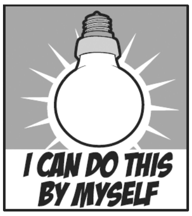
# Torch template




 ISBN 978 0 85847 317 1

# Bright sparks: Reflecting on my learning

**Name:** ______________________ **Date:** ______________________

| **Bright sparks: Reflecting on my learning** |   |   |   |
|---|---|---|---|
| I can construct a model of an electric circuit to make a bulb light up. | | | |
| I can describe the components of an electric circuit and their roles. | | | |
| I can describe what happens in an electric circuit. | | | |
| I can describe the characteristics of conductors and insulators, and explain their roles in electric circuits. | | | |
| I can use written and visual language to describe an electric circuit. For example, scientific language, symbols and diagrams. | | | |
| I can present my written and visual information in an effective and well-organised manner. | | | |
| I can use effective oral presentation skills to demonstrate my knowledge and understanding of an electric circuit. For example, scientific language and a clear, audible voice. | | | |
| My comments | | | |
| Teacher comments | | | |

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

### Introduction

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

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

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

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

The development of these collaborative skills aligns to descriptions in the Australian Curriculum: English. See page 8.

### Team structure

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

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

### Team roles

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

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

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

### Manager

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

### Speaker

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

### Director (Year 3–Year 6)

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

## Team skills

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

Students will practise the following team skills throughout the year:

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

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

## Supporting equity

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

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

# TEAM ROLES

## Manager

Collects and returns all materials the team needs

## Speaker

Asks the teacher and other team speakers for help

## Director

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

# TEAM SKILLS

**1** Move into your teams quickly and quietly

**2** Speak softly

**3** Stay with your team

**4** Take turns

**5** Perform your role

# Appendix 2
# How to use a science journal

## Introduction

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

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

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

Keeping a science journal aligns to descriptions in the Australian Curriculum: Science and English. See pages 2 and 8.

## Using a science journal

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

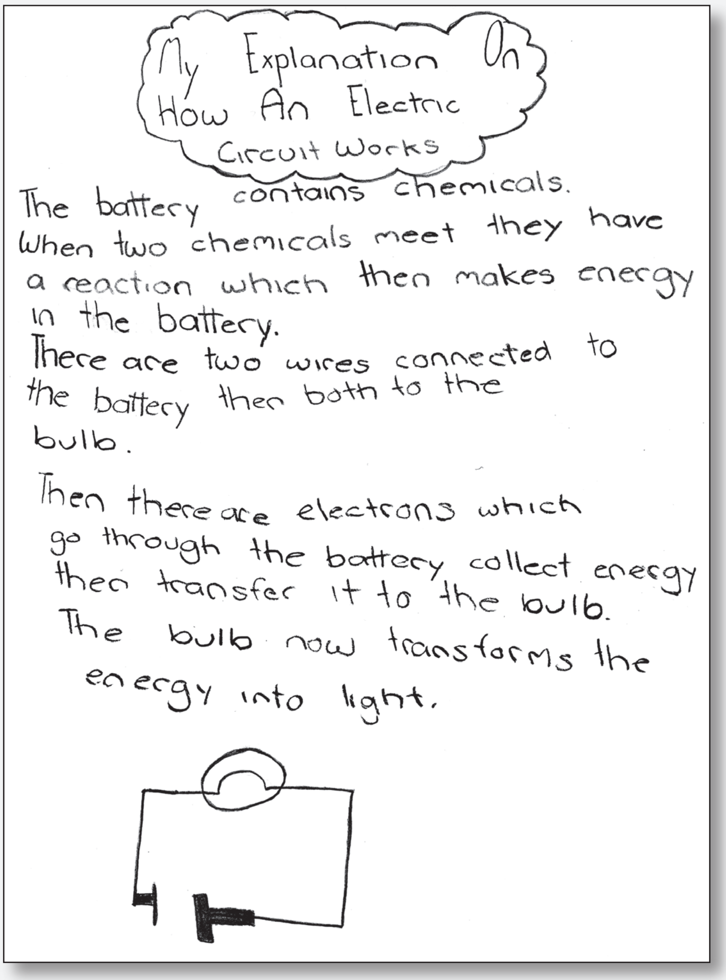
revise this material during the unit. Explore the vocabulary, visual texts and ideas that have developed from the science unit, and encourage students to use them in their science journals.

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

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

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

***It's electrifying* science journal**



My Explanation On How An Electric Circuit Works

The battery contains chemicals.
When two chemicals meet they have a reaction which then makes energy in the battery.
There are two wires connected to the battery then both to the bulb.
Then there are electrons which go through the battery collect energy then transfer it to the bulb.
The bulb now transforms the energy into light.

# Appendix 3
# How to use a word wall

## Introduction

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

The use of a word wall, including words from regional dialects and other languages, aligns to descriptions in the Australian Curriculum: English. See page 8.

## Goals in using a word wall

A word wall can be used to:

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

## Organisation

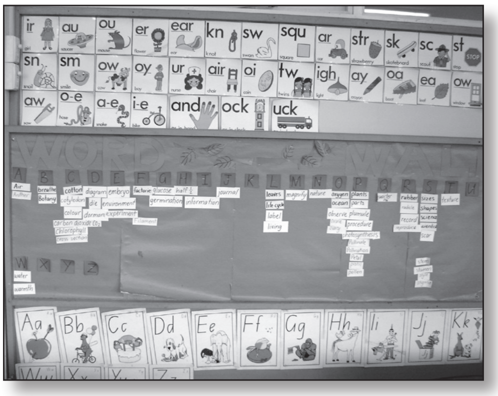
Position the word wall so that students have easy access to the words. They need to be able to see, remove and return word cards to the wall. A classroom could have one main word wall and two or three smaller ones, each with a different focus, for example, high-frequency words.

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

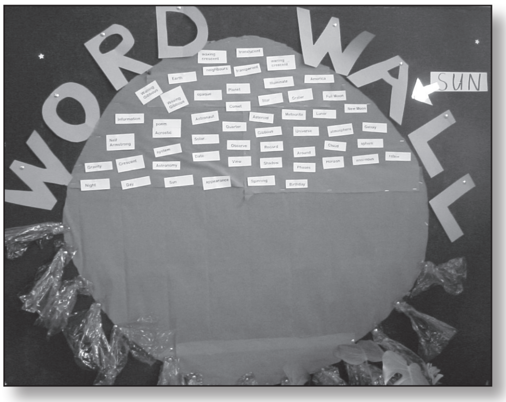
Word walls do not need to be confined to a wall. Use a portable wall, display screen, shower curtain or window curtain. Consider a cardboard shape that fits with the unit, for example, a light bulb, battery or switch for an electricity unit. The purpose is for students to be exposed to a print-rich environment 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 an *It’s electrifying* unit might be organised using headings, such as ‘Conductors’, ‘Insulators’, ‘Circuits’ and ‘Parts of a bulb’.

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 electrical component, 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.



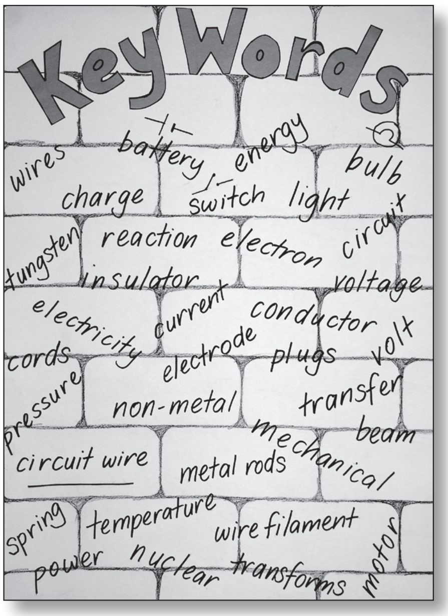
***Plants in action*** **word wall**




***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.




***It's electrifying*** **word wall**

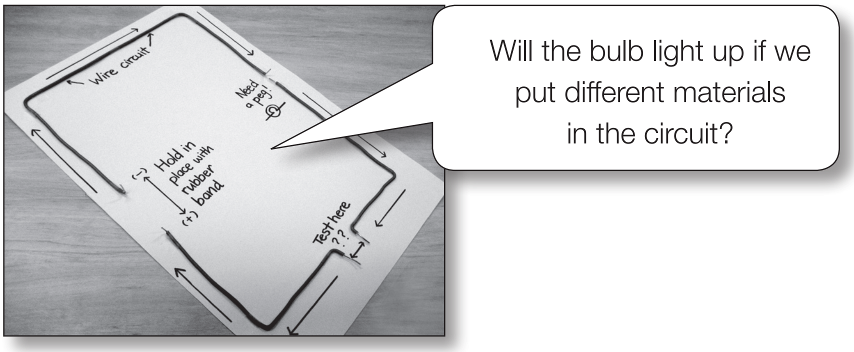
# Appendix 4
## How to conduct a fair test

### 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 *It's electrifying*, students investigate things that affect the passage of electrons in a circuit.




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:

- an independent variable—one thing to change
- a dependent variable—another thing to measure/observe, and
- controlled variables—things to keep the same.

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:

**C**ows: **Change** one thing (independent variable)
**M**oo: **Measure/Observe** another thing (dependent variable) and
**S**oftly: keep the other things (controlled variables) the **Same**.

To investigate whether different materials conduct electrons, students could.

| | | |
|---|---|---|
| **CHANGE** | the material that is placed in the circuit | Independent variable |
| **MEASURE/OBSERVE** | whether or not the light bulb comes on | Dependent variable |
| KEEP THE **SAME** | the circuit | Controlled variable |

# Appendix 5
# How to use word loops

## Introduction

Word loops provide students with an opportunity to develop a deeper understanding of the scientific vocabulary of a Primary**Connections** unit. As students actively use the language of scientific ideas and concepts, their knowledge, understanding and confidence are enhanced.

A word loop is an activity that can be used when students are familiar with the vocabulary associated with the scientific ideas and concepts in the unit. Word loops can be developed from word walls or class science chat-boards, and involve matching words with their descriptions. The number of words can be increased during the unit with additional cards added as more words are introduced.

Word loops can be used as a 'concept check' activity at the beginning of a lesson, as a consolidation learning activity or, at the end of a lesson as a reflection or assessment activity.

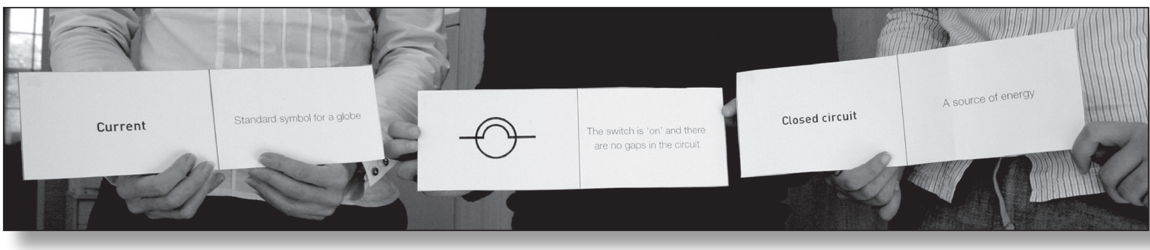
## Organisation

Word loops use a series of cards that have a description on the right-hand side and a scientific word or symbol on the left-hand side. The aim of the activity is to form a loop in which matching pairs of descriptions and words or symbols are made—similar to a game of dominoes.

Enlarge the *It's electrifying* 'Word loop cards' (Resource sheet 9) by photocopying onto card or heavy paper, and cut out the cards. The cards will last longer if they are laminated.

## How to use word loops

1. Distribute word loop cards so each student or team has at least one card.
2. The teacher, or nominated student/s, starts the activity by reading aloud the statement on the right-hand side of their card, for example, 'A battery operated device that produces light'.
3. The student/s who has the matching word or symbol on the left-hand side of their card indicates that they have the answer and reads it aloud, for example, 'Torch'.
4. The student/s with the matching word or symbol card moves to stand on the left-hand side of the person who read the matching description.
5. The word or symbol student then reads the description on the right-hand side of their card to continue the word loop.
6. This process continues until all the pairs have been matched up.



## *It's electrifying* word loop cards (the answers)

For the *It's electrifying* unit, the word loop card answers should be ordered as follows:

1 **Torch:** Battery-operated device that produces light

2 **Battery:** A source of energy

3 **Volta:** The scientist who designed the first battery

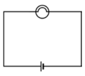
4 **Galvani:** A scientist who explored electricity at the same time as Alessandro Volta

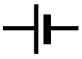
5 **Bulb:** Transforms electrical energy to light (and heat) energy

6 **Tungsten:** A type of metal used to make a light bulb filament

7 **Filament:** Spring-like wire inside a light bulb

8 **Electric circuit:** A pathway that electrical energy goes around

9  **:** A pictorial representation of an electric circuit

10  **:** Standard symbol for a battery

11  **:** Standard symbol for a bulb

12 **:** Standard symbol for a circuit wire

13 **Electrons:** Particles that carry energy around a circuit

14 **Connection points:** Where electrons enter and leave a battery or bulb

15 **Energy transfer:** The movement of energy from one place to another

16 **Transformation:** The change in energy from one type to another

17 **Volt:** The amount of 'push' provided by the battery; named after Alessandro Volta

18 **V:** The symbol for 'volts'

19 **Conductor:** Materials that allow the flow of electrons

20 **Insulator:** Materials that do not allow the flow of electrons

21 **Switch:** A device that can be used to open or close a circuit

22  **:** Electrical symbol for a switch

23 **Closed circuit:** The switch is 'on' and there are no gaps in the circuit

24 **Open circuit:** The switch is 'off' and there is a gap in the circuit

# Appendix 6
## How to use an affinity diagram

### Introduction

An affinity diagram is a visual display of a group's response to a question or issue. It allows the collation of large amounts of information quickly and without judgment. Responses are categorised relationally, enabling students to identify similarities and differences in responses. The diagram displays the type and frequency of the responses.

### Organisation

Individual students record their responses to what they have learned during the unit (one response per self-adhesive note). The notes are placed randomly onto a wall or whiteboard, therefore, providing anonymity for the author. The responses are then organised into categories on a large chart and each category is given a descriptive title.

### Steps to using an affinity diagram

**1** Prepare a large space or piece of paper for the affinity diagram with the focus issue or question displayed at the top, for example, 'Things that I have learned during '*It's electrifying*'.

**2** Provide each student with several coloured self-adhesive notes.

**3** Invite students to think about several things that they have learned during the unit and silently record each one on the self-adhesive notes. Allow three to five minutes.

**4** Ask students to place their ideas randomly on a wall or whiteboard. (It might be helpful to do this part of the activity immediately before a recess or lunch break.)

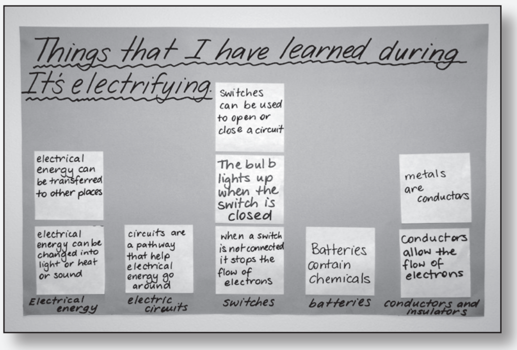
**5** Select two or three students to assist you in sorting the notes into groups. Remind your helpers that every response can have a place.

**6** Discuss each category and negotiate a heading for each group, such as batteries, bulbs, electrons, switches, conductors and insulators, teamwork.

*Optional:* When sorting responses into groups it is helpful to organise them in columns or rows to make the response type and frequency easy to see.

**7** Discuss the affinity diagram to reflect on student learning during the unit. This is an opportunity to plan for further learning as well as recognising the learning that has taken place.

**An example of an *It's electrifying* affinity diagram**



# Appendix 7
## *It's electrifying* equipment list

| EQUIPMENT ITEM | QUANTITIES | LESSON | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| **Equipment and materials** | | | | | | | | | |
| aluminium foil, A4 sheet | 1 per team | | | | | | | • | |
| battery (size C or D) | 1 per team | | • | | | | • | | |
| battery (1.5 V) | 1 per team | | | | | | | • | • |
| battery holder optional | 1 per team | | | | | | | • | • |
| card, A4 | 1 sheet per team | | | | | | • | • | |
| cellophane | 1 sheet per team | | | | | | | | • |
| clothes peg | 1 per team | | | | | | • | | |
| collection of batteries of different sizes and voltages (eg, 1.5 V battery, watch battery, D size battery) | 1 per class | | | | • | | | | |
| collection of batteries operated devices (eg, toy, music player, doorbell, hand-held computer game, mobile phone, walkie-talkies, megaphone) | 1 per class | • | | | | | | • | |
| collection of light bulbs of different sizes and shapes optional | 1 per class | | | • | | | | | |
| corrugated-card squares (10 cm x 10 cm) | 3 per team | | | | | | | • | |
| decorated container (eg, a bucket decorated with tinsel, cellophane or crepe paper) for the 'bulb' | 1 per class | | | | | • | | | |
| dictionaries (eg, hardcopy or online) | several per class | | | • | | | | | |
| insulated copper wire with the ends stripped (15 cm long) or folded foil wires | 2 per team | | • | | | | • | | |
| insulated copper wire with the ends stripped (15 cm long) or folded foil wires | 3 per team | | | | | | | • | • |
| light bulb (1.5 V) (include spares for breakages) | 1 per team | | • | • | | | • | • | • |
| light bulb holder optional | 1 per team | | | | | | | • | • |
| magnifying glass or hand lens | 1 per team | | | • | | | | | |
| metal paperclip | 1 per team | | | | | | | • | • |
| metal split pins or thumbtacks | 2 per team | | | | | | | • | • |
| packets of energy (eg, pegs, counters) | 50 or 60 (twice as many as number of students) per class | | | | | • | | | |
| paper, large sheet for affinity diagram | 1 per class | | | | | | | | • |
| paper, large sheets for class science chat-board | 1 per class | • | | | | | | | |

| EQUIPMENT ITEM | QUANTITIES | LESSON | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| ‘Scientists’ material box’ containing: | 1 per team | | | | | | • | | |
| - wood (eg, popsticks, toothpicks) | 1 per team | | | | | | • | | |
| - plastic (eg, straws, plastic cutlery) | 1 per team | | | | | | • | | |
| - rubber (eg, balloons, rubber bands) | 1 per team | | | | | | • | | |
| - metal (eg, paperclips, cutlery) | 1 per team | | | | | | • | | |
| - paper and/or cardboard | 1 per team | | | | | | • | | |
| - pencils (sharpened at both ends) | 1 per team | | | | | | • | | |
| - gardening wire or twist-ties | 1 per team | | | | | | • | | |
| - insulated copper wire with the ends stripped | 1 per team | | | | | | • | | |
| self-adhesive notes | several per student | | | | | | | | • |
| self-adhesive tape | 1 per team | | | | | | • | • | • |
| small electric buzzer or motor (substitute for bulb) optional | 1 per team | | | | | | | • | |
| stripping pliers or knife | 1 per class | | • | | | | | | |
| torch | 3 or 4 per class | • | | | | | | | |
| **Resource sheets** | | | | | | | | | |
| ‘PROE record: Lighting up my life’ (RS1) | 1 per student | | • | | | | | | |
| ‘PROE record: Lighting up my life’ (RS1), enlarged | 1 per class | | • | | | | | | |
| ‘Folded foil wires’ (RS2) optional | 1 per team | | • | | | | | | |
| ‘Inside a light bulb’ (RS3) | 1 per student | | | • | | | | | |
| ‘Inside a light bulb’ (RS3), enlarged | 1 per class | | | • | | | | | |
| ‘Alessandro Volta: Battery maker’ (RS4) | 1 per student | | | | • | | | | |
| ‘Alessandro Volta: Battery maker’ (RS4), enlarged | 1 per class | | | | • | | | | |
| ‘Chronological list: Alessandro Volta’ (RS5) optional | 1 per student | | | | • | | | | |
| ‘Lab notes: What’s this all about?’ (RS6) | 1 per student | | | | | | • | | |
| ‘Lab notes: What’s this all about?’ (RS6), enlarged | 1 per class | | | | | | • | | |
| ‘Problem solvers: Investigation planner’ (RS7) | 1 per student | | | | | | • | | |
| ‘Problem solvers: Investigation planner’ (RS7), enlarged | 1 per class | | | | | | • | | |

| EQUIPMENT ITEM | QUANTITIES | LESSON | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
| 'Making switches' (RS8) | 1 per student | | | | | | | • | |
| 'Making switches' (RS8), enlarged | 1 per class | | | | | | | • | |
| 'Its electrifying word loop cards' (RS9) | 1 per class | | | | | | | | • |
| 'Torch template' (RS10) optional | 1 per team | | | | | | | | • |
| 'Bright sparks: Reflecting on my learning' (RS11) | 1 per student | | | | | | | | • |
| **Teaching tools** | | | | | | | | | |
| class science journal | 1 per class | • | • | • | • | • | • | • | • |
| class science chat-board | 1 per class | • | • | • | • | • | • | • | • |
| student science journal | 1 per student | • | • | • | • | • | • | • | • |
| team roles chart | 1 per class | • | • | • | | | • | • | • |
| team skills chart | 1 per class | • | • | • | | | • | • | • |
| role wristbands or badges | 1 set per team | • | • | • | | | • | • | • |

# Appendix 8
## *It's electrifying* unit overview

| | | SCIENCE OUTCOMES* | LITERACY OUTCOMES* | LESSON SUMMARY | ASSESSMENT OPPORTUNITIES |
|---|---|---|---|---|---|
| | | Students will be able to represent their current understanding as they: | Students will be able to: | Students: | |
| ENGAGE | **Lesson 1** What makes it go? | • identify evidence that shows that a battery is working<br>• explain their existing ideas of how a battery works<br>• describe how they think a battery-operated device works<br>• explain their existing ideas of how a torch works<br>• explain what they know about how electric circuits work. | • record information and ideas about battery-operated devices<br>• represent what they think they know about how a torch works in a cutaway diagram<br>• contribute to the class science chat-board to represent their understanding of how electric circuits work, including further questions to investigate. | • observe and record information about the working of different battery-operated devices<br>• draw a cutaway diagram of how they think a torch works<br>• share and discuss observations. | **Diagnostic assessment**<br>• Science journal entries<br>• Class discussions<br>• Class scientists' chat-board contributions<br>• Cutaway diagrams |

* These lesson outcomes are aligned to relevant descriptions of the Australian Curriculum. See page 2 for Science and page 8 for English and Mathematics.

| | | SCIENCE OUTCOMES* | LITERACY OUTCOMES* | LESSON SUMMARY | ASSESSMENT OPPORTUNITIES |
|---|---|---|---|---|---|
| | | Students will be able to: | Students will be able to: | Students: | |
| EXPLORE | **Lesson 2**<br>Light up my life | • make predictions about circuits that will light a light bulb<br>• construct and test circuits and record their observations<br>• compare their representations of circuits. | • record predictions, observations and explanations about circuits<br>• use writing, drawing and modelling to clarify ideas about designs of circuits<br>• represent a circuit diagram using circuit symbols. | • construct and test circuits<br>• represent a functioning circuit. | **Formative assessment**<br>• Science journal entries<br>• Class discussions<br>• Class scientists' chat-board contributions<br>• Circuit diagrams<br>• 'PROE record: Lighting up my life' (Resource sheet 1) |
| | **Lesson 3**<br>Light bulb explorers | • make predictions about circuits that will light a light bulb<br>• construct and test circuits and record their observations<br>• compare their representations of circuits. | • record predictions, observations and explanations about circuits<br>• use writing, drawing and modelling to clarify ideas about designs of circuits<br>• represent a circuit diagram using circuit symbols. | • draw a light bulb from memory<br>• draw a light bulb from observation<br>• read about and complete a labelled diagram of a light bulb. | **Formative assessment**<br>• Science journal entries<br>• Class discussions<br>• Class scientists' chat-board contributions<br>• Labelled diagrams<br>• 'Inside a light bulb' (Resource sheet 3) |

* These lesson outcomes are aligned to relevant descriptions of the Australian Curriculum. See page 2 for Science and page 8 for English and Mathematics.

| | | SCIENCE OUTCOMES* | LITERACY OUTCOMES* | LESSON SUMMARY | ASSESSMENT OPPORTUNITIES |
|---|---|---|---|---|---|
| | | Students will be able to: | Students will be able to: | Students: | |
| EXPLORE | **Lesson 4**<br>Alessandro Volta: Battery maker | • identify some ways that scientists think and work<br>• understand that scientific explanations develop historically through the contribution of ideas from many scientists<br>• understand that scientific explanations are revised as new evidence emerges. | • understand the purpose and features of a biography<br>• discuss how scientific knowledge develops<br>• represent an understanding of this biography in a chronological list, role-play or researched multimedia presentation. | • read and discuss a biography about Alessandro Volta<br>• discuss the way scientists develop and change their ideas<br>• represent their ideas about the biography. | **Formative assessment**<br>• Science journal entries<br>• Class discussions<br>• Class scientists' chat-board contributions<br>• Literacy product based on reading the biography of 'Alessandro Volta: Battery maker' (Resource sheet 4)<br>• 'Chronological list: Alessandro Volta' (Resource sheet 5) |
| EXPLAIN | **Lesson 5**<br>Enacting electrons | • describe the components of a complete circuit<br>• identify the source of electrical energy in a circuit<br>• explain the role of electrons in carrying electrical energy around a circuit<br>• explain that electrical energy is changed into light energy by the bulb. | • show understanding of how a circuit works through participation in a role-play and discussion<br>• represent their understanding through drawing an annotated diagram of a circuit<br>• use scientific vocabulary appropriately in writing and talking. | • participate in a whole-class role-play of an electric circuit<br>• discuss the role of the components of an electric circuit<br>• represent their understanding using a circuit diagram. | **Formative assessment**<br>• Science journal entries<br>• Class discussions<br>• Class scientists' chat-board contributions<br>• Circuit diagrams<br>• Role-plays |

* These lesson outcomes are aligned to relevant descriptions of the Australian Curriculum. See page 2 for Science and page 8 for English and Mathematics.

| | | SCIENCE OUTCOMES* | LITERACY OUTCOMES* | LESSON SUMMARY | ASSESSMENT OPPORTUNITIES |
|---|---|---|---|---|---|
| | | Students will be able to: | Students will be able to: | Students: | |
| ELABORATE | **Lesson 6**<br>Problem solvers: What's it all about? | • formulate a question and make predictions about whether or not various materials will conduct an electric current<br>• conduct fair tests of materials to see if they are conductors or insulators<br>• identify and describe the types of materials that are conductors and insulators<br>• provide evidence to support their description. | • plan, conduct and represent a fair test to decide if materials are conductors or insulators<br>• summarise their findings about materials investigated<br>• participate in cooperative learning teams and class discussion. | • formulate a question for investigation<br>• construct a circuit and test their question for investigation<br>• observe, record and share results<br>• discuss materials that conduct electrical energy. | **Summative assessment** of Science Inquiry Skills<br>• Science journal entries<br>• Class discussions including about what to investigate<br>• Class scientists' chat-board contributions<br>• Discussion about what question to investigate<br>• 'Problem solvers: Investigation planner' (Resource sheet 7) |
| | **Lesson 7**<br>Switched on | • construct two types of electrical switch<br>• explain how switches are used to control the flow of electrical energy around a circuit. | • interpret a procedural text to construct two types of electrical switch<br>• represent their understanding of how switches control the flow of electrical energy in a circuit using a circuit diagram<br>• develop scientific vocabulary about switches. | • discuss the role of switches in an electric circuit<br>• create a circuit diagram including the switch symbol. | |

* These lesson outcomes are aligned to relevant descriptions of the Australian Curriculum. See page 2 for Science and page 8 for English and Mathematics.

| | | SCIENCE OUTCOMES* | LITERACY OUTCOMES* | LESSON SUMMARY | ASSESSMENT OPPORTUNITIES |
|---|---|---|---|---|---|
| | | Students will be able to: | Students will be able to: | Students: | |
| EVALUATE | **Lesson 8** Bright sparks: Sharing what we know | • describe a circuit in terms of components that form a continuous path for the flow of electrons<br>• describe how energy is transferred within an electric circuit<br>• explain the characteristics of conductors and insulators in terms of categories of materials. | • make a labelled model to represent how an electric circuit works<br>• make a presentation to communicate their understanding of electric circuits<br>• use a checklist to reflect on their learning in the unit<br>• list, group and label ideas about their learning in the unit. | • participate in a word loop activity<br>• work in cooperative learning teams to prepare a model of a torch<br>• prepare a description that communicates the main ideas of their model and how an electric circuit works<br>• share models and descriptions with an audience<br>• reflect on their learning during the unit. | **Summative assessment** of Science Understanding<br>• Science journal entries<br>• Class discussions<br>• Class scientists' chat-board contributions<br>• Presentations based on models<br>• 'Bright sparks: Reflecting on my learning' (Resource sheet 11) |

* These lesson outcomes are aligned to relevant descriptions of the Australian Curriculum. See page 2 for Science and page 8 for English and Mathematics.

| 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*<br>*Friends and foes* | *Material world*<br>*Package it better* | *Beneath our feet* | *Smooth moves* |
| 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*<br>*Essential energy* |

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