Science, Technology, Engineering and Mathematics (STEM) Education and Outreach

Australian Curriculum Links and Hands-On Activity Descriptions Guide

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Introduction

This document outlines the various components of the Australian Curricula in Science and Mathematics, and the Sustainability Curriculum Framework for Foundation to Year 10, and makes connections between these elements and hands-on activities available through the University of Tasmania’s School of Engineering STEM Education and Outreach Program. Links are also provided between Science Curriculum elements and Primary Connections units. For each curriculum element, links are made to Modules (i.e., standalone sessions or groups of activities in a particular area), and to Activity Reference numbers. For example, activity reference number 12.3 refers to the third activity in module 12. At the end of this guide, activity descriptions are provided which include their likely durations and a discussion on how to extend them.

Note that an approximate duration is provided for each activity which reflects the typical time required for the activity in a session run by the STEM Education and Outreach team. These times are flexible, and the prospect of activity extension and participants’ prior knowledge may both have a large effect on the actual time required for each activity. Any specialised equipment and generic materials required for each activity (including consumables) are identified. Note also that “activity guides” (which are similar to lesson plans) are available for some activities. Pre- and post-lesson resources, including a generic introduction to Engineering and the Engineering Design Process (EDP), are available in the appendix.

The inquiry modes referred to in this document have been adapted from the literature on inquiry and are summarised in the glossary. Most activities (as structured and run by the STEM Education and Outreach Team) fall into the guided and structured inquiry categories. Extended STEM programs, featuring open inquiry and running over a number of sessions, can also be put together on request.

Traditionally, the STEM Education and Outreach team has run self-contained 90-120 minute lessons relying on a sequence of activities from this guide. These activity sequences are outlined in this guide (please refer to the Appendix) and can either be followed exactly or modified to suit a particular class or learning setting. Some activities (as identified in the “Modules and Activities” section) are suitable to be used as standalone activities, while others may require some prerequisite knowledge which can be developed by following the recommended activity sequence. A few activities can be used in a number of different modules as identified throughout the activity sequencing information available in the Appendix.

In some cases, activities are identified as requiring “nil prerequisite skill or knowledge”. These activities are in general standalone and self-contained activities where all relevant concepts and skills required by the activity are introduced and developed during the activity itself. For some of these activities, prior knowledge about forces would be advantageous, but is not necessary.

In the development of this document we have used version 4.0 of the Australian Curriculum Science published on Thursday 13 December, 2012 and version 4.0 of the Australian Curriculum Mathematics published on Thursday 13 December, 2012, respectively. We have also used the 2010 version of the Sustainability Curriculum Framework available from http://www.environment.gov.au/education/publications/pubs/curriculum-framework.pdf
We also note that some terms and words in *italics* are defined and/or developed further in the Appendix.

Please let us know if you find any errors of if you have any suggestions that could help us to improve this guide. We also look forward to hearing from potential partners who would like to work with us on boosting STEM education in Australia and elsewhere.
The Australian Curriculum Science
Foundation Year

Science Understanding
Biological sciences:
- Living things have basic needs, including food and water (ACSSU002)
  
  *Primary Connections Unit: Staying Alive*

Chemical sciences:
- Objects are made of materials that have observable properties (ACSSU003)
  
  *Primary Connections Unit: What’s it made of?*

Earth and space sciences:
- Daily and seasonal changes in our environment, including the weather, affect everyday life (ACSSU004)
  
  *Primary Connections Unit: Weather in my world*

Physical sciences:
- The way objects move depend on a variety of factors, including their size and shape (ACSSU005)
  
  *Relevant Modules: Eggs-treme Crashes, The Sky is the Limit*

  *Activities: 2.1, 3.1, 3.2*

  *Primary Connections Unit: On the Move*

Science as a Human Endeavour
Nature and development of science:
- Science involves exploring and observing the world using the senses (ACSHE013)

Science Inquiry Skills
Questioning and predicting:
- Respond to questions about familiar objects and events (ACSIS014)
  
  *Relevant Modules: Eggs-treme Crashes, The Sky is the Limit, Opposites Attract*

  *Activities: 2.1, 3.1, 3.2, 13.1*
Planning and conducting:
  - Explore and make observations by using the senses (ACSI011)

  *Relevant Modules: Eggs-treme Crashes, The Sky is the Limit, Opposites Attract*

  *Activities: 2.1, 3.1, 3.2, 13.1*

Processing and analysing data and information:
  - Engage in discussions about observations and use methods such as drawing to represent ideas (ACSI233)

Communicating:
  - Share observations and ideas (ACSI012)

  *Relevant Modules: Eggs-treme Crashes, The Sky is the Limit, Opposites Attract*

  *Activities: 2.1, 3.1, 3.2, 13.1*
Year 1

Science Understanding

Biological sciences:
- Living things have a variety of external features (ACSSU017)
- Living things live in different places where their needs are met (ACSSU211)

*Primary Connections Unit: Schoolyard Safari*

Chemical sciences:
- Everyday materials can be physically changed in a variety of ways (ACSSU018)

*Primary Connections Unit: Spot the difference*

Earth and space sciences:
- Observable changes occur in the sky and landscape (ACSSU019)

*Primary Connections Unit: Up, down and all around*

Physical sciences:
- Light and sound are produced by a range of sources and can be sensed (ACSSU020)

*Relevant Modules: Seeing the Light, It Sounds Great!*

*Activities: 7.1, 7.4, 7.5, 7.10, 7.12, 7.13, 8.2, 8.3, 8.4, 8.6*

*Primary Connections Unit: Look! Listen!*

Science as a Human Endeavour

Nature and development of science:
- Science involves asking questions about, and describing changes in, objects and events (ACSHE021)

Use and influence of science:
- People use science in their daily lives, including when caring for their environment and living things (ACSHE022)
Science Inquiry Skills

Questioning and predicting:
- Respond to and pose questions, and make predictions about familiar objects and events (ACSIS024)

Relevant Modules: Eggs-treme Crashes, The Sky is the Limit, Seeing the Light, It Sounds Great!, Plane-tastic, Opposites Attract

Activities: 2.1, 3.1, 3.2, 7.1, 7.3, 7.4, 8.2, 8.3, 8.4, 8.5, 8.6, 11.1, 11.2, 11.3, 11.4, 13.1

Planning and conducting:
- Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas and accessing information sources (ACSIS025)
- Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate (ACSIS026)

Relevant Modules: Eggs-treme Crashes, The Sky is the Limit, Seeing the Light, It Sounds Great!, Plane-tastic, Opposites Attract

Activities: 2.1, 3.1, 3.2, 7.1, 7.3, 7.4, 8.2, 8.3, 8.4, 8.5, 8.6, 11.1, 11.2, 11.3, 11.4, 13.1

Processing and analysing data and information:
- Use a range of methods to sort information, including drawings and provided tables (ACSIS027)
- Through discussion, compare observations with predictions (ACSIS212)

Relevant Modules: Eggs-treme Crashes, The Sky is the Limit, Seeing the Light, It Sounds Great!, Plane-tastic, Opposites Attract

Activities: 2.1, 3.1, 3.2, 7.1, 7.3, 7.4, 8.2, 8.3, 8.4, 8.5, 8.6, 11.1, 11.2, 11.3, 11.4, 13.1

Evaluating:
- Compare observations with those of others (ACSIS213)

Relevant Modules: Eggs-treme Crashes, The Sky is the Limit, Seeing the Light, It Sounds Great!, Plane-tastic, Opposites Attract

Activities: 2.1, 3.1, 3.2, 7.1, 7.3, 7.4, 8.2, 8.3, 8.4, 8.5, 8.6, 11.1, 11.2, 11.3, 11.4, 13.1

Communicating:
- Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play (ACSIS029)

Relevant Modules: Eggs-treme Crashes, The Sky is the Limit, Seeing the Light, It Sounds Great!, Plane-tastic, Opposites Attract

Activities: 2.1, 3.1, 3.2, 7.1, 7.3, 7.4, 8.2, 8.3, 8.4, 8.5, 8.6, 11.1, 11.2, 11.3, 11.4, 13.1
Year 2

Science Understanding

Biological sciences:
- Living things grow, change and have offspring similar to themselves (ACSSU030)

Primary Connections Unit: Watch it grow!

Chemical sciences:
- Different materials can be combined, including by mixing, for a particular purpose (ACSSU031)

Relevant Modules: Chemistry Matters

Activities: 14.2

Primary Connections Unit: All mixed up

Earth and space sciences:
- Earth’s resources, including water, are used in a variety of ways (ACSSU032)

Relevant Modules: Let’s Dive Right In, Let’s Be Civil

Activities: 17.1, 17.2, 17.3, 19.2

Primary Connections Unit: Water works

Physical sciences:
- A push or pull affects how an object moves or changes shape (ACSSU033)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, Plane-tastic, The Sky is the Limit, Opposites Attract, Thrill Rides

Activities: 1.1, 2.1, 3.1, 3.2, 3.3, 11.1, 11.2, 11.3, 11.4, 13.1, 16.1

Primary Connections Unit: Push-pull

Science as a Human Endeavour

Nature and development of science:
- Science involves asking questions about, and describing changes in, objects and events (ACSHE034)
Use and influence of science:

- People use science in their daily lives, including when caring for their environment and living things (ACSHE035)

Science Inquiry Skills

Questioning and predicting:

- Respond to and pose questions, and make predictions about familiar objects and events (ACSIS037)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Opposites Attract, Seeing the Light, It Sounds Great!, Plane-tastic, Thrill Rides, Let’s Dive Right In

Activities: 1.1, 2.1, 3.1, 3.2, 7.1, 7.4, 7.5, 7.10, 7.12, 7.13, 8.2, 8.3, 8.4, 8.6, 11.2, 11.3, 11.4, 13.1, 16.1, 17.1, 17.2, 17.3

Planning and conducting:

- Participate in different types of guided investigations to explore and answer questions, such as manipulating materials, testing ideas and accessing information sources (ACSIS038)

- Use informal measurements in the collection and recording of observations, with the assistance of digital technologies as appropriate (ACSIS039)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Plane-tastic, Opposites Attract, Thrill Rides, Let’s Dive Right In, Let’s Be Civil

Activities: 1.1, 2.1, 3.1, 3.2, 11.2, 11.3, 11.4, 13.1, 16.1, 17.3, 19.2

Processing and analysing data and information:

- Use a range of methods to sort information, including drawings and provided tables (ACSIS040)

- Through discussion, compare observations with predictions (ACSIS214)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Plane-tastic, Opposites Attract, Thrill Rides, Let’s Dive Right In, Let’s Be Civil

Activities: 1.1, 2.1, 3.1, 3.2, 11.2, 11.3, 11.4, 13.1, 16.1, 17.3, 19.2

Evaluating:

- Compare observations with those of others (ACSIS041)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Plane-tastic, Opposites Attract, Thrill Rides, Let’s Dive Right In, Let’s Be Civil

Activities: 1.1, 2.1, 3.1, 3.2, 11.2, 11.3, 11.4, 13.1, 16.1, 17.3, 19.2
Communicating:

- Represent and communicate observations and ideas in a variety of ways such as oral and written language, drawing and role play (ACSIS042)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Plane-tastic, Opposites Attract, Thrill Rides, Let’s Dive Right In, Let’s Be Civil

Activities: 1.1, 2.1, 3.1, 3.2, 11.2, 11.3, 11.4, 13.1, 16.1, 17.3, 19.2
Year 3

Science Understanding

Biological sciences:

- Living things can be grouped on the basis of observable features and can be distinguished from non-living things (ACSSU044)

*Primary Connections Unit: Feathers, Fur or Leaves?*

Chemical sciences:

- A change of state between solid and liquid can be caused by adding or removing heat (ACSSU046)

*Relevant Modules: Chemistry Matters*

*Activities: 14.3, 14.4, 14.5*

*Primary Connections Unit: Melting moments*

Earth and space sciences:

- Earth’s rotation on its axis causes regular changes, including night and day (ACSSU048)

*Primary Connections Unit: Night and day*

Physical sciences:

- Heat can be produced in many ways and can move from one object to another (ACSSU049)

*Relevant Modules: Be Cool: Hot Science, Renew Your Energy, Cooking up a Storm*

*Activities: 6.5, 15.1, 15.2, 15.3, 15.4, 18.5, 18.6*

*Primary Connections Unit: Heating up*

Science as a Human Endeavour

Nature and development of science:

- Science involves making predictions and describing patterns and relationships (ACSHE050)

Use and influence of science:

- Science knowledge helps people to understand the effect of their actions (ACSHE051)
Science Inquiry Skills

Questioning and predicting:

- With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge (ACSIS053)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Planetastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Planning and conducting:

- Suggest ways to plan and conduct investigations to find answers to questions (ACSIS054)
- Safely use appropriate materials, tools or equipment to make and record observations, using formal measurements and digital technologies as appropriate (ACSIS055)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Planetastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Processing and analysing data and information:

- Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends (ACSIS057)
- Compare results with predictions, suggesting possible reasons for findings (ACSIS215)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Planetastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Evaluating:

- Reflect on the investigation, including whether a test was fair or not (ACSIS058)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Communicating:

- Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports (ACSIS060)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Year 4

Science Understanding

Biological sciences:

- Living things have life cycles (ACSSU072)
- Living things, including plants and animals, depend on each other and the environment to survive (ACSSU073)

*Primary Connections Unit:* Plants in Action/Friends and foes

Chemical sciences:

- Natural and processed materials have a range of physical properties; These properties can influence their use (ACSSU074)

*Relevant Modules:* It’s Electrifying, Chemistry Matters, It’s Full of Hot Air, Eggs-treme Crashes, Electricity on Wheels, The Sky is the Limit, Let’s Dive Right In, Thrill Rides, Cooking up a Storm, Let’s Be Civil, Sporty Science, Get a Grip!, Renew Your Energy

*Activities:*

*Primary Connections Unit:* Material World/ Package it Better

Earth and space sciences:

- Earth’s surface changes over time as a result of natural processes and human activity (ACSSU075)

*Primary Connections Unit:* Beneath our Feet

Physical sciences:

- Forces can be exerted by one object on another through direct contact or from a distance (ACSSU076)

*Relevant Modules:* It’s Full of Hot Air, Electricity on Wheels, Eggs-treme Crashes, Plane-tastic, Don’t Crack Under Pressure, The Sky is the Limit, Work Smarter Not Harder, Opposites Attract, It Sounds Great!, Thrill Rides, Let’s Dive Right In, Renew Your Energy

*Activities:*

*Primary Connections Unit:* Smooth Moves
Science as a Human Endeavour

Nature and development of science:

- Science involves making predictions and describing patterns and relationships (ACSHE061)

Use and influence of science:

- Science knowledge helps people to understand the effect of their actions (ACSHE062)

Science Inquiry Skills

Questioning and predicting:

- With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge (ACSIS064)

*Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!*


Planning and conducting:

- Suggest ways to plan and conduct investigations to find answers to questions (ACSIS065)
- Safely use appropriate materials, tools or equipment to make and record observations, using formal measurements and digital technologies as appropriate (ACSIS066)

*Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!*

Processing and analysing data and information:

- Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends (ACSIS068)
- Compare results with predictions, suggesting possible reasons for findings (ACSIS216)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Evaluating:

- Reflect on the investigation; including whether a test was fair or not (ACSIS069)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Communicating:

- Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports (ACSIS071)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Year 5

Science Understanding

Biological sciences:
- Living things have structural features and adaptations that help them to survive in their environment (ACSSU043)

*Primary Connections Unit: Desert Survivors*

Chemical sciences:
- Solids, liquids and gases have different observable properties and behave in different ways (ACSSU077)

*Relevant Modules: Chemistry Matters*

*Activities: 14.1, 14.2, 14.3, 14.4, 14.5*

*Primary Connections Unit: What’s the matter?*

Earth and space sciences:
- The Earth is part of a system of planets orbiting around a star (the sun) (ACSSU078)

*Primary Connections Unit: Earth’s place in space*

Physical sciences:
- Light from a source forms shadows and can be absorbed, reflected and refracted (ACSSU080)

*Relevant Modules: Seeing the Light, Let’s Dive Right In*

*Activities: 7.1, 7.2, 7.3, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 7.10, 7.11, 7.12, 7.13, 17.6*

*Primary Connections Unit: Light Shows*

Science as a Human Endeavour

Nature and development of science:
- Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena (ACSHE081)
- Important contributions to the advancement of science have been made by people from a range of cultures (ACSHE082)
Use and influence of science:

- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples’ lives (ACSHE083)
- Scientific knowledge is used to inform personal and community decisions (ACSHE217)

Science Inquiry Skills

Questioning and predicting:

- With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be (ACSIS231)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Planning and conducting:

- With guidance, plan appropriate investigation methods to answer questions or solve problems (ACSIS086)
- Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate (ACSIS087)
- Use equipment and materials safely, identifying potential risks (ACSIS088)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Processing and analysing data and information:

- 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 (ACSIS090)
- Compare data with predictions and use as evidence in developing explanations (ACSIS218)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Evaluating:

- Suggest improvements to the methods used to investigate a question or solve a problem (ACSIS091)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Communicating:

- Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts (ACSIS093)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Year 6

Science Understanding

Biological sciences:
- The growth and survival of living things are affected by the physical conditions of their environment (ACSSU094)

Relevant Modules: Cooking up a Storm, Renew Your Energy

Activities: 6.2, 18.1

Primary Connections Unit: Marvellous micro-organisms

Chemical sciences:
- Changes to materials can be reversible, such as melting, freezing, evaporating; or irreversible, such as burning and rusting (ACSSU095)

Relevant Modules: Chemistry Matters

Activities: 14.3, 14.4, 14.5

Primary Connections Unit: Change Detectives

Earth and space sciences:
- Sudden geological changes or extreme weather conditions can affect Earth’s surface (ACSSU096)

Primary Connections Unit: Earthquake Explorers

Physical sciences:
- Electrical circuits provide a means of transferring and transforming electricity (ACSSU097)
- Energy from a variety of sources can be used to generate electricity (ACSSU219)

Relevant Modules: Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, It Sounds Great!

Activities: 4.1, 6.1, 6.3, 6.4, 6.6, 8.1, 12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8, 13.2, 13.3

Primary Connections Unit: It’s Electrifying/Essential Energy
Science as a Human Endeavour

Nature and development of science:

- Science involves testing predictions by gathering data and using evidence to develop explanations of events and phenomena (ACSHE098)
- Important contributions to the advancement of science have been made by people from a range of cultures (ACSHE099)

Use and influence of science:

- Scientific understandings, discoveries and inventions are used to solve problems that directly affect peoples’ lives (ACSHE100)
- Scientific knowledge is used to inform personal and community decisions (ACSHE220)

Science Inquiry Skills

Questioning and predicting:

- With guidance, pose questions to clarify practical problems or inform a scientific investigation, and predict what the findings of an investigation might be (ACSIS232)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Planning and conducting:

- With guidance, plan appropriate investigation methods to answer questions or solve problems (ACSIS103)
- Decide which variable should be changed and measured in fair tests and accurately observe, measure and record data, using digital technologies as appropriate (ACSIS104)
- Use equipment and materials safely, identifying potential risks (ACSIS105)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Processing and analysing data and information:

- 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 (ACSIS107)
- Compare data with predictions and use as evidence in developing explanations (ACSIS221)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Evaluating:

- Suggest improvements to the methods used to investigate a question or solve a problem (ACSIS108)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Communicating:

- Communicate ideas, explanations and processes in a variety of ways, including multi-modal texts (ACSIS110)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Plane-tastic, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Year 7

Science Understanding

Biological sciences:
- There are differences within and between groups of organisms; classification helps organise this diversity (ACSSU111)
- Interactions between organisms can be described in terms of food chains and food webs; human activity can affect these interactions (ACSSU112)

Chemical sciences:
- Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques (ACSSU113)

Earth and space sciences:
- Predictable phenomena on Earth, including seasons and eclipses, are caused by the relative positions of the sun, Earth and the moon (ACSSU115)
- Some of Earth’s resources are renewable, but others are non-renewable (ACSSU116)
- Water is an important resource that cycles through the environment (ACSSU222)

Relevant Modules: Renew Your Energy, Let’s Be Civil

Activities: 6.1, 6.2, 6.3, 6.4, 6.5, 19.2

Physical sciences:
- Change to an object’s motion is caused by unbalanced forces acting on the object (ACSSU117)
- Earth’s gravity pulls objects towards the centre of the Earth (ACSSU118)

Relevant Modules: Don’t Crack Under Pressure, It’s Full of Hot Air, Electricity on Wheels, The Sky is the Limit, Work Smarter Not Harder, Eggs-treme Crashes, Thrill Rides, Let’s Dive Right In, Renew Your Energy, Sporty Science, Get a Grip!


Science as a Human Endeavour

Nature and development of science:
- Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people’s understanding of the world (ACSHE119)
- Science knowledge can develop through collaboration and connecting ideas across the disciplines of science (ACSHE223)
Use and influence of science:

- Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE120)
- Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management (ACSHE121)
- People use understanding and skills from across the disciplines of science in their occupations (ACSHE224)

**Science Inquiry Skills**

**Questioning and predicting:**

- Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS124)

*Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!*


**Planning and conducting:**

- Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS125)
- In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task (ACSIS126)

*Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!*

Processing and analysing data and information:

- Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships, including using digital technologies as appropriate (ACSIS129)
- Summarise data from students’ own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions (ACSIS130)

**Relevant Modules:** It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Evaluating:

- Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method (ACSIS131)
- Use scientific knowledge and findings from investigations to evaluate claims (ACSIS132)

**Relevant Modules:** It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Communicating:

- Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate (ACSIS133)

**Relevant Modules:** It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Year 8

Science Understanding

Biological sciences:
- Cells are the basic units of living things and have specialised structures and functions (ACSSU149)
- Multi-cellular organisms contain systems of organs that carry out specialised functions that enable them to survive and reproduce (ACSSU150)

Chemical sciences:
- The properties of the different states of matter can be explained in terms of the motion and arrangement of particles (ACSSU151)
- Differences between elements, compounds and mixtures can be described at a particle level (ACSSU152)
- Chemical change involves substances reacting to form new substances (ACSSU225)

Earth and space sciences:
- Sedimentary, igneous and metamorphic rocks contain minerals and are formed by processes that occur within Earth over a variety of timescales (ACSSU153)

Physical sciences:
- Energy appears in different forms including movement (kinetic energy), heat and potential energy, and causes change within systems (ACSSU155)

Relevant Modules:  Don’t Crack Under Pressure, It’s Full of Hot Air, Electricity on Wheels, Work Smarter Not Harder, Renew Your Energy, Seeing the Light, The Sky is the Limit, It Sounds Great!, Thrill Rides, Let’s Dive Right In, Be Cool: Hot Science, Get a Grip!, Cooking up a Storm, Sporty Science

Activities:  1.1, 2.1, 3.2, 4.1, 5.1, 6.1, 6.3, 6.6, 7.2, 7.3, 7.8, 7.9, 8.1, 8.9, 8.10, 8.11, 8.12, 9.1, 9.2, 9.3, 9.4, 16.1, 16.2, 17.8, 18.5, 18.6, 20.3, 20.4, 21.6

Science as a Human Endeavour

Nature and development of science:
- Scientific knowledge changes as new evidence becomes available, and some scientific discoveries have significantly changed people’s understanding of the world (ACSHE134)
- Science knowledge can develop through collaboration and connecting ideas across the disciplines of science (ACSHE226)
Use and influence of science:

- Science and technology contribute to finding solutions to a range of contemporary issues; these solutions may impact on other areas of society and involve ethical considerations (ACSHE135)
- Science understanding influences the development of practices in areas of human activity such as industry, agriculture and marine and terrestrial resource management (ACSHE136)
- People use understanding and skills from across the disciplines of science in their occupations (ACSHE227)

Science Inquiry Skills

Questioning and predicting:

- Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge (ACSIS139)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Planning and conducting:

- Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed (ACSIS140)
- In fair tests, measure and control variables, and select equipment to collect data with accuracy appropriate to the task (ACSIS141)

Relevant Modules: It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Processing and analysing data and information:

- Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships, including using digital technologies as appropriate (ACSIS144)
- Summarise data from students’ own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions (ACSIS145)

*Relevant Modules:* It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Evaluating:

- Reflect on the method used to investigate a question or solve a problem, including evaluating the quality of the data collected, and identify improvements to the method (ACSIS146)
- Use scientific knowledge and findings from investigations to evaluate claims (ACSIS234)

*Relevant Modules:* It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!


Communicating:

- Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate (ACSIS148)

*Relevant Modules:* It’s Full of Hot Air, Eggs-treme Crashes, The Sky is the Limit, Electricity on Wheels, Renew Your Energy, It’s Electrifying, Opposites Attract, Seeing the Light, Work Smarter Not Harder, Thrill Rides, Let’s Dive Right In, Cooking Up a Storm, Let’s be Civil, Sporty Science, Get a Grip!

Year 9

Science Understanding

Biological sciences:
- Multi-cellular organisms rely on coordinated and interdependent internal systems to respond to changes to their environment (ACSSU175)
- Ecosystems consist of communities of interdependent organisms and abiotic components of the environment; matter and energy flow through these systems (ACSSU176)

Chemical sciences:
- All matter is made of atoms which are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms (ACSSU177)
- Chemical reactions involve rearranging atoms to form new substances; during a chemical reaction mass is not created or destroyed (ACSSU178)
- Chemical reactions, including combustion and the reactions of acids, are important in both non-living and living systems and involve energy transfer (ACSSU179)

Earth and space sciences:
- The theory of plate tectonics explains global patterns of geological activity and continental movement (ACSSU180)

Physical sciences:
- Energy transfer through different mediums can be explained using wave and particle models (ACSSU182)

Relevant Modules: Seeing the Light, It Sounds Great!

Activities: 7.2, 7.3, 7.6, 7.7, 7.8, 7.9, 7.13, 8.1

Science as a Human Endeavour

Nature and development of science:
- Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community (ACSHE157)
- Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE158)
Use and influence of science:

- People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions (ACSH160)
- Advances in science and emerging sciences and technologies can significantly affect people’s lives, including generating new career opportunities (ACSH161)
- The values and needs of contemporary society can influence the focus of scientific research (ACSH228)

Science Inquiry Skills
Questioning and predicting:

- Formulate questions or hypotheses that can be investigated scientifically (ACSI164)

*Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!

*Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6

Planning and conducting:

- Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSI165)
- Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data (ACSI166)

*Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!

*Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6

Processing and analysing data and information:

- Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies (ACSI169)
- Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSI170)

*Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!

*Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6
Evaluating:

- Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS171)
- Critically analyse the validity of information in secondary sources and evaluate the approaches used to solve problems (ACSIS172)

Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!

Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6

Communicating:

- Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS174)

Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!

Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6
Year 10

Science Understanding

Biological sciences:
- The transmission of heritable characteristics from one generation to the next involves DNA and genes (ACSSU184)
- The theory of evolution by natural selection explains the diversity of living things and is supported by a range of scientific evidence (ACSSU185)

Chemical sciences:
- The atomic structure and properties of elements are used to organise them in the Periodic Table (ACSSU186)
- Different types of chemical reactions are used to produce a range of products and can occur at different rates (ACSSU187)

Relevant Modules: Renew Your Energy

Activities: 6.2, 6.3

Earth and space sciences:
- The universe contains features including galaxies, stars and solar systems and the Big Bang theory can be used to explain the origin of the universe (ACSSU188)
- Global systems, including the carbon cycle, rely on interactions involving the biosphere, lithosphere, hydrosphere and atmosphere (ACSSU189)

Physical sciences:
- Energy conservation in a system can be explained by describing energy transfers and transformations (ACSSU190)
- The motion of objects can be described and predicted using the laws of physics (ACSSU229)

Relevant Modules: Don’t Crack Under Pressure, Renew Your Energy, Seeing the Light, Let’s Dive Right In, Get a Grip!

Activities: 5.1, 6.1, 6.6, 7.2, 7.3, 7.8, 7.9, 17.3, 17.4, 17.7, 17.8, 21.6

Science as a Human Endeavour

Nature and development of science:
- Scientific understanding, including models and theories, are contestable and are refined over time through a process of review by the scientific community (ACSHE191)
- Advances in scientific understanding often rely on developments in technology and technological advances are often linked to scientific discoveries (ACSHE192)
Use and influence of science:
- People can use scientific knowledge to evaluate whether they should accept claims, explanations or predictions (ACSHE194)
- Advances in science and emerging sciences and technologies can significantly affect people’s lives, including generating new career opportunities (ACSHE195)
- The values and needs of contemporary society can influence the focus of scientific research (ACSHE230)

Science Inquiry Skills
Questioning and predicting:
- Formulate questions or hypotheses that can be investigated scientifically (ACSIS198)
  Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!
  Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6

Planning and conducting:
- Plan, select and use appropriate investigation methods, including field work and laboratory experimentation, to collect reliable data; assess risk and address ethical issues associated with these methods (ACSIS199)
- Select and use appropriate equipment, including digital technologies, to systematically and accurately collect and record data (ACSIS200)
  Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!
  Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6

Processing and analysing data and information:
- Analyse patterns and trends in data, including describing relationships between variables and identifying inconsistencies (ACSIS203)
- Use knowledge of scientific concepts to draw conclusions that are consistent with evidence (ACSIS204)
  Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!
  Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6
Evaluating:

- Evaluate conclusions, including identifying sources of uncertainty and possible alternative explanations, and describe specific ways to improve the quality of the data (ACSIS205)
- Critically analyse the validity of information in secondary sources and evaluate the approaches used to solve problems (ACSIS206)

Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!

Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6

Communicating:

- Communicate scientific ideas and information for a particular purpose, including constructing evidence-based arguments and using appropriate scientific language, conventions and representations (ACSIS208)

Relevant Modules: Renew Your Energy, It’s Electrifying, Seeing the Light, Let’s Dive Right In, Get a Grip!

Activities: 6.1, 6.2, 7.13, 12.3, 17.3, 17.4, 17.5, 17.6, 17.7, 21.6
The Australian Curriculum Mathematics
Foundation Year

Number and Algebra

Number and place value:
- Establish understanding of the language and processes of counting by naming numbers in sequences, initially to and from 20, moving from any starting point (ACMNA001)
- Connect number names, numerals and quantities, including zero, initially up to 10 and then beyond (ACMNA002)
- Subitise small collections of objects (ACMNA003)
- Compare, order and make correspondences between collections, initially to 20, and explain reasoning (ACMNA289)
- Represent practical situations to model addition and sharing (ACMNA004)

Patterns and algebra:
- Sort and classify familiar objects and explain the basis for these classifications. Copy, continue and create patterns with objects and drawings (ACMNA005)

Measurement and Geometry

Using units of measurement:
- Use direct and indirect comparisons to decide which is longer, heavier or holds more, and explain reasoning in everyday language (ACMMG006)
- Compare and order the duration of events using the everyday language of time (ACMMG007)
- Connect days of the week to familiar events and actions (ACMMG008)

Relevant Modules: The Sky is the Limit

Activities: 3.2

Shape:
- Sort, describe and name familiar two-dimensional shapes and three-dimensional objects in the environment (ACMMG009)

Location and transformation:
- Describe position and movement (ACMMG010)

Relevant Modules: Eggs-treme Crashes, The Sky is the Limit

Activities: 2.1, 3.1, 3.2
Statistics and Probability

Data representation and interpretation:

- Answer yes/no questions to collect information (ACMSP011)
Year 1

Number and Algebra

Number and place value:
- Develop confidence with number sequences to and from 100 by ones from any starting point. Skip count by twos, fives and tens starting from zero (ACMNA012)
- Recognise, model, read, write and order numbers to at least 100. Locate these numbers on a number line (ACMNA013)
- Count collections to 100 by partitioning numbers using place value (ACMNA014)
- Represent and solve simple addition and subtraction problems using a range of strategies including counting on, partitioning and rearranging parts (ACMNA015)

Fractions and decimals:
- Recognise and describe one-half as one of two equal parts of a whole (ACMNA016)

Money and financial mathematics:
- Recognise, describe and order Australian coins according to their value (ACMNA017)

Patterns and algebra:
- Investigate and describe number patterns formed by skip counting and patterns with objects (ACMNA018)

Measurement and Geometry

Using units of measurement:
- Measure and compare the lengths and capacities of pairs of objects using uniform informal units (ACMMG019)
- Tell time to the half-hour (ACMMG020)
- Describe duration using months, weeks, days and hours (ACMMG021)

Shape:
- Recognise and classify familiar two-dimensional shapes and three-dimensional objects using obvious features (ACMMG022)

Location and transformation:
- Give and follow directions to familiar locations (ACMMG023)
Statistics and Probability

Chance:

- Identify outcomes of familiar events involving chance and describe them using everyday language such as ‘will happen’, ‘won’t happen’ or ‘might happen’ (ACMSP024)

Data representation and interpretation:

- Choose simple questions and gather responses (ACMSP262)
- Represent data with objects and drawings where one object or drawing represents one data value. Describe the displays (ACMSP263)
Year 2

Number and Algebra

Number and place value:

- Investigate number sequences, initially those increasing and decreasing by twos, threes, fives and tens from any starting point, then moving to other sequences (ACMNA026)
- Recognise, model, represent and order numbers to at least 1000 (ACMNA027)
- Group, partition and rearrange collections up to 1000 in hundreds, tens and ones to facilitate more efficient counting (ACMNA028)
- Explore the connection between addition and subtraction (ACMNA029)
- Solve simple addition and subtraction problems using a range of efficient mental and written strategies (ACMNA030)
- Recognise and represent multiplication as repeated addition, groups and arrays (ACMNA031)
- Recognise and represent division as grouping into equal sets and solve simple problems using these representations (ACMNA032)

Fractions and decimals:

- Recognise and interpret common uses of halves, quarters and eights of shapes and collections (ACMNA033)

Money and financial mathematics:

- Count and order small collections of Australian coins and notes according to their value (ACMNA034)

Patterns and algebra:

- Describe patterns with numbers and identify missing elements (ACMNA035)
- Solve problems by using number sentences for addition or subtraction (ACMNA036)

Measurement and Geometry

Using units of measurement:

- Compare and order several shapes and objects based on length, area, volume and capacity using appropriate uniform informal units (ACMMG037)
- Compare masses of objects using balance scales (ACMMG038)
- Tell time to the quarter-hour, using the language of ‘past’ and ‘to’ (ACMMG039)
- Name and order months and seasons (ACMMG040)
- Use a calendar to identify the date and determine the number of days in each month (ACMMG041)

**Relevant Modules:** It’s Full of Hot Air

**Activities:** 1.1
Shape:
- Describe and draw two-dimensional shapes, with and without digital technologies (ACMMG042)
- Describe the features of three-dimensional objects (ACMMG043)

Location and transformation:
- Interpret simple maps of familiar locations and identify the relative positions of key features (ACMMG044)
- Investigate the effect of one-step slides and flips with and without digital technologies (ACMMG045)
- Identify and describe half and quarter turns (ACMMG046)

Statistics and Probability

Chance:
- Identify practical activities and everyday events that involve chance. Describe outcomes as ‘likely’ or ‘unlikely’ and identify some events as ‘certain’ or ‘impossible’ (ACMSP047)

Data representation and interpretation:
- Identify a question of interest based on one categorical variable. Gather data relevant to the question (ACMSP048)
- Collect, check and classify data (ACMSP049)
- Create displays of data using lists, table and picture graphs and interpret them (ACMSP050)
Year 3

Number and Algebra

Number and place value:

- Investigate the conditions required for a number to be odd or even and identify odd and even numbers (ACMNA051)
- Recognise, model, represent and order numbers to at least 10 000 (ACMNA052)
- Apply place values to partition, rearrange and regroup numbers to at least 10 000 to assist calculations and solve problems (ACMNA053)
- Recognise and explain the connection between addition and subtraction (ACMNA054)
- Recall addition facts for single-digit numbers and related subtraction facts to develop increasingly efficient mental strategies for computation (ACMNA055)
- Recall multiplication facts of two, three, five and ten and related division facts (ACMNA056)
- Represent and solve problems involving multiplication using efficient mental and written strategies and appropriate digital technologies (ACMNA057)

Fractions and decimals:

- Model and represent unit fractions including 1/2, 1/4, 1/3, 1/5 and their multiples to a complete whole (ACMNA058)

Money and financial mathematics:

- Represent money values in multiple ways and count the change required for simple transactions to the nearest five cents (ACMNA059)

Patterns and algebra:

- Describe, continue and create number patterns resulting from performing addition or subtraction (ACMNA060)

Measurement and Geometry

Using units of measurement:

- Measure, order and compare objects using familiar metric units of length, mass and capacity (ACMMG061)
- Tell time to the minute and investigate the relationship between units of time (ACMMG062)

Relevant Modules: It’s Full of Hot Air, I-Robotics

Activities: 1.1, 10.2, 10.4

Shape:

- Make models of three-dimensional objects and describe key features (ACMMG063)
Location and transformation:

- Create and interpret simple grid maps to show position and pathways (ACMMG065)
- Identify symmetry in the environment (ACMMG066)

_Relevant Modules: Seeing the Light_

_Activities: 7.4_

Geometric reasoning:

- Identify angles as measures of turn and compare angle sizes in everyday situations (ACMMG064)

_Relevant Modules: Seeing the Light, Let’s Dive Right In_

_Activities: 7.4, 7.5, 17.6_

**Statistics and Probability**

**Chance:**

- Conduct chance experiments, identify and describe possible outcomes and recognise variation in results (ACMSP067)

**Data representation and interpretation:**

- Identify questions or issues for categorical variables. Identify data sources and plan methods of data collection and recording (ACMSP068)
- Collect data, organise into categories and create displays using lists, tables, picture graphs and simple column graphs, with and without the use of digital technologies (ACMSP069)
- Interpret and compare data displays (ACMSP070)
Year 4

**Number and Algebra**

**Number and place value:**
- Investigate and use the properties of odd and even numbers (ACMNA071)
- Recognise, represent and order numbers to at least tens of thousands (ACMNA072)
- Apply place value to partition, rearrange and regroup numbers to at least tens of thousands to assist calculations and solve problems (ACMNA073)
- Investigate number sequences involving multiples of 3, 4, 6, 7, 8 and 9 (ACMNA074)
- Recall multiplication facts up to 10×10 and related division facts (ACMNA075)
- Develop efficient mental and written strategies and use appropriate digital technologies for multiplication and for division where there is no remainder (ACMNA076)

**Fractions and decimals:**
- Investigate equivalent fractions used in contexts (ACMNA077)
- Count by quarters, halves and thirds, including with mixed numerals. Locate and represent these fractions on a number line (ACMNA078)
- Recognise that the place value system can be extended to tenths and hundredths. Make connections between fractions and decimal notation (ACMNA079)

**Money and financial mathematics:**
- Solve problems involving purchases and the calculation of change to the nearest five cents with and without digital technologies (ACMNA080)

**Patterns and algebra:**
- Explore and describe number patterns resulting from performing multiplication (ACMNA081)
- Solve word problems by using number sentences involving multiplication or division where there is no remainder (ACMNA082)
- Use equivalent number sentences involving addition and subtraction to find unknown quantities (ACMNA083)
Measurement and Geometry

Using units of measurement:

- Use scaled instruments to measure and compare lengths, masses, capacities and temperatures (ACMMG084)
- Compare objects using familiar metric units of area and volume (ACMMG290)
- Convert between units of time (ACMMG085)
- Use am and pm notation and solve simple time problems (ACMMG086)

Relevant Modules: It’s Full of Hot Air, Electricity on Wheels, I-Robotics, Cooking up a Storm

Activities: 1.1, 4.1, 10.2, 10.4, 18.5, 18.6

Shape:

- Compare the areas of regular and irregular shapes by informal means (ACMMG087)
- Compare and describe two dimensional shapes that result from combining and splitting common shapes, with and without the use of digital technologies (ACMMG088)

Location and transformation:

- Use simple scales, legends and directions to interpret information contained in basic maps (ACMMG090)
- Create symmetrical patterns, pictures and shapes with and without digital technologies (ACMMG091)

Geometric reasoning:

- Compare angles and classify them as equal to, greater than or less than a right angle (ACMMG089)

Relevant Modules: Seeing the Light, Let’s Dive Right In

Activities: 7.4, 7.5, 17.6

Statistics and Probability

Chance:

- Describe possible everyday events and order their chances of occurring (ACMSP092)
- Identify everyday events where one cannot happen if the other happens (ACMSP093)
- Identify events where the chance of one will not be affected by the occurrence of the other (ACMSP094)
Data representation and interpretation:

- Select and trial methods for data collection, including survey questions and recording sheets (ACMSP095)
- Construct suitable data displays with and without the use of digital technologies, from given or collected data. Include tables, column graphs and picture graphs where one picture can represent many data values (ACMSP096)
- Evaluate the effectiveness of different displays in illustrating data features including variability (ACMSP097)
Year 5

Number and Algebra

Number and place value:

- Identify and describe factors and multiples of whole numbers and use them to solve problems (ACMNA098)
- Use estimations and rounding to check the reasonableness of answers to calculations (ACMNA099)
- Solve problems involving multiplication of large numbers by one- or two-digit numbers using efficient mental, written strategies and appropriate digital technologies (ACMNA100)
- Solve problems involving division by a one digit number, including those that result in a remainder (ACMNA101)
- Use efficient mental and written strategies and apply appropriate digital technologies to solve problems (ACMNA291)

Fractions and decimals:

- Compare and order common unit fractions and locate and represent them on a number line (ACMNA102)
- Investigate strategies to solve problems involving addition and subtraction of fractions with the same denominator (ACMNA103)
- Recognise that the place value system can be extended beyond hundredths (ACMNA104)
- Compare, order and represent decimals (ACMNA105)

Money and financial mathematics:

- Create simple financial plans (ACMNA106)

Patterns and algebra:

- Describe, continue and create patterns with fractions, decimals and whole numbers resulting from addition and subtraction (ACMNA107)
- Use equivalent number sentences involving multiplication and division to find unknown quantities (ACMNA121)

Measurement and Geometry

Using units of measurement:

- Choose appropriate units of measurement for length, area, volume, capacity and mass (ACMMG108)
- Calculate the perimeter and area of rectangles using familiar metric units (ACMMG109)
- Compare 12- and 24-hour time systems and convert between them (ACMMG110)

Relevant Modules: It’s Full of Hot Air, Electricity on Wheels, I-Robotics

Activities: 1.1, 4.1, 10.2, 10.4
Shape:
- Connect three-dimensional objects with their nets and other two-dimensional representations (ACMMG111)

Location and transformation:
- Use a grid reference system to describe locations. Describe routes using landmarks and directional language (ACMMG113)
- Describe translations, reflections and rotations of two-dimensional shapes. Identify line and rotational symmetries (ACMMG114)

Relevant Modules: Seeing the Light

Activities: 7.4, 7.5
- Apply the enlargement transformation to familiar two dimensional shapes and explore the properties of the resulting image compared with the original (ACMMG115)

Geometric reasoning:
- Estimate, measure and compare angles using degrees. Construct angles using a protractor (ACMMG112)

Relevant Modules: Seeing the Light

Activities: 7.4, 7.5

Statistics and Probability

Chance:
- List outcomes of chance experiments involving equally likely outcomes and represent probabilities of those outcomes using fractions (ACMSP116)
- Recognise that probabilities range from 0 to 1 (ACMSP117)

Data representation and interpretation:
- Pose questions and collect categorical or numerical data by observation or survey (ACMSP118)
- Construct displays, including column graphs, dot plots and tables, appropriate for data type, with and without the use of digital technologies (ACMSP119)
- Describe and interpret different data sets in context (ACMSP120)
Year 6

Number and Algebra

Number and place value:
- Identify and describe properties of prime, composite, square and triangular numbers (ACMNA122)
- Select and apply efficient mental and written strategies and appropriate digital technologies to solve problems involving all four operations with whole numbers (ACMNA123)
- Investigate everyday situations that use integers. Locate and represent these numbers on a number line (ACMNA124)

Fractions and decimals:
- Compare fractions with related denominators and locate and represent them on a number line (ACMNA125)
- Solve problems involving addition and subtraction of fractions with the same or related denominators (ACMNA126)
- Find a simple fraction of a quantity where the result is a whole number, with and without digital technologies (ACMNA127)
- Add and subtract decimals, with and without digital technologies, and use estimation and rounding to check the reasonableness of answers (ACMNA128)
- Multiply decimals by whole numbers and perform divisions by non-zero whole numbers where the results are terminating decimals, with and without digital technologies (ACMNA129)
- Multiply and divide decimals by powers of 10 (ACMNA130)
- Make connections between equivalent fractions, decimals and percentages (ACMNA131)

Money and financial mathematics:
- Investigate and calculate percentage discounts of 10%, 25% and 50% on sale items, with and without digital technologies (ACMNA132)

Patterns and algebra:
- Continue and create sequences involving whole numbers, fractions and decimals. Describe the rule to create the sequence (ACMNA133)
- Explore the use of brackets and order of operations to write number sentences (ACMNA134)
Measurement and Geometry

Using units of measurement:

- Connect decimal representations to the metric system (ACMMG135)
- Convert between common metric units of length, mass and capacity (ACMMG136)
- Solve problems involving the comparison of lengths and areas using appropriate units (ACMMG137)
- Connect volume and capacity and their units of measurement (ACMMG138)
- Interpret and use timetables (AGMMG139)

Shape:

- Construct simple prisms and pyramids (ACMMG140)

Relevant Modules: Seeing the Light

Activities: 7.5

Location and transformation:

- Investigate combinations of translations, reflections and rotations, with and without the use of digital technologies (ACMMG142)
- Introduce the Cartesian coordinate system using all four quadrants (ACMMG143)

Relevant Modules: Seeing the Light

Activities: 7.4, 7.5

Geometric reasoning:

- Investigate, with and without digital technologies, angles on a straight line, angles at a point and vertically opposite angles. Use results to find unknown angles (ACMMG141)

Relevant Modules: Seeing the Light

Activities: 7.4, 7.5

Statistics and Probability

Chance:

- Describe probabilities using fractions, decimals and percentages (ACMSP144)
- Conduct chance experiments with both small and large numbers of trials using appropriate digital technologies (ACMSP145)
- Compare observed frequencies across experiments with expected frequencies (ACMSP146)
Data representation and interpretation:

- Interpret and compare a range of data displays, including side-by-side column graphs for two categorical variables (ACMSP147)
- Interpret secondary data presented in digital media and elsewhere (ACMSP148)
Year 7

Number and Algebra

Number and place value:
- Investigate index notation and represent whole numbers as products of powers of prime numbers (ACMNA149)
- Investigate and use square roots of perfect square numbers (ACMNA150)
- Apply the associative, commutative and distributive laws to aid mental and written computation (ACMNA151)
- Compare, order, add and subtract integers (ACMNA280)

Real numbers:
- Compare fractions using equivalence. Locate and represent positive and negative fractions and mixed numbers on a number line (ACMNA152)
- Solve problems involving addition and subtraction of fractions, including those with unrelated denominators (ACMNA153)
- Multiply and divide fractions and decimals using efficient written strategies and digital technologies (ACMNA154)
- Express one quantity as a fraction of another, with and without the use of digital technologies (ACMNA155)
- Round decimals to a specified number of decimal places (ACMNA156)
- Connect fractions, decimals and percentages and carry out simple conversions (ACMNA157)
- Find percentages of quantities and express one quantity as a percentage of another, with and without digital technologies (ACMNA158)
- Recognise and solve problems involving simple ratios (ACMNA173)

Money and financial mathematics:
- Investigate and calculate ‘best buys’, with and without digital technologies (ACMNA174)

Patterns and algebra:
- Introduce the concept of variables as a way of representing numbers using letters (ACMNA175)
- Create algebraic expressions and evaluate them by substituting a given value for each variable (ACMNA176)
- Extend and apply the laws and properties of arithmetic to algebraic terms and expressions (ACMNA177)

Linear and non-linear relationships:
- Given coordinates, plot points on the Cartesian plane, and find coordinates for a given point (ACMNA178)
- Solve simple linear equations (ACMNA179)
- Investigate, interpret and analyse graphs from authentic data (ACMNA180)
Measurement and Geometry

Using units of measurement:

- Establish the formulas for areas of rectangles, triangles and parallelograms and use these in problem solving (ACMMG159)
- Calculate volumes of rectangular prisms (ACMMG160)

Shape:

- Draw different views of prisms and solids formed from combinations of prisms (ACMMG161)

Location and transformation:

- Describe translations, reflections in an axis, and rotations of multiples of 90° on the Cartesian plane using coordinates. Identify line and rotational symmetries (ACMMG181)

Geometric reasoning:

- Identify corresponding, alternate and co-interior angles when two straight lines are crossed by a traversal (ACMMG163)
- Investigate conditions for two lines to be parallel and solve simple numerical problems using reasoning (ACMMG164)
- Demonstrate that the angle sum of a triangle is 180° and use this to find the angle sum of a quadrilateral (ACMMG166)
- Classify triangles according to their side and angle properties and describe quadrilaterals (ACMMG165)

Statistics and Probability

Chance:

- Construct sample spaces for single-step experiments with equally likely outcomes (ACMSP167)
- Assign probabilities to the outcomes of events and determine probabilities for events (ACMSP168)

Data representation and interpretation:

- Identify and investigate issues involving numerical data collected from primary and secondary sources (ACMSP169)
- Construct and compare a range of data displays including stem-and-leaf plots and dot plots (ACMSP170)
- Calculate mean, median, mode and range for sets of data. Interpret these statistics in the context of data (ACMSP171)
- Describe and interpret data displays using median, mean and range (ACMSP172)
Year 8

Number and Algebra

Number and place value:

- Use index notation with numbers to establish the index laws with positive integral indices and the zero index (ACMNA182)
- Carry out the four operations with rational numbers and integers, using efficient mental and written strategies and appropriate digital technologies (ACMNA183)

Real numbers:

- Investigate terminating and recurring decimals (ACMNA184)
- Investigate the concept of irrational numbers, including \( \pi \) (ACMNA186)
- Solve problems involving the use of percentages, including percentage increases and decreases, with and without digital technologies (ACMNA187)
- Solve a range of problems involving rates and ratios, with and without digital technologies (ACMNA188)

Money and financial mathematics:

- Solve problems involving profit and loss, with and without digital technologies (ACMNA189)

Patterns and algebra:

- Extend and apply the distributive law to the expansion of algebraic expressions (ACMNA190)
- Factorise algebraic expressions by identifying numerical factors (ACMNA191)
- Simplify algebraic expressions involving the four operations (ACMNA192)

Linear and non-linear relationships:

- Plot linear relationships on the Cartesian plane with and without the use of digital technologies (ACMNA193)
- Solve linear equations using algebraic and graphical techniques. Verify solutions by substitution (ACMNA194)
Measurement and Geometry

Using units of measurement:

- Choose appropriate units of measurement for area and volume and convert from one unit to another (ACMMG195)
- Find perimeters and areas of parallelograms, trapeziums, rhombuses and kites (ACMMG196)
- Investigate the relationship between features of circles such as circumference, area, radius and diameter. Use formulas to solve problems involving circumference and area (ACMMG197)
- Develop the formula for volumes of rectangular and triangular prisms and prisms in general. Use formulas to solve problems involving volume (ACMMG198)
- Solve problems involving duration, including using 12- and 24-hour time within a single time zone (ACMMG199)

Geometric reasoning:

- Define congruence of plane shapes using transformations (ACMMG200)
- Develop the conditions for congruence of triangles (ACMMG201)
- Establish properties of quadrilaterals using congruent triangles and angle properties, and solve related numerical problems using reasoning (ACMMG202)

Statistics and Probability

Chance:

- Identify complementary events and use the sum of probabilities to solve problems (ACMSP204)
- Describe events using language of ‘at least’, exclusive ‘or’ (A or B but not both), inclusive ‘or’ (A or B or both), and ‘and’ (ACMSP205)
- Represent events in two-way tables and Venn diagrams and solve related problems (ACMSP292)

Data representation and interpretation:

- Investigate techniques for collecting data, including census, sampling and observation (ACMSP284)
- Explore the practicalities and implications of obtaining data through sampling using a variety of investigative processes (ACMSP206)
- Explore the variation of means and proportions of random samples drawn from the same population (ACMSP293)
- Investigate the effect of individual data values, including outliers, on the mean and median (ACMSP207)
Year 9

Number and Algebra

Real numbers:
- Solve problems involving direct proportion. Explore the relationship between graphs and equations corresponding to simple rate problems (ACMNA208)
- Apply index laws to numerical expressions with integer indices (ACMNA209)
- Express numbers in scientific notation (ACMNA210)

Money and financial mathematics:
- Solve problems involving simple interest (ACMNA211)

Patterns and algebra:
- Extend and apply the index laws to variables, using positive integer indices and the zero index (ACMNA212)
- Apply the distributive law to the expansion of algebraic expressions, including binomials, and collect like terms where appropriate (ACMNA213)

Linear and non-linear relationships:
- Find the distance between two points located on a Cartesian plane using a range of strategies, including graphing software (ACMNA214)
- Find the midpoint and gradient of a line segment (interval) on the Cartesian plane using a range of strategies, including graphing software (ACMNA294)
- Sketch linear graphs using the coordinates of two points and solve linear equations (ACMNA215)
- Graph simple non-linear relations with and without the use of digital technologies and solve simple related problems (ACMNA296)

Measurement and Geometry

Using units of measurement:
- Calculate the area of composite shapes (ACMMG216)
- Calculate the surface area and volume of cylinders and solve related problems (ACMMG217)
- Solve problems involving the surface area and volume of right prisms (ACMMG218)
- Investigate very small and very large time scales and intervals (ACMMG219)

Geometric reasoning:
- Use the enlargement transformation to explain similarity and develop the conditions for triangles to be similar (ACMMG220)
- Solve problems using ratio and scale factors in similar figures (ACMMG221)
Pythagoras and trigonometry:

- Investigate Pythagoras’ Theorem and its application to solving simple problems involving right angled triangles (ACMMG222)
- Use similarity to investigate the constancy of the sine, cosine and tangent ratios for a given angle in right-angled triangles (ACMMG223)
- Apply trigonometry to solve right-angled triangle problems (ACMMG224)

Statistics and Probability

Chance:

- List all outcomes for two-step chance experiments, both with and without replacement using tree diagrams or arrays. Assign probabilities to outcomes and determine probabilities for events (ACMSP225)
- Calculate relative frequencies from given or collected data to estimate probabilities of events involving ‘and’ or ‘or’ (ACMSP226)
- Investigate reports of surveys in digital media and elsewhere for information on how data were obtained to estimate population means and medians (ACMSP227)

Data representation and interpretation:

- Identify everyday questions and issues involving at least one numerical and at least one categorical variable, and collect data directly from secondary sources (ACMSP228)
- Construct back-to-back stem-and-leaf plots and histograms and describe data, using terms including ‘skewed’, ‘symmetric’ and ‘bi modal’ (ACMSP282)
- Compare data displays using mean, median and range to describe and interpret numerical data sets in terms of location (centre) and spread (ACMSP283)
Year 10

Number and Algebra

Money and financial mathematics:
- Connect the compound interest formula to repeated applications of simple interest using appropriate digital technologies (ACMNA229)

Patterns and algebra:
- Factorise algebraic expressions by taking out a common algebraic factor (ACMNA230)
- Simplify algebraic products and quotients using index laws (ACMNA231)
- Apply the four operations to simple algebraic fractions with numerical denominators (ACMNA232)
- Expand binomial products and factorise monic quadratic expressions using a variety of strategies (ACMNA233)
- Substitute values into formulas to determine an unknown (ACMNA234)

Linear and non-linear relationships:
- Solve problems involving linear equations, including those derived from formulas (ACMNA235)
- Solve linear inequalities and graph their solutions on a number line (ACMNA236)
- Solve linear simultaneous equations, using algebraic and graphical techniques including using digital technology (ACMNA237)
- Solve problems involving parallel and perpendicular lines (ACMNA238)
- Explore the connection between algebraic and graphical representations of relations such as simple quadratics, circles and exponentials using digital technology as appropriate (ACMNA239)
- Solve linear equations involving simple algebraic fractions (ACMNA240)
- Solve simple quadratic equations using a range of strategies (ACMNA241)

Measurement and Geometry

Using units of measurement:
- Solve problems involving surface area and volume for a range of prisms, cylinders and composite solids (ACMMG242)

Geometric reasoning:
- Formulate proofs involving congruent triangles and angle properties (ACMMG243)
- Apply logical reasoning, including the use of congruence and similarity, to proofs and numerical exercises involving plane shapes (ACMMG244)
Pythagoras and trigonometry:

- Solve right-angled triangle problems including those involving direction and angles of elevation and depression (ACMMG245)

Statistics and Probability

Chance:

- Describe the results of two- and three-step chance experiments, both with and without replacements, assign probabilities to outcomes and determine probabilities of events. Investigate the concept of independence (ACMSP246)
- Use the language of ‘if...then’, ‘given’, ‘of’, ‘knowing that’ to investigate conditional statements and identify common mistakes in interpreting such language (ACMSP247)

Data representation and interpretation:

- Determine quartiles and interquartile range (ACMSP248)
- Construct and interpret box plots and use them to compare data sets (ACMSP249)
- Compare shapes of box plots to corresponding histograms and dot plots (ACMSP250)
- Use scatter plots to investigate and comment on relationships between two numerical variables (ACMSP251)
- Investigate and describe bivariate numerical data where the independent variable is time (ACMSP252)
- Evaluate statistical reports in the media and other places linking claims to displays, statistics and representative data (ACMSP253)
Sustainability Curriculum Framework
Introduction

2012 was declared the “International Year of Sustainability for All” by the United Nations. Given the ongoing importance of sustainability education, links are provided with the “Sustainability Curriculum Framework” for all available activities that may be used to teach students sustainability concepts.

Years K-2

Sustainability Action Process
Making a Case for Change

Explore the following to identify a sustainability issue:

- Water systems and water use at home and school
- Energy systems and energy use at home and school
- Use of materials and products at home and school
- Use of local places and spaces
- Caring for particular living things or a part of the local natural environment

Relevant Modules: Let’s Be Civil

Activities: 19.2

Assessing the current situation to identify the needs and wants of people (and where applicable, other species) in relation to the issue

Investigate ideas or concepts necessary to understand the identified sustainability issue, including both ecological and human system ideas or concepts

Stating a case for change in relation to the issue that demonstrates:

- Why a change is needed
- How the change could result in an improvement
- A potential for the students to make a difference, individually or collectively

Defining the Scope of the Action

Exploring options for action and setting a direction by:

- Identifying possibilities for modifying their behaviour or that of others, changing procedures or systems for doing something, or altering the physical environment
- Identifying how the students would judge if the change is successful, and establishing criteria for success
- Prioritising the possibilities and selecting a direction for action that best meets the criteria for successful change
Identifying available resources and constraints including:

- People with expertise who can help
- Available materials
- Limits of cost, time, technology and community/school rules

Stating a brief for action that includes:

- A description of the nature of the desired change
- Criteria for judging the success of the change

Developing the Proposal for Action

Generate ideas for action, including:

- Identifying what others have done in response to similar issues
- Imagining and drawing or modelling ideas for action
- Trialling, testing and evaluating ideas using success criteria and recognising available resources and constraints
- Selecting an idea for the further planning of an action

Preparing and communicating the proposal, including:

- Taking advice from experts, and talking with stakeholders or decision-makers, to refine plans
- Discussing the proposal for others with the use of appropriate media
- Talking about ways of avoiding or reducing risk

Gaining agreement on the proposal by presenting it to stakeholders and decision-makers using appropriate media

Implementing the Proposal

Planning implementation by

- Organising equipment and resources to be used
- Sequencing an order of activities to be carried out

Implementing the action, including

- Using tools, equipment and resources with guidance
- Acting with regard to the safety of self, others and the immediate environment
- Monitoring the progress of implementation activities

Evaluating and Reflecting

Evaluating the action in relation to the success criteria using
- Feedback from others
- Recorded observations of results and impacts of the action

Reflecting on

- Success of the action as a means of creating a more sustainable environment
- The process used to design and implement the action
- Their learning

Knowledge of Ecological and Human Systems

Life cycles, growth and change

- Living things and their internal systems that support life
- Observable stages of the life cycle of common/local species
- Conditions that support growth and change in plants and animal species including needs for sun, water, food and nutrition, shelter, certain temperature ranges and social groupings
- Dependence of healthy plants and animals on having all their needs met in the right way
- Diversity of living things found in nearby environments
- Ways humans care for themselves, others and for other species

Ecosystems and local environments

- Ways environments provide for the needs of different species
- Relationships between species in simple ecosystems and food chains
- How we can assess the health and wellbeing of the natural environment and our community by observing, taking samples, measuring and comparing, and discussing results obtained over a period of time

Weather and climate

- Features of phenomena described as weather
- Methods of observing, describing and recording weather
- Effects weather has on themselves, family, community and on plant and animal life

Seasons

- Ways seasons are described and named
- How seasonal changes impact on themselves, their environment and their personal choices
- Seasonal differences in relation to latitude and the impact of seasonal differences on different people’s way of living
Water

- Importance of water to all life
- Stages of the natural water cycle including naming of key stages
- Managed water cycle, including systems in the built environment and the place of school, home, self in that cycle
- Managed sources of water, e.g., tap, rainwater, etc.
- Harvesting of water as a means of conserving sources of water and managed in the immediate environment
- Productive ways of using waste water and possible risks to human or environmental health

Relevant Modules: Let’s Be Civil

Activities: 19.2

Energy

- Sources of energy used in our lives
- Uses of different forms of energy in our lives (including heat, light, sound and mechanical) and the needs being met
- Products and systems that provide energy for personal use
- Ways of saving/conserving energy in the immediate environment

Relevant Modules: It Sounds Great!,

Activities: 8.2, 8.3, 8.4, 8.6

Social systems and culture

- Ways families, schools and communities depend on natural environments
- Ways groups utilise the natural environment to meet their needs and wants in different ways
- How our culture affects how we see and think about the natural and built environments
- How stories and other evidences from the past can help us learn of people’s use and care for their natural and built environment
- How stories from the past show that all people have traditions but also make changes to survive or improve their way of life and communities

Civics and citizenship

- Opportunities provided by schools and communities for caring for our environment and for making it more sustainable
- How children all over the world are working for sustainability and the reasons why it would be valuable to link up with them
Ownership and value

- The importance of ownership and recognising responsibilities of people who manage different parts of our environment when planning activities to improve sustainability
- Decisions we make as consumers in relation to their economic and environmental costs
- Money as a system for assigning an economic value to things

Materials and waste

- Sources of some materials used in everyday products
- Properties of some common materials that influence their re-use and/or recycling
- Procedures for waste avoidance and minimisation
- Systems for managing recycled waste

Built environments

- Features of buildings and spaces necessary to meet people’s needs
- Aspects of building and spaces that use resources including energy and water
- Ways of managing buildings or spaces to minimise environmental impacts and costs
- Systems that provide services in built environments, including communication, energy, waste and transport systems

Relevant Modules: Let’s Be Civil

Activities: 19.2

Agriculture and food

- Processes and requirements for growing plants and raising animals
- Sustainable methods of enriching and replacing plant nutrients in the soil
- Sources of commonly eaten foods
- Local plants and ecosystems that provided food for first Australians
Repertoires of Practice

World Viewing

- Tuning in to and sharing own and others’ perceptions of and feelings towards living things and natural environments through:
  o Practising moments of solitude in, and becoming familiar with, a variety of natural and built environments
  o Appropriately interacting with and caring for domesticated and native/wild animals
  o Cultivating or otherwise caring for native and non-native plants
  o Describing, representing and talking about these experiences
  o Contemplating and recounting the stories and interpretations of other people about living things and environments
- Discussing own and others’ accounts or stories of the origins of life, the universe and ourselves
- Describing and discussing ‘why I care’ in regard to various things or issues
- Describing and discussing the reasons for certain rules of behaviour or use of resources (e.g., recycling, water) at home and school
- Reflecting on ‘why should we do this’ in regard to sustainability issues and actions; in particular,
  o Needs, wants and values of self, family, other people/cultures
  o Needs of other species and of natural systems

Systems Thinking

Taking a big picture view

- Identify parts of a familiar system at home or school
- Describe some of the functions or processes of a system
- Explain how the removal or malfunction of part of the system affects the whole system

Identifying and modelling interdependencies

- Explain cause and effect as an event or part of a system directly causing a change in a second event or part
- Show causal relationships

Tracking changes over time

- Identify and order key events
- Describe change as a series of events that connect over time

Assessing probability, risk and benefit

- Distinguish the likelihood of an event from its consequences (desirable or undesirable)
- Qualitatively estimate the likelihood and consequences of relevant chance events (regarding safety, health, sport, the environment)
- Discuss ways of avoiding or reducing risk
Identifying intended and unintended consequences and leverage

- Recognise that actions can have desirable and undesirable effects
- Identify short-term, intended consequences
- Give an example of how a specific action can affect what happens in the short term
- Describe a basic concept of leverage, i.e., an action that would bring about a desirable effect
- Given a specific situation, identify a relevant action

Futures and Design Thinking

Appreciating change over time

- Demonstrate a sense of time from past, to present and to future based on personal experience of events and places
- Identify continuities, trends and patterns in relation to personal experience of events and places
- Identify and give reasons for change in objects, places and behaviour over the immediate past

Envisioning futures

- Predict events and changes based on trends and patterns that have been personally experienced
- Envision future events and places from a projection of personal experience by making drawings of what might be imagined for the future, and explain the need that would be met by key features

Creating solutions

- Follow a systematic design process to realise designs and actions for change in the immediate future
- Generate ideas for products and environments that respond to people’s needs and reflect a view of their personal future
- Anticipate the impact of their designs and actions on people and environments in the immediate future

Relevant Modules: It’s Full of Hot Air

Activities: 1.1

Managing change

- Identify reasons why predictions of the future can be wrong
- Demonstrate flexibility by adjusting designs and actions as a result of feedback
Years 3 – 6

Sustainability Action Process

Making a Case for Change

Exploring a sustainability issue by identifying trends in family, school or local community relating to:

- Ecosystems and biodiversity
- Local water use
- Resources, products, waste and pollution (including food)
- Built environments, travel and transport
- Energy

*Relevant Modules; Let’s Be Civil, Renew Your Energy*

Activities: 6.1, 6.5, 19.2, 19.3, 19.4

Assessing the current situation by:

- Combining assessments of family or school or local community sustainability in relation to the state of the biosphere and their ecological footprint and peoples’ wellbeing
- Using a systems model to identify major causes of observed trends and to evaluate existing or past responses to the issue

Investigating ideas or concepts necessary to understand the current situation including:

- Ecosystem and human system ideas or concepts
- Needs and wants and values of stakeholders/stakeholder groups

Stating a brief for action that:

- Advocates a case for change
- Recognises the views, interests and values of different stakeholder groups

Defining the Scope of the Action

Exploring options for action and setting a direction by:

- Sharing ideas about a local preferred future in relation to the identified issue
- Relating a local preferred future to possible actions to modify their own behaviour or that of others, change procedures or systems for doing something, or alter the physical environment
- Taking into account practicality, potential effectiveness, appropriateness and fairness when establishing criteria for evaluating the success of the action
- Selecting a type of action that best meets the criteria
**Identifying resources and constraints** including:
- Available time, money and other resources
- The people with expertise who can help and who are available
- Limits that may restrict the action, e.g., council requirements, environmental concerns

**Stating a brief for action** that includes:
- A description of the agreed type of action to be undertaken
- Criteria for evaluating the success of the action
- Details of stakeholders, major milestones, budget, resources, and potential risks and possible benefits

**Developing the Proposal for Action**

**Generating ideas for action** by:
- Researching actions others have taken in response to similar situations, and evaluating the usefulness of their approach
- Thinking laterally and transferring ideas
- Modelling, testing, evaluating, selecting and refining ideas using criteria for judging the success of the action
- Negotiating agreement with others by recognising differences in finding common ground
- Estimating risk and possible benefit in a decision situation (e.g., regarding safety, health and sustainability)
- Making judgements based on qualitative assessment of risks and benefits

**Preparing and communicating the proposal** using appropriate means and media, which includes:
- Sufficient detail to support its implementation
- Specification of resources selected for their sustainable use
- Procedures to minimise risk or mitigate consequences for people and the environment

**Gaining agreement on the proposal** by:
- Presenting it to those with authority to approve and support the action
- Providing justification of the action in terms of ‘leverage’ to produce a significant desirable result

**Implementing the Proposal**

**Planning implementation** by:
- Investigating, selecting and organising equipment and resources to be used
- Preparing a basic budget, timeline
- Allocating roles and responsibilities for implementation tasks
- Identifying and developing necessary skills and knowledge
Implementing the action, including:

- Managing implementation activities
- Choosing and using tools, equipment and resources, adjusting activities when required to improve efficiency
- Identifying and responding to issues of safety and observing safe working procedures

Evaluating and Reflecting

Evaluating the action in relation to success criteria, including:

- Planning and implementing evaluation strategies using a variety of methods
- Using quantitative and qualitative data to make evaluation judgements recognising the validity and possible weakness of data from scientific investigation and/or social research
- Developing strategies to monitor short and long-term impact and to inform future action

Reflecting on success of the action in relation to:

- Potential impacts, both short-term and long-term, on the environment and on stakeholders
- Efficiency, effectiveness and appropriateness of processes used to design and implement it

Knowledge of Ecological and Human Systems

Life cycles

- Fungi, plant and animal species, their needs, growth and health
- Photosynthesis and respiration
- Subsystems that enable life and reproduction in living things, including support and movement, digestion, circulation, respiration, sensing and response, reproduction
- Life cycles of common/local species
- How humans care for themselves, others and other species

Ecosystems and local environments

- Adaptions, roles and relationships among fungi, plant and animal species and their physical environment in local gardens and natural ecosystems; food chains, food webs and cycles of energy and materials
- Features of local terrestrial and aquatic ecosystems, their change over time and indicators of the state of their health
- Human management of different ecosystems and places (historical or cultural contexts)
- Ways of caring for and describing different ecosystems at different times of the year
- Issues and options for managing a classroom or natural area

Evolution of life

- Evolution of main forms of life, long-term trends in species change and major events in Earth’s history affecting evolution
Change in living systems
- Techniques for investigating, assessing and describing physical environmental features
- Ways of monitoring trends in the health of ecosystems and reasons for changes in ecosystem health

Weather and climate
- Differences between weather and climate
- Patterns, trends and longer term changes to climate
- Systems put in place to manage weather and extreme weather events

Solar system and energy
- Sun as the source of all energy on Earth
- Structure of the solar system, orbits and orientation to sun, seasons and gravity, moon and tides
- Sources of energy including renewable and non-renewable and the benefits or consequences of using them
- Sustainable energy choices and their impact on humans and the environment
- Processes used to transform energy for human purposes
- Processes and devices for measuring and metering energy consumption

Relevant Modules: Renew Your Energy

Activities: 6.1, 6.2, 6.5, 6.6

Water
- Natural and managed water systems and cycles
- Impact on the water cycle of human intervention (storage, supply, use and release to the environment) and the importance of, and issues related to, harvesting water at local, state and national levels
- Impact of climate change on availability of water
- Purposes of engineered water systems, including large- and small-scale
- Processes and devices for measuring and metering water flow and consumption
- Systems for managing the quality of water returned to the water cycle
- Issues associated with sustainable vs. non-sustainable water technologies

Relevant Modules: Let’s Be Civil

Activities: 19.2
Social systems and sub-systems

- Systems used to meet the needs of different groups and ways of managing these systems while recognising that ecosystems and their resources are finite
- Groups and organisations that need to take sustainability into account when making decisions and taking action, including our school, the local council, businesses, clubs, state and federal parliaments and state and federal governments, international agencies

Methods of assessing ecological sustainability

- Factors that influence our ecological sustainability including the health of our ecosystems, the conservation of our natural resources and the well-being of our community
- Alternative methods and ways of thinking required to measure ecological sustainability while recognising differing values regarding the biosphere (economic, spiritual, sentimental, historical, etc.)

Processes of historical change

- Reasons why people, events, changes in technology and issues of the past need to be understood in relation to the natural and social environment in which they occurred
- Historical change as a two-way relationship between communities and their natural environments, i.e., ecosystems affect communities and their cultures; communities and their cultures affect and change ecosystems

Civics and citizenship

- Opportunities for citizens to take sustainability action through engagement with social, economic and democratic institutions and processes
- Ways people and their communities are connected throughout the world, and how people can act as global citizens
- Responsibilities of global citizens to future generations for achieving ecological sustainability

Ownership and property rights

- How ownership and property rights are often determined by social, cultural and economic institutions and the ways these institutions contribute to shaping people’s interactions with the environment

Economic systems and costs

- Relationships between lifestyle decisions and their economic and environmental costs
- Relationships between wealth, consumption and ecological footprint
Materials and production

- Processing of common materials from source and the effects of their extraction and use
- Renewable and non-renewable nature of resources including marine, forest and mineral resources
- Systems for waste avoidance, minimisation, re-use and recycling
- Local and remote, social and environmental impacts of the processing and use of common materials

Built environment

- Ways of designing buildings to minimise environmental impacts and costs
- Re-purposing of buildings and neighbourhoods to preserve cultural features and qualities
- Sustainability considerations in the choice of building materials
- Urban and regional waste and recycling systems

Relevant Modules: Let’s Be Civil

Activities: 19.3, 19.4

Transport

- Transport planning for a more sustainable use of resources at a personal and community level
- Social and environmental costs and impacts of common power sources used for transport
- Strategies and technologies that can minimise movement of people and resources

Relevant Modules: It’s Full of Hot Air, Electricity on Wheels, Renew Your Energy

Activities: 1.1, 4.1, 6.3

Agriculture and food

- Cost and benefit of large-scale and small-scale agricultural production
- Sustainability issues in relation to food production and nutrition including local and global equity
- Sustainable agricultural and land use practices
Repertoires of Practice

World Viewing

Perceptions, feelings, values

- Becoming aware of and sharing own and others’ perceptions of and feelings towards living things and natural environments, through:
  - Practicing moments of solitude in a variety of natural and built environments
  - Describing, representing, storytelling about these environments and their sense of connection with them
  - Recounting a personal experience of changed perception of an environment as a result of learning from another person’s way of perceiving
  - Describing perceptions of environments in terms of developing systems understanding
  - Working in and caring for various environments and various plants and animals

Beliefs, ethics and actions

- Discussing own and others’ beliefs about creation/origins of life and the universe
- Describing and discussing ‘why I care’ in regard to various things or issues and empathise with others who care about different things
- Reflecting upon and discussing own and others’ values and ethical principles when:
  - Explaining why a particular action is right or desirable, including reference to sustainability
  - Negotiating agreement with peers or adults who have different viewpoints in regard to issues being addressed at school
- Identifying where own beliefs, values and ethical principles are different from others, and discussing possible reasons for this
- Negotiating common ground for collaboration on a project, by recognising and accommodating differences of belief and values
- Using a variety of aggregated information regarding human needs, wants, happiness, health and wellbeing

Systems Thinking

Taking a big picture view

- Identify and explain issues, goals and/or problems within a system as a series of interrelated details or processes
- Explain how parts of a system link or interrelate to make a whole
- Interpret existing systems models of an issue
- Create a model of a system and use it to demonstrate how change to a part of the system affects the whole system
Identifying and modelling interdependencies

- Explain cause and effect as happening in a circular fashion
- Represent causal feedback relationships as either positive (reinforcing) or negative (balancing)
- Explain some interdependent elements of a system including, stock and flows, with at least one feedback relationship
- Recognise and describe how a system’s organisation creates its behaviours over time

Tracking change over time

- Identify elements of a system that are changing over time
- Describe change as a series of events that are connected in time to produce a particular pattern of behaviour
- Represent continuous change over time (e.g., on a line graph), interpret trends and make projections into the future

Assessing probability, risk and benefit

- Use dice or other tools to develop intuitive understandings of probability
- Use a likelihood/consequence table to estimate risk and possible benefit in a decision situation (e.g., regarding safety, health, sport and sustainability)
- Qualitatively estimate probability and risk of data, relationships and outcomes of own systems model
- Propose, evaluate and enact ways to minimise risk or mitigate its consequences
- Make judgements about future school or community actions based on qualitative assessment of risk and benefits

Identifying intended and unintended consequences and leverage

- Explain how actions can create consequences, both wanted and unwanted
- Represent an identified short-term consequence, using a system archetype or causal loop diagram
- Given a specific situation, explain how certain actions may affect what happens in the short term and the long term (probability and risk/benefit of intended and unintended)
- Given a challenge, use understanding of system structure to identify and explain possible leverage actions
- Represent how an action functions as leverage in a given system using systems archetypes, stock/flow diagrams, or models

Futures and Design Thinking

Appreciating change over time

- Demonstrate a sense of time and place based on personal and historical experience
- Identify continuities, trends and patterns to support forecasting of probable local futures
- Identify how changing circumstances influence the way people meet their needs
- Relate change in objects, places and lifestyle to developments of technology
**Envisioning futures**

- Make predictions of local events and change based on a systems understanding of trends and patterns
- Envision preferred futures that respond to emerging social and environmental issues
- Build futures scenarios in images and text that reflect personal values and world views

**Creating solutions**

- Implement systematic design processes that respond to people’s needs and wants, and recognise potential impacts on people and environment into the future
- Generate ideas for strategies, environments and products that reflect a preferred future in relation to emerging social and environmental issues
- Use a systems approach to identify and analyse potential future impacts of designs and actions on people and environments

**Managing change**

- Recognise uncertainty and risk as conditions of planning for preferred futures
- Make provision for uncertainty and risk when designing and taking action for change
Years 7 – 10

Sustainability Action Process

Making a Case for Change

Identifying a sustainability issue in the local or immediate environment by:
- Gathering and responding to information about community, national or global sustainability
- Taking account of alternative theories, views and values

Making an overarching assessment of school, local community, national or global sustainability by:
- Identifying significant processes and relationships in a system from a wide or big picture view of sustainability
- Generating a systems model that represents significant processes and relationship in a system
- Using the systems model to identify and provide reasons for the most concerning trends, to critically evaluate past policy and management responses to the issue, and to identify and evaluate possible leverage responses that address the trends
- Evaluating reliability, probability and risks regarding the data used and the assessment based on it

Investigating ideas or concepts that underpin the assessment, including concepts of ecosystem health, stocks and rates of consumption/replenishment of renewable an non-renewable resources, and human wellbeing

Stating a case for change by:
- Developing a report or presentation for relevant stakeholders or decision-makers
- Presenting and advocating the case for change

Defining the Scope of the Action

Exploring options for action by:
- Consulting with stakeholders about their preferred futures in regard to the chosen issue/s
- Envisioning a preferred future that responds to the case for change and that provides evidence of systemic thinking
- Back-casting from the preferred future to identify options for action in the physical environment, in systems or processes, or in the behaviour of others/informing others
- Reflecting on and affirming or changing own views and values regarding issues and actions that have implications for sustainability
- Seeking greater understanding of the beliefs, morals, values, needs and wants of stakeholders
- Negotiating with stakeholders to establish criteria for judging the success of the change
**Setting a direction for action** by evaluating options, using established criteria and by assessing:

- Potential for change towards a preferred future, i.e., the leverage potential of possible actions
- Appropriateness and fairness for stakeholders and others who may be at risk of experiencing consequences

**Identifying resources and constraints** including:

- Available time, money and other resources
- The people with expertise who can help and who are available
- Factors that will limit the action including government regulations and approval processes

**Stating a brief for action** that includes:

- A description of the agreed type of actions to be undertaken
- Criteria for evaluating the success of the action
- Details of major milestones, budget, resources
- An assessment of risks and possible benefits
- Methods for consulting with stakeholders

**Developing the Proposal for Action**

**Generating ideas for action** by:

- Exploring the application of sustainable design and technology
- Lateral and creative thinking strategies
- Using trials, tests and collaboration with experts to assist with the evaluation of ideas against success criteria and with their selection and refinement
- Identifying the potential leverage of actions to produce the greatest desirable effect
- Modifying personal ideas or understanding to reach agreement in collaborating with others and recognising multiple views towards the environment and sustainability
- Selecting resources to suit action with reference to their sustainability

**Preparing and communicating the proposal** using appropriate means and media to suit a range of audiences including those with and without technical expertise

**Gaining agreement on the proposal** by:

- Consulting with stakeholders
- Presenting and explaining the proposal to those with authority to approve action
- Justifying the proposal, using a systems model that demonstrates complex cause-effect and time delay processes and that can be used to identify strategic leverage actions
- Advocating ways to minimise risks of the action

**Implementing the Proposal**
Planning the action by:

- Allocating roles and establishing management processes
- Researching and selecting tools, equipment and resources to meet the requirements of implementation
- Assessing environmental implications of using production methods, tools and resources, and employing environmental safeguards in their use
- Scheduling tasks in relation to order and time
- Preparing budgets
- Developing skills necessary to implement the action

Implementing the action by:

- Using tools, equipment and resources while adjusting processes as necessary to improve efficiency and to better meet success criteria
- Anticipating and responding to issues of safety
- Observing safe working procedures

Evaluating and Reflecting

Evaluating the action, including:

- Devising ways to assess the action in relation to each success criteria using quantitative and qualitative data where appropriate
- Explaining accurately how specific actions are expected to affect what happens in the short-term and the long-term
- Representing identified short-term consequences, using a system archetypes or causal loop diagrams
- Making judgements about the potential for future school or community actions based on qualitative assessment of foreseen risks and benefits

Reflecting on the action considering:

- Likely short-term and long-term impacts on the environment and stakeholders
- Personal feelings towards the value of the action and the processes used

Knowledge of Ecological and Human Systems

Living things

- Living things as self-generating/organising/regulating systems that utilise energy and materials captured from their environment
- Classification of living and non-living things, i.e., organic vs. inorganic, biotic vs. abiotic
Major forms of life

- Biological structures (simple, unicellular and complex multi-cellular)
- Sources of energy for living things and metabolic processes and growth
- Reproduction and life cycles and health and wellbeing of individuals and groups
- Sensory, communication, social and cognitive processes
- Cell metabolism and function, reproduction, DNA, genetics and heredity

Biochemistry

- Chemistry of living things, key elements and compounds, their sources, abundance and cycles
- Photosynthesis and the role of plants as the base of food chains, ecosystem and energy flows

Ecosystem and ecosystem relationships

- Species and their physical environment, habitat and niche
- Populations, communities, food webs, self-organising, population dynamics and controls in the energy and materials’ cycles of ecosystems, energy pyramid
- Biotic and abiotic interactions in ecosystems
- Key terrestrial and aquatic/marine ecosystems, including soils
- Role of biodiversity in ecosystem function (including bacteria, fungi, invertebrates, vertebrates)
- Self-regulation, balance, equilibrium, and tipping points of ecosystems, the Gaia concept
- Human communities view as functioning parts of the biosphere; impact on natural energy and materials’ cycle and net primary production; role of ecosystem health in defining human sustainability

Evolution of life and the biosphere

- Concept of species
- Influence of ecosystems in species evolution, sequence of evolution over geological time (major periods and their characteristics)
- Role of plants in the development of the atmosphere/biosphere
- Past mass extinctions/ecological collapse and their cause
- Current mass extinction period and its human causes
- Causes and effects of climate change in geological time vs. recent history
- Emergence of unique features or processes as a result of evolution
- Emergence applied to organisms, ecosystems and the whole biosphere
Biosphere processes
- Global material and energy flows and cycles (including water, carbon, nitrogen, oxygen, phosphorous)
- Net primary production of the biosphere (net global sequestration of solar energy through photosynthesis) and the proportion used by humans
- Limits to human use of resources and biosphere services and their relevance to human sustainability
- Biosphere uncertainty (issues such as climate change)

Methods of mapping, monitoring and assessing living systems
- Probability and the issue of uncertainty in monitoring ecosystem and biosphere processes, sampling and hypothesis testing
- Ecosystem state and pressures, their indicators and methods of assessment

Forces and energy
- Gravity, friction and potential, kinetic, chemical, radiant, electromagnetic energy
- Renewable and non-renewable energy sources (solar, wind, fossil fuels, nuclear, etc.)
- Laws of thermodynamics
- Sustainability issues relating to the production and use of different forms of energy
- Energy limits that influence the use of non-sustainable technologies (e.g., peak oil, Earth’s net primary production)

Relevant Modules: Eggs-treme Crashes, Electricity on Wheels, It’s Electrifying, It’s Full of Hot Air, It Sounds Great!, Let’s Dive Right In, Opposites Attract, Seeing the Light, Thrill Rides, Work Smarter Not Harder, Renew Your Energy, Don’t Crack Under Pressure, The Sky is the Limit

Activities: 1.1, 2.1, 3.2, 4.1, 5.1, 6.1, 6.2, 6.3, 6.4, 6.5, 6.6, 7.2, 7.3, 7.8, 7.9, 8.1, 9.1, 9.2, 12.1, 13.2, 13.3, 16.1, 16.2, 17.1, 17.3, 17.4, 17.5, 17.7, 17.8

Structure of the Earth
- Lithosphere, hydrosphere, atmosphere (developing and change over time) and their relation to the biosphere
- Earth’s geothermal and tectonic activity and influence on the biosphere (including effects on evolution), geological time scales

Solar system
- The sun and solar processes, solar system electromagnetic radiation and energy source for Earth and influence of solar flares on Earth’s climate
- Planets and other bodies, Earth’s orientation to the sun, seasons
- Gravity (sun and Earth) effect on planetary orbits, influence of the Moon (earth rotation and tides)
Climate
- Earth’s climate systems and major processes, energy stocks, flows and feedbacks in the atmosphere and hydrosphere; greenhouse gas concept

Social systems and culture
- Social systems designed to meet human needs and wants by utilising ecosystem (biosphere) services and resources
- Systems for regulating access to ecosystem services and resources

Sub-systems
- Structure of social systems as comprised of a number of sub-systems, such as political, legal and economic
- Influence of subsystems on the way a society interacts with its natural environment and their critical importance for achieving ecological sustainability

Methods of assessing ecological sustainability
- Techniques for holistically assessing ecological sustainability including economic, environmental and social measures and ecological footprint analysis

Historical evaluation and processes of historical change
- Processes for evaluating the history and development of human society and technology and their relation to the natural environment, including whether or not present and past societies can be judged to be or to have been ecologically sustainable
- Periods and processes of change in history that provide potential models for moving society towards sustainability

Civics and citizenship
- Practical approaches to civics and citizenship, including strategies to influence others through the democratic process, media, purchasing power of consumers and various forms of networking and social action at local, state and national levels
- Responsibilities and roles of citizens in relation to global equity, now and into the future
- Mechanisms for global cooperation and methods of facilitating intercultural understanding, including processes and functions of the United Nations and non-governmental organisations, major forums, summits and conventions

Ownership and property rights
- Systems of ownership and property rights that are fundamental to issues of sustainability and that need to be recognised when designing sustainability action
Economic systems and costs

- Economic costs, now and into the future, of the overuse of resources
- Different types of value placed on particular environments and life forms
- Factors that influence whether or not an economic value should be assigned to a particular environment or life form by current generations
- Economic and work opportunities created by new ‘green’ industries

Water technologies

- Principles of total water cycle management and total catchment management
- Principles and practices of water sensitive urban design (an application of total water cycle management)

Relevant Modules: Let’s Be Civil

Activities: 19.2

Materials and production

- States of matter, changes of state; atomic structure, elements and the periodic table; molecules, compounds (organic and inorganic) and mixtures for the function of living things
- Social and environmental costs and benefits of processing and using resources including marine, forest and mineral resources
- Factors that determine the sustainability of resource use and the classification as renewable and non-renewable resources, including considerations of embodied energy

Relevant Modules: Renew Your Energy

Activities: 6.1, 6.2, 6.3, 6.4, 6.5

- Sustainability in design and production, including the management of mass production systems, design for disassembly/recycling, issues of designed/engineered obsolescence
- Product road map as a means of identifying social and environmental impacts of products
- Method of ‘cradle to grave’ analysis including assessment of embedded energy/water

Built environment technologies

- Urban planning for sustainable development
- Models of the function of urban systems (urban metabolism) as a means of identifying and analysing flows of the materials and energy
- Biomimicry as a source of ideas for design
- Passive solar design principles and technologies
- Integrated urban and rural planning (including transport and community health)

Relevant Modules: Let’s Be Civil, Cooking up a Storm

Activities: 18.6, 19.3, 19.4
Transport

- Innovation in transport planning to improve resource use and quality of life
- Social and environmental costs and benefits of different modes of transport and transport systems
- Emerging technological developments in energy efficient power sources

Relevant Modules: Renew Your Energy

Activities: 6.1, 6.2, 6.3, 6.4, 6.5

Agriculture and food production

- Impacts of contemporary agricultural practices on health, nutrition, water security and ecosystem wellbeing
- Integration of traditional land management practices in contemporary agriculture
- Impacts of genetically engineered agricultural products on agricultural production and biodiversity

Information and communication technologies

- Application of control systems to efficiently manage systems and processes
- Remote sensing to collect data and monitor change in ecosystem and biosphere health
- Use of ICT for managing data and modelling and projecting change over time in ecosystems

Repertoires of Practice

World Viewing

Identifying perceptions, feelings and values

- Become aware of and share their perceptions, feelings, values and behaviours towards ecosystems and the biosphere by
  - Observing and reflecting
  - Describing, representing, storytelling
  - Seeking to understand alternate cultural perspectives and values
  - Developing systems understandings
  - Assessing the state of systems
  - Working in and caring for living systems (local to global)
Clarifying beliefs, ethics and actions

- Become aware of, reflect upon and share their own and others’ beliefs, morals, values, needs and wants
- Seek greater understanding of the beliefs, ethics, values, needs and wants of others in order to
  - Enrich own understanding of the world and
  - Negotiate agreement regarding issues and actions that have implications for sustainability
- Critically use a variety of aggregated information regarding human needs, wants, happiness, health and wellbeing and the state of the environment to make judgements and support recommendations regarding sustainability action

Systems Thinking

Taking a big picture view

- Identify and explain issues, goals, and/or problems within a system from a wide, “big picture” view, rather than focusing on details
- Gather information about a system to form an overarching assessment of the situation
- Create a digital model of a systems relevant relationship by taking a whole-system perspective on an issue or process
- Explain key assumptions of the model and the evidence supporting these assumptions
- Interpret the implications of the model for the issue under consideration

Identifying and modelling interdependencies

- Explain cause and effect as happening in a circular fashion that involves positive and negative feedback and multiple causation
- Explain the key interdependent elements of a system including, stocks (accumulations and levels) and flows, with multiple feedback relationships
- Represent causal feedback among two or more elements of a system and/or create multiple loops that illustrate different interpretations
- Describe how the structure of both natural and human systems determines their behaviours over time

Tracking change over time

- Identify, describe and distinguish between changes in qualitative (e.g., happiness) vs. quantitative (e.g., population) characteristics or entities that change over time
- Describe change as a continuous trend over time
- Identify and explain a system component’s continuous pattern of change/trend over a specified period of time
- Compare different patterns of change and make future projections based on current trends
- Represent continuous change over time of more than one variable, e.g., on a line graph
Assessing probability, risk and benefit

- Apply quantitative estimates of probability and risk to personal, community and environmental situations and issues, and their solutions
- Estimate probability and risk of data, relationships and outcomes for a modelled system
- Estimate the benefits and risks of sustainability in proposed actions or policies at school, in the community, or by governments
- Propose, evaluate and enact ways of minimising risk or mitigating its consequences
- Make recommendations about future school or community actions based on assessments of risks and benefits (related to the concepts of consequences and leverage)

Identifying intended and unintended consequences and leverage

- Represent or model how aspects of a specific situation inherently cause certain intended or unintended consequences over time (drawing upon concepts of causal loop, stock/flow and common systems archetypes)
- Given a challenge, use mental models and understanding of system structures to identify and select among possible leverage actions
- Identify and assess the probability of a proposed solution resulting in undesirable consequences, and assess the risks involved
- Examine and test assumptions about potential leverage actions within a real-world context, such as student-action committees, class projects, or community involvement

Futures and Design Thinking

Appreciating change over time

- Demonstrate a sense of personal location in time and place based on a world view and an understanding of global change over a significant time span
- Identify continuities, trends and patterns as factors to inform systems thinking for the construction of preferred futures
- Explain change in objects, places and lifestyle in relation to the development of technology

Envisioning futures

- Predict probable futures based on a systems understanding of patterns and trends
- Envision preferred futures that anticipate developments in science, technology and design
- Build detailed future scenarios that reflect personal values in relation to global and intergenerational equity and ecosystem health

Creating solutions

- Plan, implement and manage systematic design processes to realise ideas and actions that support change for a preferred future
- Backcast from a preferred future to generate ideas for behaviours, strategies, environments and products
- Reconcile visions of a global future with personal actions to promote behaviours and design strategies, environments and products
Managing change

- Assess and make provision for uncertainty and risk in planning for preferred futures
- Accommodate changing circumstances and reconciling differing responses from stakeholders when designing and taking action for change
Modules and Activities
Activity descriptions are introduced below and referred to by number to accompany the relevant curriculum elements. For each activity, there are many additional multimedia and print resources available for teachers to extend the ideas presented in their own classrooms. Some sample bibliographic resources including journal papers published by the ITEEA and NSTA, and educational guides produced by NASA, are listed at the end of each module description.

The identified activity durations are approximate and reflect the typical time each activity takes when run with a class by the STEM Education and Outreach team. The generic design materials mentioned in the equipment descriptions are further outlined in the Appendix. Where available, images are included for activities to demonstrate the equipment utilized and/or the end result of that activity. Please feel free to contact us with any questions or requests that you may have.
1. It’s Full of Hot Air

1.1 Balloon Powered Cars (120 mins)
This activity gives students the opportunity to learn about energy, forces, Newton’s laws and the EDP while building a vehicle powered with a balloon. Initially, students are provided with a design template and guidelines on how to construct the car, but further activity extension could involve developing new designs or redesigning the car to improve its performance. Throughout this process students can be encouraged to think as engineers would as they learn to apply the steps in the EDP. Extending students’ understanding through this activity could involve investigating pressure and the properties of balloons and materials.

This activity is a standalone activity which requires nil prerequisite knowledge or skill.

**Equipment:** Design Materials, Templates

Sample Bibliographic Resources


2. Eggs-treme Crashes

2.1 Egg crash cars (60 – 90 mins)
Students are encouraged to follow the EDP with the goal of designing and building a car to protect an egg as a passenger. Through this activity students are introduced to the physics behind common safety features in cars including airbags, crumple zones and seatbelts. The EDP is applied throughout the activity so that students have opportunities to make improvements to their designs and learn about how the properties of different materials can be utilized to best achieve the activity’s goal. Newton’s laws, forces and energy are also explored throughout the activity. Strict challenge parameters are generally specified to ensure that the student’s design will fit within the bounds of the vehicles’ track. Variations on this activity could involve creating a parachute to protect an egg when dropped from a height.

This activity is a standalone activity which requires nil prerequisite knowledge or skill.

**Equipment:** Design Materials, Templates, Eggs, Crash Track

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**Sample Bibliographic Resources**


3. The Sky is the Limit

3.1 Balloon Rockets (20 – 30 mins)
This activity involves a structured inquiry approach (which is suitable for early primary students) where a prototype is displayed of a balloon rocket suitable for travelling along a string. For upper primary students, the activity is introduced as an engineering design challenge to enable a balloon to travel from one side of the room to the other in a straight line. This creates an opportunity for students to develop a creative approach to solve this problem and can involve materials investigations, forces and motion.

This activity is a standalone activity which requires nil prerequisite knowledge or skill.

Equipment: Design Materials

3.2 Water Rockets (30 – 60 mins)
Students design and build a rocket using a plastic bottle following the EDP. These rockets then have a small amount of water placed in the bottle (as selected by the student) and are launched using a rocket launcher. Students can learn about forces, Newton’s laws, energy changes and the EDP throughout this activity. Additionally, students can explore how different materials, bottle shapes and sizes, and modifications in the amount of water used can affect the performance of their rockets.

This activity is a standalone activity which requires nil prerequisite knowledge or skill.

Equipment: Design Materials, Plastic Water Bottles, Bike pump and rocket launcher
3.3 CD Air gliders (20 – 30 mins)
Students follow guided instructions to develop a CD air glider which relies upon a balloon to hold the CD above a surface. Forces and motion, and in particular friction can be explored through this guided activity. As an extension, students can develop their own designs for a hovercraft and implement these following the EDP.

This activity is a standalone activity which requires nil prerequisite knowledge or skill.

**Equipment:** CD air glider kit (contents: balloons, CDs, and wooden spindles)

**Sample Bibliographic Resources**
In July 2012, NASA Education education@nasa.gov broadcast the following email message: Recently, an air pressurized paper rocket launcher being used by an educator failed. This launcher is described in NASA’s Rockets Educator Guide, publications EG-2011-11-223-KSC, pp. 86-90 and EG-2008-05-060-KSC, pp. 86-90. NASA completed an engineering investigation into the failure and determined that the launcher, or design equivalents, should not be used. NASA has removed the launcher design from its website and its education curriculum. Individuals and organizations should immediately discontinue use of the launcher published in the referenced NASA publications.
4. **Electricity on Wheels**

4.1 **Electric Powered Cars (120 – 150 mins)**

This activity gives students the opportunity to learn about energy, electricity, forces, Newton’s laws and the *EDP* while designing and building a vehicle powered by an electric circuit. Initially, students are provided with a design template and guidelines on how to construct the car, but further activity extension could involve developing new designs or redesigning the car to improve its performance. Throughout this process, students can be encouraged to think as engineers would as they learn to apply the steps in the *EDP*. Students are also introduced to the basics of electricity and how an electrical circuit can be used to power a vehicle. This experience can serve as an introduction to further studies on energy and electricity. Cars can be converted to balloon powered cars when the electrical circuit components are removed.

This activity is a standalone activity which requires nil prerequisite knowledge or skill.

**Equipment:** *Design Materials, Templates, Electric Motors, Batteries, Cogs, Wires*
Sample Bibliographic Resources


5. Don’t Crack Under Pressure

5.1 Hydraulicus (120 – 150 mins)
The ‘Hydraulicus’ is a fluid-controlled dinosaur that students can build using provided cut-outs, glue and tubing. Each ‘Hydraulicus’ has three joints which are controlled using the dynamic properties of fluids. This work can introduce and reinforce concepts relating to forces and pressure. As an extension, students could be asked to design their own hydraulic device through application of the EDP and investigation of materials.

This activity is a standalone activity which requires nil prerequisite knowledge or skill.

Equipment: ‘Hydraulicus’ kit, hot glue guns

Sample Bibliographic Resources


6. **Renew Your Energy**

6.1 **Wind Turbine Design Challenge (60 – 90 mins)**
Students are encouraged to think creatively and emulate the activities of engineers to design the ‘best’ wind turbine. Turbines can be constructed from basic materials including cardboard, and are assessed based upon the voltage produced when placed in front of a relatively high power fan. Redesign is an essential part of this activity, which allows students to investigate what works well and make judgements about why particular designs were unsuccessful. Throughout the activity, students are encouraged to think about the place of renewable energy in our society, and can apply their knowledge of forces, energy and materials to make reasoned judgements about the potential performance of different designs.

This activity builds upon knowledge of how a generator works and should be completed after the hand generators activity (Activity 6.6).

**Equipment:** Design Materials, Wind Tunnel, Electric Motors, Multimeters

6.2 **Yeast fermentation (10 – 20 mins)**
A *structured inquiry* approach to this activity involves presenting students with a bottle, a balloon, yeast, sugar and a small amount of warm water and detailed instructions on how to combine these materials. Over time, the balloon should become inflated due to the production of gas in the yeast formation experiment. In an *open inquiry* approach, students could be provided with materials, and asked to design their own experiment to see how changing a particular variable affects the results. Possible investigations may include relating the amount of sugar to the produced gas, or how the amount of gas produced varies with time. Chemical state changes, the design of fair experiments and the chemical reaction of fermentation are all part of this activity. Additionally, through this activity, students can start looking at bio-fuels as a potentially viable energy source.

This activity is a standalone activity which requires nil prerequisite knowledge or skill.

**Equipment:** Glass bottles (say old beer bottles), balloons, yeast, sugar, warm water
6.3 Hydrogen fuel cells and cars (15 – 30 mins)
Students can learn how to produce hydrogen from water by using a hydrogen fuel cell and then investigate how this hydrogen could be used to power a vehicle. Investigations can be customised to allow students to consider different methods of providing a power input to produce the hydrogen. In particular, students focus on the efficiency of these methods, and on different ways to use the produced hydrogen. Throughout the activity students are also prompted to think about hydrogen power as a renewable source, its advantages and limitations, and the chemistry concepts that are behind the above reaction.

This activity is a standalone activity which requires nil prerequisite knowledge or skill.

**Equipment:** ‘Dr Fuel Cell’ kits, Distilled water
6.4 Efficiency of solar panels (10 – 20 mins)

Students connect solar panels to *load boxes* and measure the power obtained under lighted conditions. Calculations can then be performed to determine, for example, the number of panels required to power a small city or building. Throughout this activity, students are encouraged to think critically about the efficiency of the solar panels, and can also be introduced to the internal workings of a solar panel.

This activity can be run as a standalone activity or can be used as an introductory solar energy activity to provide students with background knowledge to undertake the solar heaters activity (Activity 6.5).

**Equipment:** ‘Dr Fuel Cell’ kits
6.5 Solar heaters (20 – 40 mins)
Students construct a parabolic solar heater from provided materials and can then heat a water solution. The temperature can be recorded at regular intervals to assess how the solar heater works. In a structured inquiry approach, students are provided with solar heater pieces which can be easily assembled. In a structured inquiry or open inquiry approach, students are provided with materials to design their own solar heater and develop an experiment to assess its performance. As part of this activity, students can also investigate angles and learn how to calculate the focal point of a parabolic dish.

This activity can be run as a standalone activity, or can be used as a follow on activity from the efficiency of solar panels activity (Activity 6.4).

**Equipment:** Design Materials, ‘Power House’ kit

6.6 Hand generators (10 mins)
The simple hand generators provide a way for students to gain an appreciation and understanding of the basic principles of how a generator works. Generators are used in a number of renewable energy capacities and students are encouraged to think about how these devices may be used in real world applications. Connections are also made to the operation of motors and basic electrical circuits.

This activity provides a good introduction to some background knowledge necessary to understand wind, hydro and other forms of energy that rely upon a generator. Thus, it is recommended that this activity is performed prior to Activity 6.1.

**Equipment:** ‘ETB Hand Generators’
Sample Bibliographic Resources


7. Seeing the Light

7.1 Colours in white light (5 – 10 mins)
Students explore the primary colours of light using a simple colour mixing demonstration. Small groups of students are provided with a ping pong ball colour mixer which they then use to view and describe the primary colours of light and how these colours can be mixed. Links are made to the primary colours of paint, and how colours can be mixed to produce secondary colours. As an extension, students can be introduced to how the colours fit into the electromagnetic spectrum thereby emphasizing the fact that light is a form of energy.

This is an introductory optics activity which should be completed prior to activities 7.2, 7.3 and 7.8.

Equipment: ‘Ping Pong Ball Colour Mixers’

7.2 Light as an energy source (electromagnetic spectrum) (5 – 10 mins)
Students are introduced to the concept that light is a travelling wave, which is in turn a form of energy. This is highlighted through a simple introduction to waves stressing that nothing material is transported. The electromagnetic spectrum is also introduced to students as a way of characterising all forms of electromagnetic radiation. Students can learn that the differences between the light that we can see and the one that cannot be seen relates to the frequency (or wavelength) of the corresponding wave. Students also learn to calculate the wave frequency given the wavelength (or vice versa) through the universal wave equation.

This is an introductory activity which should be completed prior to activities 7.3, 7.4, 7.5, 7.6, and 7.7.

Equipment: Extension cord, computer animation
7.3 Converting light to sound (20 – 40 mins)

Energy can be neither created nor destroyed; rather it is converted from one type into another. Students can explore a variety of ways that light can be converted into sound, and vice versa, using resources such as fibre optics and lasers. The ability to send sound in the form of light across a room is demonstrated using sound-transmitting kits and lasers, and the need for a direct line of sight for the transmission is explored.

This activity builds upon basic optics knowledge acquired through activities 7.1 and 7.2. The activity is interchangeable with activities 7.8 and 7.9.

**Equipment:** ‘Laser Sound Transmitting’ kit, ‘Fibre Optics’ kit, ‘Optical voice link’ kit
7.4 Reflection and symmetry (15 – 20 mins)
Students explore their understanding of how a mirror reflects light to create (and estimate the) symmetry in particular patterns. In paired work, each student can construct half an image and get their partner to draw what the resulting image would look like if a mirror was placed along the line of symmetry. Students can also investigate the use of multiple mirrors, attached at different angles to see how their images change, while making connections to their knowledge of the different types of angles used in their investigations.

This activity builds upon basic optics knowledge acquired through activity 7.2. It provides a good basis for the Kaleidoscopes activity (Activity 7.5).

**Equipment:** Rulers, Protractors, Mirrors, Paper, Pencils

7.5 Kaleidoscopes (15 – 30 mins)
Students design and construct a kaleidoscope to demonstrate their understanding of reflection. Connections can be made to angles, symmetry and rotations. Students can also be prompted to consider three dimensional shapes and prisms throughout this activity.

This activity builds upon knowledge acquired through activities 7.2 and 7.4.

**Equipment:** Design Materials, Mirrors, Cellophane
7.6 Refraction (5 – 10 mins)
Students are encouraged to think about a time when they tried to pick up something that was under the water, such as in a pool or at the beach, and found that their hand was not in the right place. This situation can be explained by calling upon the concept of light refraction which occurs when a light ray bends as it travels between two different media. Using a demonstration, students can observe how a straight laser beam changes its direction when it moves from air into water. Students can measure the angles of the incident and refracted beams, and apply Snell’s law to determine (for example) the refractive index of water. Upper Secondary classes can also perform similar calculations for fibre optic cables.

This activity builds upon knowledge acquired in activity 7.2.

**Equipment:** Fish tank, Laser, Large Protractor

7.7 Total internal reflection (5 – 15 mins)
Total internal reflection occurs when light bounces off the boundaries of some medium such as a stream of water or a fibre optic cable, always remaining inside that medium. In doing so the light bounces off the boundaries and bends with the medium. Students are introduced to this idea through a demonstration with a water optics kit that includes a stream of water which a laser bounces off the boundaries of. Each student is encouraged to think about how this could happen given that light travels in a straight line. Students can think about areas where this concept is applied such as in fibre optic lights and cables. Upper Secondary classes can perform calculations to determine the angle at which the laser must hit the boundary between mediums so that total internal reflection ensues.

This activity builds upon knowledge acquired in activities 7.4, 7.5 and 7.6. It provides background knowledge for activities 7.8 and 7.3.

**Equipment:** Fish tank, ‘Water Optics’ kit, Laser
7.8 Fibre Optics (20 – 30 mins)
After gaining an understanding of total internal reflection, students can explore fibre optics kits which transmit different colour light along a fibre optic cable. Students can investigate colour mixing and splitting, can draw conclusions about how the light travels and bends along the cable, and can explore sending information encoded as light along the cable.

This activity builds upon knowledge acquired in activity 7.7.

**Equipment:** ‘Fibre Optics’ kit and worksheet
7.9 Laser activities (5 – 15 mins)
Students can consider how lasers also provide a means for sending information encoded in light through a demonstration of sound transmitting kits. A direct line of sight is required between the transmitter and receiver illustrating some of the potential limitations of such technologies. Upper Secondary classes, or classes with sufficient background knowledge can consider the internal workings of a laser source, gain an understanding of how a laser beam is produced, and become aware of some of the dangers associated with such beams.

This activity is interchangeable with activity 7.3.

**Equipment:** ‘Laser Sound Transmitting’ kit, ‘Optical Voice Link’ kit

7.10 Optics Suitcase (15 – 45 mins)
The Optics Suitcase consists of a variety of small activities that can be used to introduce and excite students about light and optics. Activities focus on the principles of diffraction, polarisation and selective reflection through a series of ‘theme packets’ providing students with the opportunity to observe and experiment with optics. Supplemental presentation materials are also provided.

This activity can be run as a standalone activity, but also provides good background knowledge for activity 7.11.

**Equipment:** Optics Suitcase
7.11 Spectroscopes (10 – 15 mins)

Students learn that different light sources are made up of different components by seeing the spectrum that light sources produce when light passes through a diffraction grating. By looking through the spectroscope students can verify that white light is made up of the different colours of light (as commonly seen in a rainbow).

This activity can be run as a standalone activity, but can also be used as a follow on activity for activity 7.10.

**Equipment:** Spectroscopes, Light Sources
7.12 3D Glasses (10 – 15 mins)

Students experiment with different 3D glasses technologies to understand how we see images in 3D and how 3D movies can be produced. Glasses are provided to students and they view a series of images to observe how the technology works. The activity can be extended to generating images that can be observed in 3D using 3D glasses, or by investigating the newer technologies in use for movies.

This activity can be run as a standalone activity.

**Equipment:** Red/Cyan 3D glasses, Chromadepth 3D glasses

7.13 UV beads (5 – 30 mins)

Students visualise UV light through a simple UV beads activity. When exposed to UV light the plain looking beads transform into colourful beads. Students are encouraged to understand the basics of how this transformation takes place, and to experiment with covering the beads in sunscreen to see how this affects the colours under UV light. Experiments using the beads can be designed by students and carried out in a more extensive investigation of the beads and UV light.

This activity can be run as a standalone activity, but also provides a good introduction to what light is and can accompany activity 7.1.

**Equipment:** UV beads, black light, SPF 30+ sunscreen
Sample Bibliographic Resources


8. It Sounds Great!

8.1 Cup Loud Speaker (15 – 20 mins)
The cup loud speaker provides students with an opportunity to investigate how conventional speakers work as they create their own simplified speaker. Connections are made to the concept of electromagnetism, which is fundamental to the operation of a speaker. Students can be encouraged to improve their design and materials’ selection so that the performance of their speaker is enhanced.

This activity can be offered as a standalone activity. Alternatively, to provide prerequisite knowledge this activity can be run in sequence with some electromagnetism activities (Activities 13.2 and 13.3).

Equipment: ‘Cup Loud Speaker’ kit (contains: plastic cups, 3.5mm leads, magnets, thin copper wire, and electrical tape)

8.2 Ear gongs (10 – 15 mins)
Students are introduced to the idea that sound is an energy type which originates from vibrating objects. This energy is transferred into the surrounding medium (such as air) and then travels away from the source. When these vibrations reach our ears they are perceived as sound. The ear gongs demonstrate that sound travels better through denser mediums, which is why the sound can be perceived much louder than if it was just travelling through the air. Students can use this understanding to make predictions on the speed of sound, and to explore how sound is attenuated when it goes through different materials such as solids, liquids and gases. Additionally, this activity can be used to teach students about the role of the “three small bones” in the ear that transfer vibrations to the ear drum.
This activity provides a good introduction to the concept that sound is a type of energy and forms a basis for activities 8.3, 8.5 and 8.6. Additionally, this activity is useful for activity 8.9 where the students build a model ear.

**Equipment:** Wire coat hangers, string

### 8.3 Tuning fork demonstration (5 – 10 mins)
When a tuning fork is struck it begins oscillating at a specific frequency. The size of the tuning fork is closely related to the frequency of oscillation. Students can learn about resonance when a pipe of appropriate length is placed near the tuning fork, resulting in an amplified and louder signal. This can be used to make assessments of the length of particular pipes and the corresponding musical note. Students can also place the tuning forks in water to observe the vibrations and see how the sound waves are transferred to water waves. This activity can also provide students with the opportunity to explore resonance with the tuning forks and various items including boxes, cups and tin cans.

This activity can be run as a standalone activity and provides a good introduction to Activity 8.4.

**Equipment:** Tuning forks

### 8.4 Pipes (10 – 25 mins)
Students are introduced to the idea that pipes of different length create different sounds. This is due to the length (of the sound wave) produced in the pipe and the frequency that this corresponds to (through the universal wave equation). Working in groups, students can determine the length of their pipe and the corresponding musical note and play a song. Upper Primary and Lower Secondary groups, or those with sufficient prior skill, can apply the
universal wave equation to calculate the resulting frequency and wavelength of different length pipes.

This activity builds upon knowledge acquired from activity 8.3. Nevertheless, it also can be run as a standalone activity.

**Equipment:** various lengths of PVC pipe, rulers

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**8.5 Laser show (5 – 10 mins)**

The laser show provides another demonstration of how sound results in vibrations in the air. In this case the vibrations move an elastic membrane which has a mirror affixed to one side. A laser beam is directed at the mirror, and the vibrations of the membrane result in patterns being produced. Students are encouraged to observe how the patterns change for different sounds and to attempt to make connections to the different frequencies and the nature of the corresponding patterns. Options exist to create a low-cost laser show kit using simple materials including a plastic tube, cling wrap and mirrored card. This activity can also be linked to the biology of the ear and shows how the ear drum moves when excited by sound waves.

This activity builds upon knowledge acquired through activities 8.2 and 8.3. This activity also provides a foundation for exploring how the ear drums work in activity 8.9.

**Equipment:** ‘Laser show’ kit
8.6 Tin can phone (10 – 15 mins)

Students are introduced to the idea that sound is an energy type which originates from vibrating objects. This energy is transferred into the surrounding medium (such as air) and then travels away from the source. When these vibrations reach our ears they are perceived as sound. The tin can phone demonstrates that sound travels further through solids, which is why students can hear each other better through the phone line than without it. Students can use this understanding to make predictions on the speed of sound, and to explore how sound is attenuated when it goes through different materials such as solids, liquids and gases.

This activity builds upon knowledge acquired through activities 8.2 and 8.3.

**Equipment:** Plastic cups, string, metal skewers, scissors
8.7 Slinkies (10 – 15 mins)
Using slinkies, students explore the differences between transverse waves and longitudinal waves by moving the slinky either back and forth or up and down.

This activity can be used as an introduction to waves and can be run in conjunction with activity 8.3.

**Equipment:** Slinkies

8.8 Frequency sweep (5 – 10 mins)
Students listen to a frequency sweep and observe their range of hearing by holding up their hand when they can hear a sound and putting it down when they can no longer hear a sound. Through this activity, a discussion about how humans have a limited hearing range that deteriorates with age can occur. Students can be introduced to the ideas of wavelength, frequency and the universal wave equation through this activity.

This activity is a useful follow on activity for activities 8.4 and 8.7.

**Equipment:** Frequency sweep sound file, speakers

8.9 Biology of the Human Ear (10 – 15 mins)
Students construct a model ear using the skills and knowledge they have acquired throughout the previous sound activities and use these to create a model ear in a *structured inquiry* approach. A simple ear drum model is constructed from materials similar to the ones used in the laser show kit. Straws and ping pong balls are used to emulate the small bones in the ear, with the ping pong ball resting in a pool of water to represent the cochlea.

This activity can be used to build upon activities 8.2 and 8.5. Activity 8.10 can be used either before or after this activity to explain how the inner ear hairs resonate with different frequencies.

**Equipment:** Plastic tubes, cling wrap, straws, ping pong balls, water container

8.10 Barton’s Pendulum Demonstration (5 mins)
The Barton’s pendulum demonstration can be used to show students how the hairs in the inner ear resonate with different frequencies. An example of the Barton’s pendulum demonstration can be found at [http://www.youtube.com/watch?v=kODOL-QBzSM](http://www.youtube.com/watch?v=kODOL-QBzSM).

This activity can be used in conjunction with activity 8.9.
**Equipment:** Barton’s Pendulum demonstration apparatus

### 8.11 Vocal chords and vocal tract (10 – 15 mins)

Students explore how their speech works through a number of activities including the modelling of their vocal chords ‘functionality using balloons. By inflating and then releasing the air from balloons, students can explore how the sound changes when the neck of the balloon is pulled tighter or looser. This emulates how the vocal chords work. Students then attempt saying a number of words and identifying from pictures, where the vocal tract and mouth cavity are depicted, which sound corresponds to each picture.

This activity constitutes a good foundation for activity 8.12.

**Equipment:** Pictures of vocal tract and mouth cavity arrangements, balloons

### 8.12 Straw reeds and vowel resonators (10 – 15 mins)

Each student is given a straw to construct their own reed by flattening the end and uses this as a representation of the vocal chords. Using the reeds, some foam and piping the students create vowel resonators for ‘oo’, ‘ih’ and ‘ah’. Students then blow through the straw reeds to identify the sound of each vowel resonator. The vowel resonators themselves are a representation of the shapes taken by the human vocal tract. As a conclusion to this activity, students can experiment with their reed and a balloon. By blowing up the balloon and releasing the air into their mouth and their own vocal tract they can observe how different mouth shapes correspond to different sounds.

This activity should be conducted after activity 8.11.

**Equipment:** Straws, piping, foam, balloons

### Sample Bibliographic Resources


9. Work Smarter Not Harder

9.1 Levers (10 – 30 mins)
Students are introduced to the world of simple mechanical machines through a simple lever demonstration in which a student uses a lever to pick up a teacher or activity facilitator. Following this, students construct their own levers using prisms, rulers and chocolate coins as the weights. Students can record data showing the length of the two arms and the number of coins required on each side to balance the ruler, and can graph their results in a suitable way. Through this investigation, students can also consider and demonstrate different lever classes and make connections to real-world devices that use each lever class. Students can also design an experiment to determine how much effort is required to lift a load.

This activity is an introductory simple mechanical machines activity which should be run prior to activity 9.2 to provide students with sufficient background knowledge.

**Equipment:** Prisms, Rulers, Chocolate coins

9.2 Catapult design challenge (30 – 60 mins)
Students are encouraged to apply their understanding of simple mechanical machines, materials and the EDP to design and build a catapult. After construction, students can explain the different simple mechanical machines that feature in their design and where the mechanical advantage is developed. Students should also be able to explain their devices in terms of the force applied and how this can be transferred into motion at a different point in their machine. Through this activity, students explore and investigate the applications of levers.

This activity follows on from activity 9.1.
9.3 Tug of War Challenge and designing a pulley (15 – 20 mins)
The students investigate how pulleys work by participating in a tug of war challenge. Using rope and wooden dowel students explore how pulleys work and how they can be used to make work easier. Through the activity students learn about forces and then extend their knowledge to design pulleys with C-clamps. Using these pulleys and force meters students can explore how much force is required to lift a load. Students can also investigate and discuss the real-world applications of pulleys.

This activity can be run as a standalone activity or can be used as a follow on activity for activity 9.1.

Equipment: Design Materials, tape measure, ruler, force meters, load

9.4 Inclined plane (15 – 20 mins)
Students can investigate the shape and structure of an inclined plane and perform an experiment to see how moving a load over a longer distance affects the amount of force required to do this task. Groups of students construct a small inclined plane and consider the force required to lift a load. Students can also investigate and discuss the real-world applications of inclined planes.

This activity can be run as a standalone activity or can be used as a follow on activity for activities 9.1 and 9.3.

Equipment: Design Materials, tape measure, ruler, force meters, load

Sample Bibliographic Resources


10. I-Robotics

10.1 Building robots (15 – 30 mins)
Students build Lego NXT Robots following provided instructions. While doing so students can think about the role of robots in society and some places in their daily lives where robots feature.

This is the introductory robotics activity which should be run prior to any other robotics activities (Activities 10.2, 10.3, 10.4, and 10.5).

**Equipment:** Lego NXT robotics kits

10.2 Four poles challenge (15 – 30 mins)
This challenge involves students using their Information and Communications Technology (ICT) skills to program a robot to travel around a course defined by four poles. Students can program their robot using trial and error, or can measure distances on the track and determine the wheel circumference to make more reasonable estimations in their programming. Students are encouraged to think about forces (such as friction) and why these could lead to their estimated distance being slightly incorrect.

This activity should be run after activity 10.1.

**Equipment:** Lego NXT robotics kits, computers with NXT software, four poles board
10.3 Remote control of a robot (20 – 40 mins)
Students with sufficient prior knowledge and skill can follow a *structured inquiry* approach to turn one robot into a remote control unit and provide communications between this and another robot for basic forward, backwards and turning control. Students can be encouraged to develop their own ideas to program the robot, improve the performance of the remote control unit, and add extra controllable features to their robot design.

This activity should be run after activity 10.1.

**Equipment:** Lego NXT robotics kits, computers with NXT software

10.4 Line following (15 – 30 mins)
Students are provided with a light sensor to connect to the front of the robot so that they develop a program to enable the robot to track along a line defined by the transition between dark and light intensities. To improve the program students are encouraged to make control movements as smooth as possible and in some cases can attempt to develop a program using two light sensors.

This activity should be run after activity 10.1.

**Equipment:** Lego NXT robotics kits, computers with NXT software, board with white and black sections
10.5 Dance challenge (15 – 30 mins)
The dance challenge involves students becoming creative with their programming skills and developing a sequence of moves that the robot can make as part of a dance routine. Students with sufficient prior knowledge and skills can develop new ways for launching their routines, such as by a sound or light signal being received by the robot. Students can also make modifications to their robot design to better fulfil their dance routine requirements.

This activity should be run after activity 10.1.

**Equipment:** Lego NXT robotics kits, computers with NXT software

**Sample Bibliographic Resources**

11. Plane-tastic

11.1 Paper planes/gliders (15 – 30 mins)
Students build and test paper planes and gliders using provided templates, or their own designs. During testing, students are encouraged to observe what “aircraft” travels the furthest, what “aircraft” is too heavy, and what different planes are made of. Students think critically about their observations. Students are also introduced to what a force is, and are encouraged to determine the forces acting on their planes. Newton’s laws of motion are considered. Additionally, students are encouraged to think about the different materials used in current aircraft, and their suitability for future plane design.

This can be run as a standalone activity with nil prerequisite knowledge and skill.

Equipment: Design Materials, templates

11.2 Positioning of flaps (15 – 30 mins)
Students explore the different directions of movement for a plane (roll, pitch and yaw), and learn about how to position flaps to achieve these different motions. In particular, the motion of a plane is described and then students are encouraged to think about the forces at play to determine where the flaps should be located to achieve any given motion. Flaps are placed on balsa wood planes and all students are encouraged to test their flap positioning to see if the desired result is achieved. Further discussion about the forces at play and how the corresponding motions are controlled is an integral part of this activity.

This can be run as a standalone activity with nil prerequisite knowledge and skill.

Equipment: ‘Aerolab’ planes, Design Materials
11.3 Kites (20 – 40 mins)
Students are provided with materials to develop their own kite design. Designs are tested and students are encouraged to make connections between the performance of the kite, the materials used and the forces involved.

This can be run as a standalone activity with nil prerequisite knowledge and skill.

**Equipment:** *Design Materials*

11.4 Parachutes (20 – 40 mins)
Students are provided with materials to develop their own parachute design. Designs are tested and students are encouraged to make connections between the performance of the parachute, the materials used and the forces involved. Similarly to activity 2.1, the goal of the parachute could be to protect an egg which would then represent a parachutist.

This can be run as a standalone activity with nil prerequisite knowledge and skill.

**Equipment:** *Design Materials*

**Sample Bibliographic Resources**


12. It’s Electrifying

12.1 Hand battery (5 – 10 mins)
Students are provided with a basic understanding of what electricity is through a simple modelling activity about atoms. Following this, the hand battery is used to provide a demonstration about how batteries work, and to highlight the fact that a closed circuit is required for electricity to flow. Students are encouraged to use this understanding in constructing subsequent electrical circuits.

This is an introductory activity which should be completed prior to all other electronics activities (Activities 12.2, 12.3, 12.4, 12.5 and 12.6)

Equipment: ‘Human Battery’ kit

12.2 Series and Parallel circuits (15 – 20 mins)
Using Electronic Toy Bricks (ETBs), students follow a structured inquiry approach to build series and parallel circuits and observe what happens when different switches are activated. Students are encouraged to explain their observations by identifying where the electrons flow in the circuit and by focusing on the operation of different switches.

This activity builds upon knowledge acquired in activity 12.1. It also provides students with the skills to undertake activity 12.4.

Equipment: ‘Electronic Toy Bricks’ kits
12.3 Conductors and Insulators (15 – 20 mins)

Students are introduced to the concept that some materials conduct electricity, while others insulate against the flow of electrical current. Using the ETBs, students construct a simple circuit to test different materials in a prediction-then-test mode of analysis. Ideally, students should make reasoned predictions for each material and then test this material and share results with the rest of the class. Connections can be made to real-world applications where certain materials surround electrical wires, and other observed uses of conductors and insulators.

This activity builds upon knowledge acquired in activity 12.1. It also provides students with the skill and understanding to undertake activity 12.5.

**Equipment:** ‘Electronic Toy Bricks’ kits, various materials that are conductors and insulators
12.4 Direction of Electron flow (15 – 20 mins)
Students use their knowledge of how batteries work to make assessments on the flow of electricity through a circuit. The direction of the flow is indicated by a spinning fan, which will alternate in direction depending on the “polarity” of the input power source.

This activity builds upon knowledge acquired in activities 12.1 and 12.2.

Equipment: ‘Electronic Toy Bricks’ kits

12.5 Sensor-based control of circuits (15 – 20 mins)
Following a structured inquiry approach, students investigate different sensors and their role in controlling a circuit. This is performed with the ETBs, and sensors available in this kit. Students can make their own decisions about the suitability of particular sensors for different circuit applications.

This activity builds upon knowledge acquired in activities 12.1 and 12.3.
**Equipment:** ‘Electronic Toy Bricks’ kits

**12.6 Circuit design challenge (20 – 40 mins)**
Students are encouraged to use their knowledge of electrical circuit components and previously built circuit designs to develop a circuit design for a particular application. The *EDP* is to be followed in this activity, and students are expected to document their design ideas and process.

This activity is a culminating activity for the “It’s Electrifying” module and relies upon activities 12.1, 12.2, 12.3, 12.4, and 12.5.

**Equipment:** ‘Electronic Toy Bricks’ kits

**12.7 Light Sensitive circuits (20 – 30 mins)**
Students explore light sensitive circuits by constructing light sensitive alarms and lamps using solderless electronics kits featuring real components. Through this activity, students can further their knowledge of electrical components and circuit construction.

This activity is a useful activity to be conducted following the activities that use the ‘Electronic Toy Bricks’ kits (activities 12.1 – 12.6).

**Equipment:** Neopia light sensitive kits
12.8 Radio kits (20 – 30 mins)

Students explore the world of radio and electronics by constructing one of three radio circuits using the Neopia solderless kits. The activity is conducted as a *structured inquiry* where students are provided full circuit diagrams and instructions to build a radio circuit.

This activity is a useful activity to be conducted following the activities that use the ‘Electronic Toy Bricks’ kits (activities 12.1 – 12.6) and after activity 12.7.

**Equipment:** Neopia radio kits

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**Sample Bibliographic Resources**


13. Opposites Attract

13.1 Investigation of magnets (10 – 20 mins)
Students investigate how north and south magnetic poles attract by experimenting with simple magnets. Students also explore the use of floating magnets and make connections to potential uses for such magnets. Additionally, students can be encouraged to ask questions and experiment with objects in their environment to search for sources of magnetism.

This is an introductory activity which requires nil prerequisite knowledge or skill.

**Equipment:** Magnets, Floating Magnets, ‘Magnetic Field Viewers’

13.2 Building electromagnets (15 – 30 mins)
Students are introduced to the basic idea of creating a magnet by using an electric current. Following a **structured inquiry** approach, students create their own basic electromagnet and explore its effectiveness at attracting (metallic) paperclips. Throughout the activity students are encouraged to explore the effect of the number of turns of the electromagnet’s coil on the number of paperclips collected. Their findings can be graphed to explore linear versus non-linear features. Students are also encouraged to brainstorm other factors which could reduce or improve the effectiveness of the electromagnet, and to develop ideas for where electromagnets could have practical uses.

This activity builds upon knowledge acquired in activity 13.1 and provides background knowledge necessary for activity 13.3.

**Equipment:** Basic Electromagnet kit (contents: nails, thin copper wire, alligator clips, batteries, battery clips)
13.3 World’s simplest motor (15 – 25 mins)
A simple spinning motor is constructed using a coil of wire, a battery and a magnet. Students are encouraged to make connections to their understanding of how electromagnetism works, and can develop ideas about where such motors may be used. A low cost alternative for this activity is also available using simple materials.

This activity builds upon knowledge acquired in activities 13.1 and 13.2.

**Equipment:** Simple motor kits (batteries, magnets, wire, plastic stand)

13.4 Magnetic Levitation Trains (20 – 40 mins)
Students construct a magnetic levitation train using a *guided inquiry* approach. By experimenting with the train, students make connections to their understandings of magnets and forces. For students with sufficient prior knowledge and skill, the design and
construction of a magnetic levitation train can be approached as a design challenge utilising the EDP.

This activity builds upon knowledge acquired in activity 13.1.

**Equipment:** ‘Magnetic Levitation Train’ kits, tape

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**Sample Bibliographic Resources**


14. Chemistry Matters

14.1 Identifying states of matter (5 – 10 mins)
Students are introduced to the three basic states of matter, i.e., solids, liquids and gases, and are encouraged to identify items in their environment which belong to each state.

This is an introductory activity that requires nil prerequisite skill or knowledge.

Equipment: materials around the room

14.2 Cornflour and water (10 – 20 mins)
A cornflour and water substance is prepared and students are asked to identify the state of matter that this substance belongs to. When the substance is moved slowly it appears to act as a liquid, and when moved fast appears to be a solid. Students can experiment with the substance to determine the conditions under which it appears as a solid or a liquid.

This activity relies upon knowledge acquired as part of activity 14.1.

Equipment: cornflour and water mixture

14.3 Molecular model of states (“Atomic People”) (10 – 15 mins)
As a group activity, students model the behaviour of solids, liquids and gases on a molecular level. Students gain an understanding of the different types of bonds between molecules and why different properties are observed in solids, liquids and gases.

This activity extends knowledge acquired in activity 14.1.

Equipment: none required

14.4 State Transitions (5 – 10 mins)
As a group activity, students emulate the behaviour of solids, liquids and gases to model how transitions between states can occur when temperature changes are applied.

This activity extends knowledge acquired in activities 14.1 and 14.3.

Equipment: none required

14.5 Dry Ice Experiments (15 – 25 mins)
Dry ice is the solid form of the common gas carbon dioxide. Carbon dioxide is one of the very few substances in the world which sublimes (that is, it directly transitions from a solid to a gas) at atmospheric pressure. A variety of experiments are performed to show students some interesting features of dry ice, reinforcing students’ understanding of the states of matter and transitions between states.
This activity builds upon chemistry knowledge acquired as part of activities 14.1, 14.2, 14.3 and 14.4.

**Equipment:** Dry Ice Experiments kit (contents: gloves, metal bowl, dry ice, and dishwashing liquid)

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**Sample Bibliographic Resources**


15. Be Cool: Hot Science

15.1 Diffusion (10 – 20 mins)
Students explore the concept of diffusion through water of different temperatures by placing a small amount of food dye into hot and cold water. As part of this experiment, students are encouraged to observe how the dye moves through the water and make connections to what they know about heat to explain their observations.

This activity can be run as a standalone activity with nil prerequisite knowledge or skill.

Equipment: Diffusion kit (contents: food dye, containers, water)

15.2 Conduction (10 – 20 mins)
Students are introduced to the concept of conduction as a method of heat transfer which requires direct physical contact for the transfer to occur. To explore this concept, students move around the room and observe the temperature of different objects when they place their hands on them.

This activity can be run as a standalone activity with nil prerequisite knowledge or skill.

Equipment: various materials around the room

15.3 Convection (10 – 20 mins)
Through a demonstration students are introduced to the notion of convection by observing how food dye moves through water which is heated by convection. Students are encouraged to observe what happens to the dye and make connections to what is occurring through their own understanding of the molecular model for the states of matter, and the energy that different substances have.

This activity can be run as a standalone activity with nil prerequisite knowledge or skill.

Equipment: Convection kit (contents: water, convection heat sources, food dye)

15.4 Connections to heat transfer (10 – 20 mins)
Students are presented with a list of different heat sources (or heat transfer mechanisms) and are encouraged to consider the form of heat transfer involved. In particular, students are prompted to consider how heat transfers occur in their environment and the possible uses of heat transfer processes in engineering applications.

This activity can be run as a standalone activity with nil prerequisite knowledge or skill.

Equipment: none required
Sample Bibliographic Resources


Lott, K. (2011). “Fire up the inquiry. Lose the routine, tweak your cookbook lab, and reach a level of open inquiry with these strategies used during a unit on heat”. Science and Children, March, pp. 29-33.


16. Thrill Rides

16.1 Marble jump (20 – 40 mins)
Using provided materials students need to construct a marble jump that fulfils prescribed design specifications. The goal is to enable the marble to jump into a cup while covering the greatest horizontal distance possible. Students are encouraged to consider how the speed of the marble changes throughout the marble jump and to make judgements about why things happened in a particular way. Forces and energy are introduced in this activity to help students explain their observations.

This is an introductory activity which prepares students for the rollercoaster design challenge (Activity 16.2).

**Equipment:** Marbles, Flexible Tubing, Tape

16.2 Rollercoaster design challenge (30 – 60 mins)
The rollercoaster design challenge involves students applying the EDP to design and build a rollercoaster which contains at least one loop-de-loop and one hill. Students are encouraged to apply their knowledge and understanding of forces and energy to explain how their design works and to critically evaluate the performance of their rollercoaster. Opportunities for redesign and improvement are provided as students develop a greater understanding of the forces involved.

This activity builds upon the understanding students gain from Activity 16.1.

**Equipment:** Design Materials

Sample Bibliographic Resources


17. Let’s Dive Right In

17.1 Discovering buoyancy (10 – 20 mins)
Students make predictions about whether certain objects will float or sink when placed in water. The objects are tested, and students are encouraged to justify their predictions in light of what they see. Students are introduced to Archimedes’ principle and learn the basics about how boats float.

This is an introductory activity which provides essential knowledge for activities 17.3, 17.4, 17.5, 17.7, and 17.8.

Equipment: Fish Tank, Various objects to test

17.2 Static Pressure (10 – 20 mins)
Students investigate static pressure using plastic bottles filled with water. In a *structured inquiry* approach each group is encouraged to make several holes at different heights along the side of the bottle before filling with water. Students then fill their bottles with water and alternate between holes that they block with their fingers. This activity should enable students to see that a hole closer to the base of the bottle will result in a water stream that extends much further away from the bottle than one near the water surface at the top of the bottle. Students can then make connections to their physics knowledge to explain their observations.

This is a standalone activity which requires nil prerequisite knowledge or skill.

Equipment: Plastic Bottles with holes at various heights
17.3 Boat design challenge – weight and stability (15 – 45 mins)
As a challenge, using the EDP, students design and construct a boat which can hold as much weight as possible. Students are encouraged to develop their designs using their understanding of buoyancy and forces. Boats are tested and students provided with an opportunity to improve their initial designs.

This activity builds upon basic buoyancy knowledge acquired through activity 17.1.

**Equipment:** Design Materials, large plastic container

17.4 Boat design challenge – boat speed and frontal resistance (15 – 45 mins)
Students explore how the frontal shape of the boat affects its speed and correspondingly its resistance to motion. Various frontal shapes are tested and students are guided to apply their knowledge of boat motion and forces to justify their observations.

This activity builds upon basic buoyancy knowledge acquired through activity 17.1.

**Equipment:** Design Materials, Fish tank

17.5 Submarines (10 – 15 mins)
Students are introduced to how a submarine works via a demonstration. The key concepts behind submarine operation are highlighted and students are encouraged to use their own understanding of forces and pressure to make connections with their observations.

This activity builds upon basic buoyancy knowledge acquired through activity 17.1.

**Equipment:** Submarine Demonstration kit
17.6 Periscope design activity (10 – 20 mins)
Frequently a submarine will have a periscope attached to allow the environment above the submarine to be observed. Following a closed inquiry approach students design and build a periscope using two mirrors. They are also introduced to the concept of optical reflection to explain what they observe.

This activity builds upon knowledge of reflection. If students do not already possess the essential prerequisite knowledge or skill necessary for this activity, it can be coupled with activity 7.4.

**Equipment:** Cardboard, Mirrors, Scissors, Tape

17.7 Submarine Design Challenge (15 – 45 mins)
Students apply the EDP to design and build a submarine which can change its depth in the water. In doing so, students apply their understanding of forces and materials’ properties to develop and test a design.

This activity builds upon basic buoyancy knowledge acquired through activity 17.1.

**Equipment:** Design Materials, Fish tank

17.8 Steam Boat construction (15 – 45 mins)
Students design a device which can propel a boat through the water in the form of a steam engine. The EDP is applied or students can begin with a more guided inquiry approach which they can further develop. Boats are tested and students are provided with an opportunity to use their knowledge of forces to improve their designs.

This activity builds upon basic buoyancy knowledge acquired through activity 17.1.

**Equipment:** Design Materials, Fish tank, Candles
Sample Bibliographic Resources


18. Cooking Up A Storm

18.1 Food safety and biology (10 – 20 mins)
Students discuss concepts relating to food safety and biology, in particular what happens when food goes mouldy. Rather than growing mould in the classroom, students firstly complete activity 6.2 to observe how a common microorganism (yeast) grows. This can be conducted as a student designed experiment where the student chooses to investigate the food supply, moisture or temperature required for the best growth rate. Extending on the idea of food safety, students are asked to consider how they should wash their hands to ensure that their hands are completely clean. A volunteer from the class writes on their hand in invisible ink and then tries to wash it away. The ink can be seen by using a UV light demonstrating that students rarely wash their hands well enough to remove all bacteria and germs that might be on their hands. Hand-washing guidelines are introduced and show that the invisible ink (i.e., our proxy for germs/bacteria) can be successfully washed away.

This activity provides an introduction to food safety and should be conducted before subsequent activities in this module.

Equipment: yeast, sugar, beer bottles, balloons, invisible ink pen, soap

18.2 Acids and bases (10 – 20 mins)
Students are introduced to the idea that some solutions can be acidic while others are basic. By predicting and then testing, students assess whether common kitchen products including vinegar, bi carb soda and water are acids, bases or neutral. Students can compare the results from different pH indicators such as red cabbage indicator strips, a universal pH indicator, or a narrow band indicator such as bromothymol blue. Note that red cabbage contains a pigment which is sensitive to the pH of solutions. Students can investigate this further and make their own pH indicators.

This activity provides a good introduction to food chemistry and should be conducted before activity 18.3.

Equipment: red cabbage pH strips, universal indicator, plastic cups, common household products (e.g., vinegar, water, bi carb soda, citric acid, milk)

18.3 Powdered Drink Mix (10 – 15 mins)
Some powdered drink mixes contain a warning that they should not be stored in metal containers. Throughout this activity, students explore why this warning is in place by putting small steel wool samples in some cordial mix and observing what happens. Depending on the type of cordial, the reaction may take several hours or days to complete, but students should eventually observe that some of the cordial flavours become colourless. The chemical reaction behind this phenomenon can be explored further by the class. This activity promotes the importance of reading the directions available on food packaging.

This activity should be conducted after activity 18.2.
**Equipment:** steel wool, powdered drink mix (various flavours/brands), small plastic cups

**18.4 Emulsifiers (10 – 20 mins)**
Students explore how two liquids that do not normally mix (like oil and water) can be combined by using an emulsifier. These emulsions can be temporary (like the one in this activity) or can be permanent (like in mayonnaise). Students make a temporary emulsion mix using vinegar, oil, mustard and paprika. By creating one mix with the emulsifiers and one without, students can draw what happens when they try to mix the vinegar and oil together.

This activity should be conducted after activities 18.2 and 18.3.

**Equipment:** small bottles, vinegar, oil, mustard, paprika

**18.5 Insulation (10 – 30 mins)**
In this activity, students explore food packaging and they pay special attention to how certain types of packaging can be used to keep something cool or hot (i.e., they look at thermal insulation). Each group of students is given three large cups and three smaller cups and needs to create some kind of insulation to keep water in the smaller cup cold. The smaller cup is placed in the larger cup with the insulation between the two and the large cup is placed in a warm water bath. Icy water is placed in the small cup and students record the temperature of the water (in the smaller cup) over time to see how well their insulation solutions perform.

This activity should be completed before activity 18.6.

**Equipment:** Design materials, small and large plastic cups, thermometers, large plastic containers (for water bath)

**18.6 Solar cookers (20 – 60 mins)**
Students apply their knowledge of thermal insulation gained in activity 18.5 to design a solar cooker that can heat a piece of apple. Throughout the activity, students are introduced to the EDP and their designs are tested by periodically measuring the temperature inside the cooker when placed under lights or in the sun. This activity can be linked with a discussion about optics including lenses and reflection to provide students with an opportunity to improve their solar cooker designs.

This activity should be conducted after activity 18.5.

**Equipment:** Design materials, apple, lenses, mirrored card
Sample Bibliographic Resources


19. Let’s Be Civil

19.1 Paper Cup Design Challenge (15 – 30 mins)
This activity introduces students to the world of engineering design through a challenge to create a paper cup while using only scissors and a piece of paper. Students do not have access to glue or other adhesives, which means that they are challenged to consider how they can use their piece of paper to hold water without supporting materials. Cups are tested by placing a small amount of water in them and seeing how well they hold the water for a short period of time.

This activity can be run as a standalone activity and also provides a good introduction to the *EDP* for activity 19.2.

**Equipment:** Paper, Scissors, Water

19.2 Water Filtration (30 – 60 mins)
Civil Engineers often deal with water resources. This activity introduces students to the role of civil engineering in the preparation and delivery of clean water to residential areas. The design component of the activity involves students making a simple filtering device to filter dirt, food colouring and other components from a water solution to provide water that is as clear as possible. Consideration is given to the types of materials that will filter out different components of the “contaminated” water, and efficiency in terms of cost, time and use of materials. A secondary component to this lesson investigates the considerations that civil engineers must keep in mind when designing ways to transport water from large reservoirs to residential locations.

This activity can be run as a standalone activity, but can also be run after activity 19.1 to improve student understanding of the *EDP*.

**Equipment:** Paper, Scissors, Pencils, Rulers, Plastic Bottles, Soil, Gravel, Oil, Sand, Tape, Stopwatches, Water, Plastic Spoons, Food Colouring, Hessian Squares
19.3 Tower Design (15 – 30 mins)

Students are introduced to the role of civil engineers in structure design through a design challenge. Students utilize the EDP as they design and construct the tallest tower possible that can support a golf ball on the top using newspapers, tape and scissors. Consideration is given to the design of (ground) supports to produce a stronger structure. Students test their designs by placing a golf ball at the top of the tower, and observing how well the tower stands. The activity introduces students to forces, in particular tension and compression, and how these are important in structure design.

This activity can be run as a standalone activity, but can also be run after activity 19.2 to improve student understanding of the EDP. The activity provides a good introduction for structure design as found in activity 19.4.

Equipment: Newspapers, Tape, Scissors, Paper, Rulers, Golf Balls
19.4 Straw Bridges (30 – 45 mins)
Students further explore the world of structural engineering by designing truss bridges. Design requirements indicate that the truss bridge prototype must span a distance of 30 cm, the bridge will have heavy traffic (such as log trucks) but has a limited budget. Boats also need to be able to pass under the bridge. Balancing these design considerations, students are required to efficiently design a suitable truss bridge which is tested by attaching weights to its centre. Students are encouraged to observe how different shape trusses affect the performance of their bridge and to consider the tension and compression forces in their design.

This activity follows on from activity 19.3.

Equipment: Straws (20 per group), Tape, Scissors, 100g weights
Sample Bibliographic Resources


20. Sporty Science

20.1 Balancing (5 – 10 mins)
Students are led through a series of different balancing postures and asked to describe how their body moves to counteract being unbalanced. Through discussion, the students identify those senses that assist them in keeping their balance. These include the inner ear, their eyesight, and their sense of touch. The discussion can be extended to include reflex actions to restore balance and the physical forces acting on the body in the different postures.

This activity provides an introduction to how the body moves.

Equipment: none required

20.2 Actions and forces (5 – 10 mins)
By performing actions such as push-ups, stretching to touch their toes, star jumps and sit ups (and other similar sports related actions), students are encouraged to consider the forces acting on their body. Small group discussions about the forces at play ensure that students gain a good understanding of gravity and what they need to do to overcome gravity to, say, do a push up.

This activity provides an introduction to how the body moves and can be performed in conjunction with activity 20.1. This activity should also be performed before activities 21.3 and 21.4 which are part of the next module.

Equipment: none required

20.3 Can the longest legs jump the furthest (15 – 20 mins)
Students perform a guided investigation as to whether the longest legs can jump the furthest, and record their observations and measurements on a worksheet. Group discussions following the activity enable students to identify concepts like trajectory, thrust, and gravity that affect how far they can jump. The worksheets available for this activity enable students to record their data in a table and average the results. Further work could involve graphing their results and students could be encouraged to design their own experiment to investigate how some other factor (variable), such as how high they jump, could affect the length of their jump.

This activity can be performed as a standalone activity or in sequence with activities 20.1, 20.2, 21.3, and 21.4.

Equipment: tape measures, worksheets

20.4 Engineering swimming pools (20 – 60 mins)
Students are introduced to the notion of a ‘fast’ swimming pool in which the wave interference caused by each swimmer has a minimal impact on the swimmer or others in the pool. One way this is achieved is by having a variable pool depth, or through the design
of lane ropes that can dissipate the wave energy. This activity enables a discussion of wave-related concepts including wave absorption, reflection and diffraction. Students are presented with a design challenge to create lane ropes that will minimize the waves moving past the rope and into another lane. The EDP is used throughout this activity and the lane ropes’ designs are tested by placing them in a fish tank, where a small wooden block is moved to create waves. Students can make connections to their own experiences of wave interference in a swimming pool.

This activity can be conducted as a standalone activity or in sequence with activities 20.1, 20.2, 20.3, 21.3, and 21.4.

**Equipment:** *Design materials*, fish tank, wooden block

**Sample Bibliographic Resources**


NASA (2010). “NASA’s our world: Keeping the beat”. EG-2010-002-LaRC.
21. Get A Grip!

21.1 Empathy activity (10 – 15 mins)
Students explore activities using their non-dominant hand to try to perform routine tasks such as opening a jar or tying their shoes. Following this, students cover their hand with a sock and secure their thumb with a rubber band or similar. They then try to identify objects in a bag using their covered hand. This activity provides students with an opportunity to experience common activities without the use of their hands, and is designed to promote empathy for people who cannot use their hands or fingers.

This activity is the introduction activity for the biomedical engineering workshops and should be conducted before activity 21.2.

**Equipment:** jar, socks, rubber bands, brown bag containing objects (such as balloon, pens, balls, etc.)

21.2 Assistive devices (10 – 15 mins)
Students are introduced to the EDP through a simple design challenge. The challenge is to design a device that could allow someone without the use of their hand to pick up a key ring. They are provided with a wide selection of design materials to use in the activity. As a follow on activity, students can design a cast for a broken bone (in this case represented by an ice-cream stick which has been split in half).

This activity is suitable to follow on from activity 21.1. It also forms a good introduction to the EDP before students start the prosthetic arm design challenge (activity 21.6).

**Equipment:** Design materials, key rings

21.3 The cycle of blood through the body (5 – 15 mins)
In this activity students explore how the blood is transferred through the body. In groups of five, a selection of tags (indicating the Heart, Lungs, Vein, Artery, and Body) are allocated, and the students pass a small ball around replicating the cycle of blood around the body. Students try to see how many times they can complete the correct cycle in one minute.

This activity should be completed before activity 21.4.

**Equipment:** name tags (Heart, Lungs, Vein, Artery, and Body), balls
21.4 Pulse measurement (5 – 15 mins)
Students learn through this activity how to measure their own pulse and make predictions about how it will vary after exercise. After measuring their resting pulse, students perform one minute of physical activity (running, jumping, dancing, etc.) and then measure their pulse again. Students should continue measuring their pulse every minute for 3 minutes after exercise and tabulate the results. Following this, students can graph their pulse and have group discussions about how their and other students’ pulses varied with exercise.

This activity is useful to complete after activity 21.3.

**Equipment**: stopwatch, worksheets (graph paper)

21.5 Modelling the lungs (15 – 20 mins)
Using simple *design materials* students develop a model of the lungs using a *structured inquiry* approach. The construction of the model leads into a discussion about the parts of the lung and the physics behind the breathing process. Students learn about pressure and how changes in pressure allow the lungs to fill with air.

This activity can be run as a standalone activity or can be run in sequence with activities 21.1, 21.2, 21.3 and 21.4.

**Equipment**: cups, straws, balloons, tape, scissors

21.6 Prosthetic arm design challenge (60 – 90 mins)
Students embark on a design challenge to develop a prosthetic arm designed to meet a two faceted challenge. The first part of the challenge requires the arm to demonstrate strength, and the second part requires the arm to show dexterity to pick up small objects. *Design materials* are provided to the students and the *EDP* is used throughout the process. Throughout the activity students are encouraged to consider what tasks might be difficult to complete without the use of their arm and to brainstorm the key characteristics that are necessary for a replacement arm.

The activity can be run as a standalone activity or can be integrated with activities 21.1 and 21.2.

**Equipment**: *Design materials*

**Sample Bibliographic Resources**

Appendix
Engineering

Engineering is a profession in which creativity, innovation and science come together to solve the world’s problems. Engineers can have a profound impact upon the everyday lives of people by designing new technologies and devices that make our lives better or by solving problems with significant societal relevance.

In particular, Engineers (National Academy of Engineering (2013)):

- Make a world of difference,
- Are creative problem solvers,
- Connect science to the real world, and
- Help shape the future.

Engineering is also essential to our health, happiness and safety.

The Engineering Design Process

One key idea, which is explored throughout many of the activities described in this guide, is the Engineering Design Process. This process is similar to the scientific inquiry process in that it provides students with a framework for completing design activities. The key principle that not every idea will work perfectly first time is explored throughout this process, with building, testing and evaluating in a cyclic nature being key features of the process.
The main steps in the *Engineering Design Process* are briefly described below:

<table>
<thead>
<tr>
<th>Step</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Identify Problem</td>
<td><em>Before a design project can be undertaken the goals must be clearly identified.</em></td>
</tr>
<tr>
<td>Brainstorm</td>
<td><em>Many possible solutions could fulfil the identified goals. The brainstorm phase encourages these solutions to be identified and considered.</em></td>
</tr>
<tr>
<td>Design</td>
<td><em>One idea or a combination of ideas from the brainstorm phase is chosen and developed into a more comprehensive design.</em></td>
</tr>
<tr>
<td>Build</td>
<td><em>The design is built using available materials.</em></td>
</tr>
<tr>
<td>Test and Evaluate</td>
<td><em>The design is tested to see if it meets the identified goals. The design must be critically evaluated to see where potential improvements could exist.</em></td>
</tr>
<tr>
<td>Redesign</td>
<td><em>Improvements are made to the design as the result of the evaluation phase.</em></td>
</tr>
<tr>
<td>Share solution</td>
<td><em>Once a final design has been developed, which meets all problem goals; it is important to share this solution.</em></td>
</tr>
</tbody>
</table>
Glossary

Various descriptions of the typical inquiry modes are available in the literature. The activities contained in this guide relate to the following inquiry modes synthesized from the literature (Bell, Smetana and Binns (2005), Colburn (2000), Goodrum and Druhan (2012), Hermann and Miranda (2010))

**Inquiry modes:**

**Open Inquiry**  
Students formulate their own problem to investigate, construct the investigation procedure and develop the results with little external input. The student has control of the process.

**Guided Inquiry**  
Students are provided a problem to investigate and given materials to aid in that investigation. The student is responsible for developing their own procedures and results.

**Structured Inquiry**  
Students are provided with a problem to investigate, the materials and procedures, but are required to develop their own results.

**Closed Inquiry**  
The activity acts to confirm some fact which the student has been taught. The problem, procedure and result are provided to the student.

**Other Terms used in this document:**

**Engineering Design Challenge**  
An engineering design challenge allows students the opportunity to apply their knowledge and skills to design, create and test a device, process or prototype that satisfies the goals of the challenge. The challenge environment gives students a direct goal for their design work and encourages teamwork.

**Engineering Design Process (EDP)**  
The engineering design process (as described on the previous page) is the process that the students follow when completing design challenges.

**Load Box**  
The load box is an electrical device which can measure power, current and voltage.

**Design Materials**  
The generic design materials used in most activities include:
- Scissors
- Tape
- Glue
- Hot glue guns
- Rulers
- Pencils
- Garbage bags
- Paper
- Corfu
- Cardboard
- Plastic and Paper cups and plates
- Balloons
- Wooden skewers
- Metal skewers
- Plastic bags
- Cling wrap
- Foil

## Recommended Activity Sequencing Within Modules

<table>
<thead>
<tr>
<th>Module</th>
<th>Recommended Activity Sequence</th>
</tr>
</thead>
<tbody>
<tr>
<td>It’s Full of Hot Air</td>
<td>1.1</td>
</tr>
<tr>
<td>Egg-streme Crashes</td>
<td>2.1</td>
</tr>
<tr>
<td>The Sky is the Limit</td>
<td>3.1, 3.2, 3.4</td>
</tr>
<tr>
<td>Electricity on Wheels</td>
<td>12.1, 4.1</td>
</tr>
<tr>
<td>Don’t Crack Under Pressure</td>
<td>9.1, 5.1</td>
</tr>
<tr>
<td>Renew Your Energy</td>
<td>6.6, 6.2, 6.4, 6.5, 6.3</td>
</tr>
<tr>
<td>Seeing the Light</td>
<td>7.1, 7.2, 7.4, 7.5, 7.6, 7.7, 7.8, 7.9, 8.5</td>
</tr>
<tr>
<td>It Sounds Great!</td>
<td>8.3, 8.7, 8.8, 8.5, 8.3, 8.2, 8.9, 8.10, 8.11, 8.12, 8.1</td>
</tr>
<tr>
<td>Work Smarter Not Harder</td>
<td>9.1, 9.3, 9.4, 9.2</td>
</tr>
<tr>
<td>i-Robotics</td>
<td>10.1, 10.2, 10.4, 10.3</td>
</tr>
<tr>
<td>Plane-tastic</td>
<td>11.1, 11.2, 11.3</td>
</tr>
<tr>
<td>It’s Electrifying</td>
<td>12.1, 12.2, 12.3, 12.4, 12.5, 12.6, 12.7, 12.8</td>
</tr>
<tr>
<td>Opposites Attract</td>
<td>13.1, 12.1, 13.2, 13.3, 13.4</td>
</tr>
<tr>
<td>Be Cool: Hot Science</td>
<td>15.1, 15.2, 15.3, 15.4</td>
</tr>
<tr>
<td>Thrill Rides</td>
<td>16.1, 16.2</td>
</tr>
<tr>
<td>Let’s Dive Right In</td>
<td>17.1, 17.2, 17.3, 17.4, 17.5, 17.6, 17.7, 17.8</td>
</tr>
<tr>
<td>Cooking up a Storm</td>
<td>18.1, 18.2, 18.3, 18.4, 18.5, 18.6</td>
</tr>
<tr>
<td>Let’s Be Civil</td>
<td>19.1, 19.2, 19.3, 19.4</td>
</tr>
</tbody>
</table>
Pre and Post-Lesson Plans

Lesson plans are available (on request) to introduce students to the field of engineering prior to commencing any of the design challenges outlined in this guide or prior to attending a STEM Education and Outreach Lesson run at UTAS.

The pre-lesson plan introduces students to the idea of what an engineer is through a PowerPoint presentation and by getting students to explore their environment to find things that an engineer may have been involved in designing. Through this activity students can also be introduced to the EDP.

The post-lesson is designed to reinforce student knowledge of the role of engineers and how they use the EDP. Students are required to identify the relevant steps of the EDP and apply them to solve simple design problems. A word search and crossword are also available to reinforce terms the students are introduced to throughout the engineering activities.

Additionally, modified Draw a Scientist Test (DAST) and Draw an Engineer Test (DAET) survey instruments are available to elicit prior student knowledge of scientists and engineers and can be accompanied by activity-specific survey questions. The DAST and DAET can be conducted as a pre- and post-workshop activity that demonstrates how student understanding of the role of engineers and scientists in society changes through participation in the activities.
References


