Contents at a glance

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- Applied Science
- Astronomy
- Forces
- Light and Sight
- Real Chemistry
- Science Capabilities

Shows
- Sparks Arcs and Gherkins
- Wonderful Water

Unit plan
- Electricity
We have produced this comprehensive resource of activities to better enable teachers to plan and incorporate ‘The Science Roadshow visit’ into student learning programmes. The overriding objective is to enhance learning outcomes for students.

**GUIDE**

**PREPARATION**
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**Numeracy and literacy**

Many numeracy and literacy opportunities exist within the Science Roadshow programme, both during the visit experience and within this Resource Booklet. In particular, shows, science experiments and activities, challenges, interactive exhibits and the Unit of Work found in this Resource Booklet are all contextual frameworks within which the teacher can present integrated programmes.

**Foundational Science Capabilities**

We have incorporated many implicit and explicit Foundational Science Capabilities components (functional interpretations of the Nature of Science strand) both within our 80 minute Science Roadshow visit experience (exhibits and shows) and within this Resource Booklet. And, we have an exhibit theme called ‘Foundational Science Capabilities’.

**New resources to support science education**

We would like to draw your attention to a new range of resources for science teaching made available through the TKI site at: http://scienceonline.tki.org.nz. More than sixty existing resources are adapted to meet the needs of the science curriculum based around the five Foundational Science Capabilities (that link to the key competencies of the New Zealand Curriculum) and relevant Nature of Science concepts.

**Sir Paul Callaghan Science Academy endorsement**

Research gives us very clear pointers to the components of best practice science instruction. Key aspects are incorporated within this resource book, namely: a strong emphasis on explicit teaching of the Nature of Science (through the Science Capabilities), the 5 E Instructional Model which is based on a constructivist view of learning, good questions leading to good investigations, and, a student-directed learning approach in which students are coached towards more and more opened ended forms of scientific inquiry. These practices are endorsed by the Sir Paul Callaghan Science Academy and are fundamental to creating critical-thinking, innovative students who will become part of a science savvy public.

More information about the Sir Paul Callaghan Science Academy is found on the back cover of this book.

Resource Book prepared by Peter E. Smith
(Education Manager, National Science-Technology Roadshow Trust)
Find the answer to the puzzle statement below about simple machines. Your clues are in the table. For each of the terms down the left column find the matching picture along the top of the table. Circle the letter in the box where their rows and columns meet.

### Science Vocabulary Puzzle

#### Simple machines

A simple machine is a basic device for applying a force.

**Puzzle statement:**

*A simple machine is a basic __ e __ a __ device for applying a force.*

---

**A lever, such as a taiaha (fighting weapon) is a simple machine.**
Can you decode the secret message using the alphabet box below? Hint: Each letter of the alphabet in the box has two letters as part of its code — the first letter is from along the top of the grid and the second letter is from along the side, e.g. p = zi.

**Secret message:**

_The universe is thought to have begun with a..._

**Alphabet box**

<table>
<thead>
<tr>
<th>k l b z n p</th>
</tr>
</thead>
<tbody>
<tr>
<td>a b c d e f</td>
</tr>
<tr>
<td>e g h i j k l</td>
</tr>
<tr>
<td>i m n o p q r</td>
</tr>
<tr>
<td>o s t u v w x</td>
</tr>
<tr>
<td>u y z</td>
</tr>
</tbody>
</table>

**Now, unscramble this list of secret words about the universe:** kekapekapoku, lapekabane lebipenako, zibopekokapi, kibepenekunokaku, kobozinapilibizoka.

Finally, use the alphabet box to make secret codes for these words about space: planet, moon, orbit, rotate, Matariki. You can also make up codes for other words about the universe and have your friends work out what they are.
Fun with forces!

Use the clues to help you complete the statement below. (The two missing words that complete the statement will appear in the shaded squares.) Some letters are already given.

**Clues:**

- The opposite to a pull. **U**
- Force applied to an area. (When you get a flat tyre, you lose this.) **E S**
- When forces are equal and opposite, they are ..... **C**
- A rod that connects two wheels. **X**
- Similar to mass, but this changes from one planet to another. **T**
- Used to explore space. **C**
- Another word for friction. **R**
- Transfers forces using a pivot point, e.g. a see saw. **E**
- A parachute slows due to air .......... **C**
- Aerodynamic, sleek, smooth. **S**
- A type of wheel. Used with ropes on boats. **E**

**Statement:**

A ____________ force that exists between any two objects is called ____________.

The bigger the objects, the greater this force is.
Fill in the grid below with the words from the list. Some letters are given as clues. There will be two words left over from the list. Use them to complete the two statements about light and sight.

**Word list**

- Eyebrows
- Vision
- Radiation
- Colourblindness
- Colour
- Concave
- Blackness
- Mirages
- Spectrum
- Brain
- Iris
- Ultraviolet
- Binocular
- Pupil
- Convex
- Infrared
- White
- Sun
- Compoundeye
- Illusions
- Rainbow
- Lashes
- Polaroid
- Glare
- Opaque
- Reflection
- Eyes
- Strobe
- Cornea

**Statements about light and sight**

1. *The eyes cannot work without the _________.*
2. *An _________ object does not let light through.*
Use the clues to complete the crossword on chemistry and its applications. Some letter clues are given.

Clues

Across
2) To remove the unwanted substances, contaminants or impurities.
3) A type of plastic used to make rope and sewing thread.
5) The study of chemicals.
6) A drink made from fermented sugar, hops and malt.
10) A very common material made using petrochemicals. It can be moulded into different shapes and can be hard or soft.
12) One substance made by putting different substances together.
14) A dairy product made from pressed milk curds using bacteria.
15) Substance that is made from wood fibres pressed together. We write on this.
18) A sticky substance that is used to attach two objects together.
19) Opposite to metals.
20) A tiny single-celled type of fungus used to make bread and wine.

Down
1) A common process of heating food to make it easier to eat.
2) A person who makes, mixes and sells medicines.
4) A process involving yeast feeding on sugary water to make alcohol.
5) A sweet substance made by heating sugar. Used as a flavouring in ice cream and cakes.
7) Purifying a liquid by a process of heating and cooling. Used to make spirits and ‘essences’ such as lavender oil.
8) When milk becomes jelly-like if it is mixed with an acid. A simple term for coagulation.
9) Materials that are extracted from the earth during mining.
10) How something behaves — its features, characteristics, etc.
11) Shaping metal by heating it and pouring it into moulds.
13) A process of taking substances out of the earth. Often requires huge machinery.
16) A substance made from shaking cream. We spread it on bread.
17) Hard shiny materials that conduct heat and electricity.
18) A clear substance made from melting silica sand.
SCIENCE VOCABULARY PUZZLE

Science Capabilities

Science is about...

Find 31 hidden words in the grid below.
Twenty five of the words are given to the right.
Can you find the six extra mystery words? The words can be found diagonally, vertically and horizontally, and some words are reversed.

Word list

Communication, systematic, theory, trials, hypothesis, classifying, observations, data, law, evidence, objectivity, questions, testing, critiquing, drawings, creativity, models, inferences, conclusion, variables, recording, investigating, fairest, engaging, measuring.

Extra six mystery words (list):
Challenge 3
Improving your hovercraft
Try some ways of improving your hovercraft. BUT, only change one thing at a time (so that you are performing fair tests).

Using your evidence
Use evidence in the same way as you did earlier to find out if your changes have made a better hovercraft. Make other changes and again collect evidence. Finally, once you have finished, use your evidence to decide on the best hovercraft design.

Communicate your findings
Make a chart showing your evidence for how good each design is. Discuss how it supports your ideas for the best design. Were there any problems with the way you collected evidence?
Learning intentions
Science Capabilities: Gather and interpret data from a collision.
Planet Earth and Beyond: What happens when an object like an asteroid collides with a larger object (like a planet) and it breaks up?

Challenge 1
Make close observations
If the balls successfully hit the ground one on top of the other, what happens from the moment they are dropped to when they stop?
Use all your senses to make your observations.
What happens with different combinations of ball sizes (see to right)?
What happens if the top one is slightly to one side when they reach the ground?

Challenge 2
Gather data
Chose one combination of balls. How high does the top ball rebound upwards? Decide on a way to measure this.
Does it always rebound the same distance? Can you find an average?
If the same two balls are dropped one at a time, how high do they each bounce? Can you find an average for each?

Challenge 3
Use your data as evidence
Where did all the energy go to from the two balls falling to the ground?
Use your evidence as a model for a real situation
Imagine if the two balls were in fact ONE asteroid that hit a planet and broke up to form two chunks (= the two separate balls).
Use your evidence to describe what might happen as a result of a collision between an asteroid and a planet.

Key 'Building Science Concepts' references:
Book 27 Exploring space: Discovering our place in the universe L3-4.
### PRACTICAL ACTIVITY

#### Spinning bucket

**Learning intentions**

Science Capabilities: Use evidence to support ideas and explanations.

Physical World: How do objects behave when they are spun in a circle?

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**Challenge 1**

Collect evidence to find out why this happens

**Challenge 2**

Ask other questions and investigate them

**Challenge 3**

Getting fancy

---

### What you will need:

- A bucket or large cookie container with handle.
- Light and heavy objects that will easily fit in the bucket.
- String.
- Water.
- Access to the outside.

### Setting the scene

Take an empty bucket and swing it around in an ‘up and down arc’ (so that it goes high and low by your side). Be careful to do this well away from other people.

Make observations using as many senses as you can.

Now place an object into your bucket and swing it in an arc again. What happens?

Think about how this is like a discus or a hammer thrower in the Olympics (before they let go of their discus or hammer).

### Key School Journal References:

- How to make a spinning top with sipper-bottle caps
  Article 2003 Pt 01 PATTERSON, Oliver. Making a spinning top. Article 5 1990 Pt 04 ANARU, Whainga.

### Key ‘Building Science Concepts’ reference:

- Book 42 Marbles: Exploring motion and forces L3-4.
**CHALLENGE**

**Light and sight**

**Eyes up close**

**Learning intentions**

Science Capabilities: Observations and interpreting representations (drawing and labelling). Critiquing evidence.

Living World: What parts make up the ‘outside’ of the human eye and what do they do?

**What to do**

**ALWAYS BE CAREFUL AND SENSIBLE WHEN INVESTIGATING EYES!**

**Observe very carefully**

1. Work in pairs and observe very carefully the different parts of your partner’s eyes. Just concentrating on the structures (not what they do), describe as many things as you can in detail to your partner.

2. List the parts you have observed. For each part, write down its size, colour, shape and any other features you can think of.

3. Draw a careful picture of one of your partner’s eyes. Once you have finished this first draft, swap photos and with greatest kindness, discuss how your partner might improve their drawing. Critiquing each other’s work to achieve really accurate drawings is something scientists do .... so, you are acting like a scientist!

4. Once you have thought about your partner’s comments, try drawing an improved second draft of the same eye. Repeat critiquing each other’s work. Lastly, draw a final version of the eye and label it accurately by researching the parts.

5. Add measurements to your drawing by carefully using a ruler alongside your partner’s eye.

**Observe the things the eye does**

6. Now that you know about the parts, carefully observe what they do. A torch might be helpful. List and describe your observations.

**Inferences**

7. Make inferences about the purpose of some of the eye structures such as: eyebrows, eyelashes, eyelids, tear ducts, pupils.

**Showing others**

Find a good way to show and tell others what you think the different structures of the eye are for. Discuss. Display your final eye drawings.

**Going further**

What other questions do you have about eyes? Run investigations and perform research to find answers to your questions. Your questions might be about the eyes of other animals too!

**What you will need:**

(per group)

★ Access to a partner to look at their eyes.
★ A ruler.
★ Optional extras: a magnifying glass and a torch.

**Showing others:**

There are many ways of showing or telling others what you have done and found. Ideas include: write a poem, rap or song; create a poster; write a newspaper article; do a demo or show, with each person in your group playing different parts; write a description or report; draw a labelled picture; draw a flow chart; use others as ‘guinea pigs’ to show how something works; mime what you did; build a working model; write a story; draw graphs; use photos or a video; do a PowerPoint show.

**Key School Journal Reference:**

What do you see? Article 1998 Pt CN 1 BOWES, Clare. Your marvellous sense of touch Article 4 1994 Pt 01 3 BIRCHALL, Brian.

**Key ‘Building Science Concepts’ references:**

Book 10 Light and colour: Our vision of the world L1-2.
**Learning intentions**

_**Science Capabilities:** Observations and inferences._

_Material World:_ Burning is a type of chemical reaction.

**What to do**

**MAKE SURE YOU ARE CAREFUL WHEN WORKING AROUND A FLAME!**

A burning candle is not as simple as it seems! Let’s look carefully....

1. Have your teacher light a candle and sit it on the table in front of your group.
2. What observations can you make about this candle? If you really try hard you should be able to make at least 30 observations. Measurements can be observations, so use your ruler too. List all your observations down.
3. Go through your observations and try to divide them into three main types, observations about: a) the parts or objects you have listed, b) the features, for example size, colour and shape, that you have listed, and, c) the changes you see, for example, something might be moving, growing bigger, and so on.
4. Draw a carefully labelled drawing of your burning candle. Include measurements.

**Making inferences**

An inference is a conclusion you draw from observations, in other words, the meaning you make from observations.

5. What inferences can you make from any of your observations or measurements? List and discuss.

**Share your observations and inferences**

1. Compare your list of observations with those of another group. Did your group list any that the other group did not have? Are there different ways of writing about the same observation?
2. Compare your list of inferences with those of another group. Did your group list any that the other group did not have? Are there different ways of writing about the same inference?

**Going further**

Make a list of special or scientific terms you could use to write about a burning candle.
Balancing sticks

**What you will need:**
(per group)

- Three lengths of dowel (or thin sticks): short (about 20 cm), medium (about 40 cm) and long (about 60 cm).
- Old tennis balls or similar with a hole so that they fit across the end of the dowels.

Learning intentions
Science Capabilities: Gather and interpret data, Use evidence, Critique evidence, Interpret representations, Engage with science.

Physical World: Inertia and the pendulum effect.

**What to do**

How good are you at balancing?

1. Move to an area with plenty of space around you. Outside is best. Try balancing the longer piece of dowel on the end of your finger. How long can you keep it balanced for?

2. Try balancing the other smaller lengths of dowel. Which seems easiest?

3. Are they easier to balance when you watch the top of the stick or when you watch the base near your hand?

Test your ideas

4. Now that you have had a ‘play’, think about how you can do an experiment to test your ideas. For example, how do you really know that one of them is easier to balance than another? What is your evidence? So:
   - Decide on a good question to investigate.
   - Decide on a method.
   - Perform your experiment and record your results.

5. Do your results (your evidence) agree with what you thought?

Critique each other’s method and findings

6. You need to be kind to each other in this part! Discuss your method and findings with another group and have them do the same. Was their method good? Did they set up fair tests? Did they collect enough data? The idea is to be helpful and positive in the way you approach this.

Improve on your method

7. With the feedback from the other group
   - Improve your method and again collect results.

Showing others

Present your findings and conclusions on a small poster. Discuss whether your conclusions agree with those of other groups. Why or why not?

Going further

If you want to create the ‘ultimate’ balancing stick, what must you do? Be creative and come up with ways of making a balancing stick easier for balancing. Try your ideas and scientifically test them to collect evidence.

Balancing a stick on the end of your finger. This picture shows a ball on the end of a dowel, but a plain stick works fine.

Key School Journal Reference: Keep Your Cat Inside Article 6 2013 Pt CN 04 TAPP, Mike.

**Electricity**

**SCIENCE UNIT PLAN**

**Electricity — Te Hiko**

**Topic:** Electricity

**Science Concepts**

Key concepts relating to electricity, including:
- electricity is a form of energy
- electricity can be useful and it can be dangerous
- electricity is only detected by what it does, e.g. turns a motor
- current (flowing) electricity travels through conductors, but not insulators
- an electrical circuit must be complete for electricity to flow
- a circuit needs an energy source, e.g. a dry cell and something to use the electricity, e.g. a bulb
- circuits can be arranged in many different formats to power many different devices, causing different outcomes.

**Contexts:**

Electricity, Energy.

**Key Competencies**

**Thinking**

Students will use creative, critical and metacognitive processes to make sense of information and experiences gained during this unit. They will contribute to discussion with the teacher and peers and think about and reflect on their experiences in order to shift their ideas closer to the scientific ideas.

**Values**

Innovation, Inquiry & Curiosity

These values will be promoted through both teacher and student discussion and questioning. The investigations planned give opportunity for students to make their own choices and setting concepts in a relevant context will promote students' curiosity about science concepts in their everyday lives.

**Achievement Aims**

**Nature of Science (NoS)**

Approaches to the five Foundational Science Capabilities, namely 1. Gather and interpret data, 2. Use evidence, 3. Critique evidence, 4. Interpret representations and 5. Engage with science, are outlined in the specific activities.

**Contextual**

Physical World:
- Explore and investigate physical phenomena in everyday situations.
- Gain an understanding of the interactions that take place between different parts of the physical world and the ways in which these interactions can be represented.

**ICT**

Websites and YouTube demonstrations as outlined in specific activities.

**Resources**

School Journals and Building Science Concepts books as outlined for given activities. Resources as outlined with each activity. Electrical items from Jaycar and Electroflash.

**Achievement Objectives**

**Nature of Science (NoS)**

Levels 1–4
As above.

**Contextual**

Physical World: Physical inquiry and physics concepts
Levels 1 & 2
- Explore everyday examples of physical phenomena, such as movement, forces, electricity...
- Seek and describe simple patterns in physical phenomena.
Levels 3 & 4
- Explore, describe, and represent patterns and trends for everyday examples of physical phenomena...

**The 5 Es**

Follow best practice by presenting the science unit using the 5 Es instructional model. Use the 5Es at both the macro level (the whole unit) and at the micro level (for individual activities and investigations). In summary (and see the web link http://www.miamisci.org/ph/lpintro5e.html for more detail):

Engage — ignite the students’ interest and enthusiasm.
Explore — give student time to play, explore, make mistakes and ask questions.
Explain — teacher and students build an understanding of the concepts.
Elaborate — students expand on the concepts they have learnt, attempt to answer questions and link ideas to the real world.
Evaluate — an on-going diagnostic process where the teacher and students clarify what they have learnt and what needs further work.

**Answers and teacher guidance for pages 19–23**

**Build a simple circuit** p19: 2) In a quiet location, find how far away a person can hear the buzzer. The listener should close their eyes and put their hand up when they hear the buzzer. Repeat for different distances and find the average. 3) & 4) Morse Code is a series of long and short beeps which represent letters of the alphabet. 5) & 6) Use a method similar to 2) above in front of, to sides of, and behind the cone. Narrow, long cones create directional sound (that is, loud in front, but relatively quiet to sides and behind). Build a torch circuit p20: 3) The bulb lights up instantaneously (immediately) when the terminals are touched and instantaneously when the terminals are disconnected. 4) It is about twice as bright. 5) The circuit continues to function when the bulb is reversed. It also works if both dry cells are reversed at once. The circuit will not work if any one of the dry cells is reversed. 6) Example questions: ‘Would the bulb still work if one of the wires was touched against the glass?’ and ‘Which parts of the dry cell supply the electricity?’

**Exploring components** p21: 4) There are many possible investigations. Examples of other questions that could be investigated include: “Does a motor still work when its terminals are reversed?” “How do we know when a motor is reversed?” Does the motor run faster or slower when dry cells are arranged in series or parallel?” “Can an extra bulb, buzzer or motor be added without affecting the behaviour of the other components?” etc.

**Build an electromagnet** p22: Challenge 1. Lift up paper clips (all the same size and shape) using exactly the same technique each time. Results will vary, but repeat trials can be used to find an average. Challenge 2. Without a nail in its core, the electromagnet is very weak. Anything that is steel or iron will work to some extent in the core, but other metals, plastic, wood, etc will not work. Thicker wire may affect the strength. The important thing is to create a fair comparison by using the same metal wire, e.g. copper, and the same number of windings and to find averages from multiple tests. Challenge 3. Without a nail in its core, the electromagnet is very weak. Anything that is steel or iron will work to some extent in the core, but other metals, plastic, wood, etc will not work. Thicker wire may affect the strength. The important thing is to create a fair comparison by using the same metal wire, e.g. copper, and the same number of windings and to find averages from multiple tests. Challenge 4. Without a nail in its core, the electromagnet is very weak. Anything that is steel or iron will work to some extent in the core, but other metals, plastic, wood, etc will not work. Thicker wire may affect the strength. The important thing is to create a fair comparison by using the same metal wire, e.g. copper, and the same number of windings and to find averages from multiple tests.

**Create an electrical device** p23: Outcomes will vary, but key aspects of this challenge are: good planning, sourcing the necessary materials, critiquing, ensuring their plans can realistically be built, proof of concept, effectively showing an ‘electrical principle’ and a well-delivered demonstration of their ideas.

In everyday life: Small motors are found in watches and clocks (these are called stepping motors) and electric toys; large ones are in washing machines and water pumps. Short circuits can cause overheating of wires, sparks and fires. RCDs (Residual Current Devices) can be used with extension cords. They shut the current down (or ‘trip’) when a current leakage is detected.

In everyday life: Small motors are found in watches and clocks (these are called stepping motors) and electric toys; large ones are in washing machines and water pumps. Short circuits can cause overheating of wires, sparks and fires. RCDs (Residual Current Devices) can be used with extension cords. They shut the current down (or ‘trip’) when a current leakage is detected.

**ICT Resources**

Concepts books as outlined for given activities. Resources as outlined with each activity. Electrical items from Jaycar and Electroflash.
**Specific learning intentions and activities**

**Endorsed by the Sir Paul Callaghan Science Academy, the following assumptions apply:**

- a) The 5Es instructional model is used in all sections (see details on previous page).
- b) Student-directed learning is encouraged through teaching key techniques and approaches at the start of lessons/sections, then allowing students to build on these techniques through their own more open-ended lines of inquiry.
- c) Nature of Science (NoS) components (and therefore the recently launched Five Foundational Science Capabilities) are inherent — as they are mandatory — and here we treat them in an explicit manner. Aspects of Science Capabilities are emphasised using **bold italic** script.

A combination of these approaches encourages skill development and Nature of Science (NoS) understanding, while the ‘Electricity’ context plays a supporting role only. That is, the emphasis is less on content coverage, and more on the Nature of Science.

Note, you do NOT need to cover all sections — as there are a large number of ideas presented here. The most valuable learning occurs when some areas are pursued deeply. This is especially important for Years 7 & 8 and older students.

### Specific Learning Intentions

**Foundational Science Capabilities**

(whic are a functional interpretation of the Nature of Science, see TKI Science: [http://scienceonline.tki.org.nz/Introducing-five-science-capabilities](http://scienceonline.tki.org.nz/Introducing-five-science-capabilities))

- **Gather and interpret data:** Learners make careful observations and differentiate between observation and inference.
- **Use evidence:** Learners support their ideas with evidence and look for evidence supporting others’ explanations.
- **Critique evidence:** Learners understand how to critically appraise the quality of evidence and the validity and ‘fairness’ of methods.
- **Interpret representations:** Learners and (scientists) are able to represent their ideas in a variety of ways, including models, graphs, charts, diagrams and written texts.
- **Engage with science:** Students use their other capabilities to engage with science in “real life” contexts.

### Learning Activities through 5Es model

#### ENGAGE

**Ignition activity**

- Demonstrate two or three interesting electrical items. These could include: a spinning flashing ball, a miniature solar car, a miniature solar ‘insect’ or any other interesting electric toy or gizmo. Discuss how they might work.

**How we use electricity**

- Engaging YouTube videos.
- Students bring along a safe battery or solar powered electrical device, toy or gizmo. In groups, play with the devices, then identify how they are powered and what form of energy outputs they have. How do they help us in our everyday lives? What other examples are there of similar devices? Can similar things be achieved without electricity?
- My electrical day: Students keep a diary of every electrical item or device they use during a day, from the time they get out of bed till when they go to bed. Discuss or list what we would have to do without each of the electrical items identified (i.e. the alternatives).

**Electrical safety**

- Videos
  - Important viewing: a simple overview including avoiding short circuits and safety: [https://www.youtube.com/watch?v=EJeAuQ7pKpc](https://www.youtube.com/watch?v=EJeAuQ7pKpc)
  - Discussion on electrical safety (issues with mains power, worn cords, powerlines, transformers, water and electrical items. YouTube video [https://www.youtube.com/watch?v=6Upae5eVXGg](https://www.youtube.com/watch?v=6Upae5eVXGg). First aid responses.

#### EXPLORE

**Making and investigating circuits**

**Build a simple circuit**

- Discover the basic components of an electrical circuit **[Build a simple circuit Investigation sheet]**
- Which arrangement of wires work, which don’t?
- **Gather data by drawing and labelling** a successful circuit. (Don’t use electrical symbols at this stage.)
- Learn how to locate a fault in the circuit by ‘breaking’ connections, loosening bulbs, etc. For this it is best to start with a functioning circuit, then experiment with one fault at a time. Emphasise careful observation of the outcomes. This skill is useful for independent learning throughout the unit.

**Build a torch**

Build a simple torch circuit which includes bulb, dry cells and a simple ‘switch’. **[Build a Torch Circuit Investigation sheet]**

**Exploring components**

Incorporate different components such as a motor or buzzer into a circuit. Document through careful observation, what works and what does not. Build circuits carefully, adding only one new component at a time to create valid comparisons (effectively, fair tests).

Science Roadshow visit: the Sparks, Arcs and Gherkins show is about electricity.

Understanding electricity

Conductors and insulators

Make a simple circuit, as shown to the right, to test if different materials are conductors (conduct electricity) or insulators (do not conduct electricity). Predict what sorts of materials will be conductors, then test a range of materials, e.g. metals, wood, plastic, pencil lead, etc. Make a table to represent your findings.

Polarity

Experiment to find if different electrical devices only work when electricity is flowing through them in the ‘correct’ direction, e.g. what happens when a bulb that is working correctly is then wired in the reverse direction? Repeat for buzzers, bulbs, motors, electromagnets. Make a table to represent your findings.

Series and parallel

Find out how to wire two bulbs in series (see video above). How does their brightness compare with a single bulb in a circuit? How does it compare with two bulbs wired in parallel? How can you ensure that in the process of collecting data you have done a fair test? What happens to bulb brightness when you connect dry cells (batteries) in series and parallel compared with using a single cell? Is your test fair?

Using electricity

Circuit diagrams

Find out how the various components of a circuit are represented as symbols. (This is about ‘Interpreting representations’.) Find out how the symbols listed above are used to draw circuits. Draw circuit diagrams for some of the circuits you have made so far.

Energy transformations

For each of the components you have worked with so far find out and list what energy transformations they are involved in, e.g. a bulb changes electrical energy into light and heat energy. Here are some other components to list: dry cell, motor, buzzer, LED (light emitting diode), electromagnet.

Manipulating electricity

From what students have found out so far, have them decide on what effects they can create in electrical devices (e.g. in motors, bulbs, buzzers, etc.) and how they can make these things happen. For example, a motor can be sped up, slowed down and also reversed by changing the number of dry cells used in series, or by reversing the wiring. List evidence for their findings. [Exploring components Investigation sheet]

ELABORATE

Creating devices

Build an electromagnet

Students build a simple electromagnet that is turned on and off with a switch, then, experiment to find how the electromagnet can be modified or improved. Critique each other’s methods. [Build an Electromagnet Challenge sheet]

Build a simple electric motor

https://www.youtube.com/watch?v=UY7LT3gNHXI

Make a lemon battery to power an LED

https://www.youtube.com/watch?v=AY9qcDCFeVi, or, build a simple vinegar battery: https://www.youtube.com/watch?v=V_P27iln1Qk&list=UUSzRGOMI44ZvSMOot7Zmpzg. Further elaborate by powering an LED or a calculator.

Own investigations

Students ask their own questions and conduct their own investigations. Starting points for projects and spin-off investigations might include building: a speaker, an electric motor, a solenoid, a security alarm, a Morse code device, a light signalling device. YouTube has many demonstration videos. How can these be improved and what is your supporting evidence to show that they have improved? [Create an ‘electrical device’ Challenge sheet]

EVALUATE

Evaluation is about judging or measuring how well a teaching programme is going. Teachers should be able to evaluate the success of their teaching so as to make adjustments and refinements to approaches throughout a unit of work. This ‘Evaluate’ phase occurs therefore at all stages of learning. Students should also be evaluating their understanding and success throughout the unit.
**What is electricity?**

Electricity is a form of energy caused by the flow of tiny particles called electrons through wires or other conductors. (Other forms of energy include light, heat, movement, etc.)

---

**Safety**

Because electricity is a form of energy, it can be dangerous. For safety, only work with low energy electricity up to 3 volts. To make 3 volts we add two dry cells in series:

![Two 1.5 volt dry cells in series creates 3.0 volts.](image)

We cannot see electricity, but we can detect (see, hear, feel, etc.) what is does. This means we need to be alert and careful with electrical devices.

Three important safety tips for the home include:

[Students list, for example: 1) do not overload power sockets, 2) have frayed leads repaired or replaced and 3) do not use electrical items near water.]

---

**Conductors and insulators**

A conductor is any material that allows electricity to flow through it. Common examples are:

[Students list and draw pictures, for example: any metal such as copper, steel, aluminium, brass, mercury, etc.]

Certain materials, called semiconductors, let some electricity pass through them. Examples include:

[Students list and draw pictures, for example: pencil lead (graphite), water, damp cloth.]

Materials that don’t allow electricity to flow through them are called insulators. Common examples include:

[Students list and draw pictures, for example: plastic, glass, rubber, air, dry wood, dry paper, etc.]

---

**Electrical circuits**

The simplest electrical circuit involves an energy source (like a dry cell), some conducting elements (like copper wires) and a device that uses electricity (like a bulb).

---

**Polarity**

This is how terminals are connected. For example, is the wire lead from the positive side of the dry cell connected to a given terminal of a motor, or is it the lead from the negative side of the dry cell? Polarity often makes a difference to how a device works. (Students give examples.)

---

**Electric components**

<table>
<thead>
<tr>
<th>Name</th>
<th>Picture</th>
<th>Symbol</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dry cell</td>
<td><img src="image" alt="Dry cell" /></td>
<td><img src="image" alt="Dry cell" /></td>
</tr>
<tr>
<td>(symbol also shows two dry cells in series which is called a battery)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wire</td>
<td><img src="image" alt="Wire" /></td>
<td><img src="image" alt="Wire" /></td>
</tr>
<tr>
<td>Switch</td>
<td><img src="image" alt="Switch" /></td>
<td><img src="image" alt="Switch" /></td>
</tr>
<tr>
<td>Bulb or lamp</td>
<td><img src="image" alt="Bulb or lamp" /></td>
<td><img src="image" alt="Bulb or lamp" /></td>
</tr>
<tr>
<td>Motor</td>
<td><img src="image" alt="Motor" /></td>
<td><img src="image" alt="Motor" /></td>
</tr>
<tr>
<td>Buzzer</td>
<td><img src="image" alt="Buzzer" /></td>
<td><img src="image" alt="Buzzer" /></td>
</tr>
<tr>
<td>Coil</td>
<td><img src="image" alt="Coil" /></td>
<td><img src="image" alt="Coil" /></td>
</tr>
<tr>
<td>Other (list)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

---

**Circuits I made**

Students draw examples of circuits they made. Some examples might include:

![Lamps in series with a switch in the circuit.](image)

![Lamps in parallel with a switch in the circuit.](image)

---

**Theory notes — Electricity**

Electrons flowing through a wire create electricity.

An insulated copper wire. The plastic coating is the insulator, while the copper wire is the conductor.

High energy electrons flow from the negative terminal of the battery, through the wire to the bulb where they lose most of their energy, then return to the battery to regain more energy.
INVESTIGATION

Build a simple circuit

Learning intentions
Nature of Science: observations and fair tests, science in everyday life.
Physical World: Investigate what is needed to make a buzzer circuit and discover what the parts do.

What to do

Make a simple circuit
1. Join up the wires, dry cell and buzzer as follows. Make sure you connect the buzzer the correct way around. What happens if it is not?
2. Listen carefully at how loud the buzzer is. From what distance can you hear it? Gather some good quality data on this.
3. Can you create Morse code sounds?

Change your circuit
4. Connect the buzzer to the long cable so that you can make it work a long way away. Try sending Morse code or some sort of coded message to a friend. Find out about Morse code.

Doing it yourself
5. Does a ‘speaker cone’ make the buzzer louder? Starting with a circular disc of paper, make a ‘speaker cone’ and test this. Gather evidence to support your claim either way. Discuss your results with other groups and critique each other’s evidence.
6. Can you make the ultimate directional buzzer that is only noisy when pointed directly at a person, but not when it is pointed in another direction? Gather evidence to support your claim that it is effective. Always start your investigations with good questions.

Showing others
There are many ways of showing or telling others what you have done and found. Ideas include: write a poem, rap or song; create a poster; write a newspaper article; do a demo or show, with each person in your group playing different parts; write a description or report; draw a labelled picture; draw a flow chart; use others as ‘guinea pigs’ to show how something works; mime what you did; build a working model; write a story; draw graphs; use photos or a video; do a PowerPoint show.

Key School Journal Reference:
Electric map Article 1998 Pt CN 3 BONALLACK, John.

Show your work

Electricity

What you will need:
(for a demonstration or per group)
* A buzzer (80dB Self Driven 14 mm or similar).
* Leads with alligator clips.
* One 1.5 V dry cell (AA or D size) and relevant ‘battery’ holder.
* A long twin stand cable (like a stereo speaker cable).

A buzzer.

Teacher: Engagement activity ideas
Discuss what a doorbell or a school bell/buzzer does. This is what we are going to make, a buzzer circuit.

In everyday life
Find out about where buzzers are used and how they work. How are they different from speakers?
Electricity

INVESTIGATION

Build a torch circuit

Learning intentions
Nature of Science: Observation and fair tests.
Physical World: Investigate what is needed to make a torch circuit and discover what the parts do.

What to do

Make a circuit
1. Join up the wires, dry cell and bulb as follows:

Make sure the bulb lights up, but do not leave it running for more than a few seconds (so you do not run the dry cell down).

2. Look carefully at how bright or dull the bulb is.

3. Now, disconnect any one of the leads and just touch it on the terminal for a moment. Do this over and over. You have just created a simple switch. How quickly does the bulb light up and turn off? Could you use this to signal someone at a distance?

Add another dry cell
4. Add another dry cell into the circuit as follows:

How does the brightness of the bulb compare with the first circuit?

Doing it yourself
5. Without creating a short circuit, and by only changing one thing at a time, see what happens if you reverse items in the circuit. Note, always start with the circuit you made in 4) above, and change one thing at a time only. In this way you are aiming to do fair tests!

6. Ask some good questions about your circuit and perform investigations to answer them.

Showing others
Find a good way to show and tell others 1) your questions, 2) how you did your investigations, 3) what you found out, 4) what you could do better, and 5) what new questions you could now ask. (See ideas in box to left.)

What you will need:
(per group)
★ A bulb (2.5V, 0.3A) and bulb holder.
★ Leads with alligator clips
★ Two 1.5 V dry cells (AA or D size) and relevant ‘battery’ holder(s).

Asking a good question:
Every good investigation should start with a good question. The question is, what is a good question? As a general rule, ‘why’ and ‘how’ questions are hard to answer, so in the early stages of your investigation avoid these. Try questions like ‘Which one is ....’, ‘Where is it....’, ‘When does it....’, ‘Does such in such ...’
Exploring components

Learning intentions
Nature of Science: Observations and comparisons.
Physical World: Investigate how different electrical components work both alone and in combination with other items.

What to do

1. Select your components and make sure you can name them.

2. At all times avoid short circuits and to avoid flattening your dry cells, do not complete a circuit for more than about five seconds. Practice timing this!

3. Start by making very simple circuits to see how they work. Remember to use fault-finding skills you learnt earlier.

4. First, ask good questions. For example, “How can we make the bulb half as bright?” or “How can we turn on a buzzer and a light at the same time?” Discuss how you are going to achieve these things, then set them up and test them.

Choose your best

5. Decide on your three best circuits. Now write up your questions and diagrams of the circuits you made that answer your questions. List your evidence for how your questions were answered. (For example, how did you know that your buzzer was louder or your motor had reversed? How did you collect data?)

Showing others

Find a good way to show and tell others 1) your questions, 2) how you did your investigations, 3) what you found out, 4) what you could do better, and 5) what new questions you could now ask. See ideas in box to left.

In everyday life

Find out where electric motors are used in and around the home. (Of course, do not pull electric appliances apart to find out! Where are some of the smallest motors found? What about the biggest ones you would find in the home?

What are some of the problems caused by short circuits? What device can be used on the end of a household extension cord that detects ‘electrical leakage’ and automatically stops the power supply?

Key School Journal References:

What you will need:
(per group or as a demonstration)
★ Two bulbs (2.5V, 0.3A) and bulb holders.
★ A buzzer (80db Self Driven 14mm or similar).
★ Leads with alligator clips.
★ Two 1.5 V dry cells (AA or D size) and relevant ‘battery’ holder(s).
★ A motor (3 to 12V P9000)
★ A knife switch or similar.

Teacher: Engagement activity ideas
Demonstrate and discuss a number of simple electrical items and what components might be in them in order for them to work.
Challenge 1

Collecting data
As a group, come up with an accurate way of measuring how strong your electromagnet is. Do you always get a similar result or do your results vary wildly? Trial different techniques and decide on the best. Think about how to get an accurate average result. Record the strength.

Challenge 2

Remove the nail from the wire coil
Predict what will happen. Measure how strong the electromagnet is without the nail inside the coil. Predict what will happen if you try different materials inside the coil. Do any of them affect the electromagnet’s strength? Support your answer with evidence. Predict what will happen if you use thicker wire. Conduct a fair test to find what happens.

Challenge 3

Number of windings
Predict what will happen if you use less windings. Conduct a fair test to find out. Repeat for more windings.

The ultimate electromagnet
With your available materials, create the strongest electromagnet you can. Collect evidence to support your claim. Demonstrate your findings and decide on a way of communicating them to others in your class.

Learning intentions
Nature of Science: Gather and interpret data, Use evidence, Interpret representations. Physical World: How is an electromagnet made and how is its effectiveness changed?

What you will need:
(per group)
* 1 m of thin enamelled copper wire.
* Other lengths of insulated wire of varying types and thickness.
* Two 100 mm steel nails.
* Two 1.5 V dry cells.
* Leads with alligator clips.

Setting the scene
Electromagnets are used in all sorts of devices. They can be used to pick up heavy weights like motor cars or to activate switches. Here we will investigate how they work and how they can be made stronger.

Build a basic electromagnet by combining the following components. Do not leave the circuit running for more than two or three seconds at a time as you will flatten the ‘battery’ very quickly.
**Challenge 1**

**Plan your model**
Discuss what you could build. Decide if you have the materials, electrical components and skills to build it. Decide on how you would construct the circuit(s) involved in the model.

**Critiquing**
Describe your plans to another group. Ask them to critique your ideas. What strengths and weaknesses do they see in your plan? Can they suggest improvements?

**Teacher approval**
Ask your teacher for approval of your plans. He/she needs to see that you are producing an effective model, AND that it can be achieved.

**Challenge 2**

**Build a test circuit**
Before you build any structures, build a test circuit to see that it does what you expect. This stage is called ‘proof of concept’.

**Build your model**
Build your final working model. Remember that a scientific model does not need to be ‘pretty’ (although it can be). The most important thing is that it shows the principles clearly. Test it thoroughly.

**Demonstrate your model**
Plan and practice how you will demonstrate your model. Finally, demonstrate it, clearly pointing out the electrical ideas it shows.

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**Learning intentions**
*Nature of Science: Modelling, critiquing, engaging with science.*

*Physical World: Use the principles involved in basic circuits to model a useful real world example.*
Pre- and post-unit assessment

One way of pre- and post-testing the knowledge of students on this Nature of Science based unit of work *Electricity*, is to use ‘mind mapping’. You can measure student knowledge by counting the number of words they use in their map that correspond with the list of keywords we supply to the right.

Students draw a mind map on *Science is about* — since this is the core of the unit — before they begin the unit. They repeat the same mind map after they have completed the unit and the scores are compared. Depending on the experience and ability of your students, it may be best to demonstrate how to create a mind map or two on a different topic before you begin.

**The students will need**

- An A4 sheet of paper. (The next page can be photocopied.)
- Coloured pens, pencils, felts.

**Drawing and assessing a mind map**

**Instructions to students**

Write the words ‘*Science is about*’ in the centre of the page, then write as many words as you can about this idea. Arrange these in related groups and use lines to connect them in meaningful ways, branching out from the centre. When you have written as many relevant words as you can, draw colourful thumbnail pictures and symbols alongside them that also help to explain your ideas.

**Assessing the mind map**

Give one tick for each word (or variation of the word, e.g. experiment, experiments, experimental) the student has written that is also in the keyword list. If instead of a keyword, the student has drawn a symbol or picture that clearly represents one of the keywords, also give a mark. (You could give a bonus mark for each relevant word they use that is not in the keyword list.)

**Sample mind map**

This is a student’s mind map ‘pre-test’ on *Science is about*. Ticks are given to show how marks are allocated. This student’s pre-test score was 6.

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**Keyword list**

- Aim
- Bias
- Certainty
- Checking
- Classifying
- Communication
- Comparing
- Conclusion
- Creativity
- Critiquing evidence
- Discussion
- Drawing
- Engaging with science
- Error (identifying errors)
- Evidence
- Experiment
- Explanation
- Exploration
- Fact
- Fair testing
- Gathering data
- Graphing
- Grouping
- Honesty
- Hypothesis
- Identifying
- Inference
- Inquiry
- Instruments (including named ones)
- Interpreting data
- Interpreting representations
- Investigation
- Knowledge
- Law
- Measurement
- Method
- Model
- Objective
- Observation
- Prediction
- Question (good questions)
- Record
- Repeating (replications)
- Result
- Scientist
- Sharing (ideas)
- Symbol
- Systematic
- Tentative
- Terms
- Theory
- Trial
- Unit (and units like kg, length, etc.)
- Using evidence
- Working together

*Plus extra words at teacher’s discretion.*

---

**Science is about**

- drawing labelled pictures ✔
- observations ✔ ✔
- men in white coats
- laboratories
- investigations
- facts
- explosions
- plants
- blowing up things ✔
- measuring things ✔
- test tubes
- drawings ✔
Mind map on ‘Science is about’

Name ___________________________ Date________

Year level _____ School________________________

Science is about
During Your Visit

Making the most of learning opportunities

The Science Roadshow aims to

- Generate enjoyment and enthusiasm for science and technology that can enhance your classroom programme.
- Increase students’ knowledge and skills over a range of topics from the New Zealand curriculum.
- Provide hands-on experiences in science, technology and innovation that are not generally available in the classroom.

Research tells us that

- The benefits from an educational visit are greatest when the visit forms an integral part of the classroom programme.
- The best learning outcomes for students are achieved when they are well prepared.
- Students’ learning is enhanced by opportunities for hands-on experience.
- The quantity and quality of students’ interactions with peers and adults have a significant effect on promoting students’ learning.
- Group work that includes discussion helps students to consolidate their learning.
- Numeracy and literacy are important so we aim to incorporate these learning areas within the programme.

What happens during your visit?

- You will be met outside by a member of the Science Roadshow team. (If at all possible please leave school bags at school or on the bus.)
- Your session begins with one of the fifteen-minute shows (see details p. 30). During this time all students will be seated on the floor of the hall, possibly joining another group.
- Students will have approximately forty minutes to interact with the exhibits set up in the hall. (See exhibit details on pages 28 and 29.)
- Staff will advise students when their exhibit time is over.
- Students will return to the show area for the second fifteen-minute show. Your group may be joined by students from another group for this show.
- Staff will direct your students to leave the hall at the end of the second show.

Your role as a teacher

- Move amongst your students. Interact with them and help them to engage with the exhibits and talk with others. Emphasise that they should try and understand what the exhibits are showing.
- Remind adult helpers that the exploration and discussion process is more important for students’ learning than getting the ‘right’ answer (see next page).
- Please remember that classroom teachers remain responsible for their students’ behaviour at all times.

Theme emphasis

- Prior to your visit, you may wish to organise groups who will be responsible for reporting back on specific themes or selected exhibits. Suggested ideas for reporting back: 1) exhibit name, 2) what it looked like, 3) what it did and 4) what science idea it demonstrated.
- Additional ideas: students take pen and paper for recording their selected exhibits; use a digital camera or video device to record selected exhibits for review back in class; do a project or inquiry-based investigation on the science behind one or more of the exhibits.

Managing junior groups

- Free exploration of exhibits by children of all ages is ideal. However, it is advisable to organise adults to at first supervise small groups of children of Years 0–1 (sometimes even Year 2 children) as they move around exhibits. As soon as children gain sufficient confidence they may be encouraged to freely explore exhibits in pairs or small groups. This way they are able to choose the exhibits they are most interested in while minimising time waiting in queues.

A visit to the Science Roadshow isn’t only for your students. We hope you will also see it as a great opportunity for your own professional development.

Further science PLD opportunities are available through the Sir Paul Callaghan Science Academy — details on the back cover.

Support for the New Zealand Curriculum

The Science Roadshow experience supports the New Zealand Curriculum at four levels, with respect to Principals, Values, Key Competencies and Specific Learning Intentions. The first three are outlined below, while Learning Intentions are covered within the Unit of Work found earlier in this booklet.

Principles

The Science Roadshow experience embodies:

- Inclusion: by recognising and affirming learning needs of all, through an array of sensory experiences
- Learning to learn: by giving opportunities for students to reflect on their own learning processes by free exploration of hands-on exhibits
- Community engagement: by encouraging students to connect with real life experiences and activities in science research, technology, industries, the workplace and home
- Coherence: by linking science-related experiences with language and communication, technology careers and real life experiences
- Future focus: by encouraging students to look at future-focused issues relating to science and technology, innovation, medicine and communications.

Values

The Science Roadshow embodies:

- Excellence: through perseverance to find the answer and to understand how things work
- Innovation, inquiry and curiosity: by students thinking critically and creatively about ideas presented in shows, and reflectively about how and why exhibits work
- Equity: through access for all to an interactive experience
- Participation: through encouragement of students by presenters, teachers and parents and by the feedback offered by interactive exhibits
- Ecological sustainability: through specific exhibit thematic(s) (depending on the year) and wherever possible, environmentally friendly administrative and operational practices
- Integrity: through respect for others by listening, sharing and waiting their turn.

Key competencies

All five key competencies are well supported by the Science Roadshow experience; namely,

- Thinking: by reflecting on shows and about how and why exhibits work and their relevance to everyday life
- Using language, symbols and texts: by student involvement with Presenters, Explainers, peers and with self-guided interactive exhibits
- Managing self: students decide who to work alongside, which exhibits to interact with and for how long
- Relating to others: by students working alongside and communicating with other students, teachers, parents, Presenters and Explainers as they interact with exhibits and during shows
- Participating and contributing: students participate and contribute to shows, and interact enthusiastically with exhibits.

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Teachers: Please provide each of your helpers with a copy of this page before your visit.

Thank you for helping students to learn during their school visit to the Science Roadshow.

What is the Science Roadshow?
The Science Roadshow travels around the country teaching children about science, technology and innovation. At the Science Roadshow we like to give students opportunities and experiences that they would not usually have at school. On your visit you and the students will be able to experiment with at least 60 hands-on exhibits. You will also take part in two exciting shows.

Welcoming the science barrier

A room full of exhibits can be daunting to the non-scientist and you may feel unqualified to assist students with their understanding of an exhibit when you don’t understand it yourself. However, you don’t need to know any of the science yourself. Instead, consider this approach.

- Stand alongside students who are experimenting with an exhibit.
- Show some interest in the exhibit and ask the student(s) what it does.
- You might like to try asking a question, then:
  - Pause (wait for an answer)...
  - Prompt (give them a hint)...
  - Praise (tell them they did well)...
- Tell them you don’t know about it yourself, but you want to know and you are relying on them to be the expert.
- Encourage them to investigate and try things. The first level of understanding may simply relate to ‘making things happen’ on the exhibit.
- Get them to tell you what they have found and show you how it works.
- Use questions to encourage them to investigate further. What science is it showing? How do we use this in real life?
- Ask them what the Context Board (the instructions board beside or on the exhibit) says. Assist the students to read it and repeat back to you what it means.

By these simple steps you will encourage active involvement and learning ownership by the students which will carry forward as they move onto other exhibits.

Symptoms of a kid who loves science:
- shows curiosity about the natural world
- likes experimenting and trying things out
- takes things apart and rebuilds them
- asks lots of questions about why things are the way they are.

Why does science matter? The late Professor Sir Paul Callaghan noted that the average person in the world today is better off than the richest aristocrat of 200 years ago — they will live longer, be healthier, happier, safer and more productive. Why is this? It’s largely because of science and the improvements in quality of life it has brought to millions of people around the world.

Which isn’t to say that humanity doesn’t still face a great many challenges, from climate change to food and water shortages to disease. Science will play a leading role in how society responds to and overcomes these challenges, so that life as we know it today can be sustained in the future.

Every New Zealander needs to be science savvy!

Science at home
- Spend time with your child pulling things apart to find out how they work, or building things like kit set radios. For even more fun, try engaging your child in real-life science experiments at home. You can find good ideas on the internet, and many toy shops sell relatively cheap experiment sets.
- Take advantage of what’s out there in the community. Visit your local library to find books about science. Play with interactive displays and exhibits at places like museums and planetaria.
- Develop a love of reading in your child — it builds a love of knowledge.
- Maths is the basis of all science, so make it fun, encourage it.
- If a child asks a question, don’t be afraid to say you don’t know but, importantly, show them how they can find out; do it together.
- Latch onto opportunities whenever your child displays interest, and give practical and real examples of things.
- The natural world is usually a child’s first interest; it helps if parents are a little ‘wide-eyed’ too.
**Themes**

**Applied science — Te pūtaiao whakahāngaitia**

Exhibits in this theme address specific learning intentions relating to the following: chemical energy conversion to movement; simple machines such as levers, pulleys, wheels, cogs and inclined planes; digital technologies such as data storage and data transfer.

Exhibits include:
- 2 & 4 Strokes
- Data storage
- Lock and key
- Speedo
- Awesome augers
- Digit creator
- Post driver
- Steering wheel and brakes
- Chain hoist
- Fibre optics
- Screw and inclined plane
- Clock and gears
- Gearbox

**Contexts — Simple machines, Technology, Devices.**

Key School Journal References:

**Astronomy — Te mātai arorangi**

Exhibits in this theme address specific learning intentions relating to the following: gravity in space and on planets; light intensity of sun and stars; planetary orbits and their elliptical nature; energy in space; and, models of the solar system and planet behaviour. Exhibits include:
- Black hole
- Phases of the moon
- Sundial
- Brightness
- Planetary scales
- Sunrise
- Ellipses
- True star positions
- Orery
- Spectroscope
- Turbulent planet

**Contexts — Astronomy, Space.**

Key School Journal References:

**Real chemistry — Te mātai matū ārangi**

Exhibits in this theme address specific learning intentions relating to the following: applied chemical properties such as chemical cells; physical properties of materials such as melting point, density, fluorescence, heat conductivity, surface tension, the structure of fabrics and light transmittance; the uses of elements; and, mixtures. Exhibits include:
- 3-D printer
- Microscopic fibres
- Solids, liquids, gases
- How full is the tin?
- Hot & cold handles
- Mineral origins
- Space bubbles
- Lemon battery
- Minerals
- Types of milk

**Contexts — Applied chemistry.**

Key School Journal References:

**Exhibits**

Each year we identify six conceptual Themes under which we group our exhibits. By ensuring that exhibits fit within a particular Theme we are able to provide a number of experiences that build on each other, ensuring students have the greatest opportunity to expand their knowledge base.

The notes on this page and the next page highlight the concepts that are covered within each of these Themes and may help you to focus pre- and post-visit activities and educational opportunities for your students.

Although our primary focus is on objectives from the Science Curriculum, the exhibits also contribute across most other curriculum areas, particularly by providing students with opportunities to engage with others, to discuss what they are doing, and work cooperatively on a range of experiences not normally available to them within the school environment.

**Effective use of Explainers**

Explainers are students selected from the host school to assist with explaining and demonstrating exhibits to visiting students. (They also play a vital role in assisting with setting up exhibits and later packing them away in the truck!) To prepare Explainers for their involvement we ask that before the Roadshow visit, teachers outline the following key aspects of the role with the chosen students. Explainers are there to:
- Assist others to learn (and in doing so, they will learn a lot themselves).
- Give hints and suggestions about how to use exhibits.
- Show enthusiasm and encourage involvement from visiting students.
- Ensure safe use of equipment.
- Prevent mistreatment of Roadshow equipment.

All in all, we hope that students enjoy their experience as Explainers and maximise their own learning by active, positive and enthusiastic involvement.

**Extras for experts**

The purpose of this challenge is to stretch more able and/or determined students and encourage active learning through involvement with exhibits.

How it works: Each year three or four exhibits are chosen for more detailed study. These are ‘flagged’ to identify them so that during the ‘floor session’ when students are using exhibits, they know which ones are for the ‘extras for experts’ challenge.

At any time during this part of their visit, students have the opportunity to use and study these exhibits in detail, then to explain how they work to nominated adults (who have model answers). If they explain a given exhibit correctly, they have a card clipped. They repeat this process with the other exhibits and once they collect at least two clips, they are eligible for a prize drawn at the end of their visit.

Please note: While every effort is made to display the complete range of exhibits listed, due to various factors out of our control, this is not always possible. Usually a minimum of 60 exhibits are on display at any one time.
The big questions

Before we start our second show we ask the students one or two ‘big questions’ about key ideas associated with exhibit themes. For 2015, these are as follows:

**Applied science**

A. Name some common parts found in machines. (Wheels, levers, pulleys, cogs, sprockets, gears, cams, inclined planes, etc.)

B. What do machines help us to do? (Work, in the physical science sense — they make things happen.)

**Astronomy**

A. Would you weigh more or less on Jupiter (compared with Earth)? Why? (More. Jupiter is much bigger than Earth and the bigger a planet, the more mass it has and the more mass, the greater the pull of gravity.)

B. Is there gravity in space? (Yes, but the further you are away from a planet or star, like our sun, the smaller the pull of gravity.)

**Real chemistry**

A. When you copper plate something (or plate it with zinc or gold), is this a physical or a chemical change? (Chemical, since you make a new product, e.g. copper on brass.)

B. Can electricity be created by a chemical reaction? (Yes, this happens in a dry cell or battery, and you may have seen this with our Lemon battery exhibit.)

**Science capabilities**

A. What is a word used by scientists meaning to look really carefully at something? (An observation.) What do we use to make observations? (Our senses.)

B. How do instruments like microscopes and telescopes help our senses, like our sight? (They improve our sight, allowing us to see detail that we would not otherwise see. This takes the guesswork out of understanding the details of tiny or distant objects.)

**Forces — Nga tōpāna**

Exhibits in this theme address specific learning intentions relating to the following: pushes and pulls; pressure differences and vacuums; the Bernoulli principle; distributing forces and pressure; net forces; and, rotational forces. Exhibits include:

- Acceleration d.t.g.
- Bed of nails
- Feathers and lead
- Parabolic spinners
- Air cannon
- Bernoulli blower
- Loop the loop
- Rotating chair
- Arch bridge
- Bernoulli circuit
- Magdeburg
- Tipping point
- Baffle tank
- Chaotic pendulum
- No air friction

**Contexts — Forces and motion, Forces, Pushes and pulls.**

**Light and sight — Te aho me te kitenga**

Exhibits in this theme address specific learning intentions relating to the following: illusions; the behaviour of lenses; mirror images, Moiré patterns, pinhole ‘lenses’; functioning of the eye; the stroboscopic effect; and, persistence of vision. Exhibits include:

- Dioxide glass
- Mirror alphabet
- Moiré patterns
- pivoting picture
- Pupil effect
- Zoetrope
- Laser zig-zag
- Phenakistoscope
- Pinhole camera
- UV block

**Contexts — Light, Our senses, Sight.**

**Science capabilities — Ngā āheitanga pūtaiao**

Exhibits in this theme address specific learning intentions relating to the following: observation and inference; use of instruments; objectivity; measurement; variables; estimation and data analysis; deduction; classifying; modelling; pattern seeking; understanding the development of science and technology; systematic processes; comparisons; fair testing; relating science to real life; and, interpreting representations. Exhibits include:

- Age of living things
- Chloride plates
- Early innovators
- Gyro suitcase
- Heat illusion
- Linear measure
- M & Ms
- Maps
- Milk-soft drink
- Sonar
- Spirograph
- Tensile testing
- Uphill roller
- Vernier

**Contexts — Any science context.**

**Note:** While every effort is made to have these exhibits on offer, we cannot guarantee that all of them will be on display at any one time.
While being exciting and entertaining, our shows provide a great opportunity to enhance student knowledge in two science areas each year. The shows for 2015 are Sparks, Arcs and Gherkins, all about electricity, and Wonderful Water, focusing on the properties of water and the water cycle.

To assist you in preparing for your visit, we’ve developed a unit plan called Electricity — found in this booklet — that complements the Sparks, Arcs and Gherkins show.

If time permits within your classroom programme, you may like to use notes from Wonderful Water outlined below to develop your own pre- and post-visit unit to complement that show.

**Sparks, Arcs and Gherkins show — Te whakaari māpura, tāwhana, kamoriki hoki**

This show covers specific learning outcomes relating to the properties and behaviour of electricity, including the following:

- simple circuits, use and storage of electricity
- conductors and insulators
- care with electricity
- short circuits
- electromagnetism
- electrical current and arcs.

**Key School Journal References:**

- Electric map Article 6 1992 Pt 04 1 BONALLACK, John.
- Electric map Article 1998 Pt CN 3 BONALLACK, John.
- Jumping for joules Article 7 2008 Pt CN 03 ALCBIN, Rupert.
- A new life for old machines Article 2007 Pt CN 3 HIPKINS, Rosemary.
- Of elbows and eels Article 2004 Pt CN 2 ALCBIN, Rupert.
- The old water-wheel Article 5 1989 Pt 01 2 BIRCHALL, Brian.
- Power Article 4 2011 Pt L2 Aug TAYLOR, Alex.
- Power for Puakapuka Article 2000 Pt CN 1 GOODWIN, Maureen.
- The power of rubbish Article 6 1993 Pt 03 2 QUINN, Pat.
- The power of rubbish Article 1998 Pt CN 3 QUINN, Pat.
- Profile: Marc Yeung Article 7 2010 Pt CN 03 FRANCES, Helen.
- The sleeping giant Article 6 1989 Pt 02 2 KEIR, Bill.
- Turning on the power Article 5 1981 Pt 04 3 BIRCHALL, Brian.
- Water power Article 5 2005 Pt 02 4 CARROD, Sandra.

**Wonderful Water show — Te whakaari wai mīharo**

This show covers specific learning outcomes relating to the science of water, including the following:

- physical properties of water, e.g. surface tension, conductivity, thermal mass, dissolving
- water cycle
- importance of water to living things
- importance of water to the weather and environment.

**Key School Journal References:**

- Archimedes and the crown Article 6 1986 Pt 04 1.
- Charlie and Maria Article 4 2007 Pt 02 01 HILL, Bartha.
- Counting koura Article 2007 Pt CN 1 GORE, Brian.
- Delicious steamed kai Article 4 1992 Pt 01 5 MAGUINESS, Jan.
- The disappearing spider Article 4 1984 Pt 01 1 FLOWERS, Christine.
- Frog adventure Article 4 2009 Pt 01 01 KAPA, Janine BLAIR, Carol.
- Grow your own crystals Article 5 1982 Pt 01 4 SOUTHGATE, Brent.
- Guard for a day Article 4 2001 Pt 01 1 BUXTON, Jane.
- Hard ice, soft ice Article 2004 Pt CN 2 O'BRIEN, Bill.
- Homework Article 2003 Pt YP 1 RENDALL, Logan.
- How to make a limestone cave Article 2007 Pt CN 1 LOVELESS, Mary.
- Kaitiaki of the Stream Article 4 2013 Pt L2 October MOORE, Pataka.
- Laying the drains Article 5 1981 Pt 03 3 BIRCHALL, Brian.
- Make salt water into fresh water Article 1998 Pt CN 2 ANDERSON, K.E.
- Making puddles Article 2000 Pt CN 1 AVERILL, Sue.
- Mist Article 1999 Pt CN 2 ANDERSON, K.E.
- Salt from sea water Article 4 1982 Pt 01 4 THOMSON, Jane.
- The secret life of estuaries Article 7 2006 Pt CN 03 INNES, Andrew.
- The shapes of water Article 5 1995 Pt 01 4.
- Crook, Gillian / SHANNON.
- Testing the north river Article 1998 Pt CN 2 MCCABE, Elizabeth.
- The Fish Highway Article 6 2013 Pt CN 03 JACKSON, Amanda.
- The water cycle Article 2002 Pt CN 2 REA, William.
- Water Worries Article 6 2012 Pt L3 Apr McMillan, Rachael.

**General Learning Outcomes relating to Shows**

After attending the shows students will have improved:

- interest and enthusiasm
- understanding and knowledge of scientific and technological principles and processes
- greater understanding of the Nature of Science.
**Simple machines** page 3

**Mechanical.**

**Secrets of the universe!** page 4

The universe is thought to have begun with a big bang that occurred 13.8 billion years ago. Earth formed 4.6 billion years ago. Galaxy, black holes, pulsar, Milky Way, supernova.

**Fun with forces** page 5

Pull, gravity.

**Light and sight** page 6

Solution’s missing words: 1) brain, 2) opaque.

**Chemistry in action** page 7

**Science is about...** page 8

Extra mystery words (see solution above): Trends, analyse, comparisons, instruments, grouping, graphing.

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**Balloon hovercraft** page 9

**Challenge 1:** Observations could include descriptions of the parts (e.g. the CD and the balloon, colour, shape, etc.) and how they function (the balloon becomes smaller, air comes out through the base, the CD becomes elevated, it sometimes spins as it travels, hissing noise, a moist trail is left behind. **Inferences:** The elastic rubber contracts to push the air out; the moving air forces the CD up from the surface, etc. **Challenge 2:** ‘Good’ might be measured by one of: distance travelled; how long it stays elevated; how fast it can travel, etc. **Challenge 3:** Possible improvements: size of hole, weight of cork/bung, strength of balloon rubber, level of balloon inflation, how the push is applied. Communicate with chart showing averages, bar graphs, scattergrams. Possible problems: inconsistency in strength of push and level of balloon inflation, multiple measurements need to be taken for each change tried, air escaping before hovercraft is pushed, etc.

**Astroblaster** page 10

**Challenge 1:** The balls fall together and when they hit the ground the bottom one only bounces a little, while the top one shoots upwards at high speed, etc. The smaller the top ball in comparison to the bottom ball, the higher it shoots away. If it is slightly to one side, the top ball shoots off at an angle. **Challenge 2:** Use a ruler or a scale on a wall to measure the height on many repeat trials. When they fall separately, the larger ball bounces higher and the smaller one bounces lower than when they land together. **Challenge 3:** Most of the energy from the two balls falling is transferred to the smaller ball making it rebound higher than ‘expected’. When an asteroid collides the impact might cause smaller chunks to ‘rebound’ into space at very high speeds.

**Spinning bucket** page 11

**Challenge 1:** Example of rule: ‘Any object stays in the bucket as long as the bucket is being spun around fast enough.’ **Challenge 2:** The bucket keeps going in a straight line from the exact moment it is released. Even when released, the object stays inside the bucket. Forces involved: an inertial force acting against a centripetal force. **Challenge 3:** The inertial force on the sand or water acts in the direction that the bucket is moving while the bucket forces the water back towards your hand, thus keeping it in place. With a satellite, due to its movement it ‘wants’ to keep going in a straight line out into space, but gravity holds it in its circular path.

**Eyes up close** page 12

1–2. Observations of pupil, iris, cornea, blood vessels, eye lids, eyebrows, etc. 3–5. Accurate drawings critiqued with measurements added. 6. Observations could include: blinking, squinting, pupil size changes (especially when a torch is shone into the eye), eyelid movements, etc. 7. Inferences could include: eyebrows to guide sweat away from eyes, eyelashes for flicking dust away and to help with squinting, eyelids for protection, tear ducts for making tears to cleanse and stabilise the eyeball, pupils to adjust the intensity of incoming light.

**Burn, burn, burn!** page 13

1–3. Observations might include: Parts or objects: wax, wick, flame, etc. Features: yellow flame, hot flame, white wax, 20 cm high candle, 3.5 cm high flame, molten wax at top of candle, red tip to burning wick, etc. Changes: flickering flame that moves with air currents, candle become shorter, wax runs down the side of the candle, hot air rising, etc. 5. Inferences could include: the air around the candle is rising (as it is hottest above the candle), wax is used up during burning (as the amount of wax reduces over time), it is the wax that is burning (as the wick would not contain enough material to produce all the heat generated), the candle’s flame melts the wax (as it only melts near the top of the candle, etc. **Going further:** Scientific terms might include: combustion, melting, solid, liquid, gas, convection, luminous zone, etc.

**Balancing sticks** page 14

1–3 Balancing the longer stick is easier. And, it is easier to watch the top of the dowel so that you detect sooner when it is about to tip. 4. Example of a suitable question to investigate: Is it easier to balance a long stick than a short one? Components of a suitable method would include: timing how long it can be balanced; doing multiple trials and averaging them; doing the same trial with several different people; always looking at the same part of the dowel (e.g. its top) while trying to balance it; completion of each trial might conclude when it ‘has to be caught because it is inevitable that it will fall’; doing tests with left and right hands; always using the same people for the trials; doing one trial with each different length, then repeating this over and over (rather than doing all the trials on one length before starting on the next length; this overcomes the possibility that ‘training’ on one length might mean you are more skilled when you come to trial the next length); etc. Results can be recorded as averages and displayed as bar graphs. 5. Results will vary. 6. Encourage ‘open discussion’ so all can learn. **Going further:** Could try longer and/or heavier sticks, adding weight to the top end, etc.
The Sir Paul Callaghan Science Academy runs intensive, four day professional development programmes that aim to build excellence in the teaching of science. Our vision is to create primary and intermediate teachers who celebrate science and inspire their students to explore and engage with the world through science.

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Sir Paul Callaghan

The Academy Programme

A variety of excellent facilitators present the Academy programme. It is insightful, dynamic and interactive, as well as practical and hands-on, bringing a variety of best practice techniques and experiences to the fore. The following is a snapshot of some key themes that will be the focus over the four days:

- Learn how to target all types of learners by developing practical investigations that will stimulate all the senses.
- Introduce more science to other areas of your teaching.
- Unit selection and planning.
- Investigate the cultural differences in learning styles and how teaching can be adapted to meet the needs of all learners.
- Discover that you don’t need to be an expert in science to teach science well.
- Being a Science Champion within your school or area and inspiring science learning in all classrooms.

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“Providing quality interactive learning experiences in science, technology and innovation to Aotearoa, New Zealand.”

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