THEMES
• Comparisons — Ngā whakatauritenga
• Forces — Ngā tōpana
• Materials — Ngā matū
• Observations using measurements — Te mātakitaki mā te ine
• Models — He tauira
• Patterns, grouping, classification — He tauira, he whakarōpu, he kōmakatanga

SHOWS
• On The Move
• Elemental Chemistry

UNIT PLAN
Useful chemicals — He matū whai hua
Introduction

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 over-riding objective is to enhance learning outcomes for students.

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Hints p 27
‘Useful chemicals’ unit pp 15–25
Exhibits and Shows for 2019 pp 28–30

STUDENTS
Language & numeracy puzzles linked to Roadshow Themes pp 3–8 (Answers on p 31)
‘Useful chemicals’ unit pp 15–25

ADULT HELPERS
Hints p 27

During your visit

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Encouragement
Safety
Discipline

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School Journals, Connected Series and BSC Books relevant to Roadshow Themes and Shows pp 28–30

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 Book. And, we have an exhibit themes called ‘Comparisons’, ‘Observations using instruments’, ‘Patterns, grouping, classification’ and ‘Models’.

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: www.scienceonline.tki.org.nz/Science-capabilities-for-citizenship/Science-capabilities-resources/Search-resources. 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.

Numeracy and literacy

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

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 Es Instructional Model that 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.
Comparisons

SCIENCE VOCABULARY PUZZLE

Detection and measurement

We can use instruments to detect and measure things that help us make ________________

Your answer:

1. 2. 3. 4. 5. 6. 7. 8. 9. 10.

Instrument

Measures or detects ....

- magnetic fields
- current
- air speed
- sound volume
- flame colour
- light strength
- voltage
- wind direction
- car speed
- distance

Using a pencil and ruler, draw straight lines to link the pictures with their correct clues. Make sure you join the dots carefully. Circle the letter that each line passes through. Write these letters in their numbered spaces below to find the answer. Clue 7 has been done for you and one other clue is given in the grey square.
Strongest bite

Put the bite strength numbers on the diagram from weakest at the bottom, to strongest at the top. Label each box with the name of the animal. Finally, look up books or the internet to find pictures of the animals and create ‘thumbnail’ drawings in the boxes. One has been done for you. Now complete the statement.

Animals with the strongest bite are usually .................

Circle your answer:  herbivores  omnivores  carnivores

### Animal Bite strength (kPa)

<table>
<thead>
<tr>
<th>Animal</th>
<th>Bite strength (kPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>human</td>
<td>1180</td>
</tr>
<tr>
<td>Tyrannosaurus rex</td>
<td>88200</td>
</tr>
<tr>
<td>tiger</td>
<td>6900</td>
</tr>
<tr>
<td>wolf</td>
<td>8300</td>
</tr>
<tr>
<td>Tasmanian devil</td>
<td>3800</td>
</tr>
<tr>
<td>great white shark</td>
<td>27500</td>
</tr>
<tr>
<td>saltwater crocodile</td>
<td>53000</td>
</tr>
<tr>
<td>Deinosuchus crocodile</td>
<td>160000</td>
</tr>
<tr>
<td>dog (Rottweiler)</td>
<td>2300</td>
</tr>
</tbody>
</table>

**Host the Science Roadshow**

Each year we need approximately 100 host schools around the country. We set up in a ‘host’ school’s hall or gym and other schools from the surrounding area are invited to our pre-booked sessions.

Our stay at a host school varies between one and three days — depending on our itinerary, the location, and how many students may visit from the host and surrounding schools.

The Roadshow makes a commitment to a set itinerary and venues well in advance, so it’s really important that our host schools can commit to hosting the Science Roadshow.

**Host Venue Criteria**

- **The use of your school hall or gym**
  This is where we set up our exhibits and other equipment. Your hall needs to be approximately 20x30m. All our equipment is on trolleys and wheeled into the hall. As we have 60 cubic metres of equipment, the hall will need to be clear of any chairs, tables etc.

- **A group of students to be ‘Explainers’**
  We require 13 students (Yr 7+) daily who will be trusted with assisting on specific exhibits. Our staff will conduct an extensive explainer training session that includes health and safety aspects.

- **A member of staff to act as our co-ordinator/liaison**
  This person needs to book the hall and select student explainers. They will be our go-to person if we have any issues or questions.

**Contact Maureen Jones for more info:**
maureen@roadshow.org or 04 499 7865
SCIENCE VOCABULARY PUZZLE

Mineral hardness

Knowing how hard a mineral is helps us to classify and name it. If one mineral is harder than another, it can be used to make a scratch on it. For example, quartz can be used to make a scratch on a piece of calcite, but calcite can’t scratch quartz. So, quartz is harder than calcite.

Use the statements to work out the order of mineral hardness to complete the table. One mineral, Apatite, is in the correct place already.

Statements

Apatite is harder than Gypsum.
Gypsum is harder than Talc.
Fluorite is harder than Gypsum but softer than Apatite.
Calcite comes between Gypsum and Fluorite.
Diamond is the hardest mineral.
Quartz is harder than Feldspar.
Feldspar is harder than Apatite.
Corundum is the second hardest mineral.
Quartz is softer than Topaz.

<table>
<thead>
<tr>
<th>Hardness</th>
<th>Mineral</th>
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<tbody>
<tr>
<td>1</td>
<td></td>
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<td>2</td>
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<td>3</td>
<td></td>
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<td>4</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Apatite</td>
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<tr>
<td>6</td>
<td></td>
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<td>7</td>
<td></td>
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<td>8</td>
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<td>9</td>
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<td>10</td>
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</tbody>
</table>

Now, use clues from the table to crack the coded message below.

Put the second letter of each mineral into this ‘key’.

M h s
s c
f m n r
h r d n s s.

Use the key to complete the coded message. This gives the name to the table above.

The academy opened my eyes to a whole new way of thinking.

www.scienceacademy.co.nz

The Academy offers a fresh approach to equipping primary and intermediate school teachers with skills, resources and techniques to feel more confident in delivering the science curriculum — especially the Nature of Science strand — through an intensive, four-day programme.

2019 Academy Dates (* during school holidays)

Invercargill  Mon 15 – Thurs 18 April 2019*
Auckland Central  Tues 9 – Fri 12 July 2019*
Whanganui  Tues 16 – Fri 19 July 2019*
Kerikeri  Tues 1 – Fri 4 October 2019*
Whakatane  Tues 8 – Fri 11 October 2019*
Models

SCIENCE VOCABULARY PUZZLE

Models

Use the clues to complete the crossword on scientific models. This is not a normal crossword, as most of the answers involve more than one word. So, some clues are at the bottom. Note that spaces between words are removed in the puzzle answers.

Across
1) A drawing of how water cycles in the environment.
4) A moving model created on a computer.
7) A diagram showing how different species are related.
9) A scaled down model of an aeroplane.
11) A computerised simulation model.
12) Model of the top half of a human body.
14) A slice through our planet from pole to pole.

Down
2) A mould of the marks left by a shoe.
3) A simplified drawing.
5) A simplified drawing of how electrical components are wired.
6) A model of the bones inside your body.
8) A drawing done to the correct proportions.
10) A miniature locomotive.
13) A mechanical model of the solar system.

Clues
TORSO M_D_L • ORR_RY • _OM_ UTER SIM_LA_ION
• S_ALE_RAWING • _ATER_C_LIE • F_MVILLE_2
A_P • _I_CUIT DI_RAM • EA_TH_ROSS_ECTION •

DINOS_R FAM_LEE • _ITSET P_ANE • _AGRA_
• C_ST OF F_TPR_NT • CI_CUIT D___AM • PLASTIC
SK__TON • M_DEL TRAI_
This is an exercise in measurement. Measurements help our observations to be more accurate.

Use a ruler to measure each of the items in both millimetres and centimetres and put your answers in the table to the right.

<table>
<thead>
<tr>
<th>Millimetres (mm)</th>
<th>Centimetres (cm)</th>
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</tbody>
</table>

**How long is the wasp’s body?**

**How long is the worm?**

**What is the INSIDE diameter of the eyeball at its widest point?**

**How wide is the shark’s tooth?**

**How long is the shark’s tooth?**

**What is YOUR thumbnail’s thickness?**

**How wide is YOUR handspan?**

**How high do your feet lift off the ground when you jump directly upwards?** (You will need someone else down on hands and knees to measure this.)

**Did you know the biggest eyeball in the world, at 280 mm diameter, is from the colossal squid?**
Patterns, grouping, classification

SCIENCE VOCABULARY PUZZLE

Dinosaur family tree

New findings have shown the dinosaur family is not what we used to think it was. Here's how scientists now think the different groups are related. Follow these steps to see who belongs where.

1. Cut the family tree out and paste it on a fresh A4 sheet.
2. Cut out the dinosaur pictures and look up books or the internet to find out their names. Now paste them onto the correct parts of the family tree.

Questions

- What modern day animals are related to T. rex (Tyrannosaurus rex)?
- So, do dinosaurs survive today?
- Give examples of animals that belong to the Theropoda branch of the family tree.
- Which of the dinosaur examples above are most likely to have had feathers?
Heartbeat detection

Learning intentions
Science Capabilities: Gathering & interpreting data through measurement. Comparisons and fair testing.
Living World: Life processes, circulation and heartbeats.

What to do
When we ‘take our pulse’ this tells us how fast and how strongly our heart is beating. This experiment helps us to see evidence of both these things.

Making a pulse monitor:
1. Push the end of a matchstick into a blob of modelling clay so that it will stand up by itself.
2. Find your pulse by feeling the inside of your wrist at the point shown in this picture. Mark the exact spot with a pen.
3. Lie your hand palm up on a desk and carefully balance the matchstick on the mark you have made. This will take patience! Keep very still and watch the head of the match twitching back and forth. This shows your pulse, which ‘thumps’ at the same speed as your heartbeat. Try the match in slightly different positions.

Measuring your pulse
4. How many times does your heart beat per minute? Look carefully at how far the match moves. Record.
5. Do 30 star jumps and repeat 3) and 4) above. Compare your findings. Record. Try other things.

Thinking about how it works
6. What causes your pulse?
7. Why does your heart need to beat faster and harder when you are exercising?

Going further
8. Find other places on your body where you can feel a pulse.
9. Find an interesting way to report your findings to others.

Key School Journal References: Don’t Sit if you want to Stay Fit PITCHES, Neale Article 7 CN L4 2015.
Sharing the load


What you will need:
(per group or as a class demo)

- Bathroom scales.
- A wooden plank up to 2 m long strong enough for people to stand on.
- A block of wood about half the size of a brick.

Challenge 1

Setting up
Place the block on the middle of the scales then place the end of the board on the block.

Stand on the board. What weight is shown on the scales? Move along the board. How does your measured weight change?

Challenge 2

Measurements
Find where on the board you have to stand to:
• weigh your normal body’s weight.
• weigh half your normal weight.
• weigh almost nothing.
Record your findings.

Challenge 3

More weight!
Can you set up the plank so when you stand on it, you weigh more than your normal body’s weight? (Hint: you may need someone to hold down the end of the plank that is touching the floor. Draw a picture of the set-up and record your findings.

Weight versus force
Research to find out how weight and force are slightly different, but similar!
Mineral and rock collection


Challenge 1

Describe your minerals and rocks
Look carefully at each item in your collection. Describe them and record on your labels:
- colour
- texture
- hardness/softness
- smoothness/roughness
- dullness/sparkle
- weight.

Challenge 2

Mineral or rock?
A mineral is naturally-occurring and is one substance, colour and texture, e.g. quartz.
A rock consists of two or more minerals, so a variety of textures, colours and structures can be seen, e.g. granite is made of tiny quartz and feldspar crystals that are separate minerals.

Grouping
Observe your items carefully and decide if they are rocks or minerals, then organise them in your collection under those headings.

Challenge 3

Name your items
This can be a real challenge! Here are some things that might help:
- Look up pictures of different minerals and rocks.
- Geologists use things like: Colour, Habit, Hardness, Streak, Cleavage, Fracture, Lustre and Specific Gravity to help identification.
- Streak is easy. Find out about it and use sandpaper to do the test.
- Ask a geologist or keen rockhound (a collector) to help.
Shoe print moulds CSI

Learning intentions Science Capabilities: Gather data and use evidence to support claims. Material World: Chemical change. Human-made substances.

What you will need:
(per group)
- Plaster of Paris.
- Plastic bucket and a stick for mixing.
- Light weight cardboard.
- Masking tape.
- A shoe or boot with a clear tread on its sole.
- Optional: hairspray.
- Optional: water-based paint, e.g. old acrylic house paint. (When mixed with Plaster of Paris this makes the mould much harder and stronger.)

Challenge 1
Create a footprint
Make a nice ‘clean’ shoe print that doesn’t collapse when you take the shoe out.

What evidence can you collect?
Inspect the shoe print carefully. What evidence can you collect about it? (Hint: You may need a ruler and camera to help record more detail.)

Challenge 2
Prepare the mould
Use a thin length of cardboard and masking tape to make a 5 cm high fence around the shoe print. You may wish to spray the print with hairspray first so it doesn’t collapse.

Pour the mix
Mix up the plaster of Paris to the correct recipe. You may wish to add a few spoonfuls of water-based paint to make the mould stronger when it sets. How are you going to take a mould of the shoe print? Once done, leave to set fully.

Challenge 3
Collect evidence
What evidence have you collected by creating the mould? Why would a detective take a shoe print mould from a crime scene?

Setting the scene
A burglar has left evidence at a crime scene. When climbing from a window they have left a footprint in the garden below. Can you create a mould of the footprint to see if it matches a suspect’s shoe?

Key School Journal References:
The case of the broken window SCHRODER, Margaret Story 5 03 2 1997. DNA talks every time BENN, Ken Article 5 Connected 02 2009.
Dinosaur footprints

Learning intentions
Science Capabilities: Using data and instruments to create models.
Living World: Evolution and the body forms of dinosaurs.

What to do

Setting the scene
Dinosaurs were the largest land animals ever to live. Huge amounts of evidence exists to show their size and how they lived, including fossilised skeletons and trace fossils, such as footprints. Here we are going to investigate just how big some of those footprints were.

Start with these scale drawings of footprints. Here are prints from *Tyrannosaurus rex* and a *Brachiosaurus*. Scale them up separately to real size onto butcher’s paper (see instructions to left).

How to scale up the drawing

To create a big grid:
The grid on this page is 12 cm high by 12 cm wide. You need to measure and draw a grid 10 times as large on the butcher’s paper, so it will be 120 x 120 cm, with each square being 10 x 10 cm. Join the butcher’s paper if you need to.

Scale up the footprint:
Using pencil, lightly copy the shape of the footprint to the big grid, using the squares as your guide.

Finishing
Colour the footprints with paints and cut out.

Make more footprints
Trace the footprints to make more and arrange them to show a path of prints. Create left and right prints. Or, use chalk to trace them onto a paved area.

Share your observations and laws

1. Find out about other dinosaur footprints or body sizes, and create real size ‘models’.
2. Some footprints have been found that are even larger than these ones. Look at an article on the world’s largest footprints (made by sauropods): http://www.abc.net.au/news/2017-03-27/world-biggest-dinosaur-footprint-found-north-western-wa/8391098.

Key School Journal References:
**Rock and mineral hardness**

**Learning intentions**

Science Capabilities: Gathering and interpreting data. Grouping.
Material World, Planet Earth and Beyond: Physical properties of rocks, minerals and other substances.

**What to do**

**Setting the scene**

If one rock or mineral is harder than another, it will be able to scratch it. But, the softer rock will not be able to scratch the harder one. This is called a scratch test (see picture to left).

**What to do**

1. Firstly, just scratch one mineral or rock against another. Rub the area clean to see if a scratch has been made. Which one makes a scratch on the other?

2. Do more tests and put your rock and mineral samples in order from softest to hardest.

3. How could knowing softness or hardness be useful?

**Measuring hardness**

Mohs scale can be used to measure how hard your samples are. In this scale, diamond is the hardest, and for example, topaz is harder than quartz. It’s not easy to get hold of the minerals in Mohs scale, so some everyday items can help us measure how hard things are too (see the right column below). We are going to use them as ‘tools’ to perform scratch tests to measure hardness. Examples: 1) if something can be scratched by your fingernail it must be less than 2.5 on the hardness scale; 2) if something can be scratched by a steel nail, but not by a copper coin, it must be about 4 on the scale.

**This part is Mohs scale**

<table>
<thead>
<tr>
<th>Hardness</th>
<th>Mineral</th>
<th>Everyday ‘tools’ for testing hardness</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Talc</td>
<td>1.5 HB Pencil lead</td>
</tr>
<tr>
<td>2</td>
<td>Gypsum</td>
<td>2.5 Fingernail</td>
</tr>
<tr>
<td>3</td>
<td>Calcite</td>
<td>3.5 Copper coin</td>
</tr>
<tr>
<td>4</td>
<td>Fluorite</td>
<td>4.5 Steel nail</td>
</tr>
<tr>
<td>5</td>
<td>Apatite</td>
<td>5.5 Glass or pocket knife</td>
</tr>
<tr>
<td>6</td>
<td>Orthoclase</td>
<td>6.5 Steel file</td>
</tr>
<tr>
<td>7</td>
<td>Quartz</td>
<td>8.5 Masonry drill</td>
</tr>
<tr>
<td>8</td>
<td>Topaz</td>
<td>9.5 Emery sandpaper</td>
</tr>
<tr>
<td>9</td>
<td>Corundum</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Diamond</td>
<td></td>
</tr>
</tbody>
</table>

4. Measure the hardness of a range of rocks, minerals and everyday materials. Record what you found out.

**Key School Journal References:**

**Topic:** Chemistry and society L3 and L4 (but easily adapted to L1/2)

**Science Concepts**

Key concepts relating to the uses of substances in society, including:

- pure substances are called elements; substances called compounds are combinations of elements
- different substances have different properties
- their properties can make them useful to us
- properties can be chemical or physical
- pure substances (elements) are organised on the Periodic table according to their properties
- we use some elements in everyday life
- compounds are more common than elements and are useful too
- careful observations and investigations help us to compare and understand chemicals and the uses they can be put to.

**Contexts/Strand:** Material World

**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.

**Key aim**

To gain an appreciation of the variety of chemicals and their properties

Throughout the unit, students will learn the names of chemicals and through observation and experimentation, find out about what they look like, how they behave and what uses they can be put to.

**Achievement Objectives**

**Nature of Science (NoS)**

The five Foundational Science Capabilities are the main focus within NoS and are emphasised within this unit. It is suggested that one component of a given Capability is foregrounded at any one time. However, most of the five Capabilities are inherent within most activities.

**Contextual Material World:** Chemistry and Society Levels 3&4

Relate the observed characteristic chemical and physical properties of a range of different materials to technological uses and natural processes.

**The 5 Es**

Follow good 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).

- **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**

**Dissolving eggshell p.19:**

- 3) Bubbles arise from the eggshell.
- 5) It feels softer.
- 7) Yes it bounces. Soft and rubbery.
- 8) Acetic acid.
- 9) Often up to 30 cm. Only the part of the eggshell that is immersed will dissolve. Malt vinegar causes quicker dissolving. Answers will vary. Yes, but if left too long it will dissolve the seashell. White vinegar is commonly used in water to clean windows. Citric and tartaric acids are used in baking. Citric acid is also in lemon juice which is used in cooking and baking.

**Snuff that flame p.20:**

Challenge 1. The flame becomes smaller then goes out and some smoke is released into the jar. Because oxygen is needed for burning (combustion) but the jar limits its supply. To refresh the air inside the jar you can either: fill the jar up with water, empty it, then dry with a rag, or, turn the jar in different directions while waving it about, or, leave it lying on its side for a few minutes, or, blow into the jar with a lilo pump. Challenge 2. Yes, because the bigger the jar the more oxygen is trapped. Challenge 3. Examples of laws: ‘The bigger the jar, the longer it takes the flame to go out.’ (Evidence might include the average times for the flame to be extinguished.); Doubling the jar’s volume will double the time for the flame to go out. (Again, evidence might include the average times.) Better still, ‘Given the jars are the same proportions, doubling the jar’s volume will double the time for the flame to go out.’ Uses: Oxygen can be useful, as it sustains burning and breathing. It can be a nuisance when we are trying to put out a fire as it ‘fuels’ the flame.

**Rusting p.21:**

- 3) the steel nails rusted because they were not coated with a rust-preventing substance like the zinc on the galvanised nails. It was a fair test because the conditions were the same for all of the nails tested. 4a) Copper nails won’t rust. A piece of a tin can will rust on the cut edges where the steel is exposed. Paper clips and steel wool will rust. b) Yes. c) Yes. 5) Zinc and tin coatings over the steel. 6) Copper, gold, silver or plastic coatings; paint. 7) Brush salty water onto the steel.

**Salt crystals:**

- p. 22: 5) Yes, because the only difference between the two trays was the location. 6) Warm conditions, e.g. in the sun. 7) Use a fan to help evaporate the water.

**How dense is that substance?** p.23:

Challenge 3. Some densities: copper 9.0, lead 11.3, steel 7.9, aluminium 2.7, quartz 2.7, greywacke 2.6, granite 2.6, limestone 2.5, schist 2.7. Lead is very dense, so it pulls the fishing line down quickly and stays on the bottom, and, lead doesn’t rust. Wood is less dense than water, so it floats. Density is a physical property.
### Useful chemicals

## SCIENCE LEARNING UNIT PLAN

### 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 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 'Useful chemicals' context plays a supporting role. That is, the emphasis is less on traditional content coverage, and more on the process of science as emphasised by the Nature of Science and the Science Capabilities.

Note, you do NOT need to cover all sections, as there are many 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.

<table>
<thead>
<tr>
<th>Specific Learning Intentions</th>
<th>Learning Activities through 5Es model</th>
<th>Elements are highlighted like this: $\text{He}$</th>
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</thead>
<tbody>
<tr>
<td><strong>Foundational Science Capabilities</strong></td>
<td><strong>ENGAGE and EXPLORE</strong></td>
<td></td>
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<tr>
<td>Examples for this unit include:</td>
<td><strong>Ignition activities</strong></td>
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<tr>
<td>Gathering and interpreting data</td>
<td>Explore some of these simple investigations relating chemical substances. These types of activities will prime thinking about how chemicals can be useful. A possible extra for older students is to start discussing pure substances — called elements — and their symbols (grey boxes below).</td>
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<tr>
<td>• making careful observations</td>
<td>• <strong>Helium balloons</strong>: Inflate helium balloons with strings attached. <strong>Explore</strong> how they behave. What <strong>weight</strong> can they carry? How big do they need to be to only just float. <strong>How many</strong> balloons are needed to carry a load? How many would be needed to carry a person? Sources of cylinders and the suitable balloons: Spotlight, Party Shops; gas only from BOC gas company. Symbol for the element helium: $\text{He}$.</td>
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<tr>
<td>• identifying properties</td>
<td>• <strong>Plaster of Paris moulds</strong>: Make moulds of shells, e.g. scallops. Once set, use the moulds created to make more ‘shells’. <strong>Feel</strong> the plaster as it is setting. It gets hot! How hard is the product? Make some new plaster mix with a few spoons of acrylic paint instead of some of the water. <strong>Compare</strong> how strong the product is this time. (Much stronger.) Plaster of Paris is made of calcium sulphate ($\text{CaSO}_4$). Symbols of the elements: calcium $\text{Ca}$, sulphur $\text{S}$ and oxygen $\text{O}$.</td>
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<tr>
<td>• grouping and classifying chemicals by their properties</td>
<td>• <strong>Magnets</strong>: <strong>Test</strong> what they will pick up. Try nails (mainly made of iron), copper, brass, zinc, aluminium. Only iron items are attracted. Symbols of the elements: iron $\text{Fe}$, copper $\text{Cu}$, zinc $\text{Zn}$, aluminium $\text{Al}$. Brass is made of copper and zinc combined.</td>
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<tr>
<td>• data collection</td>
<td>• <strong>Coins</strong>: New Zealand’s coins are made of aluminium-bronze alloy ($$2$ and $$1$), nickel-coated steel ($50c$ and $20c$) and copper-coated steel ($10c$). The ‘copper’ 10c coin is attracted to a magnet, so the attraction method used for copper won’t prove that the 20c and 50c coins contain iron. Symbols of the elements: aluminium $\text{Al}$, bronze is made of copper $\text{Cu}$ and tin $\text{Sn}$, nickel $\text{Ni}$. Steel is mainly iron $\text{Fe}$.</td>
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<tr>
<td>• comparing different outcomes</td>
<td>• <strong>Investigate pumice</strong>: <strong>Observe</strong> its lightness due to the holes which were originally gas-filled when the volcano erupted the pumice out. The holes are now largely filled with air which contains 20% oxygen. Float the pumice on water. Crush some to a powder and slice some with a hacksaw. <strong>Feel and describe</strong> the grit which is quite abrasive due to the silicon. Symbols of elements: pumice is mainly silicon dioxide ($\text{SiO}_2$), silicon $\text{Si}$, oxygen $\text{O}$.</td>
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<tr>
<td>• using fair tests.</td>
<td>• <strong>Charcoal versus graphite in pencils</strong>: <strong>Draw</strong> using both. Investigate strength, colour, different grades (HH, HB, 3B), messiness. Carbon and graphite are made from carbon $\text{C}$. So is diamond!</td>
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<tr>
<td>Using evidence</td>
<td>• <strong>Grow salt crystals</strong>: Dissolve table salt in hot water, adding more and more till no more dissolves. Pour the solution into a large tray or plate and sit it in a cool inside location. <strong>Observe</strong> the crystals forming as the water evaporates over the next few days. The table salt is sodium chloride, ($\text{NaCl}$) made from the elements sodium $\text{Na}$ and chlorine $\text{Cl}$.</td>
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<tr>
<td>• using observations to infer something about a substance’s properties</td>
<td>• <strong>Separate ironsand from ordinary sand</strong>: Put a mix of ironsand and any other beach sand into a sealed bottle. Rub a magnet along the bottle to separate the two types of sands. Ironsand is mainly magnetite ($\text{Fe}_3\text{O}_4$), made of iron $\text{Fe}$ and oxygen $\text{O}$.</td>
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<tr>
<td>• using evidence to support claims about the usefulness of a substance for a given purpose</td>
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<tr>
<td>• using evidence about properties of a substance in order to support an idea.</td>
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<td>Critiquing</td>
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<tr>
<td>• setting up fair tests and critically appraising them</td>
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<tr>
<td>• appreciating that cause and effect are sometimes difficult to separate.</td>
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<td>Interpreting representations</td>
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<tr>
<td>• creating data tables</td>
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<tr>
<td>• using chemical symbols</td>
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<td>• displaying and summarising data</td>
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<tr>
<td>• describing observations</td>
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<td>• explaining findings.</td>
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<tr>
<td>Engaging in science</td>
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<td>• hands-on doing; fascination</td>
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<tr>
<td>• understanding the applications that materials can be put to</td>
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<tr>
<td>• understanding the importance materials in our everyday lives.</td>
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<tr>
<td>Specific Learning Intentions</td>
<td>Learning Activities through 5Es model</td>
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<tr>
<td><strong>Content</strong> Helium balloons: Helium is lighter (less dense) than air.</td>
<td>• Discuss fluoride in toothpaste: Fluoride is often put into town water supplies too and helps to prevent tooth decay. The element fluoride's symbol is F.</td>
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<tr>
<td>Plaster of Paris moulds: A powder can be changed into a solid by mixing it with water.</td>
<td>• Perform iodine starch tests: Use a dropper to place drops of iodine onto different types of foods, e.g. bread, banana, butter. If the foods turn dark blue-black, then starch is present. Obtain iodine as ‘tincture of iodine’ from a pharmacy. Care: It stains and is mildly toxic. Wash hands after use. Symbol for the element iodine I.</td>
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<tr>
<td>Magnets: Only certain types of metals are attracted to magnets. Coins: Coins are made of metals that don’t corrode and are fairly light in the pocket.</td>
<td>• Gases in the air: What gases are present? Research the percentages of each and what they can be used for.</td>
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<tr>
<td>Investigate pumice: This volcanic rock is very light (has low density) because when it formed into a solid it was full of gas bubbles.</td>
<td>• Potato chips: Why do the bags seem to be full of ‘air’. They are not! They are filled with nitrogen to stop the food from going stale. Air contains oxygen and this would cause the food to start oxidising, changing its flavour and reducing the food value. They also put plenty of nitrogen in to prevent the chips from crushing.</td>
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<tr>
<td>Charcoal versus graphite in pencils: Are both made from pure carbon, but they don’t look or behave the same.</td>
<td>• Magnet strength: Compare strengths of magnets made from these three materials: iron (Fe), ferrite (made from Fe Ba and Si) and neodymium (made from Nd, Fe and B).</td>
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<td>Grow salt crystals: Crystals form under certain conditions and are a useful form to store substances in. Separate iron sand from ordinary sand: Some sands are magnetic because they contain iron.</td>
<td>• Make a display of chemical substances: Examples: neon tube (has neon gas inside it), aluminium can (made of Al), tin can (ordinary baked bean can has a tin coating that doesn’t rust), lead fishing weight (Sn), chalk (made of calcium carbonate, CaCO₃), light bulb (the filament is tungsten W), chalk (made of calcium carbonate, CaCO₃, contains calcium C, carbon C and oxygen O), teeth also contain calcium carbonate, tincture of iodine (contains iodine I), neodymium magnet (the super powerful ones, made from Nd, Fe and B), nickel–cadmium batteries (called NiCad for short, contain nickel Ni and cadmium Cd), plus other substances listed in previous activities.</td>
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<tr>
<td>Fluoride in toothpaste: Fluoride in small quantities helps stop tooth decay. Perform iodine starch tests: Iodine can be used to detect starch in foods. Gases in the air: Air is made of many different gases that have different uses. Potato chips: Nitrogen benefits storage. Magnet strength: Strength of a magnet is determined by what it is made of. Make a display of chemical substances: We use a huge variety of chemicals.</td>
<td>EXPLAIN AND ELABORATE Each of the above activities offers opportunities for children to seek explanations and clarify their thinking. Any one of them could be used to make teaching points (see Key Concepts on page 15 for guidance). Students should be encouraged to ask their own questions relating to activities of their choice, then investigate to find answers. They could be encouraged to find new and suitable ways of communicating their findings. In addition, the following more in-depth investigations and challenges will assist greater understanding: Uses for chemical properties Use vinegar (a mild acid) to dissolve stuff. [Dissolving eggshell Investigation sheet p19] Burning needs oxygen. [Snuff that flame Challenge sheet p20] Resisting corrosion. [Rust Lab Investigation sheet p21] Uses for physical properties Conditions that create crystals [Salt crystals Investigation sheet p22] Heavy and light substances have different uses [How dense is that substance? Challenge sheet p23]</td>
<td></td>
</tr>
<tr>
<td>Other Activities and Challenges pp 19–23 list their own Specific Learning Intentions. [Theory notes titled ‘Useful chemicals’, see over page.]</td>
<td>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.</td>
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<tr>
<td>Vocabulary: NoS: see keyword list on p24.</td>
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<tr>
<td>Content: alloy, abrasive, balloon, charcoal, chemical, compound, crystal, dissolve, element, inflate, iron sand, magnetic, mould, oxidise, physical, plaster, property, pumice, reaction, symbol, weight [also, any of the names of elements, compounds and chemicals used in these two pages].</td>
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</tbody>
</table>

Integration

It is recommended that you integrate your science with other learning areas. Use science activities, investigations and challenges to engage students and where relevant, build links to English, the arts, health and physical education, languages, mathematics and statistics, social sciences and technology.
Useful chemicals

Chemicals have many different uses because all chemicals have different properties.

Properties
Chemicals look and behave in different ways, called properties. It is the properties of chemicals that allow us to use them in different ways, e.g. steel is very hard and strong so we use it in railway lines; pumice is very light weight, so it can be used in light weight concrete; vinegar is acidic so we can use it to preserve beetroot.

Physical properties
These are changes that can be reversed, e.g. ice melts to water, but water can be cooled to make it back into ice.

Chemical properties
These are changes that can’t be reversed, e.g. if steel rusts it is a chemical change; it cannot be turned back into steel again.

Elements
There are thousands of different chemicals. Elements are pure chemicals, so they are made up of one substance only.

- they are arranged on the Periodic Table which shows groups that share common properties, see below
- there are over 100 elements
- some are light, e.g. helium, others are heavy, e.g. lead

Task: Students find out about 5 different elements and their uses and make a pictorial summary table in their books.

Compounds
Elements join together to form compounds:

- there are thousands of compounds
- they are common in nature, e.g. in rocks
- examples: table salt (symbol: NaCl) is made of the elements sodium (Na) and chlorine (Cl); chalk or calcium carbonate (CaCO₃) is made of the elements calcium (Ca), carbon (C) and oxygen (O).

Task: Students find out about 5 different compounds and their uses and make a pictorial summary table in their books.

Download this image from: http://elements.wlonk.com/Elements_Pics_11x8.5.pdf
Useful chemicals

INVESTIGATION

Dissolving eggshell

Learning intentions
Science Capabilities: Observations and inferences. Engaging with science.
Material World: The reaction between an acid and calcium carbonate.

What to do

This investigates a reaction between vinegar and an eggshell.

1. Half fill the jar with vinegar.
2. Look at and feel the eggshell. Record your observations.
3. Place the egg in the vinegar, making sure it is fully covered. Do you see anything happening straight away?
4. Leave overnight.
5. The next day gently touch the egg. Describe how it feels.
6. Leave it in the vinegar till you are sure that it is ready for a ‘bounce test’.
7. Drop the egg from a few centimetres onto a bench. Does it bounce? Describe what it feels like and how it behaves.
8. What kind of acid in vinegar ‘eats’ away at the shell?

Going further

9. Here are some other questions you could investigate:
   • How high will my rubbery egg bounce from before it breaks?
   • What happens if I repeat the experiment, but only half cover the egg?
   • Does an eggshell dissolve quicker or slower in malt vinegar?
   • Will other substances like milk dissolve an eggshell?
   • Will vinegar clean seashells? What happens if it is left too long?
   • Can vinegar be used to clean windows? Find a recipe and try it out.
   • What other acids do we commonly use in the kitchen? What for?
   • Ask your own question(s) and investigate them.
Snuff that flame!

Learning intentions Science Capabilities: Observations, measurements, laws, fair tests. 
Material World: Oxygen, carbon dioxide, burning.

What you will need: 
(per group) 
⭐ A candle on a tray. 
⭐ Matches. 
⭐ Glass jars of different sizes. 
⭐ Measuring jug. 
⭐ Lilo pump (optional).

Challenge 1

Starve the flame 
What happens when you put a jar over the flame? Why?

Try it again, but first you need to refresh the air inside the jar. How will you do that? Make sure you do this between each experiment.

Challenge 2

Different jar sizes 
Predict: Will the flame take a longer time to go out using a bigger jar? 
Do some experiments. 
Why does this happen?

Challenge 3

Make up some ‘laws’ 
In science, laws tell us what always happens when we do something, e.g. a law of gravity is ‘When we drop something, it always falls downwards’. 
Can you make up laws about the time it takes a flame to go out with different sizes of jars? You need to experiment to find evidence to support your laws. Here are some starters:

• The bigger the jar the longer it takes for . My evidence is . 
• Doubling the volume of the jar . My evidence is .

Uses 
How can oxygen be useful in some cases and a nuisance in others?

Key ‘Building Science Concepts’ reference: Book 64 Candles: Investigating Combustion L3-4
Useful chemicals

INVESTIGATION

Rusting

Learning intentions
Science Capabilities: Observations, fair tests, using evidence.
Material World: Rusting, oxidation of metals, galvanising.

What you will need:
(per group)
- Table salt and water.
- White vinegar.
- Sandpaper.
- Steel nails about 5 cm long, some coated with zinc (galvanised).
- Containers, e.g. shot glasses.
- Sandpaper.

What to do

Setting the scene
Sometimes it’s a nuisance when steel becomes rusty. It doesn’t look very good and the steel may become weaker and unsafe, e.g. in a bridge. So stopping the rusting process can be important. This experiment looks at what might cause rusting and how to stop it happening. Before you start, explore some rusty pieces of steel.

The set-up
1. Set up the following.

2. Leave for a few days, recording your observations each day.
3. Record if any of the nails rusted and explain why this happened. Was this a fair test? Explain why or why not.

Try other things
4. Set up other fair tests to investigate:
   a) Do other items rust in the salty solution, e.g. a copper nail, a paperclip, steel wool or a piece of tin can?
   b) If you remove some of the surface off a zinc nail or piece of tin can by rubbing with sandpaper, will that area rust?
   c) Does white vinegar cause rusting?

Questions
5. What sorts of substances seem to stop rust?
6. What other ways can we stop rust from forming on steel?
7. Sometimes artists like to build things out of steel and make them rust because they like the look. What would you suggest they do to speed up the rusting of their artwork?


Teacher: Engagement activity ideas
Demonstrate some fresh clean steel and contrast it with some rusted steel (like what you sometimes find on a beach). What caused the rusting? How could we stop this from happening?

A rusty fitting on a fence post.
Salt crystals

Learning intentions
Science Capabilities: Close observations, fair tests, using evidence.
Material World: Crystals and crystal formation, evaporation.

What to do

Setting the scene
Table salt and rock salt are made of the same substance, sodium chloride, but they look different. How could this be so and why might you want this?
Observe the samples of table salt and rock salt and record your findings. How are they similar and how are they different? Remember to use all your senses. The magnifying glass will be helpful.

What is the quickest way of making some crystals?

The set-up
1. Measure 200 mL of hot water and dissolve salt in it, one spoonful at a time stirring as you go. Once fully dissolved, add more salt and stir, till you can’t dissolve any more. You have now got a saturated solution.
2. Pour the same amount of salty solution into two clean trays.
3. Place one tray in a shady cool area of the classroom and the other in a hot sunny area. Label and make sure they aren’t disturbed.
4. Each day closely look at and record where crystals are forming the quickest. Are there any differences in the crystal sizes?

Questions
5. Was your experiment a fair test? Why or why not?
6. What conditions led to the fastest crystal formation?
7. How else could you speed up crystal formation?

Going further
8. How might you grow a big salt crystal? Hint: Research into hanging a crystal from a piece of cotton in a salt solution. Try it out.
9. Try similar methods with copper sulphate. Ask your own questions and investigate possible answers.
How dense is that substance?

Learning intentions  Science Capabilities: Measurements using instruments.
Material World: Density of materials.

What you will need:
- Scales that measure accurately to 1 g or better still, 0.1 g.
- Mineral and rock samples.
- Samples of metals, e.g. steel, copper, lead.
- Container of water large enough to hold any of the above samples.
- Thin string.

Challenge 1

The basic method
1. Weigh a chunk of lead (e.g. a lead fishing sinker). Record in grams.
2. Place a container of water on the scales. Zero the scales using the Tare button.
3. Tie the lead to a length of string. Dangle it in the water, making sure it is covered by the water and is not touching the sides or bottom. Again record the weight in grams.
4. Work out its density by dividing the first value by the second.

Density = \frac{\text{weight (g)}}{\text{weight in water (g)}}

You should find the density of lead is 11.3.

Challenge 2

Density check
Use the same method to test the densities of minerals and metals that you already know the name of.
Look up their correct densities online to see if your measurements and calculations were right.

Challenge 3

Unknown metals, minerals and rocks
Work out the density of a mineral or metal. If it is a metal, look up the internet to find densities of metals and compare your value with those. If you get a close match, it will be that metal.
Repeat for minerals or rocks.
Here are some things your teacher might supply for testing: copper, lead, steel, aluminium, quartz, greywacke, granite, limestone and schist.

Why is this important?
Why do we use lead for fishing sinkers?
Why do we use wood for rafts?
Is density a physical or a chemical property?

Setting the scene
The density of a material is how tightly packed it is. The more dense something is, the more it weighs for its size. A chunk of lead for example is very dense. If you had the same sized chunk of aluminium it would weigh less, so it’s therefore less dense.

Jewellers use density to check if something is pure gold or if it is just gold-plated. They can also use it to identify gemstones.

Geologists also use density. You are going to use a simple technique to find the density of some minerals and metals to help identify them.

The density of gold and gemstones can be used to make sure they are truly valuable items, not imitations.

Credits: Gold rings, Kai Stachowiak. Gemstone, Diggerglass.

Key School Journal Reference: A Sinking Feeling BENN, Ken Story 7 CN L4 2015.
Useful chemicals

Pre- and post-unit assessment

One way of pre- and post-testing the knowledge of students on this Nature of Science (and specifically Science Capabilities) based unit of work Useful Chemicals, is to use ‘mind mapping’. 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.

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.

<table>
<thead>
<tr>
<th>Keyword list</th>
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<tbody>
<tr>
<td>Aim</td>
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<td>Bias</td>
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<td>Certainty</td>
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<td>Checking</td>
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<td>Classifying</td>
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<td>Communication</td>
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<td>Comparing</td>
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<td>Conclusion</td>
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<td>Creativity</td>
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<td>Critiquing evidence</td>
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<td>Data</td>
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<tr>
<td>Discussion</td>
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<tr>
<td>Drawing</td>
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<tr>
<td>Engaging with science</td>
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<tr>
<td>Error (identifying errors)</td>
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<tr>
<td>Evidence</td>
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<tr>
<td>Experiment</td>
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<tr>
<td>Explanation</td>
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<td>Exploration</td>
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<td>Fact</td>
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<td>Fair testing</td>
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<td>Gathering data</td>
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<td>Graphing</td>
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<td>Grouping</td>
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<td>Honesty</td>
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<td>Hypothesis</td>
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<td>Identifying</td>
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<td>Inference</td>
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<td>Inquiry</td>
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<td>Instruments (including named ones)</td>
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<td>Interpreting data</td>
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<td>Interpreting representations</td>
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<td>Investigation</td>
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<td>Observation</td>
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<td>Prediction</td>
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<td>Question (good questions)</td>
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<td>Record</td>
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<td>Repeating (replications)</td>
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<td>Result</td>
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<td>Scientist</td>
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<td>Sharing (ideas)</td>
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<td>Symbol</td>
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<td>Systematic</td>
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<td>Tentative</td>
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<td>Terms</td>
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<td>Theory</td>
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<td>Trial</td>
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<td>Unit (and units like kg, length, etc.)</td>
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<tr>
<td>Using evidence</td>
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<td>Working together</td>
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</table>

Plus extra words at teacher’s discretion.
Mind map on ‘Useful chemicals’

Name ______________________ Date ______
Year level ______  School ______________________

Science is about
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.)
- Our Presenters 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 Principles, 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 book.

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

Values
The Science Roadshow embodies:
Excellence: through perseverance to find answers 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 thematice(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 participate in shows
Participating and contributing: students participate and contribute to shows, and interact enthusiastically with exhibits.
Teacher's guide

DURING YOUR VISIT

Hints for teachers and helpers — during the visit and at home

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 nonscientist 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 that 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.

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Exhibits

Themes

Comparisons — Ngā whakataaurenga

Exhibits in this theme address specific learning intentions relating to the following: simple comparisons between two observations; comparing prior knowledge with observations; using senses to assist comparisons; combining comparisons with reasoning to make deductions. Exhibits include:

- Big Ear
- Discovery Box
- Footprints
- Microwaves
- Radio Astronomy
- Test Tube Electrocope
- Whisper Dishes

Conductors and Insulators
- Braille
- Eggs
- Forensic Science
- Odours
- Rocks
- Vanishing Leprechauns
- Vein Viewer

Exhibits in this theme address specific learning intentions relating to the following:

- Air Cannon
- Catenary Arch
- Feathers and Lead
- Magnetic Detection

- Arch Bridge
- Clock and Gears
- Human Gyro
- Rise and Fall

- Bed of Nails
- Clutch
- Hydraulic v’s Pneumatic
- Road Friction

Exhibits in this theme address specific learning intentions relating to the following:

- Air Pressure
- Gravity and reaction forces
- Concentrating forces
- Friction
- Weight

- Concentration of Metals
- Condensation
- States of matters

- Clocks
- Gears
- Motion

- Condenser
- Electroscope
- Est Tube

- Condensation
- Electrostatics

- Condensor
- Electroscope
- Est Tube


Forces — Ngā tōpana

Exhibits in this theme address specific learning intentions relating to the following:

- Air Pressure
- Gravity and reaction forces
- Concentrating forces
- Friction
- Weight

- Concentration of Metals
- Condensation
- States of matters

- Clocks
- Gears
- Motion

- Condenser
- Electroscope
- Est Tube

- Condensation
- Electrostatics

- Condensor
- Electroscope
- Est Tube


Materials — Ngā matū

Exhibits in this theme address specific learning intentions relating to the following:

- Permeability
- Elasticity
- Surface tension
- Moulding of metals
- Condensation
- States of matters

- Plastic and rubber
- Rubber

- Condenser
- Electrostatics

- Condensor
- Electroscope
- Est Tube

- Condensation
- Electrostatics

- Condensor
- Electroscope
- Est Tube


The power of rubbish QUINN, Pat Article Connected 3 1998. These boots are made for walkin’ GIBBISON, Sue Article 5 01 2000.

How to make a macaroni TAPP, Mike Article 3 Junior Journal 40 2010.

Magic in the Wind WALL, Bromwen Article 5 Connected 3 2012.

Manu mujukuta KAWANA, Manu Article Connected 2 2002.

Keeping houses warm or cool DERRICK, Katharine Article 3 Connected 01 2010.


Plastic products POTTER, Kate Article 7 Connected 04 2013.


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.

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.

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Curiosity probe
At the end of their first show, our Presenters will introduce an experimental scenario that will probe into student understanding of a science idea. The necessary equipment will be displayed on the front bench for students to think about and respond to with their predictions. The correct outcome (discussed below) will not be displayed, but students can go onto the Roadshow website to see cumulative student responses. Students and teachers are encouraged to discuss and/or perform the investigation back in class.

Back in class
Repeat the setup in class and run the experiment in order to discover the outcome. This should lead to discussion about relevant key concepts and further questions could lead to student lead investigations. Probes like this can be used as a diagnostic or formative assessment tool.

Setup
You will need four iron nails. (NB. Use steel nails, which are largely made of iron. The nails should not be galvanised). Accurately weigh them to find their total mass. Place them in a moist, open dish exposed to the air for several weeks till they become rusty. Then, let them dry completely, and again record their total mass. Be careful not to let any rust fall off the nails as you handle them, but if any bits do fall off, weigh them with the nails.

Question. What do you predict will happen to the mass of the nails?
1. The mass of the dry, rusted nails will be more than the mass of the dry nails before they rusted.
2. The mass of the dry, rusted nails will be less than the mass of the dry nails before they rusted.
3. The mass of the dry, rusted nails will be the same as the mass of the dry nails before they rusted.

Ask the students to explain their thinking.

Outcome
The correct answer is 1, the mass of the rusted nails will be more than before they rusted. This is because a chemical reaction has taken place in which oxygen from the air combines with iron to form iron oxide (rust). So, the oxygen adds to the overall mass of the nails. Students often think that the mass will be less, because rusting appears to be a ‘decaying’ process in which the steel (iron) disappears. But, in fact, none of the iron is lost. Rather it is chemically changed to rust by the addition of oxygen (which is where the extra mass comes from).

For more detail, download the Rusty Nails Problem from the Classroom Resources page on our website.

Models — He tauira
Exhibits in this theme address specific learning intentions relating to the following: cut-away motors; small scale models; modelling electronic decision making; modelling large scale robotics, the tides, solar water heaters, dairying systems, the seasons, the human torso, floating and sinking of model boats. Exhibits include:

- AC/DC Generator
- Control Systems
- How Old?
- The Dairy Cycle
- Unsinking Boats
- Baffle Tank
- Dobot
- Oil Formation
- The Seasons
- Binary Numbers
- Ebb and Flow
- Solar Water Heater
- Torso

Observations using measurements — Te mātakitaki mā te ine
Exhibits in this theme address specific learning intentions relating to the following: counting calories; measuring steel and wood flexibility, energy, hearing range, electrical resistance, strength of fibres, sugar levels in drinks, temperature and distance; estimating; electronic counting; and, triangulation. Exhibits include:

- Balancing Joule Intake
- Earthquake Epicentres
- Estimating Sizes
- Strength of Wool Fibres
- Walking Measure
- Bendy Beams
- Energy Value in Fuels
- Hearing Range
- Sugar in Drinks
- Counter
- Estimating Amounts
- Resistance Wire
- Thermometers

Patterns, grouping, classification — He tauira, he whakarōpu, he kōmakatanga
Exhibits in this theme address specific learning intentions relating to the following: problem solving; patterns and trends in physical phenomena and in properties of materials; grouping and classification of things by their characteristics. Exhibits include:

- Box Puzzle
- Creativity Dice
- Digital Periodic Table
- Luminescent Wall
- Polaris Light
- Tangram
- Chimes
- Cutting the Pie
- Face Turner
- Manuka Honey
- Rope Puzzle
- Unique You
- Coloured Diet
- Digit Creator
- Listening Tubes
- Mineral Transparency
- String Ray

Contexts — Nature of Science / Science Capabilities

While being exciting and entertaining, our shows provide a great opportunity to enhance student knowledge in two science areas each year. The shows for 2019 are On the Move, all about movement and forces, and the Elemental Chemistry show, focusing on the building blocks of matter and chemical reactions.

To assist you in preparing for your visit, we’ve developed a unit plan called Useful Chemicals – found in this book – that complements the Elemental Chemistry show and the exhibit thematic Materials. Also, units from past Resource Books that relate to this show include: Spectacular Changes (2018), Mighty Materials (2016) and Kitchen Chemistry (2008).

If time permits within your classroom programme, you may like to use notes from the On the Move show outlined below to develop your own pre- and post-visit unit to complement that show. Also, see the unit Motion in the 2010 Resource Book.

On the Move – Ngā nekeneke
This show covers specific learning outcomes relating to forces and how they affect movement, including:

• inertia and how objects remain in their state of motion unless a force acts on them
• downward force due to gravity and how air friction slows things down
• forces and how they cause acceleration
• unexpected behaviour due to the Lenz effect
• circular movement and the forces that affect spinning objects
• rockets and the unbalanced forces acting on them.

Elemental Chemistry – Te mātai matū pūmotu
This demonstration covers specific learning outcomes relating to the building blocks of chemistry, including:

• models of atoms and molecules
• elements are pure substances
• the Periodic Table
• elements combine and separate during chemical reactions
• reactions, including combustion
• chemical and physical properties.

General Learning Outcomes relating to Shows
After attending the shows students will have increased:

• interest, enthusiasm, understanding and knowledge of scientific and technological principles and processes
• understanding of the Nature of Science and Science Capabilities.

Key School Journal References:

Key ‘Building Science Concepts’ references:

Key School Journal References:
Grow your own crystals SOUTHGATE, Brent; Article 5 1982 Pt 01 No. 4 Pgs 28-29.
Hokey-pokey YOCUM, Eva; Article 1998 Pt CN No. 3 Pg 28.
Tricky science ANDERSON, K. E.; Article 5 1997 Pt 01 No. 3 Pgs 18-20.
Windows made of water SOUTHGATE, Brent; Article 4 1982 Pt 01 No. 2 Pgs 24-25.

Key ‘Building Science Concepts’ references:
- Book 23 Fresh food: How food keeps and loses its freshness.
- Book 24 Preserving food: Processes in food storage.
- Book 56 Bread: The chemistry of breadmaking.
- Book 57 Eggs: Mixing, beating, crushing and heating.
- Book 58 Ice: Melting and freezing.
**Detection and measurement** page 3

**COMPARISONS.**

**Strongest bite** page 4

Order from weakest bite at the bottom of the gradient: human, dog (Rottweiler), Tasmanian devil, tiger, wolf, great white shark, saltwater crocodile, Tyrannosaurus rex, Deinonychus crocodile (extinct). Answer: CARNIVORES.

**Mineral hardness** page 5

Key: ayaleuooi. Final answer: Mohs scale of mineral hardness.

**Models** page 6

Note, spaces between words are removed in the answers.

**Water cycle**

**Computer simulation**

**Dinosaur family tree**

**How big?** page 7

Wasp (head, thorax abdomen) 15 mm, 1.5 cm; worm 64 mm, 6.4 cm; inside diameter of eyeball 19 mm, 1.9 cm; shark tooth width 32 mm, 3.2 cm, length 45 mm, 4.5 cm; thumbnail thickness 0.5 mm, 0.05 cm (approx.); width of handspan (answers will vary); height of feet off the ground (answers will vary).

**Dinosaur footprint** page 8

Birds.

Yes, dinosaurs survive today as birds. Tyrannosaurus, Archaeopteryx, sparrow. Given both living birds and Archaeopteryx are feathered, Tyrannosaurus probably had feathers too.

**Answers to pages 3–14**

**Heart beat detection** page 9

6. Your pulse is caused by blood as it surges through your arteries, causing the vessel to expand momentarily. 7. More oxygen and food need to be taken around the body and more carbon dioxide and other wastes need to be removed from cells, so the heart needs to pump more blood to achieve this. 8. Other places include neck, temple and several more. (Perform a Google images search ‘Where on your body can you feel a pulse?’ to see diagrams showing the exact locations.)

**Sharing the load** page 10

Challenge 1: Your measured weight becomes greater as you move up the lever towards the scales. Challenge 2: Over half way along the board. At the end furthest from the scales. Challenge 3:

A force is simply a push or a pull, but weight is a push or a pull due to gravity. Therefore we weigh differently in Earth's gravity compared with another planet's gravity. For example, we would weigh a lot more in the strong gravity of Jupiter than we would on Earth.

**Mineral and rock collection** page 11

A rock collection that is sensibly organised and well labelled is a good outcome. Attempts at naming the minerals and rocks are a bonus.

**Shoe print mould CSI** page 12

Attempts at naming the minerals and rocks are a bonus.

**Dinosaur footprint** page 13

For realism, left and right footprints in a path of prints need to be mirror images of each other. To create the opposite foot, flip the 'template' foot over before tracing it.'

**Rock and mineral hardness** page 14

1) The harder material always makes a scratch on the softer material. 2) Softness or hardness tests can help us to know if something is going to wear out quickly, or be tough and last a long time, e.g. for paving stones or kitchen benches. It also helps us to identify the rock or mineral we are looking at. For example, greenstone is very hard, but sometimes people try to sell a much softer green-coloured stone called serpentine as greenstone. A scratch test soon reveals the cheat! Knowing the exact hardness value on Mohs scale helps us identify minerals, as tables exist that tell us how hard each of the known minerals is (google the terms ‘Mohs scale’).
You don’t need to teach a child curiosity. Curiosity is innate. You just have to be careful not to squash it. This is the challenge for the teacher — to foster and guide that curiosity.”

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.