2013 Fonterra Science Roadshow

RESOURCE BOOK
Teacher’s guide

Introduction

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

CONTENTS

Numeracy and literacy
Many numeracy and literacy opportunities exist within the Fonterra Science Roadshow programme, both during the visit experience and within this Resource Book. In particular, shows, science experiments and activities, 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.

Nature of Science
We have incorporated many implicit and explicate Nature of Science strand components both within our 80 minute Fonterra Science Roadshow visit experience (exhibits and shows) and within this Resource Book.

A big thank you to our sponsor Fonterra
Fonterra’s support enables us to sustain and extend the programme’s reach to over 47,000 students a year and to bring new and exciting experiences. The Fonterra Science Roadshow is a good fit for Fonterra, reflecting their passion for science, technology and innovation. Fonterra invests around $100 million in R&D every year and mentors more university students into their labs than anyone else.

Resource Book prepared by Peter E. Smith
(Education Manager, National Science-Technology Roadshow Trust)

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Electricity and Magnetism

SCIENCE VOCABULARY PUZZLE

Secrets of electricity and magnetism

Can you decode this 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.

Alphabet box

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Secret message:

Electricity and magnetism are related because when ....

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Now, unscramble this list of secret words about electricity and magnetism: babilizabobabipni, babopipinalilo, nobepina, labopela.

Finally, use the alphabet box to make secret codes for these words about electricity and magnetism: switch, fuse, battery, lamp, meter, power.

Did you know:
Fonterra’s research and development (R&D) headquarters is the Fonterra Research Centre, which has operated continuously in Palmerston North for over 85 years.
SCIENCE VOCABULARY PUZZLE

Fitness wins!

Find your way to the centre of the maze by filling in the answers to the clues. Every answer uses the last letter of the previous word as its first letter, so the words form a chain. The circled letters are the start and finish letters of words. Once complete, the numbered squares are clues for spelling out two mystery words that describe what you gain when you become physically fit. One letter clue is given.

Clues
- We breathe this in.
- These pass messages to our brain.
- Muscle builders train to build ________.
- Pumps blood around our body.
- With exercise we build muscle t....n....g.
- Where we might go to exercise.
- When a person has large muscles they are said to be m........r.
- Breathing in and out.
- A popular winter sport played mainly by females.
- Used to collect oxygen from the air.
- In athletics, a very faster runner.
- A popular winter sport played mainly by males.
- An activity that improves flexibility, breath control and posture.
- These carry blood away from the heart.
- Sprinters need this. The same as velocity.
- A race involving two events, such as running and cycling.
- A person skilled in ninjutsu.
- The sport of competing in track and field events.

Mystery words:
When you become fit, you gain...

Did you know:
Fonterra’s Edendale milk drier ED4 in the South Island produces a tonne of whole milk powder every two minutes.
Use the clues to complete the crossword on feeding levels (trophic levels).

Across
1. Grows on stale bread.
6. Comical bird that feeds on plants, insects and frogs in swampy areas of NZ.
8. This tree grows from an acorn.
11. A top New Zealand bird predator.
14. This bird snatches fish with its long sharp beak.
15. One of the staple foods of humans. Used to make flour.
16. The main food of our pasture animals.

Down
2. These suck the blood of cattle.
3. A top predator of the seas.
4. The top omnivore
5. These ‘lice’ feed on rotting wood.
7. An extinct New Zealand native herbivore.
10. These suck the blood of dogs and cats.
11. Decomposers that cause wood to rot.
12. A farmland herbivore.
13. This omnivore pest feeds on insects, small reptiles, seeds and plants.

Now, list your answers under the correct headings below:

<table>
<thead>
<tr>
<th>Parasites</th>
<th>Omnivores</th>
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<tbody>
<tr>
<td>Carnivores</td>
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<td>Herbivores</td>
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<tr>
<td>Producers/Plants</td>
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<tr>
<td>Scavengers/decomposers</td>
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</table>
SCIENCE VOCABULARY PUZZLE

Materials puzzle

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 materials.

Word list
mixture, metallic, dissolving, matter, elements, liquid, states, properties, solid, air, compounds, atoms, volume, products, gas, melting, reaction, metal, density, thaw, ice, water, particles.

Statements about materials

1. Everything around us is made of ______________.

2. The least dense state of matter is a ______________.

Did you know:
Fonterra is committed to both energy efficiency and water efficiency. Fonterra’s Dennington Site in Australia has implemented a closed loop cooling water system for its refrigeration compressors. The upgrade saves as much as 240 megalitres of bore water a year, which is equivalent to 96 Olympic size swimming pools.
Fill in the missing letters in the words about movement. Use the code numbers from these letters to solve the mystery paragraph at the bottom of the page and find out something important about movement. Some of the mystery letters are given and the first word has been done for you.

1. Velocity is another name for speed.
2. Getting faster is called
3. Another word for movement is
4. A steady speed is the same as a speed.
5. A car that has balanced forces on it.
6. ‘How far’ is the same thing as
7. Another name for a push or a pull is a force.
8. Complete the saying: ‘Faster than a speeding
9. Something that is stopped is
10. Something that is not constant is

Mystery paragraph

Did you know:
Bones need a balance of nutrition and exercise. In people over 50, osteoporosis affects one in 3 women and one in 5 men.
Energy connections

Using a 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 space below to find the answer. Number 6 is done for you and the first letter is given.

The best forms of energy for the world to use for our future are ......

Your answer:

1. solar energy is from the ......
2. hot air rising
3. create electricity from the sun’s energy
4. energy from the wind
5. solar cooking
6. hydroelectric
7. hydro lake near Mt Cook
8. use electricity and petrol

What is the opposite of the above answer?
Learning intentions  Electricity and Magnetism: Can you use a simple electrical circuit to solve a maze?  Nature of Science: Observations, systematic investigations, fair tests, measuring.

Challenge 1

The best conductor
Can you find a way to show which pencil’s graphite line is the best conductor? You could try HB, 2B, 4B and 6B grades (or whatever you have available).

The best line width for conduction
Experiment to find the best line width to create the loudest sound from the buzzer.

Challenge 2

Create and solve a maze
Using the pencil grade and line width that create the loudest buzzer sound, create a ‘pencil line maze’ similar to this one.

Can the buzzer circuit be used to solve the maze? How? (Note, the lines are the maze, not the ‘paths’)

Challenge 3

Can you create a theremin?
Can you use your basic ‘pencil line circuit’ to create a theremin — a simple musical instrument. (You may need to find out what these are first.)

Can you control other devices?
Find ways to use your pencil line to control other devices, e.g. making an LED brighter or dimmer or a small motor run faster or slower.
**Finger muscles**

**Learning intentions**
- **Human body**: Find out what muscles open and close your hand.
- **Nature of Science**: Observations, investigations, comparisons.

**What you will need:**
(per group)
- A timing device such as a watch or cell phone.

**Setting the scene**
Two important sets of muscles that help our hands open and close are not actually found in our hands.

In this investigation you will use different ways of finding where these muscles are found and how they work.

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**Challenge 1**

**Working your hand hard**
Open and close your hands as fast as you can. Repeat this for a minute. What part or parts of your hand or arm are the most tired? Mark the areas on these outlines.

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**Challenge 2**

**Careful observations**
Can you find a way of locating the exact muscle that (1) bends and (2) straightens each of your fingers? Describe what you did and what you found.

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**Challenge 3**

**Are all your fingers ‘independent’?**
Find a way to show if all your fingers work fully independently of each other.

**Extensions**
(1) Are grasping muscles weaker or stronger than the muscles that open your hand? Investigate.
(2) Conduct other investigations into how the hand works. Start each investigation with a good question.

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Key School Journal References:
- Goosebumps and butterflies Article 4 2010 Pt 01 No. 4 10-16 SILK-MARTELLI, Denise: Mighty muscles Article 5 2011 Pt 01 No. 2 26-31 GIBBISON, Sue.
Life and environment

**PRACTICAL ACTIVITY**

Making fossils

**Learning intentions**

*Living World:* Investigate how fossils are created.

*Nature of Science:* observations, inferences, model building.

**What to do**

1. Roll some Play-Doh so it is flat and about 1 cm thick.
2. Press a shell into the Play-Doh to make an impression.
3. Gently pull the shell out so you don’t alter the detail of the impression. Experiment with ways to make the most detailed and complete impression (see the ‘What you will need’ list to the left for clues).
4. Squeeze white school glue into one of the best impressions, filling it up.
5. Try different ways of colouring the glue to create a more realistically-coloured fossil and pour your coloured glue into other impressions you have made.
6. Find ways of removing any bubbles in the glue.
7. Allow the glue to dry overnight, then gently pull the ‘glue fossil’ from the Play-Doh mould. Clean in water.
8. Use acrylic paints to shade and add detail to your fossil.

**Questions**

1. In real life, what does the process of pressing the shell into the Play-Doh represent?
2. How did you produce the best quality impression?
3. How did you colour your fossil?
4. During this activity, you have actually created two types of fossils. What are they? In real life what would the Play-Doh represent and how would the real fossils have been formed?
5. Are the colours of fossils the same as the original animals or plants they were formed from? Explain?

**Extension**

Find out about and trial other ways of casting fossils in moulds to produce more realistic fossil ‘models’.

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

- Play-Doh.
- Rolling pin or similar.
- Assorted seashells. Especially suitable are pipi and cockle shells.
- White school glue.
- Cooking oil or detergent.
- Toothpick.
- Paper tissues.
- Food colouring (optional).
- Acrylic paints and a fine paint brush.

**Did you know:**

Fonterra has one of the most diverse work forces of any New Zealand-based company in terms of skill sets, cultures and geographies. Almost 36 per cent of Fonterra’s 16,800 employees work overseas in more than 50 countries around the world.

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

Book 41 Fossils: Digging up the past.

**Key School Journal References:**

*Birdland Article* 2008 Pt CN No. 12 8-14 LOWE, Sarah; *Buried treasure Article* 2008 Pt CN No. 12 2-7 OWEN, Dylan; *Finding an ammonite Article* 7 1981 Pt No. 1 Pgs 8-14 STEVENS, Graeme; *A fossilised forest Article* 4 1978 Pt 01 No. 5 Pgs 12-13 RICHARDS, Grace; *Fossils Article* 4 1993 Pt 02 No. 4 Pgs 20-21 CROOK, Gillian / SHANNON, Gillian; *Mary Anning: Fossil Hunter Article* 6 2012 Pt L3 Sep 8-17 DOBSON, Barbara; *On the dinosaur trail Article* 7 2011 Pt No. 1 8-13 GIBBISON, Sue; *Rock doc Article* 3 1999 Pt JJ No. 21 Pgs 8-13 ANDERSON, K. E.; *What are fossils? Article* 4 1978 Pt 01 No. 1 Pg 7 CROOK, Gillian / SHANNON, Gillian.

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Energy from the sun

Learning intentions
Energy: Find when more radiant energy hits the earth — morning or midday.
Nature of Science: Observations, quantitative investigations, fair tests.

Challenge 1
Creating a clean ring-shaped shadow
The shadows of your fingers will probably be a nuisance in your investigations. Can you find a way to keep your tube in place without having to hold onto it? Whatever method you use should create as small a shadow as possible.

Challenge 2
Area of light
How big is the area within the ring-shaped shadow?
Hint: Use the graph paper to find this.

Challenge 3
How much energy?
Does more radiant energy fall on a given area during the early morning or at midday? Extend your investigation to find out. Communicate your findings. Frame good questions and investigate these ideas further.

Extensions
(1) How much energy falls on a given area of the Earth at different times of the year? Develop a method to investigate this.
(2) Research into what causes winter and how the tilt of the Earth is involved.
(3) Find out how solar energy is used to generate electricity.

Key School Journal References:
Make way for the Solar Kiwi Article 5 04 No. 3 1994 SOMERSET, David; Power alternatives Article CN No. 3 2010 MEYER, Anna and DICKSON, Andrew; Power for Pukapuka Article CN No. 1 2000 GOODWIN, Maureen.

Key ‘Building Science Concepts’ references:

What you will need:
(per group)
* A toilet roll tube.
* Graph paper.
* Pencil.
* Access to outside on a bright, sunny day.

Setting the scene
Sunlight is important for plant growth and for generating electricity from solar energy.
In this investigation we can ‘collect’ light from the sun using a toilet roll tube. Sit one end of it on the ground and point the other end towards the sun. Warning: Never look straight at the sun!

Position the roll till you create the smallest possible ring-shaped shadow on the ground.

This tells you the tube must now be pointing straight towards the sun.
Learning intentions

Material World: Investigate physical properties of New Zealand’s coins and find how these properties are useful in everyday life.

Nature of Science: observations, measurements, comparisons, gathering evidence, linking science to everyday life.

What to do

1. Work in pairs. Have one person close their eyes and hold out their hand. How many coins can they correctly identify by simply holding the coin in their hand (no fingertips allowed)?

2. Repeat 1) above, but allow the person to use their fingertips and fingernails to test the coins.

3. Carefully study the coins to find ways in which they look different.

4. Use your ruler to measure different dimensions of the coins.

5. Use a magnet to find which coins are attracted.

6. Do a ‘rubbing’ of each coin and label all the different properties you have discovered.

Questions

1. How are the coins different a) in weight, b) in size, c) to touch?

2. What parts of your hands are most effective in finding the difference in the touch of each coin? How would this sense be useful to a blind person?

3. List the ways the coins look different.

4. How are the coins different in their measurements?

5. Which coins are attracted to a magnet? Search the internet to find out what metal they contain that makes them magnetic.

6. List ways that the different physical properties of coins are useful.

Extension

Find out about how coin-operated slot machines work.

What you will need:
(per group)
★ New Zealand coins: $2, $1, 50c, 20c, 10c.
★ Ruler.
★ Magnet.

Key ‘Building Science Concepts’ references:
Book 13 Aluminium: Extracting and using the metal.
Book 32 Introducing metals: The properties and uses of common metals.
Book 33 Working with metals: The origins and applications of common metals.
**PRACTICAL ACTIVITY**

**Pūrerehua**

**Learning intentions**

*Material World:* Build a working pūrerehua and investigate how it works.

*Nature of Science:* observations, explorations and investigations, measurements, fair testing, being systematic, linking science learning to everyday life.

**What to do**

*Build a basic pūrerehua*

Tie 50 cm of string to the ruler, using the hole in the ruler (see picture to the left). Go outside well away from other people and spin the pūrerehua around your head. Try spinning it in both a horizontal circle and a vertical circle.

**Write-up**

In a paragraph, use your findings to describe how a pūrerehua works by explaining the reason for each of the observations a) to d) above. In what ways is it similar to some musical instruments?

**Extension**

Research into which cultures historically used the pūrerehua (or bullroarer) and why.

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**What you will need:**

(per group)

- A small plastic ruler (about 15 cm long) with a hole in one end.
- String (it is best to use curtain cord or types of fully braided cord that will not unravel).
- Coloured tape or stickers.
- Access to an open area where students cannot do damage to each other or property.

**Hints:**

1) Always record your findings and do many repeats to confirm them.
2) Time how long it takes before buzzing begins, then change the string length and repeat.
3) Use tape to colour each side of the ruler differently so you can see which way it is spinning.
4) Suddenly stop the pūrerehua to see which way it unravels. Does it always unravel in the same direction?

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**Key School Journal Reference:**

*Make a pūrerehua* Article 4 2001 Pt 01 No. 1 Pgs 11-13 KAA, Oho.
**Pressure — Te Pēhanga**

### Topic: Pressure
(Or, a sub-topic of a unit on Forces.)

#### Science Concepts
- Pressure is force divided by area.
- Gas pressure is due to collision of particles.
- A vacuum occurs when no gas particles are present. Some particles are present in a partial vacuum. Vacuums are the result of unbalanced pressures and these can collapse vessels.
- The Bernoulli Effect states that the faster a gas or liquid is moving, the lower its pressure.
- Gases can be compressed whereas liquids compress very little.
- If an enclosed vessel is heated, the pressure inside increases. Similarly, increased pressure generates heat.

#### Contexts: Pressure; Forces.

#### 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

#### Contextual
- Physical World: Investigate pressure using everyday examples.

#### Nature of Science
- Investigating in science
- Communicating in science
- Participating and contributing

#### ICT
- 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.

### Achievement Objectives

#### Contextual
- Level 3 Physical World: Explore, describe and represent patterns and trends for everyday examples of physical phenomena, such as movement, forces, electricity and magnetism, light, sound waves, and heat.

#### Nature of Science
- Level 3 Investigating in Science: Build on prior experiences, working together to share and examine their own and others’ knowledge. Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations.
- Level 3 Communicating in science: Begin to use a range of scientific symbols, conventions, and vocabulary.
- Level 3 Participating and contributing: Use their scientific knowledge when considering issues of concern to them.

#### 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/pintroSe.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 learned, 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 learned and what needs further work.

### Answers for pages 19–23

#### Cartesian diver p19:
1. The diver sinks. 2. The diver rises. 3. It becomes smaller. 4. When the bottle is squeezed, the water pressure inside the bottle increases, and this is transferred up into the diver, reducing the size of the bubble. This makes the diver less buoyant, and it sinks. 5. By applying steady pressure to the sides of the bottle.

#### Egg in a bottle p20:
1. Nothing. 2. Nothing. 3. The egg went into the bottle. 4. Something to do with the burning process. 5. The burning paper generated heat that caused the air inside the bottle to expand, forcing some air out. The egg was then used to block the bottle opening. Once the burning stopped, the inside air began to cool and contract, reducing the pressure on the inside. The higher (normal) atmospheric pressure on the outside pushed the egg into the bottle. (Note, there is no such force as ‘suction’.) 6. By blowing into the bottle, the air pressure was increased above normal atmospheric pressure and this forced the egg out. 7. Answers will vary. 8. A vacuum cleaner also creates an area of lower inside pressure resulting in air at normal (higher) atmospheric pressure flowing inwards.

#### Bernoulli Balls p21:
1a. The faster a gas or liquid flows, the lower the pressure (Bernoulli’s principle). When blowing between the balls, the region between them is thus at lower pressure than the surrounding normal air pressure. This imbalance forces the balls inwards. 4. Windows blow outwards in high winds; air movement over an aeroplane wing causes lift.

#### Egg drop p22:
1. The egg will usually break when dropped from less than 10 cm. Challenges 2 & 3. Ideas might include: placing the egg inside a clean zip-top bag to save it for eating if it breaks; partially inflating the zip-top bags and securing the egg between them; making a parachute to slow the descent of the egg; creating a ‘mattress’ for the egg to land on; painting or decorating the egg, airbags, etc.

#### Water rocket p22:
1. Release the rocket alongside a tail chimney or flagpole to obtain relative measurements; or, use a protractor mounted on a table (always the same distance from the launchpad) to measure the relative angle above the horizon that the rocket reaches. Challenge 2. Answers will vary, but usually around one third water and a high pressure setting works well. Challenge 3. To assist flight: Add fins and a weight at the front end. Also, decorate to make the rocket look realistic, ‘cool’ or ‘angry’.

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Specific learning intentions and activities

### Pressure Unit Plan

**Pressure unit**

**Specific Learning Intentions**

1. Understand that pressure is force applied over a given area. That is, pressure equals force divided by area.

   **Vocabulary:** area, balloon, barometer, dense, expand, force, inflate, pressure, propel.

2. Understand that a vacuum is a region of lowered pressure. Suction and similar vacuum-related ideas are simply the result of unbalanced pressures.

   **Vocabulary:** aluminium, partial, suction, syringe, vacuum.

**Learning Activities**

- **Rocket balloons — ignition activity**
  Introduce the unit by demonstrating, then playing with rocket balloons. Blow them up by differencing amounts, so they are under differing amounts of pressure. Which ones go farthest? Which end of the balloon expands first? Propel a rocket balloon across the room along a taut string (tape a straw to the front end of the balloon and thread the string through it).

- **Balloon pop**
  Demonstrate trying to pop a balloon with the blunt end of a pencil, then repeat (using the same force) with a sharp nail. Which one involved the greater pressure? Why? (The nail, because the same force was applied over a smaller area.)

  Discuss other situations where pressure is important. Examples: 1) you can make a hole in a wall with a drawing pin, but not with the tip of your finger. 2) Stilletto heels sink into soft grass, but flat shoes don’t. 3) You can cut with the sharp edge of a knife, but not the broad, flat side. Have the students come up with their own ideas.

- **Egg break**
  Wearing a rubber glove, attempt to break a raw egg by squeezing it in one hand. Also, try breaking it by squeezing on both ends using the fingers of one hand. It will rarely break! Now, break it on the edge of a bowl. Why did it break so easily? (The force was applied over a very small area, so the pressure was huge! Where else do you see something similar? Example: When a stone breaks a car windscreen.)

- **Cartesian diver**
  Build a Cartesian diver. By squeezing (pressurising) the bottle, the air bubble inside the diver is forced into a smaller space, making it more dense, so the diver sinks. Release, and the diver rises upwards. [Cartesian diver activity sheet]

- **Weather barometer**
  On a fine day, read and record the value on a weather barometer. Compare this with a stormy or rainy day. When is the air pressure highest and lowest? How is a barometer useful to a farmer and to people with other jobs? Check the weather forecast to find out when ‘highs’ and ‘lows’ are arriving and what this means.

   [Theory notes titled ‘What is pressure?’ and ‘Pressure in a closed vessel.’]

- **Balloons and Bernoulli**
  Fonterra Science Roadshow visit: The 2013 Balloons and Bernoulli show is all about pressure.

- **Vacuums and expansion**
  Place a fresh marshmallow sweet inside a large plastic syringe. Push the plunger up to (but not against) the sweet, place your finger over the end of the syringe, then pull the plunger outwards to create a partial vacuum. What happens to the marshmallow? Does it change size (yes, it grows larger)? Why? (Because there is air trapped inside the sweet that is at normal air pressure, but the pressure surrounding it dropped when the plunger was pulled outwards. So, the now greater pressure inside the marshmallow causes it to expand.) Repeat with a barely inflated balloon with the end tied off. It expands when you pull on the plunger. Explore other objects. Research ‘the bends’ (decompression sickness) that can affect scuba divers.

- **Vacuum packing**
  Place small objects inside clean plastic bags, then suck out the air from the bag (you could use a straw for this). Tie off the opening. Why does this happen? What pressures are involved inside and outside the bag? How else might you suck out the air? Test. Where do we use this in everyday life? Why?

- **Balloon in a flask — demonstration**
  Boil some water in a laboratory flask. Use gloves and safety glasses. Remove the flask from the heat and quickly lower the body of a balloon into the flask and stretch the neck out to seal the top of the flask. See diagram. **Warning:** Extreme care required to avoid scalding. **Work in a sink.** Predict what will happen as the flask cools. Discuss where the pressure is lowest and highest. Why does the balloon expand inside the flask? (Steam occupied the space inside the flask. When it cooled it condensed back to water, resulting in reduced pressure inside the flask — so the air pressure on the outside forced the balloon into the flask.)

- **Aluminium can crush**
  Watch or demonstrate aluminium cans being crushed by air pressure. See YouTube link: http://www.youtube.com/watch?v=vcx355K73Mg. View the crushing of a 200 litre (44 gallon) drum at YouTube link: http://www.youtube.com/watch?v=a1TlQdRjEjY.

- **Egg in a bottle**
  Perform the classic ‘egg sucked into a bottle’ activity, then investigate variations on this idea. [Egg in a bottle activity sheet] How does this relate to the way a vacuum cleaner works? [Theory notes titled ‘Vacuums.’]
<table>
<thead>
<tr>
<th>Specific Learning Intentions</th>
<th>Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bernoulli balls</td>
<td><strong>Bernoulli balls</strong> Use polystyrene balls to investigate the Bernoulli Effect. [<em>Bernoulli balls activity sheet</em>] <strong>‘Suction’ effects of high winds</strong> Blow hard across the top of an A4 sheet of paper while holding it between your fingers (see diagram to left). Why does it lift into the air? (Answer: There is lower pressure above the paper (because of the fast moving air). The normal air pressure below the paper pushes the paper upwards. Develop further questions for investigation. Where is this relevant in real life? Research. (Answer: In high winds, windows blow outwards (not inwards) and roofs blow off (not inwards). Similarly, a shower curtain will move towards you when the water is turned on, due to moving water and air.) <strong>Flight</strong> Find out about the shape of an aeroplane’s wing and how it works. (Answer: The aerfoil shape forces air flowing across it to move faster over the top surface. This reduces the pressure here and the higher pressure underneath the wing forces the wing and plane upwards.) (Theory notes titled ‘Bernoulli effect.’)</td>
</tr>
<tr>
<td><strong>Vocabulary:</strong> Bernoulli, polystyrene.</td>
<td><strong>Vocabulary:</strong> Compress, hydraulic liquid, pneumatic.</td>
</tr>
<tr>
<td><strong>blow</strong> and hold here A4 paper</td>
<td><strong>Expanding gases</strong> Seal a drinking straw into the end of an empty 1.5 L soft drink bottle. Heat the air inside the bottle by pouring hot water over the bottle and show how the air expands by bubbling it through a straw into a container of water. Make comparisons by: using cold water, using a smaller bottle, etc. <strong>Hot bicycle pump</strong> Show how compressing gases produces heat. Place your thumb over the end of a bicycle pump and vigorously push the handle in and out several times. What happens near the nozzle where the air escapes past your thumb? (It gets hot, because compressing a gas causes heat to be produced.) (Theory notes titled ‘Pressure and heat.’)</td>
</tr>
<tr>
<td><strong>Vocabulary:</strong> nozzle.</td>
<td><strong>Vocabulary:</strong> hovercraft, jack, launch, rocket.</td>
</tr>
<tr>
<td><strong>blow</strong> and hold here A4 paper</td>
<td><strong>Air jack</strong> Make an air jack by fixing a drinking straw in the mouth of a plastic bag using a rubber band. Blow through the straw to inflate the bag. Now, starting with it empty, position the bag on the edge of a desk, then place a load, such as a book, on top of the bag. Blow through the straw to lift the bag out of the air. Experiment by lifting other objects and by making the jack more elaborate, e.g. use cardboard to build sides and a platform like a lift. <strong>Balloon hovercraft</strong> Build a balloon hovercraft using a sports drink bottle top glued to the centre of an old CD disc. Inflate a balloon and attach it to the bottle top, release and push the hovercraft across a smooth table. See weblink: <a href="http://www.youtube.com/watch?v=pxqVCh__T8">http://www.youtube.com/watch?v=pxqVCh__T8</a>. Experiment with different designs. <strong>Air rocket</strong> Build an air rocket and experiment with different designs. Squash the sides of the bottle (see diagram to left) to eject the paper rocket (a toothpick with a cap made from a 70 mm diameter half circle of paper and topped with blu tack, see right). <strong>Water rocket — finale</strong> Build water rockets out of 1.5 L soft drink bottles. Add fins. Launch them using a water rocket launcher device (obtain from Crescendo in Auckland, website <a href="http://www.crescendo.co.nz">http://www.crescendo.co.nz</a>, product number PBSR09). Experiment to achieve the greatest distance or height by modifying the pressure, amount of water, type or shape of bottle, fins, etc. [<em>Water rocket challenge sheet</em>]</td>
</tr>
<tr>
<td><strong>Vocabulary:</strong> slot rocket into straw hot glue</td>
<td>Air rocket set-up.</td>
</tr>
</tbody>
</table>
**Theory notes — Pressure**

### What is pressure?
Pressure is force applied over an area, that is, force divided by area. (Remember, a force is a ‘push’ or a ‘pull’.)

*Diagram: Large force acting over a small area results in high pressure; small force acting over a large area results in low pressure.*

**Examples.**
1. If a woman stands on soft grass in flat shoes, she doesn’t sink in. The same woman wearing high heel shoes will sink into the grass because the same downward force on her (due to gravity) is being applied over a very small area (creating much greater pressure). All her weight is concentrated into a very small area.

   [Students draw their own labelled picture to show this.]

2. If you are sanding wood to prepare it for painting you ‘dig deeper’ — due to the higher pressure you apply — when pushing down on a small piece of sandpaper than if you use a larger piece (say, combined with a sanding block).

   [Students draw their own labelled picture to show this.]

3. A finger can be pressed against a wall without making a dent; however, the same finger pushing a drawing pin can easily make a hole.

   [Students draw their own labelled picture to show this.]

### Examples of pressure we investigated
[Students illustrate examples.]

### Pressure in a closed vessel
Pressure due to a gas inside a vessel is caused by the gas particles hitting the inside walls of the container. The more particles forced into the vessel, the more collisions (which create greater force over a given area = greater pressure).

*Diagram: Particles of a gas (or a liquid) move randomly. When they collide with the inside walls of the vessel, they create pressure (shown here by the black arrows).*

### Vacuums
A vacuum occurs when there are no particles inside a vessel (and a partial vacuum is when there are few particles). This means there is no or little pressure on the inside, while there is usually normal air pressure on the outside.

*Diagram: Before, normal air pressure on outside; after, container collapses due to unbalanced pressures.*

When the pressures are unbalanced like this, the vessel is likely to collapse.

[Students illustrate this from activities they have tried.]

### Bernoulli effect
The faster a gas or liquid is moving, the lower the pressure is within it. Examples: 1) When water goes through a hose nozzle, it speeds up, but its pressure falls. 2) When air flows over the top of an aeroplane wing, it goes faster than beneath it. This lowers the pressure on top. The higher pressure on the lower surface thus lifts the plane into the air.

*Aeroplane wing in cross section: lower pressure above, higher pressure below.*

[Students illustrate other examples of the Bernoulli effect.]

### Gases can be compressed
Because there is space between gas particles, gases inside a vessel can be compressed (or squashed). However, liquids have little space between their particles, so they are difficult to compress.

[Students illustrate their own example(s).]

### Pressure and heat
When the temperature inside a vessel filled with a gas or liquid increases, the pressure also increases.

[Students give their own example.]

This is because the particles are moving faster and having more violent collisions. Likewise, if a vessel is squashed, the pressure and temperature inside it increases.
**ACTIVITY SHEET**

**Cartesian diver**

**What you will need:**
(Per group)
- A disposable plastic pipette.
- Scissors.
- A steel nut with an internal diameter of about 5 mm to fit the pipette stem.
- An empty 1.5 L plastic soft drink bottle and its lid.
- A waterproof felt pen.
- Water.

**Learning intentions**

*Physical World:* Investigate how pressure affects the buoyancy of an object.

*Nature of Science:* building things, observations, investigations, evidence, deductions, linking science to everyday life.

**What to do**

1. Cut the last 2 cm off the stem of the pipette and discard.
2. Thread a nut onto the stem of the pipette. It should be a tight fit. This is your ‘diver’.
3. Fill the plastic bottle with water almost to the top.
4. Insert the diver into the bottle. The idea is that it should barely float, so suck up some water into the pipette bulb, or add an extra nut if necessary.
5. Top up the bottle so it is full and screw the lid on tightly.
6. Squeeze the bottle and observe what happens to the diver.
7. Release the pressure and observe what happens.
8. Watch carefully what happens to the air bubble inside the diver as you squeeze the bottle.
9. Draw three horizontal lines on the side of the bottle — one at 8 cm, the next at 12 cm and the third at 16 cm below the top.
10. Challenge yourself to make the diver stay exactly level with the top line drawn on the bottle, then in turn, level with each of the other lines.

**Questions**

1. What happens when you squeeze the bottle?
2. What happens when you release the pressure?
3. What happens to the size of the air bubble inside the diver when you squeeze the bottle?
4. Use evidence from the above three answers to explain why the diver sinks.
5. How did you keep the diver level with the lines on the bottle?

**Extension**

Research to find out how a scuba diver uses a buoyancy vest to rise to the surface of the water.

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Key School Journal References:
Diving with Dad Article 1995 Pt SL No. 1 Pgs 2-16
HART, John. First dive Article 5 1997 Pt 03 No. 1 Pgs 25-27

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Egg in a bottle

**What you will need:**
(for a demonstration or per group)

- A hard-boiled egg with shell removed. A small egg is best.
- Matches.
- Paper.
- Cooking oil.
- A clean glass bottle with a wide neck (about 32–35 mm diameter).

**Learning intentions**

Physical World: Investigate the effects of unbalanced pressures.

Nature of Science: observations, investigations, fair tests, comparisons, deductions, thinking like a scientist, linking science to everyday life.

**What to do**

1. Smear some cooking oil around the rim of the bottle.
2. Place the egg on top of the bottle opening. What happens?
3. Remove the egg and drop a small piece of paper inside the bottle, then replace the egg on the top. What happens?
4. Finally, remove the egg, light the paper and toss it into the bottle. When the flame is almost out, place the egg on the top. What happens?
5. Think about why a scientist might perform the three steps 2–4 above.
6. If the egg is still whole, remove it by turning the bottle upside down and blowing hard into the bottle. The egg will be ejected. Wash the egg and refrigerator for eating later.

**Questions**

1. What happened when you just placed the egg on top of the bottle?
2. What happened when you dropped the paper into the bottle first, before the egg was placed on the top?
3. What happened when you dropped the burning paper into the bottle then placed the egg on top?
4. Think like a scientist. What caused the egg to go into the bottle — gravity, the paper, or something to do with the burning process?
5. Explain why the egg went into the bottle. Write about what the burning did to the air, what happened to the air when the flame went out and the pressures inside and outside the bottle.
6. Explain why the egg came out of the bottle when you blew into it.
7. Draw a labelled diagram of your experiment.
8. Research into how a vacuum cleaner works. How is it similar to this experiment?

**Extension**

Try the same ‘trick’, except replace the egg with a partially-filled water balloon of the same size.
What you will need:
(per group or as a demonstration)
* 2 polystyrene balls (each about 60 mm diameter).
* 2 drawing pins.
* Cotton.
* A drinking straw (the type with an ‘elbow’).
* Sellotape.

Learning intentions
Physical World: Investigate the effects of moving air on pressure.
Nature of Science: observations, investigations, comparisons, deductions, linking science to everyday life.

What to do
1. Tie 30 cm of cotton to a drawing pin and push the pin into a polystyrene ball. Repeat for the other ball.
2. Hang the balls 4 cm apart from a shelf or similar. They should hang at the same level.

For each of the following tests, make sure the balls are still before you start. First make a prediction, then perform the test.

3. From about 30 cm away, blow between the balls. Observe the direction they first move. Is it towards or away from each other?
4. Repeat using the straw.
5. Bend the straw and blow air up between the balls. Observe the direction they first move. Is it towards or away from each other?
6. Observe what direction a ball moves when you use your breath (or the straw) to blow along the outside edge of a ball.

Questions
1. What direction do the balls first move when: a) you blow between them, b) when you use the straw to blow between them, and c) when you blow upwards between them?
2. What direction does the single ball first move when you blow along its outside surface?
3. Using Bernoulli’s principle (which you may need to research first), explain why the balls move the way they do.
4. Where do you see the Bernoulli principle acting in real life?

Extension
Experiment with balancing a polystyrene ball (about 5 cm in diameter) on the air jet produced by a hair dryer. How does this work?
Learning intentions

Pressure: Use the compressible nature of air to reduce damage to an object.
Nature of Science: Creativity, design, measurement, experimentation, comparisons.

Challenge 1

How high before it breaks?
As a class exercise: Find how high an egg needs to be dropped before it breaks. Drop it into a clean metal bowl so the egg can be taken home and eaten (not wasted). Record your measurements.
This shows how fragile an egg really is!

Challenge 2

Brainstorm and design
Use Edward de Bono’s ‘Six thinking hats’ and while you work in your team, record your ideas under appropriate headings.
Design a method of protecting your egg so when it hits the ground it doesn’t break. The egg will be dropped from at least 3 metres. These are the requirements: 1) The egg should not be damaged in the fall. (However, it if is, you must be able to save the egg’s contents for future, hygienic cooking purposes.) 2) The method or structure you use should have style and ‘look good’. 3) The less materials you use, the better. 4) The more times the egg survives a fall, the better. The winner will be judged on all three of the above.

Challenge 3

Build your device and use any special methods you have decided upon to drop your egg from the same measured height as everyone else. Explain how pressure is involved in your design. Your teacher will judge the competition.

Extensions

(1) What other materials could you introduce to ensure a better result?
(2) Find out about airbags used for safety in cars. How do they work and how quickly do they trigger?
**Learning intentions**

*Pressure:* Investigate to find the best design and launch method for a water rocket.

*Nature of Science:* Observations, building things, creativity, measurements, systematic investigations, fair tests.

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**Challenge 1**

**How high does the rocket go?**

Find a way of measuring how high your rocket goes. For example, this could be measured in metres, using angles or compared alongside a tall structure. Test the method so you are consistent with your measurements.

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**Challenge 2**

**Best water volume and pressure setting**

Perform tests to find the volume of water that gives the highest launch of your rocket. You will also need to find the best pressure setting (adjusted by turning the nut above the rubber seal on the launch pad). What is your best combination of the two settings? Record these for future use.

Decide on how you might record and communicate your findings to the rest of the class later.

---

**Challenge 3**

**Other additions and competition finale**

Add other features to your rocket that might assist its flight and test them. For the finale, decide on your best rocket design and launch plan and compete against the other groups for the ‘Top Rocket Award’. Later, present what you did and your findings to the rest of the class.

**Extension: Horizontal flight**

Build a rocket and launch system that propels your rocket the greatest distance horizontally.

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**What you will need:**

*per group*

- An empty 1.5 litre soft drink bottle.
- Cardboard, tape, hot glue gun.
- Access to a water rocket launcher (purchased from Crescendo in Auckland, website [http://www.crescendo.co.nz](http://www.crescendo.co.nz), product number PBRS09), a foot pump and safety glasses.
- Water.
- Measuring tape.

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**Setting the scene**

A water rocket can be made from a plastic soft drink bottle. It uses compressed air to push water backwards through the bottle opening, thus propelling the bottle forwards. A launch pad and foot pump are used to pressurise, then release the bottle.

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**Key School Journal Reference:**

Bottles into rockets Article 5 2003 Pt 03 No. 2 Pgs 12-15

EAGLE, Rex.
Pre- and post-unit assessment

One way of pre- and post-testing the knowledge of students on the unit of work Pressure, 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, or create your own list. Students draw a mind map on Pressure before they begin the unit, then again after they have completed the unit. 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 word ‘Pressure’ 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 a meaningful way, 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 mark for each word (or variation of the word, e.g. expand, expands, expansion) 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.) Students will often give situational examples (e.g. tyre pressure) rather than principles (e.g. air pressure). You will need to determine how you will handle these distinctions if at all.

Sample mind map
This is a student’s mind map ‘pre-test’ on Pressure. Ticks are given to show how marks are allocated. This student’s pre-test score was 7.

Example keyword list

- Aerofoil
- Aeroplane
- Air
- Air Jack
- Area
- Atmosphere
- Atmospheric pressure
- Balanced forces
- Balloon
- Barometer
- Bernoulli
- Barometer
- Cartesian diver
- Collapse
- Compress
- Contract
- Crush
- Dense
- Expand
- Flight, Fly
- Force
- Highs
- Hovercraft
- Hydraulic
- Inflate
- Lift
- Liquids
- Lows
- Particles
- Pneumatic
- Propel
- Pump
- Rocket
- Solids
- Suction
- The bends
- Unbalanced forces
- Vacuum
- Vacuum cleaner
- Vacuum pack
- Volume
- Wing

Plus extra words at teacher’s discretion.
Pressure

Mind map on Pressure

Name ___________________________ Date __________

Year level _____ School__________________________
The Fonterra 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 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 Fonterra 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 divide your class into six groups corresponding to the six exhibit Themes. Each group is responsible for reporting their understanding of 3–4 exhibits (selected from their Theme) back in class. 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 digital camera or video camera 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.

Support for the New Zealand Curriculum
The Fonterra 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 later in this book.

Principles
The Fonterra 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 Fonterra Science Roadshow experience embodies:
- Excellence: through perseverance to find the answer and to understand how things work
- Innovation, enquiry 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 theme(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 Fonterra 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.

A visit to the Fonterra Science Roadshow isn’t only for your students. We hope you will also see it as a great opportunity for your own professional development.
Hints for teachers and helpers — during the visit and at home

Teacher’s guide

DURING YOUR VISIT

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

What is the Fonterra Science Roadshow?
The Fonterra Science Roadshow travels around the country teaching children about science, technology and innovation. At the Fonterra 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? Professor Sir Paul Callaghan has 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.
Thematic Exhibits

**Themes**

**Electricity and Magnetism — Tā Hiko me te Autō**

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

- AC and DC electricity: circuits; magnetism and magnetic fields; magnetic coupling; electrically excited gases; conductors and insulators; eddy currents; electrical arcing; and, electromagnetism. Exhibits include:
  - AC/DC generator
  - Batteries in circuit
  - Eddy current brake
  - Jacob's ladder
  - Magnetic attraction
  - Magnetic coil
  - Magnetic attraction
  - Magnetic coil
  - Micro light
  - Powerful attraction
  - Powerful repulsion

**Contexts** — Electricity and magnetism: Energy.

---

**Human performance — Ngā Mahi a te Tinaara Tangata**

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

- Antagonistic muscles: balance; hand-eye coordination; blood pressure; functioning of the human skeleton; eye defects; eye testing; muscle strength; hearing; reaction times; and, how the heart works. Exhibits include:
  - Air muscles
  - Bones on a bike
  - Balancing sticks
  - Eye chart
  - Hand grip
  - Hearing range
  - The heart as a pump

**Contexts** — Human performance, My body, Sports science.

---

**Life and environment — Te Ora me te Taiaro**

Exhibits in this theme address specific learning intentions relating to the following: biological control; animal identification; water pollution; water resources; types of fossils; the ocean's resources; adaptations; migratory patterns; and, how animals feed. Exhibits include:

- Biological control
- Bird song
- Fossils
- Identifying organisms
- Seaweeds
- Special beans

**Contexts** — Animals; Plants; Fossils; Environment; Pollution.

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**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 co-operatively 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, 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.

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**Key School Journal References:**

- Electric map Article 6 1992 Pt No. 1 Pgs 24-25 BONALLACK, John; Electric map Article 1998 Pt CN No. 3 Pgs 30-32 BONALLACK, John; Jumping for joyles Article 2008 Pt CN No. 3 16-19 ALCHIN, Rupert; Make way for the Solar Kiwi Article 5 1994 Pt No. 3 Pgs 22-27 SOMERSET, David; A new life for old machines Article 2007 Pt CN No. 3 28-32, HIRALI, Rosemary; A new approach to the same story Article 1987 Pt No. 1 Pgs 14-19 HINDSON, Tony; The old water-wheel Article 1987 Pt CN No. 2 Pgs 8-9; BIRCHALL, Brian; Power Article 4 2011 Pt 12 Aug 10-15; TAYLOR, Alex; Power crisis — where to now? Article 7 1993 Pt No. 4 Pgs 2-10; BONALLACK, John; Power for Pukapuka Article 2000 Pt CN No. 1 Pgs 4-6; GOODWIN, Maureen; The power of rubbish Article 1993 Pt No. 2 Pgs 30-35; ORWIN, Pat; The power of rubbish Article 1998 Pt CN No. 3 Pgs 10-11; ORWIN, Pat; Profile: Marc Young Article 2010 Pt CN No. 3 30-32; FRANCES, Helen; The sleeping giant Article 6 1998 Pt No. 2 Pgs 28-33; KEIR, Bill; Super toy makers Story 2005 Pt CN No. 1 Pgs 26-32; ANDERSON, Karen; Turning on the power Article 5 1981 Pt No. 3 Pgs 17-19; BIRCHALL, Brian; Water power Article 5 2004 Pt No. 3 8-9; CARRIG, Brian; Wind power: the debate Article 2001 Pt CN No. 3 10-15; BENN, Ken; Windsmill of the future? Article 5 1981 Pt No. 3 Pgs 12-16.

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**Teacher’s guide**

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The big questions
Each exhibit theme cluster, such as Electricity and Magnetism, has associated with it a large banner with two ‘Big Questions’, questions A and B. The aim of these questions is to focus the students’ attention on key ideas associated with that theme. After the first show, Presenters will draw the students’ attention to these and then they will be discussed before the second show. The 2013 Big Questions are as follows:

Electricity and Magnetism
A. What is an electrical conductor? Give an example. (Something that allows electricity to flow through it, e.g. a copper wire.)
B. What metals are attracted to a magnet? (Iron, steel [which is mainly iron], nickel and cobalt.)

Human Performance
A. When you become fit, what two main things happen to your blood transport system? (1. The heart becomes more muscular, and therefore stronger, and 2. more capillaries [tiny blood vessels] grow throughout your muscles.)
B. What is ‘hand–eye coordination’? Give an example. (When your hands and eyes work together to perform a task, e.g. catching a ball.)

Life and Environment
A. What things make up the ‘environment’? (Communities of living things and the physical world they live in, such as soil, water and air.)
B. What are ‘adaptations’ and give some examples? (Special features that help animals and plants to survive, e.g. the long probing beak of a kiwi or the prickles on a cactus plant.)

Materials
A. When an object is heated, what happens to its length? Give an example of where this is important. (It becomes longer, or expands. In hot weather, railway tracks become longer and this is why they are laid with gaps between them, otherwise they would buckle.)
B. What are the three most common states of matter? (Solid, liquid, gas.)

Movement
A. When something is speeding up, are the forces acting on it balanced or unbalanced? (Unbalanced.)
B. What is the force called that slows something down due to ‘drag’? (Friction, e.g. air friction, or friction between a car’s tyres and the road.)

Precious energy
A. Where does most of the energy used here on Earth come from? (The sun. Note however that geothermal energy comes from nuclear reactions within the core of the Earth.)
B. What does most of the energy here on Earth eventually become? (Heat, which passes out into space.)

Materials — Ngā Matū
Exhibits in this theme address specific learning intentions relating to the following:
- permeability; strength of metals; the effects of detergents in water; melting, expansion and detection of metals; changes of state; plastic moulding; analysis of substances; the origins of products; using physical properties to separate materials; strength of fibres; and, the properties of wool fibres. Exhibits include:
  - Air through a brick
  - Bendy beams
  - Expansion of metals  - Frizz Whizzer
  - Product origins  - Separating sand
  - Bubble surround
  - Mass spectrometer
  - Metal detector
  - Strength of wool
  - Wily woolies


METALS: The biggest hole in the world Article 5 1995 Pt No 2: 2 Pgs 6-9; BONALLACK, John; ‘New shoes for Cloud Article 3 1995 Pt Jl No 12 Pgs 3-7; BEYERIDGE, Barbara; ‘Skiing while the iron’s hot’ Article 6 1983 Pt No 4: 1 Pgs 32-40, BEYERIDGE, Barbara.

Movement — Te Nekenga
Exhibits in this theme address specific learning intentions relating to the following:
- the effects of gravity on circular movement; elastic collisions; pendulums and periodic movement; ‘reliable’ collision behaviour; how a hovercraft works; acceleration due to gravity; the aerofoil effect of a yacht’s sail; artificial gravity; the best wheels for staying on track; and, wheel oddities.


Precious energy — Te Pūngao Kura
Exhibits in this theme address specific learning intentions relating to the following:
- conservation of momentum; energy in food; generating electricity; light bulb efficiency; how much energy specific household appliances use; conversion of light energy into movement; the electromagnetic radiation given off by electrical appliances; how a solar car works; conversion of radiant energy into electricity; and, electricity generation from wind. Exhibits include:
  - Airballast
  - Balancing joule intake
  - Hand generator
  - Solar car
  - Light bulb efficiency
  - Metered appliances
  - Radiant spin II
  - Radiation around us II
  - Solar generator
  - Wind generator II


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Teacher’s guide

Shows

While being exciting and entertaining, our shows provide a great opportunity to enhance student knowledge in two science areas each year. The shows for 2013 are Balloons and Bernoulli, an investigation into pressure, and The Scientific Pantry, focusing on science relating to food and liquids you find in your pantry.

To assist you in preparing for your visit, we’ve developed a unit plan called Pressure — found in this book — that complements Balloons and Bernoulli.

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

Balloons and Bernoulli — Ngā Puangi me Bernoulli

This show covers specific learning outcomes relating to pressure, including the following:

- pressure is force applied over a given area
- when a force is applied to a very small area, the pressure at that point can be huge
- a vacuum occurs when no air (or other gas) is present
- partial vacuums and total vacuums can result in unbalanced pressures
- unbalanced pressures can cause enclosed spaces to expand or collapse
- weather changes can be due to changes in air pressure
- the faster a fluid is moving, the lower its pressure (the Bernoulli Principle)
- air is elastic (compressible)
- explosive releases of air pressure can create violent movement.

Key ‘Building Science Concepts’ references:

Key School Journal References:
A cloud in a bag Article 3 1978 Pt 01 No. 6 Pgs 2-5; Bottles into rockets Article 5 2003 Pt 03 No. 2 Pgs 12-15 EAGLE, Rex; Hot air Article 1999 Pt 5 SL No. 3 Pgs 2-16 SCWON, Jenny; Race you to breakfast Article 5 1997 Pt 02 No. 3 Pgs 32-40 JOSEPH, Vivienne; The water we breathe Article 6 1978 Pt 03 No. 2 Pgs 44-48 CROOK, Gillian / SHANNON, Gillian; What Makes the Weather? Article 6 2012 Pt CN No. 3 2-16 BRENSTRUM, Erick.

The Scientific Pantry — Te Pātaka Pūtaiaro

This show covers specific learning outcomes relating to the science of things found in a typical kitchen pantry, including the following:

- density of liquids
- the refractive index of liquids
- acid–base indicator substances
- how bleaches destroy pigments
- acid–base neutralisation
- coagulation of proteins
- molecular weight and viscosity
- CO₂ release in reactions.

Key ‘Building Science Concepts’ references:

Key School Journal References:
Grow your own crystals Article 5 1982 Pt 01 No. 4 Pgs 28-29 SOUTHGATE, Brent; Hokey-pokey Article 1998 Pt CN No. 5 Pg 28 YOCUM, Eva; Tricky science Article 5 1997 Pt 01 No. 3 Pgs 16-20 ANDERSON, K. E.; Windows made of water Article 4 1982 Pt 01 No. 2 Pgs 24-25 SOUTHGATE, Brent.

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.

Did you know:

Fonterra’s streamlined supply chain efficiently gets products to customers. Every hour of the year, Fonterra closes the doors on an average of 12 containers, with over 90 per cent of them making their way across the equator to destinations far and wide.
Did you know:
Bones are living tissue, constantly breaking down and rebuilding. Every 10 years our entire skeleton replaces itself.

Teacher’s guide

Answers to pages 3–14

Secrets of electricity and magnetism page 3
1) Secret message: ... electricity flows through a wire, a magnetic field is created. 2) conductor, current, wire, bulb. 3) konobolale, pabokona, lakalonalapiku, pekakizo, kinalonapi, zibinonapi.

Fitness page 4
1) Oxygen on earth is toning, muscle, red blood cells, liver, lungs, sprinter, rugby, rugby league, athletics. 2) Strength, 3) Endurance.

Feeding levels crossword page 5
1) Crossword solution:

M O U L D S
I N O R
H A L N I
P U K E K O K
M O A K
A P H I D
F A L C O N
L O R I
H E R O N
W I C A
G R A S S
W H E A T


Materials puzzle page 6
1) Puzzle solution:

C O M P O S I T E
P E R M A N E N T
S O L I D
L I Q U I D
M I X T U R E
S O L I D S
V O L U M E
P A R T I C L E S
M E T A L L I C
R E A C T I O N
L O G

Statements about materials: 1) matter, 2) gas.

Move it page 7
1) speed, 2) acceleration, 3) motion, 4) constant, 5) stopped, 6) distance, 7) force, 8) bullet, 9) stationary, 10) changing.

Mystery paragraph: Unbalanced forces acting on an object can cause it to speed up or slow down. (Note: Unbalanced forces can also cause objects to change direction or change shape.)

Energy connections page 8
1) Renewable. 2) Non-renewable.

Maze solver page 9
Challenge 1: The best conductor: Draw lines of equal firmness, width and length with each different grade of pencil. Now place the wire terminals at the ends of each line to find which results in the loudest buzzer sound. The best line width. Use the best pencil conductor and draw lines of equal firmness, but different widths. The line that gives the loudest sound is the best to use in the maze. Challenge 2: The buzzer becomes louder if you are getting closer to ‘home’ since the line of conducting graphite is shortest Challenge 3: Theremin: Move the terminals back and forth along the pencil line to vary the pitch up and down. Controlling other devices: Replace the buzzer with either an LED or a tiny motor.

Finger muscles page 10
Challenge 1: Forearm (both front and back). Challenge 2: Place one hand flat across your other forearm. When the fingers are bent towards the palm, the lower forearm muscles move in the same order left to right as the fingers. When the fingers are bent upwards, the upper forearm muscles move in a similar order. Challenge 3: Independent: Only the thumb is fully independent. If you try to move any of the other fingers, some of the other fingers ‘want’ to move to some extent. Extensions: Grasping muscles are stronger.

Fossils page 11
1. A shell settling into a sediment layer, such as mud or sand, in a lake or ocean.
2. By first coating the outside of the shell with cooking oil.
3. Examples include 1) mixing food colouring to create a suitable colour, then combining this with the white school glue before pouring into the mould and 2) using a brush or cloth to paint the outside of the fossil once it had set.
4. The expression represents a ‘mould fossil’, a fossilised negative image made by an object such as a bone or shell in a substrate such as mud (the Play-Doh). The ‘glue fossil’ that was made represents a ‘cast fossil’ formed when the plant or animal body is replaced by minerals that harden.
5. Not usually, because the original animals or plants have been replaced by minerals that can be any colour.

Energy from the sun page 12
Challenge 1: Mount it in position using thin wire or cotton and Blu Tack. Challenge 2: To measure the area, count the squares of the graph paper. Any partial square, no matter how large, is counted as a half square. Challenge 3: When the sun is at a lower angle, the same number of light rays are distributed over a larger area. This means that at any given point, there is less radiant energy reaching the earth, so it won’t heat up as much as when the sun is high in the sky. Extensions: 1) Compare areas at the same time of the day, but at different times of the year. 2) Winter occurs when a given part of the Earth is tilted away from the sun, so the sun rays are spread over a larger area and are correspondingly weaker.

New Zealand coins page 13
1. Each coin is a different weight, diameter and thickness, as follows: (10c is 3 g, 20.5 mm, 1.60 mm; 20c is 4 g, 21.7 mm, 1.65 mm; 50c is 5 g, 24.7 mm, 1.75 mm; $1 is 8 g, 23 mm, 2.70 mm; and, $2 is 10 g, 26.5 mm, 2.70 mm); and, the edges have different grooves.
2. Fingertips and fingernails. Without seeing the coins a blind person can use touch to distinguish between them.
3. Colour, size, thickness, edge markings, pictures and numbers.
4. They differ in diameter and thickness (see above).
5. The silver and copper coins. The 10c coin is copper plated steel, 20c is nickel plated steel, and 50c is a cupro-nickel alloy. Steel and nickel are both attracted to a magnet. The $1 and $2 consist of aluminium-bronze, neither of which are magnetic.
6. Different sizes, pictures, numbers and colours make them easily recognised. Different weights, sizes and edges help blind people, and different sizes, thicknesses, weights and magnetic properties can be useful for automatic sorting, e.g. in banks and slot machines.

Pūrerehua page 14
Write-up key ideas: The spinning ruler causes the air to vibrate, which is the sound we hear. The string must first wind up tight one way before it is suddenly unravels to make the sound. It winds up again in the opposite direction, then unravels quickly, causing the buzz-stop-buzz effect. The ruler spins one way, giving it ‘top spin’ (like a tennis ball), causing it to fall, then when it reverses it has ‘bottom spin’ (like a ‘cut’ or ‘chop’ shot in tennis) causing it to rise.

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The Sir Paul Callaghan Science Academy runs intensive, live-in 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.

2013 Academies are being held 6–9 August in Matakana, and 20–23 August in Methven.

www.scienceacademy.co.nz

Each intake is for 24 teachers of Years 6-8 students from primary/intermediate schools. Candidates should preferably have at least three years teaching experience and must be nominated by their Principal.

“Even though I teach science at my school I came to the academy feeling intimidated by the mysteries of science that lay beyond my grasp. Like so many, I left science in early high school thinking it was too hard and too inaccessible for the likes of me. But four days later, I left the academy reframing my entire thinking about what it means to teach science and technology. Moreover, the academy gave me something I never learnt at school, the simple joy of wondering about the world around me and the profound satisfaction of pursuing answers...”

(Irene Stretten)

“"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 are some of the key elements that will be the focus over the four days:

- What does the research into science teaching tell us?
- Exploring The Nature of Science strand.
- Doing hands-on inquiry science.
- Making science fun and practical for all cultures and learning styles.
- How do you know your students have learnt anything?

“"It has re-sparked my love of teaching science and also provided me with an ongoing resource bank to share with my colleagues and students.""

(Janine Fryer)

The National Science-Technology Roadshow Trust

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

We specialise in developing and delivering nationally, quality science, innovation and technology education programmes and exhibitions for student, teachers and their wider communities.