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 overriding objective is to enhance learning outcomes for students.

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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 theme called ‘Observations’.

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: www.scienceonline.tki.org.nz. More than sixty existing resources are adapted to meet the needs of the science curriculum based around the five Foundational Science Capabilities (that link to the key competencies of the New Zealand Curriculum) and relevant Nature of Science concepts.

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 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.

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.

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

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Electricity

SCIENCE VOCABULARY PUZZLE

Electrical components

Find the answer to the puzzle statement below about electricity. Your clues are in the table. For each of the terms down the left column find the matching picture along the top of the table. Circle the letter in the box where their rows and columns meet.

<table>
<thead>
<tr>
<th>Electrical components</th>
<th>Lamp</th>
<th>Buzzer</th>
<th>Motor</th>
<th>LED</th>
<th>Resistor</th>
<th>Dry cell</th>
<th>Chip</th>
<th>Switch</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Q</td>
<td>A</td>
<td>Z</td>
<td>F</td>
<td>M</td>
<td>D</td>
<td>W</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>Q</td>
<td>V</td>
<td>R</td>
<td>L</td>
<td>B</td>
<td>T</td>
<td>C</td>
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<td>Z</td>
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<td>T</td>
<td>X</td>
<td>E</td>
</tr>
</tbody>
</table>

Puzzle statement:
Electricity only o s through a complete c u .
Gravity

SCIENCE VOCABULARY PUZZLE

Gravity secrets

Can you decode the secret message about gravity using the alphabet box below? Hint: Each letter of the alphabet in the box has two letters as part of its code — the first letter is from along the top of the grid and the second letter is from along the side, e.g. p = zi.

Secret message about gravity:

Use the alphabet box to make a secret code for this sentence about gravity: “The bigger a planet, the stronger the pull of gravity.”

Make up codes for words about other types of forces, e.g. magnetism, and have your friends solve your puzzles.

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

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Heat it up!

Use the clues to complete the crossword on heat and temperature. Some letter clues are given.

**Clues**

**Across**

1) Tiny bits of matter.
4) A measure of how hot or cold something is.
7) The coldest temperature possible is absolute __________.
13) Not cold, but almost.
14) Heat and light coming from the sun.
15) When a liquid turns into a gas due to heating.
16) The major source of heat energy on Earth.
17) Tiny particles.
18) The temperature today is 29 __________ Celsius.
20) Material that stops heat from moving from one place to another.
21) Red hot steel is not as hot as __________ hot steel.
23) When heat is moved from one place to another by a fluid, for example air or water.
24) This happens to water at 100 degrees Celsius.

**Down**

2) A temperature measuring device.
3) Heat and steam coming from the ground.
5) Moves heat by electromagnetic waves.
6) Most heat is lost from our homes through the ceiling and ________.
8) When particles jiggle, they __________.
9) A type of insulation used in house ceilings.
10) An old scale used to measure temperature. Still used in USA.
11) The scale used in NZ to measure temperature.
12) Where all Earth’s heat ends up eventually.
13) Heat is passed from one object to another by direct contact.
19) Heat is a form of this. So is light.
22) The opposite to cold.

A visit to the Science Roadshow is a fun, exciting and interactive learning experience of science for children.

It includes live shows and hands-on exhibits that broaden students knowledge of science, technology, engineering and mathematics. It strongly supports the Nature of Science strand and the Five Foundational Science Capabilities.

Each year our shows, themes and exhibits change, so there’s always something new for students to learn and engage with.

*Book online:* [www.roadshow.org](http://www.roadshow.org)
Human performance

SCIENCE VOCABULARY PUZZLE

Human performance

Fill in the grid with the words from the list. Some letters are given as clues. There are not enough words to finish the grid, so complete the two statements about human performance to find the two final words.

Word list

<table>
<thead>
<tr>
<th>Tendon</th>
<th>Agility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Joint</td>
<td>Hands</td>
</tr>
<tr>
<td>Flex</td>
<td>Reflexes</td>
</tr>
<tr>
<td>Hips</td>
<td>Coordination</td>
</tr>
<tr>
<td>Grasp</td>
<td>Tibia</td>
</tr>
<tr>
<td>Radius</td>
<td>Strength</td>
</tr>
<tr>
<td>Femur</td>
<td>Arm</td>
</tr>
<tr>
<td>Nerves</td>
<td>Spine</td>
</tr>
<tr>
<td>Fibula</td>
<td>Feet</td>
</tr>
<tr>
<td>Movement</td>
<td>Jump</td>
</tr>
<tr>
<td>Run</td>
<td>Catch</td>
</tr>
<tr>
<td>Twitch</td>
<td>Vertebrae</td>
</tr>
<tr>
<td>Bones</td>
<td>Muscle</td>
</tr>
<tr>
<td>Learn</td>
<td>Speed</td>
</tr>
<tr>
<td>Ulna</td>
<td>Leg</td>
</tr>
</tbody>
</table>

Statements about human performance

1. The _________ coordinates the body’s activities. 
   ___________

2. The _________ is a framework for muscles to attach to.

Features

- Over 78sqm of environmentally controlled open space (no pillars), with carpet, built in lighting, and air-conditioning
- Easy access (including disabled) up ramp and through toughened glass doors
- Onboard generator with external supply bypass options. Over thirty 230V floor mounted single phase points
- Large travel load capacity and storage
- Security alarmed
- Separate staff area

Capabilities

- Almost anywhere at any time!
- Display and transport problems solved in one go!
- Price competitive with hired marquees of similar size.
- Easily branded for one-off or repeat usage.

www.upv.co.nz
Magnetism

SCIENCE VOCABULARY PUZZLE

Magnetism

Find 31 hidden words or two word phrases about magnetism in the grid below. Twenty five of the words or phrases are given to the right. Can you find all 25 plus the six extra mystery words? The words can be found diagonally, vertically and horizontally, and some words may be reversed.

Word list

Ferrite, iron, north, magnet, magnetised, demagnetised, pull, compass, poles, maps, horseshoe, distance, magnetite, force, south, iron filings, push, magnetic south, bar, permanent, declination, repel, navigation, electromagnet, attract.

Extra six mystery words (list):

A Z B U M P O L E S X U P A Z I C L Z U
U E Y E R A F M A G N E T I S M N F M M
N A A A U N G I G A B N K B A R O E A P
I R D R N X A N E H C I O U C X N R G K
C E F T T L M T E L Q R R R E I - R N Z
K P O I I H R A T T D N L O T A M I E E
E E R Z B O L S G R I L H C N H A T T P
L L C A J O U N N N A S I Q A Y G E Y U
P D E S O U T H E L E C E N K R N S V L
Y M A P S C A K T S S T T D E W E U T L
V D E C L I N A T I O N I W A S T Y W H
Y E L E C T R O M A G N E T N W I X O D
N C K N P M X I I R O N F I L I N G S S
K K J L H P J N D H O R S E S H O E K T
A K X Z N A V I G A T I O N Y Q R Z A A
K I J C O M P A S S N Z L U P U S H D N
D Y S O R D D E M A G N E T I S E D A C
U E M A G N E T I C S O U T H O U E R E
D H U V P E R M A N E N T X P I F Q P P

Electricity Kits for Hire

Level 3/4 Science

Hands-on, Science Capabilities focus

Hire up to four class kits at a time. Make reservations online at:

www.scienceresourcebox.co.nz

Our kits are designed to take the hassle out of developing science programmes, freeing up the teacher to concentrate on what is important — their students.
Good observations are very important in science. Look at these three pairs of diagrams and mark as many differences in them as you can find. The microscopes have six differences, the brains have five and the spacecraft have six.

**Compound microscope**

**Human brain**

**Salyut and Soyuz spacecraft**
Squishy circuits

Learning intentions
Science Capabilities: Gathering and interpreting data.
Physical World: Conducting substances can be used to connect circuits.

What to do

Squishy circuits are electrical circuits made using two different types of home made ‘play dough’, one that is a conductor of electricity and one that is an insulator. The conducting dough can be used to make ‘wires’ that carry (conduct) electricity; insulating dough is used to stop electricity flowing to parts of the circuit. Components — power sources (e.g. 9 V battery), LEDs, buzzers and motors are simply pushed into the dough to make different circuits. Google search ‘Squishy circuits St Thomas’ for details. The website has great support material.

Making circuits:
1. Roll dough to about 1 cm in diameter and as long as you want. Push the various components into the dough, as shown below. Note, keep any components at least 1 cm away from the battery leads, else you may burn them out.
2. Explore making other circuits and combining the components. Some examples are given to the left, and more can be viewed on the website.

Making rules
3. Observe carefully and make up rules about the way the components work. Use evidence from your trials to support your ideas.

Share your observations and rules
4. Compare your list of observations and rules with other groups. Did your group list any that the other group did not have?

Going further
5. Find out how these circuits are similar to real everyday circuits that we use, e.g. in torches, door bells, etc. Make up some real circuits using wires instead of dough.
**Flying rolls**

**Learning intentions** Science Capabilities: Gather and interpret data from flying rollers. Fair tests.
Physical World: Flight and the forces acting on a flying object.

### Challenge 1

**Test flights exploration**
- Do some test flights to see what happens. Try different rolls and different elastic.
- Make as many observations as you can. What happens when you release it crooked?
- What happens if you stretch the elastic tighter as you wind it around the roll?
- What happens when you wind it more times?

### Challenge 2

**Fair tests**

Set up some fair tests to find out what causes:
1) straighter flight
2) longer flight
3) higher flight
4) downward flight.

### Challenge 3

**More careful fair tests**

Think carefully about how you have set up your fair tests. What things — called variables — do you need to keep the same? List them.
What is the one thing you are changing for each fair test? Think about how many repeat tests you have done for each test. Is one enough?

**Give your recommendations**

Describe what setup gives the longest flight. What evidence have you collected that supports your ideas? Share your ideas.
Research into what forces are involved in roller flight.

---

**What you will need:**

(per class)

- Cardboard and plastic cylinders of various sizes, e.g. those from inside Glad Wrap and toilet rolls, and, thick shake straws.
- Elastic (2 m long of various thicknesses, e.g. 2 mm, 10 mm and 20 mm).

**Setting the scene**

Like other flying objects such as tennis balls, flying ‘rolls’ behave in interesting ways because of the forces acting on them. This challenge involves investigating these forces.

Examples of rolls (cylinders) that will fly: cardboard rolls from inside Glad Wrap and toilet paper, and, a thick shake straw.

Start by attaching a length of elastic to one end of a table ensuring that 1 m can be laid on top of the table.

Wind the free end of the elastic about seven times around the roll, starting like this and stretching it as you do so.

Roll the elastic around the cylinder stretching it as you do so.

Hold the roll flat and straight on the table and let go. Watch it spin and fly!

---

**Key School Journal References:**

Round-the pole flying BROUGH, Murray Article 8 04 2 1997.
Manu tukutuku KAWANA, Manu Article Connected 1 2002.
Make a spinner BUXTON, Jane Article Connected 1 1999.

---

Learning intentions Science Capabilities: Gather and interpret data.

Challenge 1

Does water make a difference?
Put as much water as you can inside the balloon before you blow it up and tie it off. Now, see if the balloon pops at the same height above the flame as it did before.

Observe and record
Just for a second or two, see how close you can lower the same balloon towards the flame without it popping.

Challenge 2

How close for how long?
With a water-filled balloon, find out how long it will last over the flame. You decide on how high you will hold it (and how you will catch the spilling water when it does pop!)
Can you find some other substance that you can put inside your balloon to reduce its chances of popping?
Warning: do not use anything that is flammable.

Making it accurate
Figure out a way of recording your method and findings accurately so that if someone else tried to repeat your test, they would probably get similar findings as you.

Challenge 3

Can your result be repeated?
Good science is repeatable. Give your method and findings to another group and see if they get similar results as you. Explain why they did or did not get similar results to your group.

Simple laws
Make up some simple scientific laws about balloon popping.

Key ‘Building Science Concepts’ references:
Book 64 Candles: Investigating Combustion L3-4.

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Smell testing

Learning intentions
Science Capabilities: Make observations and inferences relating to smell.
Living World: Can we tell one smell from another? How many smells can we recognise?

Challenge 1

Make a collection of smells
Place five or six ‘smelly’ substances in different containers and cover each with foil held in place with rubber bands. Warning: Make sure you only use safe substances and because of allergies, do NOT use peanuts. How will you keep track of what is in each container?

Test your own smelling ability
Mix the containers up so you can’t tell what is inside each. Smell each container and record what you think is inside. Don’t check them till you have completed the lot. Find a way of marking (or rating) yourself on your ability to name the smells correctly.

Challenge 2

Testing another person
Test other people with the same collection of smells you used above, again starting with them mixed up. Don’t even tell them the selection of smells they are being tested on. Mark or rate them using the same method you used above. Also record the smells they like and dislike.

Making sure it’s a fair test
Before you test other people with your set of smells, how are you going to make sure your test is fair? That is, how do you ensure the only thing that changes from one test to the next is the person being tested?

Challenge 3

How many smells can we recognise?
Make a bigger smell collection and find a way of testing how many different smells a person can detect correctly. Collect data from lots of people to get an average.

About smell
Find out about how we smell things. Also, find out about how the human sense of smell compares with other animals like dogs, cats and budgies.
Magnetic pendulum

Learning intentions
Science Capabilities: Observations and inferences.
Physical World: Magnetic forces.

What to do

1. Use the instructions in this picture to build a magnetic pyramid

   * Step 1: Create a triangular base with three kebab sticks joined by rubber bands.
   * Step 2: Join three uprights to the triangular base using rubber bands, then join them at the top.
   * Step 3: Glue a magnet to the bottom end of a kebab stick to make a pendulum.
   * Step 4: Use string to hang the pendulum so it is 1–2 cm from the tabletop.

2. Tape another circular magnet firmly onto the tabletop like this and place your pyramid directly over it. There should be a gap of about 1 cm between the two magnets.

3. Swing the pendulum and observe what happens. List your observations. How long will it behave like this? Why does this happen?

4. Turn the bottom magnet upside down and re-tape it to the tabletop. Observe and list what happens when you swing the pendulum over it now. Discuss inferences. Can you now make inferences about what happened?

5. Compare your list of observations with those of another group. Did your group list any that the other group did not have?

6. Investigate further to see if your inferences were correct.

7. Find out more about magnetism and magnetic field lines. Where are magnets used? Find out more about pendulums too. Share your findings.
**Crime scene powder**

**Learning intentions**


*Material World:* Different substances can be identified by their chemical and physical properties.

**What to do**

**Setting the scene**

Some white powder was found at a crime scene and the police want to know what it is. They think it is something from a kitchen pantry. Can you help them find out?

1. **Physical Properties:**
   - Start by creating a ‘reference collection’ of white powders or crystals found in a kitchen. Label all the different substances carefully. (This will be useful in any future crimes too.)
   - Make careful observations on each substance in your collection. You will need to look at them in a variety of different lights and close up using magnification if you can. Are they shiny or dull? Smell, taste and feel them (rub them between your fingertips) too. Do ‘blind testing’ on their taste and smell to find if these are reliable properties. Can you measure or rank the size of the particles or crystals? Can you ‘measure’ how white they are by comparing them against something else? Which ones dissolve in water? Are they clear or cloudy when dissolved? Which ones melt when heated? (Caution: Adult supervision is needed.)
   - Build up and record as much information on each of them as you can, adding your own ideas too.

2. **Chemical properties:**
   - What substances do they react with? Safe chemicals to try are vinegar (an acid) or baking soda dissolved in water (a base). Which ones burn? (Caution: Adult supervision is needed.)

3. **Testing the police’s sample**
   - Your teacher will give you a sample of the powder found at the crime scene. Can you now find out what it is? Remember for police work you need to gather as much evidence as you can! So, give as many reasons for your choice as you can. One bit of evidence is not enough!

4. **Comparing with others**
   - Scientist often work together. Find a good way to show and share your choice with other groups. Do they agree with your evidence? Discuss and debate your choice. Would you be confident to take your answer to a court of law?
### Topic: Spectacular changes — chemical and physical change

#### Science Concepts

Key concepts relating to chemical and physical changes, including:

- chemical changes are nonreversible.
- chemical changes occur when substances are changed from one thing to another, either by splitting them or by recombining them in different ways.
- chemical changes can either produce or use energy, for example, burning releases heat.
- physical changes are reversible.
- physical changes include changes of state (solid—liquid—gas), changes of colour, changes of structure (powder, crystal, etc.) and dissolving and crystallisation.

#### Contexts/Strand

**Material World**

Compare chemical and physical changes.

#### Key Competencies

**Thinking**

Students will use creative, critical and metacognitive processes to make sense of information and experiences gained during this unit.

They will contribute to discussion with the teacher and peers and think about and reflect on their experiences in order to shift their ideas closer to the scientific ideas.

**Values**

**Innovation, Inquiry & Curiosity**

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

### Achievement Aims

**Nature of Science (NoS)**

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

**Contextual**

Material World: Properties and changes of matter.

**ICT**

Demonstrations as outlined in specific activities.

**Resources**

School Journals and Building Science Concepts books as outlined for given activities.

### Achievement Objectives

**Nature of Science (NoS)**

Levels 3–4

As above.

**Contextual**

Properties and changes of matter.

Levels 3&4

Compare chemical and physical changes.

**The 5 Es**

- **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

**Lemon volcano**

p19: Challenge 1. Observations: Bubbles are formed that quickly pop, creating a hissing sound. The reaction can be kept going by stirring and poking the flesh of the lemon and by adding extra baking soda. Challenge 2. Add food colouring which makes the products more obvious, and add detergent which traps the carbon dioxide gas so a stream of bubbles forms. Challenge 3. Another substance that will react with lemon juice is baking powder. Other substances that will react with baking soda or a solution of baking soda and water are: vinegar (malt or white), citric acid, tartaric acid and cream of tartar (slight reaction).

**Overnight crystal garden**

p20: Challenge 1. Epsom salt crystals are long, rod-like, square ended crystals. One option to measure crystal lengths is to create a ruler from a long, thin strip of paper (say 10 cm long and 3 mm wide with millimetre lines marked on it). Gently line it up alongside a crystal you want to measure. Challenge 2. Food colours make the crystals more vivid and obvious. Clear containers are the best for viewing the crystals. Challenge 3. The crystals usually grow longer during days 2 and 3 but don’t seem to get any longer beyond that time. To determine this accurately it would be best to measure (say) the longest 10 crystals you can find each day and average them.

**Black snakes**

p21: 5) Observations might include: yellow-blue flame (or whatever colour it is); a burnt sugar smell; brown-black ‘snake’ products growing out of the powder; bubbling brown-black liquid around the base of the snakes; smoke production; a sizzling sound; etc.

7) Adjustments that could be made (during a fair testing process): type of flammable liquid used; amount of flammable fluid; depth of the hole in the sand; the grain size of the sand; the proportions of the ingredients; the total amount of powder used; etc. Share findings to quickly learn what each variable does. 8) The chemical reactions: When king sugar (which is powdered sugar) burns it produces the carbon ash product that forms the snake. The ash is made light and fluffy by carbon dioxide released as the baking soda is heated. UV beads: p22: 1) They turn different colours. On a bright day they will change in less than 2 seconds. On duller days this will be longer. 2) Could try fluoros, LEDs, tungsten, torches, computer monitors, shady areas, cloudy days, etc. 3) UV sources. These need to be direct, not indirect like passing through a pane of glass. Reflected sunlight will work, e.g. reflected off clouds or white sand. 4) Things that block UV include: acrylic, glass, sunblock (e.g. smeared on a plastic bag), cotton, sail cloth, etc. 5) The best UV blockers are opaque, that is, materials that let no light through, e.g. canvas hats. Water, clear plastic and clouds don’t protect you much.

**Curdling milk**

p23: Challenge 1. Vinegar causes curdling. Challenge 2. Will cause curdling: white vinegar, malt vinegar, tartaric acid, citric acid. Citric acid won’t cause curdling: baking soda, salt, flour. To do fair tests: use the same quantities of ingredients, use milk at the same temperature, stir the same number of times, etc. Challenge 3. A known curdling substance, try using half, quarter or less. If it still curdles it would save money and reduce the chance of tainting the curdle.
Spectacular changes

SCIENCE 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 recently launched Five Foundational Science Capabilities) are inherent — as they are mandatory — and here we treat them in an explicit manner. Aspects of Science Capabilities are emphasised using **bold italic** script.

A combination of these approaches encourages skill development and Nature of Science (NoS) understanding, while the ‘Spectacular Changes’ context plays a supporting role. That is, the emphasis is less on traditional content coverage, and more on the Nature of Science and Capabilities. Note, you do NOT need to cover all sections — as there are a large number of ideas presented here. The most valuable learning occurs when some areas are pursued deeply. This is especially important for Years 7 & 8 and older students.

### Specific Learning Intentions

**Foundational Science Capabilities** *(that are a functional interpretation of the Nature of Science, see TKI Science: www.scienceonline.tki.org.nz/introducing-five-science-capabilities)*

- **Gather and interpret data:** Learners make careful observations and differentiate between observation and inference.

- **Use evidence:** Learners support their ideas with evidence and look for evidence supporting others’ explanations.

- **Critique evidence:** Learners understand how to critically appraise the quality of evidence and the validity and ‘fairness’ of methods.

- **Interpret representations:** Learners (and scientists) are able to represent their ideas in a variety of ways, including models, graphs, charts, diagrams and written texts.

- **Engage with science:** Students use their other capabilities to engage with science in ‘real life’ contexts.

- **Content**

  Content ideas will be specific to those investigations you choose to do. All activities are well supported with online content information. Initially see the YouTube clips listed for each activity.

- **Lemon Volcano**

  Citric acid and baking soda react to produce carbon dioxide gas. This is a chemical change.

### Learning Activities through 5Es model

<table>
<thead>
<tr>
<th>ENGAGE</th>
<th>Ignition activities</th>
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<tbody>
<tr>
<td>Explore some of these simple investigations relating to chemical and physical change:</td>
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</tbody>
</table>
| - **Dissolving:** Dissolve Raro crystals to make a drinkable solution. Can you get the crystals back? [Yes it is reversible, by evaporating the liquid. Physical change.]
| - **Grow crystals:** Make a concentrated table salt solution and pour a small amount into clean black meat trays. Leave the trays in different situations so the liquid evaporates — fridge, shade, a sunny windowsill — and compare crystal formation over several days. Can you reverse this change? [Yes. = Physical change.]
| - **Make coloured solutions:** Use food colouring and water to make different coloured solutions. Combine them in different proportions to make new colours. What proportions are needed to produce given colours? Can you repeat your combinations and get the same colours again? Starting with a single colour, can you get the original pigment back out of the solution? [Yes, by evaporation = physical change.]
| - **React two chemicals:** Place a teaspoon of baking soda and a teaspoon of citric acid and some water in a small zip-top plastic bag. Zip it up and feel the bag. Is there a temperature change? Put in on the ground and watch it pop. (Caution: Can be messy, so go outside to a lawn area.) What gas is made? Are there new substances produced? [A chemical change that uses heat (the bag feels cold) and produces new substances including carbon dioxide gas. Non-reversible. = Chemical change.]
| - **Burn something:** Make careful observations of a burning candle and/or a burning piece of paper. (= Combustion) (Caution: adult supervision required and watch that smoke alarms are not set off!) What did you start with and what did you end up with? Hold a clean piece of glass above the flame to see soot and (hopefully) condensation which are both new products. Can you get the original substances back? [No, it is non-reversible. = Chemical change.]

<table>
<thead>
<tr>
<th>EXPLORE, EXPLAIN AND ELABORATE</th>
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| Perform each of the following investigations or challenges. Each one gives ample opportunity for children to **explore, seek explanations** and then **elaborate** by branching out into student-lead investigations based around their own questions. It is suggested that you make one or more of the Five Science Capabilities explicit during your lessons.

- **Lemon volcano**

  Discover ideas relating to chemical change from this unexpected source of acid. Lemons contain citric acid which gives them their ‘acid bite’ to the taste. The acid is contained within cells inside the flesh of the lemon. When you slice off the top and bring baking soda into contact with the acid a chemical reaction occurs that results in the release of carbon dioxide gas that is seen as bubbles. Students can make **observations and inferences** about what causes the reaction. To allow more baking soda to come into contact with citric acid, gently probe and stir the lemon flesh. It will increase the duration of the reaction with more bubbles being released. Adding more baking soda will also keep the reaction going longer. Food colouring can be used to give a better visual effect, while a few drops of detergent will enable the bubbles to be trapped with a resultant ‘stream’ of bubbles spewing out of the ‘volcano’. This is a **nonreversible** change, so it a chemical change. *[Lemon volcano Challenge sheet]*

  - **Website:** www.babbledabbledo.com/science-activity-kids-lemon-volcano/
  - **YouTube:** www.youtube.com/watch?v=a08Stcy32o0
**Specific Learning Intentions**

<table>
<thead>
<tr>
<th>Content (cont.)</th>
<th>Learning Activities through 5Es model</th>
</tr>
</thead>
</table>
| **Overnight crystal garden:** Crystal formation is a physical change that is influenced by many variables. | **Overnight crystal garden**  
- Crystals of various types are generally easy to grow, but they usually take several days. However, one substance, Epsom salt (magnesium sulphate) forms crystals very quickly — overnight is sufficient. This speed of growth presents opportunities for performing various investigations by changing one variable at a time (fair tests). Will crystals form in the fridge, freezer, on a windowsill, in shade, in the sun, etc? What if you change the proportions of water to Epsom salt? Critique your methods of fair testing. Students can also make close-up observations of the characteristic rod-like crystal shapes. Measure how many millimetres they grow per day. Can you colourize the crystals? Can you reverse this change? Crystal formation is a physical change, so yes it can be reversed by re-dissolving the crystals you have created. [Overnight crystal garden Challenge sheet] |
**Theory notes**

### Spectacular changes

In the Material World, there are two main types of changes, chemical change and physical change.

#### Chemical changes

Chemical changes are reactions that result in one or more new products. Chemical changes cannot easily be reversed.

**Examples:**

A reaction can be written in word form:

**Substance A and substance B react to form substance C.**

In symbols it could be written as follows, with the arrow meaning ‘reacts to form’.

\[ A + B \rightarrow C \]

This following reaction shows A being split into two new substances.

\[ A \rightarrow D + E \]

This shows A and B reacting together to form two new substances.

\[ A + B \rightarrow X + Y \]

The arrow only points in one direction because the products formed cannot be changed back to the original substances. Chemical reactions are said to be nonreversible.

#### Examples of chemical changes

**Lemon volcano**

Citric acid (in lemon juice) plus baking soda react to form sodium citrate, water and carbon dioxide gas, or:

\[ \text{citric acid} + \text{baking soda} \rightarrow \text{sodium citrate} + \text{water} + \text{carbon dioxide} \]

**Black snakes**

<Students research into the reaction>

**Curdling milk**

<Students research into the reaction>

#### Physical changes

Other changes can be reversed and are called physical changes. When we melt ice to make water, that change can be reversed by cooling the water to make it freeze and form ice again. Below the arrow means ‘changes into’ and it goes both directions because the change can be reversed.

\[ \text{ice} \leftrightarrow \text{water} \]

### Examples of physical changes

Making crystals is a physical change because:

<Students answer>

The colour changes that UV beads go through are physical changes because:

<Students answer>

### Science is about

Teacher to choose the most appropriate language and approach to the following core ideas. It is suggested that at least some of these ideas be taught explicitly in any given unit. See the following web link for more detail: [www.scienceonline.tki.org.nz/Introducing-five-science-capabilities](http://www.scienceonline.tki.org.nz/Introducing-five-science-capabilities).

Science is a way of finding out about the world. Doing good science means to:

1. **Gather and interpret data:**
   - Wonder, explore and play with ideas.
   - Ask good questions to investigate.
   - Make good observations using all our senses and sometimes use instruments to help make more accurate observations.
   - Make inferences which are [children complete: the meaning made from observations].
   - Follow steps and record them so we know what we did and how we might change things next time.
   - Repeat trials in order to find trends and patterns.
   - Collect data and results and think about what they mean.

2. **Use evidence:**
   - Support ideas or claims using evidence from our observations and data.
   - Sometimes reject ideas or claims using evidence.
   - Realise that a negative result is still useful.

3. **Critique evidence:**
   - Think about the strong and weak points of our methods, data, interpretation of data and the evidence and conclusions we have presented.
   - Be honest about what we see and what this might mean.

4. **Interpreting representations:**
   - Find good ways of communicating our methods, findings and conclusions. Sometimes this might include creating tables, graphs, charts, posters, written text, models and simulations.

5. **Engaging in science:**
   - Learn by having fun and through being ‘seduced’ by science.
   - Get emotionally involved in our learning.
   - Understand how science ideas relate to our everyday lives.
   - Use our science understanding in different situations.
   - Take action over important scientific issues.
**Spectacular changes**

**CHALLENGE**

**Lemon volcano**

**Learning intentions**  
Science Capabilities: Observations.  
Material World: Chemical reactions involving acids and bases.

---

**Challenge 1**

**The effect of stirring**

Use the handle of a spoon to stir the baking powder into the flesh of the lemon. Poke and prod it. Observe and record what happens.

**Timing**

Time how long it keeps reacting.

**Keeping it reacting**

Find a way of making it keep reacting. How do you know that it is in fact reacting?

---

**Challenge 2**

**Make it more exciting**

Start with a fresh lemon. Before adding the baking soda, can you add a substance that might make the bubbles easier to see? Can you add another substance that will trap the gas inside the bubbles for longer? Repeat the steps in Challenge 1 above. What happens this time? Why?

**Hints:**

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**Challenge 3**

**Going further**

Can you find any other ‘food safe’ substance from your kitchen that lemon juice will react with? Can you find any other ‘food safe’ substance that baking soda will react with? Check with an adult before performing the reaction.

---

**What you will need:**

(per group)

- Lemons (x3).
- Baking powder, detergent, food colouring.
- A large plate or tray.
- Teaspoon, knife.
- Optional: salt, baking powder, sugar.

---

**Setting the scene**

Two common types of chemicals that react together are acids and bases. This challenge uses an unusual source of acid — citric acid from directly inside a lemon.

Prepare a lemon by slicing just enough off its base that you can sit it upright without it toppling. Ask an adult to help. See picture A. Once upright, cut out a hole in the top of the lemon (see picture B).

Now you can place chemicals inside the lemon to see if they react with the lemon juice. First try some baking powder, as shown below. Do not stir. Observe.

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**Adding baking soda into the lemon.**

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**Key School Journal References:**

Elephant Toothpaste REID, Nikki Article 5 Connected L3 2014.  
Pop! Froth! Fizz! BARTHOLOMEW, Rex Story 4 Connected L2 2014.  
Fast Rust WALL, Bronwen Article 5 Connected 03 2013.  
Bendy bones VAUGHAN, Marcia Article Connected 3 2000.
Spectacular changes

CHALLENGE

Overnight crystal garden


What you will need:
(Per group)

- Epsom salt (magnesium sulphate) obtained from a garden centre or places like Mitre 10.
- Small containers, e.g. yoghurt pots or clear shot glasses.
- Spoons and food colouring.
- Hot water.

Setting the scene
Crystals are solids that have very regular shapes such as cubes and hexagons. Some grow very slowly, but others can be grown very quickly. This activity challenges you to create the ‘best’ crystals overnight.

The basic recipe
Into a jug or similar, add one cup of Epsom salt to one cup of hot tap water. The water should not be boiling. Use a spoon to stir until almost all the of crystals are dissolved. Pour some of the solution into each of several different types of containers, making sure some partly dissolved crystals go into each container, then sit them in the fridge uncovered overnight. Inspect them the next day, and if you are happy with the crystals, pour off the liquid from on top of the crystals. If you don’t do this, the crystals will probably begin to dissolve. This waste liquid can be poured around trees and shrubs as it is a fertiliser.

Challenge 1

Inspect your crystals
Closely inspect the crystals. You may need to use a magnifying glass. What shape are they? Find a way of measuring the longest crystals and record your data.

Challenge 2

How can you make them more colourful?
Make up another batch of Epsom salt solution. Mix in different food colours to different containers before you place them in the fridge.

What are the best containers for viewing them in?
Choose different types of containers to find the best way of displaying your crystals. Compare your crystals from this second challenge with the first ones you made. Record your findings.

Challenge 3

The longest crystals
You may already have discovered ways of creating really long crystals. But, try this anyway. Find a way of measuring your longest crystals after one day, then grow them for another day and see if they get longer. Repeat to find the number of days needed to create the longest crystals.

These crystals are just a start. How long can you make them grow?

Key School Journal References:
Learning intentions
Science Capabilities: Gathering and interpreting data through observations and fair tests.
Material World: Investigate how two chemicals react to produce a new product (black ‘snakes’).

What to do

1. Fill an aluminium pie dish (or other heat-proof dish) with sand. Make a hollow in the middle of the sand about the size of a golf ball.
2. Mix up 1 tablespoon of baking soda and with 4 tablespoons of icing sugar. Make sure you mix the two powders well, then place one to two tablespoons of the mix in the hollow you made.
3. On a still day, place the dish outside on concrete. Take water or a fire extinguisher with you for safety.
4. Use safety glasses. Pour about two or three tablespoons of isopropyl alcohol or lighter fluid into the sand around and a little over the powder mix. Warning: Do this with an adult. Use the BBQ lighter to light the alcohol or lighter fluid.
5. Observe carefully what happens and also watch what happens to other groups’ setups. Use all your senses. Record your findings.
6. As a class: Share and discuss what you found. Do you think you could create better ‘snakes’?

Create your own setup (Remember adult supervision with fire)

7. Now that you know the basic method, make adjustments to the recipe and setup to see if you can create bigger snakes more reliably. Think scientifically! Remember to only change one thing (variable) at a time, else you won’t know what caused any changes you saw.
8. Between experiments, share your findings — through mini conferences or meetings like scientists would — so you can learn more quickly and avoid making mistakes that others have already encountered.
9. Find out about the chemical reaction involved and the products it creates.

Showing others

Find a good way to report your final outcomes. Report your: 1) questions, 2) how you did your investigations, 3) what you found out, 4) what you could do better, and 5) what new questions you could now ask. See ideas in box to left.
**INVESTIGATION**

**UV beads**

**What you will need:**
(per group)
- UV beads (8 mm diameter are best).
- Heavy cardboard.
- Scissors, PVA glue, ruler.
- Materials to test: plastic bags, cotton fabric, glass, acrylic, etc.

**Learning intentions**

*Science Capabilities:* Gathering and interpreting data. Fair tests. Using evidence.

*Material World and Physical World:* UV beads become colourful in ultraviolet (UV) light. They can be used to measure how much UV there is.

**What to do**

1. Start with beads that are white (they turn white when stored out of the light). Take a few outside and hold them in the light. What happens? How quickly?

2. Explore other places and light sources to see if the beads change colour.

3. What makes them change colour? Decide on how you are going to find this out and set up some experiments. We know it is UV light, but what light sources make UV light? How quickly do they make the beads colourful? Does heat make a difference? Do the beads need to be facing a particular direction? Will they change if facing away from the sun? What happens on a cloudy day? Explore lots of questions and ideas.

4. After establishing what causes them to change colour, see if UV light can be blocked by different substances, e.g. clear plastic, glass, white cotton fabric, water, sail cloth or shade cloth, sun block cream, and so on. Make sure you set up fair tests.

5. What would be the best substances to use to protect your skin from UV light? What substances don’t seem to protect you much at all?

6. Cut out four or five 4.5 cm x 4.5 cm cardboard squares and use PVA glue to stick yellow and orange beads in different, simple grid patterns on the cards. See examples and instructions on how to use them to the left. Use measurements you have made as evidence for how effective various fabrics, plastics and sunblocks are at blocking UV light.

**Can you use the beads to measure the strength of UV light?**

**Showing others**

Find a good way to show others about your evidence for how good the UV blocking materials and substances are (or are not).

**Find out more**

Research into why the UV beads change colour. Is there something in the plastic? What is UV light exactly? How is it useful and also harmful?
**Learning intentions** Science Capabilities: Gather and interpret data. Observations, fair tests. Material World: How some chemicals cause milk to curdle.

What you will need: (per group)
- Milk (blue top and yellow top).
- Several containers (yoghurt potties or clear plastic shot glasses are good).
- A number of possible ‘curdling agents’ found in a typical pantry such as: baking soda, citric acid cream of tartar, flour, malt vinegar, salt, sugar, tartaric acid, white vinegar.
- Teaspoons, or better still, measuring spoons.
- Optional: thermometer.

### Challenge 1

**Observations**
Warm some milk in a pot or microwave till it is about body temperature. 40°C is good if you can measure this with a thermometer. Half fill a plastic shot glass with the warm milk. Add ¼ teaspoon of white vinegar and stir. Observe and record what happens. Look at what other groups found and compare. Try it again to see if it behaves the same way again. (Good science is about repeating things to make sure your results weren’t just chance.)

### Challenge 2

**What else causes curdling?**
Test a range of substances to see if they cause curdling too, including: baking soda, citric acid, cream of tartar, flour, malt vinegar, salt, sugar and tartaric acid. You can try other substances as long as they are normally used in food preparation. Make sure you do accurate comparisons by performing fair tests. How did you ensure they were ‘fair’?

### Challenge 3

**How little do you need?**
How can you find out the smallest amount of added substance that causes curdling? Investigate. How would these results be helpful if you were in business making a food product that needed clotted milk?

**Other tests**
Design and conduct experiments to find if:
- the temperature of the milk changes the curdling
- different types of milk curdle differently
- you can create coloured curdle
- you can make new products from the curdle.
Also test your own ideas.

Research into what the curdle is and what it can be used for.

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 Spectacular Changes, is to use ‘mind mapping’. You can measure student knowledge by counting the number of words they use in their map that correspond with the list of keywords we supply to the right.

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

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

Drawing and assessing a mind map

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

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

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

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

Plus extra words at teacher’s discretion.
Mind map on ‘Science is about’

Name ____________________________ Date________

Year level _____  School ________________________

Science is about
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.
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.

**See now the power of truth; the same experiment which at first glance seemed to show one thing, when more carefully examined, assures us of the contrary.**

**Galileo Galilei**

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**Exhibits**

**Themes**

**Electricity — Te Hiko**

Exhibits in this theme address specific learning intentions relating to the following: batteries in series and parallel; collapsing magnetic fields; conductivity of different materials; electromagnetic induction; wet cells; electrical discharge; magnetic fields around wires; energy efficiency of light bulbs; magnetising and demagnetising metals; solar panels; and, AC and DC current. Exhibits include:

- Batteries in Circuits
- Collapsing Mag Field
- Conductivity Tester
- Electricity Quiz
- Flashing Pendulum
- Hand Battery
- Jacob’s Ladder
- Kicking Wire
- Light Bulb Efficiency
- Magnetising and Demagnetising
- Solar Car
- Solar Generator
- Wrigglng Filament

**Contexts — Electricity, Circuits, Power, Energy**


**Gravity — Te tō á-papa**

Exhibits in this theme address specific learning intentions relating to the following: conservation of momentum; strength of materials in resisting gravity; trajectories; strength of gravitational pull on differing masses; net forces and unbalanced forces; acceleration due to gravity; levitation; differing weights on differing planets; density and buoyancy; rotational motion; and, anti-gravity illusions. Exhibits include:

- Astroblaster Piston
- Bendy Beams
- Bounce Trajectory
- Bowling Ball
- Chain Siphon
- Hovercraft
- Impact Point
- Spinners
- Magnetic Levitation
- Planetary Weights
- Rise and Fall
- What Weighs What?

**Contexts — Gravity, Forces**


**Heat — Te pōkākā**

Exhibits in this theme address specific learning intentions relating to the following: expansion of fluids and solids upon heating; traditional fire-making methods using friction; focussing heat using a concave reflector; low density air rises; trapped air in insulation prevents heat loss; heat makes particles move faster; and, how heat can be used to generate electricity. Exhibits include:

- Bubbling Liquid
- Expansion of Metals
- Fire Making
- Focus Point
- Hot Air Balloon
- House Insulation
- Radiant Spin II
- Solids, Liquids, Gases
- Thermoelectricity

**Contexts — Heat, Temperature, Energy**


**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.
Curiosity probe
When time allows before shows, our Presenters will introduce an experimental scenario with students that will probe into their understanding of a science idea. The necessary equipment will be displayed, its use explained and students will be asked to give their opinions about the possible experimental outcomes. The actual experimental results will not necessarily be given, so students will be encouraged to discuss or perform the investigation back in class.

Back in class
The equipment will be simple and accessible so that teachers will be able to repeat the setup in class and run the experiment in order to discover the outcome. This should lead to discussion around the key concepts and further questions could lead to further investigations. Probes can be used as a diagnostic or formative assessment tool.

The probe setup
Using two identical thermometers, place one inside a mitten (or even mitt!) and leave one alongside the mitten. Check both their temperatures one hour later. (Ensure that the room temperature has not changed over that period.)

Question. Which of these outcomes will occur?
1. The thermometer inside the mitten will show a lower temperature than the one outside.
2. The thermometer inside the mitten will show a higher temperature than the one outside.
3. Both thermometers will show the same temperature.

Ask the students to describe their thinking.

Answer
Both thermometers will show the same temperature. This is because over the period of one hour, all items involved — the mitten and the two thermometers — will settle to room temperature, say 21°C. There is no heat source like a warm hand inside the mitten, so there is nothing to heat up the inside. The common misconception that it will be warmer on the inside comes from the fact that when your hand is inside the mitten it feels warmer than when it is outside the mitten. However, it is only the heat from your hand, trapped by the insulating fabric of the mitten, that elevates the temperature inside.

This probe explores energy, heat and temperature.

More detail
More detail will be available when you visit the Science Roadshow.

Human performance — Ngā Mahi a te Tinana Tangata
Exhibits in this theme address specific learning intentions relating to the following:

- variation of fingerprints; hand–eye coordination; muscular strength and fatigue; athletic performance; reaction times; strength of bones; binocular vision; voice–brain coordination; and, balance. Exhibits include:
  - Fingerprints 1 & 2
  - Jump Needle
  - Voice Delay
  - Follow the Path
  - Reaction Tester
  - Hand Grip
  - Strong Bones
  - Heart as a Pump
  - Thread the Needle
  - Magnetic Attraction
  - Separating Sand

Contexts — My body, The human body, Sport and Fitness

Key School Journal References:
- Don’t Sit if you want to Stay Fit!
- Janice Play 5 Level 2 2001

Magnetism — Te Autō
Exhibits in this theme address specific learning intentions relating to the following:

- magnetic fields and what they pass through; how the Earth is a giant magnet; interaction of magnetic fields; magnetic repulsion and attraction; magnetic levitation; magnetic coupling; how a mass spectrometer separates substances; how to detect hidden metals; and, separation of substances using magnetism. Exhibits include:
  - Breaking Magnetic Fields
  - Earth’s Mag. Field
  - Eddy Current Braking
  - Levitating Pencil
  - Magnetic Attraction
  - Magnetic Collision Trolleys
  - Magnetic Coupling
  - Magnetic Pills
  - Mass Spectrometer
  - Metal Detector
  - Powerful Attraction
  - Powerful Repulsion

Contexts — Magnetism, Forces

Key School Journal References:
- Invisible Forces: Magnetism and Static Electricity
- Book 49 Invisible Forces: Magnetism and Static Electricity

Observations — Ngā mātakitaki
Exhibits in this theme address specific learning intentions relating to the following:

- visual observations; comparisons; grouping and identifying; detailed observations using instruments; pattern seeking; cause and effect; and, inference and deduction. Exhibits include:
  - Artificial Gravity
  - Big Foot, Little Foot
  - Bird Song
  - Blue Pearls
  - Creepy Crawlies
  - Dating Trees
  - Dave’s Poorly Gut
  - Dating Trees
  - Dave’s Poorly Gut

Contexts — Gather and Interpret Data

Key School Journal References:
- My ant farm
- My body, The human body, Sport and Fitness

Note: While every effort is made to have these exhibits on offer, we cannot guarantee that all of them will be on display at any one time.
While being exciting and entertaining, our shows provide a great opportunity to enhance student knowledge in two science areas each year. The shows for 2017 are Spectacular Changes, all about chemical and physical changes, and the Hidden World show, focusing on the use of instruments to see things not normally visible to the naked eye.

To assist you in preparing for your visit, we've developed a unit plan called Spectacular Changes — found in this booklet — that complements the Spectacular Changes show. If time permits within your classroom programme, you may like to use notes from the Hidden World show outlined below to develop your own pre- and post-visit unit to complement that show.

**Spectacular Changes Show — Te Whakaaturanga Panoni Matū Miharo**

This show covers specific learning outcomes relating to physical and chemical changes, including the following:

- physical changes and how they can be reversed
- freezing and melting are examples of physical changes
- sublimation as a physical change
- changes in acidity caused by chemical change
- examples of different types of chemical reactions
- burning as a form of chemical change.

**Hidden World Show — Te Whakaaturanga Ao Huna**

This show covers specific learning outcomes relating to how we can use instruments to see things that we would not normally detect with our naked eyes. It also covers light and other parts of the electromagnetic spectrum, including the following:

- visible light, lenses and magnification
- microscopes and how they revolutionised our understanding of the world
- infrared radiation and thermal imaging
- the nature of X-rays
- radio astronomy.

**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 and Science Capabilities.
Answers to pages 3–14

**Electrical components page 3**
Electricity only flows through a complete circuit.

**Gravity secrets page 4**
Gravity is a force that acts over a distance. It is always a pull force.

**Heat it up! page 5**

**Human performance page 6**
1) Brain. 2) Skeleton.

**Magnetism page 7**
Mystery words: magnetism, nickel, non-magnetic, fieldlines, cobalt, earth

**Powers of observation page 8**
Differences marked with circles.
- Microscopes: Right microscope is reflected and narrower.
- Brain: Right brain is narrower and rotated slightly.
- Spacecraft: Right spacecraft are smaller (but in proportion).

**Squishy circuits page 9**
3) Examples of rules about components: Batteries supply the power. Without them, other components don’t work. Battery leads need to be pushed deep into the dough. Conducting dough allows electricity to flow. Insulating dough stops the electricity. LEDs have to be plugged into the dough the right way around, else they don’t work. Buzzers have to be plugged into the dough the right way around, else they don’t work. Motors need more power than the other components. When their leads are reversed, they spin the opposite direction.

**Flying rolls! page 10**
Challenge 3: When performing a fair test, all variables need to be kept the same except the one thing you are testing. For example, if you are testing whether a longer roller flies further, then keep all other variables the same — the elastic type, how many windings you use, how much you stretch it before release, how you release it, the table you use, etc. It is best to do several trials to find an average, since one trial could by chance give an odd result. Evidence example: Distance measurements taken from multiple trials, then averaged. Forces involved include: forward pull of the stretched elastic, backward drag due to air friction, upward thrust due to spinning of the roll, and, the downward pull of gravity.

**Popping balloons page 11**
Challenge 1: Most won’t pop at the same height. A balloon containing water can be lowered right down onto the candle flame without it popping. Challenge 2: Ideas of substances to try inside the balloon include: rice, wet sand, dry sand, finely crushed ice, soda water. Challenge 3: Simple laws about balloon popping include: 1) The closer to the flame, the quicker the balloon will pop. 2) A balloon that contains water is slower to pop. 3) The more stretched a balloon is the quicker it will pop. 4) The colder the balloon skin is, the slower it will pop. 5) Balloons containing watery fluids are slower to pop.

**Smell testing page 12**
Challenge 2: For a fair test, students will need to change only one thing between each test. For this investigation the thing being changed will be the person being tested. Every other aspect of the test must be kept the same, including things like: keeping the contents of the ‘smell bottles’ secret (no listening in other people’s guesses); using the same set of smell bottles, presenting the smells in the same order; determining a set time between each smell test, e.g. 20 seconds (or the person being tested might be asked to breathe in and out through their nose 5 times between each smell test); always keeping their noses the same distance from the bottle; always sniffing the same number of times; keeping to the same rules about how exact their guesses have to be; etc. Challenge 3: In fact humans can detect many thousands of distinct smells. So, the more smells tested, the greater the number of smells that will be detected correctly.

**Magnetic pendulum page 13**
3) Observations might include: If ‘like poles’ are facing each other, then: the pendulum will always sit at an angle, not straight downwards; when moved it will appear to ‘bounce’ away from the centre; it will keep bouncing, each time a little less, and take a long time to stop; when pushed towards the centre with your hand it will feel like it is being pushed away. If ‘unlike poles’ are facing each other, then: the pendulum will always sit straight up and down; when moved it will giggle around the centre, getting closer and closer to straight up and down; it feels like it is being pulled towards the centre. Students may also measure distances over which attraction and repulsion occur. 4) Through the observations above, students will be able to infer whether like or unlike poles are facing each other.

**Crime scene powder page 14**
3) Some of the substances will react with acid (vinegar) to create bubbles of carbon dioxide, including baking soda and baking powder (a weaker reaction). Substances that will react with a baking soda and water solution, again producing carbon dioxide bubbles, include citric acid, tartaric acid and cream of tartar (a slow reaction). 4) Students will need to determine what the mystery powder is by matching the physical and chemical properties of their known ‘reference collection’ with the properties of the mystery powder that the teacher supplies. Once students have got the idea, try them with a different mystery substance that has been modified to make its identification harder, e.g. citric acid whose crystals have been crushed to a powder using a mortar and pestle.
The Sir Paul Callaghan Science Academy runs intensive, four day professional development programmes that aim to build excellence in the teaching of science. Our vision is to create primary and intermediate teachers who celebrate science and inspire their students to explore and engage with the world through science.

With renewed support from the Ministry of Education, we are again able to offer “zero course fees” for 2017.

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“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.

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 students, teachers and their wider communities.