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.

Included within this resource are:

a) Language and science activity based resources that explore six exhibit themes within the 2010 Fonterra Science Roadshow programme.

Suggested usage:

<table>
<thead>
<tr>
<th>Pre-visit activities</th>
<th>Visit to Roadshow</th>
<th>Post-visit activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>(language based)</td>
<td>(exhibit use and demonstrations)</td>
<td>(practical science, activity based)</td>
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</tbody>
</table>

b) A three stage Unit Plan on Motion:

Stage 1

Pre-evaluation

Stage 2

Visit to Roadshow

Stage 3

Post-visit unit work (including unit evaluation)

Numeracy and literacy

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

Additional resources

We would also like to draw your attention to The Building Science Concepts series produced by the Ministry of Education and School Journals that will further extend your students on many of the topics covered by the Fonterra Science Roadshow.

Similarly, the Internet is an important source of information about science. We have found Wikipedia especially valuable, while YouTube is an excellent source of science demonstrations.

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A big thank you to our sponsor Fonterra

Fonterra’s support enables us to sustain and extend the programme’s reach to over 45,000 students a year and to bring new and exciting experiences. The 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.

Did you know:

Fonterra has invested over US$40 million dollars into bone research so it can pioneer milk to build bone strength.

Prepared by Peter E. Smith, Educational Solutions
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Making the most of learning opportunities

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 has 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 demonstrations. 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 will the exhibits set up in the hall. (See exhibit details on pages 5 and 6.)
- Staff will advise students when their exhibit time is over.
- Students will return to the demonstration area for the second fifteen-minute demonstration. Your group may be joined by students from another group for this demonstration.
- Staff will direct your students to leave the hall at the end of the second demonstration.

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’ learning and 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: student 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 on the science behind one or more of the 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.
Teachers: Please provide each of your helpers with a copy of this page.

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 demonstrations called *Up, down, all around* (about gases) and *On the move* (about motion).

How you can help students to get the most from their visit
• Encourage students to try things for themselves.
• Help students to read the information on exhibits.
• Talk to students about the exhibits.
• Ask students questions about what they are doing, for example:
  What do you think this is? How does it work? What can you find out from it?
• 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)…

How you can help the Fonterra Science Roadshow
The Fonterra Science Roadshow team would love to know what you thought about your visit. At the end of your visit could you please take a few moments to answer the questions below and hand to one of the staff.

If you’re not confident with science…
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.
• 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.

Did you enjoy your visit to the Fonterra Science Roadshow? Yes/No
Do you think that the students have enjoyed their time? Yes/No
Do you think experiencing the Fonterra Science Roadshow might affect a student’s decision to study science in the future? Rate on a scale of 1–10 where 1 is absolutely no chance and 10 is an absolute certainty.
Do you think students are aware of the kind of job opportunities science offers? Rate on a scale of 1–10 where 1 is not aware at all and 10 is acutely aware.
Did you learn anything from your visit? Yes/No
Do you think the visit was good value for money? Yes/No
Any other comments?

Did you know:
Alcohol (ethanol) can be produced from milk when the sugar it contains (lactose) is fermented and distilled. This alcohol is used in industrial solvents, alcoholic beverages, mouthwash, deodorants and perfumes.
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 following notes 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, then to explain how they work to nominated adults (who have model answers). If they explain a given exhibit correctly, they have a card stamped. They repeat this process with the other exhibits and once they collect at least two stamps, 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 65 exhibits are on display at any one time.

Themes

Electricity — Te Hiko
Exhibits in this theme address specific learning intentions relating to the following: electrodes and electrical discharge; power use; step up and step down voltage; electricity generation; AC and DC current; electromagnets; electromagnetic induction; electrical cells; magnetic fields; microwave hot spots; resistance in wires; and, parallel and series circuits. Exhibits include:

- Jacob’s ladder
- Metered appliances
- Magnet and compass
- Magnetising and de-magnetising
- Turbine and generator
- Wriggling filament
- Venturi gun
- Hand battery
- Micro glow
- Transformer
- Electricity quiz
- Conductivity tester
- Resistance wire

Contexts
Electricity; Electricity and magnetism; Energy; Technology.

Key School Journal References: Electric map, John Bonallack, Article, Pt CN No. 3, 1998; Light bulb, S.A. Yeates, Poem, Pt 04 No. 2, 1993; New lights at the farm, Maryan Moss, Story, Pt 02 No. 1, 1987; The old water-wheel, Brian Birchall, Article, Pt 01 No. 2, 1989; Power crisis - where to now? John Bonallack, Article, Pt 04 No. 2, 1993; The power of rubbish, Pat Quinn, Article, Pt CN No. 3, 1998; The sleeping giant, Bill Keir, Article, Pt 02 No. 2, 1989; Turning on the power, Brian Birchall, Article, Pt 04 No. 3, 1981; Water power, Sandra Carrod, Article, Pt 02 No. 4, 2005; Windmills of the future? Article, Pt 04 No. 3, 1981

Forces / Pressure — Ngā tōpanga/te pēhānga
Exhibits in this theme address specific learning intentions relating to the following: magnetic repulsion versus gravity; centre of gravity; centrifugal forces; vacuums; siphoning; buoyancy; weight; Bernoulli’s principle; pressure on skin; and, Venturi effect. Exhibits include:

- Magnetic pendulum
- Magdeburg
- Weighing with water
- Venturi gun
- Uphill roller
- Water siphon
- Bernoulli blower
- Venturi tube
- Artificial gravity
- Rise and fall
- Bed of nails

Contexts
Forces and movement; Pressure.

This theme links with the following key resources from Learning Media: Building Science Concepts Book 17 Flight, Book 34 Parachute, Book 37 Flowing and Sinking, Book 38 Understanding Buoyancy and Book 51 Standing Up.

Key School Journal References: Battles into rockets, Rex Eagle, Article, Pt 03 No. 2, 2003; A history of rock, Alan Bagnall, Article, Pt CN No. 2, 2003; Watching the world go round, Neil F. Roberts, Article, Pt 04 No. 2, 1988; The chicken-leg effect, Bill O’Brien, Article, Pt CN No. 3, 2000; Make a spinner, Jane Buxton, Article, Pt CN No. 1, 1999; Speed freaks, David Hill, Article, Pt CN No. 3, 2009; The Wall of Death, John Medcalf, Article, Pt 04 No. 2, 1993

Health & Human Performance — Te Hauora me te Pai o ngā Mahi o te Tinana Tangata
Exhibits in this theme address specific learning intentions relating to the following: vitamin D; healthy bones; the heart — pumping, stents, valves, pacemakers, preserved hearts, heartbeats and blood pressure; co-ordination; hand strength; the body’s energy use; speed of throwing; height of jumping; reaction speed; balance; antagonistic muscles. Exhibits include:

- Vitamin D
- Blood pressure
- Strong bones
- Balanced joule intake
- Co-ordination test
- Reaction tester
- Speed ball radar
- The heart
- Walk the plank
- Hand grip
- Jump
- Biceps versus triceps

Contexts
My body; Health and disease; Sports science.

Key School Journal References: How to drink a rose, Article, Pt CN No. 1, 2006; The wandering heartbeat, Vicky McCallum, Story, Pt JJ No. 23, 2001; Bendy bones, Marcsa Vaughan, Article, Pt CN No. 3, 2000; One bad banana, Jane Thomson, Article, Pt CN, No. 2, 2000; In training, Vivienne Joseph, Story, Pt 01, No. 1, 1992; In sync, Maggie Lillieby, Article, Pt 03 No. 2 9-13, 2006; Jumping for joulies, Rupert Alchin, Article, Pt CN No. 3 16-19, 2008
EXHIBITS
Teacher’s guide

Material World — Te Ao Kikokiko

Exhibits in this theme address specific learning intentions relating to the following: viscosity; different masses affected by magnetism; UV blocks; non-compressible liquids; compressible gases; porous materials; expansion of different materials; light emission and exclusion; density; microscopic views of fibres; and, water issues. Exhibits include:

- Parabolic spinners
- Mass spectrometer
- Jacob's ladder
- Air through a brick
- The Air Around Us
- Which is gold?
- Water supply
- Microscopic view of fibres
- Vitamin D
- Fixeding the Waipau River
- Water availability and use
- Dioxide glass
- My personal water use
- Where it's found and how its used
- Water

Contexts
Material World; Simple chemistry; Matter.

This theme links with the following key resources from Learning Media: Building Science Concepts Book 15; Building Science Concepts Book 29; Building Science Concepts Book 13; Building Science Concepts Book 33; Building Science Concepts Book 30; Building Science Concepts Book 48; Building Science Concepts Book 58; Building Science Concepts Book 64; Candles; The water wardens, Jill Brasell, Article, Pt CN No. 3, 2004; Alan Bagnall, Article, Pt 01 No. 2, 1995; Baffle mask; Counting frogs; Counting lambs; Night rescue; Sand, Salt and Jelly Crystals, Book 33; Speed freaks; The biggest hole in the world, John Bonallack, Article, Pt 01 No. 5, 2004; A safe and speedy crossing; Jet Car, Sharon Stratford, Poem, Pt 01 No. 4, 2000; Working with Metals, John Medcalf, Article, Pt 02 No. 5, 1978; Building a house in India, Andrew Crowe, Article, Pt 02 No. 1, 1993; Introducing Metals, Andrew Crowe, Article, Pt 02 No. 1, 2009; A new life for old machines, Rosemary Hopkins, Article, Pt CN No. 3, 2007; Super toy makers, Karen Anderson, Story, Pt CN No. 1, 2005; I'm a little microwave, Jill Brasell, Poem, Pt 01 No. 5, 1990; Counting Frogs, Janet McCallum, Article, Pt 04 No. 3, 1991; Counting kowns, Binam Gore, Article, Pt CN No. 1, 2007; Counting lambs, Sarah Reid, Article, Pt 02 No. 3, 2000; Drown for the count, Kathy White, Article, Pt CN No. 3, 2004; Night rescue, Patricia Wilson, Story, Pt 03 No. 1, 1983.

Key School Journal References: Charlie and Mania, Bartha Hill, Article, Pt 02 No. 1, 2007; Water supply, Article, Pt 04 No. 3, 1978; The water wardens, Alan Bagnall, Story, Pt CN No. 2, 2002; The biggest hole in the world, John Bonallack, Article, Pt 01 No. 2, 1995; Te Aute, Vicki-Anne Heikell, Article, Pt CN No. 3, 2005; Building a house in India, Andrew Crowe, Article, Pt 02 No. 1, 1993.

Motion — Te Nekehanga

Exhibits in this theme address specific learning intentions relating to the following: rotation; pendulum swing; angular momentum; speed of fall; harmonic motion; gyroscope; hovercraft; wave motion; spinning objects; and, bouncing objects. Exhibits include:

- Bounce trajectory
- Speedy curve
- Balloon hovercraft
- Spinners
- Length pendulum
- Spirograph
- Double wave
- Loop the loop
- Gyro suitcase
- Te Tuwiri

Contexts
Movement and forces; On the move; Simple technology.

This theme links with the following key resources from Learning Media: Building Science Concepts Book 17 Flight, Book 43 Parachutes, Book 42 Marbles, Book 49 Invisible Forces.

Key School Journal References: A feeling of speed, Colin Laing, Article, Pt 02 No. 5, 1978; Jet Car, John Medcalf, Article, Pt 02 No. 2, 1996; A safe and speedy crossing, Article, Pt 03 No. 3, 1984; Speed freaks, David Hill, Article, 2009 Pt CN No. 3, 2009; The steam-powered car, Pat Quinn, Article, Pt CN No. 2, 1999; Surprise, Sharon Stratford, Poem, Pt 01 No. 5, 2004; Zoom tube, Greg O'Connell, Poem, Pt 01 No. 1, 2009.

Technology — Nga Hangarau

Exhibits in this theme address specific learning intentions relating to the following: transmission of microwaves; arch bridge construction; data storage; infra-red TV remotes; lasers and fibre optics; electric fences; box puzzle analysis; baffles inside tanks; critical path decisions; control systems; electronic counting devices; and, stacking objects for maximum stability. Exhibits include:

- Microwaves
- TV remote
- Box puzzle
- Control systems
- Catenary arch
- Laser talk
- Baffle tank
- Counter
- Data storage
- Power fencing
- Critical path puzzle
- Best stack

Contexts
Technology; How things work.

This theme links with the following key resources from Learning Media: Building Science Concepts Book 14; Building Science Concepts Book 69; Building Science Concepts Book 13; Building Science Concepts Book 48; Building Science Concepts Book 58; Building Science Concepts Book 64; Researcher, Bed of nails; Renewable. It can be used over and over again because it cycles and is (usually) purified as it passes through the environment. Key exhibits showing this: My personal water use, Fixing the Waipau River, Water: where its found and how its used and Water availability and use; Material World

Key School Journal References: Kiwi in the city, Philippa Werry, Article, Pt CN No. 2, 2000; A new life for old machines, Rosemary Hopkins, Article, Pt CN No. 3, 2007; Super toy makers, Karen Anderson, Story, Pt CN No. 1, 2005; I'm a little microwave, Jill Brasell, Poem, Pt 01 No. 5, 1990; Counting Frogs, Janet McCallum, Article, Pt 04 No. 3, 1991; Counting kowns, Binam Gore, Article, Pt CN No. 1, 2007; Counting lambs, Sarah Reid, Article, Pt 02 No. 3, 2000; Drown for the count, Kathy White, Article, Pt CN No. 3, 2004; Night rescue, Patricia Wilson, Story, Pt 03 No. 1, 1983.

The big questions
Each exhibit theme cluster, such as Forces, 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 demonstration, Presenters will draw the students’ attention to these and then they will be discussed before the second show. The 2010 Big Questions are as follows:

Electricity

A. If conductors allow electricity to flow, then what do insulators do? (They prevent the flow of electricity.) Examples of conductors: copper wire, gold bracelet. Examples of insulators: plastic, rubber. Key exhibits showing this: Jacob’s ladder and Conductivity.)

B. We can’t see electricity, so how do we know it is a form of energy? (It makes things happen. For example it can generate light, heat or movement. Key exhibits showing this: Flashing pendulum, Jacob’s ladder and Metered appliances.)

Forces/Pressure

A. Give an example of a ‘pull’ force. (Gravity. Key exhibits showing this: Weighing yourself, Bed of nails and Rise and fall.)

B. When a fluid like air or water moves faster, what happens to the pressure ‘around’ the moving fluid? (The pressure reduces. Key exhibits showing this: Venturi gun, Bernoulli blower and Venturi tube.)

Health & Human Performance

A. Give two examples of a substance that helps strengthen our bones. (Calcium in our diet; vitamin D obtained from some foods and made in our skin in the presence of sunlight. Key exhibits showing this: Vitamin D and Healthy bones.)

B. What three things are involved in co-ordination? (Our brain, nerves and muscles. Key exhibits showing this: Reaction tester, Co-ordination tester and Walk the plank.)

Material World

A. Is water a renewable or non-renewable resource? Why? (Renewable. It can be used over and over again because it cycles and is (usually) purified as it passes through the environment. Key exhibits showing this: My personal water use, Fixing the Waipau River, Water: where its found and how its used and Water availability and use.)

B. What do we mean when we say ‘the properties of a substance’? Give examples of properties. (How that substance behaves. Key exhibits showing this: Parabolic spinners, Air through a brick, Welding mask, Hydraulic versus pneumatic, UV block and Expansion of metals.)

Motion

A. What is acceleration? (It’s when something gets faster and faster. Key exhibits showing this: Speedy curve, Spinners and Loop the loop.)

B. When something is changing speed or direction, are the forces acting on it balance or unbalanced? (Unbalanced. Key exhibits showing this: Speedy curve, Spinners, Length Pendulum, Bounce trajectory and Loop the loop.)

Technology

A. Other than the decimal numbering system, what system is commonly used in today’s technology? (The binary system. Key exhibits showing this: Control systems, Counter and Date storage.)

B. What is technology? (Using science for a practical purpose. Key exhibits showing this: TV remote, Control systems, Baffle tank, Counter, Data storage and Power fencing.)
Material world pages 14–15

Element names
Hydrogen.

Surface tension
1. Bonds normally holding water molecules together are concentrated across the surface of water to create a layer of bonds that create ‘surface tension’.
2. Objects that either a. have protruding parts (like the pin’s head) or b. are heavier, can break through the surface tension.
3. They sink. Because the surface bonds are weakened by the detergent.
4. The bread tie shoots forward like a little boat. This is because the detergent weakens the bonds at the end with the exit channel. The bonds at the other end are still strong, so they pull the bread tie forward.

Motion pages 16–17

Motions opposites
Unbalanced

Flying spinners
Challenge 2: Fold arms the opposite way. Spin faster — use shorter and/or narrower wing blades. Spin slower — use longer and/or wider wing blades. Fall faster — increase the weight (or design poorly so it virtually falls without spinning). Fall slower — use less paper clip weights.

Challenge 3: Make it fly by spinning between palms of hands. Curve edges of wing blades up (a bit like a propeller) to give it lift.

Technology pages 18–19

Technology terms
Electronics.

Hot water solar panels
1. Graph.
2. The bottle with the solar panel attached.
3. Drawing should show water flowing in a circular manner (upwards through the solar panel pipes, across towards the top of the bottle, downwards inside the bottle, then into the bottom of the solar panel).
4. A convection current.

Did you know

By using energy-efficient lighting at the Fonterra Allerton site (USA) Fonterra has reduced electricity use by 3.5%.

Electricity word search

Find twenty five hidden words in the grid below. Twenty of the words are given below. Can you find them and the additional five mystery words?

Word list

Current, circuit, fuse, battery, wires, electromagnet, conduct, insulate, switch, bulb, electricity, power, watts, amps, volts, resistance, metals, motor, static, electronics.

Remember, there are five extra mystery words to find!
**Aim**
To use sunlight to split water into hydrogen and oxygen, then use these gases to power a chemical 'battery'.

**Key ideas**
Solar energy is used to split water into hydrogen and oxygen which can 'store electricity'.

**What to do**
1. Make holes in the wood or plastic and glue two lengths of pencil lead in place (see top picture).
2. Position the solar cell facing the sun and attach it to the pencil lead 'electrodes' (or, if you haven’t got one, use a 9 volt battery as a power supply). Hang the electrodes in the water as shown in the bottom picture.
3. Watch closely what is forming on the electrodes. You are making a liquid-gas battery (or solar battery).
4. After about 5 minutes, disconnect the solar cell (or 9 volt battery).
5. Connect a voltmeter (set to measure millivolts) to the pencil lead electrodes and hang them in the water again. Watch the voltage over a minute or so.

**Questions**
1. What do you see forming on the pencil lead electrodes?
2. What supplies the electricity to create the ‘solar battery’ in the first place?
3. What voltage did your solar battery produce? Did it increase or decrease when the voltmeter was attached?
4. How is the energy stored in your battery?

**Extension**
5. Find out about electrolysis.
6. Find out about hydrogen powered cars.

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**What you will need:**
(per group or per class if done as a demonstration)
- A photovoltaic cell, that is, an electrical solar cell. (A 9 volt battery can be used in place of this.)
- Insulated wires with alligator clips on their ends.
- A strip of wood or plastic (about 80 x 30 x 3 mm thick).
- A clear glass vessel, e.g. a drinking glass, full of water.
- Two lengths of pencil lead (about 70 mm long, cut from an old pencil).
- A voltmeter.
- Access to strong sunlight (if using the solar cell above).

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**Key resources from Learning Media:**

**Key School Journal References:**
Jumping for joules, Rupert Alchin, Article, Part CN, No. 3, 2008; Make way for the Solar Kiwi, David Somerset, Article, Part D4, No. 3, 1994; A new life for old machines, Rosemary Hipkins, Article, Part CN, No. 3, 2007; The power of rubbish, Pat Quinn, Article, Part CN, No. 3, 1998; The sleeping giant, Bill Keir, Article, Part 02, No. 2, 1989; Water power, Sandra Carrod, Article, Part 02, No. 4, 2005

These word tiles have been scattered by huge forces. Put them back together to find out how forces and motion are related. (We have put some in the right order already.)
Forces / Pressure

PRACTICAL ACTIVITY

Pulley power

Aim
To discover how pulleys help us lift loads.

Key Ideas
Pulleys are machines that help us to lift loads by reducing the force needed to do the work.

What to do
1. Make a simple force meter by taping or hot gluing a rubber band to a piece of wood and attaching a hook made from a paperclip. Use a ruler to make a scale on your force meter. A mark every 0.5 cm will do (see Picture a. to right).
2. Hang the lead fishing sinker on the force meter’s hook and read off the downward force at the top of the sinker (see Picture b.). Record.
3. Now, attach a paper clip to a stand. Tie a length of cotton to the sinker and hook it over the paper clip (which acts as your pulley), then attach the other end to your force meter. Pull steadily on the force meter to lift the sinker. (See diagram to right.) What force was required?
4. Try the other arrangements shown to the left, measuring the force required each time.

Questions
1. What was the force when the sinker was hanging straight down?
2. Which pulley arrangement required the smallest force to lift the sinker?
3. What effect did friction between the cotton and the paper clip pulley have on the force needed to lift the sinker?
4. How would real pulleys be better than using paper clips?

Extension
5. Find out about chain winches. Where are they used?
6. Build a model crane out of Lego, using pulleys to make the lifting easier.

Key resources from Learning Media:
Building Science Concepts Book 34 Parachutes and Book 49 Invisible Forces.

Key School Journal References:
Phils machines, Lindy Kelly, Article, Pt 01 No. 2, 2008
A student wants to know more about Vitamin D and how it helps our bodies. Use the clues to complete the paragraph below.

Vitamin D helps our ______ take up _______ from our food so we grow strong, ________ bones. If we don’t get enough, ________ our bones become weaker, ________ and poorly formed, causing ________ in young people and osteoporosis in older people. We get Vitamin D from exposing our ______ to sunlight and from eating ________, eggs, fish liver oils, margarine, oily fish like ______ and ________ and by having drinks like ______ and juice containing ______ vitamin D.

Did you know:
Fonterra scientists and technologists are able to unlock and explore over 3000 components that make up milk.
How hard can you squeeze?

**Challenge 1**

**Compare forces**

How can you compare the strength of each of your hands? Perform a fair test to find the answer. Do repeats to ensure accuracy and record your results. Which hand was stronger and why?

Repeat using both hands at once. Record.

Do both hands squeeze with double the force of one hand alone?

Can you squeeze your body weight?

Compare your squeeze strength with your friends.

**Challenge 2**

**Calculate the forces**

Convert the ‘weight’ values you found to Newtons of force by using this formula:

\[ \text{Force} = \text{weight squeezed (kg)} \times 10 \, \text{N/kg} \]

For example, if you squeezed 35 kg, then the force you created was:

\[ \text{Force} = 35 \, \text{kg} \times 10 \, \text{N/kg} \]

\[ \text{Force} = 350 \, \text{N} \]

For left, right and both hands, find the average (mean) squeeze strength for the class.

**Challenge 3**

**Measure strength of other muscles**

Devise a way of measuring the strength of other muscles in your body, such as your thigh muscles.

---

**Setting the scene**

Imagine you are training for a body building competition. Each day you work on improving your strength, but how do you know that it is improving?

One thing you can measure is your hand and forearm strength using bathroom scales.

To measure your strength, hold the scales and squeeze as hard as you can for two seconds. Record the ‘weight’ you squeezed (in kilograms).

---

**What you will need:**

(per group)

- Bathroom scales.
Element names

Find the answer to the puzzle question below about one of the elements of the Periodic Table. For each of the elements listed at the left of the table, find the correct symbol along the top of the table. Circle the letter in the box where their rows and columns meet.

<table>
<thead>
<tr>
<th>Element names</th>
<th>Symbols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Si</td>
<td>N</td>
</tr>
<tr>
<td>helium</td>
<td>m</td>
</tr>
<tr>
<td>calcium</td>
<td>a</td>
</tr>
<tr>
<td>nitrogen</td>
<td>p</td>
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<tr>
<td>lead</td>
<td>n</td>
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<tr>
<td>chlorine</td>
<td>i</td>
</tr>
<tr>
<td>silver</td>
<td>c</td>
</tr>
<tr>
<td>gold</td>
<td>h</td>
</tr>
<tr>
<td>mercury</td>
<td>o</td>
</tr>
</tbody>
</table>

Question

The most common element in the universe is ____________________________

Extension

Now that you have done this puzzle, use the elements of the Periodic Table to make up your own puzzle and test it on your classmates. For example, your puzzle could ask the question, “What is the most common gas in air?” or “Name a metal that is liquid at room temperature”.

Did you know:

Calcium is one of the most important nutritional factors in determining how strong our bones develop.
Surface tension

Aim
To investigate the surface ‘skin’ on water (surface tension) and what affects its strength.

Key ideas
Surface tension, bonds between water molecules. Reducing surface tension using detergents.

What to do
1. Use a fork to gently lower a needle onto the surface of water. The aim is to get it to float (see picture to right). Now, try to do the same with the pin and the paper clip. Were they as easy to float as the needle? Why or why not?
2. Bend your paper clip so you can hang onto it with your fingers (see picture to lower right). Can you lower it onto the water?
3. Dip a toothpick into some detergent. Then, with one of the metal objects floating, dip the toothpick into the water near the edge of the container. What happens to the floating object? Why?
4. In a large, fresh, clean dish (there must not be any detergent in it at all), float a bread tie. Watching carefully, use a toothpick to introduce a drop of detergent into the hole in the middle of the bread tie (see picture to left). What happens to the bread tie? Why? (You could try this same thing in a bath, spa pool or swimming pool to see how good a result you can get.)

Questions
1. Why does the needle float?
2. Give two reasons why it can be harder to float objects like the pin or the paperclip.
3. What happens when you put detergent in the water that has a floating metal object in it? Why?
4. What happens to the bread tie when you place detergent in the middle of it? Why?

Extension
5. Have a competition to find the largest metal object you can float on the top of water.

Motion opposites

Join the motion-related word opposites with a straight line. Each line must start (on the left side) and finish (on the right side) exactly on the dots beside the correct words. There are more words on the right hand side than you need. Use the letters that the lines pass through (read from top to bottom) to answer the puzzle question below.

Question

*When an object speeds up or slows down it always involves___________________________ forces.*
Challenge 1

Build a basic spinner
Mark out this design on a piece of paper. Cut out and fold along the dotted lines to make a basic spinner.

![Diagram of spinner design]

Drop your spinner from as high as you can reach. Even try from an upstairs room if you can. Note how smoothly it spins, how quickly it rotates and how long it takes to reach the ground.

Challenge 2

Re-design your spinner
How can you adjust your spinner so it spins in the opposite direction?

Make several new re-designs of your spinner so it 1. spins faster, 2. spins slower, 3. falls faster, 4. falls slower. How did you achieve each of these things?

Challenge 3

Use new materials
Using a cork, some plastic and a kebab stick, along with hot glue, can you build this spinner? How do you make it work?

Key resources from Learning Media: Building Science Concepts Book 17 Flight and Book 34 Parachutes.

Key School Journal References:
Kite-maker of Kota Bahru, Jan Kemp, Article, Part 03, No. 1, 1980; Mad Dog Pearse and the aerial machine, Murray Reece, Story, Part 03, No. 3, 1999
Make a spinner, Jane Buxton, Article, Part CN, No. 1, 1999; Round-the-pole flying, Murray Brough, Article, 04, No. 2, 1997; You can make a feather helicopter, Brian Birchall, Article, Part 01, No. 3, 1995
Use the clues to help you answer the question below. (The missing word that is the answer will appear in the middle column.) Some letters are already given.

Without this, computers could not have become the powerful tool they are today.

1. These cables are being laid to allow high speed Internet connections. ______________ o ____________

2. A very narrow, powerful beam of light. ______________

3. A man-made device that orbits Earth. ______________

4. Used to build tall buildings. Lifts heavy objects. ______________

5. A foot pedal in a car. ______________

6. Use this to listen to the news. Found in cars and homes. ______________ d ____________

7. A device to turn on TV from a distance. ______________

8. Use this to jump off a bridge safely. A bit rubbery! ______________

9. Often attached to a computer. Can make black and white or colour pages. ______________

10. Biology and technology combined. ______________ t ____________

11. We use these to stop our car. ______________

**Answer**
**Technology**

**PRACTICAL ACTIVITY**

**Hot water solar panels**

**Aim**
To use sunlight to heat water in solar panels.

**Key ideas**
Heating, sunlight, convection currents.

**What to do**

1. Make one hole near the top and one hole near the bottom of a 2 litre soft drink bottle.
2. Make up your solar panel by measuring, cutting and gluing tubes (or use bought connectors) together as shown to the right. Notice the filling tube at the top. This allows you to fill the tubes up with water so there will be no airlocks.
3. Glue the solar panel to your bottle.
4. Fill the bottle and solar panel with water, making sure there are no air bubbles in the solar panel tubes.
5. Fill up the other bottle to the same level, and place both in the sun (see lower picture).
6. Measure the temperature of the water in each bottle, pushing the thermometer into the water to the same level in each case, then put the lids on.
7. Measure the water temperature every half hour over two or three hours of strong sunshine.

**Questions**

1. Graph the water temperature in each bottle against time.
2. Which bottle increased in temperature the most?
3. Draw a picture to show how the solar panels worked. Add arrows to show the direction of water flow.
4. What is the water flow in the panels called?

**Extension**

5. Investigate solar water panels on the Internet. How effective are they in New Zealand? How much do they save on power bills?

---

**What you will need:**
(per group)
- Two 2 litre soft drink bottles or similar. They must be the same.
- 1 metre of plastic tubing (about 5–10 mm in diameter). A good type is used for home irrigation systems. This has fittings that help when connecting everything up.
- Hot glue gun.
- A drill or sharp point.
- Thermometer.
- Water.

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**Key resources from Learning Media:** Building Science Concepts Book 29 Solar Energy and Book 54 Windmills and Waterwheels.

**Key School Journal References:** Power for Pukapuka, Maureen Goodwin, Article, Part CN, No. 1, 2000.
Demonstrations

While being exciting and entertaining, our demonstrations provide a great opportunity to enhance student knowledge in two science areas each year. The demonstrations for 2010 are *Up, Down All Around*, a look at gases and how they behave and *On The Move*, focusing on movement and the forces involved in creating movement.

To assist you in preparing for your visit, we’ve developed a unit plan called *Motion* that complements the *On the Move* show. This makes up the remainder of the kit. If time permits within your classroom programme, you may like to use notes from the *Up, Down All Around* show outlined below to develop your own pre- and post-visit unit to complement that demonstration.

**On The Move  Kei te Neke Haere**
This demonstration covers specific learning intentions relating to what motion is and what influences it, including the following:
- inertia (the unwillingness of an object to change its state of motion)
- movement due to gravity and what happens to falling objects in a vacuum
- acceleration
- the forces acting on objects
- circular motion
- action and reaction.

**Up, Down All Around  Ki Runga, ki Raro, Huri Noa**
This demonstration covers specific learning intentions relating to gases in the context of the material world — what they are and how they behave, including the following:
- the gases making up air
- the behaviour of nitrogen, oxygen, hydrogen, carbon dioxide and helium
- how much a substance expands when turning from liquid to gas
- air pressure — causes and effects
- putting out fires with carbon dioxide (and helium) and making fires more intense using oxygen
- burning of gases in the presence of oxygen.

**General Learning Outcomes relating to Demonstrations**
After attending the demonstrations students will have improved:
- interest and enthusiasm
- understanding and knowledge of scientific and technological principles and processes.

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**Key School Journal References:**


*Biogas station*, Jane Thomson, Article, Part 04, No. 2, 1986; *Cooking with biogas in India*, Andrew Crowe, Article, Part CN, No. 3, 1998

*Endless energy*, Jane Thomson, Article, Part 04, No. 2, 1986; *The power of rubbish*, Pat Quinn, Article, Part 03, No. 2, 1993

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**Did you know:**
Water removed from milk during processing at Fonterra’s Dennington site (Australia) is used to irrigate the fairways and greens at Warrnambool Golf Club. This has reduced the club’s reliance on the town’s water supply, providing an extra 80 megalitres (enough to fill 32 Olympic swimming pools) of precious drinking water to the local township.
Motion unit  SCIENCE UNIT PLAN

Motion — Te Nekehanga

Introduction

Contexts
• On the move
• Movement and forces
• The Olympics (physics of sport)

Unit Aim
To investigate motion and the underlying forces that are involved. This includes the behaviour of objects in different states of motion, including when stationary and spinning.

Achievement Objectives (Learning Intentions) and Levels
This unit targets Level 4 Learning Intentions of the Physical World in the Science Curriculum (but most activities are easily adapted to Levels 3 and 5) as follows:

‘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.’

Key science concepts — motion
1. Inertia is the unwillingness of an object to change its state of motion, whether the object is stationary or moving at a constant speed.
2. To overcome an object’s inertia, unbalanced forces must be applied to it.
3. When an object is stationary or moving at a constant speed, the forces acting on it are balanced.
4. When an object is accelerating (getting faster), or decelerating (getting slower), the forces acting on it are unbalanced.
5. Circular motion involves balanced inward and outward forces.
6. For every action there is an equal and opposite reaction.

After completion of this unit children will be better at explaining and describing:
• Inertia.
• Different types of motion.
• Constant speed, acceleration and deceleration.
• Forces, including gravity, involved in different types of motion.
• Circular motion.
• How actions have an equal and opposite reaction.

Timing
• Specific Learning Intentions: 8 to 10 hours in class.
• Fonterra Science Roadshow visit: 80 minutes plus travelling time.

Assessment
• Pre-assessment—Mind mapping exercise explained on page 30.
• Post-assessment—Repeat of mind mapping exercise explained on page 30.

Answers for activity sheets (pages 25–29)

Circular-winged glider
1. Diagram drawn by child.
2. Yes, this is usually possible.
3. During forward steady speed flight, the forward arrow (thrust) should be of equal length to the backwards arrow (air friction). But, the upwards arrow (lift) should be smaller than the downwards arrow (gravity), since the glider accelerates downwards.
4. It will be somewhere in the range of 2–4 metres per second (approx.).

Pendulums
1. They accelerate towards the bottom of the swing then decelerate as they swing upwards.
2. Yes.
3. The long pendulums take longer to swing back and forth. (Children support this fact with measured data.)
4. The longer pendulums swung in time with each other and so did the shorter pendulums.

Straw rocket
1. Diagram drawn by child.
2. The force due to the air being pushed out from the pump.
3. They make the rocket stable as it flies through the air—the weight keeping it pointing in one direction and the fins keeping the tail in a straight line to the direction of travel.
4. It accelerated till it left the ‘launch pad’, decelerated as it was flying upwards, it was stationary at the top of its flight (assuming no wind blew it sideways), then accelerated back towards earth.

Hero engine
1. Diagram drawn by child.
2. Unbalanced forces (the force due to water pressure inside the container not being balanced at the exit holes).
3. The container spun faster, but for a shorter time.

Action–reaction
1. Diagram drawn by child.
2. The weight and the trolley didn’t move as far. Because of friction between the moving objects and the table surface.
3. (a) They both went the same distance (assuming they were both equally ‘slippery’ and that the rollers were positioned equally in both directions), (b) the weight moved less than the trolley, and (c) the trolley moved less than the weight.
## Specific learning intentions and activities

<table>
<thead>
<tr>
<th>Specific Learning Intentions</th>
<th>Learning Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Investigate different forms of motion (movement).</td>
<td>Introduce the topic by discussing ‘Where do we see motion (movement)?’ Examples could include:</td>
</tr>
<tr>
<td></td>
<td>• different forms of motion seen at the Olympics, including: sprinters, javelin throwers, hammer throwers, swimmers, etc.</td>
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<tr>
<td></td>
<td>• flight: birds, planes, helicopters</td>
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<td></td>
<td>• transport or racing: cars, trains, racing bikes, motorcross.</td>
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<td></td>
<td>Make a collage of different types of motion. Pictures could be grouped according to whether air, land, water, space, etc.</td>
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<td></td>
<td>Show and tell regarding pupil’s favourite activity that involves motion, e.g. skateboarding, cycling, gymnastics. Pupils give practical demonstrations. Discuss what aspects involve steady movement, acceleration and deceleration. How do they ‘get moving’ and ‘stop moving’?</td>
</tr>
<tr>
<td></td>
<td>[Theory notes titled ‘Examples of motion’]</td>
</tr>
<tr>
<td></td>
<td>Vocabulary: movement, motion, forwards, backwards, flight</td>
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<td></td>
<td>Fonterra Science Roadshow visit: On the Move show and the exhibit theme Motion — reinforcing ideas about motion and the forces involved.</td>
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<tr>
<td>2. Investigate inertia, in both stationary and moving objects.</td>
<td><strong>Inertia in stationary objects</strong></td>
</tr>
<tr>
<td></td>
<td>• Demonstrate how an object like a book that is on a table will stay there unless you push or pull on it (that is, you apply a force to it). This unwillingness to move is called inertia.</td>
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<tr>
<td></td>
<td>• Make a small force meter (see activity sheet Pulley Power earlier in this booklet) to measure the forces needed to get objects sliding along a table top. Find what factors make it hard to get things moving, e.g. the weight of the object and the roughness of the surface it is being dragged along.</td>
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<tr>
<td></td>
<td>• Ask a large child and a small child to have a pushing competition against each other. Who moves first? Discuss why large men are used in rugby scrums and in sumo wrestling.</td>
</tr>
<tr>
<td></td>
<td>[Theory notes titled ‘Inertia’]</td>
</tr>
<tr>
<td></td>
<td>Vocabulary: inertia, unwillingness, forces, push, pull</td>
</tr>
<tr>
<td>3. Show that when an object is stationary or moving at a constant speed, the forces acting on it are balanced.</td>
<td><strong>Stationary and constant speed investigations</strong></td>
</tr>
<tr>
<td></td>
<td>• Use two force meters to pull on an object with equal forces from opposite directions. Does the object move? (No.) Explain. (Balanced opposite forces are acting on the object.)</td>
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<tr>
<td></td>
<td>• Use a force meter to measure the force needed to pull an object across a table at a steady speed. Repeat several times to show that the force is constant. (When this happens the pull force is equal and opposite to the force of friction ‘holding it back’.)</td>
</tr>
<tr>
<td></td>
<td>• Make a tractor using a pencil, rubber band and a cotton reel. Does it travel at a constant speed? What causes the force required to drive it forward? (The wound up rubber band.)</td>
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<tr>
<td></td>
<td>• Make a circular-winged glider. Create designs with the aim to make it glide at a constant speed. [Circular-winged glider activity sheet]</td>
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<tr>
<td></td>
<td>• Work out the average speeds that objects travel at, e.g. a car, a runner, a paper dart, etc. To do this, measure the distance travelled divided by the time it takes. Example, a car takes 2 hours to travel 60 km. It therefore travels at 60/2 = 30 km per hour. For fair comparisons, convert everything to the same units, e.g. metres per second.</td>
</tr>
<tr>
<td></td>
<td>[Theory notes titled ‘Balanced forces’]</td>
</tr>
<tr>
<td></td>
<td>Vocabulary: stationary, constant, speed, velocity, time, distance, metres, kilometres, metres per second, balanced forces</td>
</tr>
<tr>
<td>Specific Learning Intentions</td>
<td>Learning Activities</td>
</tr>
<tr>
<td>-----------------------------</td>
<td>---------------------</td>
</tr>
</tbody>
</table>
| 4. Show that when an object is accelerating or decelerating, the forces acting on it are unbalanced. | Introduce acceleration by discussing driving a car. What are the three pedals in a manual car? What is each used for? When we put our foot hard on the accelerator, what happens (we speed up or accelerate). How do we decelerate? (By taking our foot off the accelerator, allowing road and engine friction to slow the car down, or, by braking.) How do we make the car travel at constant speed? (By putting our foot on the accelerator sufficiently to make the engine forces equal to engine and road friction combined.)

**Acceleration and deceleration investigations**
- Research into Olympic 100 or 200 metre sprinters. How fast do they run the first 20 m, the second 20 m and so on? This can be found on the Internet by using search words like ‘Usain Bolt, 100m record, splits’. At what stages are runners accelerating (speeding up), running at a steady speed and decelerating (slowing down)?
- Make pendulums and investigate how they swing and at which stage are they accelerating and decelerating [*Pendulums activity sheet*].
- Show acceleration and deceleration by launching a straw rocket. [*Straw rocket activity sheet*]

- Vocabulary: speeding up, acceleration, slowing down, deceleration, unbalanced |
| 5. Show that circular motion involves balanced inward and outward forces. | Introduce circular motion by having children compete in a knock-out competition to see how long they can cause a 10c piece to spin on a table or the floor. Follow on by seeing how long a small coin will spin compared with a large coin. Children do 10 repeats of each and average their results. The 10c piece could be substituted with a spinning top made from a piece of cardboard and toothpick.

**Spinning investigations**
- Flick a playing card off the side of a desk to see it spin across the room. Compare with throwing the card. (It doesn’t go far at all.) Also compare a spiral rugby ball punt with a ‘wonky’ kick. Which goes further? Discuss where else spinning helps an object travel further, e.g. a golf ball, a bullet and a boomerang. Investigate one or more of these on the Internet.
- Throw a sycamore seed into the air and watch it spin to the ground. Repeat outside in the wind to see it travel away as it spins. What purpose does it have in nature? (Seed dispersal.) Remove the wing from the seed and compare its ‘flight’. (It drops straight to the ground.) Make spinners out of paper (*Flying spinners challenge sheet found earlier in this booklet*), then investigate changes to their design.
- Make a ‘spinning button’ by tying a loop of string through the eyes of a large, heavy button. (The very effective example to the right uses a heavy piece of perspex.) Using both hands, pull in and out on the string to make the button spin back and forth. What forces cause it to spin? (Outward force on string alternating with tension in the twisted string.)
- Half fill a bucket with water. Spin it around in an arc using your outstretched arm so that the bucket goes completely upside-down. Why doesn’t the water come out? (The water is forced outwards against the bottom of the bucket that is being held onto.) Investigate or research into similar examples, including spinning space stations, the moon’s orbit around Earth, etc.
- Use unbalanced forces to create rotational movement. [*Hero engine activity sheet*]

- Vocabulary: circular, rotation, spinning |
| 6. Show that for every reaction there is an equal and opposite reaction. | **Action-reaction investigations**
- Make a water rocket (using a 2 litre plastic soft drink bottle that is pumped up with air (plenty of design examples are on the Internet). Whose will fly the furthest? What is the action? (The water flying out the bottle opening.) What is the reaction? (The rocket flying forwards.)
- Investigate action-reaction. [*Action — reaction activity sheet*]

- Vocabulary: action, reaction, gyroscope |
Theory notes — Motion

What is motion?
Motion is movement. When anything changes its position it has undergone movement.

Examples of motion
Motion can mean movement in a straight line or in a curved path. It can mean movement upwards or downwards. In fact, it is any type of movement. Examples of movement include:

- A flying rocket
- A paper dart in flight
- A person running
- A gymnast spinning on bars

Motion also looks at stationary objects as these are a special example of movement.

Inertia
Inertia is the unwillingness of an object to change its current state of motion.

Stationary objects
So, when an object is stationary, it doesn’t ‘want’ to move. It will only move when a strong enough force is applied to it. This force must not be balanced by an equal and opposite force, otherwise the object would not move.

Moving objects
When an object is moving at a steady speed, it doesn’t ‘want’ to speed up, slow down or change direction. It will only do so if a strong enough force is applied to it. (On Earth an object naturally slows down, but this is because a force called friction is acting against the direction of movement.)

Different masses
The bigger an object (that is, the more mass it has) the greater its inertia, whether it is moving or not.

Balanced forces
When a stationary object has equal and opposite forces acting on it, it remains stationary.

Unbalanced forces
When the forces acting on an object are unbalanced, the object will either speed up, slow down or change direction.

Circular motion
A spinning object ‘wants’ to keep moving in a straight line, but an inward force (called centripetal force) keeps it on its circular path.

Action and reaction
For every action there is an equal and opposite reaction.
Aim
To build a circular-winged glider, then change its design to improve its performance so it will glide at a steady speed.

Key ideas
Motion, flight, constant speed, design.

What to do
1. Measure and cut a piece of paper 3 cm x 30 cm in size and another one 2 cm x 18 cm in size. Make each of them into a loop and sellotape them to the straw as shown in the picture. Add some weight to the front of your glider using blu tack or plasticine.

2. Fly your glider to test how well it goes into the wind, with the wind and across the wind. Make adjustments to the weight and position of the wings to see if you can get it to glide in a long, straight, steady path.

3. If necessary, change the size and position of the circular wings.

4. Once you have it flying in a straight line, time how long it takes in seconds to fly 10 metres. You will need to measure this distance out on the ground before you start. (Use a smaller distance if necessary.) Repeat this 10 times. Divide the distance (10 m) by the average time, to find the average speed in metres per second.

Questions
1. Draw your final best design and label all the measurements so you could make exactly the same model again.

2. Could you get your glider to fly straight ahead at a steady speed?

3. Draw a picture with arrows to show the forces acting on your glider.

4. What was your glider’s average speed in metres per second?

Extension
5. Find out about real glider design. How do they stay in the air?
**Activity Sheet**

**Pendulums**

**What you will need:**
(see group or per class if done as a demonstration)

- Four equal weights. A good way of making a weight is to hot glue a paper clip to a large marble, as follows:

- Two short strings of equal length (say 20 cm) with paper clips tied to each end.
- Two long strings of equal length (say 40 cm) with paper clips tied to each end.
- A stand to hang your pendulums from (see below).

- A stopwatch.
- A ruler.

**Aim**
To investigate pendulums to find out if acceleration and deceleration are involved and if the length of the pendulum affects how long they take to swing back and forth.

**Key ideas**
Acceleration, deceleration, gravity, potential energy, kinetic energy.

**What to do**

1. Attach a string to a weight as shown to the right. (The paper clips are useful because it is easy to 'clip' them on and off.) Prepare two short pendulums and two long pendulums of exactly the same lengths. Make fine adjustments to their lengths by tying knots in the strings.

2. Hang the two long pendulums and use the ruler to pull them back an equal amount, then release them at exactly the same time. Observe (a) when they accelerate and decelerate and (b) if they swing at the same or different speeds.

3. Time how long it takes for them to swing back and forth 10 times. Repeat 10 times and find the average.

4. Repeat 2. and 3. above for the two short pendulums.

5. Hang all four pendulums and pull them back to the same angle, releasing them at exactly the same time. Observe carefully.

**Questions**

1. At what point in their swing do the pendulums (a) accelerate and (b) decelerate?

2. Do pendulums of the same length swing in time with each other?

3. Which pendulums take longer to swing back and forth, the short ones or the long ones? Support your answer with measurements you gathered.

4. Describe what you observed when all four pendulums were released and swinging at the same time.

**Extension**

5. Find out about clocks that use pendulums. Why are pendulums used in them?

6. Find out about gravitational potential energy and kinetic energy. How are these forms of energy involved when a pendulum is in motion?
**ACTIVITY SHEET**

**Straw rocket**

---

**What you will need:**
(per group or per class if done as a demonstration)
- A drinking straw.
- Another drinking straw that is narrower in diameter so it will slip inside the other straw.
- Light cardboard.
- Scissors.
- A hot glue gun.
- Blu tuck or plasticine.
- A bicycle pump (the type that fits directly to the valve, see picture below) that the thinner straw will fit into.

---

**Aim**
To make and launch a rocket made from a drinking straw, then observe acceleration and deceleration during flight.

**Key ideas**
Forces, acceleration, deceleration, flight path, trajectories.

---

**What to do**

1. Make your rocket from the thicker straw. It should be about 12 cm long. Cut out three fins and glue them to the straw. Push some blu tack into the other end for weight (see picture to right).

2. To prepare for launching your rocket, slip it over the thinner straw that is stuck into the bicycle pump.

3. In an open area outside, hold the pump firmly on a flat, steady surface, pointing your rocket skywards. Push the pump handle in with a sudden force.

4. Watch your rocket fly. Repeat several times. Each time, see if you can tell at what parts of its flight it (a) accelerates (b) decelerates and (c) is stationary.

---

**Questions**

1. Draw a labelled diagram of your rocket. List measurements too.

2. What made the rocket fly into the air?

3. Why are the fins and weight important?

4. At what points during the flight was the rocket (a) accelerating, (b) decelerating and (c) stationary?

---

**Extension**

5. Find out about rocket engines and how they work.

6. What is a rocket’s trajectory? How is it useful to know about this?
**Aim**
To make one of the earliest known engines invented in the first century AD by Hero of Alexandria and investigate the forces that cause it to spin.

**Key ideas**
Circular motion, unbalanced forces, the Hero engine.

**What to do**
1. Use the smallest diameter drill you have to make one hole in each side of the plastic container as follows.
   - Looking from side-on:
   - Hole positions when looking from above:

2. Drill a small hole in the exact middle of the top, knot the cotton at one end and pass it through the hole. Or, make a hole and hot glue a fishing swivel into it, then tie the cotton to the swivel (see picture to above).

3. Working in a sink, fill the container with water, quickly put the lid on and lift the container up by the cotton. Watch what happens. Experiment with larger holes to find the most efficient ‘engine’.

**Questions**
1. Draw and label your Hero engine. Use arrows to show the direction of spin.
2. What caused the engine to spin?
3. What happened when you drilled larger holes?

**Extension**
4. Search the Internet to find out about the real Hero engine, called an aeolipile. Did it use cold water? How did it work?
5. Find out how steam engines work.
**What you will need:**
(per group)
- A small piece of customwood (about 10 cm x 5 cm x 3 mm).
- Into this, hammer three nails, as shown in the picture to the right, or, drill holes and hot glue the nails in place.
- A long, thin rubber band.
- Thin string.
- A small weight, e.g. an AA sized battery or a large rubber.
- 10 lengths of drinking straw each 10 cm long.
- A long match, or a BBQ lighter.

**Aim**
To investigate motion that clearly shows action-reaction behaviour.

**Key ideas**
Motion, action-reaction, mass, speed.

**What to do**

1. Cut the rubber band and tie each end to the nails (see top picture).
2. Stretch the rubber band and using the string, tie it to the nail at the other end of the wooden base (see top picture).
3. Place your set-up on the rollers made from drinking straws and position the weight (in this case an AA battery) between the rubber band (see top picture).
4. To launch your action-reaction tester, carefully bring a flame down towards the string, keeping it above the tops of the nails. Watch what happens when the string burns through. Where does the battery go and where does the trolley go? *(Caution, be careful to smother any bits of burning string!)*
5. Repeat several times. Try without rollers and with rollers, try different sized weights, and do measurements to see how far the trolley goes compared with the weights.

**Questions**

1. Draw a labelled diagram of your set-up. On it, use labelled arrows to show which direction the trolley went and which direction the weight went.
2. What happened when you didn’t use rollers? Why?
3. From the measurements you took, what happened at launch-time when (a) the weight and the trolley were equal in weight, (b) when the weight was heavier, and (c) when the trolley was heavier?

**Extension**

4. Find out about the recoil that occurs when a gun or canon is fired.
Pre- and post-unit assessment

One way of pre- and post-testing the knowledge of students on the unit of work ‘Motion’, 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 ‘Motion’ 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 used side-on, i.e. landscape format. (The next page can be photocopied.)
Coloured pens, pencils, felts.

Drawing and assessing a mind map

Instructions to students
Write the word ‘Motion’ (explaining that this means ‘movement’) 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.

Assessing the mind map
Give one mark for each word (or variation of the word, e.g. petrol, petroleum, gasoline) 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 key list.)

Sample mind map
This is a student’s mind map ‘pre-test’ on ‘Motion’. Ticks are given to show how marks are allocated. This student’s pre-test score was 8.

Keyword list
acceleration
action
activities relating to motion such as: sprinting, walking, etc.
backwards
balanced forces
circular movement
deceleration
distance
falling
flight or flying
forces
forwards
gravity
gyroscope
inertia
movement
pulls
pushes
reaction
rotating
slowing down
speed
speeding up
spinning
stationary
time
turning
unbalanced forces
units such as metres, seconds, etc.
velocity

Plus extra words at teacher’s discretion
Mind map on Motion

Name ______________________ Date ______

Year level ______ School ______________________

Motion
Do you feel the students' attitudes to science have changed as a result of a visit to the Fonterra Science Roadshow?  Yes ☐ No ☐
If so, in what way?

Have you done any pre-visit or post-visit activity related to the Fonterra Science Roadshow visit?

<table>
<thead>
<tr>
<th></th>
<th>Yes ☐</th>
<th>No ☐</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-visit</td>
<td></td>
<td></td>
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<tr>
<td>Post-visit</td>
<td></td>
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</tbody>
</table>

If yes, what form did it take?

Did you make use of our resource booklet?  Yes ☐ No ☐
What impact do you consider this programme has had on students' learning, e.g. skills or knowledge?

Were there any other gains from the visit?  Yes ☐ No ☐
What were they?

Would you bring your students in the future?  Yes ☐ No ☐
Why/why not?

Improvements/Enhancements — Is there anything you’d like to see next time you visit?

Do you have any other comments?

Optional, but we may need to contact you to clarify any comments

Your Name: ___________________________ Email address: ___________________________
School: ___________________________ Phone Number: ___________________________

The National Science-Technology Roadshow Trust

“We 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. In 2009, over 240,000 people directly engaged with Trust led activities. We also undertake wider consultancy work.