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Teacher’s guide

Introduction

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

**Included within this resource are:**

a) Literacy and science activity based resources that explore six exhibit themes within the 2012 Fonterra Science Roadshow programme.

**Suggested usage:**

- Pre-visit activities (literacy based)
- Visit to Roadshow (exhibit use and demonstrations)
- Post-visit activities (practical science, activity based)

b) A three stage Unit Plan on Light:

1. **Stage 1**
   - Pre-evaluation

2. **Stage 2**
   - Visit to Roadshow

3. **Stage 3**
   - Post-visit activities (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 this 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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**Did you know:**

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

Fonterra’s Edendale milk drier ED4 in the South Island produces a tonne of whole milk powder every two minutes.

Prepared by Peter E. Smith and Hannah Bridgman-Smith, Educational Solutions, PO Box 100, Lincoln, Canterbury, New Zealand.

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 have a significant effect on promoting students’ learning.
- Group work that includes discussion helps students to consolidate their learning.
- Numeracy and literacy are important so we aim to incorporate these learning areas within the programme.

What happens during your visit?

- You will be met outside by a member of the Fonterra Science Roadshow team. (If at all possible please leave school bags at school or on the bus.)
- Your session begins with one of the fifteen-minute 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 with 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’ behaviour at all times.

Theme emphasis

- Prior to your visit, you may wish to divide your class into six groups corresponding to the six exhibit Themes. Each group is responsible for reporting their understanding of 3–4 exhibits (selected from their Theme) back in class. Suggested ideas for reporting back:
  1. exhibit name, 2. what it looked like, 3. what it did and 4. what science idea it demonstrated.
- Additional ideas: students take pen and paper for recording their selected exhibits; use digital camera or video camera to record selected exhibits for review back in class; do a project or inquiry-based investigation on the science behind one or more of the exhibits.

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.
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 Spectacular Changes (about physical and chemical change) and The Hidden World (about things we cannot see or detect with our limited senses).

Welcoming the science barrier

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

• Stand alongside students who are experimenting with an exhibit.
• Show some interest in the exhibit and ask the student(s) what it does.
• You might like to try asking a question, then:
  • Pause (wait for an answer)…
  • Prompt (give them a hint)…
  • Praise (tell them they did well)…
• Tell them you don’t know about it yourself, but you want to know and you are relying on them to be the expert.
• Encourage them to investigate and try things.

The first level of understanding may simply relate to ‘making things happen’ on the exhibit.

• Get them to tell you what they have found and show you how it works. Use questions to encourage them to investigate further. What science is it showing? How do we use this in real life?
• Ask them what the Context Board (the instructions board beside or on the exhibit) says. Assist the students to read it and repeat back to you what it means.
• By these simple steps you will encourage active involvement and learning ownership by the students which will carry forward as they move onto other exhibits.

Symptoms of a kid who loves science:

• shows curiosity about the natural world
• likes experimenting and trying things out
• takes things apart and rebuilds them
• asks lots of questions about why things are the way they are.

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

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

Every New Zealander needs to be science savvy.

Science at home

• Spend time with your child pulling things apart to find out how they work, or building things like kit set radios. For even more fun, try engaging your child in real-life science experiments at home. You can find good ideas on the internet, and many more 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 planetarium.
• 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.
Teacher’s guide

2012 exhibits

Exhibits

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

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

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

Effective use of Explainers

Explainers are students selected from the host school to assist with explaining and demonstrating exhibits to visiting students. (They also play a vital role in assisting with setting up exhibits and later packing them away in the truck!) To prepare Explainers for their involvement we ask that before the Roadshow visit, teachers outline the following key aspects of the role with the chosen students. Explainers are there to:

- Assist others to learn (and in doing so, they will learn a lot themselves).
- Give hints and suggestions about how to use exhibits.
- Show enthusiasm and encourage involvement from visiting students.
- Ensure safe use of equipment.
- Prevent mistreatment of Roadshow equipment.

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

Extras for experts

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

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

At any time during this part of their visit, students have the opportunity to use and study these exhibits in detail, 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.

Themes

Astronomy — Te Mātāi Arorangi

Exhibits in this theme address specific learning intentions relating to the following: how light intensity diminishes as it travels through space; the constellations; what causes the tides; Earth’s rotation; Earth’s weather patterns; black holes; moiré and interference patterns; the strength of gravity on different planets; how a sundial works; radio astronomy; and, what causes the seasons. Exhibits include:

- Black Hole
- Ellipses
- Sundial
- Brightness
- Moiré Patterns
- Constellations
- Planetary Scales
- Sunlight
- The Seasons
- Ebb and Flow
- Radio Astronomy
- Turbulent Planet

Exhibits include:

- Canterbury’s Earthquakes
- Liquefaction
- Shake Table
- Volcanoes Quiz
- Earthquake Epicentres
- Mineral Transparency
- Shock Box
- Wind Tunnel
- Frustrating Fault
- New Zealand Rocks
- Tsunami

Contexts — Planet Earth; Earth Science; Earthquakes and volcanoes.

Earth Science — Te Pūtaiao A-nuku

Exhibits in this theme address specific learning intentions relating to the following: locating an earthquake’s epicentre; shock waves from an earthquake; how we can represent the world with different types of maps; NZ’s different rock types; the effects of an earthquake on buildings and other objects; properties of natural minerals; NZ’s volcanoes; how liquefaction occurs; what causes a tsunami; how violent Canterbury’s earthquakes were; how an earthquake is created by a fracturing fault and, the effects of a storm velocity wind.

Exhibits include:

- Canterbury’s Earthquakes
- Liquefaction
- Shake Table
- Volcanoes Quiz
- Earthquake Epicentres
- Mineral Transparency
- Shock Box
- Wind Tunnel
- Frustrating Fault
- New Zealand Rocks
- Tsunami

Contexts — Planet Earth; Earth Science; Earthquakes and volcanoes.

Farming — Te Mahi Pāmu

Exhibits in this theme address specific learning intentions relating to the following: detecting if food is produce using botanical or free range methods; special characteristics of manuka honey; introduced plants that have become pests; what causes stingers; the world of the worm; the mechanics behind a post driver; how biofuel can be extracted from plants; the uses of the different types of cereals; the stages in development of a crop; managing a cow through its productive life; steps in producing common foods and drinks; the purpose of different types of tractor implements; tracking using RFID tags; the logistics of supply chains.

Exhibits include:

- Biofuel
- Our Food
- Staggers
- Worm World
- Cereals
- Plant Pests
- Tanker Logistics
- Tractor Attachments
- Eggs
- Post Driver
- The Crop Cycle
- Manuka Honey
- RFID tags
- The Dairy Cycle

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

Key School Journal References:

1. Birchall, Brian Article 8-9 01 No. 1 1990, Preventing mistreatment of Roadshow equipment.
2. Lorenz, O. Article 8.5-9.5 02 No. 4 1984, Give hints and suggestions about how to use exhibits.
3. Wairapa, Moira Article 03 No. 2 2003, Assist others to learn (and in doing so, they will learn a lot themselves).
4. Hill, David Article CN No. 2 2003, Show enthusiasm and encourage involvement from visiting students.
5. Miller, A. Article 9-10 02 No. 3 1996, Ensure safe use of equipment.
6. Hill, David Article 9-10 02 No. 1 2001, Prevent mistreatment of Roadshow equipment.

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


Contexts — Agriculture; Farming; Managing the land; The environment; Sustainable living.

Key School Journal References: A bowl of rice MACGREGOR, Jill Article 9-10 01 No. 1 2009, Counting lambs REID, Sarah Article 8.5-9.5 02 No. 3 2000, Creature figure/fact ORBIEHN, Bill Article 10-12 03 No. 1 2001, Daisy farmer HILL, David Article 9-10 02 No. 4 1990. Do you eat grass? ESLER, Lloyd Article 8.5-9.5 02 No. 4 1999, Forest round-up THOMSON, Jane Article 9-9 02 No. 3 1890, A fragrant task THOMSON, Jane Article 9-9 01 No. 3 1991, Goat farm BONALLACK, John Article 8.5-9.5 01 No. 4 1984, A good kind of work MCVEAGH, Janine Article 10-12 03 No. 3 1985, He kept a journal — David Ballfour MOONEY, Kay Article 11-13 04 No. 3 1978, How much do they eat? ANDERSON, K.E. Article CN No. 1 1998, Hundreds of pets BUXTON, Jane Article 9-9 01 No. 3 2000, Janine McVeagh, her pigs and her garden MCVEAGH, Janine Article 11-13 No. 1 1984, Lambing time MAGUINESS, Jan Article 9-10 01 No. 3 1992, Leafcutting bees in the Lucerne fields DONOVAN, B. J. Article 10-12 04 No. 2 1982, Mrs Heine — soil scientist MCMICHAEL, Jan Article 9-9 02 No. 3 1979, Mustering STEWART, Kyle Article YP No. 1 1997, An organic orchard CLARK, Marjorie Article 10-12 No. 3 1998, Picking peas MATHIAS, Kaaren Article 8-9 01 No. 4 2010, Raising calves on dairy cows GALE, Amiria Article YP No. 1 1992, Sheep trek DUNCAN, Alfred H. Article 8.5-9.5 02 No. 3 1978, Smile! NOONAN, Diana Article CN No. 1 1999, A war against rabbits RICHARDS, Grace Article 8-9 03 No. 3 1979.

Light — Te Aho

Exhibits in this theme address specific learning intentions relating to the following: what causes light to bend; how our eyes can be fooled into seeing colours in black and white objects; magnification; how colour images are printed; refraction; combining light of different colours; luminescence; how colours disappear when it is dark; merging paint colours; the effects of polarised light; how filters work; and, creating a spectrum. Exhibits include:

- Bending Light
- Colour Picture Overlay
- Light Combo
- Newton's Colour Disc
- Polarisated Light

Contexts — Light; Light and colours; The world we see; The electromagnetic spectrum.

Key School Journal References: The aurora REA, William Article CN No. 3 2001, Blaze lamps — a bright idea for bikes NOONAN, Diana Article 13-16 04 No. 3 1995, Bright lights window decorations SOMMERVILLE, Blair Article 9-10 05 03 No. 2 2004. Colour in black and white Article 9-10 03 No. 2 1979, The eye ANDERSON, K.E. Article CN No. 3 1999, First light: the history of telescopes HEAD, Marilyn Article CN No. 3 2003, Gifts from the sun ORBIEHN, John Article 9-9 02 No. 3 1995, Gifts from the sun ORBIEHN, John Article CN No. 1 1997, Make a periscope FULLER, Sue Article 9-10 03 No. 1 1999, Patterns of light TUAKOB, Feana Article CN No. 2 2006, The riddle of light CAMPBELL, Rob Article 9-10 04 No. 2 1993, What is light? BELL, Alison Article CN No. 2 2006.

The Human Body — Te Tinana Tangata

Exhibits in this theme address specific learning intentions relating to the following: normal and anaemic blood; the relationship between coloured foods and their health benefits; analysis of foods in a meal; what additives are added to our food; how our lungs work; skin structure and microscopic detail; how much sugar is in soft drinks; the positions of our body organs; and, how much of our body consists of water. Exhibits include:

- 3D Skin
- Blood
- Coloured Diet
- Dinner Tonight
- Food Additives
- Lungs
- Soft Drink Diet
- Torso
- Water Proportion
- My Skin

Contexts — My body; The human body.

Key School Journal References: Bendy bones VAUGHAN, Marcia Article CN No. 3 2000, Blood in the bank KEIR, Bill Article 10-12 04 No. 1 1987, Goosebumps and butterflies SILK-MARTELLI, Denise Article 8-9 01 No. 4 2010, Mighty muscles GIBBISON, Sue Article 9-10 01 No. 2 2011, Polo COOK, Karen Article 8.5-9.5 01 No. 3 1983, Sleep tight HILL, David Article 8.5-9.5 02 No. 1 2001.

The big questions

Each exhibit theme cluster, such as Light, 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 2012 Big Questions are as follows:

Astronomy

A. Is using visible light the only way of ‘seeing’ what is out in space? Why? (No. We can also ‘see’ into space using infrared and radio wave telescopes, space probes, visits by humans.)
B. What sorts of things that happen in space affect us here on Earth? (Moon affects tides; sunspots affect radio reception; asteroids and meteors collide with earth; day and night due to sun’s rays relative to Earth’s rotation; the seasons due to sun’s rays relative to Earth’s tilt.)

Earth Science

A. What are some of the most devastating effects of earthquakes? (Liquefaction; tsunami; collapsing buildings that injure and kill people; physical damage to buildings, land and services.)
B. What happens at an earthquake’s epicentre? (Parts of the earth’s crust suddenly move past one another along fault lines. This creates shock waves that we feel as earthquakes.)

Farming

A. What is the most useful machine used on a farm? Why? (A tractor, because it can perform so many tasks, e.g. ploughing, sowing, grass cutting, post driving, manure spreading, raking, etc.)
B. The time to do things like planting, sowing, harvesting, lambing and irrigating are determined by what? (The seasons.)

Forces

A. What are some examples of forces? (Push or pull events such as gravity, magnetism, a car pulling a trailer, a person pushing a supermarket trolley, etc.)
B. What is it that can speed something up, slow something down or change its direction? (A force.)

Light

A. What do we get when we mix red, green and blue light? Hint: The same thing happens when we mix all the colours of the rainbow. (White light.)
B. Does light always travel in straight lines? (Only when it is going through one type of medium, like air or water. However, it can bend as it passes from one medium to another if they are different densities.)
While being exciting and entertaining, our demonstrations provide a great opportunity to enhance student knowledge in two science areas each year. The demonstrations for 2012 are Spectacular Changes, a look at physical and chemical changes, and The Hidden World, focusing on aspects of the world that we cannot see without the aid of special equipment and devices.

To assist you in preparing for your visit, we've developed a unit plan called Light that complements the Hidden World. This makes up the latter part of the kit.

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

### Spectacular Changes

This demonstration 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.

### The Hidden World

This demonstration covers specific learning outcomes relating to 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 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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**Did you know:**

Fonterra's streamlined supply chain efficiently gets products to customers. Every hour of the year, Fonterra closes the doors on an average of 12 containers, with over 90 per cent of them making their way across the equator to destinations far and wide.

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SCIENCE VOCABULARY PUZZLE  Astronomy

Solar system puzzle

Use your research skills to: (a) label the planets and (b) add each of the facts below to the correct planet.

Facts
1. Closest to Sun.
2. Biggest planet.
4. Hottest planet.
5. Coldest planet.
7. Planet with strongest gravity.
8. Planet with longest ‘day’.
9. Planet with shortest ‘day’.
10. Planet with temperature closest to Earth’s temperature.
Phases of the moon

Aim
To investigate the phases of the moon and why these occur.

Key ideas
The moon’s different phases, shadows, illumination.

What to do
1. Paint the inside of the shoebox black.
2. Cut small peepholes through the sides of the shoebox as shown to the right. Also, cut a hole in one end of the box and position the torch so it can shine the length of the box.
3. Mount the ball in the middle of the box on a toothpick using blu tack (see diagram). Place the lid on the box.
4. Look at the small ball (representing the moon) through one of the peepholes. Draw the part of the ball that is lit up by the torchlight. (A compass or a bottle lid may help you to draw neat circles.) Repeat for each of the holes.

Questions
1. What does the ball inside the box represent?
2. What does the torch represent?
3. When you are looking through the peepholes, where are you ‘looking from’?
4. From which direction do you see: a full moon; a half moon; a new moon; a crescent moon; and, a gibbous moon? (Hint, you may need to google these names to find out what they mean.)
5. Find out about how the phases of the moon affect the tides on Earth. What are ‘spring tides’ and what are ‘neap tides’?

Extension
Find out about ‘Earth tides’ What causes them?
Earth science fallen phrase puzzle

Solving a fallen phrase is like decoding a “secret code”.

A fallen phrase is a puzzle in which a sentence is listed, and all of the letters that go into a particular column are listed below that column. The challenge is to ‘unscramble’ the sentence to reveal the original sentence.

Clue: Some of the words used to solve the puzzle are as follows: area, many, occur, an, volcanic, earthquakes.

Did you know:
Fonterra’s research and development headquarters has operated continuously in Palmerston North for over 85 years.
What you will need:
(per group)
★ A 2 litre plastic ice cream container.
★ At least three types of media: sand, very fine silt, fine shingle, etc.
★ Water.
★ A wood block about 10 cm high by 5 cm wide, by 3 cm deep.
★ A medium-sized screwdriver or a heavy spoon.
★ A measuring jug.

Aim
To find out what type of media is most likely to liquefy when vibrated.

Key Ideas
Earthquakes, liquefaction, vibrations, building stability.

What to do
1. Half fill the plastic ice cream container with fine silt. Pour in a little water at a time and mix together. Keep doing this until your mixture is damp, but not puddling with water. Flatten the mixture and allow it to settle for an hour. (You may need to adjust this mixture to get the desired outcome — which is a saturated mix, but with no free water present.)
2. Place the block (representing a building) upright in the middle of the bowl, on top of the silty mixture.
3. Counting as you go, quickly tap the edge of the bowl with the handle of the screwdriver (or with a similar device such as a spoon). Repeat, keeping the force of the taps the same throughout, until the block of wood collapses onto its side. Record the number of taps needed before the building slumps on its side.
4. Repeat steps 1–3 for each of the different types of media.

Questions
1. What do the different media and the block of wood represent in real life?
2. What does the ‘tapping’ represent?
3. In what type of medium did you notice the typical liquefaction ‘puddling’ that we see during an earthquake?
4. Which type of medium was most prone to liquefaction?
5. Which medium resulted in the block slumping the quickest? Was this what you expected? Explain why or why not.

Extension
Find out more about liquefaction and the problems it caused in Canterbury’s 2010 and 2011 earthquakes. What geological feature(s) is it most likely to occur near?
SCIENCE VOCABULARY PUZZLE

Farming wordsearch

Find the following farming terms in the wordsearch below.

Word list
Beef, butterfat, casein, cattle, cheese, cultivate, dairy, fertiliser, fleece, flock, graze, harvest, heifer, irrigation, livestock, paddock, pasture, photosynthesis, sheep, sustainability, udder.
**Did you know:**
Fonterra has one of the most diverse workforces of any New Zealand-based company in terms of skillsets, cultures and geographies. Almost 36 per cent of Fonterra’s 16,800 employees work overseas in more than 50 countries around the world.

**What you will need:**
(per group, or as a class exercise)
- A dozen unripe or slightly ripe cherry tomatoes. (Ensure they all look the same.)
- A ripe banana.
- Access to a fridge.

**Aim**
To find out what things speed up or slow down the ripening of fruit.

**Key Ideas**
Fruit ripening, food storage.

**What to do**
1. For this experiment, select cherry tomatoes that are very similar in colour. It is best if they are greenish orange, that is, just beginning to ripen.
2. Take two tomatoes and place them in each of the following situations:
   - on a shelf out of direct sun
   - on a window sill where it receives direct sun
   - in a dark cupboard
   - in a fridge
   - in a warm place, such as a hot water cylinder cupboard
   - in a plastic bag in a warm place
   - in a plastic bag (along with a ripe banana) in a warm place.
3. Every three days check the colour of the tomatoes in each of the situations. Find a way of recording their colours. (Hint, you could create a colour chart with coloured pencils, or you might use a digital camera.

**Questions**
1. Why was it important to start with tomatoes that were all the same colour?
2. In which situation did the tomatoes ripen the fastest and the slowest?
3. Why, in a real life situation, might you want to speed up fruit ripening? What recommendation would you give to achieve this?
4. Why, in a real life situation, might you want to slow down fruit ripening? What recommendation would you give to achieve this?
5. What effect did the ripe banana have? Why?

**Extension**
Find out about how fruit is stored so it doesn’t ripen too quickly. How is it then ripened artificially when needed? (Hint, find out about the effects of carbon dioxide, nitrogen and ethylene gases.)
SCIENCE VOCABULARY PUZZLE

Forces and motion

Find the answers to the crossword puzzle by answering the questions below about forces and motion.

Across Clues
4. A force that occurs when two objects rub against one another.
6. A simple machine made from a rigid bar and fulcrum.
8. A unit of force and also a famous scientist.
11. The rate at which an object increases its speed.
12. How much matter is in an object.
17. A force that pulls things downwards.
18. The amount of space between two points.

Down Clues
1. A push or a pull.
2. Something that slows things down when they’re flying through the air.
5. A type of force involving magnets.
7. The opposite to ‘action’.
9. Similar to speed.
10. The process of moving.
13. How fast something is moving.
14. To cause something to be drawn near.
15. The tendency of a moving object to keep moving.
16. The amount of gravitational pull on an object.

Facts

Did you know:
In 2011, Fonterra traded approximately 2.5 million tonnes of dairy ingredients in world markets, of which around 2.1 million tonnes came from New Zealand.
Challenge 1

The trick
As the magician you must challenge a member of your ‘audience’, e.g. a friend, to somehow get the coin into the glass. Remember, they must not grab or hold onto any of the items. If they cannot achieve this, then show them how by flicking the edge of the card with your finger, as follows:

Flicking the card with middle finger.

Coin on card on top of glass.
This is the starting point for your trick.

Challenge 2

Modifying the trick
Try the same trick, but this time using several coins. How is it best to set up the coins so that the trick always works? How many coins can you use and still have the trick work reliably?

Explaining the science
Can you explain why the trick works? Explain in a couple of sentences as though you were a presenter on a TV science programme.

Challenge 3

Creating a more spectacular trick
Using the same idea, can you create your own very exciting trick that will enthral and excite your audience? It could be bigger, more daring, more colourful and more ‘risky’. (Note: Be careful though not to cause any mess or harm to anyone.)

Key resources from Learning Media:

Key School Journal References:
Friction ANDERSON, K.E. Article CN No. 2 1999, The Wall of Death MEDCALF, John Article 9.5-10.5 04 No. 2 1993.
Laser letter tile puzzle

Unscramble the tiles to reveal a message.

WAVE THA

NGTH

AS

NST

INGLE

STSS

LYI

LASER

CONS

EP

MO

TM

OF

EWA

RLI

VEE

XACT

SOF

Did you know:
Bones need a balance of nutrition and exercise. In people over 50, osteoporosis affects one in 3 women and one in 5 men.
**Challenge 1**

**Bending of light**

Use a pencil to act like a miniature spear and attempt to ‘spear’ a coin in a glass of water. Try looking from above and spearing straight down. Then try spearing from an angle. When does the spear appear to bend? Which direction does it appear to bend?

**What you will need:**

(per person)

* A pencil or kebab stick.
* A coin.
* A tall container of water.
* A straight stick or fish spear
* A bucket or aquarium of water
* A fish ‘target’ cut from an ice cream container lid.

**Setting the scene**

Imagine you were lost in a wild area and had to survive by finding food. There are fish in a stream, but to eat them you must first spear them. What must you learn about light and how it bends as it passes into water, before you can be good at catching your dinner?

**Challenge 2**

**Releasing your spear**

Prepare to aim at the fish (the coin), but do not have the pencil in the water. When looking from an angle into the water, where must you aim before releasing the spear — above, directly at, or below the fish? Try it out until you are satisfied that you can hit the fish every time.

Is it the actual ‘spear’ that bends or is it the light we see reflecting off the spear? What is this bending behaviour called?

**Challenge 3**

**Real life demonstration**

Hold a real spear (or a long stick to represent a spear) at an angle above an aquarium or bucket full of water. Now, by measuring angles and water depth, make up some rules for aiming at a fish in order to hit it every time. Demonstrate the application of these rules to other classmates.

---

**Key School Journal References:**

* The eye ANDERSON, K.E. Article CN No. 3 1999.
* Make a periscope FULLER, Sue Article 9.5-10.5 03 No. 1 1999.
* The riddle of light CAMPBELL, Rob Article 9.5-10.5 04 No. 2 1993.
* What is light? BELL, Alison Article CN No. 2 2006.
Human body double puzzle

Unscramble each of the clue words.
Copy the letters in the numbered cells to other cells with the same number to find the answer to the riddle below.

SONBE
NEEKOSLT
OOLDB
VEIDETGIS TYSEMS
SEMSCLU
NSREVE
RANBI
SIKN
SYEE
RASE
TARHE
NUSGL
PAICALSIREL
TUONEG
TOCMAHS

Riddle: What is another name for all the blood vessels and heart combined?
The Human Body

**Hand–eye co-ordination**

**What you will need:**
(per group)
- A ping-pong ball.
- Access to a flat, hard floor.

**Aim**
To investigate factors that affect hand–eye co-ordination.

**Key ideas**
Hand–eye co-ordination, movement, muscles, nerves, brain.

**What to do**
1. Stand on a hard, flat floor. Now bounce the ping-pong ball from your writing hand, catching it in your non-writing hand. Repeat 100 times, counting the number of times it is dropped.
2. Repeat step 1. above, but reverse the direction, bouncing the ball to your writing hand.
3. Repeat step 1. above, but with one eye closed.
4. Repeat step 1. above, but in lower light conditions, e.g. with the room’s lights off.
5. Investigate some other factors that might affect the outcome, e.g. the age of the person, the sex of the person, catching the ball in only three fingers (thumb, index and middle fingers).
6. Show your results in a bar graph.

**Questions**
1. Why do you think this activity is called an example of hand–eye co-ordination?
2. Which hand is best at catching? Why?
3. Is it easier to catch the ball when using one or two eyes? Why?
4. How do low light conditions affect the outcome? Why?
5. Describe the other factors you investigated and what you found.

**Extension**
Describe the steps your body must take in order to catch a ball. (Hint: use terms like eyes, brain, nerves, muscles, move, distance, judge, etc.)

**Key School Journal References:**
Goal shooting TAUMAUNU, Waimarama Article 9.5-10.5 04 No. 1 1990, Jan TRAFFORD, Jan Article 8-9 02 No. 3 2000, Mighty muscles GIBBISON, Sue Article 9-10 01 No. 2 2011.
### Astronomy pages 8–9

**Solar system puzzle**


**Phases of the moon**

1. The moon.
2. The sun.
3. The Earth.
4. A full moon is seen when looking from the same direction as the sun (the torch); a half moon is seen when looking side on to the moon; a new moon is seen when observing the moon from the opposite side to the moon to the sun; a crescent moon is seen when looking from slightly behind the moon; and, a gibbous moon is seen when looking from an angle slightly forward of the moon.
5. A full moon and a new moon create extreme high and low tides (called spring tides). Half moons create the least extreme tides (called neap tides).

**Extension:** Earth tides occur when the Earth's crust shifts in response to the moon and sun's gravitational pull (as well as other influences).

### Earth Science pages 10–11

**Earth science fallen phrase puzzle**

The Pacific Ring of Fire is an area where many earthquakes and volcanic eruptions occur.

**Liquefaction**

1. The different soil types.
2. The vibrations caused by an earthquake and its aftershocks.
3. Probably in a fine medium, such as a fine silt.
4. Probably a fine silt.
5. Probably a fine silt. This is to be expected, as it is the typical material in which liquefaction occurs in real life. If this did not occur, then probably not all the relevant factors were in place to replicate the real earthquake situation.

**Extension:** Typical problems: silt erupts out of the ground, swamping properties, flooding houses, lifting roads and causing buildings and other structures to collapse. It usually occurs near rivers, past river channels and on previously swampy land.

### Farming pages 12–13

**Farming wordsearch**

```
S + + + + C + + E + + P + + + + + +
+ U + A + E + E + S + + + A + H + + + +
+ + + E + T + + T + + + + + + + + + +
+ + + + + + + I + + E + A + I + + + + + + +
+ L + T + + + + + + + + + + + + + + + + +
+ N + H + L + L + D + A + I + R + + + + +
+ R + + + + + + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + + + + + + + +
+ + + + I + + + + + + + + + + + + + + + + +
+ + + + + + + + + + + + + + + + + + + + +
```

**Did you know:**

Bones are living tissue, constantly breaking down and rebuilding. Every 10 years our entire skeleton replaces itself.

**Harvest readiness**

1. So it was a fair test.
2. Fastest — in warm situations, especially when the banana was present. Slowest — in cold situations.

### Light pages 16–17

**Laser light puzzle**

Laser light consists of waves of a single wavelength that move exactly in step.

**Spear a fish**

**Challenge 1:** Bending of light — when entering the water at an angle to the surface (not at 90 degrees). The tip of the spear appears to bend upwards.

**Challenge 2:** Below the fish. The light bends, not the spear. Refraction.

**Challenge 3:** The rules should be along the following lines: The greater the water depth, the further below the fish you need to aim in order to hit it. And, the greater the angle of release is from the vertical, the further you need to aim below the fish.

### The Human Body pages 18–19

**Human body double puzzle**

**Circulatory system.**

**Hand–eye co-ordination**

1. Our eyes and hands must work together to catch the ball.
2. Usually the ‘writing’ hand. It is more practised at hand–eye type activities like catching a ball.
3. Two eyes usually, because they can judge distances better than one eye.
4. It is more difficult to catch the ball. Less light makes it harder to judge distances.
5. Examples: Very young people are not as good at catching the ball. It is harder to catch the ball using three fingers than using the whole hand.

**Extension:** The eyes see the ball and tell the brain where it is and how fast it is moving. The brain uses this information to pass messages to the arm and hand instructing it to move and grasp at the ball.

### Forces pages 14–15

**Solar system puzzle**


**Coin drop**

**Challenge 2:** By piling them on top of one another. Up to about 10 coins. How the trick works: The coins are being pulled downwards by gravity. When the card is flicked out from under them, they resist sideways movement due to their inertia (their ‘unwillingness to move’). Hence, they drop straight downwards.

**Challenge 3:** Creating a more spectacular trick: Examples could include: place items on top of a tall tube, use ‘risky’ items like a hen’s egg (boiled is best, just in case), use bigger, brightly coloured items, etc.

**Challenge 3 example.**

**Did you know:**

Fruit is stored at low temperatures in atmospheres containing less oxygen and higher carbon dioxide and nitrogen. Fruit can be ripened by increasing the temperature and introducing ethylene gas.

**Light unit**

**SCIENCE UNIT PLAN**

**Light — Te Aho**

**Introduction**

**Contexts**
- Light.
- The visible world and beyond.
- Microscopes and telescopes.
- The electromagnetic spectrum.
- Te Aniwaniwa.
- Kahurangi.
- Atakura.

**Unit Aim**
To investigate the nature of light and how it behaves. How light can be put to use.

**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 — light**
1. Light is a form of energy that we can see.
2. Light can carry useful information.
3. Light sources include: fire, sun, stars, very hot objects, lightning, bioluminescent animals, and electric discharge.
4. Properties of light include:
   - it travels in straight lines
   - it travels very fast
   - it can travel through translucent materials, but not opaque ones
   - colour and how white light is a combination of all the rainbow’s colours
   - reflection
   - refraction
   - lenses.
5. Blackness is the absence of all colours.
6. Light belongs to a family of waves called the Electromagnetic Spectrum.

**After completion of this unit children will be better at explaining and describing:**
- the nature of light and where it comes from
- key properties of light and how it behaves
- what white and black are due to
- the wider family to which light belongs — the Electromagnetic Spectrum.

**Timing**
- Specific Learning Intentions: 12 to 16 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)**

**Radiometer**
1. In light warm locations.
2. In dark or low light locations.
3. Place it in a dark, cool location so the radiometer is not spinning. Bring a ‘cool lamp’ such as a fluorescent bulb near to the radiometer. It will spin. To confirm that no heat is involved, place a small aquarium (or similar) full of water between the lamp and the radiometer. Confirm no changes in temperature using a thermometer positioned by the radiometer.
4. Move a cool light source closer and closer to the radiometer. It will spin faster and faster. (See 3. above to avoid any effects from heating.)

**Extension:** There are two reasons: Light hits the dark side of the vanes and is converted to heat which makes the particles on the dark side vibrate faster than on the silver side. They move faster and push the dark side away. Secondly, there are tiny pressure differences due to movement of molecules (energised by the light) near to the edge of the vanes, causing unbalanced forces to move the black sides of the vanes away.

**Newton’s colour disc**
1. A light greyish white.
2. Yes. The colours don’t seem to merge as much.
3. Sometimes violet, bottle green, etc.
4. They would be a muddy dark colour such as brown-black.

**Extension:** This is an example of persistence of vision. As the disc spins, our eye is stimulated by one colour, say, blue. Before it’s response ceases, it is stimulated by another colour, say, red. All the lingering responses therefore overlap to merge the combination of reflected colours. When the right balance of colours is achieved, a near white outcome can be achieved, just like combining the colours of the rainbow. Note, this is not the same as mixing paint colours.

**Mirror writing**
1. Yes, very. Because you keep trying to push the pen in the direction the mirror indicates, but this is exactly the wrong direction.
2. Yes. We are developing our brains learn that by instructing our hand to move to the right, results in it moving to the right. With mirror writing we have to un-learn old behaviours — we must instruct our hand to move to the left for it to appear to move to the right.
3. Regular shapes are easier. Because, once you start heading your pen in the right direction you can concentrate on your hand’s movement and to some extent disregard what you see in the mirror, relying on previously learnt drawing actions.
4. Irregular shapes are more difficult. Because you cannot rely on previously learnt drawing actions to trace the shape.

**Why is the sky blue?**
1. (a) the sky or atmosphere (b) the sun.
2. Blue or bluish. A small amount.
3. Red or reddish.
4. Sunset or sunrise. At these times the sun is low in the sky, so its light has to travel through a lot of atmosphere to reach us.
5. blue, blue, sun, red, low.

**Pinhole magnifying lens**
1. About 3–10 cm away (depending on the size of the hole).
2. Yes.
3. No.
4. Yes.
5. Too big — there is little magnification. Too small — the image is dull and fuzzy around the edges.

**Extension:** The pinhole magnifier acts like a lens by allowing you to move much closer to the object you are viewing, while still keeping it in focus. This means the object seems larger so you can see more detail. For a detailed explanation, see http://www.exploratorium.edu/snacks/pinhole_magnifier/index.html.
### Specific Learning Intentions and Activities

**Specific Learning Intentions**

1. Understand that light is a form of energy that we can see. And, light has many uses.

2. Light sources include: fire, sun, stars, very hot objects, lightning, bioluminescent animals and electric discharge.

3. Properties of light include:
   - it travels in straight lines
   - it travels very fast
   - it can pass through space
   - it can travel through translucent materials, but not opaque ones
   - colour
   - reflection
   - refraction

**Learning Activities**

- Introduce the unit by discussing what we use light for. Discussion could include: helping us to see where we are going, what we are looking for, helping plants to grow, etc. How do we know that plants use light? (They die when kept in the dark, all other things equal.)
- Show how light is a form of energy. [*Radiometer activity sheet*]

If light is able to help plants grow and us to see when otherwise it would be dark, what is it an example of? (Energy)
- Brainstorm how we use light of different colours and what messages those colours carry. (Examples of coloured light sources: traffic lights; red car tail lights, white head lights, navigation lights on boats and planes and stars of differing colours. Examples of reflected light: colour coded electrical wires; the red or yellow of ripe fruit; different skin colours caused by disease or other conditions. Homework: Find specific examples of what these colours tell us. Bring objects along to school that demonstrate the messages that can be carried by colours. [For more details, see *Square Kilometre Array, Years 7&8* found as a pdf file at www.roadshow.org/ska.]
- Brainstorm how flashes of light can carry messages. (Examples include: car blinkers; light houses; aeroplane strobe lights; signalling lamps and heliographs.) Homework: Find specific examples of what these flashes of light tell us. As an extension, children could build a simple heliograph using two mirrors (see Wikipedia) to send messages using a code they make up. ([Theory notes titled ‘What is light?’])

**Fonterra Science Roadshow visit:** *Light* Theme of interactive exhibits and the *Hidden World* show both re-enforce ideas about light.

- Light a candle and discuss what a flame is. (The visible portion of a fire and consisting of glowing hot gases.) What are some other sources of light? Research on the internet. Create a chart showing different sources of light and research what creates the light in each case. ([Theory notes titled ‘Light Sources’])

- Look at spectra produced by shining white light through a prism or by reflection off a compact disc (CD). Name the colours in order from red through to violet. (ROYGBIV — red, orange, yellow, green, blue, indigo, violet.) What must white light be made up of? (All the colours combined.) Research or experiment to find other ways of producing spectra, e.g. spraying a fine mist of water in sunlight, using water and a mirror, etc. Have children demonstrate what they have found.

- Change the light to a coloured source, or, put coloured cellophane between the light source and prism (or CD). How does this affect the spectrum created? Try other colours. What do filters do to the spectrum? (They can be carried by colours. [For more details, see *Specweb* page 8 of *Square Kilometre Array, Years 7&8* found as a pdf file at www.roadshow.org/ska.)

**Light travels in straight lines**

- Does light travel in straight lines? Demo and discussion: Line up a lamp (or torch) and two cards with holes mounted using blu tack, as follows: Have the children line the two cards so they can sight the lamp through the holes. Stretch a string out along the light path. Is it straight? Move one of the cards. Can the light still be seen? (No.) Discuss other examples of light’s straight path, e.g. lasers, sighting along a gun barrel, etc. Would the use of one card be sufficient to prove this? Why? (No. Because a straight line can always be drawn between two things. You need three items to confirm a straight line.)

**Light travels very fast**

- Research to find how fast light travels. (Approx. 300,000 km per second). Can you prove light travels faster than sound? Demonstrate by having a child stand 100 m away and ‘clap’ two pieces of timber together. Do you see the movement or hear the sound first? (You see it first, hence light travels faster than sound.) Discuss where else you see this. (Starter guns at races, lightning followed by thunder.) Task: Research how you can calculate how far away lightening is.

**What can light travel through?**

- Investigate what materials light will travel through. How do you know that it can pass through these or not? (We can see through them or we can detect light coming through them.) Which materials allow images — shapes and details — to pass through them? (Acrylic, glass, water, etc.) Which materials only allow scattered light through? (Frosted glass, net curtain, light weight paper, etc.)

**Colour**

- The spectrum and filters: Look at spectra produced by shining white light through a prism or by reflection off a compact disc (CD). Name the colours in order from red through to violet. (ROYGBIV — red, orange, yellow, green, blue, indigo, violet.) What must white light be made up of? (All the colours combined.) Research or experiment to find other ways of producing spectra, e.g. spraying a fine mist of water in sunlight, using water and a mirror, etc. Have children demonstrate what they have found.

- Change the light to a coloured source, or, put coloured cellophane between the light source and prism (or CD). How does this affect the spectrum created? Try other colours. What do filters do to the spectrum? (They cut out all the colour range except the colour they let through.)

- Rainbows: Find out about what causes rainbows. Draw and label a rainbow with its correct colour sequence. Due to refraction of light, which colours are forced to ‘bend’ the most? (Colours at the violet end of the spectrum.)

- Analysing spectra: Investigate the colours given off by different types of lights by building a simple spectroscope [See page 8 of *Square Kilometre Array, Years 7&8* found as a pdf file at www.roadshow.org/ska. The template for the cardboard spectroscope can be found at https://pantherfile.uwm.edu/awschwab/www/specweb.htm.] Relate the bands of colours seen through the spectroscope to the different ‘warmth’ of the white lights we have in our buildings, e.g. tungsten, fluorescent lights, etc.
### Specific Learning Intentions | Learning Activities

**Reflected colours:** Discussion: An object appears to be a certain colour because it absorbs or ‘takes up’ all the colours except the colours bouncing off it and into your eyes. Children attempt to prove this using a combination of coloured cards and different colours of cellophane used as ‘filters’.

**Mixing colours (persistence of vision):** Create a colour mixing wheel to see the effects of mixing different colours of light.  
[Newton’s colour disc activity sheet]

**Reflection**

**Mirror images:** Investigate reflection through activities such as:
1. Make a kaleidoscope (plenty of plans on the internet);
2. Use a laser pointer (Warning: may cause blindness if looked at directly! These are cheaply purchased for a few dollars at a $2 Shop.) to bounce its beam off several mirrors and eventually hit a target. Discuss the predictability of the angles, where reflections occur like those in billiards. (The reflection angle is the same as the angle it hits at.)
3. Look at your reflection using the front of a spoon. Does it magnify or reduce your image? Compare with the backside of the spoon.

Investigate the reverse nature of reflections.  
[Mirror writing activity sheet]

**Scattering of colours:** Investigate into how colours can be scattered.  
[Why is the sky blue? activity sheet]

**Refraction**

Investigate into how light bends when it moves from one medium to another, for example from air to water.  
[Spear a fish activity sheet on page 17]

**Lenses:** Lenses work by bending light as it passes from air into the glass and then bending again when re-entering the air. Children can prove this by using a light source that shines light through a comb, then through a magnifying glass, as shown to the right:

Investigate into how a tiny hole can behave like a lens.  
[Pinhole magnifying lens activity sheet]

**Applications of lenses:** Do a brief student-led investigation into any instrument that uses lenses. Examples might include: how to use a magnifying glass, then looking at details in leaves, skin, etc; using microscopes to look at very close, tiny objects; telescopes; cameras; etc.

Colour separation using a prism is a special case of refraction, because the different colours are bent by differing amounts.  
[Theory notes titled ‘Properties of light’]

4. Blackness is the absence of all colours and /or all light.  
Blackness is the absence of light. Prove this by painting the inside of a shoebox with fluorescent paint. Cut a peephole in the side, then put the lid on. Look through the peephole to see the blackness within. Keep looking through the peephole and lift the lid to reveal the colour (only seen when light is present).  
[Theory notes titled ‘Blackness’]

5. Light belongs to a family of waves called the Electromagnetic Spectrum.

**The Electromagnetic Spectrum**  
Discuss other types of waves that belong to the wider ‘light’ family. These are called electromagnetic waves. Draw up a simplified diagram of the Electromagnetic Spectrum (see Wikipedia diagram at http://en.wikipedia.org/wiki/Electromagnetic_spectrum).

**Infrared (IR) waves**  
Where do we experience infrared rays? (Heat from the sun, a heater, etc.). Investigate the harmless infrared rays produced by a TV (or similar) remote device by doing activities from ‘Messages In Light We Cannot See’, pp 9–10 of Square Kilometre Array, Years 7&8 found as a pdf file at www.roadshow.org/ska.

**Ultraviolet (UV) waves**  
When do we encounter ultraviolet rays? (UV rays give us sunburn.) Are they high or low energy waves? (High.) What do you notice about the wavelength of these waves? (They are shorter than visible light.) Discuss how the shorter the wavelength the higher their energy, and therefore the more dangerous they are.

**Radio waves**  
Are radio waves short or long? (Very long.) Investigate into radio waves by doing activities from ‘Messages In Light We Cannot See’, pp 11–12 of Square Kilometre Array, Years 7&8 found as a pdf file at www.roadshow.org/ska.

Research into the Square Kilometre Array, one of largest scientific projects every undertaken. This is a fascinating radio astronomy project that Australia and NZ are currently bidding on. Website links:
- www.ska.gov.au – The Australian and NZ part of it
- www.ska.ac.nz – The NZ part of the project
- www.ska.edu.au – An educational site
- www.skatelescope.org – Overview of the whole project
  – Overview of project.  
[Theory notes titled Electromagnetic Spectrum]
The colours of the visible spectrum are: (children list), which are what we see in the rainbow. An easy way to remember these is to use ROYGBIV. When all the colours of the rainbow are combined we get whiteness. Filters block out some of these colours, while letting others through. A coloured object absorbs (takes up) all the colours of the rainbow except for the colours reflected back to our eyes, e.g. a green leaf absorbs all the colours except green.

Plants use light to grow and we use it to help us sense the world around us.

Light can carry messages in its colours and as flashes. Examples include: (children list and draw examples).

Using the lenses in our eyes and with the help of our brains we can use light to see shapes and details of objects. This is called sight.

We can use a spectroscope to see the colours given off by a light source. (Children draw and label their spectroscope and draw some spectra from different light sources.)

Reflection occurs when light bounces off an object. It will bounce off a shiny flat surface in a predictable way giving an image that is reversed.

Scattering occurs off uneven surfaces.

Refraction occurs when light bends as it travels from one substance into another, e.g. air into water. Lenses use refraction to magnify objects.

Blackness

Pure blackness occurs when there is no light or there are no colours present.

Electromagnetic spectrum

Light belongs to a wider family called the Electromagnetic Spectrum, which also includes: (children list, e.g. infrared, ultraviolet, X-rays, radio waves, gamma rays, microwaves, etc.)
Light unit

ACTIVITY SHEET

Radiometer

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

* A radiometer (obtained from a science or discovery shop).

**Aim**
To investigate whether light is a form of energy.

**Key ideas**
Light, energy, intensity, absorption, particles, molecules, vacuum.

**What to do**
1. Place the radiometer onto a sunny windowsill and see what it does.
2. Move it to other locations to investigate whether it will go. Try light and dark places, inside and outside, warm and cool, etc. When does it go the fastest?
3. Design an experiment to show that heat is not needed for the radiometer to spin.
4. Design another experiment to show how light intensity affects the speed of rotation.
5. Design a test to see if heat affects the speed of rotation.

**Questions**
1. Generally speaking, when does the radiometer spin the fastest?
2. When does it not spin?
3. How did you show that heat is not needed for the radiometer to spin?
4. How did you show that light intensity affects the speed of rotation?

**Extension**
Research and write about how a radiometer works by looking up ‘Crookes Radiometer’. This is not as simple as it appears!

**Did you know:**
A single glass of milk contains as much protein as an egg. It has as many carbohydrates as a ¼ cup of cooked rice and the same calcium as 4 cups of broccoli.

Key resources from Learning Media:

Key School Journal References:
Gifts from the sun O’BRIEN, John Article 8-9 02 No. 3 1995, Gifts from the sun O’BRIEN, John Article CN No. 1 1998, The riddle of light CAMPBELL, Rob Article 9.5-10.5 04 No. 2 1993, What is light? BELL, Alison Article CN No. 2 2006.
Newton’s colour disc

**Aim**
To show how combining certain colours of reflected light can create the appearance of other, often lighter tones of colours.

**Key ideas**
Light, colours, primary colours, complementary colours, persistence of vision.

**What to do**
1. Drill two small holes either side of the centre of the CD making sure they are in line with the very centre of the disc, as shown at far left.
2. Thread about a metre of string through the holes and tie the ends to form a loop, as shown at near left.
3. Draw straight lines to divide the disc up and colour in the portions you have created, as follows:
   - ¼ yellow
   - ¼ red
   - ½ light blue.
4. Hold the ends of the string in your hand and spin the disc by pulling in and out rhythmically. With practice and by ensuring the disc is always upright, you should be able to get it to spin very quickly, or quite slowly too. Practise.
5. Carefully observe and record the colours you get at both slower and faster speeds.
6. Repeat the process, but use different proportions and combinations of colours (but preferably typical colours you would find in the rainbow, not for example, brown).

**Questions**
1. What new colours do you see when you spin the disc quickly?
2. Do different turning speeds make a difference? Give examples.
3. What unexpected colours did you see at medium and lower speeds?
4. If you were to mix paints that were these colours, how would the colours be different to what you see when the disc is spinning?

**Extension**
Explain why you see these colours. Hints: look up ‘persistence of vision’; and, it is something to do with how movie (not video) film works.

**What you will need:**
(per group)
- 2-3 old CDs or DVDs (the ones with a plain white printable surface).
- String.
- Coloured pencils.
- A small drill and bit.
- Pen and ruler.

**Key resources from Learning Media:**

**Key School Journal References:**
The aurora REA, William Article CN No. 3 2001,
Bright lights window decorations SOMMERVILLE, Blair Article 9.5-10.5 03 No. 2 2004, Colour in black and white Article 9-10 03 No. 2 1979, The riddle of light CAMPBELL, Rob Article 9.5-10.5 04 No. 2 1993, What is light? BELL, Alison Article CN No. 2 2006.
**ACTIVITY SHEET**

**Mirror writing**

**Aim**
To investigate mirror images.

**Key ideas**
Mirror images are reversed, reflection, co-ordination, learning and un-learning.

**What to do**
1. Write your name in large letters on the paper.
2. Using blu tack, position the mirror upright and about 2 cm beyond the letters. You should be able to see your name reflected in the mirror.
3. Using your non-writing hand, hold the card in front of you so as to block out the original writing. You must still be able to see your name reflected in the mirror.
4. Now, attempt to trace your name with a different coloured pen.
5. Try copying some other shapes that you have created, e.g. a circle, a rectangle, other regular and irregular shapes too.
6. Create a challenge for your partner to copy.

**Questions**
1. Was it difficult to trace the mirror image of your name? Why?
2. Explain in terms of past learning, why this was difficult.
3. Was it easier copying regular shapes like circles? Why or why not?
4. Was it easier copying irregular shapes? Why or why not?

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

- A mirror at least 8 x 10 cm in size.
- Blu tack to prop the mirror upright.
- A4 paper.
- Two different coloured pens.
- A piece of card (about 20 x 15 cm).

**Key School Journal References:**

Why is the sky blue?

**Aim**
To observe the effect of light scattering, similar to what causes the sky to be blue.

**Key ideas**
Light, scattering, colours, atmosphere, blue sky.

**What to do**
1. Work in a darkened room. (It does not need to be totally dark.)
2. Three quarters fill the container with water and place it on a piece of white paper.
3. Add one teaspoon of milk and stir to make an even mix. Take note of its colour. The milk mix represents the atmosphere.
4. Shine the torch through the ‘atmosphere’ from one end of the container to the other.
5. Looking down into the ‘atmosphere’, carefully observe and record the colour of the beam nearest to the torch, and at the end furthest from the torch.
6. Increase the amount of milk by a half-teaspoon worth and record the beam colour at both ends. Repeat until you have added about five teaspoons of milk.

**Questions**
1. What do each of these represent (a) the milky solution and (b) the torch?
2. The milky mix nearest the torch represents when the sun is overhead, say at midday. What is the colour of the beam nearest to the torch? Through how much ‘atmosphere’ did the beam travel to this point?
3. What is the colour of the beam furthest from the torch?
4. When the beam of light has to travel through a lot of the milky mix, that is, a lot of atmosphere, what time of the day does this represent? Why?
5. Complete the following. When the sun’s light travels through a small amount of atmosphere the colour _______ is scattered sideways, while the rest of the colours continue straight through. This is why the sky appears _______ when the _______ is directly overhead. When light travels through a lot of atmosphere, the last of the colours to be scattered are at the _______ end of the spectrum. This is why we see reddish colours at sunset when the sun is _______ in the sky (and light has to travel through a lot of atmosphere).

**Did you know:**
A glass of milk contains around a quarter of our daily calcium needs.

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**Key School Journal References:**
- The aurora REA, William Article CN No. 3 2001,
- Bright lights window decorations SOMMERVILLE, Blair Article 9.5-10.5 03 No. 2 2004, Colour in black and white Article 9-10 03 No. 2 1979, The eye ANDERSON, K.E. Article CN No. 3 1999.
**Light unit**

**ACTIVITY SHEET**

**Pinhole magnifying lens**

**What you will need:** (per group)
- A square of cardboard (about 10 x 10 cm).
- A square of aluminium foil (about 5 x 5 cm).
- Scissors or a craft knife (Care!).
- Sellotape.
- A pin or needle.

**Aim**
To show how a tiny hole can act like a magnifying lens.

**Key ideas**
Magnification, lenses, pinhole lenses.

**What to do**
1. Cut out a 4 x 4 cm hole in the centre of the cardboard.
2. Tape the piece of aluminium foil over the hole.
3. Carefully use a pin to make a tiny, clean hole in the middle of the aluminium foil.
4. Hold the card very close to your eye and look through the hole at some very small letters on a page. Move in and out to find the best focus point and greatest magnification. Take your pinhole magnifier away to see if you can focus this close.
5. Compare the detail you can see with what you would normally see.
6. Make different sized holes in the aluminium foil (at least 5 mm away from each other) and compare how good they are at magnifying things.

**Questions**
1. Using your magnifier, how close can you move towards the letters and keep them in focus?
2. Are the letters magnified?
3. Can you get this close and see an in-focus image without your pinhole magnifier?
4. Can you see more detail than without your magnifier?
5. What happens if the hole is too big? Too small?

**Extension**
Research into how the pinhole magnifier works.

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Did you know:
Fonterra currently has over 600 patents and patent applications to protect their intellectual property.
Pre- and post-unit assessment

One way of pre- and post-testing the knowledge of students on the unit of work Light, 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 Light 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 ‘Light’ 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 Light. Ticks are given to show how marks are allocated. This student’s pre-test score was 7.

Keyword list
Additive colour
Beam
Black
Colour
Dark
Electromagnetic spectrum
Energy
Filters
Incidence
Infrared
Intensity
Kaleidoscope
Laser
Lens, lenses
Magnify
Mirror
Newton’s colour disc
Pinhole camera
Prism
Radio waves
Rainbow
Ray
Reduce
Reflection
Refraction
ROYGBIV
Scatter
Shadow
Spectroscope
Spectrum
Straight lines
Subtractive colour
Sun
Ultraviolet
Visible
Waves
White
Plus extra words at teacher’s discretion.
Mind map on Light

Name ________________________ Date __________

Year level _____ School ________________________
Students are motivated to learn when they can see a purpose for their learning. Developing students’ understanding of how study connects to work is one way to give them a purpose for learning.

In years 1-8, help students to make connections between their own strengths and interests, and the jobs they see and learn about. This is a great time to help students to broaden their horizons and dream of possible futures.

Fonterra Science Roadshow pre- and post-visit activities

The two activities suggested below explore the application of subject learning to different jobs, and the way technology changes the work people do. They have been selected from the activities included in the activity guide of the resource Kiwi Cards.

Kiwi Cards activities help students analyse the relationships between jobs, learning and individuals. They also suggest:

Self-awareness questions — An important way to help students relate what they have seen and learned to their own possible futures.

Extensions — Help build a simple starter activity into a lesson.

Pre-visit activity or lesson

Refer to ‘Subjects to Jobs’, page 18 of the Kiwi Cards activity guide where students think about the ways different subjects are applied in a job. Work with a classmate as follows:

- Look at the cards you have got and decide what jobs they represent.
- Discuss how people in these jobs use what they have learned in the subjects below.
- Write your conclusions in a table similar to this.

<table>
<thead>
<tr>
<th>Job 1</th>
<th>Job 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Name</td>
<td></td>
</tr>
<tr>
<td>Uses English</td>
<td></td>
</tr>
<tr>
<td>Uses Science</td>
<td></td>
</tr>
<tr>
<td>Uses Maths</td>
<td></td>
</tr>
<tr>
<td>Uses Technology</td>
<td></td>
</tr>
</tbody>
</table>

Post-visit or lesson

Refer to ‘The Changing World of Work’, page 30 of the Kiwi Cards activity guide. In this activity students think about how a job may change over time, especially as a result of technology.

Alternatively, you could ask students to use the job they were assigned or one they heard about at the Fonterra Science Roadshow.

Students could learn more about this job by reading the associated job description on the Careers New Zealand website, www.careers.govt.nz, before completing the activity. Work with a classmate as follows:

- Look at the cards you have got and decide what jobs they represent.
- Discuss what technology people use in these jobs, and how this might have been different in the past and how it might be different in the future.
- Write your conclusions in a table similar to this.

<table>
<thead>
<tr>
<th>Job 1</th>
<th>Job 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Job Name</td>
<td></td>
</tr>
<tr>
<td>In the past</td>
<td></td>
</tr>
<tr>
<td>In the present</td>
<td></td>
</tr>
<tr>
<td>In the future</td>
<td></td>
</tr>
</tbody>
</table>