2024 RESOURCE BOOK

THEMES

Ngā Matū — **Materials**

Te Porotiti me te pūrorohū — **Spinning and whizzing**

Te Inenga — **Measurement**

Te tinana tangata — **The body**

Te Tautohu ki te rerekētanga — **Telling the difference**

Te Pūngao — **Energy**

SHOWS

Te Whakaaturanga Ao Huna — **Hidden Worlds**

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

UNIT PLAN

Te Pūngao toitū — **Sustainable energy**

SCIENCE ROADSHOW

scienceroadshow.nz

TE TĀHUHU O TE MĀTAURANGA
MINISTRY OF EDUCATION

SCIENCE ALIVE Mātauranga

Science ROADSHOW

CONTENTS

This booklet

This resource contains language-based puzzles and hands-on activities that relate to the exhibit themes in the Science Roadshow's 2024 programme. Also included is a unit of work called 'Sustainable Energy', which relates to the programme's *Energy* theme.

CONTENTS

Local Curriculum

Throughout the booklet reference has been made to ways in which activities and investigations can be tailored to a Localised Curriculum, with emphases on: using the experiences students (ākonga) bring to the classroom; providing rich opportunities for learning based on students' strengths, identities and priorities; and, better connecting students with people and happenings in their communities.

Mātauranga Māori

Mātauranga Māori is a system of thought that encompasses knowledge, wisdom, philosophical and traditional understanding, and skills. Viewing science through this lens means taking a holistic approach, linking and communicating ideas to and via cultural practices, ceremonies, language and narratives. However, this system of thought has much in common with western science disciplines too. For example, they are both empirical — using observations and experience, cause and effect, trial and error, repetitive trials, pattern seeking, grouping, and comparisons, to verify ideas about the natural physical world and to build knowledge systems.

Cross-curriculum

While the activities in this booklet are primarily science focused, many suggestions are given on how to link them across different areas of learning, as well as connecting the ideas to the community and wider world.

Foundational Science Capabilities

We have incorporated many implicit and explicit Foundational Science Capabilities components (functional interpretations of the Nature of Science strand) both within our 70 minute Science Roadshow visit experience (exhibits and shows) and within this Resource Booklet.

Science kits to support science education

We would like to draw your attention to a range of hands-on science kits for science teaching, available from the House of Science. We have referenced them in relevant places throughout this booklet. Kits are available for loan to schools on a membership basis.

House of Science website https://houseofscience.nz/science-kits/.

Sir Paul Callaghan Science Academy

The Sir Paul Callaghan Science Academy endorses the ethos and learning principles of the Science Roadshow.

More information about the Sir Paul Callaghan Science Academy is found on the back cover of this booklet.

Resource Booklet prepared by Peter E. Smith

Overview

Science puzzles (pages 4–9)

The purpose of the science puzzles is to expose students to vocabulary and maths principles that will help them gain more from their visit to the Science Roadshow and from other science experiences. Like any discipline, science uses words and aspects of numeracy that are specific and purposeful, which aid students' understanding and their ability to communicate ideas.

For puzzle answers see page 27.

Hands-on activities (pages 10–15)

Two types of activities are included:

1) INVESTIGATIONS:
- emphasise the *process* of science using an array of Nature of Science concepts, with emphasis on the Science Capabilities
- involve any combination of approaches including: observations, inferences, pattern seeking, grouping and fair tests
- provide direct acts of teaching ideas
- scaffold students towards more open-ended discovery and independent scientific inquiry
- contribute to science content knowledge.

2) CHALLENGES:
- aim to solve problems or present practical challenges
- scaffold students, but are more open-ended in their outcomes
- present opportunities for more creative and critical thinking.

For guidance, possible 'answers' and outcomes, see page 27.

Abbreviations used throughout booklet

WALT = We Are Learning To (included at the start of Investigation and Challenge Sheets)

WILF = What I'm Looking For

TIB = This Is Because

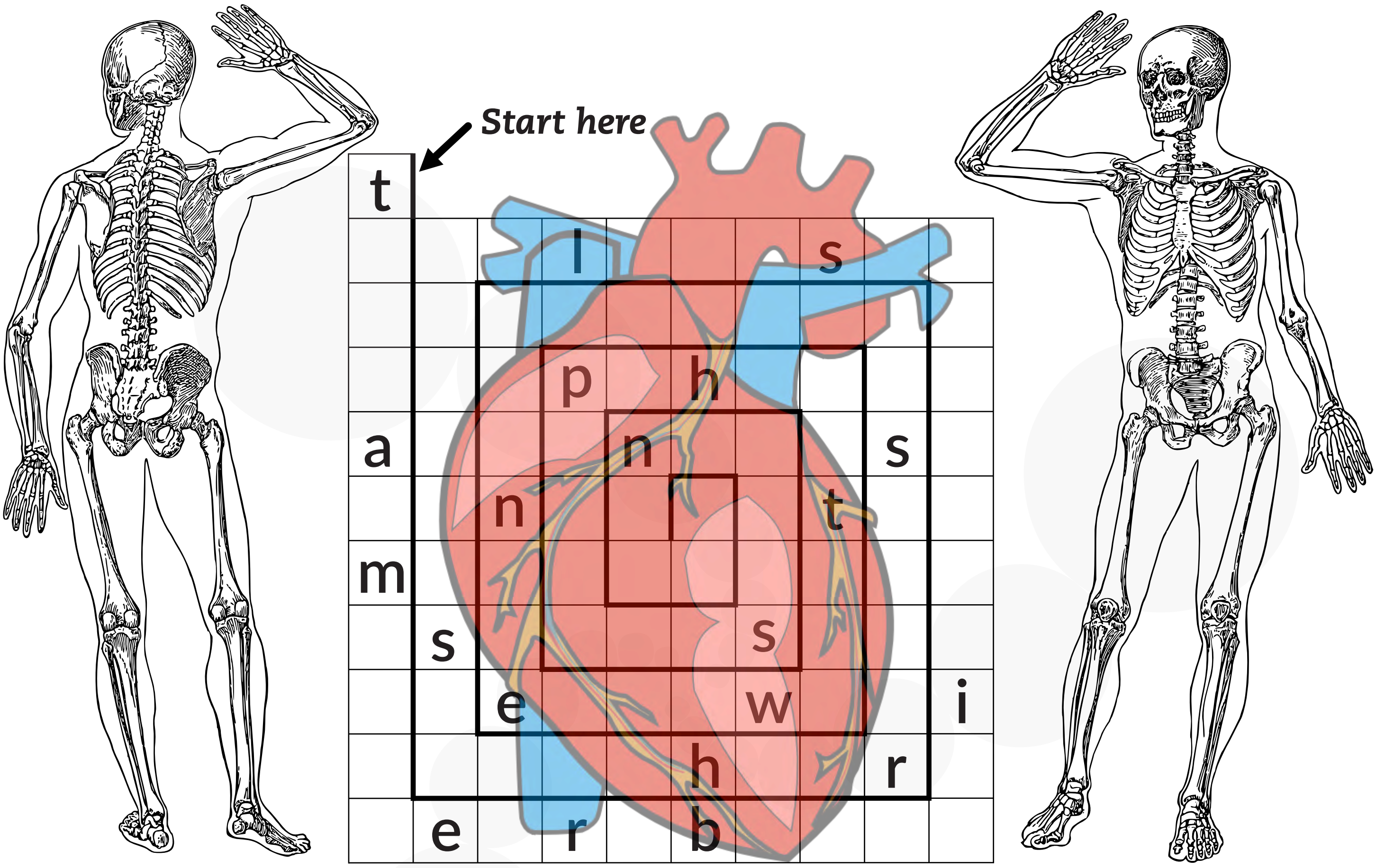
For the teacher

Hands-on activity	Engagement activities ('hooks')	WILFs & TIBs	Resources SEARCH WORDS (Google, School Journals) Specific resources (Building Science Concepts **BSC**, House of Science kits **HoS**)
The celery experiment p 10	Show examples of different veggies and fruits and pose the question 'How do we gain nutrients from these?'	**WILF**: Students will discover that food must be broken down into a slurry of juices before nutrient and energy value can be obtained from it. **TIB**: Only tiny particles (molecules) can pass through the gut lining and into our bloodstream.	DIGESTION, ABSORPTION **BSC:** Bk 51 *Standing up* L1–2. **HoS:** *Dem Bones, Food for Thought*
Create a solar oven p 11	Show how a magnifying glass concentrates the sun's rays to a point which becomes very hot.	**WILF:** Students will investigate how to build a simple solar oven and understand how the sun's rays can be concentrated for heating/cooking purposes. **TIB:** Solar energy is a great source of renewable energy so it is an important resource for the future.	SOLAR OVEN, SOLAR ENERGY, RENEWABLE ENERGY **BSC:** Bk 36 *Heat on the move* L3–4, Bk 46 *Keeping warm* L1–2, Bk 29 *Solar energy* L2–4, Bk 54 *Windmills and waterwheels* L3–4. **HoS:** *Electric Future, Flexi-Physics, Hot Stuff*
Biodegradable plant pot p 12	Show some products that have been made from recycled materials, e.g. egg cartons, insulation packing.	**WILF:** Students will learn that there are environmentally friendly ways of re-purposing products that in the past would have been thrown away. **TIB:** Our world's resources are becoming scarce, so they need to be used sparingly, and recycled.	RECYCLING PAPER **BSC:** Bk 48 *Fabrics* L1–4, Bk 47 *Insulation* L3–4.
Discovering volumes p 13	What is volume? How could we find how many of these boxes would fit into a covered truck?	**WILF:** Students will discover that the volume of water displaced by an object equals its own volume. **TIB:** When an object is put into a full container of water (or in the case of a buoyant object, pushed under water), the volume of water spilling out equals the object's volume.	MEASURING VOLUME, WATER DISPLACEMENT **HoS:** *Measurement Matters*
The magic of spinning p 14	Demonstrate a spinning top or show a video of an ice skater pirouetting.	**WILF:** Students will be able to build their own spinning top and change its shape to investigate the effect on stability. **TIB:** This is because they need to understand the idea of cause and effect. (Changing a factor and observing the effect it has.)	SPINNING, ROTATION, GYROSCOPIC EFFECT **HoS:** *Simple Machines*
Observe the difference — growing crystals p 15	Show pictures of crystals. Observe jelly crystals under magnification.	**WILF:** Students will understand how to grow different types of crystals and observe their shapes. **TIB:** They need to know how to conduct fair tests and make good observations.	FAIR TESTS, CRYSTALLISATION, OBSERVATIONS **HoS:** *What do you think?*

SCIENCE WORD PUZZLE

Body word chain

This puzzle uses the last letter of each answer, as the first letter of the next answer. The first answer and some letters have been filled in to help you along the way.



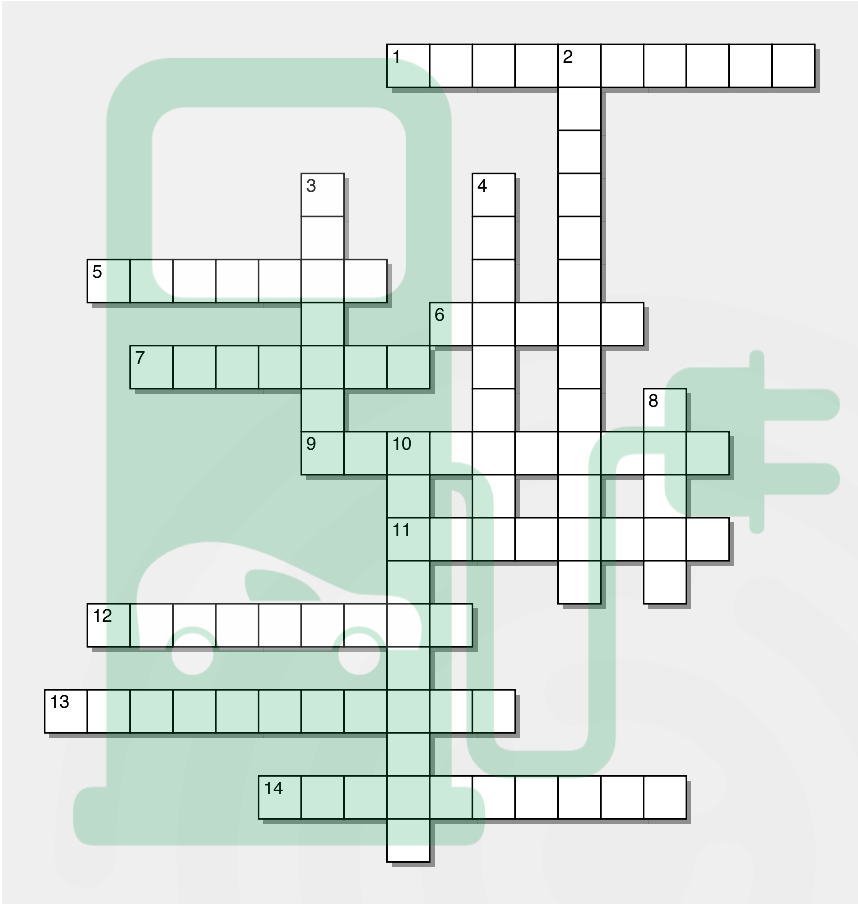
Clues

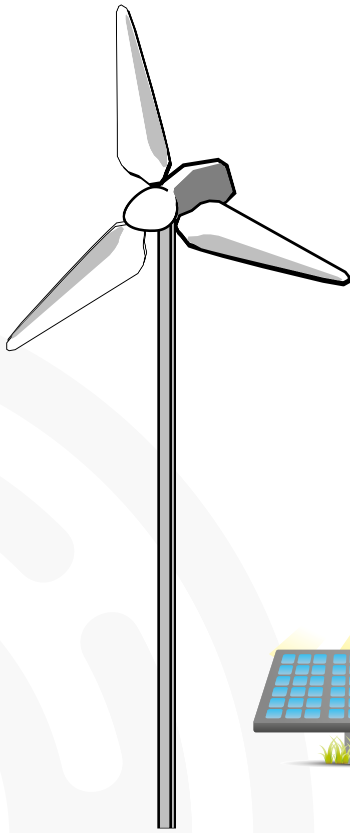
1. The large bone in your lower leg.
2. A limb used for holding and moving things.
3. The tissue in your body that helps you move.
4. The organ you use to hear sounds.
5. One of the curved bones that protect your lungs and heart.
6. The tubes that connect your windpipe to your lungs.
7. The long, coiled tubes that digest food in your body.
8. The bony structure that protects your brain.
9. The strong, stretchy bands that connect bones to other bones.
10. The organ that breaks down food with acids.
11. The thin strands growing from your skin, found on your head and body.
12. One of the two bones in your forearm.
13. The series of bones that protect your spinal cord and support your upper body (two words).
14. The facial organ used for smelling and breathing.
15. The joint that connects your upper arm to your forearm.
16. The joint connecting your hand to your forearm.
17. The hard, white structures in your mouth used for biting and chewing food.
18. The joint where your thigh bone connects to your pelvis.
19. The organ that helps with digestion and controls blood sugar.
20. The organ that filters blood and helps your immune system.
21. A cell that sends messages between your brain and the rest of your body.

SCIENCE WORD PUZZLE

Energy crossword

Use the clues to solve this crossword about **energy**.





Clues

Across:
1) Energy generated from heat within the Earth.
5) Energy from atomic nuclei.
6) A unit for measuring energy.
7) Energy of an object in motion.
9) Another term for burning.
11) Energy stored in fossil fuels.
12) Type of energy related to height.
13) A device that converts wind energy into electricity (two words).
14) A device that converts sunlight into electricity (two words).

Down:
2) A form of energy generated by moving water.
3) Energy stored in objects that can be compressed or stretched.
4) One thousand joules.
8) Energy from the Sun.
10) Energy from a force pushing or pulling an object.

Looking locally

What forms of energy do you use in a typical day at school? Give examples of how they are useful to you.

SCIENCE WORD PUZZLE

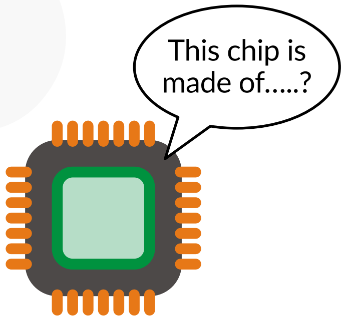
Elements double puzzle

Unscramble each of the words about elements. The first is done for you. The first 20 elements of the Periodic Table will give you clues, and there are picture clues too.

Copy the letters in the numbered cells to other cells with the same number to complete the mystery statement.

Clues	*Unscramble*	
NOCIILS	S I L I C O N	22 7 15 10 11 8 28
NOEN	☐☐☐☐	3 19
NOROB	☐☐☐☐☐	14 6 32
EGORDYNH	☐☐☐☐☐☐☐☐	2 9 18 17 5
MUIHLE	☐☐☐☐☐☐	16 24 35 20 26
EFNIROUL	☐☐☐☐☐☐☐☐	33 36 23
MUIGESNAM	☐☐☐☐☐☐☐☐☐	13 37 25 30
TMUISAOPS	☐☐☐☐☐☐☐☐☐	4 1 31 46 45
MUHTILI	☐☐☐☐☐☐☐	12 40
UDOMSI	☐☐☐☐☐☐	44 34
HUOSPPHORS	☐☐☐☐☐☐☐☐☐☐	21 42 38 41
EYXOGN	☐☐☐☐☐☐	27
RNEGOITN	☐☐☐☐☐☐☐☐	29 43 39

Some picture clues



Mystery statement

1 2 3 / 4 5 6 7 8 9 10 11 / 12 13 14 15 16 / 17 18 19 20 21 22 / 23 24 25 26 27 28 29 30

31 11 11 32 33 34 35 36 37 / 29 8 / 12 38 39 40 41 / 42 43 44 42 3 6 1 45 3 46.

SCIENCE NUMBER PUZZLE

Units blitz

This puzzle is about units of measurement, for example, distance units include kilometres (m) and millimetres (mm), while time units include minutes (min) and hours (h).

For each item, replace the question mark with a number to make the statement true. The first one is done.

1

Clue: A common unit of volume.

Puzzle: *? L = 1,000 mL*

Answer: 1

2

Clue: Time it takes for a clock's minute hand to move one space.

Puzzle: *60 s = ? min*

Answer: ________

3

Clue: A bag of sugar often weighs this.

Puzzle: *? kg = 500 g*

Answer: ________

4

Clue: The height of a tall 3-year-old child.

Puzzle: *100 cm = ? m*

Answer: ________

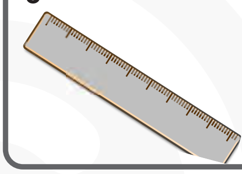
5

Clue: A common unit of time in computing.

Puzzle: *? ms = 1 second*

Answer: ________

6

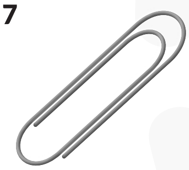


Clue: The length of a long school ruler.

Puzzle: *1,000 mm = ? m*

Answer: ________

7

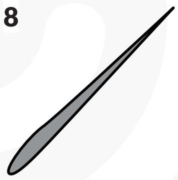


Clue: A small paperclip's mass.

Puzzle: *1,000 mg = ? g*

Answer: ________

8



Clue: The thickness of a human hair.

Puzzle: *? µm = 1 mm*

Answer: ________

9

Clue: The volume of a milk bottle.

Puzzle: *2,000 mL = ? L*

Answer: ________

10

Clue: The mass of an adult cat.

Puzzle: *4,500 g = ? kg*

Answer: ________

Find out more

Find examples of units used for:

- temperature
- power
- force
- money.

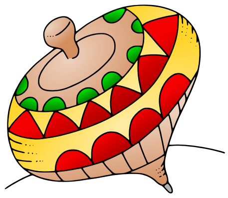
Research

What are SI units?

Spinning and whizzing

SCIENCE WORD PUZZLE

Spinning word search



Complete the word search by finding 15 words that relate to spinning. The first letter of each word is circled.

Use the words in the creative writing task below.

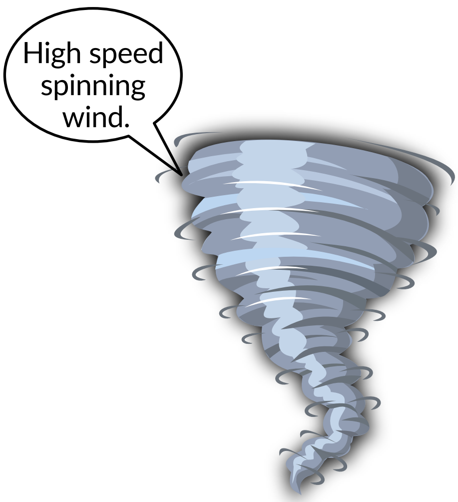
P	J	H	F	D	M	D	(T)	D	X	A	Q	A	S	E	B	Z	H	M	L
F	T	W	M	M	O	E	A	O	K	I	N	A	C	(G)	I	K	D	P	T
K	(R)	D	Y	O	L	D	H	O	R	K	U	P	U	Y	L	C	U	F	(S)
O	O	(W)	H	E	E	L	E	T	C	N	W	D	Y	R	A	Q	M	P	W
L	T	I	Z	C	Y	A	F	P	P	U	A	Q	K	A	Q	F	R	J	I
U	A	I	W	J	S	Q	W	A	P	Z	M	D	K	T	K	G	T	T	R
P	T	E	B	U	D	D	N	P	B	(C)	D	O	O	E	F	A	(T)	G	L
P	E	X	H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

Words I've found

Creative writing task

Use at least 10 words you found in a short paragraph about 'a scientific experiment that went wrong'. First write up to four different starter ideas, then choose the best to write your paragraph. Here is an example of a starter:

We were doing a science project at school about tornadoes....



1.

2.

3.

4.

SCIENCE WORD PUZZLE

What makes the difference?

Each science mystery below is a thinking puzzle, where you are comparing one thing with another. Decide on an answer to each mystery, then compare what you think with a friend.

1

Magnets: You have two magnets: Magnet A and Magnet B. Magnet A is a bar magnet and Magnet B is a horseshoe magnet. You test them by seeing how many paperclips each can pick up. Which type of magnet do you think can pick up more paperclips and why?

2

Sound: You have two musical instruments: Instrument A is a guitar, and Instrument B is a violin. If the same note is played on both instruments, they produce different sounds. Why is this and how does the structure of the instruments affect the sounds they make?

3

Materials: You have two identical cups, but they are made from different materials. Cup A is made of plastic, and Cup B is made of metal. You fill both with equal amounts of hot tea. After 10 minutes, which cup do you predict will have cooler tea and why?

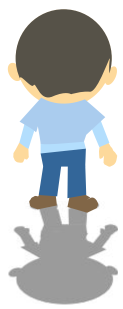
4

The Tale of Two Apples: You have two apples: Apple A and Apple B. They look exactly the same, but when you drop them into a tank full of water, Apple A floats, but Apple B sinks. What could be the reason for this difference in their behaviours?

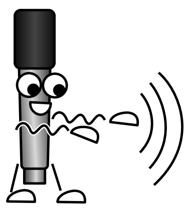
5

The Story of the Sun and Moon: The Sun and the Moon look about the same size when you look up at them from Earth. But, in reality, one is much larger than the other. Can you guess which one is larger and why they appear the same size from Earth?

6



The Two Blazing Shadows: You stand in the park on a sunny day and measure your shadow's length. The next day your friend repeats this, but their shadow is much longer than yours, even though you're about the same height. What could explain this mystery?



Research and hands-on investigations

Go deeper with one of the mysteries by researching about the idea, doing hands-on tests and experiments, or creating models to gather evidence to support your answers.

INVESTIGATION

The celery experiment

WALT

We are learning to investigate the process of digestion in the human body by observing the changes to a piece of celery over a few days.

What you will need:
(per group)

- ☆ *Fresh celery sticks.*
- ☆ *Kitchen scales.*
- ☆ *Journal and pen.*
- ☆ *A camera (optional).*

Celery, a healthy, high fibre food.

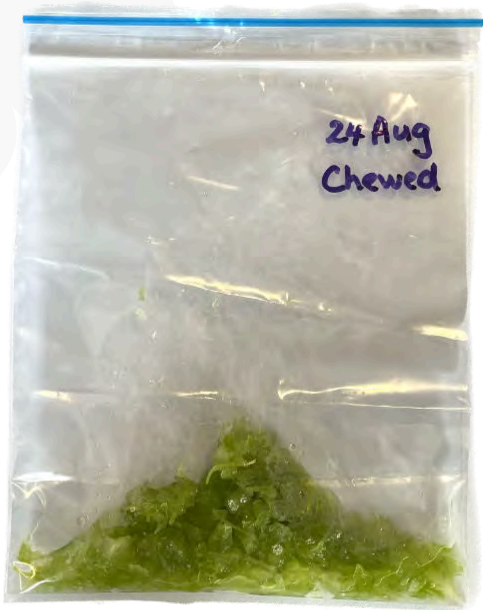
What to do

Engage · Explore · Explain · Elaborate · Evaluate

On Day 1

1. Wash your hands thoroughly before and after this experiment.
2. Each student should take a fresh celery stick and observe and record the following:
   - the colour of the celery
   - the texture (how it feels to touch)
   - the weight (if a scale is available)
   - draw a picture of the celery in their journal.

3. After you've recorded these observations, chew the celery stick thoroughly for about 10 seconds and then spit it into a resealable bag (you shouldn't swallow it).
4. Seal the bag, label it and photograph the contents.
5. Store the bag in a safe place at room temperature.
6. On Day 2, 24 hours later, observe and record the same things as in step 1, and take another picture.
7. Keep this experiment going for a few more days and record any further changes.



Questions and discussion

1. What changes did you observe in the celery stick after 24 hours?
2. Were there any other changes in the following days?
3. How are these changes similar to what happens in the human body during digestion?
4. How might the saliva have started the process of breaking down the celery?

Extension

Research to find out how the different parts of the human digestive system work to process food.

INVESTIGATION

Create a solar oven

WALT

We are learning to create a model of a solar oven. This shows us how, with the right design, solar energy can be focused to create a region of high temperature for heating and cooking food.

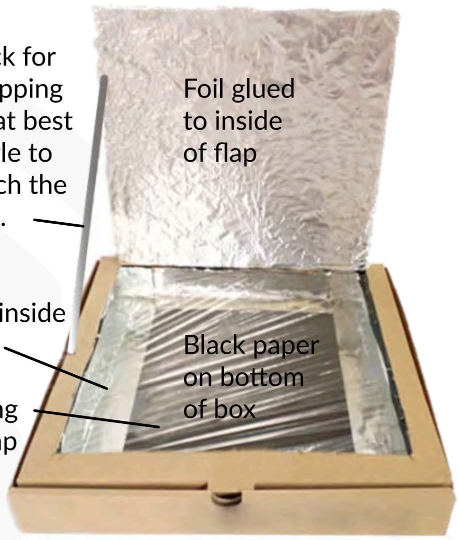
What you will need:
(per group)

- *A pizza box (or any other shallow cardboard box).*
- *Aluminium foil.*
- *Black paper.*
- *Cling wrap, e.g. Glad wrap.*
- *Scissors.*
- *Tape.*
- *Stick or straw for propping the box lid open.*
- *A snack to heat (like a chocolate chip or cheese on a cracker).*

What to do

Engage Explore Explain

1. Start by cutting a flap in the top of the pizza box, leaving a 2 cm border around three sides, creating a flap that can be folded back.
2. Cover the inside of the flap and the inside of the box (the bottom, below the flap) with aluminium foil, shiny side out. Use tape to keep it in place.
3. Line the bottom of the box, over the aluminium foil, with black paper.
4. Stretch cling wrap across the opening you cut in the box lid and tape the edges down.



Pizza box solar oven.

5. Prop the flap open with a stick or straw. Angle the flap so that it reflects sunlight into the box.
6. On a sunny day: Place your snack on the black paper inside the box, close the lid (leaving the foil-covered flap propped open) and point the box towards the sun.

Depending on the strength of the sun, the snack might take some time to show signs of melting.

Questions and discussion

Elaborate Evaluate

1. What happened to the snack after the box was left in the sun?
2. How do the a) black paper, b) the aluminium foil and c) the cling wrap help in the heating process?
3. How is this similar to or different from how solar (photovoltaic) panels work?
4. Why is solar energy a sustainable source of energy?
5. List advantages and disadvantages of solar ovens.

Extension

Improve on your solar oven by finding ways of focusing the light rays from the sun and using better materials. ***Care!*** *Avoid burning.*

CHALLENGE

Biodegradable plant pot

WALT

We are learning to explore the properties of natural fibres by creating biodegradable plant pots using a mixture of paper and natural fibres. We will then plant seeds in these pots to observe their growth.

What you will need:
(per group)

- *Different natural fibres (cotton balls, jute, wool, hemp).*
- *Newspaper or any waste paper.*
- *Warm water.*
- *Blender (under adult supervision).*
- *Seeds (flowers, herbs, or small vegetables).*
- *Compost or potting soil.*
- *Ruler.*
- *Journal and pen for observations.*

Basic method

1. *Tear the newspaper or waste paper into small pieces and soak them in warm water for about an hour.*
2. *Blend the soaked paper pieces and water into pulp in a blender (with adult supervision).*
3. *Use your finge s to form the pulp into a small cup-shaped pot for sowing seeds. Squeeze excess water out as you go. Allow it to dry for a few days until it hardens.*

4. *Fill the dried plant pot with compost or potting soil and plant seeds in each one.*
5. *Observe and record the plant growth in each pot over time, and monitor the decomposition of the pots as you water them.*

Challenge 1

Perform fair tests

Mix some natural fib es into some paper pulp and mould this into a pot. Repeat for one or two different types of natural fib es and compare the results.

*How did you make sure these were **fair** tests?*

Natural fibres that can be mixed with paper pulp. Knitting wool (left, needs to be teased out first) and cotton wool.

Challenge 2

Fibres from nature

Find your own fib es from nature. They need to be dry. For example, you could try the fib es from dried cabbage tree leaves.

Natural fibres left to right: dog hair, tī kōuka / cabbage tree leaf fibres, human hair, raupō seed head fluff.

Repeat trials using the same method used earlier and record any differences you observe.

Challenge 3

Are your pots suited to their purpose?

Design experiments to answer these questions:

1. *Which fibres created the strongest pots?*
2. *Which pots fell apart the most easily when watered?*
3. *Which pots could be planted with the seedling still in them, and allowed the roots to grow through them as they decomposed?*

Discovering volumes

WALT

We are learning about volume and improving our estimation skills using the water displacement method. This skill will help us estimate sizes and quantities in real-life situations, where reasonably accurate estimations are important.

What you will need:

(per group)

- *Clear container with measurements (large measuring jug or graduated cylinder if available).*
- *A range of different objects that sink in water, for example, marbles, pebbles, pieces of metal, plastic blocks, fishing sinkers, heavy plastic toys.*
- *Water*
- *Pen and paper for recording measurements and estimates.*

The basic method

Fill the container with a known amount of water. Write down this volume.

1. *Choose an object to measure. Estimate how much water it will displace (how much the water level will rise) and write this estimate down.*
2. *Carefully place the object into the water and observe the change in water level.*
3. *Find the volume of the object by subtracting the original volume from the new volume.*
4. *Record the volume.*

Volume of Marmite jar: Final water volume (880 mL) minus water volume before putting jar into jug (600 mL), so volume of jar equals 280 mL.

Challenge 1

Different shaped objects

*Use the method for **different shaped objects**, such as cubes, pyramids and spheres.*

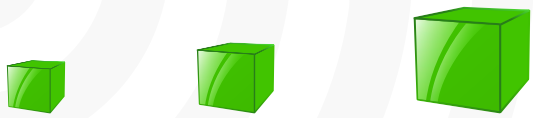


1. *How close were your estimates to the actual volumes?*
2. *How does the shape of the object affect its volume and your ability to estimate?*
3. *How might estimation skills be useful in everyday situations?*

Challenge 2

Size challenge

*This time, use the same shaped objects of **different sizes**. Start with smaller objects working up in size.*

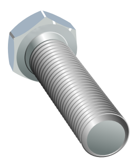


1. *Were your estimates more accurate with different-sized objects?*
2. *How did the size of the object affect the volume estimation?*

Challenge 3

Advanced Estimation

*This time, choose objects with **irregular shapes**, like a bolt, a jagged rock, or a toy dinosaur.*


1. *Was it more challenging to estimate the volumes of irregular objects?*
2. *What strategies did you use to estimate their volumes?*

INVESTIGATION

The magic of spinning

WALT

We are learning to understand the principles of rotation and stability in spinning objects through the creation and testing of a home-made spinning top.

What you will need:
(per group)

- A small, sturdy disc (a plastic lid, a cardboard cutout, or an old DVD).
- A pencil or a wooden skewer.
- Plasticine.
- Timer.
- Pen and paper for recording observations.

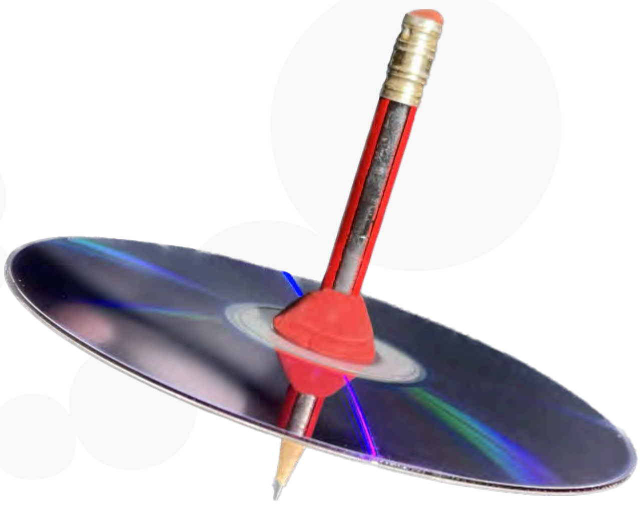
What to do

Engage

Setting the scene

Spinning tops are a great way to learn about rotational physics. This experiment helps you to understand the principles of angular momentum and stability.

The steps



1. Start by pushing the pencil through the centre of the disc and use Plasticine to hold it in place. At the start fit it low down towards the sharpened end of the pencil.
2. Make sure the disc is balanced evenly on the pencil.
3. On a flat surface, spin the top by twisting the top of the pencil between your fingers. Time how long the top spins before it falls over. Repeat several times.
4. Experiment with adjusting the position of the disc along the pencil. For example, try it near in the middle and near the top, each time spinning the top and recording how long it spins.
5. Record the spinning times and your observations for each position.

Explore

Explain

Questions and discussion

Elaborate

1. What happens when you spin the top?
2. How does changing the position of the disc on the pencil affect the spinning?
3. What makes the top eventually stop spinning?
4. How do you think this relates to the spinning of objects like the Earth or a bicycle wheel?

Going local

Evaluate

Where in your community do you see examples of things spinning?

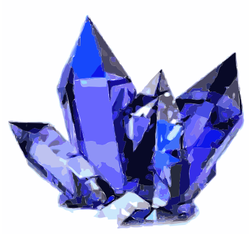
Extension

Accuracy
How can you ensure your findings are reliable and not just chance? Set up and use a method to achieve this.

Observe the difference – growing crystals

WALT

We are learning to compare the crystallisation processes of sugar and salt by observing and documenting their structures as they form crystals.



What you will need:
(per group)

- *Table sugar (sucrose).*
- *Table salt (sodium chloride).*
- *Two clear glass jars.*
- *Two pieces of string or thread.*
- *Two pencils.*
- *Hot water (to be handled by an adult).*
- *Plastic clothes pegs.*
- *A magnifying glass.*
- *Journal and pen for recording observations.*

Setting the scene

Both salt and sugar are common household items, yet they form different crystal structures due to their unique molecular structures.

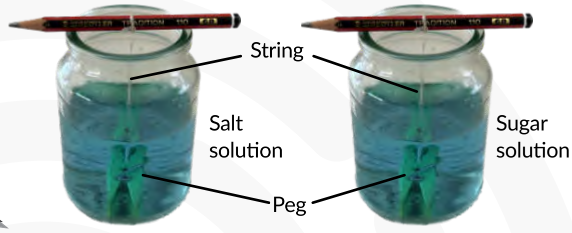
Basic method

1. *Fill both jars with hot water.*
2. *Stir in the sugar in one jar and the salt in the other, slowly adding each substance until no more can dissolve. These are now super-saturated solutions.*
3. *Tie one end of each piece of string to a pencil. Attach a clothes peg to the end of the string to weigh it down.*
4. *Lower the string into each jar, making sure it's fully immersed and not touching the sides or bottom of the jar. The pencil should rest on top of the jar, keeping the string in place. See pictures to the right.*

Challenge 1

Comparing salt and sugar crystals

1. *Leave the jars in a cool place where they won't be disturbed for about a week.*



2. *Over the week, observe the formation of the crystals on the string in each jar. Use the magnifying glass to see the shape and structure of the crystals. Were they different?*
3. *Record any differences in the crystals, and other observations in your journal.*

Challenge 2

Comparing warm and cool conditions

Create a fair test experiment where you compare the size of crystals formed in cool conditions compared to warm conditions.

Record any differences you observed.

Challenge 3

Compare the string

Create an experiment to see if the type of string or thread changes how the crystals form.

Observe and record your results in your journal.

SCIENCE UNIT PLAN

Sustainable energy — Te Pūngao toitū

Curriculum level:
Science L3 and L4

Contexts/Strands:
Physical World, Planet Earth and Beyond

Science Concepts

Key concepts:
- What is energy?
- Types of energy
- Energy transformations
- Sustainable energy
- Types of sustainable energy, e.g.
  - solar
  - wind
  - hydroelectricity
  - geothermal
- Using energy efficiently and wisely
- Energy conservation
- Pros and cons of different energy sources.

Cross-curriculum studies and Mātauranga Māori

Approach:
This unit reflects how a cross-curriculum approach is the process of experiencing and understanding connections and, because of this, seeing things as a whole.

Best practice suggests drawing from only relevant Learning Areas, so for this unit, the Learning Areas of most value are likely to be: Technology, English, Mathematics and statistics, Science, History and Social sciences.

The scope of a full cross-curriculum unit is too large for inclusion in just a few pages, so practical, hands-on science activities are emphasised here, with supporting references to cross-curriculum approaches.

Mātauranga Māori is fundamental to a holistic approach and could indeed be a useful focus for the unit. What traditional Māori knowledge, wisdom, understanding and traditions might contribute to kaitiakitanga (guardianship and stewardship) and a sustainable energy future?

Key aims

To investigate different types of sustainable energy. This involves students:
- Understanding what energy is in its different forms
- Understanding the difference between renewable (sustainable) and non-renewable (non-sustainable) energy forms
- Exploring, investigating and modelling different renewable forms of energy generation.

ICT & Resources

Websites and YouTube demonstrations as outlined in specific activities.

Building Science Concepts books and House of Science kits as referred to in specific activities.

Achievement Objectives

Nature of Science (NoS)

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

Contextual

Planet Earth & Beyond, L3–4:
Interacting systems: *Investigate the water cycle and its effect on climate, landforms, and life.*

Physical World, L3–4:
Physical inquiry and physics concepts
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.

Localised curriculum

Use some of the following to help pursue a localised approach to your *Sustainable Energy* unit:
- Investigate forms of energy used in your homes and community.
- Research into types of ***sustainable*** energy used in the past by early Māori, and later, by European settlers.
- Find out about types of ***sustainable*** energy generated or used in your local community today, and, plans for the future.
- Debate issues associated with new local solar or wind farms.
- Invite a solar panel installer or enthusiast to explain how they work, and how they help the environment while reducing our power bills.
- Find out about the benefits of on-shore and offshore wind farms. What are their strengths and weaknesses?
- Investigate new emerging foods and how they might be used to supply our future food energy needs.

Answers and teacher guidance for pages 20–24

Hydroelectric power p20: ***Challenge 2.*** Answers will vary. However there will be an optimum number of blades. Too many or too few will give poorer results. Scoop-like blades or ones with 'hooks' on their ends may work more effectively.

Make a wind turbine p21: Q1. Blades, hub and shaft. Q2. Blades catch the wind. Hub holds the blades in the right position and connects them to the shaft. Shaft sits within the bearing and allows the turbine to spin. Q3. When it spins its energy of rotation is transferred through a gearbox to a generator to create electricity. Q4. Wind is a renewable form of energy, so it isn't depleted, and it is 'clean', producing no emissions. Q5. Challenges: Finding suitable sites that are windy and away from human habitation (because turbines are noisy), yet suitable for road access; electricity is only generated when it is windy; danger of spinning turbines to birds (the blade tips can spin at hundreds of metres per second).

Mini solar car p22: ***Challenge 1.*** The solar cell generates the electricity, demonstrated by the fact that the wheels stop spinning if the cell is shaded. The little electric motor at the back uses the electricity to spin the wheels. ***Challenge 2.*** Answers will vary, but students should be able to support their ideas with the results of experiments they have conducted. ***Challenge 3.*** Recommendations could include things like using: bright light angled down on the car at right angles to the solar cell, focused light, very smooth surface, a track where the car doesn't hit any side rails.

Potato power p23: Q1. Potatoes combined with the two metals (copper and zinc) supply the electricity (0.5 V or more), wires conduct the electricity around the circuit, LED uses the electrical energy to product light. Q2. A potato battery is a simple electrochemical cell that produces electricity using chemical reactions between two dissimilar metals (copper and zinc) and an electrolyte (the potato juices). Q3. A more powerful battery makes the LED shine brighter and is achieved with: larger areas of copper (a bigger coin) and zinc (a bigger nail) in contact with the potato; more potatoes linked into the circuit; and, cleaner metals and wire ends. The spacing between the nail and coin within the potato and the type of potato used may also affect the voltage produced.

Best insulators p24: ***Challenge 1.*** Aluminium foil is the better insulator. Evidence: At each reading over the first hour the temperature is 1–3°C higher in the jar covered by the foil compared to the jar covered with paper. The shiny surface of the foil works by reflecting radiant heat energy back into the jar, whereas the paper doesn't. ***Challenge 2.*** Answers will vary, but some materials are much better than others at trapping heat in. Placing insulation under the jar helps to reduce heat loss downwards by conduction and radiation. ***Challenge 3.*** Answers will vary, but the best insulation against the jar will be one that is non-metallic, thick and traps tiny pockets of still air. Combining this with an outer reflective layer can improve the insulation properties further.

Specific learning intentions and activities

Endorsed by the Sir Paul Callaghan Science Academy, the following assumptions apply:

a) The 5Es instructional model is used as a general approach to lessons.

b) Student-directed learning is encouraged through teaching key techniques and approaches at the start of lessons/sections, then allowing students to build on these techniques through their own more open-ended lines of inquiry.

c) Nature of Science (NoS) components (and therefore the Five Foundational Science Capabilities) are inherent and treated in an explicit manner.

Note, you do NOT need to cover all parts, as there are many ideas presented here. The most valuable learning occurs when some areas are pursued more deeply. Tip: Print pages 16–18 to A3 size for ease of reading.

Specific Learning Intentions	Learning Activities through 5Es model	
Foundational Science Capabilities/NoS These capabilities are embedded throughout the unit, in both the content and the way it is taught. The aim is to help students develop a well-rounded set of scientific skills and attitudes, not just learn scientific facts. ***Gather and interpret data*** Students will develop this capability through activities such as conducting energy audits, experimenting with solar cookers and wind turbines, and analysing their data to draw conclusions. ***Use evidence*** Students will strengthen this capability as they use evidence to make decisions about energy use, such as the pros and cons of different energy sources, and use their experimental data to support their conclusions. ***Critique*** Students will develop this capability as they learn to question and evaluate the sources of information they use, such as when researching different energy sources and technologies, and when interpreting their own and others' data from experiments. ***Interpret representations*** Students will develop this capability as they learn to interpret different ways that information about energy is represented, such as in diagrams of energy transformations, graphs of energy use, and symbols in electrical diagrams. ***Engaging in science*** This unit, with its focus on sustainable energy, provides many opportunities for students to connect with how science relates to their lives, their community, and global issues. They can engage with science by discussing ethical and societal issues related to energy use, designing solutions to energy problems, and communicating their ideas and findings.	***ENGAGE* to ignite interest:** **Energy brainstorming:** Brainstorm different types of energy and discuss where that energy comes from. **Energy in our lives:** Keep a one-day 'energy diary' where students write down all the ways they use energy in their daily lives. Discuss environmental impacts of energy use and the concept of a carbon footprint. **Energy scavenger hunt:** Embark on a scavenger hunt to identify objects that use different forms of energy. List the item, type of energy it uses and whether this is renewable or non-renewable. **Energy charades:** Student picks a card that has a form of energy written on it. They then act it out and the class guesses which type of energy it is. **Solar-powered toys:** Place them under a lamp or in sunlight. Discuss how these devices use light energy to function. **Rubber band racers:** Build rubber band racers using household materials, then explore the potential and kinetic energy involved as the rubber band unwinds and propels the car. **Bottle rocket:** Use water and a bicycle pump to launch a plastic bottle skywards to show potential energy (water under pressure) being converted into kinetic energy (the bottle's movement). **Hand crank torch or emergency radio:** Show how mechanical energy (rotating the handle) converts into electrical and then light or sound energy. **DIY musical instruments:** Create musical instruments (e.g. drums) using recycled materials, then explore the conversion of mechanical energy (striking or plucking the instrument) to sound energy.	***EXPLORE*:** ***Create a solar oven* Challenge p11:** Construct solar ovens from pizza boxes, aluminium foil, and clear plastic wrap. **Sun and shadows:** On a sunny day, have students draw chalk outlines of their shadows at different times and note how their shadow moves due to Earth's rotation. This helps them visualise how a solar oven or solar panels need to be positioned to capture the most sunlight. ***Hydroelectric power* Challenge p20:** Build a hydroelectric power station to harness the energy from running water. ***Make a wind turbine* Investigation p21:** Build a simple wind turbine to explore the power of wind energy. Use a small electric fan to provide 'wind' during testing. For best positioning outside, use a compass and simple materials like feathers or light fabric pieces to map the direction and strength of the wind over the course of a day or week. ***Mini solar car* Challenge p 22:** Put a miniature solar-powered car through its paces to find out how it works. ***Potato Power* p23:** Students can use a potato, zinc and copper electrodes, and some wire to create a potato battery. They can measure the output voltage with an LED or by using a multimeter so as to learn about chemical-to-electrical energy conversion. ***Best insulators* p24:** Use aluminium foil as a means of insulation to prevent heat loss from a home, e.g. when used in under floor insulation or around a hot water cylinder. Then, compare it with different materials and different thicknesses of materials.

Specific learning intentions and activities

Specific Learning Intentions	Learning Activities through 5Es model
Learning intentions for this unit Students will: **1. Energy transformations:** Understand how energy can be transformed from one form to another, including mechanical, chemical, electrical, etc. **2. Energy sources:** Be able to identify different sources of energy, both renewable (such as solar) and non-renewable (like coal, oil, and natural gas). **3. Sustainable energy:** Comprehend the concept of sustainable energy, recognising the benefits and drawbacks of renewable and non-renewable resources. **4. Energy transformations:** Apply their understanding of energy transformations to practical tasks, e.g. constructing a simple wind turbine. **5. Energy efficiency:** Understand the concept of energy efficiency, including ways to save energy in everyday life. **6. Real-world:** Be able to investigate energy use and efficiency in real-world scenarios, such as conducting an energy audit of their school or home. **7. Energy conservation:** Explore the principle of energy conservation. **8. Energy use:** Understand the environmental impact of different energy sources and make informed choices about energy use. ***Other Activities and Challenges pp 20–24 list their own specific Learning Intentions.*** **[Theory notes titled 'Understanding energy', see over page.]** **Vocabulary:** audit battery coal conservation dams efficiency electrical energy environment geothermal hydropower insulation kinetic light mechanical non-renewable panel (as in solar panel) potential renewable research solar sound sustainability thermal transformation turbine (as in wind turbine) vibration voltaic (as in photovoltaic) watt (unit of power) wind	*EXPLAIN* **During or after the exploration activities:** **Formal definitions:** Introduce formal definitions of renewable energy, non-renewable energy, and sustainability. Discuss different sources of renewable energy, like wind, solar, and hydroelectric power. **Energy transfer:** Explain how energy is transformed from one form to another. For example, in the wind power experiment, kinetic energy (wind motion) is transferred into mechanical energy (the moving turbine). **Sustainability in energy:** Discuss how using renewable energy sources can help reduce carbon emissions and slow climate change. Explain how renewable energy technologies, like solar panels and wind turbines, work. **Energy transformation flowcharts:** Teach students how to create flowcharts to depict different energy transformations. They could illustrate how energy transforms in a toaster, car, wind turbine, or the process of photosynthesis in plants. **Visual presentations:** Utilise visual aids such as presentations or video clips that depict various forms of energy and how they transform from one to another. **Analogy discussions:** Use everyday analogies to explain complex energy transformations. For example, you could compare the transfer of energy in a food chain to passing a ball in a game, where the ball represents energy and the players are organisms. **Compare and contrast:** Have students create a Venn diagram to compare and contrast renewable and non-renewable energy sources, e.g. hydroelectric v's coal fired generation of electricity. Use them to represent aspects that both share in common (the overlapped areas) v's aspects they don't share in common. **Interactive whiteboard activities:** Use online whiteboard tools to graphically represent different energy transformations. Students could drag and drop different forms of energy and draw arrows to show the transformation process. **Discussion panels:** Organise discussion panels where groups of students are assigned to research and explain different energy topics (like solar energy, wind energy, bioenergy). This can be followed by a Q&A session to ensure understanding. *ELABORATE* Examples of experiments that could extend students' understanding of concepts to real-world applications, particularly focusing on sustainable energy: **1. Energy Efficiency Audit:** Students can conduct an energy audit of their school or home. They'll measure energy consumption using watt meters and then make recommendations for how to improve energy efficiency. This activity directly applies their understanding of energy transformation and conservation to a real-world context. **2. Hydropower Project:** Extend the 'DIY Hydropower' experiment by having the students design and build a more efficient water turbine. They can experiment with different materials and blade designs, aiming to produce the most electricity (measurable with a small voltmeter or multimeter) from a given amount of water flow. **3. Wind Turbine Design:** Similar to the hydropower project, students can design and build their own wind turbines. They can try different materials, number of blades, blade shapes, and orientations to see which design generates the most power from the wind. *EVALUATE* Teachers should be able to evaluate the success of their teaching so as to make adjustments and refinements to approaches throughout a unit of work. Are students learning? How do we know? Can we measure this? Students should also be evaluating their own understanding and success throughout the unit.

Theory notes

Understanding energy

[Adjust language and content to suit student level and ability.]

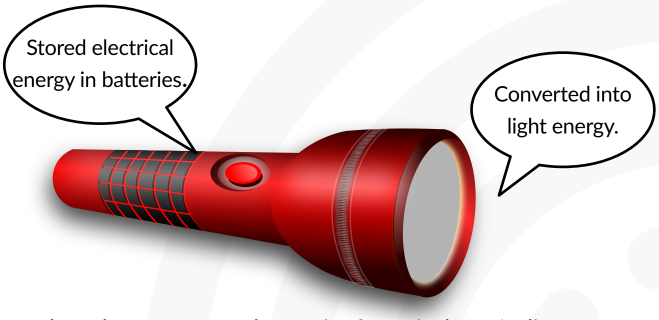
What is energy?

Energy is like a special kind of power that makes things happen. It's what gives us the ability to do things, like moving, playing, or even thinking. Think of it as a fuel that makes everything in the world work.

Just like we need food to have energy for our bodies, everything around us needs energy to do its job too.

1. Changing energy (energy transformations)

Energy can change its form, like a superhero! For example, a torch changes electrical energy from the batteries into light energy that you can see.



Even though energy can change its form, it doesn't disappear — this is called *The law of conservation of energy*.

Different types of energy: [Students draw their own pictures]

- **Mechanical**: Energy of movement (like a moving ball) or stored energy (like a stretched rubber band)
- **Chemical**: Energy that comes from changes in tiny particles (like in a battery)
- **Electrical**: Energy of moving electric charges (like in wires)
- **Thermal**: Energy of heat (like in a warm cup of cocoa)
- **Light** (Radiant): Energy of light (like a torch beam)
- **Sound**: Energy of vibrations (like music from speakers).

2. Long-lasting energy (sustainable energy)

Sustainable (or renewable) energy comes from sources that don't run out, like sun (solar), wind, and heat from inside the Earth (geothermal).

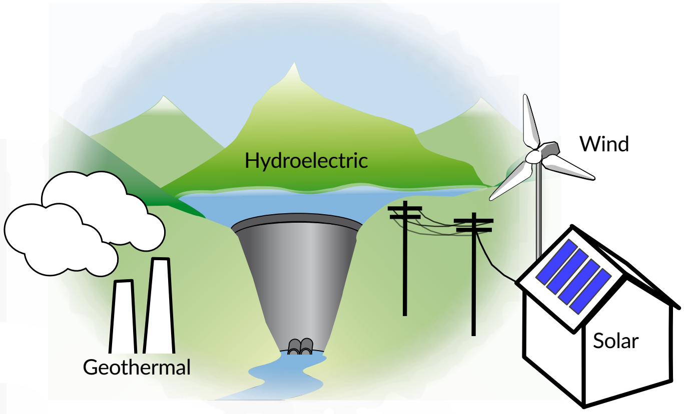
Wind energy (moving air)

Geothermal energy (hot water and steam)

Solar energy (heat and light)

These types of energy are kinder to our planet than using things like coal and oil, which can harm the environment and will eventually run out.

Long-lasting energy generation:



- **Solar:** Turns sunlight into electricity or hot water (e.g. using solar panels)
- **Wind:** Changes the energy of moving air into electricity (using wind turbines)
- **Hydroelectric:** Turns the energy of moving water into electricity (using dams and turbines)
- **Geothermal:** Uses steam turbines to convert heat from inside the Earth into electricity.

3. Using energy wisely (energy efficiency)

Energy efficiency means doing the same things but using less energy. It's like scoring the same points in a game with fewer tries. This is really important to help us look after the Earth. [Students give examples]

4. Using what we learn

Understanding about changing energy, long-lasting energy, and using energy wisely are important, not just for our brains but for real life too. We can use this knowledge to create better things like more efficient wind generators, better solar ovens, or homes that stay warm without using lots of energy.

5. Energy conservation

The rule of energy conservation is like the ultimate superhero power — energy can't be made from nothing and it can't disappear into nothing. Even when energy changes its form, the total amount of energy stays the same.

6. Thinking hard about energy

Different types of energy have good points and bad points. Like superheroes and supervillains, they have strengths and weaknesses. We need to think carefully about these when deciding what types of energy to use. For example, coal gives us lots of heat energy, but it also pollutes the environment.

CHALLENGE

Hydroelectric power

WALT

We are learning to build a model hydroelectric generator using LEGO to understand how electricity can be produced.

What you will need:

(per group)

- *LEGO parts.*
- *Optional extras: various items from around the home such as bottle tops, plastic spoons, toy wheels, containers, superglue, hot glue gun and tape.*
- *In order to demonstrate the generation of electricity you will need a small motor, wires and a LED.*

LED light.

Setting the scene

Hydroelectric dams generate most of our country's electricity. This challenge is to build a working model of hydroelectric generation. LEGO can be used for some components, combined with various other items.

To help you to understand the key ideas, watch some of these videos:

https://www.youtube.com/watch?v=CA5Gmi2p9gE

https://www.youtube.com/watch?v=N4pctTyhvdw

https://www.youtube.com/watch?v=Wu9fmgBhRlg

https://www.youtube.com/watch?v=ebZWNeD-JIk

https://www.youtube.com/watch?v=vG1AthYVgl8

https://www.youtube.com/watch?v=7eSyXK2sVGA

You may wish to research more online ideas too, for example search 'LEGO hydroelectric model' on Youtube.

Challenge 1

Plan a turbine

The turbine is the spinning part of your hydroelectric generator.

Draw and label a plan of your turbine, then gather the materials you will need.

Measure carefully

Your turbine must be balanced, so carefully measure and mark out the positions of your blades.

Build your turbine

Carefully construct it and check that it spins very freely.

Challenge 2

Use water to make the turbine spin

Find a way of testing your turbine using a flow of water.

Refine our turbine

See if you can make it turn faster by changing the shape or number of blades. What was the best shape? Draw and label.

Challenge 3

Make electricity

By spinning a little motor it will generate electricity through its leads. (The motor becomes a 'generator'.) Find a way of using your turbine to spin your generator very quickly. Be sure to protect your motor from water. Test to see if electricity from its leads can be used to make an LED glow. (Hint, the leads to the LED need to be the correct way around. If they are back to front, it won't work.)

Demonstrate your model to others.

Extra challenge: Make a model

Create a model hydroelectric dam and power station.

Make a wind turbine

WALT

Build a simple wind turbine, explain how it works, and measure how much lifting power it has.

What you will need:
(per group)

- *Wooden kebab sticks (one each for the number of blades you want), plus one for the axle.*
- *A cork.*
- *String.*
- *Sellotape.*
- *A drinking straw to fit the wooden skewer.*
- *Light weight cardboard.*
- *A 2L drink bottle. This could be filled with sand to create a free-standing tower for the turbine.*
- *A wooden peg to mount your wind turbine on.*
- *Scissors.*
- *A small object that your wind turbine will lift.*

The power of wind!

Wind, an ever-present force on Earth, varies from a gentle breeze to powerful gusts. This movement of air, a result of Earth's uneven heating by the sun, contains kinetic energy. Excitingly, we can harness this energy and convert it into a renewable source of electrical energy!

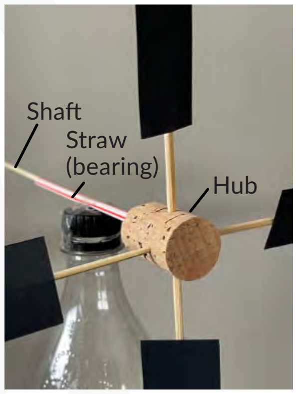
Extension

1. Experiment to find out what happens when you change the angle (pitch) of the blades. What is the best angle? 2. Experiment with ways to improve your wind turbine.

What to do

1. **Design your blades:** Decide on the shape and number of blades for your wind turbine. Conduct some research on effective designs.
2. **Craft your blades:** After cutting out your first blade from cardboard, use it as a template to cut out the remaining blades.
3. **Attach kebab sticks to the blades:** Using sellotape, secure a kebab stick to each blade. Make sure you leave about 3cm of the kebab stick poking out at the pointed end.

4. **Assemble your turbine:** Insert the pointed ends of the kebab sticks into the cork, positioning the blades evenly around it. Now, take one more kebab stick and push it into the end of the cork — this will form the turbine's shaft.
5. **Create the bearing:** Cut a piece of the straw and feed it onto the shaft. This straw acts as the bearing, allowing the shaft to spin freely. Tape it to the top of the drink bottle.



Blades angled.

6. **Prepare the turbine base:** Hammer a wooden peg into the ground and tape your drink bottle onto it so your turbine stays upright and points into the wind. (Or, fill the bottle with sand so it is free-standing.)
7. **Test your wind turbine:** Observe as the wind spins the blades. Adjust it so it spins as fast as possible.
8. **Add a lifting object:** Cut a length of string and tie it to the shaft and wrap it around a couple of times, then attach a small object to the free end. Can the turbine lift the object?

Turbine ready to attach to a peg or fence post.

Questions and discussion

1. What are the three main components of your wind turbine?
2. What is the purpose of each component?
3. How does a real wind turbine convert wind energy into electricity?
4. What are the benefits of using wind energy?
5. List some challenges of using wind energy.

CHALLENGE

Mini solar car

WALT

We are learning to investigate what a mini solar powered car is capable of, and why.

What you will need:
(per group)

- *A mini solar powered car (purchased from websites like AliExpress for less than $2 ea). Use search words 'mini solar car'. See picture below.*
- *Cardboard and flat pieces of wood or plastic to use as ramps and tracks.*
- *Ruler and protractor.*
- *A device with a stopwatch app.*
- *Clear plastic and other transparent and semi-transparent materials.*

Setting the scene

Solar power is becoming more and more important for generating electricity. Solar cells, called photovoltaic cells, can be seen on the roofs of houses and other buildings all around the country, helping to power their lights and heaters, heat water and charge e-bikes and electric cars.

This challenge investigates how solar panels attached directly to the roof of a miniature car behave and how different conditions affect how well they work.

Miniature solar car less than 3.5 cm long, powered by solar panels on its roof.

Challenge 1

Explore what the car can do

Take the car outside on a sunny day and let it go on a flat sur ace.
***Care!** Make sure you don't stand on it by mistake!*

List all the things it can do.

What makes it go?

Hold it by its sides in the sun so its wheels can spin freely. What makes the power? How do you know? What makes the wheels spin?

Draw

Draw and label the parts of your car and describe what they do.

Challenge 2

What changes its speed?

Experiment with different situations and different materials, to find out how the amount of light or shade changes the car's speed. Support any claims you make with numbers, facts and figures.

Challenge 3

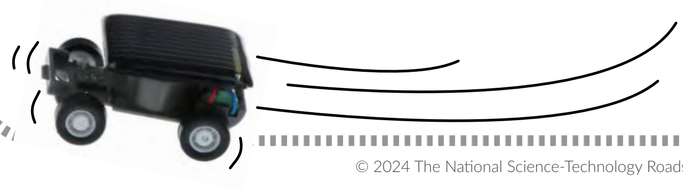
Make it go faster

Investigate ways of making your car go faster. Consider the strength and direction of the light, the surface the car runs on, and so on, to achieve the fastest speed possible.

Speed time trials

As a group, demonstrate the method you have developed. Measure which group's time trial was fastest.

Once the races are over, based on everyone's findings, discuss and write recommendations and draw diagrams showing ways to achieve the greatest speed.



INVESTIGATION

Potato power

WALT

We are learning to construct a potato battery that will light up an LED light and to explain how the battery works. We are also learning to identify factors that change the brightness of the LED light.

What you will need:

(per group)

- *2–3 potatoes.*
- *2 copper coins (e.g. 10c pieces).*
- *2 galvanised nails (these are zinc-coated.)*
- *Several lengths of electrical wire.*
- *LED light.*
- *Multimeter (optional).*
- *Sandpaper.*

LED light. The longer terminal is +ve and the shorter is -ve. They must be connected the correct way round in a circuit.

How to use the multimeter

Plug the black lead into the meter's COM hole and the red lead into the red V hole. Switch the dial to $\overline{V}$ (DC voltage). Hold the red lead onto the copper coin and black lead onto the galvanised nail. Read the voltage off the dial. In the picture it reads 0.86 V.

Extension

Research how to make a lemon battery. Build one and see if it is better than the potato battery.

Engage

Explore

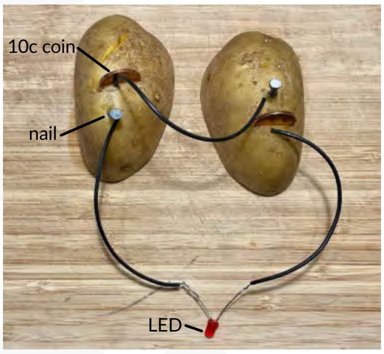
Explain

Elaborate

Evaluate

What to do

1. Cut the potatoes in half.
2. Insert a 10c coin and the end of one wire into one of the potatoe halves so that they are pressed together inside the potato.
3. Wrap the loose end of the wire around a nail and insert it into the other potato half.
4. Push a nail into the potato with the 10c coin in it and wrap the end of a wire around the top of the nail.
5. Insert a 10c coin and the end of another piece of wire into the potato that has no coin in it.
6. Connect the two loose ends of the wires to the LED light. If it doesn't work, try reversing the wires on the LED. If it still doesn't work, go to step 7 below.
7. If you have a multimeter, measure the voltage produced by the potato battery. If it is less than 3 volts (3 V) it won't be enough for most LEDs which require 3 V, so go to *'Improve your battery'* below.



Improve your battery

1. Try adding one or two extra potatoes 'in series' using the same wiring pattern. Does the LED or multimeter show a difference?
2. Try other things, for example: bigger nails and coins, lightly sanding the surfaces of the coins and nails before inserting them, and so on.

Questions and discussion

1. What do each of the components of your circuit do?
2. Explain how the electricity is produced.
3. What changes produced a more powerful battery?
4. Draw and label your circuit.

CHALLENGE

Best insulators

WALT

We are learning to use fair tests to investigate which materials are the best insulators for stopping heat loss around the home.

What you will need:
(per group)

- *Two identical clear jars, e.g. jam jars.*
- *Aluminium foil and other materials such as wool, bubble wrap, polypropylene, fibreglass insulation.*
- *Photocopy paper.*
- *Scissors.*
- *Thermometer.*
- *Device with a stopwatch.*

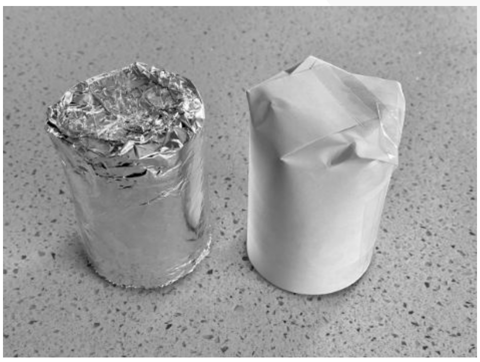
Setting the scene

To keep us cosy, and to save energy and money, we insulate our homes. Insulation also keeps heat out on hot days. This experiment uses fair tests to help us find out what materials are the best insulators.

Basic method

1. Make a paper cover that easily slips on and off one of the jars. It should only be one layer thick.
2. Make a similar aluminium foil cover that can be easily slipped on and off the other jar.
3. Run hot water from a tap till it is at its hottest temperature, then use it to fill each jar to the same level.

You are now ready for the challenges.



Aluminium and paper covers slipped over glass jam jars.

Challenge 1

Track the temperatures

Find a way of measuring the starting temperature of the water in the jars.

Every quarter hour slip the covers off and measure the temperature of the water near the top of each jar. Record.

Which is the better insulator?

Which material, the paper or the aluminium foil, is the better insulator? What evidence do you have to support this?

Where in a house is aluminium used as an insulator? How does it work?

Challenge 2

Other materials

Set up fair tests to find how good other materials are as insulators. Record evidence to support any claims you make about their ability to insulate.

Is it useful to insulate the bottom of the jars too?

Challenge 3

Different thicknesses

Set up fair tests to find out if thicker insulation is better for retaining heat. Record evidence to support any claims you make about their ability to insulate.

Recommendations

What combination of insulation type and thickness is the best?

Assessment rubric

Example assessment rubric

Since the Nature of Science (NoS) strand is overarching, it is important to assess this in order to monitor learning progress in NoS skills and development of Science Capabilities. The following is an example of a rubric that might be used formatively and summatively, with the proviso that it is tailored to your learning situation. Change the words as you see fit.

Rubric relating to: 'Science Models'

Science models

Name	Year

Stage	Level	Descriptor
Blossoming tree 	Level 4	I can make an advanced model without adult assistance and describe how it relates to science and its relevance to real world situations. COMMENTS:
Tree 	Level 3	I can make an advanced model without adult assistance and describe how it relates to science. COMMENTS:
Sapling 	Level 2	I can make a basic model without adult assistance. COMMENTS:
Seedling 	Level 1	I can make a basic model with adult assistance. COMMENTS:
Assessments that contribute to this overall summation		

In a nutshell

"Assessment measures learning"

Formative assessment
This is assessment ***for*** learning. It occurs ***during*** the process of learning and can inform students and teachers of progress on a day-to-day basis. Its immediacy allows for fine-tuning of direction and pace, and highlights where improvements, changes and re-working of the learning process need to occur. Both teachers and students should be actively involved in this process.

Summative assessment
This summarises what has ***been*** learnt. It occurs at the ***end*** of a block of work. Typically it is used for reporting purposes (to parents, principals, boards of trustees), or for the purpose of bench-marking progress for the broader analysis of learning over time, e.g. from one year to the next.

It is recommended that assessments should test ***both*** students' understanding of the ***process*** of science (the Nature of Science strand, including the Foundational Science Capabilities), and relevant ***content*** (i.e. relating to the *The Living World*, *The Material World*, *The Physical World* and *Planet Earth and Beyond*).

EXHIBITS AND SHOWS

Exhibit Themes

Each year we have on display six different themed collections of exhibits available during your 70 minute programme. For 2024 these themes are shown below. To assist you in preparing for your visit, we've also developed a unit plan called Sustainable Energy / Te Pūngao toitū — found earlier in this booklet — that complements the Energy theme. Past units on other themes can be found within pdf downloads of Resource Books at: https://scienceroadshow.nz/resources-archive/

The body — Te tinana tangata

Exhibit learning intentions relate to: digestion and the digestive system, diet, food types, vitamins, internal organs.

Contexts — The body, Food and Health.
House of Science Kit — Food for Thought / He Kai mā te Hinengaro

Localised curriculum ideas — Professions relating to food and diet, e.g. nutritionists, doctors, lab technicians, health shop attendants. Where to find healthy foods. Community gardens. Exercising. At the gym. Sport science.

Energy — Te Pūngao

Exhibit learning intentions relate to: power generation, units of energy, energy in fuels, potential and kinetic energy, renewable energy such as solar and wind.

Contexts — Energy, Electricity, Sustainable energy.
House of Science Kits — Flexi-Physics / Mātai Ahupūngao Pīngore, Fossil Fuels / Ngā Koranehe, Electric Future / Anamata Hiko, Hot Stuff / Te Wera Hoki

Localised curriculum ideas — Related local professions: electricians, solar panel installers. Tracing where our power comes from. Local solar or wind farms, hydroelectric schemes. Domestic and school solar panels. Power in homes.

Materials — Ngā Matū

Exhibit learning intentions relate to: properties of materials, permeability, insulation, luminescence, transparency, metals, solids, liquids, gases.

Contexts — Material world, Chemistry, Properties.
House of Science Kits — Fireworks / Pahūahi, Float my Boat / Te Whakamānu i Taku Poti, Sweet & Sour / Te Reka me te Kawa

Localised curriculum ideas — Materials in the classroom, at school and at home. Which materials do what? Everyday uses of materials. Local fabricators, artists, builders.

Measurement — Te Inenga

Exhibit learning intentions relate to: estimation; measuring distance, weight, friction, proportions, UV light, temperature and specific gravity.

Contexts — All science contexts.
House of Science Kit — Measurement Matters / Te Whakahirahira o te Inenga

Localised curriculum ideas — How we use measurement in our lives. Use of measurement by trades people, shop keepers, boat builders and by other local professions such as surveyors. Indirect measurements of tree heights and other landmarks. 'A week without measurement.'

Spinning and whizzing — Te Porotiti me te pūrorohū

Exhibit learning intentions relate to: centripetal forces, spinning, rotation, eddy currents, gyroscopes, vortexes, angular momentum.

Contexts — Forces, Spinning.

Localised curriculum ideas — Spinning at the playground or fun park, twirling demonstration by a local dancer, machines we use that have spinning parts, gearbox demonstration by a local mechanic, learn ball spinning from a local sports coach, e.g. tennis topspin, rugby spiral pass, baseball pitching.

Telling the difference — Te Tautohu ki te rerekētanga

Exhibits learning intentions relate to: close observations, comparisons, fair tests, measuring differences.

Contexts — All science contexts.
House of Science Kit — Who-Dunnit? / Nā Wai i Mahi?

Localised curriculum ideas — Close observations of seasonal changes in the landscape or in a garden. Comparing growth outcomes in the school veggie garden. Comparing the speed or power of local sports team members.

Shows

While being exciting and entertaining, our shows provide a great opportunity to enhance student knowledge and understanding in two science areas each year. The shows for 2024 are as follows.

Hidden World show — Te Whakaaturanga Ao Huna

This show covers specific learning outcomes relating to how we can use instruments to see things that we would not normally detect with our naked eyes. It also covers light and other aspects 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.

Spectacular Changes Show — Te Whakaaturanga Panoni Matū Miharo

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

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

Shows — Learning Outcomes

After attending shows students will have increased:

- understanding of the Nature of Science and the Science Capabilities
- engagement, interest and enthusiasm for science
- understanding and knowledge of scientific ideas.

Key References for Exhibit Themes and Shows

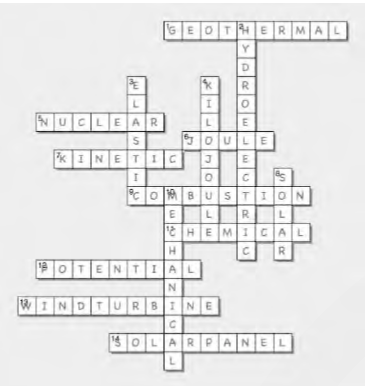
Science kits: House of Science https://houseofscience.nz/science-kits
School Journal and Connected series: https://journalsurf.co.nz/
Building Science Concepts series: google search 'tki building science concepts'.

Answers to pages 4–15

Body word chain page 4

1) tibia 2) arm 3) muscle 4) ear 5) rib 6) bronchi 7) intestines 8) skull 9) ligaments 10) stomach 11) hair 12) radius 13) spinal column 14) nose 15) elbow 16) wrist 17) teeth 18) hip 19) pancreas 20) spleen 21) Nerve.

Energy crossword page 5



Examples of energy use during a school day: Light from classroom light bulbs help us to see our writing. Heat from a heat pump keeps us warm. Chemical energy from our food gives us energy to move and think. Electrical energy received through wires powers the computers that help us with our learning.

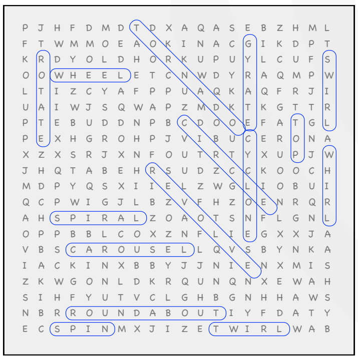
Elements double puzzle page 6

Unscrambled words: SILICON, NEON, BORON, HYDROGEN, HELIUM, FLUORINE, MAGNESIUM, POTASSIUM, LITHIUM, SODIUM, PHOSPHORUS, OXYGEN, NITROGEN. **Mystery statement:** THE PERIODIC TABLE GROUPS ELEMENTS ACCORDING TO THEIR PROPERTIES.

Units blitz page 7

1) 1 L, 2) 1 min, 3) 0.5 kg, 4) 1 m, 5) 1000 ms, 6) 1 m, 7) 1 g, 8) 1000 µm, 9) 2.0 L, 10) 4.5 kg. Find out more: Temperature units include °C, °F and °K; power units include W, kW and MW; force units include N and kN; money units include $ and c.

Spinning word search page 8



Example paragraph: "We were doing a science project at school about tornadoes. We had a spinning **top** that we were supposed to watch as it **twirled**. But then, something crazy happened! The top started to **spin** so fast it looked like a mini **tornado**. It was like when you spin super fast on the **roundabout** in the park, you know? Everything started to **whirl** and **rotate** like a wild **carousel**. Papers flew up into the air and **swirled** around the room in a big **circle**. We felt like we were inside a real **cyclone**, but then the teacher turned off the power and everything stopped. It was the most exciting science project ever!"

What makes the difference? page 9

1. Magnet strength, not shape, determines how many paperclips it can pick up. However, horseshoe magnets might have stronger pull due to their closer poles. **2.** A guitar and violin sound different due to structural and material differences affecting their vibration and resonance. **3.** The tea in the metal cup will cool faster due to metal's better heat conductivity compared to plastic. **4.** Apples contain air, water and solid tissue. If Apple B lost water because it wilted, then its percentage of heavier solid tissue would be higher, causing it to sink. **5.** The Sun is larger than the Moon but appears a similar size from Earth due to distance. The Sun is about 400 times larger but also about 400 times further away. **6.** Shadows vary in length with the time of day. Morning and late afternoon shadows are long, while noon shadows are short. So shadow length differences could be because they were measured at different times of the day.

The celery experiment page 10

Questions. Qs 1&2. The celery became more mushy and liquid, then eventually turned brown. **Q3**. Digestion starts in the mouth with mechanical (chewing) and chemical (enzymes in saliva) digestion. The experiment represents that initial process. **Q4**. Enzymes in saliva start to break down the celery's cell walls, a process that continues in our stomach and intestines.

Create a solar oven page 11

Q1. It started to soften or melt. **Q2.** The black paper absorbs the sun's heat rays, the aluminium foil reflects the sun's heat rays towards the black paper, while the cling film traps the heat inside. **Q3.** They both use energy from the sun, but a solar oven uses the sun's heat rays, while solar panels use the sun's light energy and converts this into electricity. **Q4.** It is sustainable because the sun's energy is likely to last for millions of years. **Q5.** Advantages: Portable, low cost, no on-going costs. Disadvantages: Needs bright sunshine, can't be used at night, can't heat to high temperatures.

Biodegradable plant pot page 12

Challenge 1. Ensuring fair tests: use same paper type, use the same amount of paper and fibres each time, make the pots the same size and thickness, water them the same amount, etc. **Challenge 2.** Use dry fibres from, for example: harakeke (NZ flax), tī kōuka (cabbage tree) leaves, fluffy tufts from seeds, grass, etc. **Challenge 3.** Results will vary.

Discovering volumes page 13

Challenge 1. 1) Accuracy of estimates will vary. 2) Compact objects like spheres and cubes have similar lengths in all dimensions, making them easier to estimate. 3) Examples: When cooking and baking, packing and storing, grocery shopping, undertaking DIY projects, etc. **Challenge 2.** 1) Answers will vary. 2) An object that is doubled in size (in all dimensions) has eight times the volume. **Challenge 3.** 1) Yes. 2) You could visualise 'swapping bumps for hollows', or scrunching it down in size to make it fit into a cube, which is easier to estimate.

The magic of spinning page 14

Q1. It spins and wanders over the surface. When it begins to slow down it wobbles more, then eventually tips over and skids to a stop. **Q2.** The further the disc is up the pencil, the harder it is to spin. Q3. Friction between the spinning top and the surface, plus air friction, slows it down, and when it topples over, the friction of the disc skidding against the surfaces finally stops it. **Q4.** The spinning of objects like the Earth and bicycle wheels helps them to stay in a stable position just like our top. **Going local.** Merry-go-rounds, spinning the ball when sports people pass, shoot, or strike it, ferris wheels, ceiling fans, fidget spinners, wind turbines, dancers performing pirouettes, spins, or turns. **Accuracy.** Accuracy and reliability can be achieved through repeated trials and pooling results with others to reduce the effects of chance.

Observe the difference – growing crystals page 15

Challenge 1. Salt crystals appear as tiny, uniform cubes with straight edges and flat surfaces. Sugar crystals form as long, slender prisms or as clusters of smaller, irregularly shaped crystals. **Challenge 2.** In cool conditions, table salt crystals will form into larger crystals than in warm conditions. **Challenge 3.** Answers will vary.

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A variety of excellent facilitators present the Academy programme. It is insightful, dynamic and interactive, as well as practical and hands-on, bringing a variety of best practice techniques and experiences to the fore. The following is a snapshot of some key themes that will be the focus over the four days:

- Learn how to target all types of learners by developing practical investigations that will stimulate all the senses.
- Introduce more science to other areas of your teaching.
- Unit selection and planning.
- Investigate the cultural differences in learning styles and how teaching can be adapted to meet the needs of all learners.
- Discover that you don't need to be an expert in science to teach science well.
- Being a Science Champion within your school or area and inspiring science learning in all classrooms.

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