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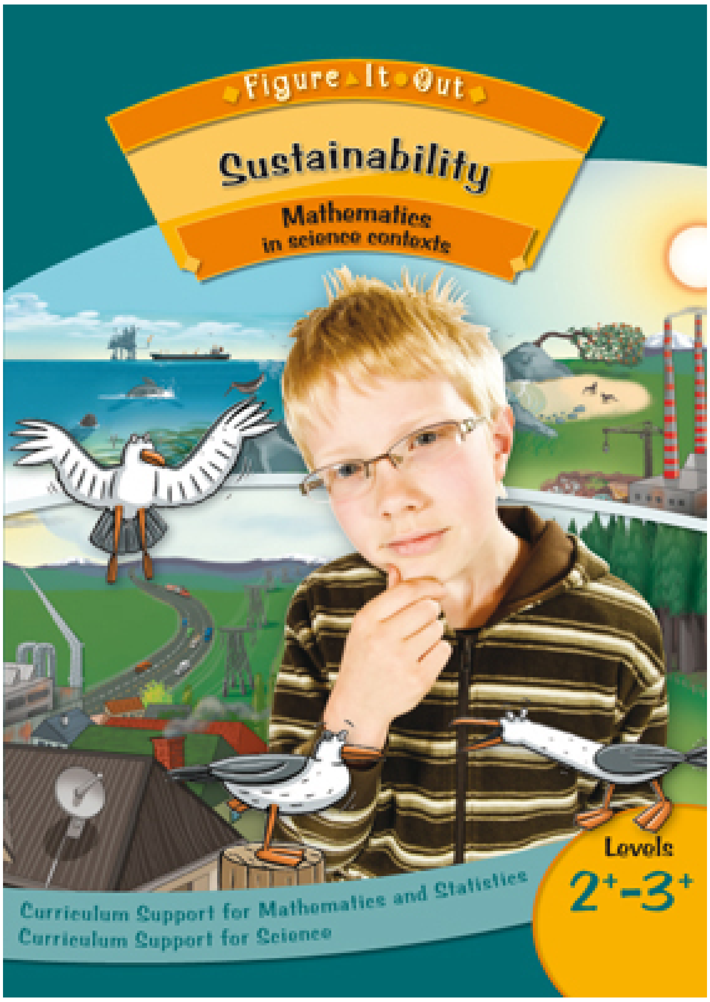
The New Zealand Curriculum

Teacher Support Material
(including Answers)



MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

Contents

Introduction

The books in the Figure It Out series are issued by the Ministry of Education to provide support material for use in New Zealand classrooms. The achievement objectives for mathematics and statistics and for science and the key competencies referred to in this *Teacher Support Material (including Answers)* are from *The New Zealand Curriculum.*

Student books

The activities in the Figure It Out student books are written for New Zealand students and are set in meaningful contexts, including real-life and imaginary scenarios. The contexts in the level 2^+–3^+ *Sustainability* book reflect the ethnic and cultural diversity and the life experiences that are meaningful to students in years 4–6. However, you should use your judgment as to whether to use the students' book with older or younger students who are also working at these levels.

Figure It Out activities can be used as the focus for teacher-led lessons, for students working in groups, or for independent activities. You can also use the activities to fill knowledge gaps (hot spots), to reinforce knowledge that has just been taught, to help students develop mental strategies, or to provide further opportunities for students moving between strategy stages of the Number Framework.

Teacher Support Material (including Answers)

In this new format, the answers are placed with the support material that they relate to. The answers are directed to the students and include full solutions and explanatory notes. Students can use these for self-marking, or you can use them for teacher-directed marking. The teacher support material for each activity, game, or investigation includes comments on mathematics and science ideas, processes, and principles, as well as suggestions on teaching approaches. The *Teacher Support Material (including Answers)* for *Sustainability* can also be downloaded from the nzmaths website at www.nzmaths.co.nz/node/1994

Using Figure It Out in the classroom

Where applicable, each page of the students' book starts with a list of equipment that the students will need in order to do the activities. Encourage the students to be responsible for collecting the equipment they need and returning it at the end of the session.

Many of the activities suggest different ways of recording the solution to the problem. Encourage your students to write down as much as they can about how they did investigations or found solutions, including drawing diagrams. Discussion and oral presentation of answers is encouraged in many activities, and you may wish to ask the students to do this even where the suggested instruction is to write down the answer.

Students will have various ways of solving problems or presenting the process they have used and the solution. You should acknowledge successful ways of solving questions or problems, and where more effective or efficient processes can be used, encourage the students to consider other ways of solving a particular problem.

Figure It Out

Sustainability

Mathematics in science contexts

Teacher Support Material (including Answers)

Overview of Sustainability, Levels 2+–3+

Introduction to Science

> Science is a way of investigating, understanding, and explaining our natural, physical world and the wider universe.
>
> *The New Zealand Curriculum,* page 28

Inquiry in science is called investigating. Science investigations can take many forms, including classifying and identifying, pattern seeking, exploring, investigating models, fair testing, making things, and developing systems. Investigating in science may involve more than one type of investigation. Scientists choose the appropriate type of investigation to answer their question(s). Each investigation can share elements with other investigations. Science investigations also provide students with rich contexts for mathematical opportunities as they decide what and how to measure, what units to use, and how to record findings as they identify trends and patterns and describe relationships. See www.tki.org.nz/r/science/science_is/dssa/focus_07_approach_e.php for examples of different types of science investigations and activities that illustrate them.

Figure It Out *Sustainability* provides mathematics content within rich interdisciplinary contexts in both science and social sciences. Many of the activities in the book involve statistical investigation – gathering, organising, and interpreting data and communicating findings using appropriate representations. Statistical literacy is directly relevant to interpreting the results of science investigations as well as being a major area of emphasis in the mathematics and statistics learning area of *The New Zealand Curriculum*.

The teacher support material for the students' book includes conceptual background material and suggestions for wider and deeper exploration. However, you are the best judge of how far to take a particular idea with your students. For example, the analysis of packaging on pages **10–11** of the students' book involves a consideration of both mass and volume. The activity can therefore be extended to a discussion of density (mass ÷ volume) or other ways of selling cereal besides by mass.

Students working at levels 2^+–3^++ are expected to be able to understand and describe the geometry of plane (2-dimensional) shapes. Several activities in the book challenge students to think abstractly about 3-dimensional shapes, for example, empty volume in a box, the orbit of Earth around the Sun, and the volume of bricks in a wall. Physical models are particularly useful in helping students to make the jump from 2-D to 3-D, especially when trying to visualise angles between different 3-D solids.

Internet links: Note that on the downloadable version of this support material (www.nzmaths.co.nz/node/1994), all the Internet links can be activated by clicking on a hyperlink.

Investigating in Science

EXPLORING A SITUATION
A problem, question, situation, phenomenon, artefact, model, event, story

I wonder why ...?

I wonder how ...?

OBSERVE
What is happening?

What changes happen?

What materials are involved?

What are the main parts?

What are the key aspects?

What do these parts do?

ASKING QUESTIONS
Why? How? What? When? Where?

PLANNING AN INVESTIGATION
What will we observe/measure? What do we want to find out? How can we find out? What can we do to find out? Are there things we need to change or keep the same?

MAKING PREDICTIONS
What do we think will happen and why?

GATHERING DATA
Find out, measure, compare, verify, test, clarify, identify

PROCESSING AND INTERPRETING
Creating personal explanations supported by evidence

What is the cause and effect of change?

What patterns keep occurring?

What parts are interacting with other parts?

What are the outcomes of these interactions?

EVALUATION
What do the results mean?

Does our investigation answer our question?

Do our results support or challenge our predictions?

Is there another explanation for what we found out?

What do other people think about our investigation?

What have other people found?

APPLICATION AND SHARING OF NEW THINKING
How could we use our idea or explanation?

Does it explain other things?

What next? Where to now?

FURTHER INVESTIGATION
Do we have another question to investigate?

Is there another idea or explanation that needs testing?

Teacher Support Material (including Answers)

Pages 1–3: The 5Rs and Scram!

Science Achievement Objectives

- Communicating in science: Begin to use a range of scientific symbols, conventions, and vocabulary (Nature of Science, level 3)
- Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)
- Earth systems: Explore and describe natural features and resources (Planet Earth and Beyond, level 2)

Mathematics and statistics context

Students could:

- explore simple notions of rate of use and distribution.

Students should discover that:

- numbers are vital when describing, explaining, and understanding resource issues.

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science context

Students will:

- explore the meanings of terms associated with the management and use of resources and caring for the environment.

Students should discover that:

- there are finite amounts of resources on Earth
- there are different ways of recycling or reusing products.

Related information

Building Science Concepts: Book 60, *Rubbish*; Book 61, *Recycling*; Book 15, *Where's the Water?*

Connected 1 1999: "Oranges: An Experiment to Prove That Rubbish Does Not Exist"; "What Goes Around Comes Around"

Connected 2 2002: "Easy as Child's Play"; "The Water Wardens"

Connected 3 2007: "A New Life for Old Machines"

Further information and related activities can be found in *Making Better Sense of the Material World* and in *Making Better Sense of Planet Earth and Beyond*.

Answers

Game (The 5Rs)

A card game that introduces ways of recycling household items or reducing our use of resources

Game (Scram!)

A game that helps you understand words about the environment and resources

Activity

1.

Word	Meaning
water	A liquid that animals and plants need to live
resources	Materials or energy from the environment that are used to meet human needs or wants
air	What we need to breathe
renewable	Can be replaced by growing, making, or collecting more
environment	The world we live in
recharge	Replace used-up power
reduce	Cut down the amount of rubbish we produce
repair	Replace or mend a faulty part
reuse	Use more than once
biodegradeable	Decomposes or breaks down
non-renewable	Can't be replaced after it has been used
waste	Any material that is discarded
recycle	Use waste materials to make new products
conservation	Protecting the environment and natural resources
inorganic	Not part of the animal or vegetable kingdom

2. a. Examples will vary. Here are some possibilities:

Word	Situation or example
water	In some parts of the world, there is not enough clean water for drinking.
resources	The air we breathe, the oil we extract for fuel, and the food we grow to eat are all resources because we use them to meet our needs and wants.
air	Air contains the oxygen that we need to live.
renewable	Grass is renewable because it grows back when eaten by animals.
environment	Our house, our school, the roads we travel on, and the fields we play sport in are all part of our environment.
recharge	Some batteries can be recharged so that they can be used again.
reduce	We can reduce the amount of food rubbish we produce by putting compostable material into a compost bin or heap.
repair	Things such as clothes, shoes, and electronic equipment can often be repaired so that they are "as good as new".
reuse	We can reuse a water bottle by filling it again from the tap.
biodegradeable	Apple cores and banana peels will rot and decompose because they are biodegradable.
non-renewable	Oil is a non-renewable resource because once it is used, it cannot be replaced.

Continued on next page

Word	Situation or example
waste	Anything we put into the rubbish bin is waste.
recycle	Melting glass bottles to make new bottles is recycling.
conservation	Catch-and-release fishing is a form of conservation.
inorganic	Water and rocks are inorganic because they are not alive.

b. Practical activity

c. Examples of extra words are: sustainable, natural, packaging, energy, solar, exploit, consume, soil.

Notes

Preparation

As with any group activity, consider the needs of individual students when grouping, especially when selecting students to play the roles of caller and judge in the Scram! game.

Establish suitable norms for “scramming”.

Points of entry: Mathematics

Resource issues almost always come back to numbers: too many people for too little resource (water in some parts of the world), too many people doing something that destroys a resource (using a river as a drain), people using more than their share and leaving too little for others (land), people using something up at a faster rate than it can be replaced (fish). Most students at this level cannot manage the large numbers typically found in information about resource use, but they can understand simple rate-of-use and distribution scenarios. For example, *How long will a bag of nuts or sweets (a finite resource) last if …?* They can also pose and discuss scenarios that begin *What if everybody …?*

The games involve the key competency *participating and contributing* because, for success, they require all the students to be committed and involved.

Points of entry: Science

By this stage, your students will already have encountered information and teaching related to resource use, conservation, and sustainability. The 5Rs is a suitable activity for finding out about their prior knowledge. Challenge the students to answer the questions *Why bother?* and *Why does it matter?* and to think about why things that human beings have been doing since the dawn of time (cutting down trees, using open fires, disposing of waste, and so on) have now become serious issues in some places and, in some cases, for the entire planet.

When the students are familiar with the card sets provided, challenge them to create their own. They could also devise ways to use the games with younger students by using photos, pictures, or drawings instead of words.

Pages 4–5: Is Rubbish a Problem?

Mathematics and Statistics Achievement Objectives

- Measurement: Create and use appropriate units and devices to measure … volume and capacity, weight (mass) … (Geometry and Measurement, level 2)
- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions
  - identifying patterns and trends in context, within and between data sets
  - communicating findings, using data displays (Statistics, level 3)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objectives

- Investigating in science: Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations (Nature of Science, level 3)
- Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)

Mathematics and statistics context

Students will:

- gather, sort, and display category, whole-number, and simple time-series data and communicate their findings through graphs
- estimate whole-school data.

Students should discover that:

- different representations suit different types of data
- sample data can be used to make predictions about the whole
- statistics can mislead if important variables are ignored.

Science context

Students will:

- plan ways to collect and measure data
- use the data collected to make informed decisions.

Students should discover that:

- a class of students generates a lot of waste in a year, both directly and indirectly (the school creates waste as well)
- the amount of waste can be reduced by changes in behaviour.

Related information

Building Science Concepts: Book 60, *Rubbish*; Book 61, *Recycling*

Connected 1 1999: “Oranges: An Experiment to Prove That Rubbish Does Not Exist”; “What Goes Around Comes Around”; “How to Wear a PET”; “Smile!”

Answers

Activity

1. **a.** Weighing the rubbish would show the total mass for each day but not what was being thrown away. A tally chart would show the number of items of each type of rubbish – but only if everyone remembered to record everything.

   b. Suggestions will vary. For example, you could put all the paper into one bag, all the food scraps into another, and so on, and then weigh them.

2. **a.** Investigations will vary but should be based on the statistical enquiry cycle: problem, plan, data, analysis, conclusion.

   b–c. One graph can’t show everything, and different groups may have focused on different features of the data, so graphs and the stories that the graphs tell will differ.

   d. Discussion and ideas will vary. There is unlikely to be a “best way” of graphing the data. Rubbish could be graphed on a single bar chart, as a series of 1-day charts, or as a time-series graph. A pie chart will show how big a "share" of the total each type of rubbish has, but it won't tell the reader anything about the amount.

 e. Answers will vary. They should be based on the approximate number of weeks in a school year. (Not much rubbish is generated in the holidays!)

3. Answers will vary. A reasonable method would be to multiply the amount of rubbish 1 class makes for the year by the number of classes.

4. There will be rubbish in the staffroom. There will also be office and administration waste, such as photocopy paper, cardboard boxes, and broken or outdated equipment. Bins around the school grounds will contain mostly food and food wrappings. For these bins, you may decide to analyse several and use this information to estimate a total. (Your caretaker may be able to provide you with some useful data.) Your school may also have recycling bins that need to be taken into account.

5. Graphs and accuracy of estimates will vary. Test your estimate by asking the caretaker how much waste they dispose of.

Notes

Preparation and points to note

Think through the safety and hygiene aspects of handling rubbish: disposable gloves are likely to be needed.

The students will need access to suitable scales if they are to quantify rubbish by mass. To gather data for the in-class study, it will be simplest if the bins used are a standard size.

If possible, have the students use a computer spreadsheet for the data collation. This will facilitate graphing.

You could focus on the key competency *relating to others* here because the students need to be open to each other's ideas and able to involve others, including adults, when doing their research.

Note that estimating is not the same as guessing. An estimate is a number arrived at by calculation and based on certain assumptions. When estimating how much rubbish is likely to be generated over time, the students have to make some assumptions and then do some calculations. In this case, when making assumptions, they should think about seasonality and other possible causes of variation. For example, in the winter, students will probably have less fresh fruit and more packaged goods in their lunches.

Points of entry: Mathematics

Students at this level are used to counting and to measuring using informal and formal units. But in this activity, they are challenged to find ways of quantifying something that is awkward to handle and for which there is no obvious or convenient method.

Ask the students to brainstorm the options and to categorise them. All will fall into one of these three categories: counting, weighing, measuring by volume. Have them debate the advantages and disadvantages of each category before the preferred option is chosen and a methodology refined. Ask *How precisely will we do this?*

This is a good activity for teaching or reinforcing the fundamental difference between counting and measuring: measuring always requires a device and a unit of measurement (for example, measuring jug and litre, ruler and centimetre, scales and gram, bin and binful); counting does not. (Discuss with your students why "hill" as in "5 hills" or "paper" as in "19 pieces of paper" are not units of measurement.) If the students decide to measure the amount of rubbish (for example, by volume, mass, or type), they will need to decide what measuring device and unit to use.

Particularly given the amount of work involved in the data gathering, encourage your students to extract as much information from it as possible. If all they do is weigh a week's rubbish and multiply it by 40 to estimate the rubbish produced in a school year, what they learn will be limited. Challenge them to also collect data that will enable them to estimate how much of the rubbish they generate could be easily recycled. They could also work out whether most of the rubbish is being generated by only some people in the school community or how much of the rubbish is packaging.

The students should make full use of the statistical enquiry cycle, beginning with experimental design and working through to drawing conclusions from graphs. Make explicit the elements of the enquiry cycle (problem, plan, data gathering, analysis, conclusion) so that the students see the framework for a valid statistical study. If they do this, they will see the reason behind every part of the investigation. When they reach the end, they should have "stories to tell" and ideas for further investigation. Drawing graphs is not an end in itself. Encourage the students to use different types of data and/or representations and to use the comparisons between groups as a way of evaluating if improvements are possible in their own graphs.

Points of entry: Science

Discuss cause and effect and how the students' data can help them determine strategies for reducing rubbish. Ask them to think about whether there are fixed as well as variable effects; in other words, some of the school rubbish may be constant and outside the students' control.

Test the students' experimental investigation designs against the scientific method: *Are your measurements meaningful? Are your conclusions practical?* For example, students could make less rubbish by not eating lunch at all, but the negative effects of skipping lunch make this a poor strategy.

Challenge the students to justify their results by showing evidence that their estimates or conclusions are reasonable. Ask *How could you test your conclusions?*

Pages 6–8: Types of Rubbish

Mathematics and Statistics Achievement Objectives

- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions
  - identifying patterns and trends in context, within and between data sets
  - communicating findings, using data displays (Statistics, level 3)
- Number knowledge: know fractions and percentages in everyday use (Number and Algebra, level 3)
- Measurement: Create and use appropriate units and devices to measure … volume and capacity, weight (mass) … (Geometry and Measurement, level 2)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objectives

- Investigating in science: Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations (Nature of Science, level 3)
- Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)

Mathematics and statistics context

Students will:

- gather, sort, display, and use category and whole-number data and communicate findings based on the data
- use a known relationship (area–mass) to estimate other quantities
- measure volume and mass.

Students should discover that:

- volume and mass are not related (for example, plastic waste is high in volume but low in mass, whereas paper waste is high in both).

Science context

Students will:

- plan ways to classify, collect, and measure data
- use the data collected to make informed decisions.

Students should discover that:

- rubbish has multiple dimensions (for example, type, origin, mass, volume, dampness)
- how different types of rubbish contribute to mass and volume depends on their content and structure.

Related information

Building Science Concepts: Book 60, *Rubbish*; Book 61, *Recycling*

Connected 1 1999: "Oranges: An Experiment to Prove That Rubbish Does Not Exist"; "What Goes Around Comes Around"; "How to wear a PET"; "Smile!"

Useful websites

Auckland Regional Council waste activity:
www.arc.govt.nz/albany/fms/main/Documents/Council/Education/AWOW/AWOW%20Unit%202%20-%20Waste.pdf

www.globalfootprints.org/pdf/waste_num56.pdf

www.ew.govt.nz/Environmental-information/Solid-waste/What-we-throw-away/

History of television: www.tvhistory.tv/

Answers

Activity One

1. **a.** Practical activity

   b. Answers will vary, depending on what is put in the bins that day.

   c. Amounts will vary. One day's rubbish x 5 will provide a reasonable estimate for 1 week. A table or bar graph should be suitable for presenting the data.

2. **a.** Discussion will vary. Plastic is light (mass), but some of it takes up a lot of space (volume); paper and cardboard occupy less space than plastic bottles but weigh more; food scraps compress well but can be heavy.

   b. Observations will vary but will probably be similar to those for **a**.

   c. The rubbish could be compressed in a compactor. Plastic bottles could be squashed and cardboard cartons flattened. Sheets of paper take up less volume if they are stacked flat instead of screwed up.

Activity Two

1. **a.** Landfills (which used to be called rubbish dumps or tips) are places set aside for the disposal of solid (non-hazardous) waste. The most common method of disposal is to spread the rubbish and compact it and then cover it with a layer of earth. Some landfills also accept hazardous waste, which is disposed of safely, as well as whiteware, glass, paper, and so on for recycling.

   b. The people who run landfills are more likely to be concerned with volume (space) than mass, but most landfills charge by mass because it is easier to measure. Heavy items such as cars can be compressed to take less space, as can most plastics, but polystyrene, although light, is very bulky. Vehicle tyres are big and heavy. Shredding reduces their volume. Unshredded tyres can be a problem; they have a way of making their way to the surface.

2. About 27. (90 000 ÷ 9 ÷ 365)

3. **a.** Estimates will vary depending on the method used. They should be to the nearest 5 000 or 10 000 (greater precision is not possible). Suggested estimates are:

Type of waste	**Tonnes (estimate)**
Timber and rubble	130 000
Organic	115 000
Paper	75 000
Potentially hazardous	55 000
Plastics	45 000
Other (glass/rubber/textiles)	40 000
Metals	25 000
Nappies, wipes, and so on	15 000

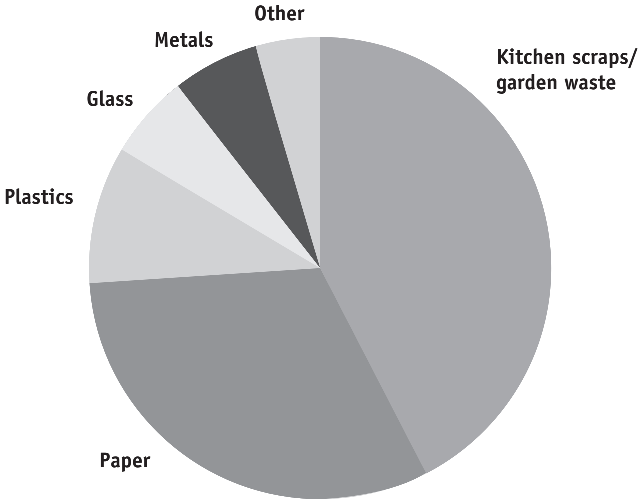
   b. **i.** Plastics, because they are very light (see **Activity One**)

   ii. Compacting has little effect on most plastics. The best options for reducing the volume of plastics in landfills are to reduce consumption and increase recycling. Burning plastic releases toxins into the air.

c. Much of this waste could be stored separately and composted. Some landfills already do this on a large scale. Material such as tree branches is shredded as a first step.

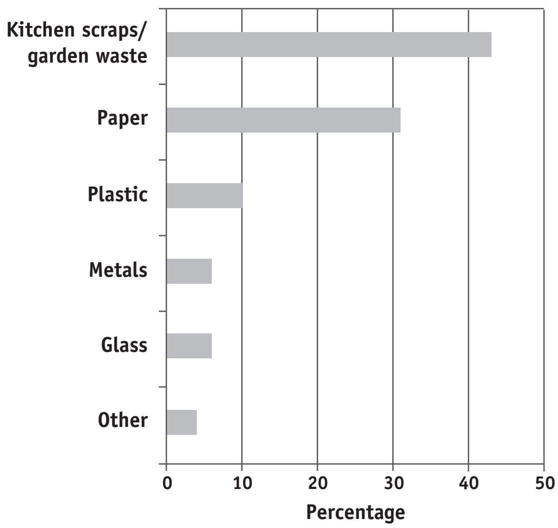
4. a. A possible computer-created pie chart is:

A Typical Household Rubbish Bag



b. You could use a bar graph, or any other representation that shows relative proportions, for example:

A Typical Household Rubbish Bag



5. Landfills receive industrial as well as household rubbish, so they will always have a higher percentage of materials such as metals, timber, and rubble. Households tend to accumulate a lot of paper (for example, from newspapers and advertising). Households without compost bins tend to have a lot of organic waste.

Activity Three

1. Discussion will vary. 70 years ago, most people had far fewer possessions than we do today (and had them mended when they broke), made many of their own clothes (and mended them when necessary), had large vegetable gardens, bought locally produced meat that was not pre-packaged, bought milk and drinks in glass bottles that were recycled, ate mostly home-cooked meals, often did not have cars, and had no electronic products at all. Think of the packaging that comes with most of the items we buy today – all that plastic and polystyrene! Most everyday plastics only came into use in the 1950s and 1960s.

   Today, we have many "consumer products" that become outdated very quickly. We often replace them even if they are working well. If they break down, it is cheaper to get a new one than to get the current one fixed. (You could do some research on when computers and other items such as video games, televisions, and cellphones were invented or became commonly used and how long they are expected to last. You could also find out how far some of the food we eat travels to get to our supermarkets – this affects the amount and kind of packaging needed.)

2. Answers will vary, but they should cover "the 5Rs" (see page **1** of the students' book).

Notes

Preparation and points to note

These activities are a good sequel to Is Rubbish a Problem? Because some rubbish sorting is involved, the same hygiene precautions will be necessary.

The students sort the waste into buckets, so 2 variables are being considered: type and volume. A standard bucket or bin can provide an informal unit of volume. Alternatively, the students could use a 2 litre milk bottle to determine the volume in litres of the buckets or bins to be used and then describe the volume of waste in litres. They will need to reach agreement on the extent (if at all) to which the waste should be compacted before measuring.

Students may disagree on how best to classify their rubbish; for example, they may want to sort by soft/hard, wet/dry, or paper/plastic/metal. The categories they decide on must be workable, but they don't have to match the table shown for Room 4's rubbish.

The students are required to devise processes, gather data, and work with information that they have found or been given, so these activities lend themselves to a focus on the key competency *thinking*.

Students may (wrongly) think that volume and mass are related and that objects that take up more space have more mass. Volume does not predict mass; for example, the mass of an albatross with a 3.5 metre wingspan is only about 8 kilograms. Inductive methods involving examples and counter-examples can help students appreciate the complex non-relationship between volume and mass: *Which is heavier, a netball or a tennis ball? A tennis ball or a billiards ball? A netball or a bowling ball? A balloon or a tennis ball?*

Points of entry: Mathematics

Data gathering is often a messy business. It is in this activity, in more than one sense of the word! Ask: *How can rubbish be measured with the resources that you have at your disposal? Should you measure by volume or mass? What units should you use? What categories should you use? How might your choice of categories affect the conclusions you reach?* Encourage the students to develop a hypothesis (a theory they want to either prove or disprove) and to follow the steps in the statistical enquiry cycle (see the notes for pages **4–5**). Above all, ensure that they reach a conclusion: *What is this data telling me?* A suitable graph or graphs enables them to share their conclusions with others.

In **Activity Two**, question **3a**, the students are asked to estimate quantities from the pie chart shown, based on the mass provided for waste metal. This is an opportunity to work with them on estimating fractions visually in relation to other sectors of the chart.

The activity introduces some large numbers. Students need concrete examples that can act as frames of reference or benchmarks if they are to make sense of these. This is the role of the bus comparison: all students can visualise a bus (although they have to remember that it is its mass, not its volume, that is of interest here). Perhaps the single most helpful benchmark when it comes to mass is the fact that 1 litre of water weighs 1 kilogram.

Students can create their own benchmarks. They could select a common item of household rubbish (for example, newspapers, advertising flyers, disposable nappies, or plastic bottles), weigh a representative sample, and estimate how long it would take their household to generate 100 kilograms (or a tonne) of this waste product. Ask *How can you refine your estimate?*

Points of entry: Science

Find out what your students already know about waste disposal: *What happens to waste after it gets put in a bin? Who has been to a landfill? What happens there?*

If they don't already know, get the students to investigate exactly where their rubbish goes and how it is managed. For example: *Does the local landfill have a comprehensive process for recovering and recycling materials that can be recycled? Is your "local" landfill actually local, or do residents take their waste to a transfer station to be trucked to a landfill far away? Does the landfill charge by volume or mass?*

The students should consider the implications of measuring rubbish by mass instead of volume – a common practice. Ask *What are the pros and cons of the two methods?* If a landfill charges by mass, it is likely to fill more quickly because users are charged the same whether their rubbish takes up lots of space (volume) or not. If a landfill charges by volume, people will try to minimise cost by compacting their waste before dumping it. For example, a bookcase has the same mass whether assembled or disassembled, but taken apart, it occupies much less space so would cost less to dump. In practice, many landfills operate both systems: private vehicles are charged by the carload (more for a station wagon) and/or trailer load, whereas trucks are weighed before and after they dump their load and charged for the difference in mass.

Ask your students to suggest how the make-up of waste nationally will differ from that of their classroom waste and also from that in the typical family rubbish bag or bin (see the illustration on page **5** of the students' book).

Page 9: Breaking Down

Mathematics and Statistics Achievement Objectives

- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions
  - identifying patterns and trends in context, within and between data sets
  - communicating findings, using data displays (Statistics, level 3)
- Statistical literacy: Compare statements with the features of simple data displays from statistical investigations … undertaken by others (Statistics, level 2)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objective

- Properties and changes of matter: Group materials in different ways, based on the observations and measurements of the characteristic chemical and physical properties of a range of different materials (Material World, level 3)

Mathematics and statistics context

Students will:

- gather data on how long it takes for various items to decompose
- represent data on a timeline
- draw conclusions from data.

Students should discover that:

- patterns can be found in data
- these patterns have meaning.

Science context

Students will:

- gather information to help them classify waste
- plan a classifying investigation.

Students should discover that:

- scientists group materials according to their chemical and physical properties
- the chemicals that make up a material, and the way they are arranged, give the material its chemical and physical properties
- items that are compostable share specific characteristics
- items decompose at different rates
- we can recycle some kinds of rubbish more easily than others.

Related information

Building Science Concepts: Book 60, *Rubbish*; Book 61, *Recycling*

Connected 1 1999: "Oranges: An Experiment to Prove That Rubbish Does Not Exist"; What Goes Around Comes Around"; "How to Wear a PET"; "Smile!"

Useful websites

Compostable items: www.improvemyhome.com.au/articles/garden-and-outdoor/home-compost-turn-green-rubbish-into-something-useful

Additional source for decomposition times: www.slate.com/id/2169287/nav/navoa/

Answers

Activity

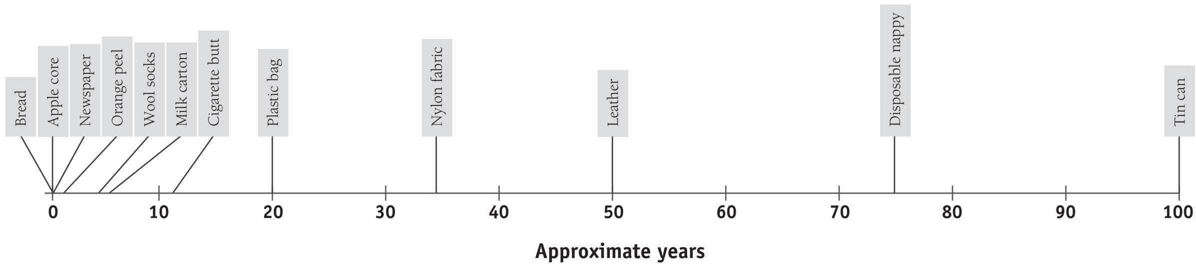
1. **a.** Under normal conditions (that is, when not buried in a landfill), the time an item takes to break down depends on a variety of factors, including temperature, moisture, chemicals in the soil, work of bacteria, and exposure to air and sunlight. The table gives suggested times for some everyday items. (Different sources suggest different times; even so, they show clearly that some items break down quickly and others may never.)

Item	Time to break down	Item	Time to break down
Apple core	2 months	Glass bottle	Forever
Orange peel	1–6 months	Polystyrene*	Forever
Aluminium can	80–500 years	Nylon fabric*	30–40 years
Newspaper	6 weeks	Tin can	100 years
Cigarette butt	10–12 years	Leather	Up to 50 years
Plastic bag*	10–20 years	Wool socks	1–5 years
Disposable nappy	75 years	Milk carton	5 years
Plastic bottle*	450 years	Bread	3–4 weeks

* Even when these petrochemical products break down, they leave traces in the environment.

When buried in a landfill, most waste (even food scraps) does not break down because the mass that covers it tends to "mummify" it.

b. Timelines will vary. Here is an example, using data from the above table:



More than 100 years

Aluminium can (80–500)
Glass bottle (never)
Plastic bottle (450)
Polystyrene (never)

c. Discussion will vary. Points might include:

- There is very big difference in the time it takes for different items to break down.
- Fruits break down quite quickly.
- Some very common items will not decompose in a human lifetime.
- Items that don't break down in 100 years or less can take hundreds of years to break down.

2. Recommendations will vary. For example:

a. items that decompose within a matter of months should go into a compost bin

b. items that decompose within 5 years could go into a landfill with a 40 year lifespan

c. items that won't decompose in a lifetime should go into a permanent landfill.

3. Compostable items commonly disposed of at school would include food scraps (except for meat and dairy food, which shouldn't go into a compost bin). Food scraps are more dense than the paper and plastic that would make up most of what is in the non-compostable waste bins.

Notes

Preparation and points to note

Although the issues explored by this activity are important and urgent, there is little readily available, authoritative information on how long it takes for different types of waste to decompose. If students input "waste breakdown times" into a browser and look at the few references that are clearly on the topic, they are likely to find the same or similar unsourced data popping up. According to one analysis (see www.thatdanny.com/2008/06/06/how-long-does-it-take-a-plastic-bag-or-a-glass-bottle-to-decompose/?), there are three similar lists of items and times circulating, and these came originally from *The New York Times (2001)*, Penn State University, and *Pocket Guide to Marine Debris* (The Ocean Conservancy, 2004). The data in the table in the answers (above) comes from these lists.

An Internet search under "compostable school" will bring up some useful websites on compostables, including the introduction of compostable lunch trays, plates, and plastic bags.

As for many other environmental questions, there are no simple answers to questions about waste breakdown times. Different materials decompose at different rates depending on a host of environmental factors that include temperature, presence of moisture, exposure to sunlight, whether or not they are buried, and if buried, how deep and in what kind of substrate. Also, plastic products have only been around for a few decades (fewer than 50 years, in most cases), so scientists have little historical data to go on. Students need to be able to come to terms with such uncertainty, recognising the reasons for it.

If computers are not available, you could simply give your students the data in the table and ask them to estimate for other items they may have listed. This would, however, remove the value of the activity in terms of teaching research skills.

This activity challenges students to make sense of patterns within sometimes disparate information. It is therefore well suited to a focus on the key competency *thinking*.

Points of entry: Mathematics

How long is forever? In this case, the term means simply "so long that we can't measure". All things will eventually wear away from the action of wind, water, or geothermal activity, but many of the products we use every day will outlast us – some may outlast humankind.

Timelines are well-suited to portraying information like this. They organise time-related data so that relationships can be easily observed and interpreted. They are also easy to create. The students could create small-scale timelines in their books or on A3 paper. If there is space along a classroom wall, a group of students could create a larger-scale timeline by first joining sheets of paper together.

Students need to find a way of coping with data that is provided as a range (for example, 30–40 years). The suggestion in the students' book is to use the point that is midway between the two given numbers (that is, the median). Alternatively, a case could be made for using the larger of the two numbers, given the uncertainty around the times. Encourage your students to think about the meaning of the numbers and the issues around them. They should not get too worked up about the "exact" place to put a number that may be little more than an educated guess!

Points of entry: Science

Encourage the students to investigate why some items take longer to break down than others. Link the question to their own knowledge of the environment: *If wood took forever to break down, what would forests look like? Why do we see plastic rubbish washed up on the shore but little paper rubbish?*

Things break down for a reason. Encourage the students to realise that some waste items are sources of food for animals or micro-organisms, and some are not. Those that are will completely decompose over time unless they are placed where animals or micro-organisms can't access them or can't survive. Items made of plastic or metal are not sources of food so they take much longer to break down and, even when they do, they may leave a residue. Specific everyday items can be the focus for investigation or discussion. For example, an apple (the activity of micro-organisms, animals), an animal (the activity of other animals, maggots, micro-organisms), newspaper (the activity of micro-organisms, fire), a tree (the activity of animals, fungi, micro-organisms, fire), a tin can (chemical action [rusting]), an aluminium can (chemical action [corrosion]), rock (water, temperature change, chemical action, plant action, abrasion [slow mechanical demolition]).

Have the students think critically about how they categorised their data. Ask: *Which data did you find the most surprising? Which data was easiest to explain or understand?*

Some students may note that glass and polystyrene both take an extremely long time to break down. Ask *Does this mean that the two materials pose similar environmental issues?* You could challenge interested students to research and compare these materials: how they are made and used, how they are disposed of, under what circumstances they break down, and what the implications are of continuing to use large volumes of these materials.

Simple experiments can demonstrate how conditions affect the breakdown of materials. For example, test manufacturers' claims that a plastic bag is biodegradable: put one bag in a jar on a sunny window ledge, put one in a jar in a dark cupboard, bury one 50 centimetres down in a place where it can be found again. Or take several apples and leave/bury them in different environments. Plan such experiments so that they follow the scientific inquiry process (see the chart on page **5**).

Students could also investigate how the presence or absence of moisture/water affects the breakdown of organic materials.

A final discussion could include questions such as: *If you were to bury the contents of a school rubbish bin and leave it for 100 years (like a time capsule), what would the people who dig it up find? How would the answer to this question be affected by the place (particularly soil and climate) and conditions (type of container)? Would people in 100 years' time be interested in our rubbish? What might they think about us, judging from what we threw out?*

Pages 10–11: All That Packaging!

Mathematics and Statistics Achievement Objectives

- Number knowledge: Know fractions and percentages in everyday use (Number and Algebra, level 3)
- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions
  - identifying patterns and trends in context, within and between data sets
  - communicating findings, using data displays (Statistics, level 3)
- Statistical literacy: Compare statements with the features of simple data displays from statistical investigations … undertaken by others (Statistics, level 2)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objectives

- Investigating in science: Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations (Nature of Science, level 3)

  Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)

  Properties and changes of matter: Group materials in different ways, based on the observations and measurements of the characteristic chemical and physical properties of a range of different materials (Material World, level 3)

Mathematics and statistics context

Students will:

- gather and record category data and investigate features of the data
- interpret data displays and draw conclusions from graphs.

Students should discover that:

- there is only a weak relationship between volume, mass, or product type and how it is packaged.

Science context

Students will:

- plan ways to collect and measure data about packaging.

Students should discover that:

- packaging materials protect food; they keep food fresh by maintaining its water content at stable levels and keeping air out, and they prevent items from being crushed, spilt, or damaged
- the way an item is packaged has a big impact on the waste produced; different packaging choices can reduce waste without affecting food preservation.

Related information

Building Science Concepts: Book 60, *Rubbish*; Book 61, *Recycling*

Connected 1 1999: "Oranges: An Experiment to Prove That Rubbish Does Not Exist"; What Goes Around Comes Around"; "How to Wear a PET"; "Smile!"

Answers

Activity One

1. **a.** Decisions and reasoning will vary. Buying raisins from a bulk bin uses the least packaging, but the cardboard box for 375 g creates the least packaging waste (because cardboard is recyclable or will break down).

   b. Most likely, the convenience factor. If you buy raisins in large packets, they need to be repackaged in smaller amounts for school lunches.

2. a.–b. Investigations will differ but should follow the inquiry approach. As a general rule, the smaller the individual serving, the more wasteful the packaging. Buying pre-packaged fruit or vegetables in plastic-wrapped trays is a lot more wasteful than putting them into a paper or plastic bag or straight into your shopping basket.

c. Ideas will vary. For example, supermarkets could sell all their fruit and vegetables loose. They could encourage more shoppers to buy products that are available loose from bins instead of buying them pre-packaged. They could investigate ways of packaging meat that do not involve foam plastic trays.

d. Ideas will vary, including some from **a–c**.

e. Manufacturers have to think about protecting their products from damage during transportation, storage, and shelving and, for food in particular, from contamination by other food products or from the places where they are displayed or stored. Insufficient or bad packaging can result in breakage, leakage, or health risks. Manufacturers also use packaging to convey information and to appeal to customers.

Notes

Activity One

Preparation and points to note

For their investigation in question **2**, students will have to estimate the amount of packaging by volume in relation to the amount of product (small/medium/large) because measuring is out of the question. Consider doing a calibration exercise in advance, using sample items, before the students investigate their chosen product line. Groups can rate the amount of packaging for items as different as rice, cereal, apples, juice, or health bars and reach a consensus on the amount of packaging relative to the amount of product.

This activity requires students to share their findings and conclusions, so it provides an opportunity to focus on the key competency *relating to others*. Keep an eye out for students who are reluctant to listen to the views of their classmates (reluctant to participate in a respectful exchange of ideas) or who are not learning to resolve differences by means of mathematical argumentation.

Make sure that students select a product that comes in a variety of packaging; for example, in a small box, a loose bag, and a tray with plastic wrap. Make sure that the students make meaningful comparisons; for example, "A 2 litre bottle of soft drink and a 6-pack of soft drink contain about the same volume, but the 2 litre bottle uses considerably less packaging."

Points of entry: Mathematics

The focus of this activity is on comparing amount of product with amount of packaging in simple, non-formal ways. Students do not need to be advanced proportional thinkers on the Number Framework to understand that a plastic bag used to hold a single apple is more wasteful than the same bag used to hold 8 apples.

Provide concrete examples; for example, 200 g of chocolate could be packaged as a single bar with a single paper and foil wrapper or as five 40 g bars, individually wrapped. Showing the bars, unwrapping them, and displaying the packaging side by side will illustrate what a difference packaging can make in terms of waste.

Packaging introduces a wide range of variables. For example, based on the chart in question **1**, raisins can be purchased as: a sealed 300 g plastic bag, 18 small boxes in a bag, a 375 g cardboard box, or from a bulk bin put into a plastic bag. The notion of variable needs to be deliberately taught. In this context, a variable is mass, volume, or some other factor that might affect or influence packaging (for example, liquid content or "wetness", temperature, serving size, fragility, bruisability, saleability, or stability). Not all variables are numeric!

When a manufacturer is deciding how to package a product, a consideration is how the packages will stack in a carton or on a pallet. As an extension activity, the students could explore this aspect of packaging and see if they can discover why cylindrical shapes (most jars and bottles) are so popular when they use up so much space in a carton or pallet. (They use less packaging material for the amount of product they contain, they are stronger [less crushable] than alternative shapes, and they do not have corners that product gets stuck in. It may be that their shape is also more aesthetically pleasing.)

Points of entry: Science

In these activities, students explore packaging and over-packaging and the reasons for them; these reasons – some science-related, some not – include food safety, hygiene, preservation, marketing, price discrimination, tamper-proofing, excluding insects, and ease of transportation.

Encourage the students to look for environmental factors that may have influenced the choice of packaging; for example, cans (which are opaque) are used instead of jars (which transmit light) for products that degrade in the light. Ask: *What happens to [product] as it moves from processing plant to table? How might temperature, humidity, light, vibration, or handling impact on the product, and how does its packaging seek to minimise these impacts? How does age affect this product, and how does the packaging help give it the longest lifespan possible?*

Further investigations

Milk would be a good study. Students may be surprised to learn that, in warm climates, prior to refrigeration and sophisticated treatment, milk had to be used within a day or it went off. They could try and discover why milk, which used to be sold in bottles that were refilled many times before being recycled, is now sold in opaque plastic bottles and cartons. Ask: *What have been the consequences of this shift? Is there a reason why milk containers are not transparent like most juice bottles?*

Encourage the students to use the scientific method in experimental design: develop a hypothesis concerning milk packaging, find a valid way to test the hypothesis, experiment, record the data, and come to a conclusion about the validity of the hypothesis.

Another possible product for investigation could be tomato sauce, which is sold in tubes, glass jars, cans, and both clear and opaque plastic bottles. The students could easily investigate the two types of plastic bottle:

- Hypothesis: tomato sauce spoils more quickly in clear plastic bottles than in opaque plastic bottles.
- Experiment: pour equal amounts of tomato sauce into a clean, clear plastic bottle and into a clean, coloured plastic bottle and place them outside for a week.
- Data: at the end of the week, record the appearance, smell, and amount of mould in each container.
- Conclusion: (will depend on the data, which may be influenced by the weather conditions).

Answers

Activity Two

1. **a.** Light & Fit is probably contained in a strong cardboard box, perhaps with a light plastic liner. Sport Fuel probably has a strong plastic bag inside a light cardboard box.

   b. Max-muesli has no cardboard component (unlike the other products) and is therefore packaged straight into a plastic bag.

   c. Wheat Bics (approximately 92%)

   d. The most likely answer is Cornie Crisps. Cornie Crisps is packaged in plastic inside a box. The proportion of cardboard suggests that the box is nowhere near full. In fact, almost half of the total mass is plastic and cardboard, so even if the product itself is light, there isn't much product for all that packaging!

2. The graph doesn't tell you the mass of each product, the overall size of the product, or whether the cost is reasonable for the amount of product you get.

Notes

Activity Two

Points of entry: Mathematics

The graph here is a 100% stacked bar graph, a type that is particularly suited for comparing the make-up of products of different size. Your students may not have met a graph like this before, but its interpretation is fairly intuitive: if they look at any one breakfast cereal, they can instantly compare the mass of the cereal with the mass of the packaging.

They should note, however, that the graph does not provide information about total mass or volume (or value for money) and that the boxes of cereal are unlikely to be all the same size. It may be, for example, that the Light & Fit box contains only 250 g of product, while Super Crispies may be a much larger box that contains 500 g of product.

Your students can easily get real data of this kind at the supermarket. (You may need to have a word with the manager first!) They should choose several cereal boxes, note the brand and amount of product (net weight) as listed on the packets (for example, 600 g), weigh them on one of the digital scales in the fruit and vegetable department, and record the mass. Entered into a table, their data might look like this:

Cereal	Listed product mass (net weight)	Total mass (including packaging)
Wheat biscuits	1 000 g	1 107 g
Puffed wheat	375 g	478 g

Clearly, using this method, they cannot get separate data for cardboard and plastic when the packaging includes both.

By level 3 of the curriculum, students are expected to know percentages in everyday use and to use percentages in simple additive and multiplicative strategies. This activity does not ask for calculations, but it can be used to reinforce students' growing understanding of percentage. They could, for example, be asked to estimate the various percentages on the graph. Emphasise that the purpose of percentage is to enable comparisons.

[***Note for teachers***. Percentage is not a unit – you can't buy a scale marked "%"; it only has meaning when applied to a specific situation, for example, "25% of the seeds did not germinate" or "37% of people do not pass their driving test the first time". "Regular" fractions like $\frac{1}{4}$, $\frac{3}{5}$, or 0.9 have identifiable positions on a ruler or scale (that is, they are numbers on a number line) and are used as measures of relativity ("$\frac{3}{5}$ of the cyclists had at least 1 puncture"). Percentages have only the latter function; in the current context, they enable students to compare products that come in different-sized packages and contain different quantities.]

Consider using two or three packets of different cereals as a concrete illustration: weigh the full box, take out the inner bag and weigh the empty box, then calculate what percentage of the total mass is cardboard. Challenge your students to compare the contents in the best way they can. Some may use word comparisons (more/less), familiar fractions and/or percentages, or graphic representations. Others may have enough knowledge of percentages to attempt more accurate comparisons.

If you do this, consider also comparing the different cereals by volume. In each case, you will need to empty the contents of the inner bag into the box and shake it down. The students can either estimate visually the fraction of the box that is filled with cereal or find a way of measuring the volume of the cereal as well as the box. The students should realise that it is the volume of the box, not the volume of cardboard, that is of interest here.

Points of entry: Science

Make connections to the composition of each product and packaging. For example, plastic is relatively light and cardboard relatively heavy when compared with some cereals. Ask: *Why is the portion of packaging for all cereals less than 50%? What does this mean in terms of the amount of cereal you are paying for?* (It's the cereal you want, not the packaging!) Ask *If some of the ingredients in mixed cereals are very light, such as puffed wheat or cornflakes, which ingredients probably add the most mass?* (Oats, sugar, fruit pieces)

Link this discussion to the students' knowledge of density; in other words, even if boxes are made of heavy card, they are less dense than cereal because they are hollow. Also, the same ingredient can be cooked or processed in different ways and have different densities, for example, puffed wheat, wheat flakes, or wheat biscuits. Relate density to its constituent parts (density = mass ÷ volume) and challenge the students to compare densities. In other words, given 2 boxes of the same volume, the one that weighs less is less dense, and given 2 boxes of the same mass, the bigger one is less dense. Ask *What might be the least dense cereal and the most dense?* (Most likely rice bubbles and muesli)

The key competency *thinking* is suggested as a focus for this activity.

Pages 12-15: Location, Location …

Mathematics and Statistics Achievement Objectives

- Number strategies: Use a range of additive and simple multiplicative strategies with whole numbers, fractions, decimals, and percentages (Number and Algebra, level 3)
- Measurement: Create and use appropriate units and devices to measure … turn (angle), temperature, and time (Geometry and Measurement, level 2)
- Measurement: Use linear scales and whole numbers of metric units for … angle, temperature, and time (Geometry and Measurement, level 3)
- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions
  - identifying patterns and trends in context, within and between data sets
  - communicating findings, using data displays (Statistics, level 3)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objectives

- Astronomical systems: Share ideas and observations about the Sun and the Moon and their physical effects on the heat and light available to Earth (Planet Earth and Beyond, level 2)
- Investigating in science: Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations (Nature of Science, level 3)
- Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)

Mathematics and statistics context

Students will:

- use a protractor to measure angles
- interpret data displays and draw conclusions from graphs and tables
- investigate the relationship between season, latitude, and the angle of the Sun.

Students should discover that:

- daylight hours are a function of latitude – the lower the latitude, the lower the angle of the Sun and the bigger the difference between winter and summer
- temperature is a function of the angle of the Sun – the higher the angle of the Sun, the warmer the climate.

Science context

Students will:

- collect and measure weather data
- use the data collected to evaluate garden sites
- explore the geometry of Earth's orbit around the Sun.

Students should discover that:

- seasons are caused by the axial tilt of Earth's rotation compared with its axis of orbit around the Sun
- summer is hotter than winter because the Sun is shining more directly and for a longer portion of the day (that is, it's not because Earth is closer to the Sun).

Related information

Building Science Concepts: Book 20, *Our Star, the Sun*; Book 29, *Solar Energy*

See also *Making Better Sense of Planet Earth and Beyond*, pp. 72–78.

Answers

Activity One

1. a. i. Jazmyn's site has the highest average temperature; Dembe's is the coolest.

   ii. Liam's site has the least wind.

   iii. The best site will depend on what type of plants the students wish to grow. Because Jazmyn's site is warm and relatively wind-free, it is likely to be the best choice for most plants.

   b. Other factors might include type of soil, access to water, access for wheelbarrows, and security.

2. Practical activity. Graphs and choice of sites and will vary.

3. Evaluations and decisions will vary but should be clearly based on the evidence that you have gathered.

Notes

Activity One

Preparation and points to note

Instructions for making an anemometer can be found on page 77 of *Making Better Sense of Planet Earth and Beyond* or in Chilling Out, *Measurement: Book Two*, Figure It Out, level 4+.

As with any group activity, carefully consider the needs of individual students when grouping. It can be a good strategy to give group members specific roles, such as recorder, measurer, or map maker. All members in a group need to participate fully in brainstorming, scouting sites, and evaluating.

There may be no site that is clearly the best. Encourage the students to question the evidence and to determine which of the criteria are most important. Group decisions require co-operation, participation, and the ability to listen, so the key competency *participating and contributing* is a very suitable focus for this activity.

Points of entry: Mathematics

The graphs in the students' book and on the copymaster use 2 vertical scales simultaneously: temperature on the left and wind speed on the right. It is likely that your students have not encountered this feature before. Ask them to think about why Jazmyn and her friends might have chosen to represent their data in this way. *What stories do the graphs tell? What comparisons do they allow you to make? (Is one site always hotter?) What patterns do they help you spot? (Is there a relationship between temperature and wind speed?) Are the graphs easier to read than the tables that contain the same data?*

Prompt the students to interpret the data in a real-world context: *What was the weather at each site on a particular day?* (For example, on the third day, site 1 was warm and relatively calm and on the fourth day, warm and windy. Site 1 is the warmest of all the sites, so it is probably gets the most sun and shelter.

The students need to realise that while they can compare the temperature (at 3 p.m.) across the 5 days, they can't compare temperature and wind speed. For example, it is meaningless to say "The wind speed is always lower than the temperature." There is no mathematical or scientific connection between the two vertical scales; they have been separately selected for convenience.

Some students may wonder why the data values for the 5 days are not joined with line segments to better show the trends. This is not normally done for spot readings because there may be major fluctuations – in this case, in temperature and wind speed – between readings.

The students should consider the timing and frequency of their measurements: *Is one set of measurements taken at 3 p.m. enough to give us a true picture?* This raises the issue of sampling. They can't be out there monitoring their sites all day (and night), so they need to consider what is the best compromise between a complete data set and manageability. You could challenge them with other examples of data gathering in which sampling is used.

Any activity like this that involves measurement should include discussion on sources of measurement error and variation: no measurement is ever 100% accurate, so what matters is that it is accurate enough for the purpose for which it is made. Ask the students how they could calibrate the anemometer.

Points of entry: Science

For question **1**, the students should think about the environment at each site and the types of plants the students in the activity might grow. Ask *What data is missing?* (The activity mentions access to water, but the three students gather data only on wind and maximum temperature.)

Challenge your students: *What assumptions have you made? Will the hottest site be the best site for plants?*

Answers

Activity Two

1. **i.** 90º

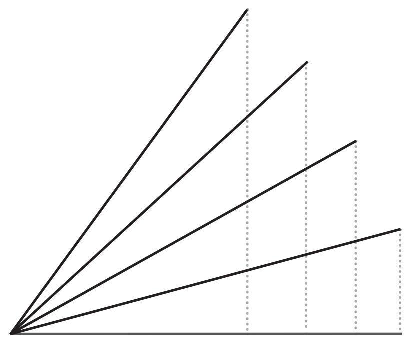
ii. 30º

iii. 15º

iv. 55º.

2. Earth is tilted in relation to the Sun. In winter, the Southern Hemisphere is angled away from the Sun. In autumn and spring, the axial tilt is sideways to the Sun, so the solar angle is not affected by the tilt. In summer, the Southern Hemisphere is angled towards the Sun.

The Sun is highest in the sky in the summer and at its lowest angle in winter, like this:



3. **a.** Auckland: 47º; Wellington: 47º; Christchurch: 47º; Dunedin: 47º. They are all 47º!

b. All the angles between summer, autumn, winter, and spring for each city are 23.5º (which is half of 47º). The reason is that Earth is tilted 23.5º.

4. **a.** When the Sun is higher in the sky, its energy is more intense because it shines more directly on the ground. (Its rays take a more direct route through the atmosphere, and the light and heat produced are more concentrated.)

b. In the summer, the Sun's high angle means that the days last longer (the Sun shines on us for more time, and the heat from it is more concentrated), so the ground is heated for a larger part of the day and the temperatures are hotter.

5. **a.** The points for each city are at different heights because the cities are at different latitudes.

The figures for the Sun's altitude at solar noon are highest for Auckland because it is the most northern of New Zealand's cities; the figures are slightly lower as you move south. The latitudes for the four cities are:

Auckland	36.8° south
Wellington	41.3° south
Christchurch	43.5° south
Dunedin	46° south

b. You might notice that:

- the pattern repeats (this happens because Earth goes around the Sun following nearly the same path every year)
- the Sun's angle to the ground is the same for spring and autumn
- the path of each line is parallel to the paths of other cities.

Activity Three

1. a.–b. Answers and discussion will vary. Points you might notice include:
   - All four cities follow the same pattern, and differences between the cities are not particularly large (because the spread in latitudes is not great).
   - Dunedin gets the most summer daylight hours (this might surprise you) and the lowest winter daylight hours.
   - The further south you go, the greater the difference between summer and winter.
2. There is no correct answer. Tropical plants that require warm temperatures and a lot of sunlight will grow better in Auckland. Pines and other cold-climate plants will grow better in Dunedin. Many vegetables need a period of cold temperatures. Make sure that whatever city you choose, you have evidence to back up your selection!

Notes

Activities Two and Three

Preparation and points to note

If your students are not familiar with angle measurement (a curriculum level 3 concept), start with the notions of quarter and half turns and create the need for a method of describing turn that allows for finer discrimination. If they know the terms 360º turn, turn 180º, or 90º angle, these can provide a bridge to a more comprehensive understanding of how angle is measured and described. Once they have accepted that a one-quarter turn is 90º, draw a variety of angles less than and greater than 90º and challenge your students to estimate their size. The classroom door is a handy tool for illustrating turn.

Like anything else to be measured, angle requires a device with a scale: in this case, a protractor. Like a ruler, a protractor has a linear scale (one that is divided into equal, numbered units). The only complication – one that can confuse students – is that the scale on a protractor is numbered from both ends (0→180, or clockwise, and 180→0, or anticlockwise). To avoid problems, they should estimate the size of an angle before measuring it. When they know what they are looking for, they will find that only one of the two alternatives on the protractor can possibly be the right one.

Challenge your students to explain why a ruler marked in centimetres (cm) is not a suitable means of measuring turn/angle. Ask *Why not simply say "The door is open 20 cm"?* (Only the points on the outer edge have moved 20 cm. Points in the middle have moved 10 cm, and points on the inner edge have moved just millimetres. When we say "the door is open 20 cm", our focus is the gap, not the turn.)

[***Note for teachers***. The words "angle" and "turn" mean the same thing, but the latter is used only when the context involves movement.]

These activities require students to interpret and work with unfamiliar kinds of diagrams; as such, they provide opportunity for a focus on the key competency *using language, symbols, and texts*.

Points of entry: Mathematics

Angle is fundamental to geometry. Ask the students to think of familiar contexts where angle is important. For example, *How does the angle of a skateboard ramp affect your acceleration? At what angle will a kicked ball travel the furthest (45º)? How can the angle of the Sun be a problem for the driver of a car?*

What matters most is that your students begin to get a conceptual understanding of angle. Understanding that a 70º angle is much greater than a 30º angle (and, therefore, that the Sun at 70º will be much higher in the sky) is more important than being able to identify or draw the difference between 35º and 39º.

Points of entry: Science

To understand why there is a day and a night, why there are seasons, and why some parts of Earth are so much colder or hotter than others, students need to understand something about how the Earth, the Moon, and the Sun move in relation to each other. But orbital motion and the geometry of orbits are exceptionally complex. Earth revolves (spins) on a tilted axis and rotates around the Sun, while the Moon rotates around Earth but does *not* revolve relative to it. Physical models or kinetic activities can greatly aid understanding, for example, a tilted basketball rotating around a light bulb to demonstrate the effect of axial tilt.

In space, objects are not oriented the same way in a single plane, so the concepts up and down have no meaning. What matters is how different bodies relate to each other in terms of their orbits. (You could explain this in terms of comparing the everyday concepts of left or right: the instruction “Turn left” means “Turn to *your* left”. Your left may be my right. “Left” has no meaning unless we can answer the question “left of whom/what?”)

The seasons are *not* caused by Earth moving closer to or further from the Sun as many students (and adults) suppose. What happens is that the Sun’s rays enter the Earth at a different angle and for a different length of time. Earth is actually closest to the Sun in January, but the Northern Hemisphere experiences this as winter because the reduction in distance has much less impact than the angle to the Sun and the resulting amount of daylight. If distance from the Sun was the important factor, it would be summer everywhere when the distance was least and winter everywhere when it was greatest.

The rotating Earth tilts about 23.5º on its axis relative to the plane of its orbit around the Sun (see the diagram in the students’ book, but note that the sizes of the Sun and Earth are *not* to scale). It is this tilt that is responsible for the 47º summer–winter difference in the Sun’s peak altitude and for the seasons summer and winter.

In the Southern Hemisphere, the Sun’s path lies further north in winter and further south in summer. As the Sun’s path moves south, we get higher temperatures and longer days. In summer, depending on latitude, the Sun peaks almost overhead. In winter, everything is reversed.

The difference between the length of a summer day and a winter day increases the further you move from the Equator. South of the Antarctic circle, there is at least 1 day in the year when the Sun does not rise; 6 months later, there is at least 1 day when the Sun does not set.

The sunrise and sunset figures in the table are for the equinoxes (around September 20 and March 20) and the solstices (around December 22 and June 22). The table uses New Zealand Standard Time for the winter months and New Zealand Daylight Time for the summer months. (See www.rasnz.org.nz/SRSStimes.htm)

	Auckland		Wellington		Christchurch		Dunedin	
	Rise (a.m.)	Set (p.m.)	Rise (a.m.)	Set (p.m.)	Rise (a.m.)	Set (p.m.)	Rise (a.m.)	Set (p.m.)
Autumn	7:25	19:30	7:25	19:30	7:33	19:39	7:42	19:47
Winter	7:33	17:11	7:47	16:58	8:03	16:59	8:20	16:59
Spring	6:18	18:14	6:18	18:13	6:27	18:21	6:36	18:29
Summer	5:56	20:37	5:42	20:51	5:43	21:08	5:42	21:26

Students could investigate the times for the four cities to see what impact latitude has on length of day at different times of the year.

Page 16: The Heat's On!

Mathematics and Statistics Achievement Objectives

- Measurement: Create and use appropriate units and devices to measure … temperature, and time (Geometry and Measurement, level 2)
- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions
  - identifying patterns and trends in context, within and between data sets
  - communicating findings, using data displays (Statistics, level 3)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objectives

- Life processes: Recognise that there are life processes common to all living things and that these occur in different ways (Living World, level 3)
- Investigating in science: Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations (Nature of Science, level 3)
- Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)

Mathematics and statistics context

Students will:

- record and graph time-series data for temperature
- interpret data displays and draw conclusions from graphs and tables.

Students should discover, in relation to compost, that:

- there is a relationship between temperature and appearance (the hotter it gets, the darker the compost)
- the graph of temperature over time is non-linear.

Science context

Students will:

- measure and collect time-series data for appearance and temperature
- investigate the causes of temperature change in compost over time.

Students should discover that:

- compost decays due to changes (including changes in temperature) caused by moulds and bacteria
- decomposition of naturally occurring materials involves chemical reactions
- chemical reactions, which occur naturally around us all the time, can release heat or take in heat.

Related information

Building Science Concepts: Book 53, *Moulds are Fungi*; Book 36, *Heat on the Move*; Book 23, *Fresh Food*; Book 24, *Preserving Food*; Book 6, *Soil Animals*

Connected 1 1999: "Oranges: An Experiment to Prove That Rubbish Does Not Exist"

Useful website

Composting in schools: http://compost.css.cornell.edu/schools.html

Answers

Activity

1. Practical activity
2. a. The temperature should be rising. (Temperatures can reach 70° or more if the moisture content is right; the bacteria that cause the rotting need moisture.)

   b. Theories will differ, but the temperature increase is caused by bacteria. The tarpaulin will help keep the pile hot, but even if uncovered, a large heap of clippings will heat up due to the heat released by the bacteria as they break the grass down.

c. At first, the clippings look green and smell sweet. Before long, they become a smelly brown sludge. (Grass needs to be layered with other material to make good compost.) If the heap is too dry, the bacteria can't function properly and the grass may not reach the sludge stage.

3. a. Results and graphs will vary.

   b. The graph should show the temperature peaking and then beginning a long, slow decline. The increase in temperature is associated with the darkening of the clippings.

   c. A bigger heap will tend to generate more heat, so you could add more grass clippings or other material that breaks down easily. A dark or black tarpaulin will attract more heat from the sun.

Notes

Preparation and points to note

It may be unrealistic for each group to have its own compost heap; if this is the case, establish a class heap and get different groups to take temperature readings at different times of the day.

As this task involves monitoring heap activity over a minimum of 2 weeks, the students need to remember to take the readings, do the observations, and keep a record. Challenge them to be fully responsible for this process; in this way, they will be both demonstrating and developing the key competency *managing self*. They may find that taking the temperature in the centre of the heap is easier if they securely tape the thermometer to a metre ruler, broom handle, or similar.

All students should take care when handling compost; this is particularly important for any who are known to be sensitive to or allergic to mould, fungi, or bacteria.

There have been cases when, in hot, dry conditions, compost heaps have become so hot that they have caught fire (and haystacks that were stacked when the hay was wet have ignited spontaneously). While the likelihood of this happening is extremely low, make sure that heaps are not right next to buildings. The students will, of course, need the co-operation of grounds staff for this project.

The Internet is a useful resource when researching compost heaps and decomposition.

Points of entry: Mathematics

In this practical activity, temperature and time are both variables. Time is an independent variable: it goes marching on regardless of heap temperature (or any other factor, for that matter). Temperature is a dependent variable: it depends on which day we are talking about (in this case, which day in the life cycle of the heap).

This activity requires students to use a thermometer to measure temperature in the middle of the compost heap. Have the students discuss and problem-solve how to get the thermometer into the centre of the heap and take an accurate reading, bearing in mind that the reading will drop rapidly as soon as the thermometer is removed from the heap. (They may not realise this because spirit-type thermometers used to take body temperature hold the maximum until shaken down.) A digital thermometer with a probe will get around this problem. If one is not available, speed and teamwork will provide the best remedy. Ask: *How long will you need to leave the thermometer in the heap? Will poking around in the heap change its characteristics (and therefore influence the outcome of the experiment)? The instructions call for once-a-day readings; would it be best to take more?*

The temperature data needs to be graphed. Challenge the students to come up with a graph that effectively tells "the story of the heap". It will need to be a time-series graph of some kind: time or date (the independent variable) on the horizontal axis and temperature (the dependent variable) on the vertical axis. Note that the data points can be joined, unlike those in the graph for Location, Location … Ask your students if they can suggest why. (In the earlier activity, the temperature will fluctuate quite dramatically between data points; joining them with a line would obscure this fact. In this case, the temperature at the centre of the heap will change only slightly between readings; joining the data points will emphasise the continuity.)

Although the students are only asked to include the temperature data on their graphs, you could challenge them to find a way of incorporating the appearance data on the same graph. This will reinforce the difference between quantitative data (data that can be counted or measured, such as temperature) and qualitative data (data that can only be described or categorised, often subjectively). The best solution may simply be to annotate in handwriting those points where a visible change was noted.

Use this as an opportunity to compare and contrast change that is linear (constant, always at the same rate) and non-linear (speeds up, slows down, or fluctuates over time). For example, ageing is linear: we grow 1 day older every day (never more, never less) but compost heap temperature is not linear – it increases, stabilises, then decreases.

Points of entry: Science

Make connections between your students' prior experience of temperature and decomposition (things decaying, going mouldy, going bad) and the experiment with the grass clippings. Get them to think about what they already know about the role of temperature in decomposition. Ask: *Do things spoil faster on the bench or in the fridge? What sort of temperatures do bacteria like? Do living things heat up their environment?* They are also likely to have had experiences that suggest a link between moisture and decomposition (for example, mould growing in damp or humid conditions or places). These experiences can usefully be explored.

Encourage the students to do their own research into what goes on in a compost heap and to relate this to the grass clippings experiment. For example, *What does your graph suggest about the life cycle of the bacteria in the heap or when the grass clippings will be fully composted?* If the local landfill has a composting operation, it may be possible to get the manager to come and talk about it. The students could ask what the optimal conditions for composting are and how these are achieved.

The smell given off by the compost heap comes from the gases produced when organic matter decays. Link this to what students already know of gases such as methane or nitrogen. Ask: *What properties do they have? When organic matter is buried in a landfill, large quantities of these gases are produced and gradually make their way to the surface. What are the implications of this?*

If circumstances allow for groups to have their own compost heaps, consider a competition, for example, to generate the hottest composting temperature. Location, use of black polythene as a cover, adding other materials, aeration, amount of moisture, and turning are some of the variables worth exploring.

Page 17: Is Walking Free?

Mathematics and Statistics Achievement Objective

- Number strategies: Use a range of additive and simple multiplicative strategies with whole numbers, fractions, decimals, and percentages (Number and Algebra, level 3)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objective

- Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)

Mathematics and statistics context

Students will:

- calculate the cost of walking to school
- calculate the cost of a daily breakfast.

Students should discover that:

- the decisions we make often ignore important costs and benefits
- estimates need to be evaluated in context for reasonableness.

Science context

Students will:

- compare the environmental and health costs and benefits of different modes of transport.

Students should discover that:

- walking to school is not free
- the modes of transport we use have resource and environmental impacts.

Related information

For information about walking to school, see:

www.walktoschool.org.uk/

www.cdc.gov/nccdphp/dnpa/kidswalk/resources.htm

Answers

Activity One

1. Discussion will vary. Comments are likely to include reference to pollution, the number of cars on the road, the benefits of using public transport, health and other benefits of walking.
2. Discussion will vary. Comments on walking are likely to include health benefits (and possible adverse effects from exposure to fumes, depending on location and route), saving money on transport, good and bad aspects of the time it takes to walk, possible costs of extra clothing/shoes. Comments on the benefits of car or public transport may include a saving on time, protection from weather, or convenience. Cost factors may involve comparing costs of a car (including parking fees or savings by car pooling) with that for public transport.

Activity Two

1. $360 (3 people x $60 x 2 pairs a year). (If instead they each rode the bus for $1 each way, they would spend about $1,200 on bus fares [3 people x $1 each way x 200 school days] and would still need at least 1 pair of shoes each.)
2. a. Based on the costs given and using rounding, the approximate cost of 1 breakfast would be $1.90 (rounded costs: 3 wheat biscuits 50 cents, 10 g sugar 2 cents, 1 banana 40 cents, milk $1.00).

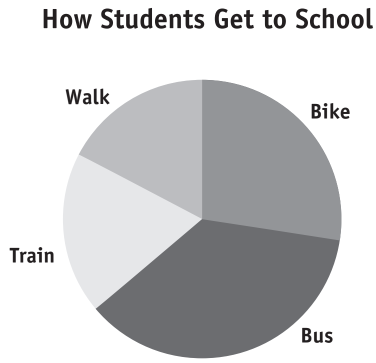
   b. i.–ii. Answers will depend on the number of students in your class. (For a class of 25 students, 1 day = $35; 1 week = $175.)

Notes

Preparation and points to note

You could introduce this activity by having students conduct an impromptu in-class survey on how they get to school. The data could be simply collated and represented like this:

Student	Transport	Transport	Tally
Jeremy	bike	bike	3
Kirsty	bus	bus	4
Susan	train	train	2
Matt	walk	walk	2
Helen	walk		
Migoto	bike		
Teremoana	bus		
Carol	bus		
Peter	train		
Rupert	bike		
Waitangi	bus		



The students could then think about how much it costs for a bicycle, shoes, bus fare, and other related costs (petrol, roads). Evaluating this information will help them develop the key competency *thinking*.

Points of entry: Mathematics

This activity requires students to make a number of calculations, including multi-part calculations. The students should do these without a calculator, using tidy numbers and other strategies to come up with realistic approximations or estimates.

Students sometimes think that estimating or approximating gives a rough and therefore "wrong" answer. This theory needs teasing out with the help of examples such as the ones in this activity. Take the milk that Jaimie uses: 500 mL from a 1 L carton costing $1.89 comes out at 94.5 cents. Is this the "right" answer? No, because Jaimie doesn't measure the milk that goes onto her cereal, she simply tips on about a quarter of a carton. Also, the price of the milk is unlikely to be stable; it may vary considerably according to brand, special prices, place of purchase, or seasonal price changes. So it's better to say that Jaimie uses "about half a litre" of milk for breakfast and that the cost of this is "about $1.00" (95 cents, rounded). It is important that students learn to think about the meaning of numbers in the context in which they are used.

Discuss what it is reasonable to assume from a single person's breakfast. Ask: *How realistic do you think this estimate would be? How could we get a better estimate? Could we average the cost of a number of different breakfast choices and base a calculation on this?*

Points of entry: Science

As the speech bubble in the students' book says, legs are a resource. But they are not exactly free: they need to be suitably looked after (hence footwear) and energised (hence breakfasts and other food), regardless of whether or not students walk to school. Of course, those who walk some distance to school will wear out their shoes at a faster rate and burn up additional breakfast kilojoules.

Every choice has costs and benefits. The process (often subconscious) of weighing these is known as a cost–benefit analysis. It can be difficult to do this analysis honestly because we are often trying to justify the decision that we want to make! A student who wants to get a ride to school will emphasise the benefits (faster, drier, easier) and minimise the costs (parent time, car, health). Ask your students to do a more detailed cost–benefit analysis on walking than they are asked to do in the activity. *Can you reach a consensus decision? If not, why not?* (It will probably come down to different values.)

Reinforce the idea that science is about justifying decisions with evidence. Encourage the students to back up any viewpoints or opinions with facts.

Before leaving this activity, bring your students back to the question posed by the title: Is Walking Free? The activity is not suggesting that only those who walk to school need shoes and breakfast!

Pages 18-19: Cool Colours

Mathematics and Statistics Achievement Objectives

- Statistical investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate category and whole-number data and simple time-series data to answer questions
  - identifying patterns and trends in context, within and between data sets
  - communicating findings, using data displays (Statistics, level 3)
- Statistical literacy: Compare statements with the features of simple data displays from statistical investigations ... undertaken by others (Statistics, level 2)
- Measurement: Use linear scales and whole numbers of metric units for ... temperature, and time (Geometry and Measurement, level 3)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objectives

- Investigating in science: Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations (Nature of Science, level 3)
- Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)
- Chemistry and society: Relate the observed, characteristic chemical and physical properties of a range of different materials to technological uses and natural processes (Material World, level 3)
- Physical inquiry and physics concepts: Explore, describe, and represent patterns and trends for everyday examples of physical phenomena, such as ... heat (Physical World, level 3)

Mathematics and statistics context

Students will:

- read a linear scale on a thermometer and record temperatures
- plot 3 series on a time-series graph.

Students should discover that:

- the slope of the graph (which represents the rate of change) is different for each tin
- temperature change is proportional to volume (the larger a volume of water, the longer it takes to heat).

Science context

Students will:

- gather data to develop explanations and make informed decisions
- compare the rate of temperature change for different-coloured tins.

Students should discover that:

- dark colours absorb more heat energy than light colours
- solar heating is non-linear (varies over time).

Related information

Related ideas from the Building Science Concepts series and *Making Better Sense of the Physical World* are:

- Temperature is a measure of the heat of an object and is related to how fast the particles that make up the object are moving and vibrating.
- Heat is a form of energy.
- Heat moves by radiation, conduction, and convection.
- Radiation is the movement through space of electromagnetic waves, including heat.
- The internal energy of an object is transferred along a gradient from hotter to cooler temperatures.
- Dark surfaces absorb radiant heat more readily than light ones.
- Insulation is a barrier to the movement of heat. Insulation keeps hot things hot and cold things cold.
- What insulating materials are made of and where they are located influences the rate at which heat energy flows.

Building Science Concepts: Book 46, *Keeping Warm*; Book 47, *Insulation*; Book 36, *Heat on the Move*

See also *Making Better Sense of the Physical World*, pp. 55–64.

Connected 1 1998: “Gifts from the Sun” and “Sun Facts”

Answers

Activity One

1. Practical activity. You should find that the water in the tins that were in the sun or part-sun is warmer than the water in the tin that was in the shade.
2. Results and discussion will vary. Water from the tap is typically around 15 or 16°C. Over the course of the day, the water in each tin will heat up but at different rates for each colour. Darker colours will tend to heat up faster (absorb heat better) than lighter colours.

Activity Two

1. **a.** The rate of temperature rise will decrease, and the water will stop getting warmer. If the cloud persists, the water may start to cool.

   b. If the air temperature (ambient temperature) is greater than that of the water, the air will gradually warm the water. But the air can't make the water any hotter than itself. When the air temperature drops, the water will cool until it is no warmer than the air.

2. **a.** The darkest tin is the top line (tin B) and the lightest tin is the bottom line (tin C). This is implied by findings from the investigation: dark colours absorb more heat than light colours.

   b. The temperature of all 3 tins started at 15°C, increased to a peak about 2 p.m., and then cooled slightly. Tin B warmed up faster and reached a higher temperature than tin A, which was faster and hotter than tin C.

   c. The results of your investigation should be similar, but the slope of the lines will vary depending on the colours used, the volume of water, and exactly how sunny the day was. On a really hot, sunny day, water temperatures will increase rapidly, while on a cool cloudy day, the temperatures may not change much at all.

   d. The data was gathered over time (from a series of observations), so it is best shown as a time-series graph (a particular type of line graph). The 3 series or data sets (the different tins) can conveniently be plotted on the same set of axes.

Activity Three

1. **a.** All the tins cooled down to the same temperature (17°C). (This would have been the ambient [air] temperature, which was slightly higher than the initial water from the tap.)

   b. The larger tins didn't heat up quite as much as the smaller tins – the maximum temperature was 30º (compared with 37º). The next morning, the temperature of the water was slightly higher than that of the initial tap water, which suggests that the ambient temperature was about 17°C in the morning.

2. **a.** Graphs will vary, but they should be similar in shape to the graph shown.

   b. The actual temperatures that you record will depend a lot on your local weather conditions; your tins may be hotter or cooler. The lines on your graph should look similar to those on Chichang's graph, but their slopes will vary depending on how sunny the day was. (On very hot, sunny days, the tins will absorb more heat, with the result that water temperature will increase much more rapidly.)

3. If you wanted maximum warmth, you could paint the roof a dark colour. If you wanted your house cool, you could paint the roof white or silver.
4. What we see as colour is a measure of how well the surface reflects light.

   If light of all wavelengths is absorbed, none comes back to the viewer, so the surface appears black. If all wavelengths are reflected, all light bounces off the surface and right back at the viewer, so the object appears white.

   This is why the Moon, which doesn't generate any light of its own, appears white in the sky but goes "away" during the lunar cycle. When the rays of the Sun reach the Moon, the Moon reflects them back to us. When the Moon moves behind Earth (it's in Earth's shadow), no light is reflected back to Earth and the Moon blends into the black night sky.

For coloured objects, only some wavelengths are reflected and we see only those. Different wavelengths have different colours.

To summarise: light-coloured objects are light because their material is reflecting almost all wavelengths, so very little light is absorbed by (and therefore heats) the material. Dark-coloured objects reflect almost no light, so most of it is absorbed as heat.

Notes

Preparation

Try to find a spot that gets consistent sunshine throughout the day. Alternatively, run the experiment indoors using 3 identical desk lamps, each focused on a different tin.

The tins should be the same size, of the same material, and painted with acrylic art paint or tightly wrapped with coloured material. They need to be covered by lids made of foil or plastic wrap, with the same kind of lid for each tin. For **Activity Three**, catering tins are suitable containers.

The 3 colours need to be quite distinct; the darkness is more important than the shade. For example, 3 blue tins are fine as long as one is very light blue, one medium blue, and one very dark blue.

The students should ensure that the sides of the tins, not just the foil, receive plenty of sun. The foil will reflect light and heat away from the water (have an insulating effect).

This is a practical activity that will require students to work well together, listen actively, and contribute ideas. As they do so, they will be using and developing the key competency *participating and contributing*.

Points of entry: Mathematics

This activity exemplifies the stages of the statistical enquiry cycle: problem (Does colour affect heat absorption?), plan, data gathering, analysis, and conclusion. Reinforce this framework with your students at every opportunity. They won't always go through the complete cycle, but they should always be able to see how what they are doing fits into it.

Once the students have done the observations in the Investigation, they graph their data and are challenged to look for and interpret patterns. A pattern is a line of any kind, a cluster or clusters of any kind, any regular/repeating feature. Where there is a pattern, there is something interesting going on – there must be a cause. Learning to look for patterns and possible explanations is a crucial part of statistical learning.

In this context, the students create a time-series graph and are given two others. In all 3 graphs, the data points for each tin form a line. These lines rise at different rates as they go from left to right. In the third graph, the lines head downwards at the end. In no case do the lines in a graph cross each other. These are the patterns that all students should be able to identify and describe.

Interpreting the patterns involves going a step further. A rising line always means that the variable (in this case, temperature) is increasing; a descending line means it is decreasing. The steeper the line, the faster the increase or decrease. If a line is horizontal, the variable is constant (not changing). When interpreting graphs, the student needs to know the context and read the labels on the axes.

In each of the 3 graphs in this activity, one line climbs higher and faster than the others; this line represents the temperature of the darkest coloured tin. Not only does this tin get hottest, it gets hotter faster. It is very important that students can relate the lines to what is happening to the water in the tins.

Have the students compare their results with those of other groups and try to explain any differences. (Did some groups position their tins next to a light-painted wall that was radiating extra heat? Did some sit their tins on grass and others on concrete? Did groups use different paints? Did groups take water from different taps?) You could use this to discuss the idea of fair testing (see the glossary in *Forces*). Ask *How would changing [a particular variable] affect the results?*

Points of entry: Science

Tap into the students' prior experience of colour and heat absorption. Ask: *On a very hot day, what is it like walking barefoot on asphalt/concrete, light concrete/dark concrete? Why is white a good colour to wear on a very hot day? Why are so few houses painted in dark colours?*

See the answers for an explanation of why dark colours absorb light and light colours reflect light. Relate this to the students' experience of the glare that comes off very white surfaces when the sun shines directly on them.

Probe the students' ideas about heat transfer. *Ask How is the water getting heated inside the tins?* (The sunlight heats the surface of the tin by radiation, and then the warm metal heats the cool water by conduction.) This difference can be illustrated by holding your hand near a light bulb (radiant heat) and then touching the body of the lampshade (conduction).

In **Activity Three**, the students should discover that the large tin did not get as hot as the smaller container. Large volumes heat more slowly.

As a science extension, students could investigate some of the interesting properties of water. It has a high specific heat, which gives it relatively unusual heating properties. It is slow to heat up and slow to cool down, and at phase changes (freezing or boiling), it maintains a constant temperature. That is, once it starts to boil, it remains at 100º Celsius until it is completely boiled away.

Page 21: Building an Eco-house

Mathematics and Statistics Achievement Objective

- Number strategies: Use simple additive strategies with whole numbers and fractions (Number and Algebra, level 2)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objectives

- Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)
- Earth systems: Explore and describe natural features and resources (Planet Earth and Beyond, level 2)

Mathematics and statistics context

Students will:

- add and subtract whole numbers.

Students should discover that:

- to win, the sum of the squares they land on must be greater than or equal to zero.

Science context

Students will:

- use a game to explore ways of responsibly using resources and caring for the environment.

Students should discover that:

- actions may be good or bad for the environment.

Notes

Game

Points of entry: Mathematics

As students play, ask them to think metacognitively (think about their thinking). Ask: *What strategies are you using to add or subtract after each square? Which numbers are easier to add or subtract?*

Check that your students know what to do if they end up in the negative numbers. For example, ask: *What would happen if you had no points and you landed on square 28?* They do not need a formal knowledge of integers (which are introduced in level 4); all they need is a way of keeping a tally of what they "owe" if they lose all their "credit".

Remind students about fair dice rolls. They should all have an equal probability of landing on any square.

Points of entry: Science

Ask students why some squares are positive (gain points) and others are negative (lose points). Ask them to judge whether the "punishment fits the crime". In other words, *Are the points values a good measure of the environmental impact?* Another way of putting this is: *Why might buying iron for a roof be worse than buying straw for insulation? Why does buying straw for insulation lose points?* [It still costs money to buy.] *Why does draining a swampy area lose points?* [It can destroy the wetland environment that wildlife depends on.] *Why does planting native tree seedlings collect lots of points?*

Students can identify which penalties seem the fairest and justify them. For example, *Should putting compost on a garden be worth fewer points than giving a talk on eco-houses?*

Pages 22-23: Adobe Bricks

Mathematics and Statistics Achievement Objectives

- Measurement: Use linear scales and whole numbers of metric units for length, area ... (Geometry and Measurement, level 3)
- Number strategies: Use a range of additive and simple multiplicative strategies with whole numbers, fractions, decimals, and percentages (Number and Algebra, level 3)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objectives

- Investigating in science: Ask questions, find evidence, explore simple models, and carry out appropriate investigations to develop simple explanations (Nature of Science, level 3)
- Properties and changes of matter: Observe, describe, and compare physical and chemical properties of common materials and changes that occur when materials are mixed, heated, or cooled (Material World, level 2)

Mathematics and statistics context

Students will:

- multiply and divide to find quantities of bricks for given lengths, heights, and areas.

Students should discover that:

- area is the product of length by width; volume is the product of length by width by height.

Science context

Students will:

- make adobe bricks and investigate how different cultures use mud bricks.

Students should discover that:

- the composition of ingredients in the bricks changes their material properties.

Answers

Activity One

1. Investigations will vary. Cultures that used mud bricks include ancient Egypt, Rome, Sumeria, and Native Americans (especially Peruvian pyramid builders). Mud bricks are still an important building material in many parts of the world.
2. Bricks and recipes will vary.
3. The number of bricks needed will depend on their size.

Activity Two

1. **a.** If the bricks are laid lengthwise, 47 will be needed (1 400 ÷ 30 = 46.67).

   b. 25 rows. (250 ÷ 10 = 25)
2. **a.** One suitable estimate would be 50 x 25 = 1 250. (50 is the nearest tidy number to 47. 4 x 25 = 100, so 40 x 25 = 1 000; 10 x 25 = 250, so 50 x 25 = 1 000 + 250 = 1 250. Estimating 50 bricks per row leaves 3 "spares" per row,

which allows for breakages. This may not be enough if the bricks break easily.)

b. Your estimate and method may be different from that provided. Make sure that you can explain how you used your answers to question **1** to come up with your estimate.

3. At $3.50 per brick, 1 250 bricks would cost $4,375.

Notes

Preparation and points to note

Before the students start this activity, you may want to experiment yourself to find the best mix of ingredients.

Making the bricks requires the students to work together on a practical project that may throw up unexpected challenges and problems. To progress, they will need to share their ideas. The solutions will not necessarily come from the student who is a natural leader or the most talkative! The key competency *participating and contributing* is suggested as a suitable focus.

Points of entry: Mathematics

The various tasks in these activities involve "how many …?" questions. There are two complications to be aware of: the units of measurement are not all the same, and the numbers don't always go into each other exactly.

The flooring question lends itself to a tiling approach. It may help to measure or mark off an area of floor or asphalt that is 2 m by 1 m. One or more mud bricks or brick-sized cardboard rectangles will help students who need the support of materials. If necessary, encourage them to move from a 1-brick-at-a-time additive strategy to a multiplicative strategy and to generalise their method. They could apply their generalised method to bricks of different dimensions.

The students need to work with both centimetres and metres. In this case, it is probably easier to use centimetres as the working unit. Understanding how common metric units relate to each other is crucial when it comes to making sense of most tasks that involve measurement and estimation. A metre ruler is the single most useful benchmark; if students can clearly visualise its size and its divisions into centimetres, this will help them in countless mathematical and real-life situations.

What if a length is not a tidy multiple of the corresponding brick dimension? In such situations, the students need to get into the habit of going back to the practicalities of the context: is 1 under or 1 over the best choice? Clearly, in this case, Daniel and his dad don't want a gap at the end of every other row where a whole brick won't fit, so wherever they need a part-brick, they will have to use a whole brick and chip the required length off it. In contrast, in most packing-type problems, "1 under" is the correct decision because it is not usual to cut items to fit them in a box and you can't fit more items into a box than the box will hold.

The estimation exercise involves making a number of assumptions, including what allowance to make for breakage. The students could end up with quite different estimates. Some estimates are likely to be better than others; what matters most is that the students can provide a rationale for their estimate and that they can articulate this rationale to another student or group.

Relate the brick dimensions to area and volume. Ask: *Does the orientation of the bricks matter? What assumptions did you or Daniel's dad make about the orientation of the bricks in the wall?*

Points of entry: Science

The students should try to compare the properties of bricks made with different proportions of ingredients and in different sizes. Ask: *What are the important properties of bricks? Why should bricks all be the same size? Why not make bigger bricks?*

Making good mud bricks is not as simple as it might seem. The students should discover that not all "mud" (clay) has suitable qualities. Excess water is likely to cause cracks. Air temperatures and drying speed are important factors. These variables can be investigated scientifically. For example, to find out how long it takes for bricks to dry right through, a brick could be "sacrificed" (split in two) each week. Data should be kept of any investigation. This could be used as part of a class or school display.

Possible further investigations include: Why are mud bricks often regarded as eco-friendly? Are mud bricks a real option for New Zealand, or are they unsuitable in an environment that receives a lot of rain?

Page 24: An Eco-kennel

Mathematics and Statistics Achievement Objectives

- Number: Use a range of … simple multiplicative strategies with whole numbers … and percentages (Number and Algebra, level 3)
- Measurement: Use linear scales and whole numbers of metric units for length, area, volume and capacity … (Geometry and Measurement, level 3)
- Measurement: Find areas of rectangles and volumes of cuboids by applying multiplication (Geometry and Measurement, level 3)

Mathematics standards. The approaches and thinking that students demonstrate as they engage with these tasks and problems can provide evidence in relation to the mathematics standards.

Science Achievement Objectives

- Participating and contributing: Explore and act on issues and questions that link their science learning to their daily living (Nature of Science, level 2)
- Chemistry and society: Relate the observed, characteristic chemical and physical properties of a range of different materials to technological uses and natural processes (Material World, level 3)

Mathematics and statistics context

Students will:

- make a scale drawing of an eco-kennel to suit a given volume
- scale up the drawing by specified percentages.

Students should discover that:

- volume is length by width by height
- increasing dimensions by 50% or less can double the volume of a cuboid.

Science context

Students will:

- investigate suitable materials for a sustainably constructed kennel
- use information to make informed decisions about the design of an eco-kennel.

Students should discover that:

- choices about building materials have a potentially large impact on the environment.

Answers

Activity

1. Your ideas about suitable materials will vary, but they should be fit for the purpose and be sustainable. For example, you might decide on recycled corrugated iron for the roof. Make sure that you have a good reason for each choice of material.
2. a. Designs will vary. Perry is 45 cm long, 30 cm high, and 20 cm wide, so he will occupy a space 45 x 30 x 20 = 27 000 cm^3. The kennel must have a door that he can fit through (a bit bigger than 30 cm x 20 cm) and be large enough for him to lie down in. A possible kennel might be a box shape measuring 60 x 40 x 30 cm. Your design should indicate the materials for each part of the kennel.

   b. The volume of his kennel is the product of the 3 measurements. If his kennel is 60 x 40 x 30 cm, the volume is 60 x 40 x 30 = 72 000 cm^3.
3. Answers will vary, depending on the size of the kennel you have designed for Perry.

   If Perry's kennel is 60 x 40 x 30 cm as in the example for **2b**, the dimensions for Tosh's kennel will be:

   length: 60 x 150% = 60 x 1.5 = 90 cm

   height: 40 x 120% = 40 x 1.2 = 48 cm

   width: 30 x 120% = 30 x 1.2 = 36 cm.
4. Yes: Tosh's kennel will be twice the volume of Perry's (a bit more than twice, actually). This will be true whatever the size of the kennel that

you planned for Perry. You can show this by multiplying the dimensions for Tosh's kennel and comparing the result with the volume of Perry's kennel. (Using the example from question **3**, Tosh's kennel would have a volume of 90 x 48 x 36 = 155 520 cm^3. This is more than double 72 000 cm^3, which is the volume of Perry's kennel.)

Notes

Preparation and points to note

Some students may need the help of materials when working with volumes. Help them to find the volume for rectangular prisms such as different-sized cereal boxes or shoe boxes. Check that your students' understanding of percentages is sufficient for them to be able to increase dimensions by 20 and 50 percent.

This activity uses terms such as volume, percent, and the symbol %. Students take time to build up understanding of the abstract concepts embodied in these terms, and they need multiple opportunities to do so. A suitable key competency focus is *using language, symbols, and texts*.

Points of entry: Mathematics

In this activity, volume is described as length by height by width. It might just as easily be described as length by width by height, as it is in the previous activity. You could use this to discuss with the students why the order doesn't matter (as long as it's used consistently in the same context): the volume is the same, regardless of whether it is 45 x 30 x 20, 45 x 20 x 30, or 30 x 20 x 45.

Have the students visualise how big Perry is so that they can get a feel for appropriate measurements. For example, ask them to make a pile of books equal in size to Perry. Note that a 45 x 30 x 20 cm kennel will be too small because Perry needs to be able to move around inside it. The students may find it useful to mark out dimensions in chalk or use tape on the floor. Encourage them to test for reasonableness. Ask *How big should the door be?*

Your students may be tempted to introduce circular or diagonal elements into their design. Give them freedom to be creative, but suggest that they calculate the volume of a rectangular box that encloses their kennel instead of working out the exact volume of a difficult design. As a practical consideration, construction materials tend to come in rectangular pieces.

Question **3** requires the students to increase the dimensions of their kennel by 20 and 50 percent. They can think of these either as increases of $\frac{1}{5}$ and $\frac{1}{2}$ or as an increase of $\frac{1}{10}$ doubled and an increase of $\frac{1}{10}$ multiplied by 5. They should learn that an increase of 20% is represented as 120% and that 120% = 1.2.

The calculation in question **4** may require use of a calculator. Regardless of the dimensions chosen, Tosh's kennel will have a volume that is 216% of Perry's. In other words, the bigger kennel will have 2.16 times the volume of the smaller kennel. You could invite discussion on what is meant by "twice the size"; students may interpret this in different ways (for example, as twice the height). You could also discuss whether it is correct to say that Tosh's kennel is "twice the size" of Perry's when, technically, it will be 2.16 times the size.

[***Note for teachers***. The extent of the increase can be found by the multiplication 1.5 x 1.2 x 1.2 = 2.16. However, you don't need to tell your students this as it involves unnecessary abstraction at a time when most students are still trying to work out how to apply percentages in simple, practical contexts.]

As an extension, the students might try to work out how much of each material they would need to buy (bearing in mind that they would be using recycled materials, if available), find out prices, and then work out the cost of their kennels.

Points of entry: Science

Consider introducing this activity by picking up on the speech bubble "conversation" in the students' book. The prefix "eco-" is often tacked onto things (including houses) as a marketing ploy. Have your students discuss in groups what "eco" might mean in this context and then share their ideas with the wider class.

This activity could be made into a challenge by restricting the type and amount of materials. Encourage the students to draw on expertise and understanding gained from previous activities in making their decisions. They will need to discuss and identify the needs of the dog before making any decisions; this investigation could form part of the design brief and/or the basis for a set of criteria against which to check their design. (Similar processes are followed in technology.)

In question **1**, the students brainstorm requirements for an eco-kennel (it should protect the dog from the elements, be relatively inexpensive to make, use sustainable materials, and so on). Encourage them to research eco-houses, what materials are best suited to their construction, and how they compare in cost with more conventional materials.

Discuss with the students the fact that good scientists make sure that their decisions are informed by evidence. Ask the students probing questions so that they justify their decisions about their eco-kennels. For example, "I chose recycled plastic for the roof because it needs to keep the rain off, and I chose a straw-filled cotton mattress for the floor because it's cheap, organic, and comfortable."

I have a ☆. How can you reuse a jam jar?	**Store pens and pencils in it.** How can you recycle apple peel?	**Feed it to the worms in the worm bin.** How can you reuse a cardboard milk container?
Grow seeds in it. How can you reuse your washing-up water?	**Use it to water outdoor plants.** How can you reuse the coat you have outgrown?	**Hand it on to a younger person.** How can you cut down on the amount of plastic shopping bags going to the landfill?
Take your own recyclable bags when you go shopping. How can you reduce the amount of paper you use?	**Use both sides of the paper.** How can you reduce the amount of waste when you buy a hot takeaway chocolate?	**Ask for a biodegradable cup.** What can you do when the brakes on your bike wear out?
Replace the brakes rather than buying a new bike. What warm clothing can be made from recycled plastic drink bottles?	**Fleecy jackets** What can be made from recycled newspapers?	**Egg cartoons and packaging** What type of batteries can be used many times?
Rechargeable batteries How can you reuse an envelope?	**Stick a label over the address.** How can you reuse packaging such as foil and wrapping paper?	**Donate them to a school or kindergarten where they can be used in art and craft projects.** How can you reuse old clothes?

Make them into other items, such as cushion covers.

How can you reuse an old tyre?

Make a tyre-swing by tying a strong rope around the tyre and attaching it to a tree or a frame.

How can you reuse wood scraps?

Use them to make simple wooden objects, such as a bird box or a trolley.

How can you recycle eggshells and used tea bags?

Add them to a compost bin to make new soil for your garden.

How can you reuse worn-out furniture?

Mend any broken parts and repaint them in bright colours.

How can you recycle glass?

Separate it into brown, clear, and green and take it to a recycling centre.

What can you do with waste oil when the car needs an oil change?

Find an oil recycling company and deliver it to them in a container.

Can you recycle printer cartridges?

Yes, if they can be refilled.

How can you recycle old pantihose?

Use them to tie up plants in the garden.

How can you reuse cracked or chipped crockery?

Use them as plant pots or trays beneath your pot plants.

Can you recycle your flower plants when they have gone to seed?

You can collect and dry the seeds to plant next year.

How can you reuse plastic bags?

Use them to line your kitchen waste bin.

How can you reduce the volume of plastic containers you use?

Use refill packs of cleaners and detergents.

What happens to the aluminium cans that you throw in the recycling bins?

They get melted down and made into new cans.

How can you reuse an old carpet?

Use it to cover a worm farm, to keep warmth in and rain out.

Who has a ☆?

Game words (put on A3 paper or card)

water	air
environment	recharge
repair	reuse
recycle	reduce
waste	conservation

resources

renewable

non-renewable

biodegradable

inorganic

Scram! Word Meanings

Replace used-up power
Replace or mend a faulty part
Cut down the amount of rubbish we produce
Decomposes or breaks down
Protecting the environment and natural resources
A liquid that animals and plants need to live
Use waste materials to make new products
What we need to breathe
Can't be replaced after it has been used
Not part of the animal or vegetable kingdom
Can be replaced by growing, making, or collecting more
Use more than once
Materials or energy from the environment that are used to meet human needs or wants
The world we live in
Any material that is discarded

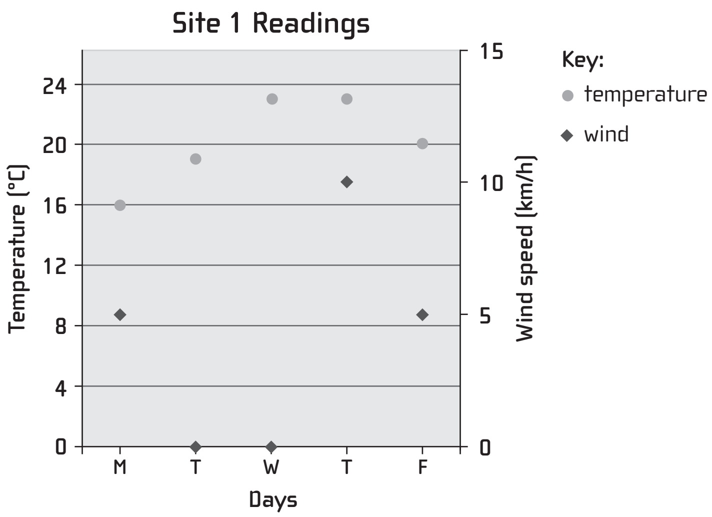
Scram! Judge's sheet

Word	**Winning group**
water	
resources	
air	
renewable	
environment	
recharge	
reduce	
repair	
reuse	
biodegradable	
non-renewable	
waste	
recycle	
conservation	
inorganic	

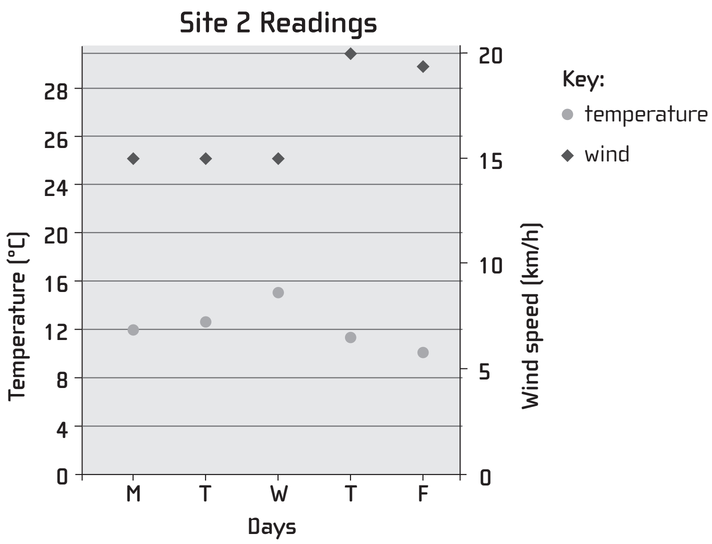
Replace used-up power	Water	Can't be replaced after it has been used
Replace or mend a faulty part	Resources	Not part of the animal or vegetable kingdom
Cut down the amount of rubbish we produce	Air	Can be replaced by growing, making, or collecting more
Decomposes or breaks down by bacteria	Renewable	Use more than once
Protecting the environment and natural resources	Environment	Materials or energy from the environment that are used to meet human needs and wants
A liquid that animals and plants need to live	Recharge	The world we live in
Use waste materials to make new products	Reduce	What we need to breathe
Any material that is discarded	Repair	
	Reuse	
	Biodegradable	
	Non-renewable	
	Waste	
	Recycle	
	Conservation	
	Inorganic	

Copymaster: Location, Location ...

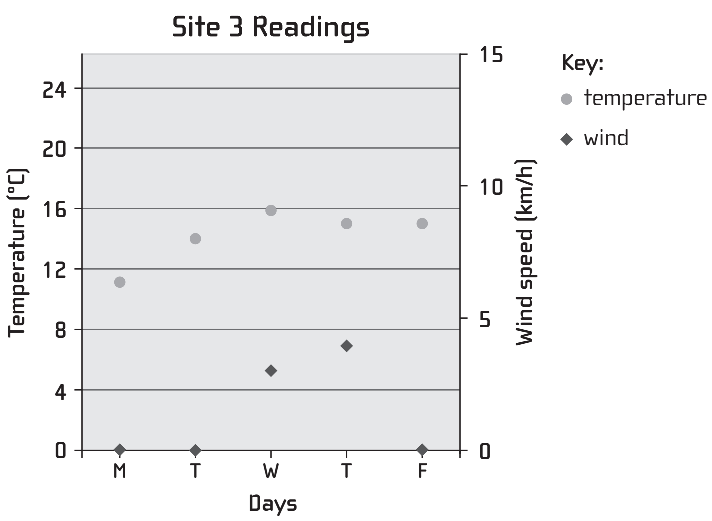
Site 1 (Jazmyn)		
Day (3 p.m.)	Temperature (°C)	Wind speed (km/h)
Monday	16	5
Tuesday	19	0
Wednesday	23	0
Thursday	23	10
Friday	20	5



Site 2 (Dembe)		
Day (3 p.m.)	Temperature (°C)	Wind speed (km/h)
Monday	12	15
Tuesday	13	15
Wednesday	15	15
Thursday	11	20
Friday	10	18



Site 3 (Liam)		
Day (3 p.m.)	Temperature (°C)	Wind speed (km/h)
Monday	11	0
Tuesday	14	0
Wednesday	16	3
Thursday	15	4
Friday	15	0



Copymaster: Adobe Bricks

Recipe

You will need:

- a space outside that can get a bit messy
- a garden sieve and a mallet
- clay soil that has been dried and then sifted (a small bucketful)
- sand
- water
- dried grass or straw
- small moulds approximately 15 cm x 8 cm x 8 cm.

Method:

i. Sieve the clay soil and return the remaining debris to the ground.

ii. With the mallet, beat half the sieved clay into a powder.

iii. Mix equal amounts of the powder and sieved clay with some straw.

iv. Slowly add water until it is a very thick (but not too wet) mud pie.

v. Push the mixture into the mould and press really hard all over.

vi. Leave your brick on a sunny shelf for a day, then remove it from the mould. Leave it on the shelf for another week.

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Te Tāhuhu o te Mātauranga

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