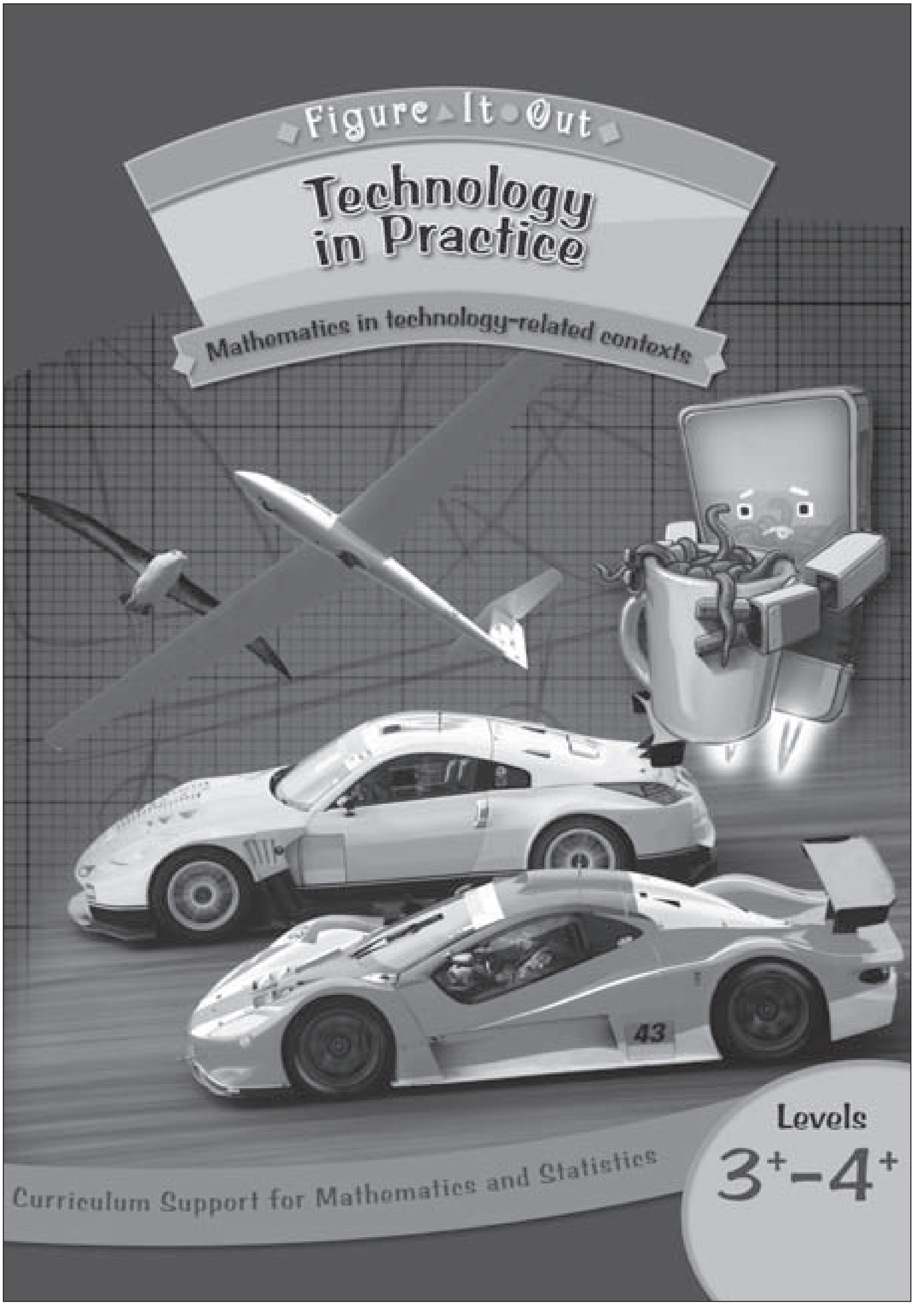
MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

Teacher Support Material
(including Answers)



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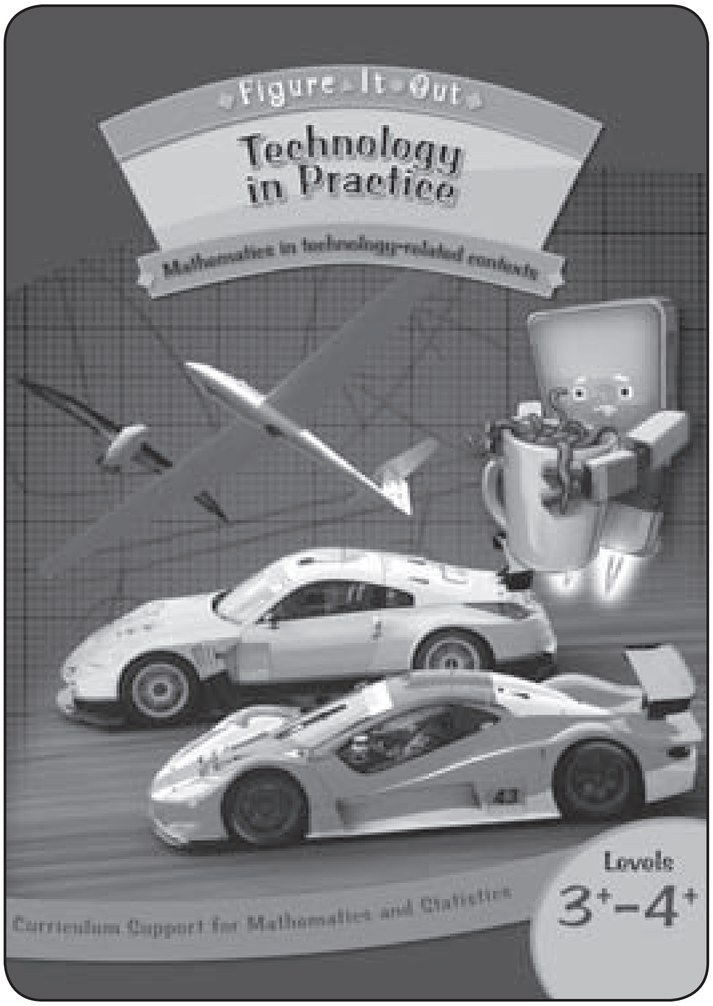
Teacher Support Material
(including Answers)



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 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 3^+–4^+ *Technology in Practice* book reflect the ethnic and cultural diversity and the life experiences that are meaningful to students in years 6–8. However, you should use your judgment as to whether to use the student 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 the mathematics and the technology-related context, as well as suggestions on teaching approaches. The *Teacher Support Material (including Answers)* for *Technology in Practice* can also be downloaded from the nzmaths website at www.nzmaths.co.nz/node/1992

Using Figure It Out in the classroom

Where applicable, each page of the student 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

Technology in Practice

Teacher Support Material (including Answers)

Overview of Technology in Practice, Levels 3+–4+			
Title	**Focus**	**Page in students' book**	**Page in support material**
Building Specs	Drawing views of three-dimensional structures	1	6
Safety in Numbers	Exploring prime factors and algorithms	2–3	8
Winging It	Estimating area and using ratios	4–5	10
Looking for Lift	Exploring ratio and measurement	6–7	13
Making Tracks	Using information from tables and diagrams	8–9	16
Speed Sailing	Using statistics to evaluate performance	10–11	18
Bouncing Back	Using graphs to determine relationships	12–13	20
Emergency Shelters	Exploring area and interpreting diagrams	14–15	23
Paralympic Power	Working with time, distance, and speed	16–17	26
Penguin Properties	Interpreting diagrams and describing locations	18–19	28
Worms at Work	Using ratios and calculating volume	20–21	31
Dynamic Darts	Using measurement data to improve designs	22–24	34

Introduction to the Technology-related Contexts

The contexts surrounding these mathematical activities are based on technology – its practice, body of knowledge, and relevance to society. As they engage with the activities, students may be inspired to further investigate a particular technological principle or issue.

While further investigation is encouraged, it should be remembered that the technology learning area has its own set of objectives. So before using any of these activities as part of your technology programme, refer to the technology learning area of *The New Zealand Curriculum*. In your technology programme, you need to give your students opportunities to engage in effective technological practice and to enhance their technological literacy.

For information on how to construct effective and exciting units of work, Techlink (www.techlink.org.nz) is an excellent resource. It provides in-depth analysis of what technology education is all about, along with case studies, examples of student work, and teachers' inspiration.

Support for English Language Learners

Many students, including English language learners, need support in meeting the language demands of the curriculum. You can help them by identifying the language demands of particular activities before you begin teaching and by scaffolding tasks so that all students can participate fully.

As you and your students work with the activities, you can support them by providing:

- opportunities to notice language in context
- explanations, illustrations, and examples of language
- opportunities to encounter the same information many times and in many different forms (to hear it, see it, touch it, read it, say it, write it, draw it)
- opportunities to encounter language (through listening and reading) as well as to use it (in writing and speaking) in the context of the activities
- language-focused activities that are meaningful and contextualised.

After focusing on language in the given context, you will want to keep revisiting the same language in other contexts.

You may need to provide English language learners with any culturally specific prior knowledge needed for the activities. You will also want to ensure that you find out about and make links to their prior knowledge, including cultural and linguistic knowledge.

All of the activities make multiple language demands. This support material includes strategies for supporting learners with selected English language demands for some mathematics activities. You can adapt and apply these strategies to support students with other language needs that you identify.

In this support material, the activities with support for English language learners are:

- Page 1: Building Specs: Supporting students with the language needed to express obligations
- Pages 4–5: Winging It: Supporting students with topic-specific vocabulary
- Pages 6–7: Looking for Lift: Supporting students with topic- and subject-specific vocabulary
- Pages 22–24: Dynamic Darts: Supporting students with writing a report to explain a process.

Some other useful resources are:

The English Language Learning Progressions (This was sent to all schools in 2008. PDFs of the four booklets are available online at http://esolonline.tki.org.nz/ESOL-Online/Student-needs/The-English-Language-Learning-Progressions)

Supporting English Language Learning in Primary Schools: A Guide for Teachers of Years 5 and 6 (SELLIPS). For information about ordering a PDF of this booklet, go to http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Supporting-English-Language-Learning-in-Primary-School-SELLIPS

Making Language and Learning Work 3: Integrating Language and Learning in Years 5 to 8 (DVD). For more information, see ESOL Online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Making-language-and-learning-work-DVDs

The Focus on English resource is designed to help teachers provide language support for mathematics, science, and social studies in years 7–10. It is available online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Cross-curricular/Focus-on-English

Principles of effective teaching and learning for English language learners, available online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Pedagogy/Principles-of-effective-teaching-and-learning-for-English-language-learners

ESOL Online at www.esolonline.tki.org.nz

Teacher Support Material (including Answers)

Page 1: Building Specs

Achievement Objective

- Shape: relate three-dimensional models to two-dimensional representations, and vice versa (Geometry and Measurement, level 4)

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. For example:

- Draw plan, front, side ... views of objects (Geometry and Measurement, year 7).

Developing students' mathematical understandings

Spatial-visualisation skills are important in many technical and scientific occupations. Reading, making, and using diagrams are good ways for students to develop these skills.

In this activity, students make "buildings" that meet certain specifications and then draw visual representations of the buildings they create.

Exploring the technology-related context

Some people confuse attributes with specifications. Attributes are the general properties of a product. A coat can be waterproof, warm, or colourful. A car can be fuel-efficient and a meal can be nutritious. Specifications are measurable. A camera may have 4.9 million effective pixels, an aeroplane engine may produce 160 horsepower, and a biscuit may have 280 kilojoules. Attributes and specifications are linked. For instance, to evaluate the healthiness of a meal, a dietician could identify the kilojoule, salt, and fat content.

Vocabulary alert

architects, engineers, specifications

Answers

Activity

1.–3. Practical activity

Mathematics and Statistics Notes

Many students enjoy working with multilink cubes. Spatial skills are needed to draw two-dimensional representations of three-dimensional objects. Closing one eye when viewing the building from the side, top, or front can help students to "see" the view as two-dimensional, making it easier to draw.

Most students will need to make the buildings shown in their classmate's drawings in order to identify which specifications have been met. Students with highly-developed spatial skills may be able to use visualisation alone.

Related activities from the Figure It Out series include Cube Creations (page 13) and Building Boldly (page 14) in the level 3–4 *Geometry* book.

Creating two-dimensional representations of three-dimensional objects develops the key competency *using language, symbols, and texts*.

Extension

Show students how to create drawings of buildings on isometric dot paper. Isometric paper is readily available on the Internet. See A Chip off the Old Block (*Geometry*, level 3, page 10) for a good introductory activity.

Support for English Language Learners

Supporting students with the language needed to express obligations

English language learners may benefit from support with understanding and expressing obligation using *must* and *mustn't*.

Discuss specifications and provide examples of stated requirements, for example, *Your presentation must be …, Your project must have …* Ask the students which word signals that the requirements are compulsory. Draw attention to the use of *must + base form of the verb* and note that, in this context, the main verb is usually *be* or *have*. Prompt students to provide further examples from a range of contexts. Include the negative form *mustn't*.

Students who need a lot of support with writing specifications may benefit from sentence starters. For example:

The building must be ______________________________

The building must have ____________________________

It's a good idea to use only one or two ways of expressing obligation at a time and not a range of contrasting meanings and forms (for example, structures with *can*, *may*, or *should*). In addition, note that structures with *must* can also express probability but, again, it's generally most useful to focus on one meaning at a time.

Technology-related student activities

- Research items such as cars, cameras, and watches to increase awareness of what is meant by technical specifications.
- Build a bridge that meets certain specifications (see www.wow4water.net/grownups/resources/8).

Pages 2–3: Safety in Numbers

Achievement Objectives

- Number strategies and knowledge: Use a range of multiplicative strategies when operating on whole numbers (Number and Algebra, level 4)
- Number strategies and knowledge: use prime numbers, common factors ... (Number and Algebra, level 5)

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. For example:

- use multiplication and division as inverse operations on whole numbers (Number and Algebra, year 8).

Developing students' mathematical understandings

Number theory is a branch of mathematics that explores the properties of numbers. Examples of properties of numbers include whether the number is odd, even, a square number, a multiple of another number, or a prime.

Number theorists have played an important role in developing systems to protect the security of online transactions.

In these activities, students see how properties of numbers can be used to create encryption keys.

Exploring the technology-related context

Security of online transactions is a major issue for e-commerce. People need to protect their finances, intellectual property, and privacy from criminals who have access to increasingly sophisticated software. One way to thwart hackers is to encrypt electronic data.

A more traditional security device is the use of a password or passcode. Strong passwords are typically a combination of numerals and letters and do not resemble actual words.

Passwords are often required to access emails, networks, files, databases, websites, blogs, and bank accounts. Added to these are passcodes for ATM, mobile phones, and access to buildings. Remembering all these passwords and passcodes can be problematic.

Vocabulary alert

online, e-commerce, security, privacy, credit card, computer hackers, encryption, prime numbers, decrypt

Answers

Activity One

1. **a.** **i.** 84. (42 x 2)
ii. 35
iii. 5
iv. 124

b. 6. (124 + 6 = 130)

2. **a.** Answers will vary depending on the number changed.

b. Answers will vary depending on the numbers swapped.

Activity Two

1. A prime number has exactly 2 factors (1 and itself).

2. **a.** **i.** 1, 2, 5, 10
ii. 1, 3, 5, 15
iii. 1, 3, 11, 33
iv. 1, 5, 13, 65

b. Each number has 4 factors, 2 of which are primes.

c. Answers will vary. Possible answers include: 6, 14, 21, and 55.

3. a. i. 527
      ii. 13 and 47
   b. The first one is easier – you only have to do the multiplication on a calculator. In the second problem, you need to investigate lots of possibilities to find the answer.

4. a. 437 ÷ 19 = 23
   b. 2 909

5. Practical activity

Mathematics and Statistics Notes

In these activities, students investigate credit card security using number strategies, prime numbers, and factors.

Begin by discussing "properties of numbers". For example, 10 is positive, even, and divisible by 1, 2, 5, and 10. 3 is odd, positive, and a prime.

Activity One

In this activity, students use an algorithm, which is a series of instructions used in mathematical applications, to complete a task or problem. Students can work in small groups or individually.

Barcodes use a different algorithm. The 13th digit used on book barcodes is the check digit. Here is how it is calculated:

Barcode digits	9	7	8	0	7	9	0	3	3	8	0	8	8
	x 1	x 3	x 1	x 3	x 1	x 3	x 1	x 3	x 1	x 3	x 1	x 3	
	9	21	8	0	7	27	0	9	3	24	0	24	

The 12 products are added (132). The 13th (check) digit is the number needed to bring this total up to the next multiple of 10. (132 + 8 = 140, so the check digit is 8).

Note that this algorithm can also be described as follows: find the sum of the digits in the even positions and multiply by 3. Add on the sum of the odd digits. Divide the result by 10 and subtract the remainder from 10 to get the check digit.

It is satisfying to know the "trick" that is used to work out a check digit. Encourage students to verify these algorithms using an actual credit card and a book barcode.

Activity Two

As this activity demonstrates, primes are remarkably hard to find when buried in a large number, particularly when the large number is the product of two primes. This elusiveness gives them a strange power – a power that has led to their harnessing for cryptography purposes.

For numbers of 100 and less, the Sieve of Eratosthenes can be used to identify prime numbers. This sieve is available at http://nzmaths.co.nz/resource/sieve-eratosthenes. If your students have not come across this tool before, it will provide a good introduction to this second activity.

As they do question **3**, students will discover for themselves that while they can easily multiply two primes on a calculator, it is an entirely different matter to be given the product of two primes and have to find its factors. The bigger the product, the harder the task.

Like primes, cryptography is a fascinating subject. Briefly, the most common type of cryptography used for web-based transactions is "public key – private key" cryptography. The public key is made available to anyone who may need it and is used to encrypt a message before sending it. The matching private key is in the hands of the individual or organisation for whose eyes the message is intended and is used to decrypt (unscramble) the message.

One analogy is a locked letterbox. Anyone can drop a letter into the box (the "public key") because it is in a public location (at the gate), but only the owner can unlock it (because only they have the "private key") and retrieve and read the letter.

A second analogy concerns two people, Alex and Brenda. If Brenda wants Alex to send her a secure message, she sends him a box and an unlocked padlock (the "public key"). Alex puts the message in the box, snaps the padlock shut, and couriers it to Brenda. Because only Brenda has the matching key (the "private key"), only she can open the box and read the message.

The credit card activity is based on a similar activity from the NRICH website (http://nrich.org/public). The site provides a wide range of rich tasks and mathematical explorations.

For another Figure It Out activity involving prime factors, see Nifty Networks, found in the level 3+–4+ *Technology Transformations* book (pages 6–7).

Technology-related student activities

- Research the history of locks and other security systems.
- Research common passwords and discuss why it is not a good idea to use such words.

Pages 4–5: Winging It

Achievement Objective

- Measurement: Use linear scales and whole numbers of metric units for length, area … (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. For example:

- measure … the attributes of objects, choosing appropriate standard units (Geometry and Measurement, year 6).

Developing students' mathematical understandings

Proportion involves comparing one dimension of an object or image with another dimension or comparing the same dimension in two different objects. The emphasis is on the relationship between measurements, not the measurements themselves. Ratios can be used to quantify this comparison and can be expressed in several ways. For example, if a person's arm span is 146 cm and their height is 150 cm, this can be expressed as an arm span: height ratio of 146:150 or $\frac{146}{150}$ or just 0.97 (146 ÷ 150). In these activities, students use measurements to estimate the "aspect ratio" of bird wings and then relate their findings to aircraft designs.

Exploring the technology-related context

Technology is all about human innovation, but technologists can be inspired by nature. Birds have influenced many technological breakthroughs. For example, examining owls' wings and kingfishers' beaks helped engineers develop the Japanese bullet train.

Biomimicry has helped people to produce a number of innovative products, such as the Ultracane for the blind (imitating the ultrasonic waves emitted by bats), superadhesives (imitating the pads on gecko feet), and dirt-and water-resistant paint (imitating the leaves of the lotus plant).

Vocabulary alert

aircraft, observation, technological innovations, inspired, nature, manoeuvring, albatross, glide, falcon, soaring, aspect ratio, wingspan, estimate

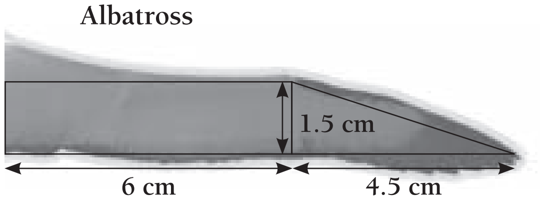
Answers

Activity

1\. **a.** **i.** Albatross image: 22 cm
Kārearea image: 15.5 cm

ii. The wing area in both images is approximately 25 cm^2.
For example:

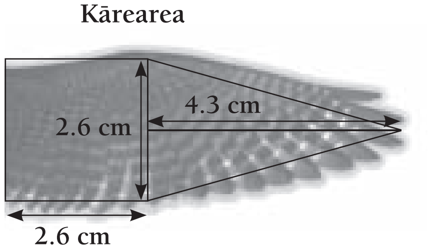
Albatross



Area of 1 wing: 1.5 cm x 6 cm + 0.5 x 1.5 cm x 4.5 cm = 12.375 cm^2

Area of 2 wings: 12.375 cm^2 x 2 = 24.75 cm^2.

Kārearea



Area of 1 wing: 2.6 cm x 2.6 cm + 0.5 x 2.6 cm x 4.3 cm = 12.35 cm^2

Area of 2 wings: 12.35 cm^2 x 2 = 24.7 cm^2.

b. Based on the area estimates above, the wing aspect ratio of the albatross is 19 (22 x 22 ÷ 25) and that of the kārearea is 9.6 (15.5 x 15.5 ÷ 25).

c. The albatross has a higher aspect ratio than the falcon, which suggests that a high aspect ratio is better for gliding.

2\. **a.** The kūaka wing has an aspect ratio of 10.2 (73 x 73 ÷ 520). This is similar to that of the kārearea and much smaller than that of the albatross.

b. The aspect ratio of a kūaka wing suggests that they flap rather than glide when flying.

3\. **a.** The plane on the right has a higher aspect ratio than the plane on the left; its wings are long and narrow.

b. This plane glides when it flies but is probably hard to manoeuvre quickly.

Mathematics and Statistics Notes

Students begin by exploring the relationship between the wingspan and the wing area of an albatross and a kārearea.

Although no two birds of the same species are exactly the same, certain relationships allow us to distinguish one species from another. One of these relationships is that between wingspan and wing area.

Albatross wings can be about 7 times longer than the wings of a kārearea, but because students are calculating the relationship between two measurements (wingspan and wing area) the size of the images (or the birds) is irrelevant. This is because the relationship between the two measurements is constant. For example, if the two wings were as depicted (same shape, different scale), the aspect ratio would be the same for both:

length x length ÷ area = 4 x 4 ÷ 8 = **2**

length x length ÷ area = 2 x 2 ÷ 2 = **2**

To further explore scale and proportion, see Faceprints in *Technology Transformations*, Figure It Out, Levels 3⁺–4⁺.

A simple way to estimate the area of each bird's wings is to draw shapes such as rectangles and triangles on one wing, find and add the area of each shape, and then multiply the result by 2 to find the total area. Even a rough estimate of area will show that the aspect ratio of an albatross is higher than that of a kārearea.

Glider wings have high aspect ratios – they are long and narrow. A high aspect ratio reduces drag, making the aircraft very efficient aerodynamically. But a high aspect ratio makes it harder to turn quickly.

Not all aircraft have wings with high aspect ratios because reducing drag is not always the priority. Designers of military fighter planes, for example, prioritise speed and manoeuvrability above aerodynamic efficiency. There are also practical considerations, such as how long and thin a wing can be before it no longer supports a load.

In question **2**, students compare the aspect ratio of a kūaka wing to that of an albatross and a kārearea. As the wing aspect ratio suggests, kūaka do indeed flap to propel themselves rather than glide. For more information on kūaka migration, see www.sciencelearn.org.nz/Contexts/Flight/NZ-Research/Flight-of-the-godwit

Exploring relationships such as these develops the key competency *thinking*.

Support for English Language Learners

Supporting students with topic-specific vocabulary

Distinguish between vocabulary that students need in order to understand this specific activity and the language they are likely to encounter in a wider range of contexts. Focus vocabulary learning on the latter. *The English Language Learning Progressions: Introduction*, pages 39–46, has useful information about learning vocabulary.

Conduct a brainstorming session on the topic of flight, using the illustrations in the student book as a starting point. This will give you information about the students' prior knowledge and vocabulary.

- Ask pairs of students to record words associated with flight, along with ideas about what the birds and/or planes have in common.
- Have the students share and display their ideas. Introduce key vocabulary as part of this discussion and record these words as well.
- Co-construct a vocabulary list and have students place the words in a table, using categories such as Things that fly, Flying, Estimating area, and Making calculations. Review the list as a class and agree on a shared version that can be displayed in the classroom.

Technology-related student activities

- Research nature-mimicking technologies (see www.explainthatstuff.com/biomimeticclothing.html for examples).
- Use a natural object or pattern as the basis for a design on a piece of clothing.

Pages 6–7: Looking for Lift

Achievement Objective

- Measurement: Use side or edge lengths to find the perimeters and areas of rectangles … and triangles … (Geometry and Measurement, level 4)

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. For example:

- use side or edge lengths to find the perimeters and areas of rectangles … given whole-number dimensions (Measurement, year 7).

Developing students' mathematical understandings

While discrete objects (such as people in a room) can be counted, continuous variables (such as length, time, angle, volume, mass, and temperature) can only be quantified (that is, measured) with the aid of a suitable device and unit.

Measurement skills include being able to use devices (for example, a ruler, a jug, a protractor, a thermometer), read scales, estimate, choose appropriate units, interchange units, round, interpret a decimal point, and assess the sensibleness of a result.

Measurement is the basis of most quantifying and most comparing. Confidence in measuring is developed over time, through experiences in many different contexts. Ideally, students extend and develop their skills in response to a need. In these activities, they need a basis for comparing the lift of two kites.

Exploring the technology-related context

Testing a technological product is an important part of the design process. The Wright brothers used kites to test the performance of gliders because the forces operating on an aircraft flown as a kite are very similar to those operating on a glider. Modern engineers use models and wind tunnels to explore flight dynamics.

Vocabulary alert

lift, force, flowing, breeze, gale, template, doubling, halving, perimeter, device

Answers

Activity

1.–2. Practical activity

3. a. Practical activity

b. If the perimeter of the kite is twice that of the smaller kite, the area will be 4 times larger. If the perimeter is halved, the area will be one-quarter of the first kite's area.

However, this relationship is only true because the shape of the two kites is identical (one is an enlargement of the other).

c. Practical activity

4. When the kite pulls on the string, the rubber band will stretch. By measuring the distance from the end of the paper clip to the brick, Hasini can compare the lift of different kites.

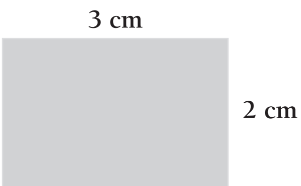
5. a–c. Methods will vary.

Mathematics and Statistics Notes

Intuitively, it makes sense that some connection exists between area and perimeter: a large shape should have a large perimeter, a small shape should have a small perimeter. If the length of each side in a shape is doubled, the perimeter will double, but the area will be four times larger. If each length is halved, the area of the resulting shape will be one-quarter that of the original. Note that this relationship only exists because the two shapes are geometrically similar.

Introduce question **3** by showing your students that the perimeter of two simple shapes with the same area can be quite different. For example, both of these rectangles have an area of 6 cm^2 but they have different perimeters:

Area = 0.5 cm x 12 cm = 6 cm^2
Perimeter = 25 cm



Area = 2 cm x 3 cm = 6 cm^2
Perimeter = 10 cm

Kite flying requires a fine day with a steady breeze. In a good investigation, variables will be controlled, but there is no way to maintain a consistent wind speed. One way around this is to measure the lift of the two kites simultaneously. Another option is to create the wind artificially, for example, using a large fan.

If the students' kites lack stability, attaching a tail (strip of paper) to the end of each straw may help.

In order to make a statistical comparison between the lift of two kites, students need to find a way to quantify lift. Aside from measurement of time, most of the students' prior experience of measurement will have involved objects that they can see or hold. Hasini's device can be used to compare the lift of two kites by measuring the length of the stretched rubber band.

Extension

Students could make and fly a small Eddy (diamond-shaped) kite or a miniature kite (see www.miniaturekiteguild.org). The latter are so small they fly at the end of just 2 or 3 metres of cotton line.

Flight, Book 17 of Building Science Concepts, provides ways for students to investigate how kites achieve lift. See also www.sciencelearn.org.nz/Contexts/Flight/Science-Ideas-and-Concepts/Wings-and-lift

Support for English Language Learners

Supporting students with topic- and subject-specific vocabulary

Introduce the topic by showing students pictures of kites from around the world, discussing their origin. Conduct a brainstorming activity with small groups recording words associated with kites on chart paper. Set an appropriate time limit.

When the allocated time is up, pair each group with another group. Groups read and discuss each other's ideas.

Encourage students who know a first language other than English to contribute ideas in this language. If possible, allow these students to explore the topic of kites in their first language (through written or audio-visual material or through discussing it with someone who shares the same first language) before beginning this activity.

Review the charts as a whole class, noting key ideas and vocabulary.

The DVD *Making Language and Learning Work 3: Integrating Language and Learning in Years 5 to 8* (Curriculum Focus, Year 7 Technology) includes an example of a class making lanterns and shows how the teacher incorporates support for language within a mainstream classroom lesson by using a similar strategy to the one described above.

Question **5** asks students to share their findings with the class. Some students, particularly English language learners, may need support and preparation time to take part. A speaking frame (similar to the writing frame on page 36 of these notes) is a useful tool.

The Focus on English resource on ESOL Online provides suggestions and resources to support learners with the language for shapes and for measurement. This resource may be useful for many of the activities in this book. See ESOL Online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Cross-curricular/Focus-on-English/Measurement

Technology-related student activities

- Investigate customary Māori kites, including their purpose and the materials used to make them (see www.tki.org.nz/r/hpe/exploring_te_ao_kori/games/kite_e.php).
- Investigate the history of kites, including how they were used by the Wright brothers (see www.grc.nasa.gov/WWW/k-12/airplane/kite1.html).

Pages 8–9: Making Tracks

Achievement Objectives

- Measurement: Interpret and use scales … (Geometry and Measurement, level 4)
- Number strategies and knowledge: Find… percentages of amounts expressed as whole numbers (Number, level 4)

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. For example:

- apply additive and multiplicative strategies flexibly to whole numbers (Number and Algebra, year 7).

Developing students' mathematical understandings

Spatial-visualisation skills are important in many technical and scientific occupations. Reading, making, and using diagrams are good ways for students to develop these skills.

Statistical literacy is the ability to read and interpret data. Statistics provides the means to organise large amounts of data in such a way that it communicates meaning. Students need to be able to interpret and evaluate the statistical information they will encounter in everyday life.

In these activities, students interpret information in a table and connect it to the context. Students also use scale and proportional reasoning to solve problems.

Exploring the technology-related context

Technologists need to understand the performance qualities of materials in order to produce goods that are fit for purpose. Manufacturers of high-performance products strive to achieve optimum design and material performance.

In motor racing, having the right tyres is essential. Weather and track conditions are an important consideration. A team using high-performing tyres will have a competitive advantage.

Vocabulary alert

material, performance, grip, budgets, oval, lap, stretch, grip, braking, cornering, tight curves, trickiest, manufacturer, underestimated, blew out, caution, overtake, compulsory

Answers

Activity One

1. Answers may vary, but the actual tri-oval course is 4 000 m long (4 km).

2. **a.** **i.** B
ii. C
iii. D
iv. A

b. The harder the compound, the faster the top speed and the slower the cornering. The most likely ranking, from hardest to softest, is: tyre 3, tyre 2, tyre 1, tyre 4.

Activity Two

1. **a.** 160 (644 ÷ 4.025)

b. About 48 km (12 x 4.025 = 48.3 km)

c. 48 ÷ 128 x 100 = 38%

2. **a.** 130–182 seconds, but it could have been more or even less.

b. No. Although we know that most tyre changes take 10–14 seconds, some might take longer. Also, each car had at least 13 tyre changes; some could have had far more.

Mathematics and Statistics Notes

Students can find it challenging to relate information in a diagram or a table to its real-life context, but being able to do this is an important skill.

Activity One

Measuring a curved object presents a challenge. Students could use a piece of string to compare the total length with the 1 200 m straight stretch. The total length is slightly more than 3 times the straight stretch. For a more precise answer, students could work out the scale of the diagram (1 cm represents 200 m). Wrapping a piece of string or a dressmaker's tape around the tri-oval course diagram will give a result of 20 cm.
20 x 200 = 4 000 m.

Working with scale diagrams helps to develop proportional reasoning. Ask your students to share the strategies they used with the class.

Activity Two

Question **1** requires multiplicative thinking. To solve $4.025 \times a = 644$ km, students need to calculate $644 \div 4.025$. They could also estimate the number of laps by using a halving strategy, for example, $640 \div 4 = 320 \div 2 = 160 \div 1 = 160$.

Question **1b** is more straightforward, requiring simple multiplication.

Question **2** can be used to discuss variation. Although most tyre changes take between 10 and 14 seconds, some will be faster or slower. We can't put an upper limit on time spent in the pit because there are two unknowns: the greatest number of tyre changes and the duration of the longest tyre change.

Technology-related student activities

- Compare the various types of tyre available for either cars or bikes. Relate the features of the different tyres to the kind of vehicle or the driving/riding that they are intended for.
- Alter the performance of a toy car, measuring the distance it travels when released from the top of a ramp. For example, increase or decrease the car's weight or change the surface of the track.

Pages 10–11: Speed Sailing

Achievement Objective

- Statistical literacy: Evaluate statements made by others about the findings of statistical investigations … (Statistics, level 4)

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. For example:

- investigate summary, comparison … questions by using the statistical enquiry cycle:
  - interpret results in context, accepting that samples vary … (Statistics, year 7).

Developing students' mathematical understanding

Statistical literacy is the ability to read and interpret data. Statistics provides the means to organise large amounts of data in such a way that it communicates meaning. However, by presenting statistical information in a simplified form, it is also possible to manipulate or misinterpret it.

Statistical information is seen as adding weight to a discussion because it is thought to be scientific. People often accept statistics without asking how data has been gathered or whether crucial information has been left out. Students need to be able to intelligently evaluate and interpret the statistical information they will encounter in everyday life.

In these activities, students interpret data in order to compare the performance of two model land yachts.

Exploring the technology-related context

Designers of high-performance racing yachts know that even a small competitive advantage can lead to success. For events such as the America's Cup, designers often take risks to achieve this advantage, sometimes compromising the structural integrity of the yachts. In recent competitions, this has resulted in dramatic failures of masts, sails, and hulls.

Vocabulary alert

innovation, America's Cup (yacht race), reduction, drag, defeat, victory, model land yacht, fixed distance, penalty, modify, axles, stability

Answers

Activity

1. Answers will vary. Here are two possible conclusions:
   - Rohit's yacht performed best: It performed more reliably than Jake's. Rohit's poorest result was 9.1 s, while one of Jake's trials was over 12 s.
   - Jake's yacht performed best: Rohit's best time was more than 9 s. Jake's best time was 7.4 s.
2. **a.** Jake has not included the 15 s penalty for the boat tipping over. This is misleading. If the 15 is included, his mean result is 8.85 s. [(6.4 + 15 + 7.3 + 6.7) ÷ 4]

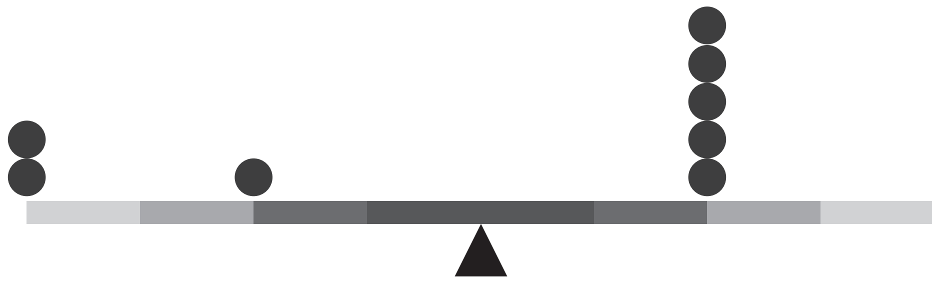
   b. (6.4. + 15 + 7.3 + 15) ÷ 4 = 10.925 s.
3. **a.** Rohit's yacht. Although Rohit's yacht tends to sail more slowly than Jake's, it is more stable and, therefore, more reliable. In the trials, Jake's yacht tipped over 3 times out of 12 trials. One of his trials was over 10 s.

   b. Jake's yacht. Although Jake's yacht is less reliable, it usually travels faster than Rohit's yacht. Its best time was close to 6 s; Rohit's yacht's fastest time was more than 7 s.

Mathematics and Statistics Notes

The word "average" is often used informally to identify something as typical or ordinary. In mathematics, an average is a single value that is used to represent or summarise a set of data. There are three types of average: median, mean, and mode. Of these, median and mean are generally much more useful than mode. The median and mean are called "measures of central tendency" because data tends to cluster around these values.

Students often become preoccupied with calculating the mean and fail to think about the information it provides. Emphasise the idea of "centre" in data. The median is literally the mid-point. The mean will usually be close to the median, but it can be unduly influenced by very large or small values. One way of understanding the mean is to imagine a dot plot as a seesaw, with the dots being people. Where would the fulcrum have to be placed if the seesaw were to balance? That point is the mean.



Variation occurs in all situations and variability in performance is expected. Averages are useful for comparing data sets, but spread of data is also important. If data is very spread out, the mean is less representative than if data values are close together. A large spread makes it harder to predict the outcome of a trial. If the boys had limited their investigation of the modified yachts to four trials, it would be difficult to decide whether Jake's 15 was an unlucky trial or whether his yacht is less reliable than Rohit's. By conducting further trials, a pattern is revealed: Jake's yacht tends to travel faster than Rohit's, but it is an inconsistent performer.

Students need to consider how the two yachts will be judged before deciding which yacht should be used in the competition. Use this to discuss the importance of looking at both central tendency and spread when analysing data.

Interpreting visual representations such as diagrams develops the key competency *using language, symbols, and texts*.

Technology-related student activities

- Research design failures in America's Cup races, for example, *oneAustralia AUS-35* in 1995.
- Conduct an inter-school technology challenge (see www.techlink.org.nz/teaching-snapshot/Y07-10-Middle/Inter-school-Technology-Challenge.htm for ideas).

Pages 12–13: Bouncing Back

Achievement Objectives

- Patterns and relationships: Use graphs … to describe linear relationships found in number and spatial patterns (Number and Algebra, level 4)
- Measurement: Use appropriate scales, devices, and metric units for length … (Geometry and Measurement, level 4)
- Statistical Investigation: Conduct investigations using the statistical enquiry cycle:
  - gathering, sorting, and displaying multivariate category … 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. For example:

- use metric and other standard measures (Measurement, year 8).

Developing students' mathematical understanding

Statistical thinking involves the exploration and use of patterns and relationships in data and comprises four key processes:

- describing data – connecting the information in a table or graph with a real-life context
- organising and reducing data – ordering, grouping, and summarising
- representing data – creating visual representations
- analysing and interpreting data – recognising patterns and trends and using them to make inferences and predictions.

In these activities, students carry out a mathematical investigation to explore the relationship between the height a ball is released from and the height of the first bounce. Students then conduct a similar investigation comparing the bounce of a ball before and after it has spent at least 12 hours in a refrigerator.

Exploring the technology-related context

Endeavours such as building in arctic environments, undersea operations, and space flight rely on the use of technology to enable humans to adapt to extreme conditions. Extreme environments can alter the performance properties of materials and products.

Vocabulary alert

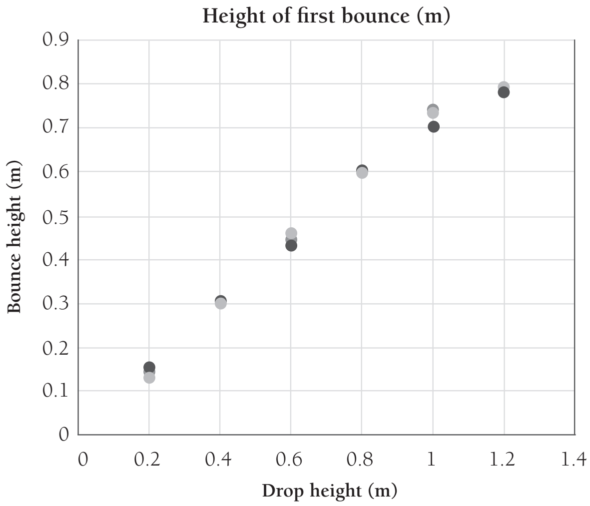
developments, materials, construction, scatter plot, refine, prediction, inflatable, solid-core

Answers

Activity One

1. **a.–b.** Answers will depend on data. Here is a sample table and graph:

Drop height (m)	Height of first bounce (m)		
	Trial 1	Trial 2	Trial 3
0.2	0.15	0.16	0.14
0.4	0.3	0.31	0.3
0.6	0.45	0.44	0.47
0.8	0.6	0.61	0.6
1	0.75	0.7	0.74
1.2	0.78	0.77	0.79



c. The scatter plot shows that as the height from which the ball is dropped increases, the height that the ball bounces also increases.

d. Predictions will vary. One way to make a prediction is to extend the graph and then draw a line that goes through most of the data, extending it to above the 3 m mark.

2. Answers will vary. It is likely that the actual bounce height will be lower than predicted. This is because as the drop height increases, the bounce height eventually levels out.

3. It's not sensible to predict the bounce height of a ball dropped from 20 m without conducting more trials. It's important not to go too far beyond known data when making predictions.

4. Practical activity. Although balls have different degrees of bounce, at some point all balls reach a maximum bounce height.

Activity Two

1. Practical activity

2. a.–c. Answers will vary. You should find that the ball doesn't bounce as high after it has been in the refrigerator.

d. Being in the refrigerator overnight decreased the air pressure in the ball. A flat ball has less bounce than a ball that is fully inflated. Being in the refrigerator may also have temporarily altered the properties of the material from which the ball is made (for example, reduced its flexibility).

Activity Three

1. Results will vary.

2. a.–c. Results will vary. The type of inflatable ball used will influence the results. A beach ball will be more sensitive to the cold than a basketball. The inflatable ball and the solid-core ball will both have been affected by the cold, making their materials less elastic.

Mathematics and Statistics Notes

Activity One

Discuss measuring techniques and the importance of conducting fair tests. For a test to be fair, only one variable should be changed and the others kept constant. Variables that need to be controlled in this context include the size, material, and air pressure of the ball and the surface the ball is dropped onto.

Useful websites on fair tests include:

- www.ise5-14.org.uk/prim3/New_Guidelines/investigations/Fair_test.htm
- www.sciencebuddies.org/science-fair-projects/project_experiment_fair_test.shtml

Working out how to accurately measure the height of a ball bounce is a challenge. One approach is to drop the ball close to a wall that has a paper measuring scale taped to it. Bounce heights can then be marked on the paper. Alternatively, students could record the height reached using a freeze-frame video. (Make sure that the measuring scale is easy to see.)

Students can create a multiple scatter plot (as in the answers) or use the median result of several trials at each drop height.

Discuss with the students how to draw a line on the graph to show the trend. This line is called “the line of best fit”. It is unlikely that the data will fall in a perfect line. Students should try to have the same number of data values above and below the line. It makes sense to draw the line through (0,0) because the ball will have no bounce height unless it is dropped.

Data values that are obviously outliers (extremely large or small values) should, in this instance, be ignored or removed because they are probably inaccurate. Discuss this with your students.

The relationship between drop height and bounce height is only linear for small drop heights. Once a ball reaches a certain height, the bounce height will begin to level off because the ball will reach its terminal velocity. (See www1.appstate.edu/~goodmanj/4401/labnotes/bouncingballs/bouncingballs.html for further information about the forces at work.) This is a useful discussion point; we should be less confident about predictions for heights that are considerably larger than those used in an experiment.

Activity Two

In this activity, students compare the bounce of a ball before and after it has been chilled. The bounce of an inflatable ball depends largely on its internal air pressure. As the air inside the ball cools, its pressure drops, making the ball flat. Placing the ball in a freezer rather than a fridge will create a more pronounced effect.

Activity Three

Solid-core balls are also affected by temperature, but for different reasons. When materials are cooled, they become less elastic. This makes the ball absorb energy rather than transfer it, reducing its bounce. Note that these changes will also be present in the inflatable ball.

To compare change in the two different balls, the students will need to use proportional reasoning. The simplest way is to compare the AF (after fridge) and BF (before fridge) bounce for the inflatable ball and express the result of AF/BF as a percentage, and then to do the same for the golf ball. Because percentage is a standardised fraction (always part of 100), it will be very easy to see which bounce changed most: the smaller the percentage, the smaller the change, and vice versa.

Useful websites for exploring bounce include:

- www.exploratorium.edu/baseball/bouncing_balls.html
- www.exploratorium.edu/sports/ball_bounces/index.html

Measuring the bounce of a ball would be a complicated process if you were working alone. Working with a partner or a group to conduct the investigation develops the key competency *participating and contributing*.

Extension

Do two balls bounce higher than one? See the following websites for further details:

- www.bbc.co.uk/bang/handson/twoballbounce.shtml
- www.abc.net.au/spark/experiments/s1090896.htm

Technology-related student activities

- Investigate the technologies that Antarctic explorers used to cope with extreme conditions.
- Investigate what it is like to live and work in space (see http://spaceflight.nasa.gov/living/index.html).

Pages 14–15: Emergency Shelters

Achievement Objectives

- Measurement:
  - Convert between metric units, using whole numbers and commonly used decimals
  - Use side or edge lengths to find the perimeters and areas of rectangles … and triangles … (Geometry and Measurement, level 4)
- Shape: Relate three-dimensional models to two-dimensional representations, and vice versa (Geometry and Measurement, level 4)

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. For example:

- make simple conversions between units, using whole numbers (Geometry and Measurement, year 7).

Developing students' mathematical understanding

Spatial-visualisation skills are important in many technical and scientific occupations. Reading, making, and using diagrams are good ways for students to develop these skills.

In these activities, students construct models and interpret two-dimensional representations of three-dimensional objects.

Exploring the technology-related context

Technological practice is often undertaken in an attempt to address a need. Floods and earthquakes often result in a loss of homes. Emergency shelters need to be easy to assemble, durable and, as far as possible, comfortable. The materials used to make them need to be readily available and affordable.

Vocabulary alert

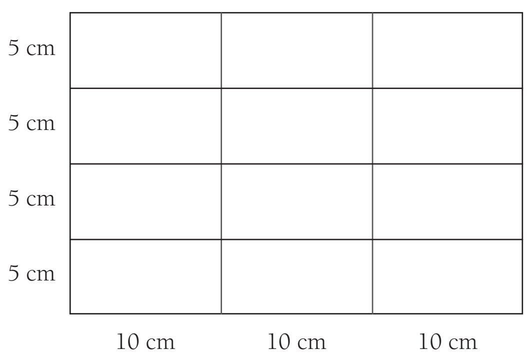
emergency shelter, inexpensive, hexayurt, diagonally, rejoined, hexagon, adapted, extended

Answers

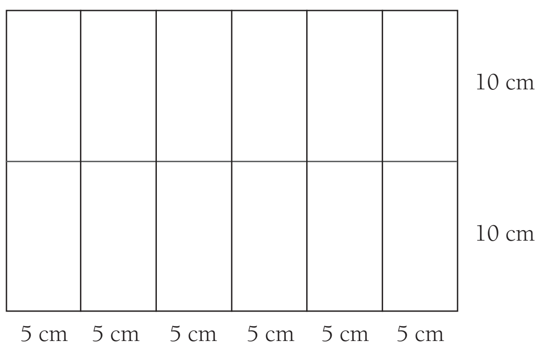
Activity One

1. **a.** 5 cm x 10 cm. The area of the card is 600 cm² (20 x 30). Each hexayurt rectangle will have an area of 50 cm² (600 ÷ 12). The rectangles are twice as long as they are wide, so the rectangles will be 5 cm x 10 cm.

   Another way to find the dimensions is to draw a diagram:



or

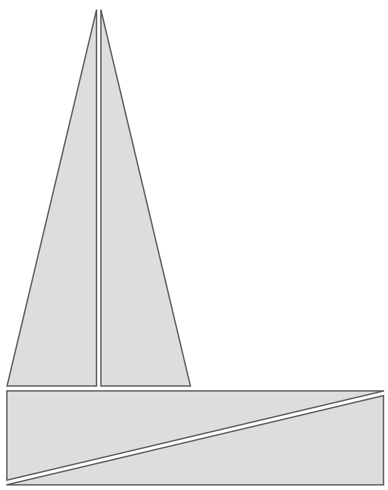


   b. Not all rectangles that are 600 cm² can be divided into exactly twelve 2:1 rectangles. For example, if the rectangle were 1 cm x 600 cm, it would be impossible to cut out even one 5 cm x 10 cm rectangle.

2. **a.** Practical activity.

   b. Approximately 2 m. Answers will vary slightly, but a perfectly constructed hexayurt will have a height equal to the length of one of its walls.

3. No. The hexayurt design only works because the base of the roof triangle is the same length as the side of the rectangle. If the 2:1 ratio is changed, this relationship no longer exists.



4. Practical activity. Designs will vary.

Activity Two

1. **a.** The base is 360 cm by 360 cm.
   360 ÷15 = 24 tubes. Without taking into account the door and the window, there are 24 + 24 + 22 +22 = 92 tubes for the walls.

   The door takes up the space of 6 tubes (90 cm ÷ 15 = 6). The window takes up the space of 4.5 tubes (90 cm ÷ 15 = 6, and the window is $\frac{3}{4}$ of a tube high, so altogether this is 4.5 tubes).

   Total number of tubes is 92 – 6 – 4.5 = 81.5 tubes.

   b. The length of double-sided tape is the same as the total length of the tubes.
   200 cm = 2 m. 2 m x 81.5 tubes = 163 m of double-sided tape.

   c. The length needed for the frame is
   360 x 6 + 200 x 6 = 3 360 cm (33.6 m).

   d. Plastic sheeting (without allowing for overlap) is 17.64 m^2:

   The roof is made from 2 rectangles and 2 triangles.

   - area of 1 rectangle: 2 m x 3.6 m = 7.2 m^2
   - area of 1 triangle: $\frac{1}{2}$ x 0.9 m x 3.6 m = 1.62 m^2

   Total area of 2 rectangles and 2 triangles is
   7.2 m^2 + 7.2 m^2 + 1.62 m^2 + 1.62 m^2 = 17.64 m^2

2. **a.–c.** Practical activity.

Mathematics and Statistics Notes

Activity One

Question **1** is challenging. If necessary, scaffold the problem by asking the students these questions:

- How can you find the area of the board? (20 x 30 = 600 cm^2)
- What will the area of each rectangle be? (600 cm^2 ÷ 12 = 50 cm^2)
- Can you draw some rectangles that have an area of 50 cm^2?

Students could also divide a 20 cm x 30 cm piece of paper into 12 rectangles to find the dimensions. Note that the 2:1 ratio between length and width must be maintained. Be aware that an A4 sheet is very close to, but not equal to, 20 x 30 cm.

The hexayurt was designed by Vinay Gupta. See www.hexayurt.com for related links, including a video about how to make a folding hexayurt.

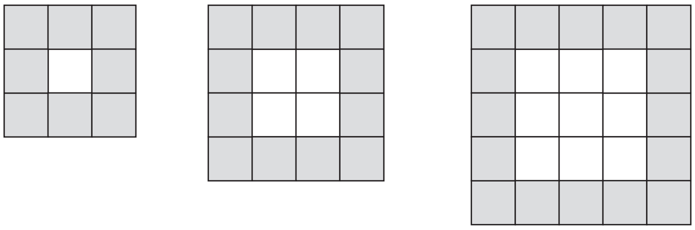
Examples of modified hexayurts are also available online and can be easily found by doing a search for “new hexayurts”. See www.tilings.org.uk/Hexayurt_Family.pdf to access Edmund Harriss’s nets of hexayurt relatives, “the tri-dome” and “the quad-dome”. Both these structures are based on the 2:1 rectangle and triangles.

Activity Two

This activity involves using different units of length (centimetres and metres). Give your students practice converting between the two units. They can choose whether to work in centimetres or metres, but remind them that when calculating perimeter or area, the measurements they use must have the same unit.

Students can find the number of tubes on each side by dividing the length of the wall by the diameter of each pole (360 ÷ 15 = 24). They may then make the mistake of simply multiplying this by 4 to find the total number of tubes. By doing so, each corner tube ends up being counted twice.

Multilink cubes can be used to show the relationship between the number of tubes on each side and the total number of tubes. For example:



This can form the basis of a good investigation:

Number of squares on each side	Total number of squares
3	8
4	12
5	16

This will help students to identify that the total number of tubes is 4 times the number of tubes in each wall minus 4.

Interpreting a two-dimensional representation of a three-dimensional object requires good spatial-visualisation skills. Students who struggle to visualise the shapes that make up the roof may benefit from creating a model of it. This will help them to see that the roof is made up of two rectangles and two triangles.

Alternatively, students could construct a scale model of the entire shelter.

To estimate how many emergency shelters could fit on the school field, students could pace out the field to estimate its dimensions and then pace out the amount of space required for each shelter. Another option is to work out the dimensions of the field using an online map and then use a scale drawing or calculation to work out how many shelters would fit on it.

Working in a group to estimate the number of emergency shelters that could fit on the school field is a good opportunity to develop the key competency *participating and contributing*.

Technology-related student activities

- Construct models of emergency shelters using paper, card, and ice-block sticks. Investigate how well the models cope with wind produced by a fan or leaf blower.
- Research commercially made survival suits and the materials used to make them.
- Research other emergency shelter designs. For examples, see http://weburbanist.com/2008/11/12/lifesaving-temporary-emergency-shelters-buildings

Pages 16–17: Paralympic Power

Achievement Objective

- Number strategies and knowledge: Apply simple linear proportions … (Number and Algebra, level 4)

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. For example:

- apply additive and multiplicative strategies flexibly to whole numbers … (Number and Algebra, year 7).

Developing students' mathematical understandings

Mathematics is the science of patterns and relationships. Mathematical relationships are often described using formulae. Mathematicians explored the relationship between a circle's circumference and its diameter for hundreds of years before identifying a precise relationship ($C = \pi d$).

In these activities, students use an approximation of this relationship. They use another type of relationship (rates) to compare the speed of a runner with that of a rower.

Exploring the technology-related context

Assistive or adaptive technology is the development of products and systems useful for people with disabilities. Some assistive devices relate to everyday life; others have specialist applications, such as on the sports field. Some paralympians use technology that is similar to that used by able-bodied athletes and others use technological products that have been uniquely modified to meet their needs.

Vocabulary alert

Paralympic, stability, manoeuvrability, diameter, perimeter, circumference, rotation, single sculls rowing

Answers

Activity One

1. a. Similarities: Both wheelchairs have big back wheels.

Differences: The racing wheelchair only has 3 wheels. It has doesn't have footrests, armrests, or a back, and its front wheel extends out a long way. The back wheels of the racing chair slope inwards. The hand wheel of the racing wheelchair is much smaller.

b. The racing chair is designed for speed and for racing tracks that have no tight curves. A normal wheelchair needs to be able to turn easily.

2. a–c. Answers will vary. Manoeuvrability and speed are important in basketball, and speed in a 100 m race and a marathon. Stability is essential for archery. It could be argued that tennis players need all three in equal measure.

d. Practical activity

3. a. Circumference of rear wheel ≈ 3 x 70 = 210 cm. The circumference of hand wheel ≈ 3 x 40 = 120 cm.

b. About 50. (210 cm ≈ 2 m. 2 m x 50 = 100 m, so about 50 rotations.)

Activity Two

1. a. Galina Rostov won by 14 s.

b. 1 min 46 s (17 s + 29 s + 1 min)

2. a. 160 s

b. 2 min 40 s, which is a lot faster than the fastest rower

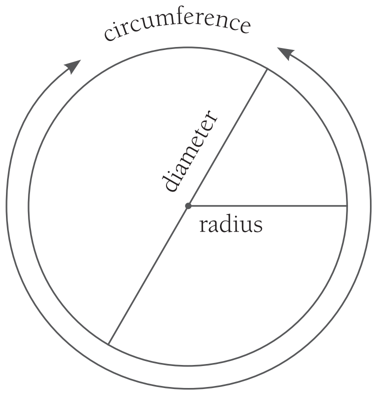
c. It's not a fair comparison. Jayna can run fast for 100 m, but she wouldn't be able to keep running at this speed if she had to run 1 000 m. However, if Jayna runs 100 m in 16 s, she will have 6:27 min (387 s) to complete the remaining 900 m. If Jayna can run at an average speed of 100 m / 43 s for 900 m, she will have travelled faster than the rowers.

Mathematics and Statistics Notes

Activity One

Students are asked to quantify their perception of the relative importance of three factors in wheelchair sports. Quantifying perceptions by using ratings or rankings is a common statistical approach. It is simpler to analyse numerical data than qualitative or descriptive data. Working with numbers makes it easier to draw comparisons between people's perceptions. Rating or ranking objects can also be a useful way for people to evaluate their own perceptions.

A problem arises when a person believes that two items are equivalent. Rankings may force them to differentiate between the two items unless they are given the option of equal rankings. In this example, if a student believes that a wheelchair deserves 4 out of 9 points for speed, it is not clear whether they can divide the remaining 5 points equally between the other 2 factors.



Before beginning question **3**, introduce the language of circle geometry. The radius is a line from the middle of the circle to the circumference. The diameter is the width of the circle.

The circumference of a circle is found using the formula: circumference = $\pi \times$ diameter. Using formulae and working with the number π (pi) are appropriate for students working at level 5 of the curriculum. However, students at levels 3 and 4 can and should explore the relationship between diameter and circumference:

- Regardless of the size of the circle, dividing the circumference by the diameter always gives the same number, known as π (pi). π is an "irrational number" because it can't be written as a simple fraction. This special number has fascinated mathematicians for nearly 4 000 years. The value of π is approximately 3.14, but at levels 3 and 4, it is sufficient for students to know that the circumference of a circle is roughly three times its diameter.
- If the school playground has a large painted circle, ask the students to count the number of paces they use to walk around the circumference of the circle and the number they use to walk across its diameter. Compare the results as a class. The number of paces for the circumference should be approximately three times the number for the diameter.
- Provide students with circular objects, such as cans, hula-hoops, saucepan lids, and plates, and several pieces of string. Working in pairs, have the students wrap string around their object, cutting it so that it is the same length as the circumference. Then ask them to stretch the string over the diameter of the circle, making sure that it is both flat and straight. The students should cut as many diameters as they can from the circumference string. By comparing results with their classmates, they will see that the circumference of a circle is always slightly more than three times the diameter.

  The same activity can be adapted to provide measurement practice. Ask the students to measure the length of a piece of string wrapped around a circular object and to measure the diameter of the object using a ruler.

In question **3**, students use an approximation of π to estimate the number of rotations the rear wheel of the wheelchair makes. Introduce students to the symbol used to show an approximate answer ($\approx$). Discuss the difference between this symbol and the = sign. Many students perceive the = sign as a command to carry out the operation that comes before it. This can result in run-on sentences that are mathematically incorrect. For example, a student calculating 2 + 7 and then multiplying the result by 3 may write this as 2 + 7 = 9 x 3 = 27. The true meaning of = is "is the same as". Understanding the = sign is important for mathematical reasoning.

Interpreting and using mathematical symbols develops the key competency *using language, symbols, and texts*.

Activity Two

Students often treat recorded times as if they were decimals. Discuss with the students that 6:43 represents 6 minutes and 43 seconds, not 6.43 minutes, and explain the difference between the two. The two values would only be equivalent if there were 100 seconds in a minute. However, the principles used to order decimal numbers still apply. For example, the athletes can be ranked from first to fifth by looking first at the number of minutes and then at the number of seconds.

Because time is seldom written as a decimal, students should avoid using their calculators to find differences in time. Encourage them to adapt their number strategies, for example, by using "tidy numbers" but making numbers up to 60 instead of 100.

Comparing Jayna's time to the rowers' times involves proportional reasoning. Students need to consider whether the rate Jayna runs will remain constant. Without this constancy, the comparison between her speed and that of the rowers is unfair.

Technology-related student activities

- Discuss the difference between "performance-enhancing" sports-related technologies and "essential for performance" technologies.
- Debate whether athletes with disabilities should be allowed to use technology to compete against able-bodied athletes.

Pages 18–19: Penguin Properties

Achievement Objectives

- Shape: Relate three-dimensional models to two-dimensional representations and vice versa (Geometry and Measurement, level 4)
- Position and orientation: Communicate and interpret locations and directions, using compass directions, distances, and grid references (Geometry and Measurement, level 4)

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. For example:

- describe locations and give directions, using grid references … (Geometry and Measurement, year 7).

Developing students' mathematical understanding

Spatial-visualisation skills are important in many technical and scientific occupations. Reading, making, and using diagrams are good ways for students to develop these skills.

In these activities, students draw front, plan, and side views of a penguin nest box. They also use co-ordinates to describe the location of nest boxes positioned on a map.

Exploring the technology-related context

The wide variety of animal species and their needs provide excellent opportunities for inquiry and technological learning. Students are often enthusiastic about working on animal-related projects. Programmes designed to assist endangered species and protect their habitats can be used as examples of innovative technological practice.

Teachers are reminded that animal "technology", such as beaver dams or chimpanzee fishing, does not fall within the domain of technology education.

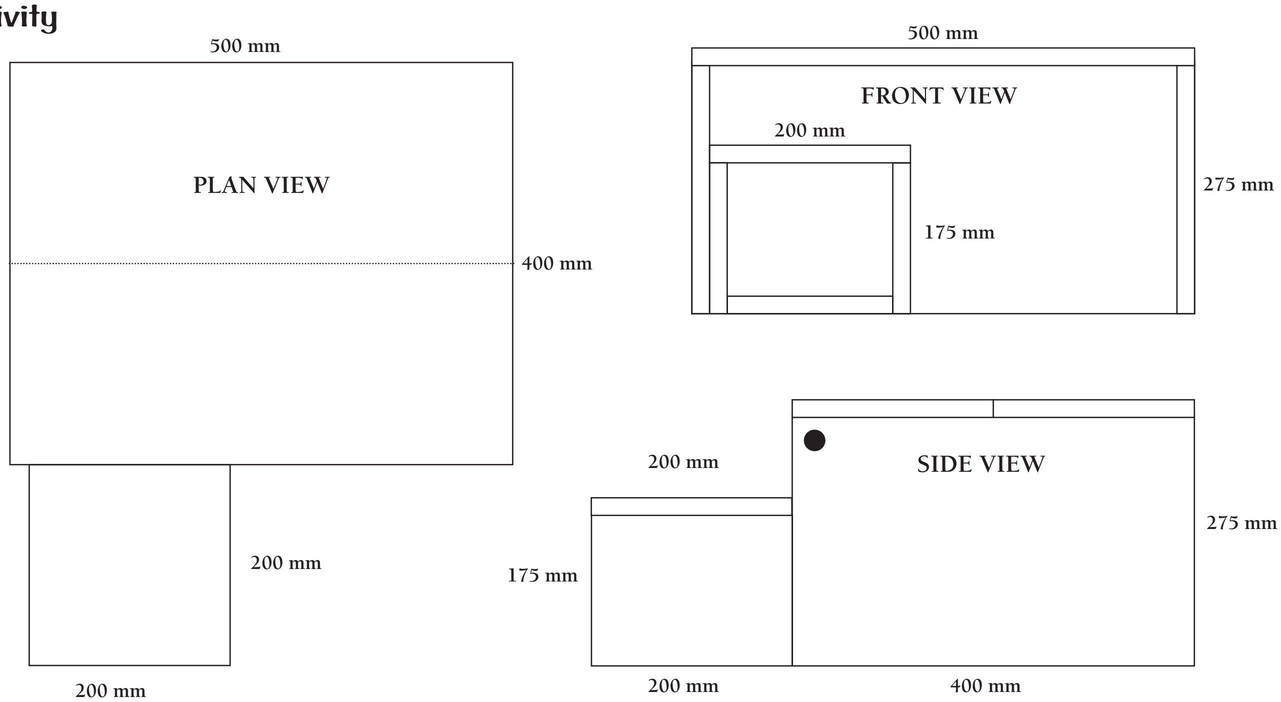
Vocabulary alert

habitats, modify, predators, fragile, nest boxes, monitored, Department of Conservation, disturbance, grid references

Answers

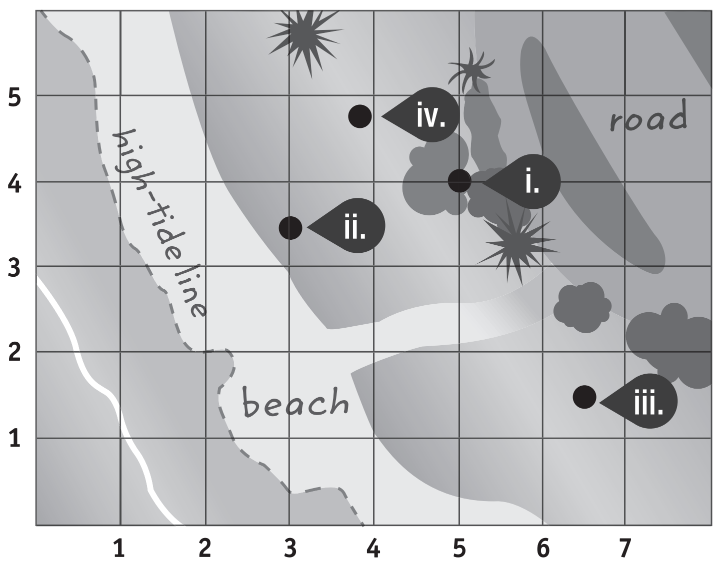
Activity

1.



2. **a.** Several constraints need to be considered before placing the nesting boxes: the beach won't be suitable, nor will places too close to the road. The boxes should be on the seaward side of the road.

b. Methods will vary. One example is shown below:



Using the grid references on the example map, the penguin boxes are located at:

i. (5, 4)
ii. (3, 3.5)
iii. (6.5, 1.5)
iv. (3.8, 4.75)

c.–e. Results will vary.

Mathematics and Statistics Notes

In this activity, students are presented with two types of scale diagrams – a plan of a penguin nest box and a map.

In question **1**, students are asked to draw front, plan, and side views of the nest box. Spatial skills are required to interpret the diagrams and to visualise the resulting nest box. Students could transfer measurements onto the two-dimensional representation of the constructed nest box (see the map copymaster), using this as a guide for their front, plan, and side view drawings. Alternatively, a group of interested students could make a scale model that could then be used by other students to help them visualise the three views.

The thickness of the timber (25 mm) has been factored into the design. This explains why the lid is 500 mm while the front and back pieces in the diagram are only 450 mm wide. The thickness of the timber has also been incorporated into the plan views in the answers. Note that 25 mm of each tunnel side slots inside the box.

Discuss the language of geometry that is useful for describing three-dimensional shapes, for example:

- view (plan, front, side) – what you see when looking directly from above, in front, or from the side (includes all structural features but excludes decoration)
- face – a flat surface
- edge – the intersection of two faces
- vertex – the point where three or more edges intersect.

In question **2**, students create their own grid reference system to describe the placement of the nest boxes. Students can choose whether to label the grid lines or the squares and whether to use letters or numbers. Ask students to evaluate how effective their method is.

Technology-related student activities

- Research the needs of an endangered animal and design a suitable habitat for it.
- Design an enrichment toy for a zoo animal.
- Research existing structures, such as the Maungatautari predator-proof fence, to learn how designers achieved desired outcomes.

Pages 20–21: Worms at Work

Achievement Objectives

- Number strategies and knowledge: Use a range of multiplicative strategies when operating on whole numbers (Number and Algebra, level 4)
- Measurement: Use side or edge lengths to find the perimeters and areas of rectangles … and the volumes of cuboids (Geometry and Measurement, level 4)

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. For example:

- apply … multiplicative strategies flexibly to whole numbers, ratios … (Number and Algebra, year 7).

Developing students' mathematical understanding

Proportion involves comparing one aspect of an object with another aspect. The emphasis is on the relationship between components, not the components themselves. Ratios can be used to quantify this comparison and can be expressed in several ways. For example, if a drink concentrate requires 1 part concentrate and 8 parts water, this can be expressed as a concentrate:water ratio of 1:8 (or $\frac{1}{8}$ or 0.125), which is a part–part comparison. The ratio of concentrate to the resulting drink is $\frac{1}{9}$, which is a part–whole comparison.

In these activities, students use ratios related to products made from worm castings and explore possible dimensions for worm farms.

Exploring the technology-related context

Establishing a school worm farm involves setting up an appropriate environment for the worms and learning about useful by-products. Commercial worm farmers are likely to be a useful source of information. Worm farms are an example of a crossover between structures and food technology.

Vocabulary alert

waste, products, conserves, resources, worm farm, fertiliser, castings, nutrients, compost, seed-raising mix, dimensions, commercial

Answers

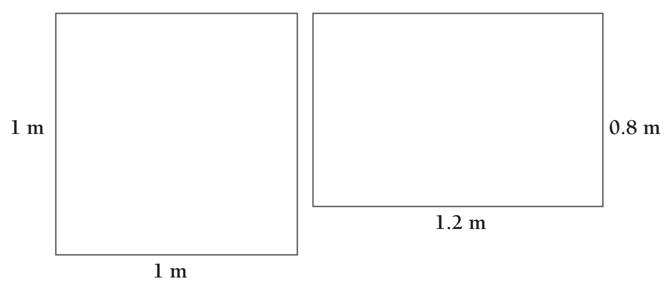
Activity One

1. a. 6 kg
   b. 4 kg. (12 ÷ 3 = 4)
2. a. 900 mL
3. a. 3 x 4 = 12 m^2, 12 x 2 = 24 L
   b. 2 400 mL (2.4 L). One litre of fertiliser needs 100 mL of worm tea.
   24 x 100 mL = 2 400 mL.

Activity Two

1. a. 12.5 m. (25 m ÷ 2 = 12.5 m)
   b. The frames are 3 pieces of timber tall, so the perimeter of each frame needs to be 4 m (12.5 m ÷ 3 = 4.17 m)

   Here are 2 possibilities:



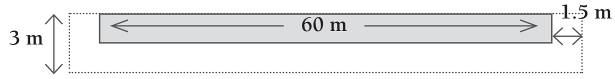
   c. Answers will vary. For the rectangles above, the area of mesh required would be 1 x 1 = 1 m^2 and 0.8 x 1.2 = 0.96 m^2.

2. a. 90 cm. (6 x 15 cm)

b. Answers will vary. Using the dimensions above, the volumes would be 0.90 m x 1 m^2 = 0.9 m^3 and 0.90 m x 0.96 m^2 = 0.864 m^3.

Activity Three

1. 18 x 60 m x 1.5 m = 1 620 m^2
2. About 18 500. (30 000 000 ÷ 1 620 = 18 518.5)
3. Answers will vary. One option is to have 1 column of 18 rows, with 1.5 m between each bed:



3 m x 63 m x 18 = 3 402 m^2

If the worm farm is laid out like this, Mali's parents would need at least 3 400 m^2.

Mathematics and Statistics Notes

Activity One

Students use the proportional relationship between the amount of castings and compost to calculate quantities.

This table shows the relationship between the quantities of castings and compost:

Casting	Compost
1 kg	3 kg
2 kg	6 kg
3 kg	9 kg
4 kg	12 kg

This part–part relationship can be written in ratio form as 1:3. This ratio can also be written in fraction form: the ratio of castings to compost is $\frac{1}{3}$ (that is, the amount of castings is $\frac{1}{3}$ the amount of aged compost). Similarly, the ratio of compost to castings is 3:1 = $\frac{3}{1}$ = 3. The amount of compost is 3 times the amount of castings.

A part–whole ratio compares a part of the whole (for example, the castings) to the whole (for example, the seed-raising mix). The ratio of castings to seed-raising mix is $\frac{1}{4}$.

The relationship between worm tea and the amount of fertiliser is shown in the table below:

Worm tea	Water	Fertiliser
100 mL	900 mL	1 000 mL or 1 L

If 100 mL is required for 1 L of fertiliser, then 24 x 100 mL = 2.4 L is needed for 24 litres.

Activity Two

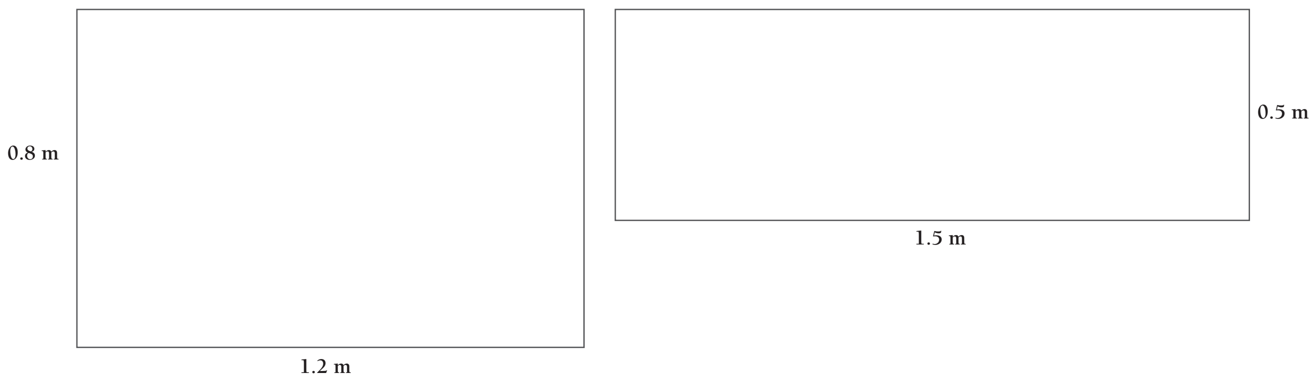
Reading, making, and using diagrams is a good way for students to develop their spatial-visualisation skills.

Discuss with the students that when calculating perimeter, area, or volume, the unit of measurement for each dimension must be the same.

Challenge more confident students to move beyond whole numbers to find possible dimensions for the frame. One option is to convert all of the measurements into centimetres. However, this means that the students will be working with very large numbers, particularly once they start calculating volume. For example, in 1 m^3, there are 1 000 000 cm^3. Numbers of this magnitude are hard to visualise and best avoided.

Explore the relationship between the width and the length of rectangles with perimeters of 4 m. If the perimeter is 4 m, then one width and one length of the rectangle will add up to 2.

For example:



Exploring different possibilities for perimeter, area, and volume when given a constraint of perimeter length develops the key competency *thinking*.

Activity Three

Encourage your students to share the strategies they used to estimate the amount of land that Mali's parents need.

Technology-related student activities

- Research the inputs, process, and outputs involved in worm farming.
- Make a list of desirable attributes for a school worm farm by researching the importance of air vents, moisture and pest control, the use of high-density polyethylene, and other features.
- Practise design skills (two- and three-dimensional) by drawing possible worm farms.
- Consider effective ways to advertise and market worm castings and vermicompost.

Pages 22–24: Dynamic Darts

Achievement Objectives

- Measurement: Use appropriate scales, devices, and metric units for length … and time (Geometry and Measurement, level 4)
- Statistical investigation: Plan and conduct investigations using the statistical enquiry cycle (Statistics, level 4)

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. For example:

- use metric and other standard measures (Geometry and Measurement, year 8).

Developing students' mathematical understanding

While discrete objects (such as people in a room) can be counted, continuous variables (such as length, time, angle, volume, mass, and temperature) can only be quantified (that is, measured) with the aid of a suitable device and unit.

Measurement skills include being able to use devices (for example, a ruler, a jug, a protractor, a thermometer), read scales, estimate, choose appropriate units, interchange units, round, interpret a decimal point, and assess the sensibleness of a result.

Measurement is the basis of most quantifying and most comparing. Confidence in measuring is developed over time, through experiences in many different contexts. Ideally, students extend and develop their skills in response to a need.

In this activity, students need a basis for judging performance. They explore which attributes enable a paper dart to fly further, straighter, or faster, or to stay in the air for longer, and they work together to try to create a "best ever" dart.

Exploring the technology-related context

Technologists use models to test ideas. These can be a relatively inexpensive and safe way to determine whether an idea is feasible. The model can represent a complete product or a component. A new technology may need components that have yet to be invented, and models can reduce development time. From concept design (possibly computer-assisted) and mock-ups through to a prototype, model making is an essential aspect of technological innovation. Paper darts illustrate how models can demonstrate the performance of aircraft designs.

Sometimes, models become products in their own right. Many people enjoy controlling model cars, boats, and trains.

Vocabulary alert

economical, evaluate, furthest, performance categories, attributes, modify, length:breadth ratio

Answers

Activity One

1. a.–b. Ideas will vary. Darts with narrow, tapered wings are likely to travel further, faster, and straighter. Darts with wide wings are likely to be slower and to stay in the air longer, but they are less likely to travel in a straight line.

2. a.–e. Practical activity.

Activity Two

1. a.–e. Practical activity

2. Practical activity. Reports will vary.

3. It’s not possible to directly compare the improvements made by each group because they were investigating different variables. However, Calvin’s group more than doubled their dart’s flight time (6.5 ÷ 3 = 2.2), while Mali’s group increased flight distance by a rather smaller factor of 1.74 (10.8 ÷ 6.2). So it could be argued that Calvin’s group did better than Mali’s group.

Mathematics and Statistics Notes

Paper dart designs can be readily found on the Internet. For examples, see:

- www.paperairplanes.co.uk/planes.php
- www.bestpaperairplanes.com

Evaluating the relative flights of the darts requires group consensus on how to measure and record performance.

If the students are measuring flight distance, they will need to define “distance”. The flight paths of the darts are unlikely to be straight. In sporting competitions such as shot put or javelin, the flight distance is measured from the point that the object first touches the ground rather than the object’s final resting point. Discuss the practicality of using this approach in a paper dart competition.

Measuring the speed of a dart is incredibly challenging. Although in theory this could be achieved by measuring speed over a fixed distance, the speed a dart travels is dependent on the force with which it is thrown. The flight path of the dart is unlikely to be perfectly straight, nor will it be level. Discuss these challenges with the students. They should conclude that they are not equipped to deal with this variable.

Straightness of flight could be measured using a centre line (from the throwing point) and measuring the angle of deviation with a large protractor and string.

Students need to decide what degree of accuracy they should aim for. For example, should they measure to the nearest centimetre or to the nearest millimetre? To the nearest second or the nearest tenth of a second? If they are timing flight duration, there will be variation in the reaction times of those doing the timing. Ask three students to time the same flight and compare their times. Discuss the reasons for any differences.

Check that your students are using their measurement equipment correctly.

Discuss how the steps in this activity relate to the statistical enquiry cycle:

- **P**roblem: What is it we are trying to find out? For example, which attributes enable a dart to fly further?
- **P**lan: How will we collect and record the data to answer our question?
- **D**ata: Collect and record data.
- **A**nalysis: Which darts flew the furthest? What design features do they share?
- **C**onclusion: What else could we try to make the dart fly further?

Working in groups to investigate modifications develops the key competency *participating and contributing*.

Support for English Language Learners

Supporting students with writing a report to explain a process

In **Activity Two**, question **2** (page 24) students are asked to write a report explaining a process. To support your students, especially English language learners, you could provide (or co-construct) a writing frame to show ways to create such a report (see the example below). Use the frame to co-construct a report, modelling how they can use the frame to write their own reports.

Consider writing a short report yourself (on a similar topic) to help you identify the language demands of this kind of report: the structure of the text, sentence types, language structures (for example, phrases and clauses signalling sequence), and vocabulary.

Some students will be able to write more effectively after presenting their process orally. Students who share a first language other than English will also benefit from opportunities to explain their process in this language.

Example of a writing frame for an explanation of a process

Section	Content	My notes	My report
Introduction	• Introduce the process. • Introduce the three stages.		
Stage 1	• Introduce the first stage. • Explain each step in the stage.		
Stage 2	• Introduce the second stage. • Explain each step in the stage.		
Stage 3	• Introduce the third stage. • Explain each step in the stage.		
Conclusion	• Restate the process and the three stages. • Explain the final outcome.		

Adapt the writing frame to provide different levels of support according to the needs of your students. Some may need just the first column, some the first and second. Some students may benefit from sentence starters or even cloze sentences (gap-fill sentences) in the last column (where they write their first draft).

For information about language for explaining and ideas on how to support students, see *Supporting English Language Learning in Primary Schools: A Guide for Teachers of Years 7 and 8*, Explaining, pages 50–59.

The Focus on English resource on ESOL Online provides suggestions and resources to support learners with the language for measurement. See ESOL Online at http://esolonline.tki.org.nz/ESOL-Online/Teacher-needs/Reviewed-resources/Cross-curricular/Focus-on-English/Measurement

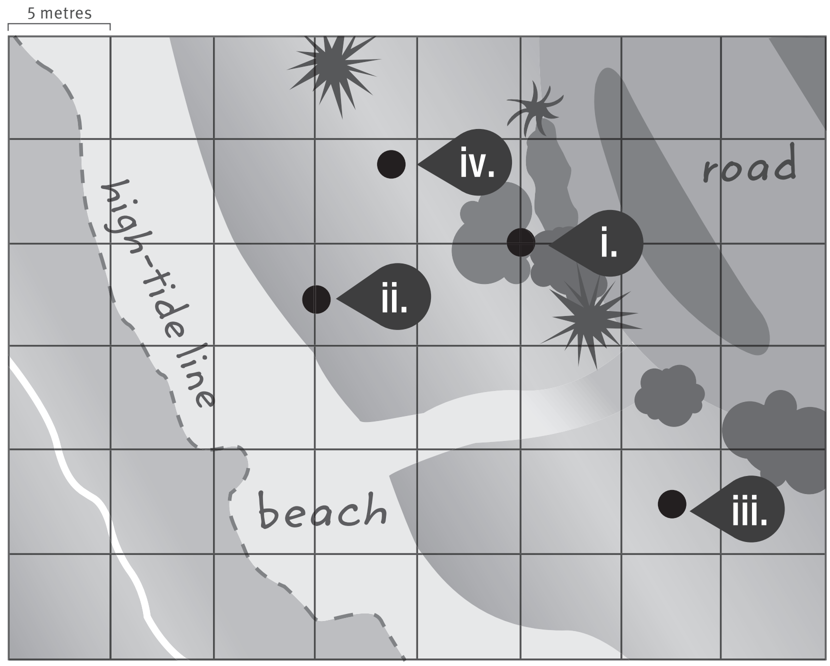
Technology-related student activities

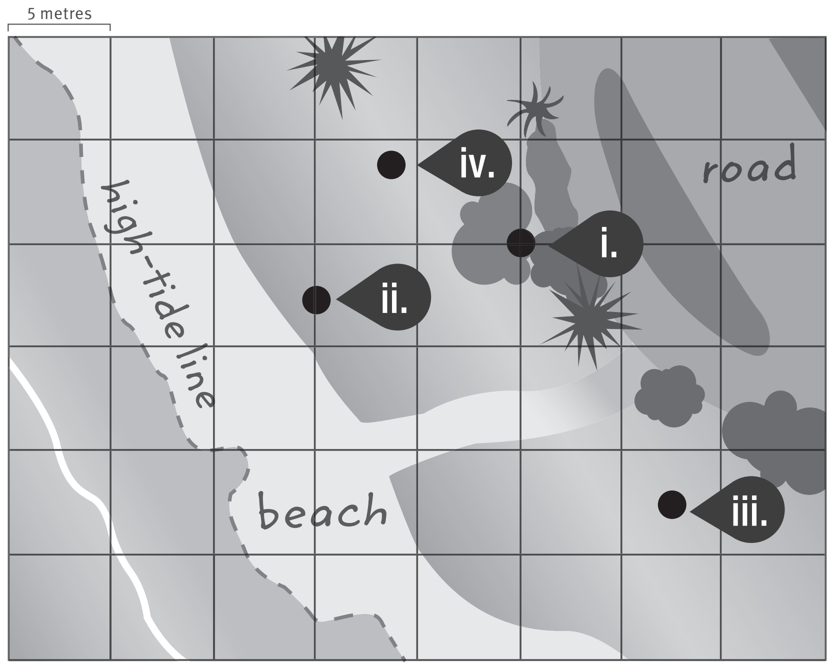
- Construct the model aeroplanes as illustrated in the student booklet to investigate thrust, lift, weight, and drag.
- Research world-record performances for paper darts.
- Hold a school-wide paper-dart-throwing event.

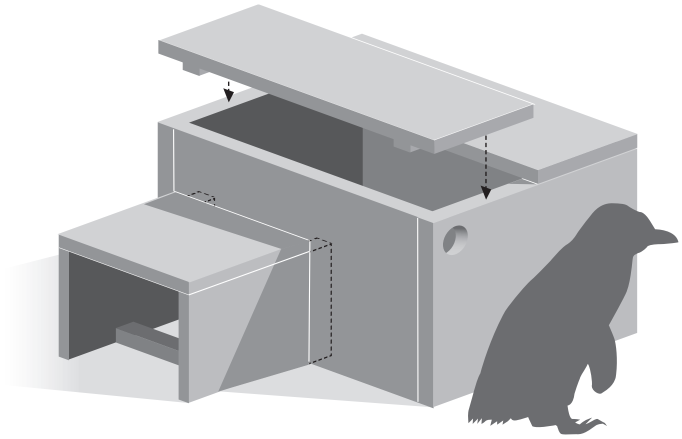
Albatross

Kārearea

Copymaster: Penguin Properties pages 18–19







Notes

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