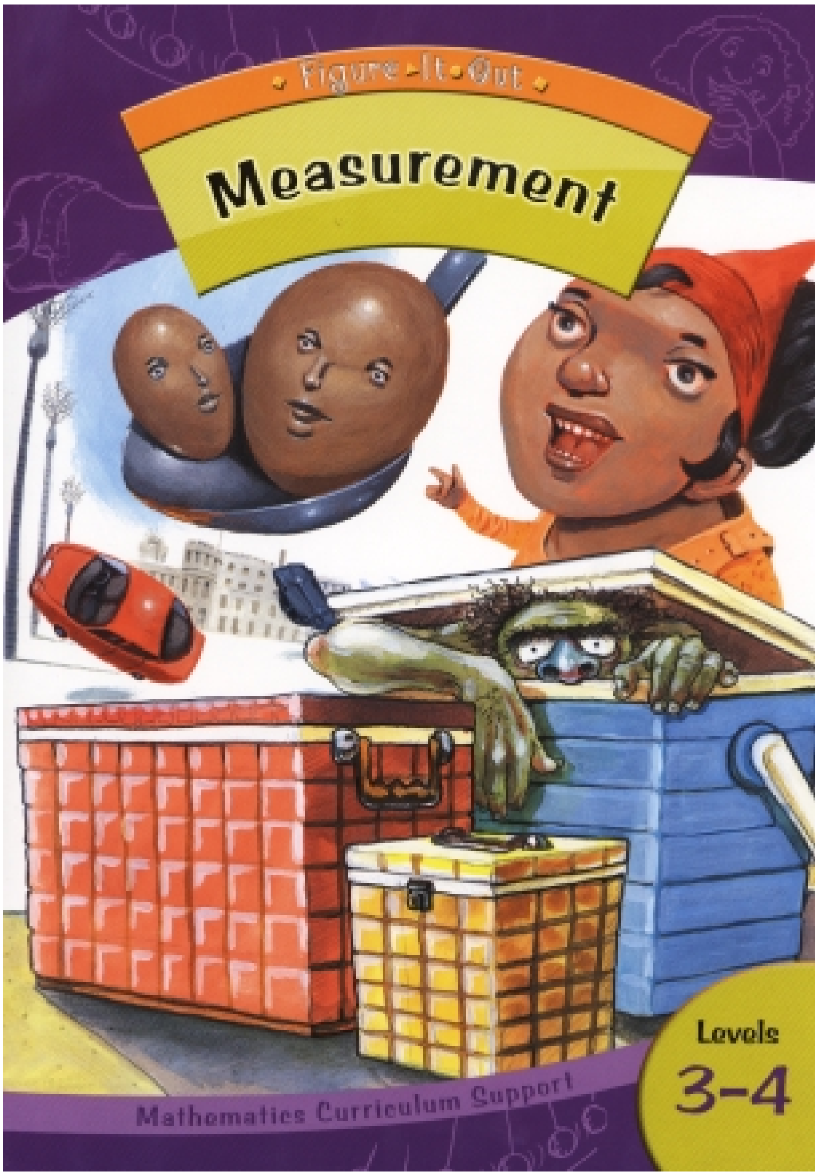
Answers and Teachers' Notes



Contents

Introduction

The Figure It Out series is designed to support *Mathematics in the New Zealand Curriculum*. The booklets have been developed and trialled by classroom teachers and mathematics educators. The series builds on the strengths of a previous series of mathematics booklets published by the Ministry of Education, the School Mathematics supplementary booklets.

Figure It Out is intended to supplement existing school mathematics programmes and can be used in various ways. It provides activities and investigations that students can work on independently or co-operatively in pairs or groups. Teachers can select particular activities that provide extension to work done in the regular classroom programme. Alternatively, teachers may wish to use all or most of the activities in combination with other activities to create a classroom programme. The booklets can be used for homework activities, and the relevant section in the teachers' notes could be copied for parents. These notes may also provide useful information that could be given as hints to students. The teachers' notes are also available on Te Kete Ipurangi (TKI) at www.tki.org.nz/community

There are eight booklets for levels 3–4: one booklet for each content strand, one on problem solving, one on basic facts, and a theme booklet. Each booklet has its own *Answers and Teachers' Notes*. The notes include relevant achievement objectives, suggested teaching approaches, and suggested ways to extend the activities. The booklets in this set (levels 3–4) are suitable for most students in year 6. However, teachers can decide whether to use the booklets with older or younger students who are also working at levels 3–4.

The booklets have been written in such a way that students should be able to work on the material independently, either alone or in groups. Where applicable, each page starts with a list of equipment that students will need in order to do the activities. Students should be encouraged 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 a problem. Teachers could encourage students to write down as much as they can about how they did investigations or found solutions, including drawing diagrams. Where possible, suggestions have been made to encourage discussion and oral presentation of answers, and teachers may wish to ask the students to do this even where the suggested instruction is to write down the answer.

> The ability to communicate findings and explanations, and the ability to work satisfactorily in team projects, have also been highlighted as important outcomes for education. Mathematics education provides many opportunities for students to develop communication skills and to participate in collaborative problem-solving situations.
>
> *Mathematics in the New Zealand Curriculum*, page 7

Students will have various ways of solving problems or presenting the process they have used and the solution. Successful ways of solving problems should be acknowledged, and where more effective or efficient processes can be used, students can be encouraged to consider other ways of solving the problem.

Figure It Out

Measurement

Answers

Page 1: Shady Shadows

Activity One

Answers will vary, but they should be based on the ratio of the ruler to its shadow.

Activity Two

Stephanie is right because 680 x 2 = 1 360, which is very close to 1 350 mm, and the shadows were measured at the same time of the day.

Investigation

Answers will vary, but you should find that the shadow gets smaller in the middle of the day and then gradually gets longer again.

Pages 2–3: High Hopes

Activity One

1. a. Between 164 cm and 184 cm

   b. Yes. She might be between 168 cm and 188 cm, but with both parents being tall, her genes will probably mean she will be at the higher end of the estimate.

   c. Because the method gives only an approximate height. There are other factors that determine someone's height as well as their parents' heights. For example, a short parent may have very tall people in his or her extended family. Other factors include nutrition.

2. a. Tom's predicted adult height is 180 cm. This fits in with the estimate in **1a**.

   b. Based on the answers to **1b,** the actual estimate would be between 84 and 94 cm. Elizabeth might have been about 90 cm, based on her parents being tall.

Activity Two

1–2. Answers will vary. Based on the formula and using his parents' heights, Paul will be between 171.5 cm and 191.5 cm. However, Paul is more likely to be at the lower end, given his father's height and the fact that at 3 years, Paul was only 88 cm. Even if he had been 88 cm at 30 months, his estimated height would have been 176 cm, so he is likely to be less than that. Based on his average growth between $1^1/_2$ and 3 years, he was probably about 83.6 cm at 30 months, meaning he would be about 167 cm as an adult, which in this case, is outside the range based on the formula using his parents' heights.

Based on the formula and using her parents' heights, Deborah will be between 158.5 cm and 178.5 cm. Her average growth between $1^1/_2$ and 3 years means she was probably about 83.3 cm at 24 months, meaning she would be about 167 cm as an adult, which does fit in with the first formula used.

Page 4: Home Run

Activity

Game ends	Bus leaves Karori Park	Bus arrives at Kilbirnie
10.30 a.m.	10.50 a.m.	11.22 a.m.
11.00 a.m.	11.20 a.m.	11.52 a.m.
11.30 a.m.	11.50 a.m.	12.22 p.m.
12.00 p.m.	12.20 p.m.	12.52 p.m.
12.30 p.m.	12.50 p.m.	1.22 p.m.
12.45 p.m.	1.05 p.m.	1.37 p.m.
1.00 p.m.	1.20 p.m.	1.52 p.m.
1.30 p.m.	1.50 p.m.	2.22 p.m.
1.45 p.m.	2.05 p.m.	2.37 p.m.
2.00 p.m.	2.20 p.m.	2.52 p.m.

Page 5: Can You?

Activity One

1. If the length of all the cans is 12.5 cm (standard can size), 750 cans would measure 93.75 m (9 375 cm).
2. a. Answers will vary. You could weigh a number of empty cans to get a mass you can actually measure on the scales (a can weighs approximately 18 g), or you could weigh a full can and subtract the mass of the liquid.

   b. Approximately 13.5 kg (13 500 g)

   c. 266.25 L (266 250 mL)

Activity Two

1. Between 800 000 and 900 000.
   (A more precise answer is 875 000.)
2. a. Answers will depend on those given for question **1**. (Based on the more precise answer for question **1**, an exact answer is 656 250 000.)

   b. Answers will depend on those given for question **1**. (The exact answer in kg is 11 812 500 kg.)

   c. Answers will vary, again depending on earlier estimates and whether you allow for the cardboard (many cans in six-packs are joined by plastic). Using the measurements given at the start of the activity (and not allowing for the cardboard), the volume of one six-pack would be 2 700 cm^3 (18 cm x 12 cm x 12.5 cm). So for 109 375 000 six-packs (656 250 000 cans), the volume would be 295 312.5 m^3 (295 312 500 000 cm^3).

Page 6: Fuel for Thought

Activity One

Tank 2. Most fuel gauges in cars measure the *height* of the fuel in the tank (using a floating device), not the amount. So a tank with a wider base will have more fuel left than a tank with a narrower base or one that is a regular shape.

Activity Two

1.–2. Practical activities. Results will vary.
Teacher to check graph

3. Results will vary. Teacher to check graphs

Page 7: Cold Comfort

Activity One

1. 27 cubes
2. 27 L

Activity Two

Practical activity. The most likely side lengths of the boxes that you find would be close to:

a. 25 cm x 20 cm x 20 cm

b. 40 cm x 40 cm x 30 cm

c. 40 cm x 50 cm x 40 cm

However, you may come up with boxes with other measurements that are close in capacity to 10, 48, and 80 litres.

Page 8: Cool It

Investigation

1. Practical activity
2. a. The uninsulated tube should cool most quickly.

   b. Results may vary, depending on the effectiveness of the insulating material.

   c. Hot objects cool down until they are at the same temperature as their surroundings. Insulation slows this process down, but some insulating materials do this better than others.

Page 9: Breaking Bags

Activity

1. Practical activity
2. 1 L of water = 1 kg. You can use this to work out the mass of a bottle without weighing the bottle.
3. Practical activity. Results will vary.

Page 10: Hundreds and Thousands

Activity

Answers will vary. You could do a fraction of each activity (for example, $^1/_5$, $^1/_{10}$, $^1/_{100}$) and then multiply the result by the relevant whole number. (Fractions used could vary according to the activity, for example, you might wash your hands once but read 100 words.)

Page 11: Candle Trials

Activity

1.–2. Practical activities

3. Answers will vary, but you will need to find a rate to use as a unit for estimation. For example, 700 mL ÷ 23 sec = rate.

Investigation

Practical activity. You should find that the water rises $^1/_5$ of the way up the jar. (Air contains $^1/_5$ or 20% oxygen. The rest is nitrogen.)

Page 12: Hearty Applause

Activity One

Practical activity

Activity Two

1. Practical activity
2. About 50 mL

Investigation

Answers will vary. Activities could include running, jumping, skipping, cycling, and swimming.

Page 13: Pondering Pendulums

Investigation One

Investigation will show that the shorter the length of the string, the faster the pendulum completes a full swing and the longer it is, the slower the swing.

Investigation Two

1. As long as the string length is unaltered, the time taken for each full swing will always stay the same even though the speed of the pendulum slows down.
2. Research activity

Pages 14–15: Gigantic Jumbo

Activity One

1.–2. Practical activities

Activity Two

1. 31 200 kg (31.2 tonnes)
2. 37.44 m^3 (37 440 000 cm^3)

Activity Three

1. From Auckland: Hong Kong, Osaka, Singapore, T´aipei, and Tokyo
   From Wellington: None. (All the flights from Wellington go to Australia first.)
   From Christchurch: Osaka, Singapore.
   (The other destinations require passengers to stop at Auckland first.)
2. Auckland–Hong Kong: 10.05 p.m. Wednesday
   Auckland–Osaka: 8.25 p.m. Wednesday
   Auckland–Singapore: 9.15 p.m. Wednesday
   Auckland–T´aipei: 10.35 p.m. Wednesday
   Auckland–Tokyo: 10.55 p.m. Wednesday
   Christchurch–Osaka: 10.50 p.m. Wednesday
   Christchurch–Singapore: 10.15 a.m. Wednesday
3. Auckland–Hong Kong: 2205
   Auckland–Osaka: 2025
   Auckland–Singapore: 2115
   Auckland–T´aipei: 2235
   Auckland–Tokyo: 2255
   Christchurch–Osaka: 2250
   Christchurch–Singapore: 2015

Pages 16-17: The Heat Is On

Activity

1. Neither is right. Overall, temperatures for the 9 days at both places add up to 203°, an average of 22.6°C. On four of the days, the airport temperature is slightly higher than the city temperature. On another 4 days, the city temperature is higher than the airport temperature, and on the remaining day, the temperatures are the same.
2. Discussion will vary and may include the impact of daylight saving, the way temperature increases and decreases during the day, and the way this is different in winter and in summer.
3. Summer. Temperatures in Wellington rarely reach 25°C at other times of the year.
4. Practical activity

Pages 18-19: Growing in Water

Activity

Note: your answers could vary by + or – 1 mm.

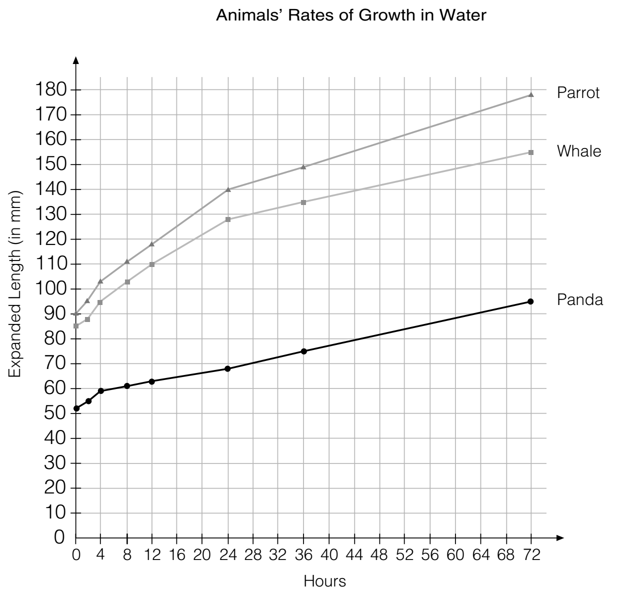
1.–2.

Hours	Whale	Panda	Parrot
0	85	52	90
1	88	55	95
4	95	59	103
8	103	61	111
12	-	-	-
24	128	69	140
36	-	-	-
72	155	90	178

3.

Hours	Whale	Panda	Parrot
0	85	52	90
1	88	55	95
4	95	59	103
8	103	61	111
12	**116**	**65**	**126**
24	128	69	140
36	**142**	**79**	**159**
72	155	90	178

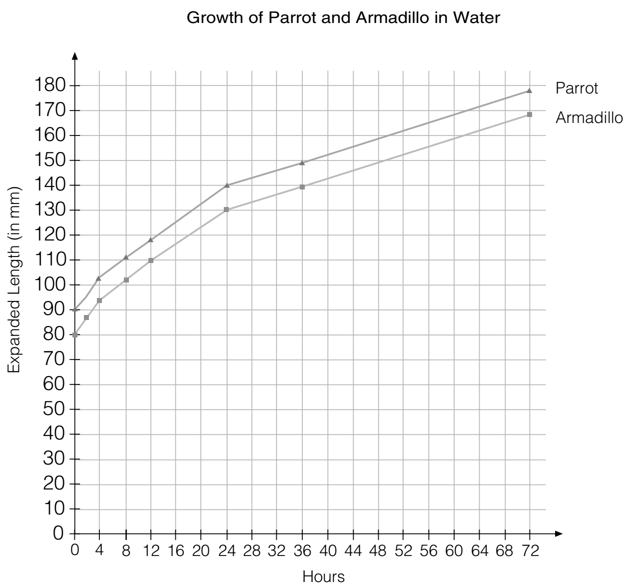
A graph of the three animals, with definite and estimated times, could look like this:



4. Note that the answers in bold are estimates only (based on the parrot pattern).

Hours	0	4	12	24	72
Armadillo	80	**93**	**116**	**131**	**169**

These lengths could be worked out on a graph like this:



5. Yes. The company's claims are based on the volume (size) increasing by six. A small increase in length may correspond to a large increase in volume. If you have experimented with objects that grow in water, you will probably have found that they do grow to over six times their size (volume).

Page 20: Covering Up

Activity

1. Yes, he is right. Red Cuisenaire rods measure 2 x 1 x 1, the same proportions as the hay bales (100 x 50 x 50).

2. a. Under a 10 x 10 m tarpaulin, 162 bales can be stacked in a one-bale-high haystack, 256 in a two-bale-high haystack, 294 bales in a three-bale-high haystack, and 288 in a four-bale-high haystack. After the three-bale-high haystack, the numbers of bales decreases. So the three-bale-high haystack has the most bales in it (294).

   b. You could work this out without modelling it if you organise your data systematically. For example, you could use a table like this:

Bales wide	Bales long	Bales high	Total Bales
18	9	1	162

Page 21: Egging You On

Activity

1. Practical activity. The recommended mass ranges used by most poultry farmers are:
   Grade 5: 43–53 g
   Grade 6: 53–62 g
   Grade 7: 62–71 g

Note: A 53 g egg can go in grade 5 or in grade 6, and a 62 g egg can go in grade 6 or in grade 7.

2. a. Practical activity. Results will vary.

   b. Practical activity. Answers will vary. Possible ways are:
   - divide the middle circumference by 2
   - add the longways and the middle circumferences and divide this by 4.5
   - multiply the longways and the middle circumferences and then divide by 360.

Investigation

Practical activity. Results will vary.

Page 22: It's a Wrap

Activity

1. To get the width of the piece of paper, she took the width of the box, added the height, and then added 2 cm for overlap. To get the length of the piece of paper, she multiplied the depth by 2, added that to the height multiplied by 2, and added 2 cm overlap. For the tape length, she went: (2 x 30 cm) + (2 x 20 cm) + (4 x 15 cm) + 40 cm for tying.

2. Answers will vary. Teacher to check

3. Rules could be expressed as:
   paper width = box width + box height + 2 cm
   paper length = (box depth x 2) + (box height x 2) + 2 cm
   tape length = (2 x box length) + (2 x box width) + (4 x box height) + 40 cm.

Page 23: Popcorn Peril

Activity

1. Answers may vary. The increase could be expressed in mL or as a proportion of uncooked popcorn volume to cooked popcorn volume.

2. Answers will vary.

3. Answers will vary, depending on the answer to question **1**. If the answer to question **1** was "20 times bigger", for the small bag ($V = 10 \times 5 \times 20 = 1\,000$ cm^3) you could say 1 000 ÷ 20 = 50, so you need 50 mL of uncooked popcorn. The big bag would be 3 240 ÷ 20 = 162 mL.

4. Answers will vary, depending on the quality of the popcorn, how it was cooked, and the temperature at which it was cooked. You could use your answers from questions **1** and **2** and find out how much 1 cm^3 of cooked popcorn weighs (mass of cooked popcorn ÷ volume of cooked popcorn). There are 1 000 cm^3 in a cubic metre, so multiply your answer by 1 000.

5. Answers will vary, depending on the size of the classroom.

Page 24: Working with Data

Activity

1.–3. Answers will vary.

Measurement

Teachers' Notes

Overview: Measurement

Title	Content	Page in students' book	Page in teachers' notes
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Cold Comfort	Measuring length and capacity	7	14
Cool It	Measuring temperature	8	15
Breaking Bags	Measuring mass	9	16
Hundreds and Thousands	Solving problems with time	10	17
Candle Trials	Measuring capacity and time	11	17
Hearty Applause	Exploring length, mass, volume, and time	12	19
Pondering Pendulums	Exploring problems of time and length	13	20
Gigantic Jumbo	Solving problems involving time, length, and volume	14–15	21
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Working with Data	Using scales	24	29

Page 1: Shady Shadows

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- read and interpret everyday statements involving time (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)

Activity One

In this activity, students estimate the height of an object by comparing the length of its shadow with the length of a shadow of an object with a known height (in this case, a metric ruler held vertically).

The students will need to measure the shadow of the metre ruler carefully. They will need to keep the ruler vertical because only a slight change of angle can cause a large error. They could do this by holding a plumb line (a string with a sinker at the bottom) beside the ruler or using a carpenter's level or large classroom set square.

The metre ruler in the example in the students' book is twice as long as its shadow. The length of the shadows of the other objects measured will be in the same proportion to the height of the object as the ruler is to its shadow.

Object	Height of object	Length of shadow	Object ÷ shadow
	1 000 mm	500 mm	1 000 ÷ 500 = 2
	$\boxed{?}$	600 mm	$\boxed{}$ ÷ 600 = 2

So, if the other object has a shadow of 600 millimetres (measured at the same time of day), it must be 2 x 600 = 1 200 millimetres high.

The students may think of this in a number of ways. For example:
"Because the ruler's shadow is half as long as the ruler, the object must be twice as long as its shadow."
"If 600 millimetres is $^1/_2$, then one whole would be 1 200 millimetres (600 x 2)."

When the students are measuring actual shadows, the numbers may not be quite so neat, so they may need to round their measurements to estimate the height of the object. You could ask them, "About how many times bigger than its shadow is the metre ruler? This is how many times bigger than its shadow the object will be."

If the students want accurate results, they can use a calculator to divide the metre ruler by its shadow to get the proportion. For example, if the shadow of the metre ruler is 270 millimetres, 1 000 ÷ 270 = 3.7, so all the objects measured at the same time that day will be 3.7 times bigger than their shadows.

If the students measure objects late in the day, they may find that the shadows are longer than the height of the object.

Activity Two

Stephanie is correct because the shadows were measured at the same time of day and the length of the shadow of the tree is approximately half the length of the shadow of the goalpost.

You can show this to the students using a metre ruler and a spring peg. Clip the peg halfway along the ruler. Hold the ruler vertically and show the students that the peg's shadow is still halfway up the ruler's shadow. Tilt the ruler to change the shadow length. Note that the peg's shadow is still at the halfway position. Therefore, if one object is half the height of another object, its shadow will always be half the length of the shadow of the other object (if measured at the same time of the same day).

Investigation

Once again, the students need to keep the metre ruler vertical for all measures (see **Activity One**). They could measure the shadow at regular intervals, such as every hour. They could then graph their results to see how the shadow changes with time.

The students should be able to see that the shadow is shorter in the middle of the day (allowing for daylight saving if necessary) and longer at the beginning and the end of the day.

See also *Shadows,* Book 9 in the Building Science Concepts series (Ministry of Education, 2001).

Pages 2–3: High Hopes

Achievement Objective

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)

Activity One

After the students have found the average of the parents' heights, ensure that they *subtract* 6.5 centimetres for girls and *add* 6.5 centimetres for boys. This is done because men tend to grow taller than women.

The formulas in question **2** are based on girls' heights at 24 months and boys' heights at 30 months. This is because boys tend to grow more slowly than girls when they are young.

Question **2b** asks students to work backwards from their answer in question **1b**. There, they worked out that Elizabeth's height was likely to be between 168 and 188 centimetres. By taking this figure and dividing by 2, they can estimate that she is likely to have been between 84 and 94 centimetres at 2 years. Ask the students to discuss why they had to divide by 2. To predict the adult height from the height at 2 years, they had to multiply by 2. They need to see that to work back from adult to child, they reverse the formula, so they would divide by 2.

Activity Two

The students can estimate Paul's and Deborah's adult heights in two ways: they can use the formula based on the parents' heights, or they can use the formula based on Paul's and Deborah's heights as children. It is worth them using both methods and comparing the results. This comparison can lead to discussion about the accuracy of such formulas and estimates. The Answers section includes useful discussion about how to use the estimate from one formula to improve the accuracy of the estimate from another formula.

Using the formula based on parent heights, students will estimate that Paul's adult height will be between 171.5 and 191.5 centimetres and Deborah's adult height will be between 158.5 and 178.5 centimetres.

In question **2**, the students may need some help to match the data given with the formula based on children's heights. Deborah and Paul's heights are given at $1\frac{1}{2}$ years (18 months) and 3 years (36 months), but the formula for girls doubles the height at 24 months and the formula for boys doubles the height at 30 months. Because the data does not match exactly to the formula, the students will have to make a reasonable estimate from the data to use in the formulas.

One way to do this would be to work out the average growth between $1^1/_2$ and 3 years in 6 month periods. To do this, find the difference between the heights at 18 months and 36 months and divide it by 3 (three lots of 6 months).

	At 18 months	At 36 months	Average 6 month growth
Deborah	78 cm	94 cm	$^{16}/_3 = 5^1/_3$ cm
Paul	75 cm	88 cm	$^{13}/_3 = 4^1/_3$ cm

This means that Deborah at 24 months is likely to be $83^1/_3$ centimetres and Paul at 30 months is likely to be $83^2/_3$ centimetres. These heights will be doubled to estimate the adult height. (See the Answers for further comment.)

Page 4: Home Run

Achievement Objectives

- read and interpret everyday statements involving time (Measurement, level 3)
- read and construct a variety of scales, timetables, and charts (Measurement, level 4)

Activity

This activity introduces students to a common timetable layout. By working through the exercise, they will confront the variations needed in laying out a transport timetable so that it solves timetabling problems, such as changes in demand levels over a typical day.

Before the students begin the activity, they could look at the first section, showing buses leaving Karori Park between 6.40 a.m. and 9.50 a.m., to make sure that they understand how to read the timetable.

Ask questions such as:
"What time does the bus that leaves Karori Park at 8.35 a.m. get to Wellington Hospital?"
"How long does the trip from Karori Park to the Kilbirnie shops take?"
"Is Courtenay Place closer to Karori Park than Lyall Bay? Use the timetable to help you decide."

Ask the students to investigate the frequency of the buses and explain the variations throughout the timetable. For example, the middle section of the timetable, with the 15 minute space between buses, is a different layout. Questions that may help include:
"What hours in the day apply to this section of the timetable?"
"Why are there only four times listed in this section for each stop?"
"What time does a bus that leaves Karori Park at 11.20 a.m. get to Wellington Hospital?"
"Why did the timetable designers choose to use this layout for the middle section of the day?"

The last section of the timetable reverts to the original format. Ask:
"What do the dashes at Lyall Bay for the last two trips of the day mean?"

When the students can confidently read the timetable, they can complete the chart. Ensure they allow 10 minutes after the end of the game for Geoffrey to get to the bus. After they have completed the table, they could investigate other timetables that they are likely to use, such as local bus or train timetables or the times of games in a sports tournament. As well as checking that they can read the timetables accurately, encourage them to think about the layout of the timetables. You could ask, "Why did the designer of the timetable use this particular layout?"

Page 5: Can You?

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- perform measuring tasks, using a range of units and scales (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)
- calculate perimeters of circles, rectangles, and triangles, areas of rectangles, and volumes of cuboids from measurements of length (Measurement, level 4)

In these activities, students work with the length, mass, and volume of a single object to find the length, mass, and volume of a large number of these objects.

Activity One

For questions **1**, **2b**, and **2c**, encourage the students to express the answer in a variety of units so that they can see the relationship between centimetres and metres, grams and kilograms, and millilitres and litres. You could challenge some students to express the lengths in kilometres (0.09375 kilometres) or the volume in kilolitres (0.26625 kilolitres).

For question **2a**, the students may find it difficult to get an accurate reading on the scale if they only weigh one can at a time. Encourage them to try a variety of techniques to find a more accurate measure.

Discuss the methods that the class come up with. For example, they could weigh 10 cans and divide by 10 to find the average mass. This should reduce the errors made by weighing one can at a time.

Activity Two

In this activity, students estimate rather than calculating more exactly as they did in **Activity One**. For example, in question **1**, they can explore different strategies for estimation. Some may round up the 3 500 000 people to 4 000 000 and find $^1/_4$ of this, which is 1 000 000. If they do this, ask them if they can think of a more accurate method, such as rounding 3 500 000 to 3 600 000, which is easily divided by 4. This answer would be 900 000. Others may reduce 3 500 000 to 3 200 000. Their estimate would then be 800 000.

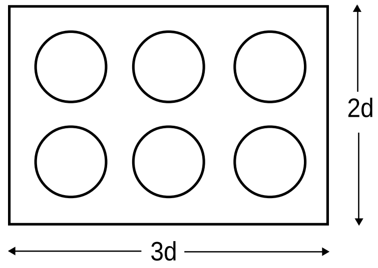
Discuss which strategy gives the closest estimate. Explore the idea of finding the average of the estimates for a more accurate answer. For example:
900 000 + 800 000 = 1 700 000
    1 700 000 ÷ 2 = 850 000

In question **2a**, the students predict the product of 750 (the number of cans used by each household) times their answer to question **1**. Some may realise that 750 is $^3/_4$ of 1 000 and so work out $^3/_4$ of, say, 800 000, which is 600 000, and then multiply this by 1 000 to make 600 000 000. Others may round 750 to 800 and then multiply 800 000 or 900 000 by 800 and get 640 000 000 or 720 000 000 as an answer.

A good technique would be to round up 750 to 800 and then use the lowest estimate of question **1** (800 000): 800 x 800 000 = 640 000 000. This technique of using one high estimate and one low estimate reduces the error caused by rounding and gives a very accurate estimate.

Once again, the calculation in question **2b** will depend on earlier estimates and the students' answers to questions **2a** and **2b** in **Activity One**. Have the students explain their thinking and calculation. Make sure that they use the correct unit in the answer.

For question 3, the students can either measure a real six-pack or work out the diameter of a can and calculate the volume. The calculation would be (3 x the diameter) x (2 x the diameter) x 125 (the height) plus a little for spacing for the six-pack.



Page 6: Fuel for Thought

Achievement Objectives

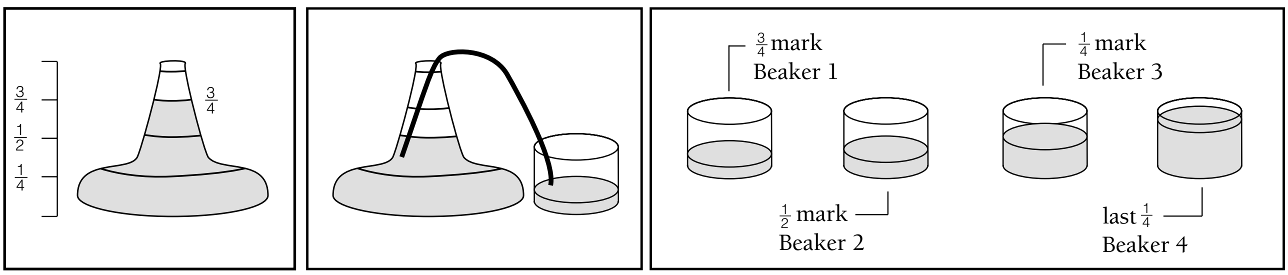
- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)

In these activities, students compare the height of the liquid in a container with the amount of liquid. They will see that, depending on the shape of the container, water filled to half the height of the container is not necessarily half the volume of the container.

Activity One

The students who don't understand how the shape of a container can affect the level of an amount of liquid might answer that all the tanks have the same amount of fuel. A practical demonstration will help them see that this is not the case. (The method suggested here uses siphoning to remove liquid from the container. This means that the students can fairly easily control how much liquid is removed. They may also like to use siphoning instead of tipping for **Activity Two.**)

Mark four equal gradations on the sides of a flask with a large base. Fill the flask to the top mark with water and colour the water with food colouring to make it easier to see. Use some plastic tubing as a siphon and siphon the water into a beaker until it reaches the $^3/_4$ mark. At this point, one of the students can stop the flow temporarily by placing their finger over the end of the tube, but they need to make sure that they do not remove the tube from the water in the flask because it will not start flowing again if they do. Remove the beaker and siphon the water into another beaker until the water in the flask reaches the $^1/_2$ mark. Repeat this two more times until the flask is empty. The students can then compare the water in the four beakers. They will see that a quarter drop in the height of the water isn't the same as a drop of one-quarter of the capacity.



Activity Two

The experiment above would lead nicely into **Activity Two**, where students graph the results of similar experiments with several different-shaped bottles.

After the students have completed their graphs, they should compare the shape of their graph with the outline of the bottle it comes from and discuss any similarities in the patterns.

Make sure that they have realised that the height of the water drops most quickly at the narrowest part of the bottle and most slowly at the widest part of the bottle.

Page 7: Cold Comfort

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- calculate perimeters of circles, rectangles, and triangles, areas of rectangles, and volumes of cuboids from measurements of lengths (Measurement, level 4)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)

Activity One

In this activity, students work with the equivalent volumes of 1 000 cm^3, a 1 000-place-value cube, and 1 litre. A 1 000-place-value cube is 1 000 cm^3, and the bin is 30 centimetres x 30 centimetres x 30 centimetres (or 27 000 cm^3), so three cubes will fit in the width, three will fit in the length, and three will fit in the depth. 3 x 3 x 3 (or 3^3) = 27, so 27 place-value cubes fit in the bin. The students may like to model this with place-value cubes.

A 1 000-place-value cube is easy to make. Cut a 10 centimetre x 10 centimetre x 10 centimetre block of wood and draw centimetre gridlines on the surface. It can be used to remind the students what a 1 litre volume looks like.

A good way of relating 1 000 cubic centimetres to 1 litre is to shape a bit of Plasticine into an exact 1 cm cube. Take a measuring cylinder (available from the science room) and half fill it. Then carefully lower the Plasticine cube into the water. The easiest way to do this is pick it up with a toothpick. Take note of how much the water level rises (1 millilitre). This shows that 1 000 cubic centimetres is 1 000 millilitres, which is 1 litre.

A 1 000-place-value cube and 1 000 cm^3 both have the same volume as 1 litre. The students can use their answer to question **1** to answer question **2**. If 27 place-value cubes fit in the bin, the size of the bin must be 27 litres.

The students could also calculate the volume using the formula V = L x W x D (where V = volume, L = length, W = width, and D = depth). 30 x 30 x 30 = 27 000 cm^3, so the volume is 27 litres.

Activity Two

In this activity, the students are reversing the process they used in **Activity One**. In that activity, they used the dimensions to find the capacity. Here, they use the capacity to find the dimensions.

The students could begin by estimating what size supermarket box would hold 10 litres, 48 litres, and 80 litres. They could then check their estimate by measuring the dimensions and calculating the capacity.

Another approach is for the students to make a chart showing some dimensions for each box that would result in the required capacity and then select one that would be practical to use. For example:

For 10 litres

Length		Width		Depth		Total		Capacity
100 cm	x	10 cm	x	10 cm	=	10 000 cm^3	=	10 litres
50 cm	x	20 cm	x	10 cm	=	10 000 cm^3	=	10 litres
40 cm	x	25 cm	x	10 cm	=	10 000 cm^3	=	10 litres
25 cm	x	20 cm	x	20 cm	=	10 000 cm^3	=	10 litres

For 48 litres

Length		Width		Depth		Total		Capacity
120 cm	x	20 cm	x	20 cm	=	48 000 cm^3	=	48 litres
60 cm	x	40 cm	x	20 cm	=	48 000 cm^3	=	48 litres
30 cm	x	40 cm	x	40 cm	=	48 000 cm^3	=	48 litres

For 80 litres

Length		Width		Depth		Total		Capacity
200 cm	x	20 cm	x	20 cm	=	80 000 cm^3	=	80 litres
100 cm	x	40 cm	x	20 cm	=	80 000 cm^3	=	80 litres
50 cm	x	40 cm	x	40 cm	=	80 000 cm^3	=	80 litres

Note that these measurements should be for the inside of the container.

Page 8: Cool It

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)

Investigation

Caution: Hot water taps usually give hot water at approximately 55°C. Many primary schools do not have normal hot water taps at this temperature. You will need to ensure that water from a Zip heater or electric jug is provided between 50°C and 55°C. Do not let the students handle very hot water.

Have the students set up the six test tubes in the toothpaste packets, with another non-insulated tube in the holder. Each student should practise reading their spirit thermometer accurately and with reasonable speed.

Check that everything is ready before the students take the temperature of the water in the jug. Fill all the test tubes as quickly as is practicable then have a student start the stopwatch to measure each $2^1/_2$ minute period.

All the insulated test tubes should cool more slowly than the uninsulated one. Which test tube cools more slowly will depend on how well the insulating material "protects" the warm water from the outside environment. Just as a marble perched on a slope rolls down to level ground, so hot objects lose their heat to the surrounding environment until they are the same temperature as their surroundings. The task of the insulating material is to stop the heat being lost to the surrounding environment. Some insulators are better than others. For more information on this topic, you might like to visit the following website:
http://www.eecs.umich.edu/mathscience/funexperiments/agesubject/lessons/caps/htransfer.html

For other background information on heat and insulation, see Science Focus: Heat in *Making Better Sense of the Physical World* (Ministry of Education, 1999).

The third method of heat transfer is called radiation. Another test tube could be painted in aluminium paint to see if this method of insulation can prevent heat loss.

Page 9: Breaking Bags

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- perform measuring tasks, using a range of units and scales (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)

Activity

Many shoppers complain that plastic shopping bags don't hold very much before they break. Here is an opportunity to test out an interesting everyday situation, even though it may not be strictly realistic because the bag doesn't have to be lifted or the handles subjected to a moving, jiggling load.

This experiment may have some surprising results. Some bags can hold as much as 18 kilograms of carefully packed bricks before giving way. You will need to supervise this activity carefully so that the students do not get injured if bricks fall out of the plastic bag. One alternative is to use packets of rice. Another way is to fill small freezer bags with sand until the bag and the sand have a mass of 250 grams.

Results will vary widely. If the students wrap the bricks in newspaper, as suggested, they will need to include the mass of the newspaper. The way the bricks are placed or dropped into the bag will affect the result. Placing bricks with a corner poking into the plastic at the bottom of the bag may also cause early breakage. Does the placement of the handles wide apart or close together change the result? These ideas could be explored in an extended investigation.

Question 2 draws on the students' knowledge that 1 litre of water has a mass of 1 kilogram. So, if they are using 1.5 litre plastic bottles filled with water, the mass will be 1.5 kilograms (with a little extra for the mass of the plastic bottle).

In question 3, try and have the students keep as many aspects as possible the same. Use the same bricks, rocks, or water bottles, put them in the bag in the same way, and have the handles in the same positions. This should highlight the idea of fair testing by trying to have everything constant except the variable being tested. A good question to conclude this activity would be, "Did we do a fair test?" and have the students explain their views.

Page 10: Hundreds and Thousands

Achievement Objectives

- read and interpret everyday statements involving time (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)
- perform calculations with time, including 24-hour clock times (Measurement, level 4)

Activity

The purpose of this activity is for students to find an efficient way to work out how long it would take them to perform various tasks, without actually completing all the tasks. Introduce the activity carefully so that the students do not waste their time completing the task. Ask them to suggest quick ways to time each task. They might suggest that they do a fraction of each task and from this, calculate the time to do the complete task.

If necessary, suggest this strategy by asking questions such as:
"How could you use the time taken to blink 10 times to make a good estimate for 1 000 blinks?"
"What fraction are you actually measuring?"
"How can you use this fraction to work out the time for the whole task?"

A common example of this that you could discuss with the students is taking a pulse. A pulse is usually measured in beats per minute, but the beats of the pulse are rarely counted for a whole minute. Usually they are counted for 10 seconds (which is $^1/_6$ of a minute) and then this count is multiplied by 6 to give the number of beats per minute.

Make sure that the students can use the reciprocal of the fraction, for example, $^1/_{10}$ and $^{10}/_1$, to solve the problem. They should be able to explain this in words, such as: "If we only measure $^1/_{10}$ of the task, we could work out the time by multiplying that measure by 10."

The students could use class time to work out a good fraction to use with each task. They could then measure some of the tasks for homework, using the reciprocal of the fraction to answer each question.

Page 11: Candle Trials

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- read and interpret everyday statements involving time (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)
- perform calculations with time, including 24-hour clock times (Measurement, level 4)

Activity

This activity provides a scientific context for students to develop and apply statistics skills.

Some careful preparation is necessary:

- Ensure that the working surface is smooth and level. A small whiteboard laid on some desks works well.
- Use food colouring to make the water level easier to observe.
- Remove labels from the jar so that observation is unimpeded.
- Place the candle on a lid that is smaller than the tops of the jars so that the jar can fit over it. The lid will collect any drips from the candle and can also be used to help stick down the candle if it is wobbly.
- Cut the candles so that they are smaller than the jars being used, but they should be at least 5 centimetres in height.

The students could work in groups of three or four, with designated tasks to encourage safe practice:

- a responsible person to light the candle (or you may do this)
- a person to place the jar over the candle
- a person to time the activity with a stopwatch, from placing the jar until the flame goes out
- a person to record the results on a table.

Ensure that the students realise that the flame went out because it had used all the oxygen that was in the air.

Question 3 develops higher order thinking by applying the results of the previous work. The students can use their previous results to find the rate, in millilitres per second, at which the candle uses the oxygen in the air. For example, if the candle in a 700 millilitre jar went out in 23 seconds, the rate would be 700 ÷ 23, which is approximately 30 millilitres per second. This rate could then be used to estimate the time taken for other jars.

Jar size	Rate	Estimated time taken
150 mL	30 mL per second	5 seconds
300 mL	30 mL per second	10 seconds

Investigation

Once the jar is in position, the students should carefully watch the water level inside the jar. They may notice that at first it drops a little as the flame adds some water vapour and carbon to the inside of the jar as well as expanding the gas in the jar by heating it.

The level will then rise up and stop rising 1 or 2 seconds after the flame goes out. Make sure that the students mark the height of the water in the jar before lifting out the jar. They should see that the water has risen approximately $^1/_5$ of the way up the jar. This is the amount of oxygen that has been removed from the air by the burning candle. This shows that air contains $^1/_5$ or 20% oxygen. Most of the rest is nitrogen.

Page 12: Hearty Applause

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- perform measuring tasks, using a range of units and scales (Measurement, level 3)
- read and interpret everyday statements involving time (Measurement, level 3)
- show analogue time as digital time, and vice versa (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)
- perform calculations with time, including 24-hour clock times (Measurement, level 4)

Activity One

The students may like to model their hearts using 500 grams of playdough. They could make a core using newspaper and build up the heart model with the dough. Ask them to try and make the distance around the heart the same as the distance around their clenched fist. Alternatively, they could weigh and measure objects at home or school to find something the right shape and size. For example, they could try a 500 gram pack of butter, a shot put, a hockey ball, a stone, or a hacky sack.

Activity Two

Measuring 5 litres will help the students visualise how much blood their heart pumps per minute. After they have done question **2**, they could measure 50 millilitres to see how much blood their heart pumps with each beat.

Investigation

Before the students begin the investigation, discuss with them ways to accurately take their pulse. They may like to work in pairs, with one person taking the other person's pulse or one person timing while the other person takes their own pulse.

If the students are trying various exercises to test out their pulses, make sure they do not try to exceed the 75% of the maximum rate for their age. Students with colds or other viral symptoms should not participate in these physical exercises, but they could do some research on the subject.

Repetitive, aerobic exercises are the easiest way to increase the pulse to the desired heart rate. Jogging, skipping, cycling, and fitness circuit activities would all be useful.

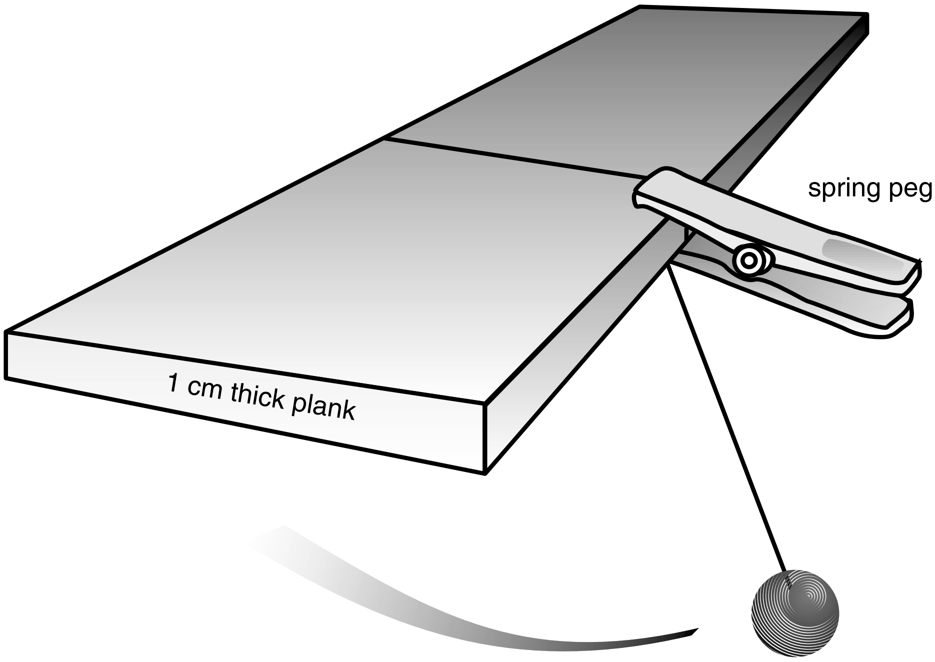
Page 13: Pondering Pendulums

Achievement Objectives

- read and interpret everyday statements involving time (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)
- perform calculations with time, including 24-hour clock times (Measurement, level 4)

Investigation One

One way to make a pendulum that is easily adjusted is to use a fishing line with a sinker on the end. Hang the line over a plank that is 1 centimetre thick, and then use a spring peg to clip the line to the plank. The students can easily adjust the length, and the pendulum swings more truly than if the line is held by hand.



Investigation will show that the shorter the length of the string, the faster the pendulum completes a full swing and the longer it is, the slower the swing. Note that the length of the arc that the pendulum swings does not affect the time of the swing. Only the length of the string affects the time. This is how some pendulum clocks are adjusted for accuracy. The weight is moved slightly up or down the length of the arm.

Investigation Two

The result of the investigation in question **1** should confirm that as long as the string length is unaltered, the time taken for each full swing will always stay the same, even though the speed of the pendulum slows down. Discuss the reason for this. The students may be able to see intuitively that as the pendulum slows, the swing distance shortens, so the time for each swing stays the same.

A good website that can be used for the investigation in question **2** is www.howstuffworks.com

Pages 14–15: Gigantic Jumbo

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- perform measuring tasks, using a range of units and scales (Measurement, level 3)
- read and interpret everyday statements involving time (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)
- calculate perimeters of circles, rectangles, and triangles, areas of rectangles, and volumes of cuboids from measurements of length (Measurement, level 4)
- read and construct a variety of scales, timetables, and charts (Measurement, level 4)
- perform calculations with time, including 24-hour clock times (Measurement, level 4)

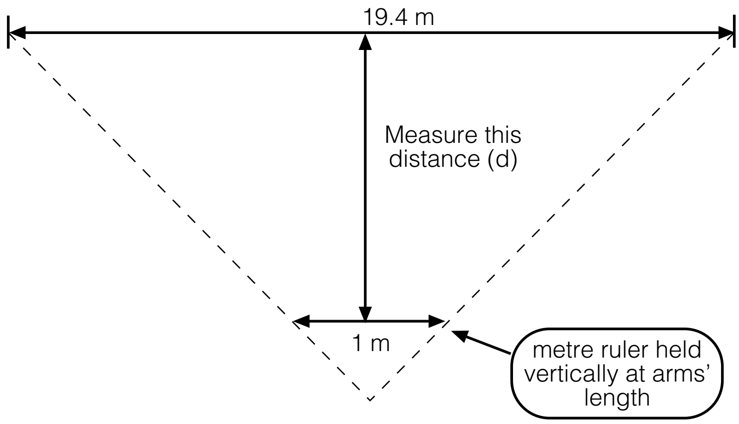
Activity One

Have the students use their knowledge of the size of their playing field to estimate the positions for the pegs to show the length and wingspan. Then they can use a trundle wheel or a 20 metre tape measure to confirm the actual positions for the pegs.

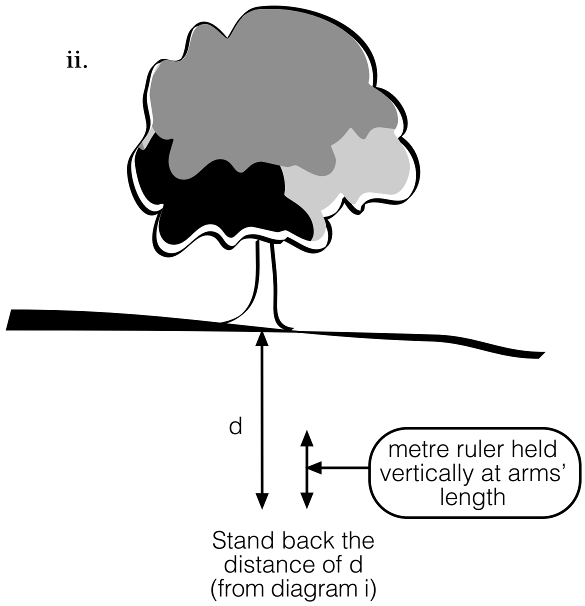
Remind the students how to use the trundle wheel correctly. Most trundle wheels revolve in only one direction so the clicking device will not break. Show the students the correct starting position so that the wheel makes a full turn before the count begins.

One way of finding an object that would be the same height as a jet would be to mark a distance of 19.4 metres with pegs on the ground. Then hold a metre ruler at arms' length and parallel to the 19.4 metre marks and walk backwards until the length of the ruler appears to be the same as the marks. (Perspective will make the marks seem closer together the further back you stand.) Measure the distance between you and the marks. Next, hold the ruler vertically and at arms' length and find an object that appears to be the same height as the ruler when you are standing the same distance back from it. This will be the height of the jet.

i.



ii.

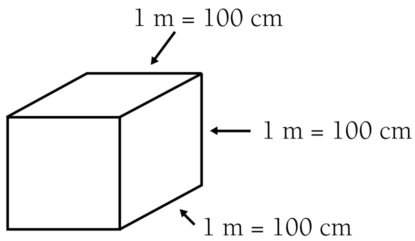


Alternatively, the students could use the shadow technique on page **1** of the students' booklet to find an object 19.4 metres high.

Activity Two

Have the students answer question 1 in kilograms and tonnes to highlight the relationship between these two units of measurement. In question 2, the volume could also be expressed as 37.44 m^3 or as 37 440 000 cm^3 because 1 000 000 cm^3 equals 1 m^3.

A cubic metre is a cube with sides of 1 metre. There are 100 centimetres in a metre, so this means each side of the cube is 100 centimetres long. If you calculate the volume of the cube in centimetres, it will be 100 x 100 x 100 = 1 000 000 cubic centimetres.



$$V = 100\text{ cm} \times 100\text{ cm} \times 100\text{ cm} = 1\,000\,000\text{ cm}^3 = 1\text{ m}^3$$

The students could compare this result to the volume of their classroom.

Activity Three

Note that question 1 requires direct flights that must be at least 6 700 kilometres (that is, half a tank of fuel) away from the point of departure. The International Country and Area Codes section in the telephone book, referred to in question 2, shows how many hours each place is behind New Zealand. Daylight saving is specifically excluded from the question because this could cause unnecessary complications for the students. However, the impact of daylight saving on travel is an interesting topic for discussion.

The students should be able to work out the times without too much difficulty. Singapore, for example, is 4 hours behind New Zealand before daylight saving. So if the 747 departs Auckland on a Wednesday at 3.00 p.m., the flight will take 10 hours 15 minutes, which would make it 1.15 a.m. on Thursday, New Zealand time. But take off 4 hours, and the time would be 9.15 p.m. on Wednesday in Singapore.

A chart like this may be useful:

Depart NZ	24 hour time	Time in flight	NZ time of arrival at destination	Time adjustment	Local time	24 hr time
3.00 p.m. Wednesday	1500	10 hr 15 min	1.15 a.m. Thursday	– 4 hrs	9.15 p.m. Wednesday	2115

Another activity that deals with international time zones is on page 18 of *Algebra,* Figure It Out, Levels 3–4.

For **Activity Three**, question 3, you may need to discuss with the students how to work out 24 hour time.

Pages 16–17: The Heat Is On

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- perform measuring tasks, using a range of units and scales (Measurement, level 3)
- read and interpret everyday statements involving time (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)

Activity

This activity uses a common query about local temperatures as a context for measuring temperature.

Discuss the possible factors that cause the temperature to vary in different locations. Exposure to sun and wind, altitude, and proximity to water, vegetation, or concrete surroundings can cause quite different temperatures even though the locations may be quite near each other. This leads into the idea of microclimates. The students could investigate the microclimates within the school grounds by measuring the temperature at different places at the same time on the same day. Have them predict the temperature based on observations of the site before measuring.

In order to make comparisons as seasons change, a town's temperature is usually measured at a consistent time and place, such as the airport or town hall.

Giving one temperature for each day, always measured at the same time and place, may not suit some people living in the town. Discuss with the students why some people may like to know the highest or lowest possible temperature for their town or some other town. They could also discuss some of the other temperature information given in some newspapers, for example, soil temperature, and who might use this information.

Pages 18–19: Growing in Water

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)

Activity

There is something a little magical about the way these toys can grow so dramatically in water. Find out if anyone in the class has done this with similar toys at home. Discuss their findings. (For example, they may have found that the toys distorted as they enlarged.)

This activity focuses on the change in length. Discuss whether this is the only way to measure a change in size. This discussion will be important in evaluating the manufacturer's claim for sixfold growth in question **5** because they are likely to be claiming an increase in volume, not length.

The students need to use given data to estimate unknown lengths. As explained in the students' book, there is no definite pattern in the growth of the animals, so a graph is the best way to estimate the unknown lengths. The students should not try to find an algebraic rule for the growth patterns. For example, the estimate for 36 hours is not found by multiplying the length at 12 hours by three.

Discuss with the students what scale they will use for the axes of their graphs before they begin because the axis for animal lengths will be quite long and they need to be sure it will fit on their page. If they use a scale of 10 millimetres : 4 hours for the time on the x axis (the horizontal axis), the axis will be about 190 millimetres long (allowing for extending beyond the last figure required). They could use a scale of 10 millimetres : 10 millimetres growth for the animal length on the y axis (the vertical axis), which will make this axis also about 190 millimetres long. These axes will fit on an A4 page.

As the students begin to graph the data, make sure that they realise that the times given are not at regular intervals and that they mark the lengths at the correct points on the graphs.

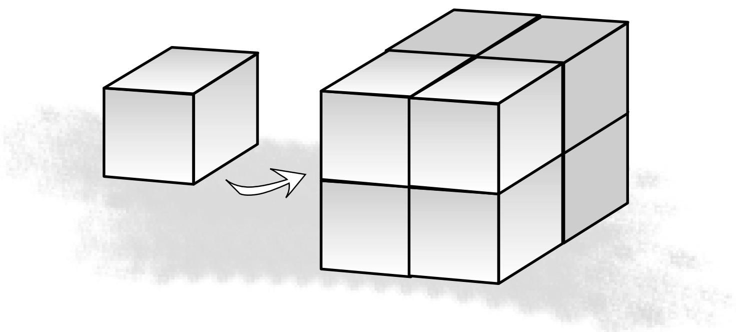
When the students have completed their graphs, they can interpolate (work within the data set) from the graph to estimate the animal lengths at 12 and 36 hours. For example, to estimate the length of the parrot at 12 hours, they will draw a vertical line up from the 12 hour point on the x axis until it meets the line on the graph. Then they will draw a horizontal line from the point above 12 hours on the line of the graph across to the y axis. The point at which the line hits the y axis is the length of the parrot.

In question **4**, the students will need to begin the armadillo graph at 80 millimetres and draw its growth line parallel to that of the parrot. (See the graph in the Answers.) It would be too complex to try to calculate a fraction to show the rate of growth at each of the time stages. After they have drawn the line, the students could use a ruler to help them read off the lengths after 4, 12, 24, and 72 hours.

The students also interpolate from given data in the activity on page 19, *Algebra*, Figure It Out, Levels 3–4.

Question **5** highlights the fact that changes in size can be measured in more dimensions than just length. These objects expand in all directions at once, and so they grow in volume more than in length. The manufacturers are correct because a small increase in length may correspond to a large increase in volume.

You could demonstrate this to the students with multilink cubes. If you double the length of all the sides of one cube, you increase the volume eight times.



Page 20: Covering Up

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- calculate perimeters of circles, rectangles, and triangles, areas of rectangles, and volumes of cuboids from measurements of length (Measurement, level 4)

Activity

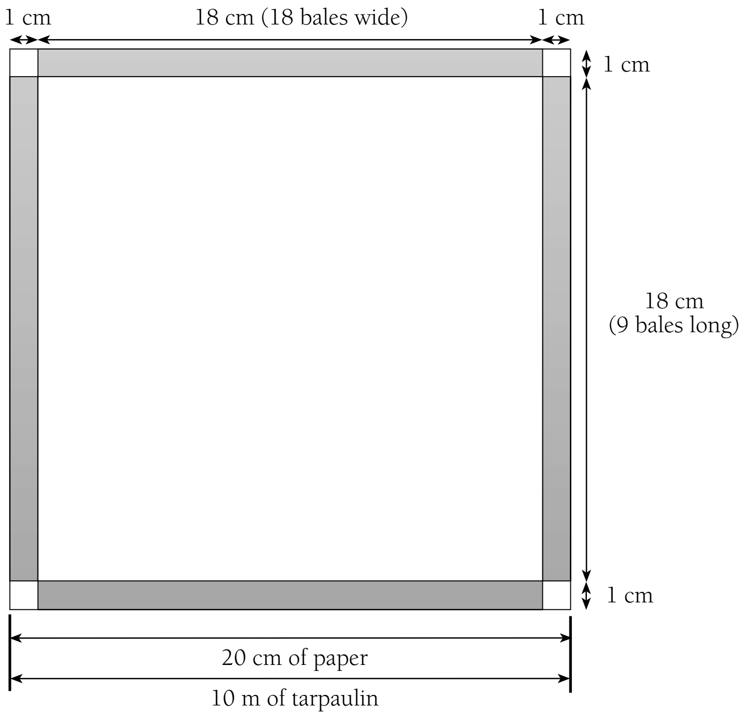
This activity encourages students to use a scale model to solve a volume measurement problem. It is very important that they understand the scale used so that the connection between the Cuisenaire rod and the hay bale is understood.

The red Cuisenaire rod has dimensions of 2 centimetres x 1 centimetre x 1 centimetre. The hay bales are 100 centimetres x 50 centimetres x 50 centimetres, so the scale is 1 : 50. Make sure that the students understand that the 20 centimetre x 20 centimetre paper model of the tarpaulin is also to a scale of 1 : 50. Hence, 2 centimetres of paper models 1 metre of tarpaulin.

If working with both metre and centimetre units becomes a source of error, discuss the importance of working in a common unit. This could be either centimetres or metres.

You may need to remind the students that the tarpaulin must completely cover the top and all four sides of the haystack. This means that each dimension of the tarpaulin must be able to cover up one side, along, and down the other side of the haystack. So the higher the haystack, the more tarpaulin is needed to cover the first side and the less tarpaulin there is left to cover the other sides of the haystack.

For a two-bale-high haystack:



Observe the students to see if they are trying a systematic approach. If necessary, suggest that they model haystacks that are one bale high, two bales high, and so on. Encourage them to record on a chart the dimensions of each stack while comparing the model to the haystack it represents.

Model					→	Haystack						
Height		Length		Width	→	Bales high		Bales long		Bales wide		Total bales
1 cm	×	18 cm	×	18 cm	→	1	×	9	×	18	=	162
2 cm	×	16 cm	×	16 cm	→	2	×	8	×	16	=	256
3 cm	×	14 cm	×	14 cm	→	3	×	7	×	14	=	294
4 cm	×	12 cm	×	12 cm	→	4	×	6	×	12	=	288

Note that the most bales that can be stacked under a tarpaulin are 294 in a three-bale-high haystack. After that, the number of bales decreases. You could discuss with the students why this happens. Points to discuss include the relationship of volume to surface area and the amount of tarpaulin at the corners, which cannot be used to cover any hay bales.

By organising the data systematically, some students may be able to predict the dimensions of the models without making them. This is the purpose of the last question.

As an extension, you could vary the dimensions of the tarpaulin or the hay bales.

Page 21: Egging You On

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)

Activity

The graded size of an egg is determined by its mass, but of course the larger the egg, the more it should weigh. Question 1 suggests weighing four eggs at a time as a practical way of handling a dozen eggs, rather than weighing one egg at a time. The students will need to find the average mass by dividing by four.

Egg cartons have the minimum net mass stamped on them. A dozen grade 7s has a minimum net mass of 744 grams. The average is therefore 62 grams. The students could compare their average to the minimum net average stated on the carton.

Question 2 explores the relationship of size to mass by looking at the circumferences longways and around the middle. There is not a correct answer to question 2b. The students can hypothesise possible ways to come up with a technique to estimate mass from this data.

Have the students work in problem-solving groups of four to suggest at least two ways that might be used to estimate the mass. (Some ways are suggested in the Answers.) Encourage the students to use a calculator.

Investigation

Ensure that there are sensible safety precautions so that the students do not handle hot eggs or boiling water.

The conclusions that the students make in this investigation will depend on the accuracy of the measuring instruments available. Finding a correct answer is not important – it is the reasoning they use to justify the conclusions and the measuring skills they display that are of interest.

Some students may measure a number of eggs before and after boiling to give a better chance of seeing whether there is a difference.

Page 22: It's a Wrap

Achievement Objectives

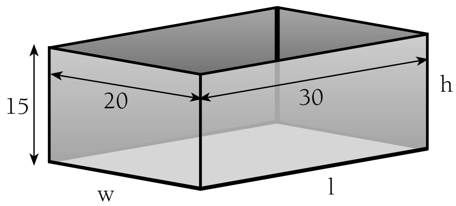
- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- perform measuring tasks, using a range of units and scales (Measurement, level 3)
- calculate perimeters of circles, rectangles, and triangles, areas of rectangles, and volumes of cuboids from measurements of length (Measurement, level 4)

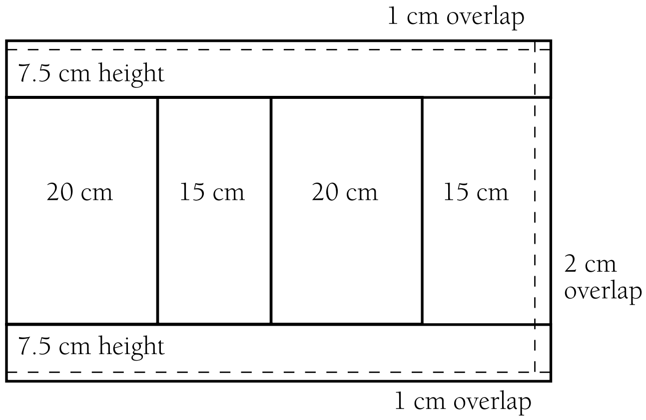
Activity

Before the students begin question **1**, they could wrap up a box with newspaper so they understand how the paper wraps around the box, especially around the ends, and how much paper is needed.

A common mistake is to assume that the width of the piece of paper is the length of the box plus two times the height of the box. If the students make this mistake, point out that the paper needs to cover the length of the box and then go only halfway up the height of the box. The other half of the box height will be covered when the paper wraps around the box and folds down. The students could model this to check.

Another potential source of confusion is that the long side of the box, or the *length* of the box, is used to work out the *width* of the piece of paper. This is because the length of the paper has to cover the width of the box twice and the height of the box twice. This will usually be longer than the box's length.





In question **3**, the students can express the rules in words or symbols or in any other way as long as the rule is equivalent to the answer shown. After they have a correct rule, you may wish to show them some efficient ways to use symbols to express their rules. For example, using P for paper and B for box: $Pw = Bw + Bh + 2$ cm and $Pl = 2(Bh + Bw) + 2$ cm. Note that the paper length rule can be expressed as $Pl = 2Bh + 2Bd + 2$, which can be compressed as $P1 = 2(Bh + Bd + 1)$, using the common factor rule.

Page 23: Popcorn Peril

Achievement Objectives

- demonstrate knowledge of the basic units of length, mass, area, volume (capacity), and temperature by making reasonable estimates (Measurement, level 3)
- perform measuring tasks, using a range of units and scales (Measurement, level 3)
- carry out measuring tasks involving reading scales to the nearest gradation (Measurement, level 4)
- calculate perimeters of circles, rectangles, and triangles, areas of rectangles, and volumes of cuboids from measurements of length (Measurement, level 4)

Activity

Step 1: Encourage the students to measure as accurately as possible.

Step 2: The students are more likely to get a variety of answers, but most results will be within 10 grams of 125 grams. The class could display their results in a stem-and-leaf graph in order of size and then discard any obvious outliers. They can then find an average measure. This could be the median (middle) result, the mode (most frequent) result, or the mean result. The mode might be a good one to choose as the class example for the mass of 125 millilitres of popcorn.

Step 3: Discuss with the class how much they think popcorn expands when it cooks. Draw on the experience of students who have cooked popcorn.

Next, discuss with the class what unit of measurement they will use for this step. One millilitre of water has the same volume as 1 cubic centimetre (1 cm^3), so if the students choose to use cubic centimetres, they can estimate the volume of popcorn in millilitres (or cups that are converted to millilitres) and then convert this amount to cubic centimetres.

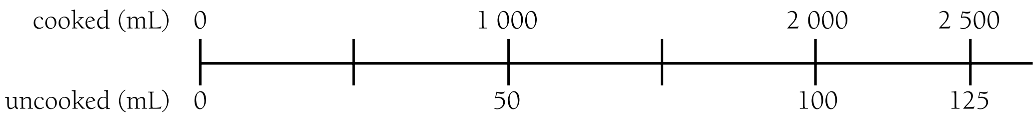
Step 4: Discuss with the class safe methods to cook popcorn.

In question 1, the students will have to measure cooked popcorn in the same unit in which the uncooked popcorn was measured in step 3 so that they can compare like with like. The answer can be expressed in a number of ways. Additive thinkers may say: "The popcorn increased by 2 375 millilitres. It is now 2 500 millilitres." Proportional thinkers may say: "The popcorn is 20 times bigger." Ask the students to explain why these statements mean the same thing. Then encourage them to give their answers as a proportion, for example: "My popcorn increased by about 20 times." The students may need access to a calculator because the growth proportion is unlikely to be a simple number.

The students can approach question 3 in several ways. They will need to use their answers from question 1. First, they need to calculate the volume of popcorn in the small and large bags. The small bag holds 1 000 millilitres (or 1 000 cm^3 or 1 litre) and the large bag holds 3 240 millilitres. Some students may then use the proportion from question 1 to find the amount of uncooked popcorn needed: "As the cooked popcorn was 20 times bigger than the uncooked, I divided 1 000 millilitres by 20. So 50 millilitres of uncooked popcorn is needed to make the litre."
Other students may use a table showing amounts of uncooked and cooked popcorn:

Uncooked	Cooked	
125 mL ($^1/_2$ cup) ? mL	2 500 mL 1 000 mL	÷ 2.5

This could also be shown on a double number line:



They need to divide 2 500 millilitres of cooked popcorn by 2.5 to get 1 000 millilitres of cooked popcorn, so they will also divide 125 millilitres of uncooked popcorn by 2.5 to get 50 millilitres, which is the amount of uncooked popcorn needed for a 1 000 millilitre bag. A similar process can be used for the large bag.

Question **3** will be easier if the students first weigh a smaller amount of cooked popcorn (for example, 250 millilitres) that they can easily multiply to get a litre or 1 000 cm^3. They can use this to find the mass of 1 litre of cooked popcorn and then the mass of a cubic metre of cooked popcorn. They will also need to know that there are 1 000 litres in a cubic metre.

Note: The mass of cooked popcorn is much less than uncooked popcorn because water is released during the popping stage of cooking.

In question **4**, the students could use the answer from the small bag in question **2**. This bag has a capacity of 1 litre, so the amount of corn to make a cubic metre will be 1 000 times this answer. The students will then have to find the number of cubic metres in the classroom to give them the other factor for the solution.

The students may find it useful to visit the website www.popweaver.com

Page 24: Working with Data

Achievement Objectives

- perform measuring tasks, using a range of units and scales (Measurement, level 3)
- design and use a simple scale to measure qualitative data (Measurement, level 4)

Activity

This activity provides an opportunity for students to discuss the use of a qualitative scale and the relative merits of different sorts of scales. A copymaster for the scales is at the end of these notes.

The students need only circle their chosen option. For example:

Homework is a good idea.

Questions **1a–1d** are all asking for a level of agreement. These could all be done easily on scale **ii**. Scale **iv** would not fit at all, but it will be useful for a scale of difficulty as asked in question **1e**. Scales **i** and **iii** can be used for anything, provided that the students annotate them to show the meaning of the smiley face or the values of the numerals from 0 to 10. For example, the numerical scale may have 0 meaning the lowest level of agreement and 10 the highest level of agreement. But 0 could also mean the easiest, with 10 meaning the hardest.

Some questionnaire writers prefer to use a scale with an even number of options. This means there is no neutral option in the middle of the scale for respondents to choose. They must choose some level of agreement or disagreement. Scales **i**, **ii**, and **iv** in this activity do have an odd number of options. You can change them to an even number of options if you wish.

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The person coming out of the Chilly-Billy bin in the main illustration on the cover and contents page is by Matt Gauldie. The rest of the main illustration on the cover and contents page is by Daron Parton. The line art on the cover, contents page, and pages 2, 3, and 8 is by Greg Broadmore (the fist), Christine Tate (the woman with her hand over her mouth and the swinging pendulums), Ali Teo (the whale), and Matt Gauldie (the boy's downturned face).

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