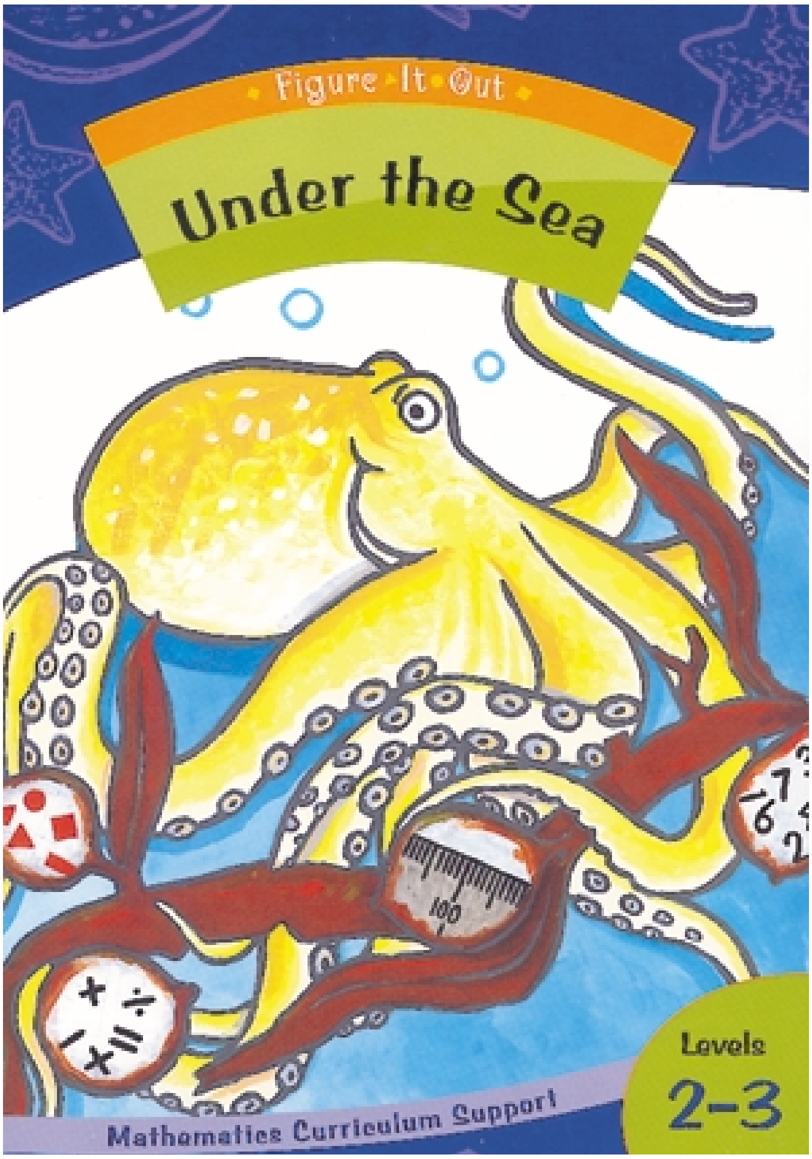
Answers and Teachers' Notes



MINISTRY OF EDUCATION
Te Tāhuhu o te Mātauranga

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.

There are eight booklets for levels 2–3: 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 2–3) are suitable for most students in year 4. However, teachers can decide whether to use the booklets with older or younger students who are also working at levels 2–3.

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 the 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

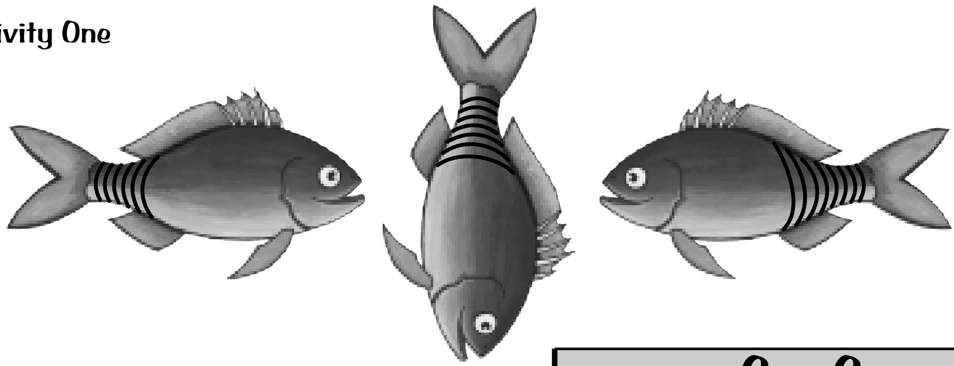
Under the Sea

Answers

Page 1: Flipping Fish

Activity One

1.



2. Do a quarter turn clockwise and add an extra stripe each time.
3. Answers will vary.

Activity Two

1.

(8 stripes)

2. After the first two numbers, each new number in the sequence is found by adding the previous two numbers (1 + 1 = 2, 1 + 2 = 3, 2 + 3 = 5, 3 + 5 = 8, 5 + 8 = 13, etc.).
3. 13 stripes

Pages 2–3: Measure Up

Activity

1. Estimates: **a.** 5 cm **b.** 3 m **c.** 30 cm **d.** 12 cm **e.** 1000 cm **f.** 1 cm **g.** 20 cm **h.** 12 cm **i.** 8 cm **j.** 3 cm
2. Teacher to check
3. Answers will vary.
4. Answers will vary. Teacher will need to check that the answers are realistic.
5. Answers will vary.

Page 4: Sea Symmetry

Activity One

Teacher to check

Activity Two

Answers will vary.

Page 5: Shapely Sea Creatures

Activity One

a. Triangles and a rhombus

b. Triangles and an octagon

c. Triangles and a hexagon

d. Triangles and a trapezium

e. A hexagon

f. Triangles and a square

g. Trapezia and a triangle

Activity Two

Answers will vary.

Pages 6–7: Treasure Trove

Game

A game using co-ordinates

Page 8: Under the Waves

Activity

1. 8
2. 90 cm
3. 16 dolphins

   8 sea horses

   8 sea snails
4. Two possible answers: 9 cabins (3 in each) or 27 cabins (1 in each)

Page 9: Fishing Fancy

Activity One

Teachers will need to check the graph. There are 4 sharks, 3 crabs, and 5 starfish.

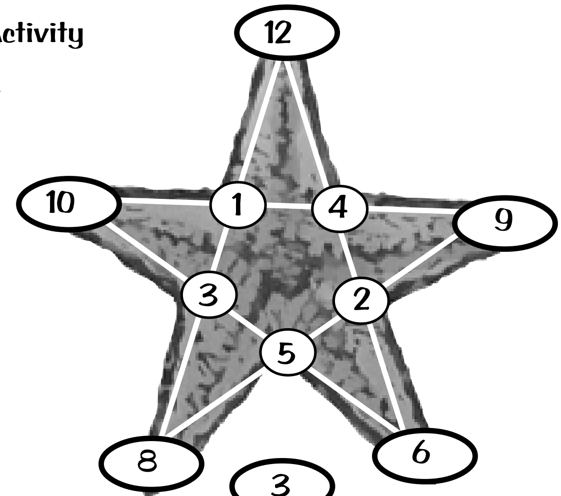
Activity Two

Answers will vary.

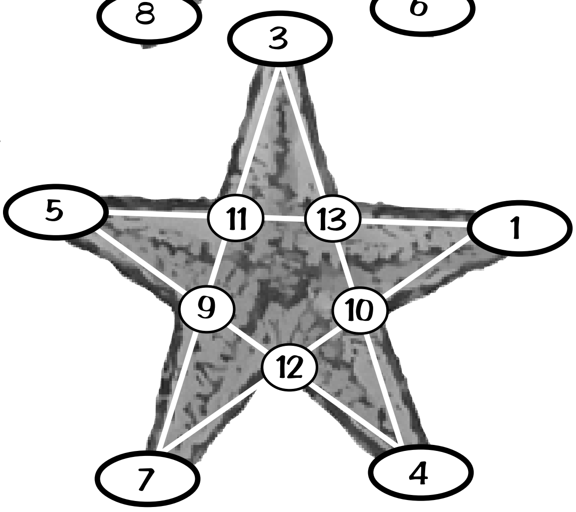
Page 10: Starry-eyed

Activity

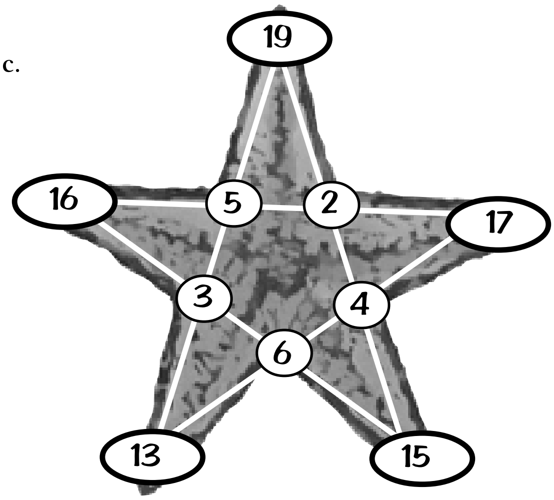
a.



b.



c.



d. Answers will vary.

Page 11: A Whale of a Time

Activity

Answers will vary.

Page 12: Fish Fair

Game

A game about data recording

Page 13: Megamaze

Activity

The shortest route is:

3 cm east

6 cm north

2 cm east

1 cm south

1 cm east

1 cm south

2 cm east

3 cm south

2 cm east

1 cm south

1 cm west

1 cm south

2 cm east

1 cm south

1 cm east

Page 14: Fish Forms

Activity

1. **a.** 90c **b.** 90c
2. $1.35
3. $2.10
4. Answers will vary.

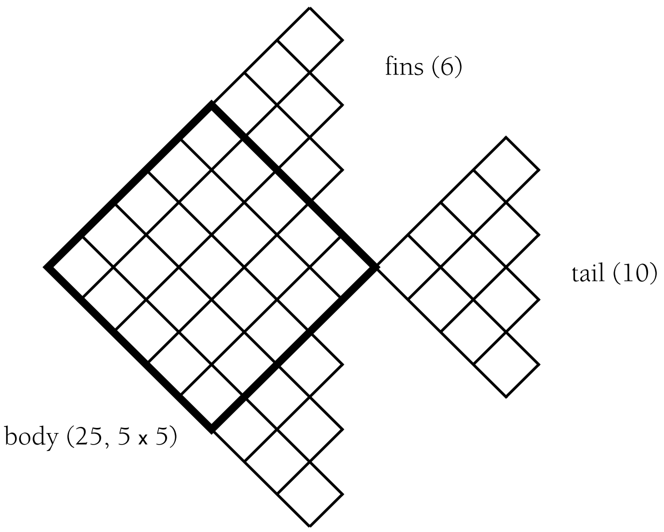
Page 15: Scaling Up

Activity

1. Baby fish have 5 scales, teenage fish have 14 scales, and adult fish have 28 scales.
2. There are 137 scales. Students could work this out in a table using multiplication:

Fish	Number	Scales	Total
baby	5	5	25
teenage	4	14	56
parent	2	28	56
Total			137

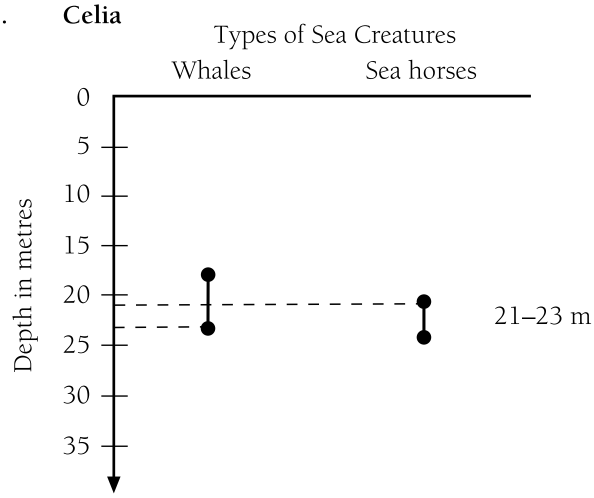
3.



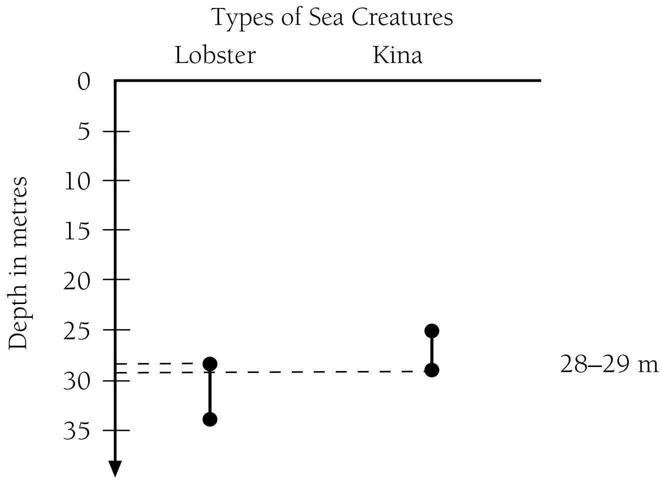
Pages 16–17: Deep-sea Diving

Activity

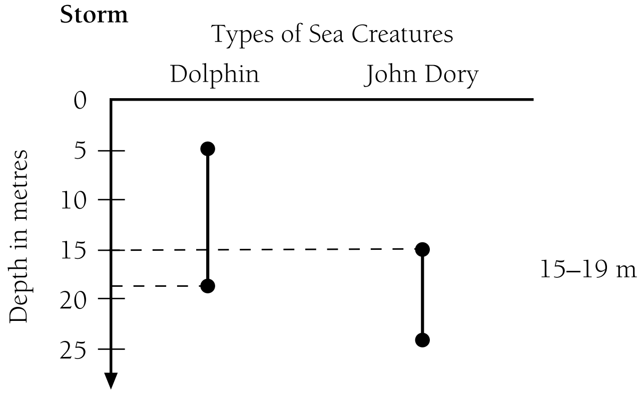
1. Between 4 m and 8 m (common to both sea creatures)
2. **Celia**



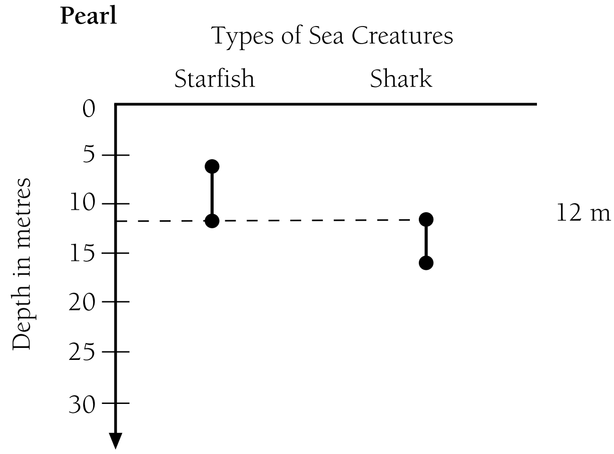
Fin



Storm



Pearl



3. At 22 m, they might see whales, John Dory fish, and sea horses.

Pages 18–19: Horse Racing

Game

A game of numbers

Investigation

Answers will vary but will be based on the various ways of getting differences.

Page 20: Sea Shelters

Activity

Seaweed:	b, c, k, l, u, r
Coral:	d, e, j, n, s
Kelp:	a, g, i, o
Shipwreck:	f, h, m, p, q, t

Page 21: Time It Right

Activity

1. Sailfish
2. Sea horse
3. 108 km/h
4. 15 times
5. 3 km/h

Page 22: Hot or Cold?

Activity

1. 200 mL at 4°C and 200 mL at 10°C: mixture at about 7°C
2. **a.** 10°C and 20°C: mixture at about 15°C

   15°C and 25°C: mixture at about 20°C

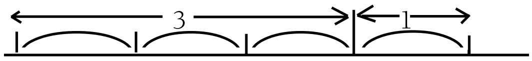
   10°C and 30°C: mixture at about 20°C

   20°C and 40°C: mixture at about 30°C

   5°C and 35°C: mixture at about 20°C

   b. Each temperature is the halfway point between the two numbers when the amount of water is the same.
3. 10°C and 30°C: mixture at about 23–24°C. There is twice as much of the warmer water, so it will affect the temperature about twice as much.

   5°C and 25°C: mixture at about 20°C. There is three times as much warmer water, so it will affect the temperature about three times as much.



4. Answers will vary.

Page 23: Sea Sorting

Activity

1. Answers will vary.
2. Answers will depend on the answers given for question **1**.
3. Teachers will need to check whether the graph used is suitable and accurate.
4. Answers will vary. Questions might include:

   What are the names of the different groups?

   How many sea creatures are in each group?

   Which group has the largest sea creatures?
5. Answers will vary.

Page 24: Floating Ideas

1. Approximately $^{7}/_{8}$ of each iceberg is underwater.
2. Answers will vary. Students may comment on the various shapes of the icebergs shown. The third picture gives the best clue.
3. A ruler does not take into account the different shapes measured.

Investigation

Answers will vary, but students should realise that no matter what the shape of the iceberg is, the same proportion ($^{7}/_{8}$) will be under the water.

Figure It Out

Under the Sea

Teachers' Notes

Overview: Under the Sea

Title	Content	Page in students' book	Page in teachers' notes
Flipping Fish	Patterns	1	8
Measure Up	Measurement	2–3	9
Sea Symmetry	Symmetry	4	11
Shapely Sea Creatures	Matching and making shapes	5	12
Treasure Trove	Using co-ordinates	6–7	13
Under the Waves	Solving story problems	8	13
Fishing Fancy	Writing and solving story problems	9	15
Starry-eyed	Addition	10	16
A Whale of a Time	Tessellation	11	17
Fish Fair	Recording data	12	18
Megamaze	Measurement, compass points	13	18
Fish Forms	Patterns	14	19
Scaling Up	Sequential patterns	15	20
Deep-sea Diving	Measurement	16–17	21
Horse Racing	Subtraction	18–19	22
Sea Shelters	Addition, subtraction, multiplication, division	20	23
Time It Right	Understanding speed	21	23
Hot or Cold?	Temperature	22	24
Sea Sorting	Classifying and graphing	23	24
Floating Ideas	Measuring mass and volume	24	25

Page 1: Flipping Fish

Achievement Objective

- continue a sequential pattern and describe a rule for this (Algebra, level 2)

Activity One

There are two variables in this fish pattern: the orientation of the fish and the number of stripes on its tail. To make rules for the pattern, it is wise to analyse each variable separately:

Order	1st	2nd	3rd	4th	5th	
Orientation	↑	→	↓	←	↑	Quarter turns clockwise
Number of stripes	1	2	3	4	5	Increasing by one

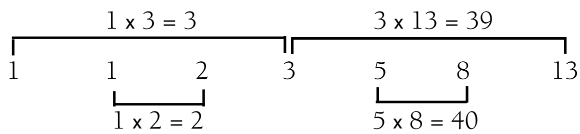
This pattern is a good example of how important it is to help students understand the concept of a relationship. In this case, two relationships exist: one is between the order of the fish and its orientation; the other is between the order of the fish and the number of stripes.

Activity Two

The variable in the whale pattern is the number of stripes on its tail. This pattern is known as the Fibonacci sequence and is named after a famous mathematician called Leonardo Fibonacci of Pisa, Italy, who lived nearly 800 years ago. The Fibonacci sequence progresses as 1, 1, 2, 3, 5, 8 …

Each new number in the sequence is found by adding the previous two numbers (for example, 2 + 3 = 5, 3 + 5 = 8). So the next number in the sequence shown above is 13, the result of 5 + 8.

Examples of the Fibonacci sequence are found in nature, such as in the number of new stems in plants and the family trees of bees. The number sequence is the subject of much investigation and has many fascinating patterns, such as:



The product of the outside numbers in a set of four Fibonacci sequence numbers is always one greater than or one less than the product of the centre pair of numbers.

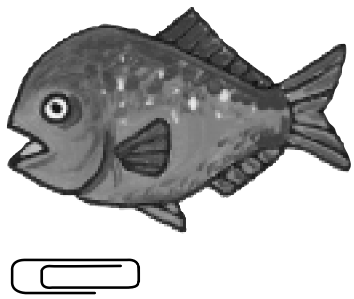
Pages 2–3: Measure Up

Achievement Objective

- carry out practical measuring tasks, using appropriate metric units for length, mass, and capacity (Measurement, level 2)

Activity

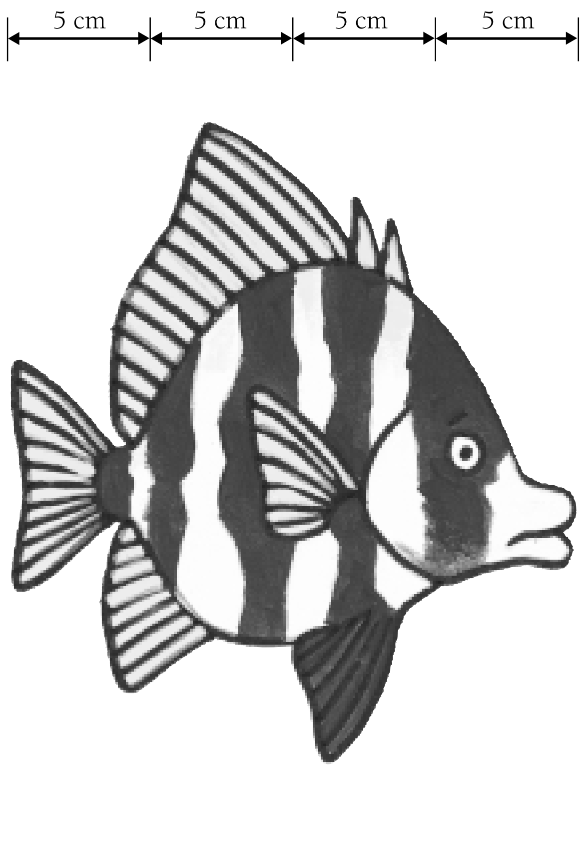
The use of scale is a difficult concept, but it is very helpful for drawing objects that are very large or very small. Students will understand the idea of looking at a creature through a magnifying glass to make it seem bigger or through a camera lens to make it look smaller. As a starter to the discussion, make an enlarged photocopy of a fish with a paper clip next to it.



Ask, "How long is this fish, really?"

Students may say that they know the length of a paper clip and can work it out from there. This illustrates the need for scale to interpret the real size of things depicted in drawings.

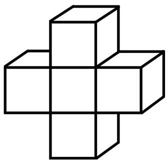
It is wise to work through the example of one creature with the students before they attempt the page independently. Consider the striped fish on the top right. Students will need to use the given scale as a unit.



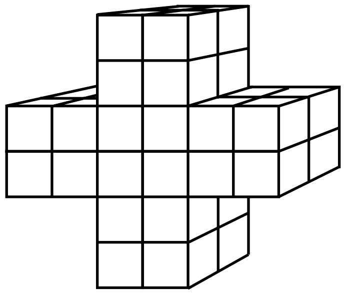
So this fish will be 4 x 5 = 20 centimetres long.

The comparison of size brings out a number of interesting points. Students may consider that when a fish is doubled in length, it is twice its former size. In reality, this has a much greater effect on both the creature's area (in two dimensions) and its volume (in three dimensions). The *Junior Journal* 11 (1994) article "How Do You Measure a Dinosaur?", published by Learning Media for the Ministry of Education, may be a useful resource for question **2**.

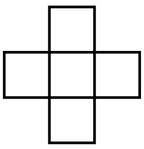
Question **5** is designed to reinforce that point. Consider a student who makes this starfish from multilink cubes:



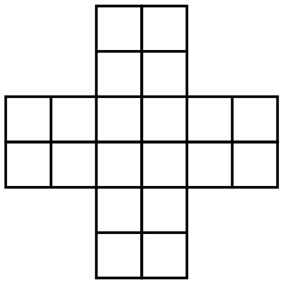
Doubled in size in all its dimensions (lengths), it becomes:



If the two-dimensional area is considered, the change is from:



to



Although the length of each side is doubled, the area increases by 2 x 2.

5 squares

20 squares

When all three dimensions are considered, the number of cubes used increases from 5 to 40, so volume increases by 2 x 2 x 2, or eight times, when the length is doubled. This has implications for the mass of sea creatures as well. A fish that is twice the length of a similar fish is likely to have a mass eight times greater than the other fish.

Page 4: Sea Symmetry

Achievement Objective

- create and talk about geometric patterns which repeat (show translation), or which have rotational or reflection symmetry (Geometry, level 2)

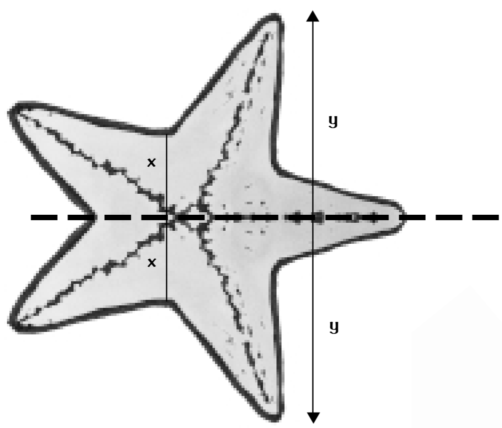
Activity One

In this activity, students complete shapes that have reflection symmetry. Students can complete the drawings in two ways:

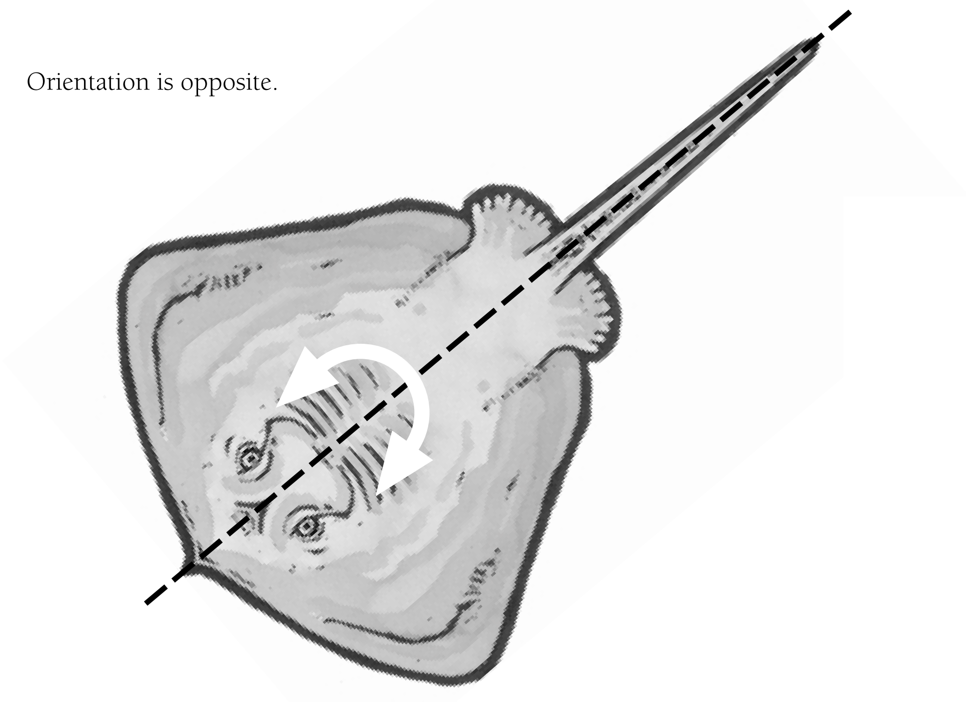
- Use a mirror along the line of symmetry and draw the image that they see in the mirror.
- Draw one half of the shape, fold it along the line of symmetry, and trace the other half against a window, if necessary.

Key points about reflection are:

- Corresponding distances from the line of symmetry must be equal.



- Orientation is opposite.



Encourage students to make sea creatures with rotational symmetry (see page 16 of *Geometry*, level 2–3, in the Figure It Out series).

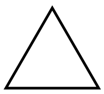
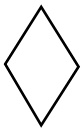
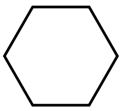
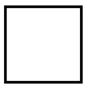
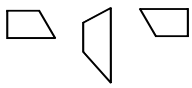
Page 5: Shapely Sea Creatures

Achievement Objective

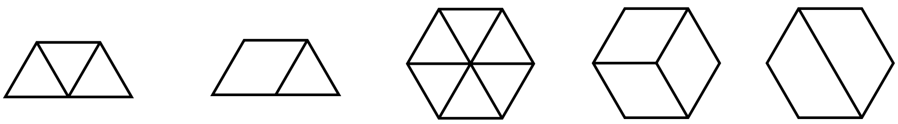
- make, name, and describe, using their own language and the language of geometry, everyday shapes and objects (Geometry, level 2)

Activities One and Two

Students will need to know or be familiar with the names and properties of the shapes found in a pattern block set:

	Equilateral triangle	sides and angles equal
	Rhombus (plural: rhombuses or rhombi) Quadrilateral (four-sided polygon) Note: A square is a special rhombus.	sides and opposite angles equal
	Regular hexagon Note: "Regular" denotes the equality of sides and angles.	six sides, sides and angles equal
	Square Quadrilateral	sides and angles equal
	Trapezium (plural: trapezia or trapeziums) Quadrilateral Note: Other trapezia are: 	one pair only of parallel sides

Pattern blocks are designed with equal side lengths so that they can be used for tiling (tessellations). Students may notice that some blocks are composites of others:



This structural feature becomes more apparent when students trace around the silhouette of their sea creature and then give the silhouette to a partner to complete.

Pages 6–7: Treasure Trove

Achievement Objective

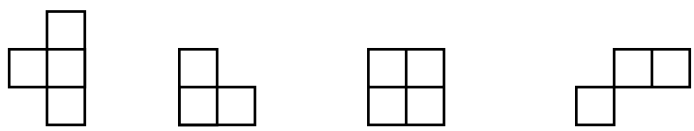
- describe and interpret position, using the language of direction and distance (Geometry, level 2)

Game

This game is a version of the traditional game Battleships, which uses ordered pairs on a co-ordinate grid to specify position. Since the "treasure chests" are represented by multilink cubes, which have an area of 2 cm x 2 cm, students can think strategically about which co-ordinates (ordered pairs) to choose.
For example, finding out that B 2 is not a co-ordinate for a treasure chest effectively eliminates the co-ordinates A 1, A 2, and B 1. If E 2 also is not a co-ordinate for a chest, that effectively eliminates C 1, C 2, D 1, D 2, and E 1. Note that this strategy is good for locating the approximate position of treasure chests, but to finish the game, students must give all four corner co-ordinates of each chest.

An interesting variation of the game is for students to use 16 unit place-value cubes to make four "gold nuggets". These nuggets can take any shape the player wants them to within the squares.

For example:



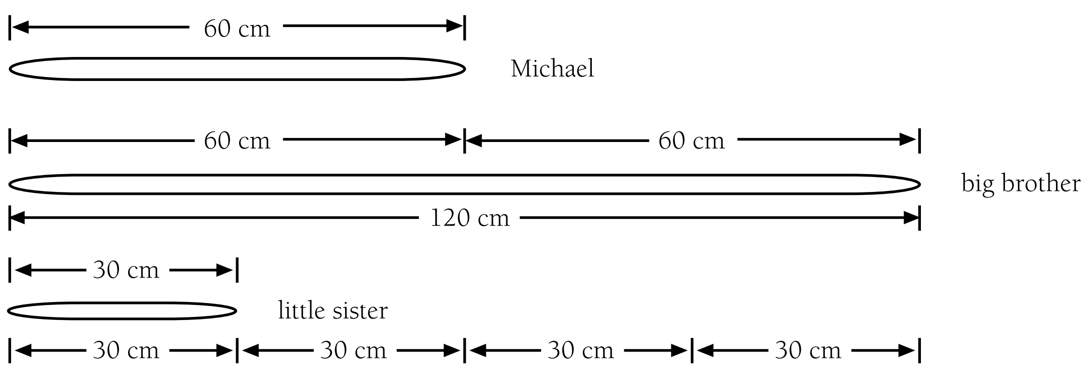
Page 8: Under the Waves

Achievement Objective

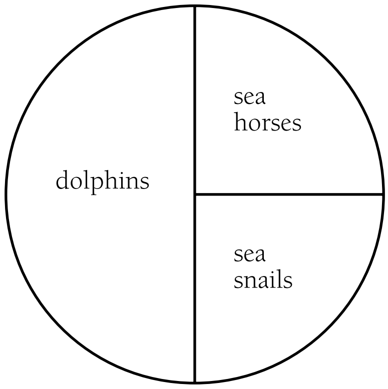
- write and solve story problems which involve whole numbers, using addition, subtraction, multiplication, or division (Number, level 2)

Activity

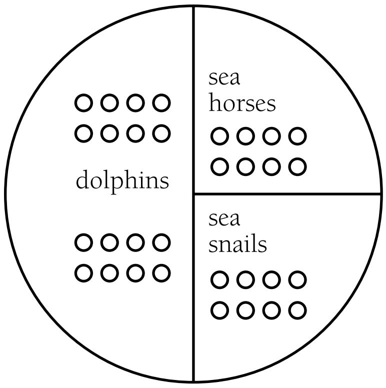
Each of the problems given on this page provides excellent opportunities for students to apply problem-solving strategies (see *Mathematics in the New Zealand Curriculum*, pages 24 and 25). Particular emphasis should be on the strategies of drawing diagrams and acting out. For example, a diagram of question **2** might look like:



Similarly, a pictorial diagram of question **3** might be:



Students might use 32 counters to represent the class members and share them out evenly among the quarters. It is important that students realise that one-half is two-quarters.



So eight of the class are sea horses, eight are sea snails, and 16 are dolphins.

Question **4** is a "bits missing" problem. Students will need to work out how many cabins are possible given that the number of sea creatures in each cabin must be the same. Students can use a variety of strategies to find a solution:

- Trial and improvement (sharing 27 counters between a number of piles)
- Elimination (trying different numbers of cabins but eliminating numbers such as six, eight, and 10, which are not possible because 27 is an odd number)
- Using multiplication facts that have an answer of 27 (1 x 27, 3 x 9, 9 x 3, 27 x 1). As there are more than four cabins, this leaves two possibilities (27 cabins with one sea creature in each or nine cabins with three sea creatures in each).

Page 9: Fishing Fancy

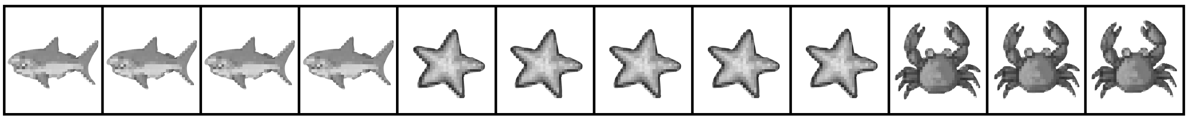
Achievement Objectives

- collect and display category data and whole number data in pictograms, tally charts, and bar charts, as appropriate (Statistics, level 2)
- write and solve story problems which involve halves, quarters, thirds, and fifths (Number, level 2)

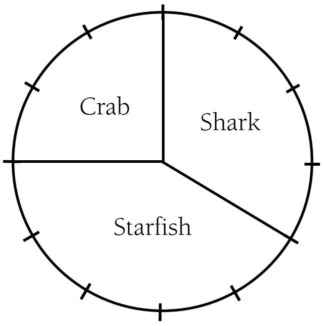
Activity One

The sea creatures shown can easily be classified into categories. Examples of appropriate displays that students could create would be:

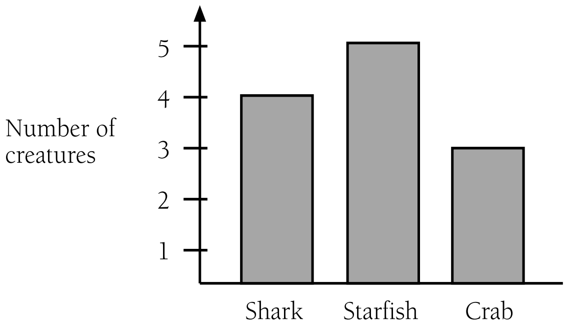
Shark	////
Starfish	~~////~~
Crab	///



Sea Creatures



Sea Creatures



Activity Two

The emphasis of this activity is on students writing story problems. The relevant data here is:

Type of Fish	Number	Fraction
White	4	$\frac{4}{20} = \frac{1}{5}$
Stripy	6	$\frac{6}{20} = \frac{3}{10}$
Spotty	10	$\frac{10}{20} = \frac{1}{2}$

Teachers may decide to model the process of writing problems by providing examples, such as:

"Four more fish swim along. Now Sam could catch one-third of the fish, and Liam could catch one-quarter of them. What kind of fish were these new fish?"

"Emily caught some fish. Sam and Liam caught none. Then one-third of the remaining fish were spotty fish. How many fish did Emily catch?"

Page 10: Starry-eyed

Achievement Objective

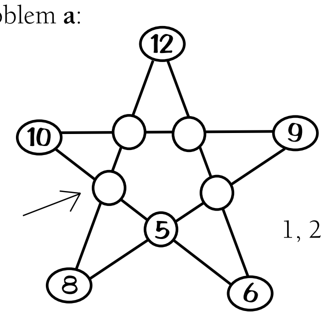
- mentally perform calculations involving addition and subtraction (Number, level 2)

Activity

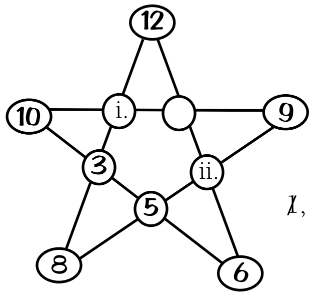
Usually in number problems like this, all the spaces are left blank and you are given a list of the numbers to place. This makes it difficult to complete the number patterns. The problems on this page are more accessible for students because they have been given some line and some positional numbers.

These problems help students to develop systematic thinking. Consider this process for solving problem **a**:

target this space



1, 2, ~~3~~, 4



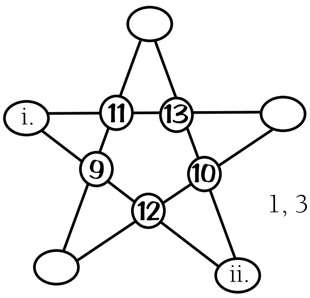
~~1~~, ~~2~~, ~~3~~, 4

Since 6 + 5 + ☐ + 10 = 24, the ☐ number must be 3.

For i., 8 + 3 + ☐ + 12 = 24, and so ☐ = 1, and for ii., 8 + 5 + ☐ + 9 = 24, and so ☐ = 2.

This leaves 4 to go in the remaining space.

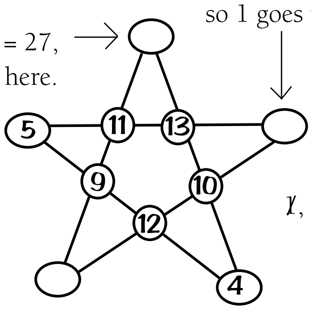
Similar reasoning can be used for problem **b**:



1, 3, ~~4~~, ~~5~~, 7

4 + 13 + 10 = 27, so 3 goes in here.

5 + 11 + 13 = 29, so 1 goes in here.



~~1~~, ~~3~~, ~~4~~, ~~5~~, 7

9 + 12 = 21, so the two numbers for spaces i. and ii. must add to 9. Only 4 and 5 do that.

The numbers for the other spaces can be found using the line total.

The side totals of the inside pentagon tell you what each pair of outside numbers must add to.

Another way for students to solve these problems is to write the missing numbers on small pieces of paper or card and put them in different circles to find what works. This trial and error process is cumbersome, but it can be effective. It also provides lots of mental computation practice.

Page 11: A Whale of a Time

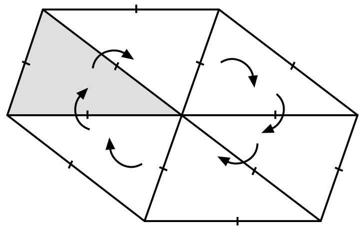
Achievement Objective

- create and talk about geometric patterns which repeat (show translation), or which have rotational or reflection symmetry (Geometry, level 2)

Activity

This tessellation activity uses a technique made famous by the Dutch artist, M.C. Escher. Since the internal angles of a triangle add to 180°, any triangle can tessellate the plane by half-side rotation.

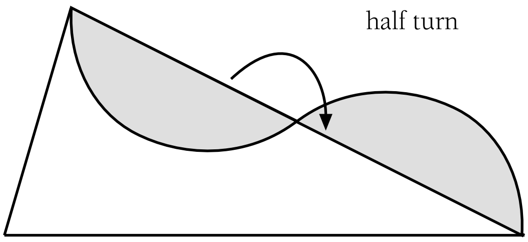
For example:

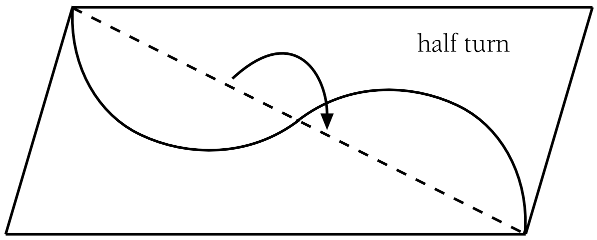


This diagram shows the halfway point of each side of the triangle being used as the rotation point.

Note that each angle of the triangle is used twice about the central point, so 180° + 180° = 360° will complete a full turn.

Since every triangle can tessellate by half-side rotation, it can be modified by the same process of half-side rotation and the tessellation will still hold:

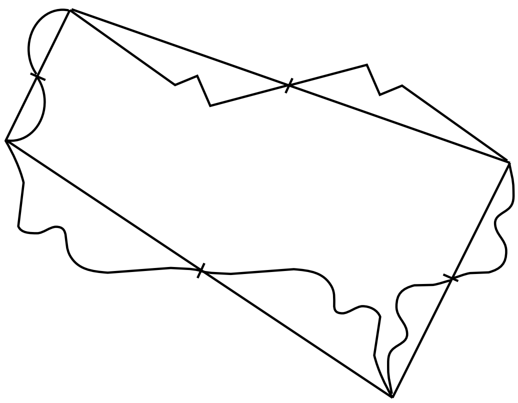




When making their tessellating whale, students should mark the corners of their triangle before cutting. This helps considerably when tracing around the cardboard template to make the tessellation.

The half-side rotation technique also works for quadrilaterals and can be an excellent extension for capable students.

For example:



Since the angles of any quadrilateral add to 360°, each angle of a quadrilateral will be used once about a point.

Page 12: Fish Fair

Achievement Objectives

- compare familiar or imaginary, but related, events and order them on a scale from least likely to most likely (Statistics, level 2)
- use a systematic approach to count a set of possible outcomes (Statistics, level 3)
- predict the likelihood of outcomes on the basis of a set of observations (Statistics, level 3)

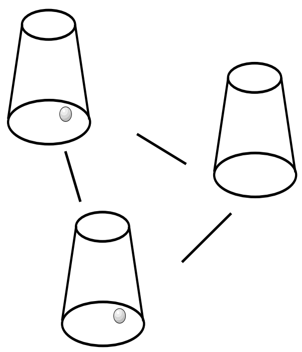
Game

Students can play this game in pairs and record their results systematically. For example, they can use a tally:

✓	III
✗	~~IIII~~ II

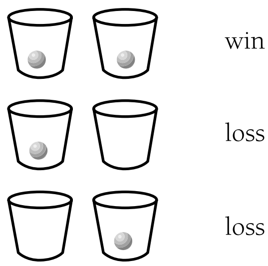
Discuss the need to play a large number of games to increase the reliability of results. If many students are playing the game, the results can be collated to get a larger sample.

Students should notice that a player wins only about one-third of the time. Encourage them to explain these results. Here are some possible methods:



"One of the three cups will make you lose." (the opposite of winning)

Possible results:



Page 13: Megamaze

Achievement Objectives

- make clockwise and anticlockwise turns (Geometry, level 2)
- carry out practical measurement tasks, using appropriate metric units for length, mass, and capacity (Measurement, level 2)

Activity

This activity focuses on length. Some students will have difficulty interpreting instructions for movement. An important point here is that north, south, east, and west stay constant irrespective of Crusty's orientation. To develop the students' understanding of this, play a compass version of the game Stern, Bow, Port, Starboard, labelling the walls of the school hall north, south, east, west. Make sure that you have labelled the walls correctly.

Begin by giving the students instructions for pacing out letters of the alphabet. The students follow these instructions in line-dancing formation. For example:

"Ten steps north, five steps south, five steps east, five steps north, ten steps south. What letter have you walked out?" (H)

This will encourage students to visualise the path they are walking as they follow instructions.

A more competitive game is to shout compass directions, for example, "East". The last student to touch the correct wall is out. Play continues until only one student remains.

Students will enjoy creating their own maze and developing a set of directional instructions for someone else to follow.

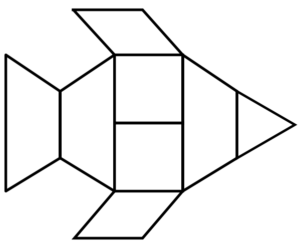
Page 14: Fish Forms

Achievement Objectives

- write and solve story problems which involve whole numbers, using addition, subtraction, multiplication, or division (Number, level 2)
- continue a sequential pattern and describe a rule for this (Algebra, level 2)

Activity

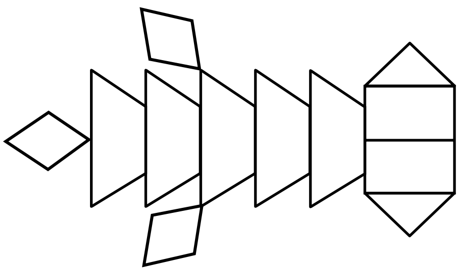
Encourage the students to use systematic counting when calculating the cost of the sea creatures. This will involve looking for common shapes and using multiplication rather than shape-by-shape counting. For example, consider this shape:



Shape	Number	Block cost	Total cost
⏢	3	15c	45c
◇	2	10c	20c
□	2	10c	20c
△	1	5c	5c
			90c

Question **3** involves students applying the relationship between the number of trapezia in the body of the sea serpent and the total cost of the creature.

A five-trapezia-bodied serpent costs:



Shape	Number	Block cost	Total cost
⏢	5	15c	75c
◇	3	10c	30c
□	2	10c	20c
△	2	5c	10c
			$1.35

Adding five more trapezia will cost another 75c (5 x 15c), which gives a total cost of $2.10.

This can be organised in a table to check (60c + [number of trapezia x 15c]).

Length of body in trapezia	1	2	3	4	5	6	7	8	9	10
Total cost	75c	90c	$1.05	$1.20	$1.35	$1.50	$1.65	$1.80	$1.95	$2.10

Page 15: Scaling Up

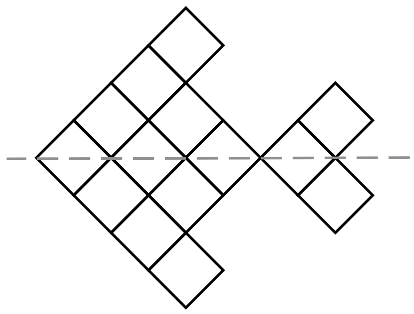
Achievement Objectives

- write and solve story problems which involve whole numbers, using addition, subtraction, multiplication, or division (Number, level 2)
- continue a sequential pattern and describe a rule for this (Algebra, level 2)

Activity

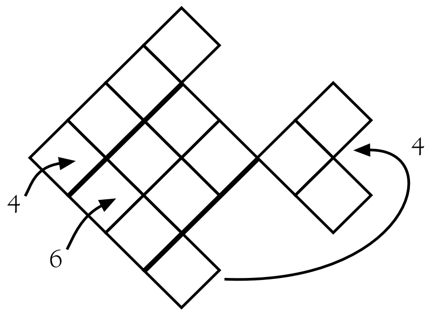
There are many ways that students can count the number of square tiles in each fish. Most will use one-by-one counting if you do not encourage them to explore other interesting ways to count. Methods might include:

- using symmetry:



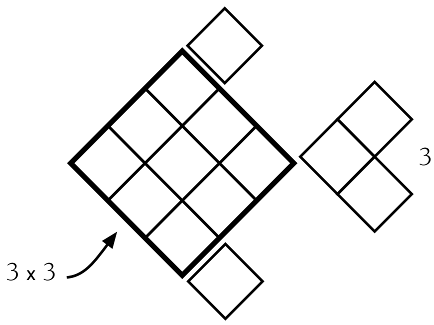
There are four tiles on this line of symmetry;
2 x 5 = 10 tiles are not on the line of symmetry.
Total: 10 + 4 = 14 tiles.

- using composite blocks:



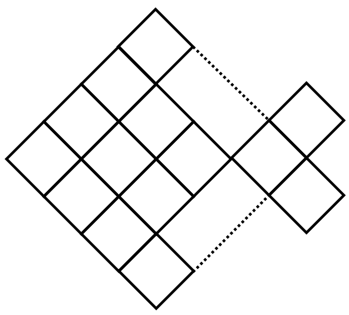
4 + 4 + 6 = 14 tiles.

- multiplication:



(3 x 3) + 3 + 2 = 14 tiles (or 4 x 3 + 2)

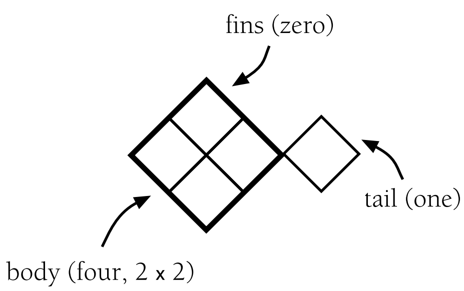
- using the larger enclosing square and noting the missing and additional tiles:



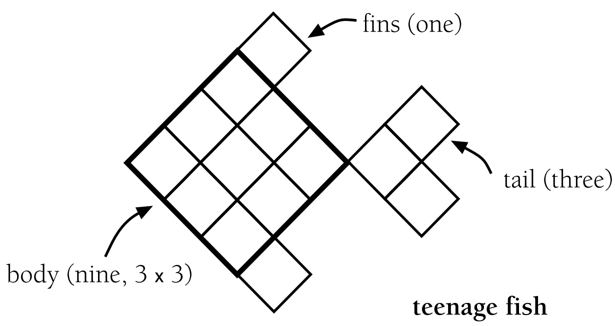
(4 x 4) + 2 – 4 = 14 tiles

Students should try to use equal additions or multiplication to simplify the task of counting the scales (square tiles). A table using multiplication is illustrated in the Answers section.

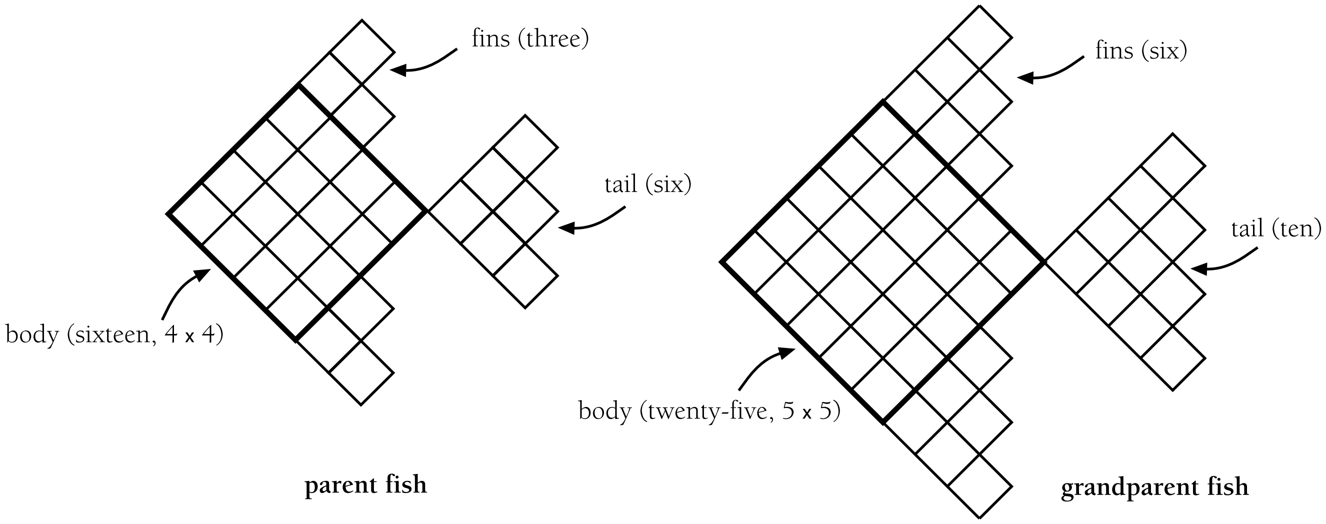
A grandparent fish will build on the pattern of body, fins, and tail shown in the other fish.



baby fish



teenage fish



The total number of scales on a grandparent fish is 25 + 6 + 6 + 10 = 47.

Pages 16–17: Deep-sea Diving

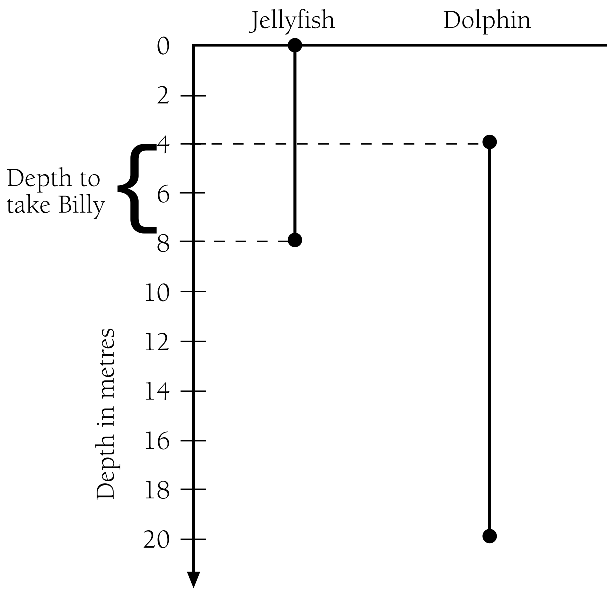
Achievement Objective

- use graphs to illustrate relationships (Algebra, level 2)

Activity

Graphs are an excellent visual solution to the diving depth problem. They depict the relationship between the creature and its favoured living depth.

In the case of Billy Bends, the depth which Delilah should go to is the depth that is common to the two creatures:



To draw suitable graphs for each sea creature, students will first need to decide on the vertical scale. This is determined by the greatest depth one of the creatures is found at. The graphs for each customer are shown in the answers.

To find the solution to question **3**, students may draw a graph for all the sea creatures or scan the table for depth ranges that include 22 metres. This means that the creatures that are likely to be seen at that depth will be whales, John Dory fish, and sea horses.

Pages 18–19: Horse Racing

Achievement Objectives

- use a systematic approach to count a set of possible outcomes (Statistics, level 3)
- predict the likelihood of outcomes on the basis of a set of observations (Statistics, level 3)

Game

This game focuses on the probability of different outcomes when two dice are thrown. Moves are worked out according to the dice differences, and this table gives the relative likelihood of different sea horses moving:

Dice 1

Dice 2

	1	2	3	4	5	6
1	0	1	2	3	4	5
2	1	0	1	2	3	4
3	2	1	0	1	2	3
4	3	2	1	0	1	2
5	4	3	2	1	0	1
6	5	4	3	2	1	0

5 – 2 = 3

5 – 5 = 0

5 – 3 = 2

The relative frequencies of each difference are:

Difference	0	1	2	3	4	5
Frequency	$^{6}/_{36}$	$^{10}/_{36}$	$^{8}/_{36}$	$^{6}/_{36}$	$^{4}/_{36}$	$^{2}/_{36}$

These frequencies are reflected in the distances the different sea horses must travel on the playing board to win. Although sea horse 5 looks an attractive proposition, the chances of throwing the two dice to form a subtraction equation that results in five are small. These varied distances ensure that each sea horse has an equal chance of winning.

Encourage students to explain why some sea horses move more frequently than others. Although they are unlikely to have developed systems such as the table above, many students will be able to offer explanations such as:

"There are lots of ways of getting a difference of one, such as six minus five, five minus four, four minus three, three minus two."

"There is only one way of getting a five: that's with six and one."

Page 20: Sea Shelters

Achievement Objective

- make sensible estimates and check the reasonableness of answers (Number, level 2)

Activity

Students can use various methods to find out which place each creature lives in without performing the calculations. These methods include:

- Ones-digit focus
  (For example, 245 x 3 will have an answer with a ones digit of 5, and so that sea creature must live in the shipwreck.)
- Estimating the relative size of answer
  (For example, 1000 – 176 will have an answer greater than 800, and so that sea creature must live in the coral.)
- Applying place value
  (For example, 103 x 8 is (100 x 8) + (3 x 8), which is 824, and so that creature must live in the coral, or 300 + 70 + 8, which is 378, and so that sea creature must live in the seaweed.)

Page 21: Time It Right

Achievement Objective

- write and solve story problems which involve whole numbers, using addition, subtraction, multiplication, or division (Number, level 2)

Activity

Speed, expressed in kilometres per hour, is an advanced concept. Students will have some reference for this from their knowledge of the speed limit for vehicles, 50 km/h on city streets and 100 km/h on open roads. You will need to explain to them that a speed of 65 kilometres per hour means that the creature would swim 65 kilometres if it kept swimming for an hour at that speed.

These speeds can be related to a journey with which the students are familiar. For example, it would take a mako shark just over two hours to swim the distance from Christchurch to Ashburton.

Students can perform the operations required in these problems by using the distance part of each speed. For example, for question **4**, a human swims at 4 km/h and a flying fish at 60 km/h. Since 15 x 4 = 60, the fish is travelling 15 times as fast as the human. Note: Not every human swims this fast, and you may have to explain to students that this is an example of average speed.

If it is the swimming season, students might like to know how fast they can swim or run. Time them over 50 metres in seconds (for example, they may take 90 seconds to swim 50 metres). Divide 180 by their time in seconds (for example, 180 ÷ 90 = 2) to work out their speed in kilometres per hour.

Page 22: Hot or Cold?

Achievement Objective

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

Activity

The following ocean temperatures are useful as background information for this page.

Most of the water in the oceans has a temperature at or below 4°C. Give students access to tap water, ice cubes, a container, and a thermometer to create water at 4°C. This is the average temperature of the oceans.

Students will realise that this is extremely cold. Ask them where they think the water may be warmer (in equatorial areas and shallow depths). Tell them that this temperature difference causes sea water to move in large streams called currents. Some currents are warm, and some are cold.

These currents have a significant effect on Earth's climate. The weather patterns El Nino and La Nina are caused by disruption to the normal structure of the ocean currents.

Scientists are interested in the temperature of the currents as a means of predicting weather around the globe. At water temperatures below 50°C, the relationship when mixing two amounts of water is linear. That means if equal capacities of water at 10°C and 20°C are mixed, the mixture temperature will be 15°C, the average or median of the temperatures. In some instances, the physical action of mixing may cause slight warming or cooling.

When unequal amounts of water are mixed, the larger quantity will have a proportionately greater influence on the temperature. In the case of 100 mL at 10°C mixing with 200 mL at 20°C, the temperature of the mixture will be about 16 or 17°C because there is twice as much warmer water as cooler water.

To avoid accidents, you need to check that the hot water the students use is not too hot.

Page 23: Sea Sorting

Achievement Objective

- collect and display category data and whole number data in pictograms, tally charts, and bar charts, as appropriate (Statistics, level 2)

Activity

This activity involves students handling category data. The methods by which they sort this type of data and present it are well documented in *Statistics*, level 2–3, in the Figure It Out series. Students need to recognise that bar, pie, and strip graphs are the most appropriate displays for category data, although tally charts could also be used. Stem-and-leaf graphs, dot plots, and line graphs are appropriate displays for numeric data.

Page 24: Floating Ideas

Achievement Objective

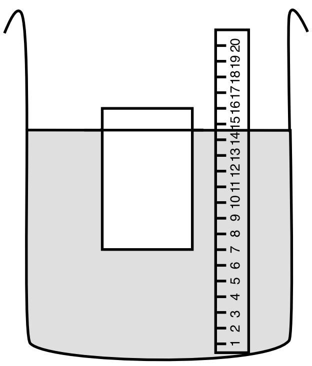
- carry out practical measuring tasks, using appropriate metric units for length, mass, and capacity (Measurement, level 2)

Activity

Students may be tempted to use the ruler as a definitive measure (it does work for picture **c**), but a better way of working out how much of the ice is below the surface is to work with volume.

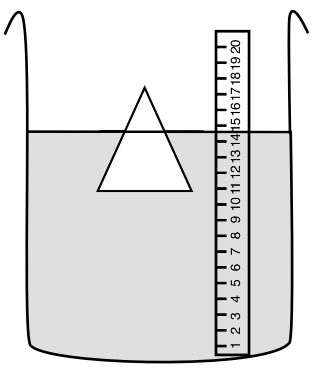
Though the density of icebergs varies according to the pressure and time during which they were formed, usually about seven-eighths of the iceberg is below the water surface. Students will need quite large pieces of ice. These can easily be made by leaving plastic containers full of water in a deep-freeze overnight. For cube shapes or other rectangular prisms, line a cereal packet with plastic wrap or a plastic bag, fill it with water, and freeze it. (If this method is used, students will need to float their pieces of ice in something larger than a large drinking glass.) For such regular solids, it is appropriate to measure the proportion of the piece of ice above the water surface.

For example:



Since the cross-section is constant, the proportions are accurate.

This is not the case for irregular solids, as demonstrated by the varying shapes shown in pictures **a**, **b**, and **d**. For example, a pyramid-shaped block like the one below may give the illusion of a greater proportion of ice being out of the water, particularly if a linear measure is used.



By volume, the proportions one-eighth above and seven-eighths below the water surface will hold because the bulk of the block of ice is still in the base of the pyramid.

Students may wish to look up Internet sites about icebergs to check their findings from their investigations.

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