

A wide-angle photograph of the Great Wall of China winding through lush green mountains under a dramatic, cloudy sky.

Chapter

11

Measurement

What you will learn

- 11A Measurement systems
(Extending)
- 11B Using and converting metric lengths *(Consolidating)*
- 11C Perimeter *(Consolidating)*
- 11D Areas and rectangles
- 11E Area of a triangle
- 11F Area of a parallelogram
- 11G Area of composite shapes
(Extending)
- 11H Volume of rectangular prisms
- 11I Capacity *(Consolidating)*
- 11J Mass and temperature
(Consolidating)

Australian curriculum

MEASUREMENT AND GEOMETRY

Using units of measurement

Establish the formulas for areas of rectangles, triangles and parallelograms and use these in problem solving (ACMMG159)

Calculate volumes of rectangular prisms (ACMMG160)

Shape

Draw different views of prisms and solids formed from combinations of prisms (ACMMG161) 



Online resources

- Chapter pre-test
- Videos of all worked examples
- Interactive widgets
- Interactive walkthroughs
- Downloadable HOTsheets
- Access to HOTmaths Australian Curriculum courses

Measurement everywhere

Imagine trying to describe facts about the world around us without using any form of measurement. We use units of length to describe distance and degrees Celsius ($^{\circ}\text{C}$) to describe temperature. Other units are used for area, volume, time, capacity and mass.

Here are some examples of facts that use different units of measurement.

- The Eiffel Tower in France is painted with 50 tonnes of paint every 7 years.
- The Great Wall of China is more than 6000 km long.
- The Great Pyramid of Giza was built

around 2500 BCE and includes about 2 300 000 blocks of stone, each weighing about 2500 kg.

- The world's smallest country is Vatican City in Rome, with an area of 0.44 km^2 .
- The maximum temperature during the day on Mars is about 20°C .
- The distance between the orbits of Mars and the Earth around the Sun is about 78 000 000 km.
- The volume of water in Sydney Harbour is about 500 gigalitres or five hundred thousand million litres or 0.5 km^3 .

11A

Measurement systems

EXTENDING



Interactive



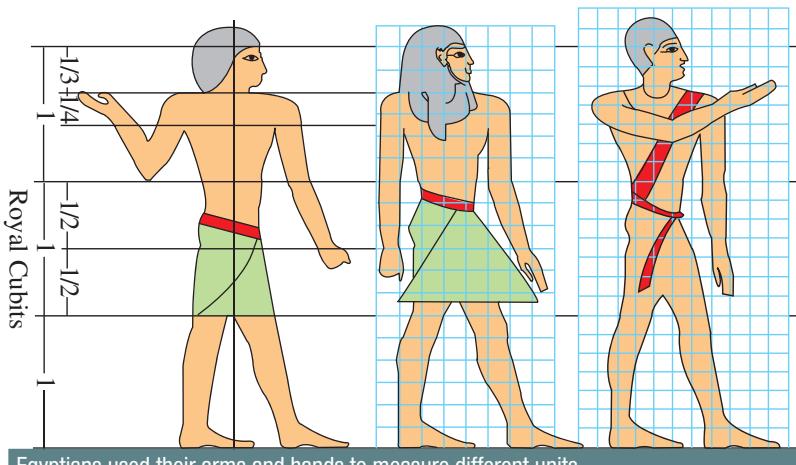
Widgets



HOTsheets



Walkthroughs



Because each individual's arm length and finger width is different, there was a need to develop a standard unit of length. The Egyptians defined a *standard royal cubit* (about 524 mm), and this was represented as a stone rod. From this cubit the following divisions were made: 28 digits in a cubit, 4 digits in a palm and 14 digits in a span.

Many of these units of measurement were adapted and developed by the Babylonians, Greeks, Romans, English and French over many centuries. The English imperial system, which was adapted from the Roman and Greek systems, is commonly used in the United Kingdom and the United States today, and was used in Australia until the 1970s. Many people today still prefer to describe lengths and other measures using Imperial units, such as the *inch* and *mile*.

The metric system was developed in France in the 1790s and is the universally accepted system today. The word *metric* comes from the Greek word *metron*, meaning 'measure'. It is a decimal system where length measures are based on the unit called the *metre*. The definition of the metre has changed over time.

Originally it was proposed to be the length of a pendulum that beats at a rate of one per second. It was later defined as 1/10 000 000 of the distance from the North Pole to the equator on a line on the Earth's surface passing through Paris. In 1960, a metre became 1 650 763.73 wave lengths of the spectrum of the krypton-86 atom in a vacuum. In 1983, the metre was defined as the distance that light travels in 1/299 792 458 seconds inside a vacuum.

Let's start: Egyptian trader

Imagine you are in ancient Egypt and you are trading goods at a market. You use the Egyptian units: *digit* (width of a finger), *palm* (width of four fingers) and *span* (distance from the top of the thumb to the tip of the little finger in an outstretched hand).

- Use a ruler to find the metric equivalent of your *digit*, *palm* and *span*.
- You purchase a wad of papyrus paper that is 1 digit thick. Which students in the class would get the least paper if they used their own finger width?
- You purchase a bowl of grain 1 span deep. Which student in the class gets the most grain?
- You purchase 5 cubits of cloth. Which student gets the most cloth?

■ Ancient measurement systems that developed from about 3000 BCE include the Egyptian, Babylonian, Greek and Roman systems. The **metric system** is the commonly used system today.

■ **Roman system**

- 1 foot = 12 inches = 16 digits = 4 palms
- 1 cubit = 6 palms
- 1 pace (double step) = 5 feet
- 1 mile = 1000 paces

■ **imperial system**

- 1 foot = 12 inches (1 inch is about 2.5 cm)
- 1 yard = 3 feet (1 yard is about 91.5 cm)
- 1 rod = 16.5 feet
- 1 chain = 22 yards
- 1 furlong = 40 rods
- 1 mile = 8 furlongs = 1760 yards (1 mile is about 1.6 km)

■ **metric system**

- 1 centimetre (cm) = 10 millimetres (mm)
- 1 metre (m) = 100 centimetres (cm)
- 1 kilometre (km) = 1000 metres (m)



Key ideas

Example 1 Using measurement systems

- a How many feet are there in 1 mile, using the Roman measuring system?
 b How many inches are there in 3 yards, using the imperial system?

SOLUTION

$$\begin{aligned} \text{a } 1 \text{ mile} &= 1000 \text{ paces} \\ &= 5000 \text{ feet} \end{aligned}$$

$$\begin{aligned} \text{b } 3 \text{ yards} &= 9 \text{ feet} \\ &= 108 \text{ inches} \end{aligned}$$

EXPLANATION

There are 1000 paces in a Roman mile and 5 feet in a pace.

There are 3 feet in an imperial yard and 12 inches in a foot.



Example 2 Choosing metric lengths

Which metric unit would be the most appropriate for measuring these lengths?

a width of a large room

b thickness of glass in a window

SOLUTION

a metres (m)

b millimetres (mm)

EXPLANATION

Using mm or cm would give a very large number, and using km would give a number that is very small.

The thickness of glass is likely to be around 5 mm.

Exercise 11A

1–4

4

—

UNDERSTANDING

1 Complete these number sentences.

a Roman system

$$\begin{array}{ll} \text{i} & 1 \text{ _____ } = 12 \text{ inches } = 16 \text{ _____ } = \text{_____ palms} \\ \text{ii} & 1 \text{ _____ } = 1000 \text{ paces} \end{array}$$

b imperial system

$$\begin{array}{ll} \text{i} & 1 \text{ foot } = 12 \text{ _____ } \\ \text{iii} & \text{_____ } = 1760 \text{ yards} \end{array} \quad \begin{array}{l} \text{ii} \quad 3 \text{ _____ } = 1 \text{ yard} \end{array}$$

c metric system

$$\begin{array}{ll} \text{i} & 1 \text{ m } = \text{_____ cm} \\ \text{iii} & \text{_____ km } = 1000 \text{ m} \end{array} \quad \begin{array}{l} \text{ii} \quad 1 \text{ cm } = \text{_____ mm} \end{array}$$

- 2 List the units of length (e.g. cubit), from smallest to largest, commonly used in the Roman system.
- 3 List the units of length (e.g. inch), from smallest to largest, commonly used in the imperial system.
- 4 List the units of length (e.g. centimetre), from smallest to largest, commonly used in the metric system.

5–8

5–9

5–9(½)

Example 1

FLUENCY

5 Use the Roman system to state how many:

a feet are in 1 pace

b feet are in 1 mile

c palms are in 1 foot

d palms are in 1 pace

e digits are in 1 foot

f digits are in 1 pace

- Example 2**
- 6 Use the imperial system to state how many:
- a inches are in 1 foot
 - b feet are in 1 yard
 - c yards are in 1 mile
 - d yards are in 1 chain
 - e inches are in 1 yard
 - f rods are in 1 furlong
- 7 Use the metric system to state how many:
- a millimetres are in 1 centimetre
 - b centimetres are in 1 metre
 - c metres are in 1 kilometre
 - d millimetres are in 1 metre
 - e centimetres are in 1 kilometre
 - f millimetres are in 1 kilometre
- 8 Which metric unit would be the most appropriate for measuring the following?
- a the distance between two towns
 - b width of a small drill bit
 - c height of a flag pole
 - d length of a garden hose
 - e width of a small desk
 - f distance across a city



A drill bit

- 9 Choose which metric unit would be the most suitable for measuring the real-life length indicated in each of these photos.

a



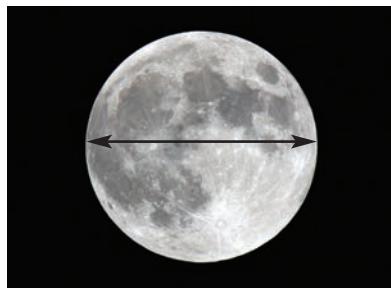
b



c



d



11A

FLUENCY



10, 11

11–13

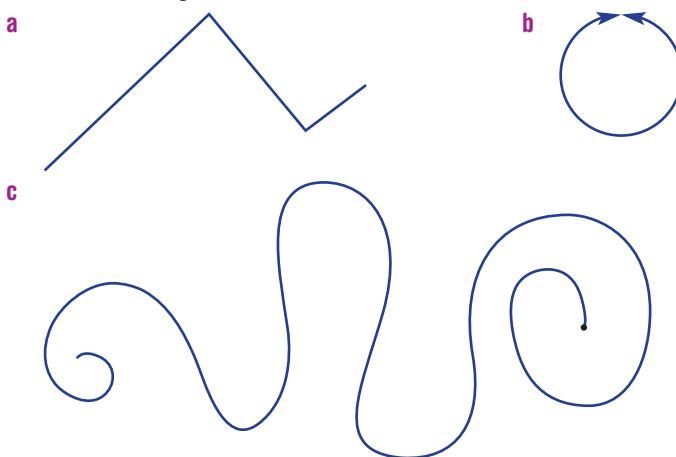
12–14

PROBLEM-SOLVING

- 10 A Roman offers you either 12 palms or 1 pace of cloth. Which option gives you the most cloth?
- 11 The Roman army marches 5 Roman miles to the next post. How many paces is the journey?
- 12 An English cricketer runs 1 chain for each run made. How many yards will he run if he makes 20 runs?
- 13 Here is the length of 1 mm and 1 cm. Use these diagrams as a guide to estimate the length of these lines.

- a —
- b —
- c —————
- d ——————
- e ——————

- 14 Estimate the length of each line or curve, in centimetres.



15

15, 16

16, 17

11A

15 Complete these tables.

a metric

| | mm | cm | m | km |
|----|------|----------------|---|----|
| mm | 1 | $\frac{1}{10}$ | | |
| cm | 10 | 1 | | |
| m | 1000 | | 1 | |
| km | | | | 1 |

b imperial

| | Inch | Feet | Yard | Mile |
|------|------|------|----------------|------|
| Inch | 1 | | $\frac{1}{36}$ | |
| Feet | 12 | 1 | | |
| Yard | | | 1 | |
| Mile | | | 1760 | 1 |

c Roman

| | Digit | Palm | Feet | Pace | Mile |
|-------|-------|------|----------------|------|------|
| Digit | 1 | | $\frac{1}{16}$ | | |
| Palm | 4 | 1 | | | |
| Feet | | | 1 | | |
| Pace | | | | 1 | |
| Mile | | | | | 1 |

16 Why would it be more difficult to include the imperial units of chains and rods in the table in Question 15b?

17 Generally speaking, why is the metric system easier to use than either the imperial or Roman systems?

Walking paces

18

18 The Roman pace involves 2 steps, and 1000 of these paces make up a Roman mile. These units would have been used to estimate distances for the Roman armies that spread throughout much of the world during that time.

- a Estimate how many paces (i.e. double steps) you would take in 1 kilometre (1000).
- b Calculate how many paces you would take to cover 1 kilometre.
- c If each pace takes 1 second, find how long it would take to walk from Sydney to Melbourne (about 900 km) non-stop. Convert your answer to number of hours.



11B

Using and converting metric lengths

CONSOLIDATING



Interactive



Widgets



HOTsheets



Walkthroughs

To avoid the use of very large and very small numbers, an appropriate unit is often chosen to measure a length or distance. It may also be necessary to convert units of length. For example, 150 pieces of timber, each measured in centimetres, may need to be communicated as a total length using metres. Another example might be that 5 millimetres is to be cut from a length of timber 1.4 metres long because it is too wide to fit a door opening that is 139.5 centimetres wide.



A carpenter may need to measure lengths of wood in metres, centimetres and millimetres.

Let's start: How good is your estimate?

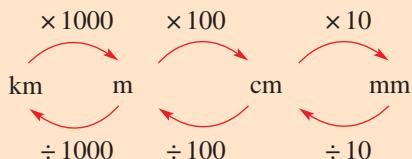
In less than 3 seconds, guess the length of your desk, in centimetres.

- Now use a ruler to find the actual length in centimetres.
- Convert your answer to millimetres and metres.
- If you lined up all the class desks end to end, how many desks would be needed to reach 1 kilometre? Explain how you got your answer.



■ The **metre** (m) is the basic metric unit of length.

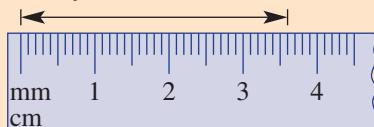
- $1 \text{ km} = 1000 \text{ m}$
- $1 \text{ m} = 100 \text{ cm}$
- $1 \text{ cm} = 10 \text{ mm}$



■ **Conversion**

- When converting to a smaller unit, multiply by a power of 10 (i.e. 10, 100, 1000). A smaller unit means you need more of them, so it makes sense that you multiply.
- When converting to a larger unit, divide by a power of 10 (i.e. 10, 100, 1000). A larger unit means you need less of them, so it makes sense that you divide.

- When reading scales, be sure about what units are showing on the scale. This scale shows 36 mm.





Example 3 Converting metric units of length

Convert to the units given in brackets.

a 3 m (cm)

b $25\ 600 \text{ cm}$ (km)

SOLUTION

$$\begin{aligned} \mathbf{a} \quad 3 \text{ m} &= 3 \times 100 \text{ cm} \\ &= 300 \text{ cm} \end{aligned}$$

$$\begin{aligned} \mathbf{b} \quad 25\ 600 \text{ cm} &= 25\ 600 \div 100\ 000 \\ &= 0.256 \text{ km} \end{aligned}$$

EXPLANATION

$$1 \text{ m} = 100 \text{ cm}$$

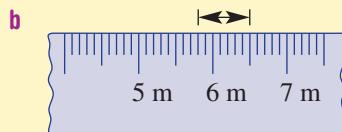
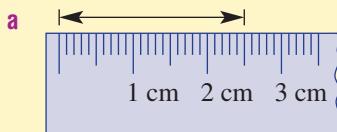
Multiply since you are converting to a smaller unit.

There are 100 cm in 1 m and 1000 m in 1 km and $100 \times 1000 = 100\ 000$.



Example 4 Reading length scales

Read the scales on these rulers to measure the marked length.



SOLUTION

a 25 mm

EXPLANATION

2.5 cm is also accurate.

b 70 cm

Each division is $\frac{1}{10}$ of a metre, which is 10 cm.

Exercise 11B

1–3

3

—

UNDERSTANDING

1 Write down the missing number or word in these sentences.

- a When converting from metres to centimetres, you multiply by _____.
- b When converting from metres to kilometres, you divide by _____.
- c When converting from centimetres to metres, you _____ by 100.
- d When converting from kilometres to metres, you _____ by 1000.
- e When converting to a smaller unit, you _____.
- f When converting to a larger unit, you _____.

2 Calculate each of the following.

a 100×10

b 10×100

c 100×1000

d $10 \times 100 \times 1000$

- 3 a When multiplying by a power of 10, in which direction does the decimal point move – left or right?
- b When dividing by a power of 10, in which direction does the decimal point move – left or right?

11B

4–7(½), 8

4–7(½), 8, 9

4–7(½), 8, 9

FLUENCY

Example 3a

- 4 Convert these measurements to the units shown in brackets.

- | | | | |
|---------------|---------------|----------------|---------------|
| a 5 cm (mm) | b 2 m (cm) | c 3.5 km (m) | d 26.1 m (cm) |
| e 40 mm (cm) | f 500 cm (m) | g 4200 m (km) | h 472 mm (cm) |
| i 6.84 m (cm) | j 0.02 km (m) | k 9261 mm (cm) | l 4230 m (km) |

- 5 Add these lengths together and give the result in the units shown in brackets.

- | | | |
|----------------------|----------------------|------------------------|
| a 2 cm and 5 mm (cm) | b 8 cm and 2 mm (mm) | c 2 m and 50 cm (m) |
| d 7 m and 30 cm (cm) | e 6 km and 200 m (m) | f 25 km and 732 m (km) |

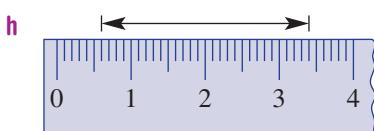
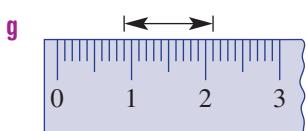
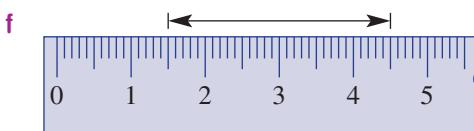
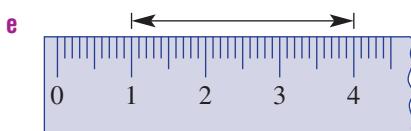
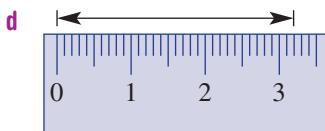
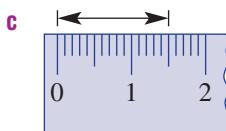
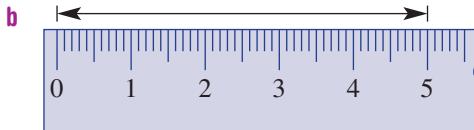
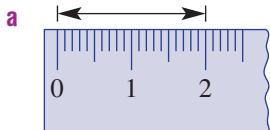
Example 3b

- 6 Convert to the units shown in the brackets.

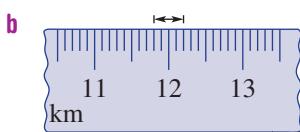
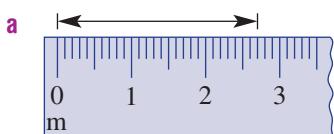
- | | | |
|-------------------|------------------|------------------|
| a 3 m (mm) | b 6 km (cm) | c 2.4 m (mm) |
| d 0.04 km (cm) | e 47 000 cm (km) | f 913 000 mm (m) |
| g 216 000 mm (km) | h 0.5 mm (m) | |

Example 4

- 7 These rulers show centimetres with millimetre divisions. Read the scale to measure the marked length.



- 8 Read the scale on these tape measures. Be careful with the units shown!



- 9 Use subtraction to find the difference between the measurements, and give your answer with the units shown in brackets.

- | | | |
|--------------------|---------------------|---------------------|
| a 9 km, 500 m (km) | b 3.5 m, 40 cm (cm) | c 0.2 m, 10 mm (cm) |
|--------------------|---------------------|---------------------|

10–12

12–14

15–17

11B

PROBLEM-SOLVING

- 10** Arrange these measurements from smallest to largest.
- a 38 cm, 540 mm, 0.5 m b 0.02 km, 25 m, 160 cm, 2100 mm
 c 0.003 km, 20 cm, 3.1 m, 142 mm d 0.001 km, 0.1 m, 1000 cm, 10 mm
- 11** Joe widens a 1.2 m doorway by 50 mm. What is the new width of the doorway, in centimetres?
- 12** Three construction engineers individually have plans to build the world's next tallest tower. The Titan tower is to be 1.12 km tall, the Gigan tower is to be 109 500 cm tall and the Bigan tower is to be 1210 m tall. Which tower will be the tallest?
- 13** Steel chain costs \$8.20 per metre. How much does it cost to buy chain of the following lengths?
- a 1 km b 80 cm c 50 mm
- 14** A house is 25 metres from a cliff above the sea. The cliff is eroding at a rate of 40 mm per year. How many years will pass before the house starts to fall into the sea?
- 15** Mount Everest is moving with the Indo-Australian plate at a rate of about 10 cm per year. How many years will it take to move 5 km?
- 16** A ream of 500 sheets of paper is 4 cm thick. How thick is 1 sheet of paper, in millimetres?
- 17** A snail slithers 2 mm every 5 seconds. How long will it take to slither 1 m?

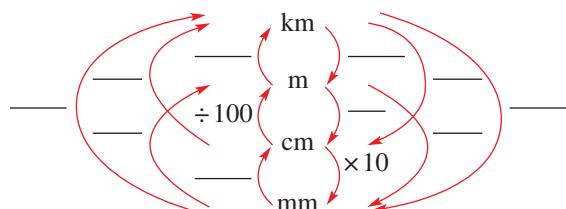
18

18

18, 19

REASONING

- 18** Copy this chart and fill in the missing information.



- 19** Many tradespeople measure and communicate with millimetres, even for long measurements like timber beams or pipes. Can you explain why this might be the case?

Very small and large units

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20

ENRICHMENT

- 20** When 1 metre is divided into 1 million parts, each part is called a **micrometre** (μm). At the other end of the spectrum, a **light year** is used to describe large distances in space.
- a State how many micrometres there are in:
- i 1 m ii 1 cm
 iii 1 mm iv 1 km
- b A virus is 0.000 312 mm wide. How many micrometres is this?
- c Research the length called the light year. Explain what it is and give examples of distances using light years, such as to the nearest star other than the Sun.

11C

Perimeter

CONSOLIDATING



Interactive



Widgets



HOTsheets



Walkthroughs

The distance around the outside of a two-dimensional shape is called the perimeter. The word *perimeter* comes from the Greek words *peri*, meaning ‘around’, and *metron*, meaning ‘measure’. We associate perimeter with the outside of all sorts of regions and objects, like the length of fencing surrounding a block of land or the length of timber required to frame a picture.

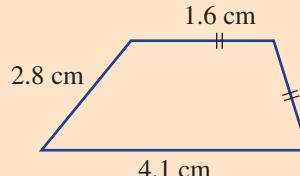
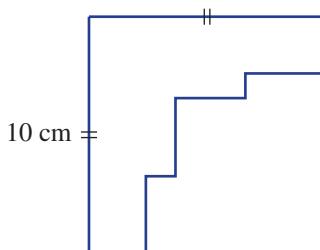


This fence marks the perimeter (i.e. the distance around the outside) of a paddock.

Let's start: Is there enough information?

This diagram, which is not drawn to scale, includes only 90° angles and only one side length is given. Discuss if there is enough information given in the diagram to find the perimeter of the shape.

What additional information, if any, is required?



$$\begin{aligned}P &= 1.6 + 1.6 + 2.8 + 4.1 \\&= 10.1 \text{ cm}\end{aligned}$$

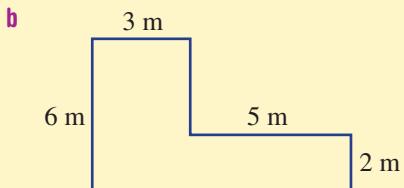
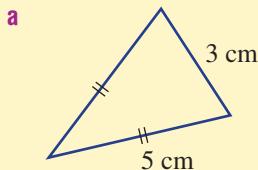


- **Perimeter**, sometimes denoted as P , is the distance around the outside of a two-dimensional shape.
- Sides with the same markings are of equal length.
- The unknown lengths of some sides can sometimes be determined by considering the given lengths of other sides.



Example 5 Finding the perimeter

Find the perimeter of each of these shapes.



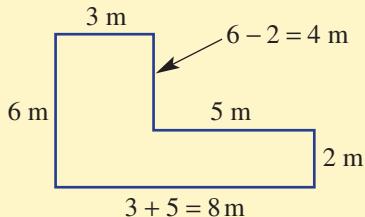
SOLUTION

a perimeter = $2 \times 5 + 3$
 $= 13$ cm

b perimeter = $2 \times 6 + 2 \times 8$
 $= 28$ m

EXPLANATION

There are two equal lengths of 5 cm and one length of 3 cm.

**Exercise 11C**

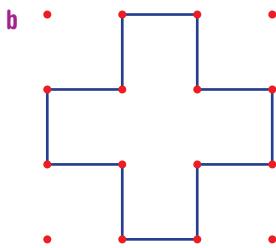
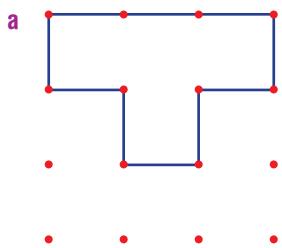
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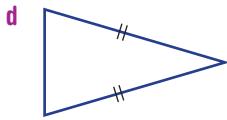
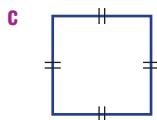
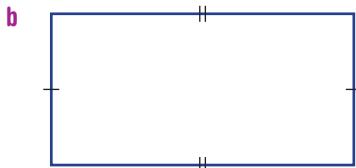
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UNDERSTANDING

- 1 These shapes are drawn on 1 cm grids. Give the perimeter of each.



- 2 Use a ruler to measure the lengths of the sides of these shapes, and then find the perimeter.



11C

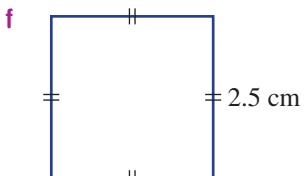
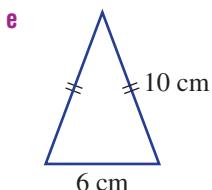
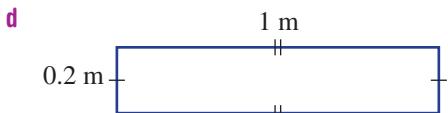
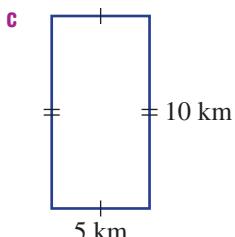
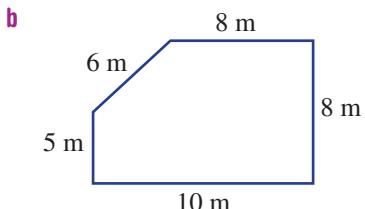
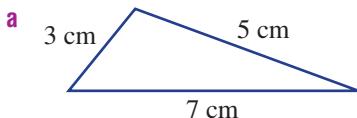
3, 4

3–5

3(½), 4, 5

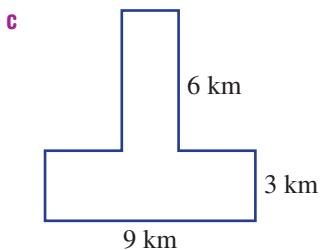
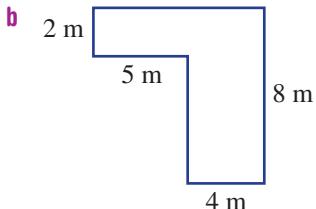
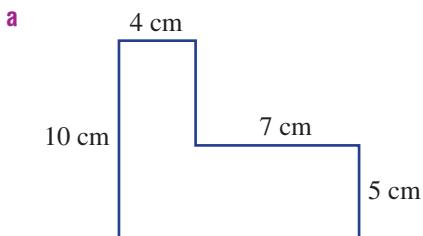
Example 5a

- 3 Find the perimeter of these shapes. (Diagrams are not drawn to scale.)



Example 5b

- 4 Find the perimeter of these shapes. All corner angles are 90° .



- 5 a A square has a side length of 2.1 cm. Find its perimeter.
 b A rectangle has a length of 4.8 m and a width of 2.2 m. Find its perimeter.
 c An equilateral triangle has all sides the same length. If each side is 15.5 mm, find its perimeter.

FLUENCY

6, 7

7–9

10–12

11C

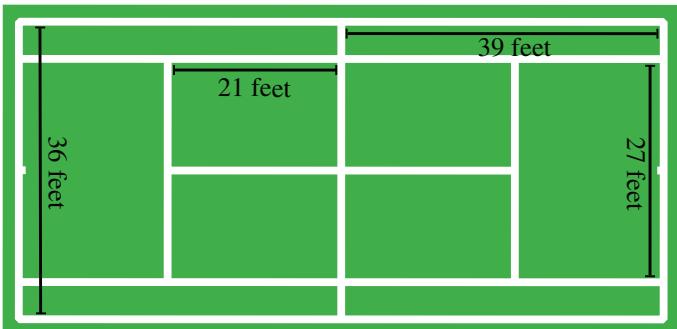


- 6 A grazing paddock is to be fenced on all sides. It is rectangular in shape, with a length of 242 m and a width of 186 m. If fencing costs \$25 per metre, find the cost of fencing required.



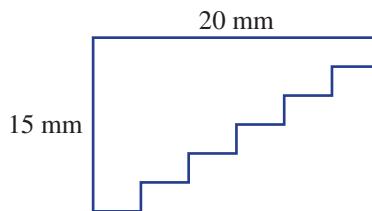
- 7 A grass tennis court is lined with chalk. All the measurements are shown in the diagram and given in feet.

- a Find the total number of feet of chalk required to do all the lines of the given tennis court.
 b There are 0.305 metres in 1 foot. Convert your answer to part a to metres.

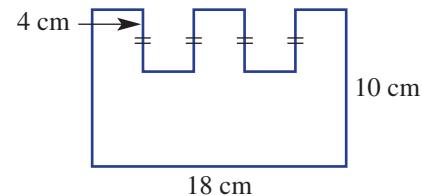


- 8 Only some side lengths are shown for these shapes. Find the perimeter.

a

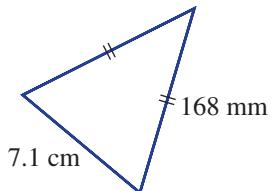


b

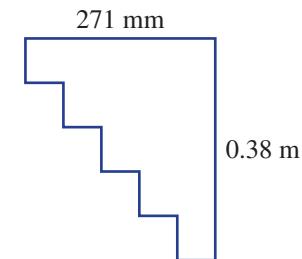


- 9 Find the perimeter of each of these shapes. Give your answers in centimetres.

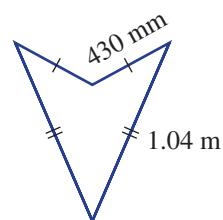
a



b



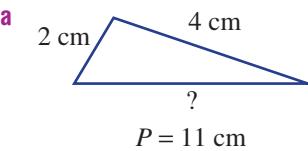
c



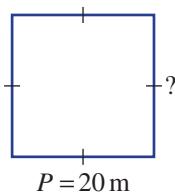
- 10 A square paddock has 100 equally-spaced posts that are 4 metres apart, including one in each corner. What is the perimeter of the paddock?

- 11 The perimeter of each shape is given. Find the missing length of each.

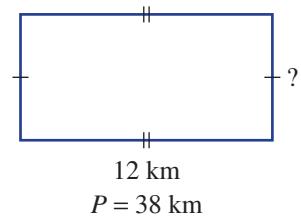
a



b

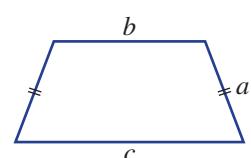
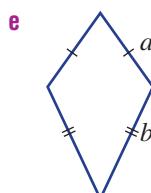
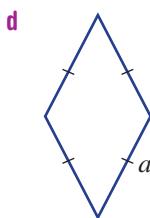
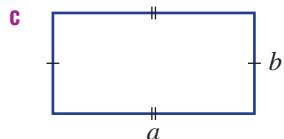
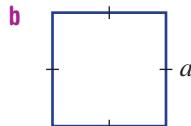
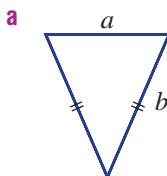


c

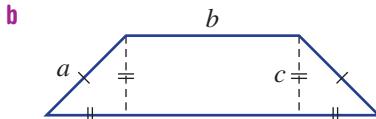
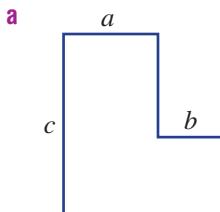


- 12 A rectangle has a perimeter of 16 cm. Using only whole numbers for the length and width, how many different rectangles can be drawn? Do not count rotations of the same rectangle.

- 13 Write an algebraic rule (e.g. $P = 2a + b$) to describe the perimeter of each shape.



- 14 Write an algebraic rule for the perimeter of each given shape.



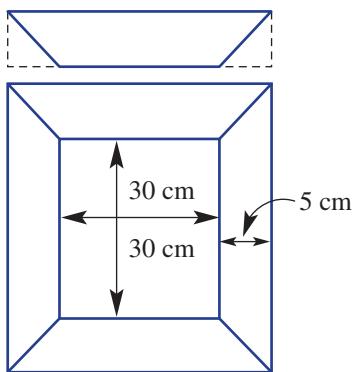
- 15 a A square has perimeter P . Write an expression for its side length.

- b A rectangle has perimeter P and width a . Write an expression for its length.

Picture frames

- 16 The amount of timber used to frame a picture depends on the outside lengths of the overall frame. These are then cut at 45° to make the frame.

- a A square painting of side length 30 cm is to be framed with timber of width 5 cm. Find the total length of timber required for the job.
- b A rectangular photo with dimensions 50 cm by 30 cm is framed with timber of width 7 cm. Find the total length of timber required to complete the job.
- c Kimberley uses 2 m of timber of width 5 cm to complete a square picture frame. What is the side length of the picture?
- d A square piece of embroidery has side length a cm and is framed by timber of width 4 cm. Write an expression for the total amount of timber used in cm.



11D Areas and rectangles



Interactive



Widgets



HOTsheets



Walkthroughs

Area is measured in square units. It is often referred to as the amount of space contained inside a flat (i.e. plane) shape; however, curved three-dimensional (3D) solids also have surface areas. The amount of paint needed to paint a house and the amount of chemical needed to spray a paddock are examples of when area would be considered.



The greater the area of the paddock, the more chemicals the plane needs to carry.

Let's start: The 12 cm^2 rectangle

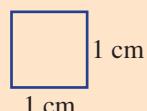
A rectangle has an area of 12 square centimetres (12 cm^2).

- Draw examples of rectangles that have this area, showing the length and width measurements.
- How many different rectangles with whole number dimensions are possible?
- How many different rectangles are possible if there is no restriction on the type of numbers allowed to be used for length and width?

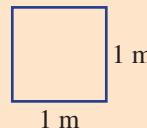
■ The metric units of area include:

- 1 square millimetre (1 mm^2)
- 1 square centimetre (1 cm^2)
 $1 \text{ cm}^2 = 100 \text{ mm}^2$
- 1 square metre (1 m^2)
 $1 \text{ m}^2 = 10000 \text{ cm}^2$

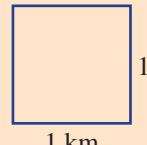
■ 1 mm
1 mm



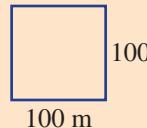
■ 1 cm
1 cm
1 m (Not drawn to scale.)



■ 1 m
1 km (Not drawn to scale.)



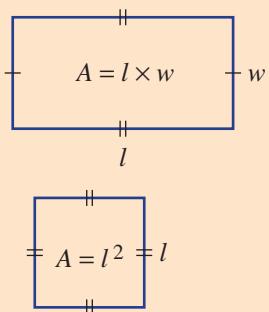
■ 1 ha
100 m (Not drawn to scale.)



Key ideas

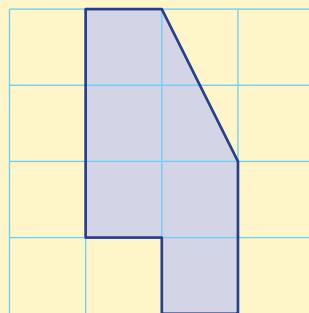
Key ideas

- The area of a rectangle is given by the number of rows multiplied by the number of columns. Written as a formula, this looks like: $A = l \times w$. This also works for numbers that are not whole.
- The area of a square is given by: $A = l \times l = l^2$



Example 6 Counting areas

Count the number of squares to find the area of the shape drawn on this centimetre grid.

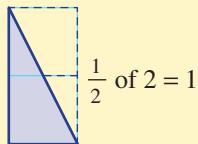


SOLUTION

$$6 \text{ cm}^2$$

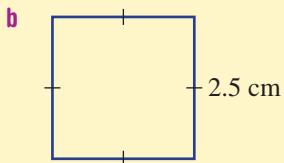
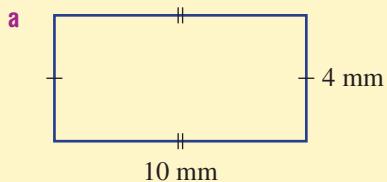
EXPLANATION

There are 5 full squares and half of 2 squares in the triangle, giving 1 more.



Example 7 Areas of rectangles and squares

Find the area of this rectangle and square.



SOLUTION

a Area = $l \times w$
 $= 10 \times 4$
 $= 40 \text{ mm}^2$

b Area = l^2
 $= 2.5^2$
 $= 6.25 \text{ cm}^2$

EXPLANATION

The area of a rectangle is the product of the length and width.

The width is the same as the length, so
 $A = l \times l = l^2$.
 $(2.5)^2 = 2.5 \times 2.5$

Exercise 11D

1–4

4

—

UNDERSTANDING

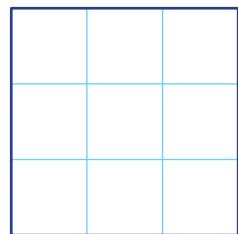
- 1 For this rectangle drawn on a 1 cm grid, find each of the following.

- a the number of single 1 cm squares
- b the length and the width
- c length \times width

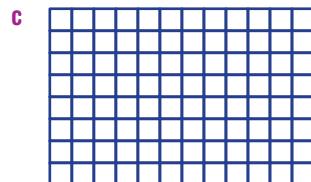
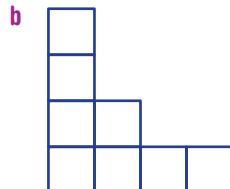
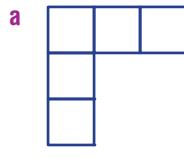


- 2 For this square drawn on a centimetre grid, find the following.

- a the number of single 1 cm squares
- b the length and the width
- c length \times width



- 3 Count the number of squares to find the area of these shapes.



- 4 Which unit of area (mm^2 , cm^2 , m^2 , ha or km^2) would you choose to measure these areas? Note that 1 km^2 is much larger than 1 ha.

- a area of an A4 piece of paper
- b area of a wall of a house
- c area of a small farm
- d area of a large desert
- e area of a large football oval
- f area of a nail head

11D

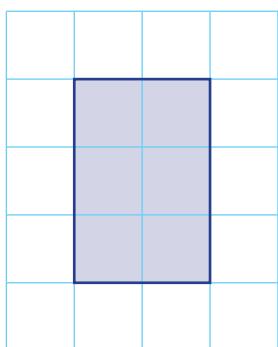
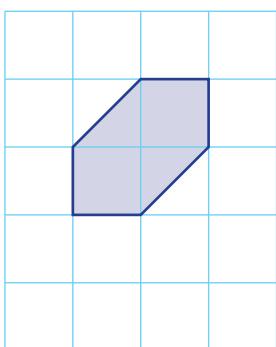
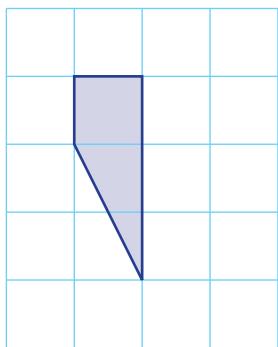
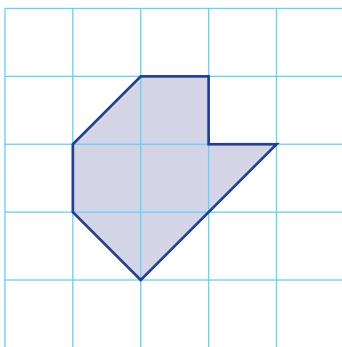
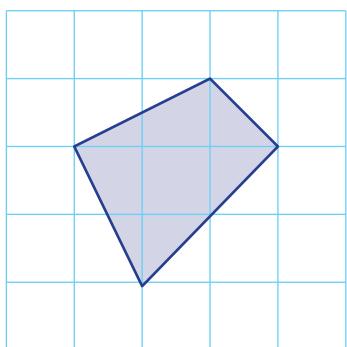
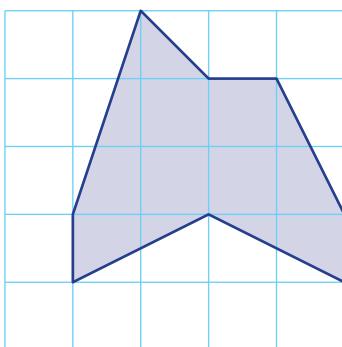
5, 6(½), 7–10

5, 6(½), 7–11

5, 6(½), 7–11

Example 6

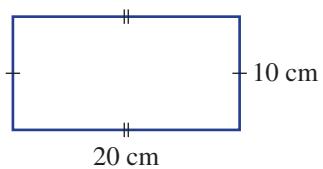
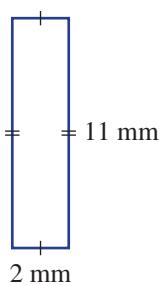
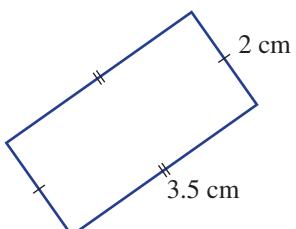
- 5 Count the number of squares to find the area of these shapes on centimetre grids.

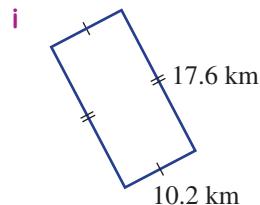
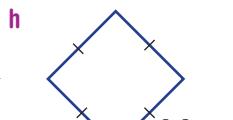
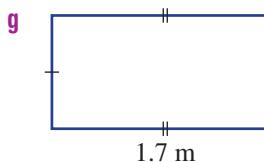
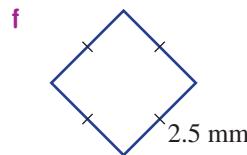
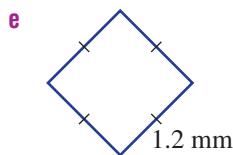
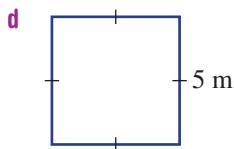
a**b****c****d****e****f**

FLUENCY

Example 7

- 6 Find the area of these rectangles and squares. Diagrams are not drawn to scale.

**a****b****c**



- 7 Find the side length of a square with each of these areas. Use trial and error if you are unsure.

a 4 cm^2

b 25 m^2

c 144 km^2

- 8 There are 10000 m^2 in one hectare (ha). Convert these measurements to hectares.

a 20000 m^2

b 100000 m^2

c 5000 m^2

- 9 A rectangular soccer field is to be laid with new grass. The field is 100 m long and 50 m wide. Find the area of grass to be laid.

- 10 Glass is to be cut for a square window of side length 50 cm. Find the area of glass required for the window.

- 11 Two hundred square tiles, each measuring 10 cm by 10 cm, are used to tile an open floor area. Find the area of flooring that is tiled.

12, 13

13, 14

13–15

- 12 a A square has a perimeter of 20 cm. Find its area.

b A square has an area of 9 cm^2 . Find its perimeter.

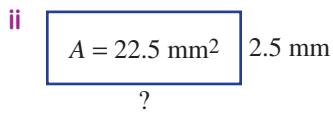
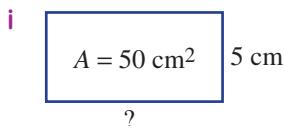
c A square's area and perimeter are the same number. How many units is the side length?

- 13 The carpet chosen for a room costs \$70 per square metre. The room is rectangular and is 6 m long by 5 m wide. What is the cost of carpeting the room?

- 14 Troy wishes to paint a garden wall that is 11 m long and 3 m high. Two coats of paint are needed. The paint suitable to do the job can be purchased only in whole numbers of litres and covers an area of 15 m^2 per litre. How many litres of paint will Troy need to purchase?

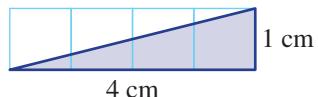
- 15 A rectangular area of land measures 200 m by 400 m. Find its area in hectares.

- 16 a** Find the missing length for each of these rectangles.



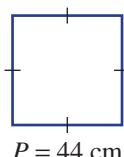
- b** Explain the method that you used for finding the missing lengths of the rectangles above.

- 17** Explain why the area shaded here is exactly 2 cm^2 .



- 18** A square has perimeter P cm.

- a If $P = 44$ cm, find the area of the square.
b If P is unknown, write an expression for the area of the square, using P .

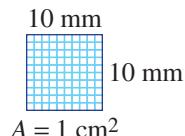


- 19** A square has all its side lengths doubled. How does this change the area? Investigate and justify your answer.

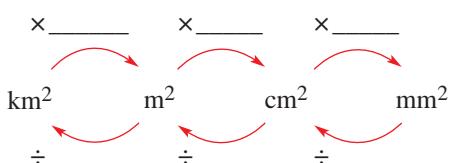
Area conversions

- 20 a** Use this diagram or similar to help answer the following.

- i How many mm^2 in 1 cm^2 ?
ii How many cm^2 in 1 m^2 ?
iii How many m^2 in 1 km^2 ?



- b** Complete the diagram below.



- c** Convert these units to the units shown in brackets.

- i 2 cm^2 (mm^2)
ii 10 m^2 (cm^2)
iii 3.5 km^2 (m^2)
iv 300 mm^2 (cm^2)
v $21\,600 \text{ cm}^2$ (m^2)
vi $4\,200\,000 \text{ m}^2$ (km^2)
vii 0.005 m^2 (mm^2)
viii 1 km^2 (ha)
ix $40\,000\,000 \text{ cm}^2$ (ha)



Guess the area of the paddock in the foreground in square millimetres.

11E Area of a triangle



Interactive



Widgets

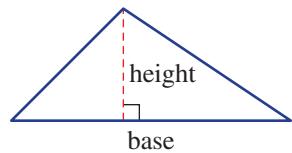


HOTsheets



Walkthroughs

Put simply, a triangle can be considered to be half a rectangle, which is why the formula for the area of a triangle looks very much like the formula for the area of a rectangle but with the added factor of $\frac{1}{2}$. One of the sides of a triangle is called the base (b), and the height (h) is the distance between the base and the opposite vertex. This is illustrated using a line that is perpendicular (i.e. at 90°) to the base.



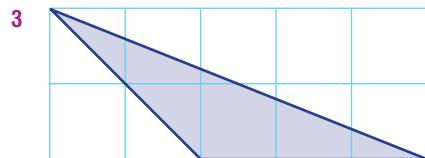
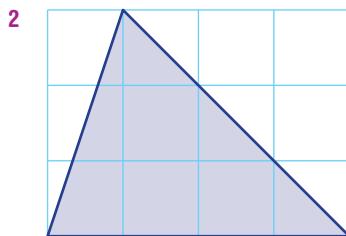
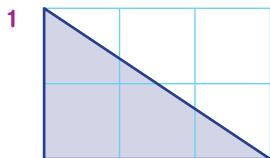
Any shape with all straight sides (i.e. polygons) can be divided up into a combination of rectangles (or squares) and triangles. This can help to find areas of such shapes.



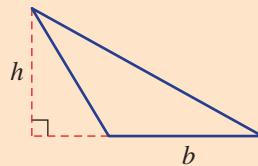
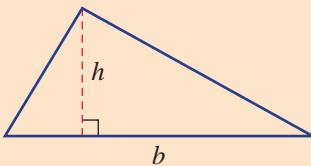
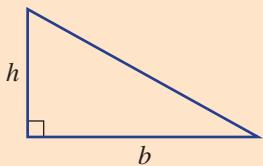
Any area of floor with straight sides can be filled with square and triangular tiles.

Let's start: Half a rectangle

Look at these triangles. For each one, discuss why the area could be considered as half a rectangle. Give reasons for each case.



- One side of a triangle is called the **base**, b .
- The **perpendicular** distance from the base to the opposite **vertex** is called the height, h . In the third illustration below, the base needs to be extended to help show the height.



- The area of a triangle is given by the formula:

$$A = \frac{1}{2} bh = \frac{1}{2} \times \text{base} \times \text{height}$$

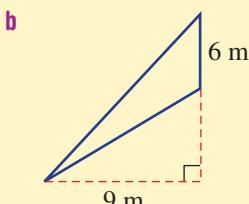
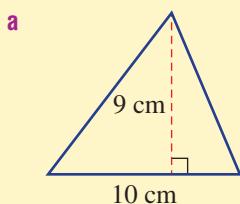
Note that $\frac{1}{2} bh$ is equivalent to $\frac{bh}{2}$.

Key ideas



Example 8 Finding areas of triangles

Find the area of each given triangle.



SOLUTION

$$\begin{aligned} \text{a} \quad \text{area} &= \frac{1}{2}bh \\ &= \frac{1}{2} \times 10 \times 9 \\ &= 45 \text{ cm}^2 \end{aligned}$$

$$\begin{aligned} \text{b} \quad \text{area} &= \frac{1}{2}bh \\ &= \frac{1}{2} \times 6 \times 9 \\ &= 27 \text{ cm}^2 \end{aligned}$$

EXPLANATION

Use the formula and substitute the values for base length and height.

The length measure of 9 m is marked at 90° to the side marked 6 m. So 6 m is the length of the base and 9 m is the perpendicular height.

Exercise 11E

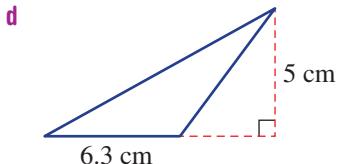
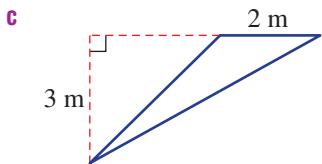
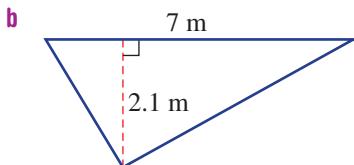
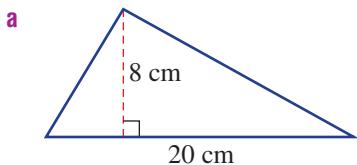
1–3

3

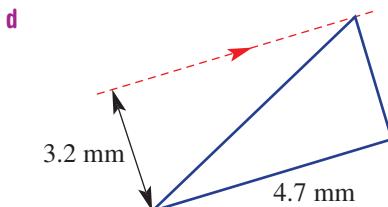
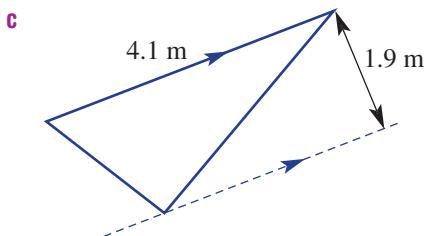
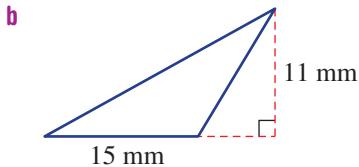
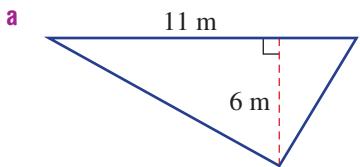
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UNDERSTANDING

- 1 For each of these triangles, what length would be used as the base?



- 2 For each of these triangles, what length would be used as the height?



- 3 Find the value of A in $A = \frac{1}{2}bh$ if:

a $b = 5$ and $h = 4$

b $b = 7$ and $h = 16$

c $b = 2.5$ and $h = 10$

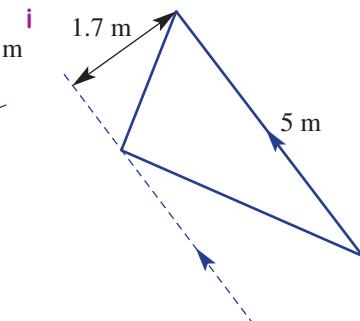
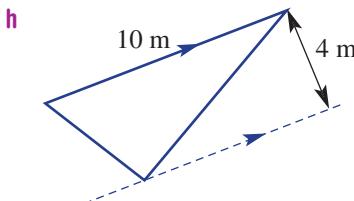
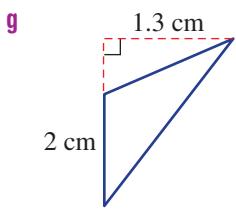
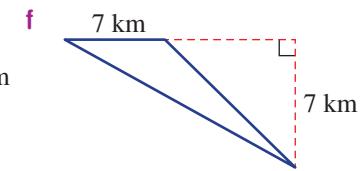
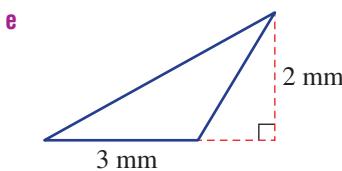
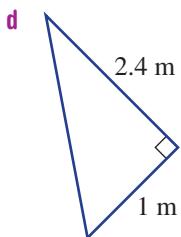
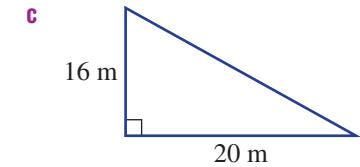
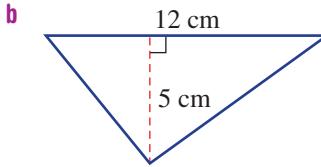
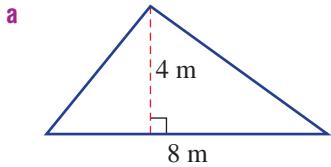
4(½), 5, 6

4(½), 5–7

4–5(½), 6–7

Example 8

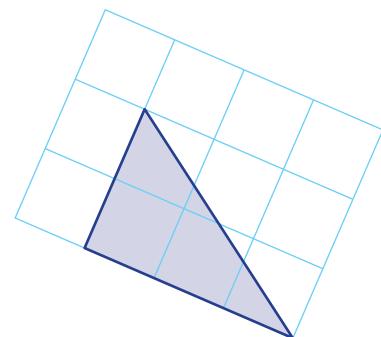
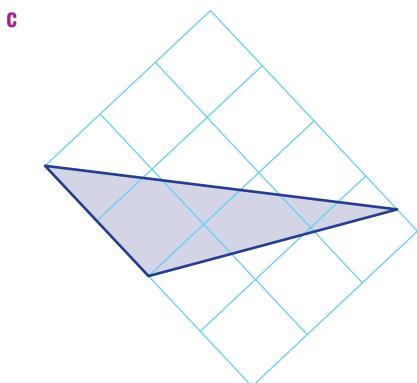
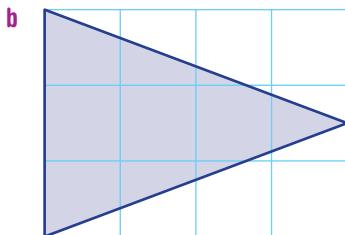
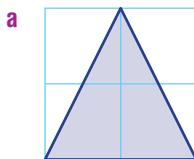
- 4 Find the area of each triangle given.



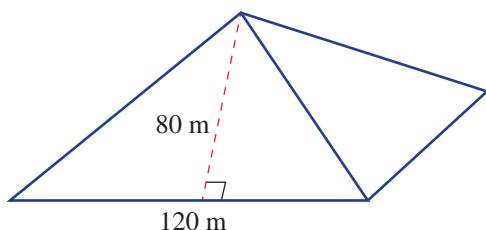
11E

FLUENCY

- 5 Find the area of these triangles, which have been drawn on 1 cm grids. Give your answer in cm^2 .



- 6 A rectangular block of land measuring 40 m long by 24 m wide is cut in half along a diagonal. Find the area of each triangular block of land.
- 7 A square pyramid has a base length of 120 m and a triangular face of height 80 m. Find the area of one triangular face of the pyramid.



8, 9

9, 10

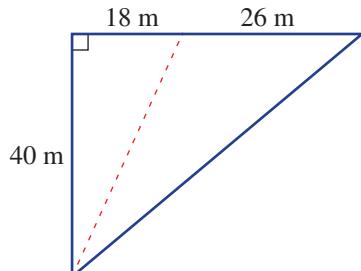
9–11

11E

PROBLEM-SOLVING

- 8** Each face of a 4-sided die is triangular, with a base of 2 cm and a height of 1.7 cm. Find the total area of all 4 faces of the die.

- 9** A farmer uses fencing to divide a triangular piece of land into two smaller triangles, as shown. What is the difference in the two areas?



- 10** A yacht must have two of its sails replaced as they have been damaged by a recent storm. One sail has a base length of 2.5 m and a height of 8 m and the bigger sail has a base length of 4 m and a height of 16 m. If the cost of sail material is \$150 per square metre, find the total cost to replace the yacht's damaged sails.



- 11 a** The area of a triangle is 10 cm^2 and its base length is 4 cm. Find its height.
b The area of a triangle is 44 mm^2 and its height is 20 mm. Find its base length.

11E

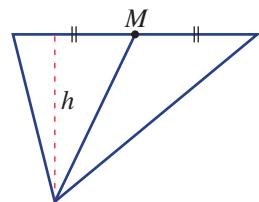
12

12, 13

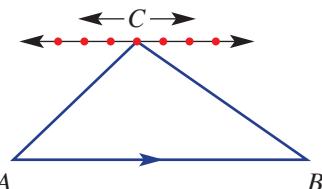
13, 14

REASONING

- 12 The midpoint, M , of the base of a triangle joins the opposite vertex. Is the triangle area split in half exactly? Give reasons for your answer.



- 13 If the vertex C for this triangle moves parallel to the base AB , will the area of the triangle change? Justify your answer.



- 14 The area of a triangle can be found using the formula $A = \frac{1}{2}bh$. Write down the formula to find the base, b , if you are given the area, A , and height, h .

Estimating areas with curves

—

—

15

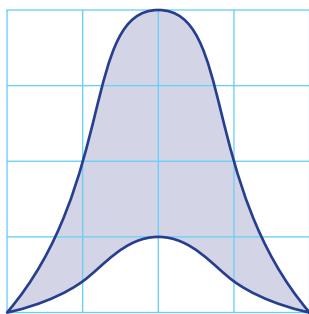
ENRICHMENT

- 15 This diagram shows a shaded region that is $\frac{1}{2}$ of $3 \text{ cm}^2 = 1.5 \text{ cm}^2$.

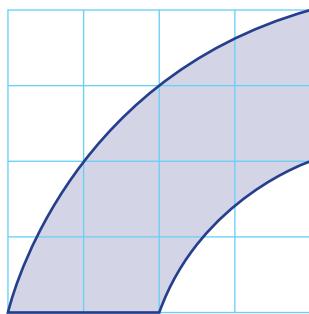


Using triangles like the one shown here, and by counting whole squares also, estimate the areas of these shapes below.

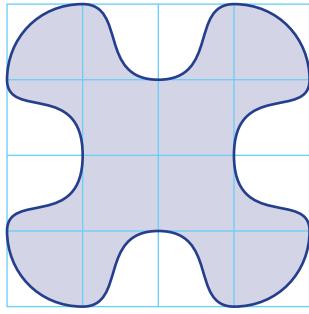
a



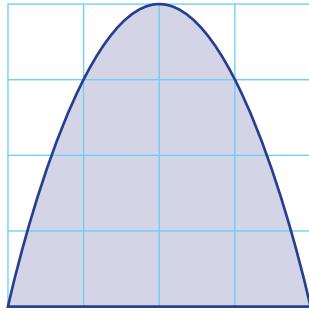
b



c



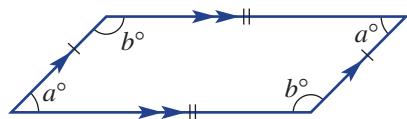
d



11F Area of a parallelogram



Recall that a parallelogram is a quadrilateral with two pairs of parallel sides. Opposite sides are of the same length and opposite angles are equal.



Interactive

SOLUTION

a $A = bh$
 $= 12 \times 5$
 $= 60 \text{ m}^2$

b $A = bh$
 $= 2 \times 3$
 $= 6 \text{ cm}^2$

EXPLANATION

Choose the given side as the base (12 m) and note the perpendicular height is 5 m.

Use the given side as the base (2 cm), noting that the height is 3 cm.

Exercise 11F

1, 2

2

—

UNDERSTANDING

- 1 Copy and complete the following, using the given values of b and h .

a $b = 5, h = 7$

$$\begin{aligned} A &= bh \\ &= \underline{\quad} \times \underline{\quad} \\ &= 35 \end{aligned}$$

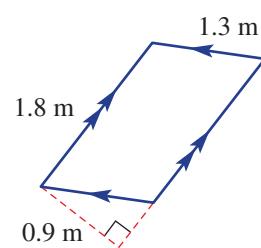
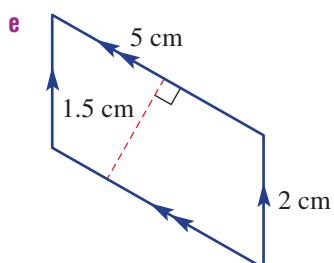
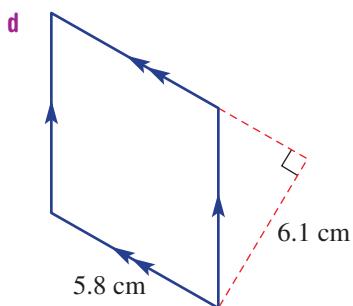
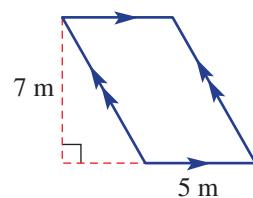
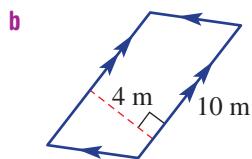
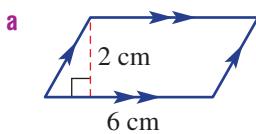
b $b = 20, h = 3$

$$\begin{aligned} A &= \underline{\quad} \\ &= 20 \times \underline{\quad} \\ &= \underline{\quad} \end{aligned}$$

c $b = 8, h = 2.5$

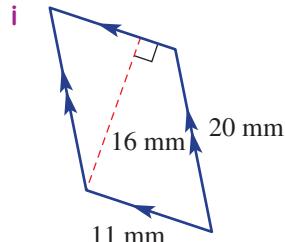
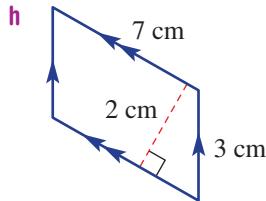
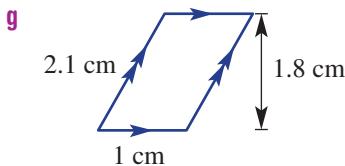
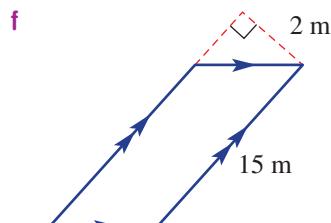
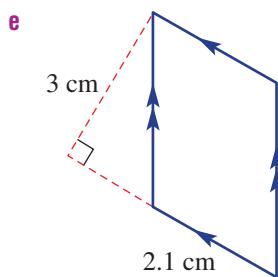
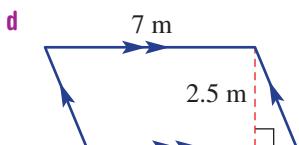
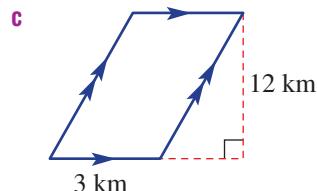
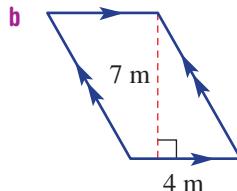
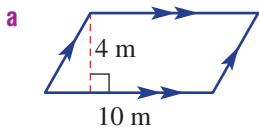
$$\begin{aligned} A &= \underline{\quad} \\ &= 8 \times \underline{\quad} \\ &= \underline{\quad} \end{aligned}$$

- 2 For each of these parallelograms, state the side length of the base and the height that might be used to find the area.

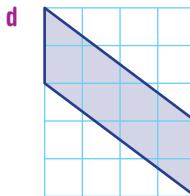
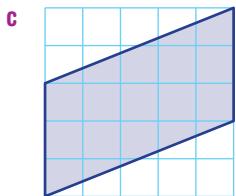
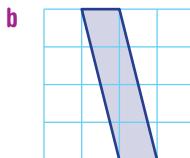
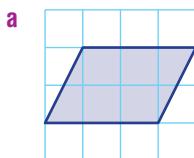


Example 9

- 3 Find the area of these parallelograms.



- 4 These parallelograms are on 1 cm grids (not to scale). Find their area.



- 5 The floor of an office space is in the shape of a parallelogram. The longest sides are 9 m and the distance between them is 6 m. Find the area of the office floor.

FLUENCY

- 6 Find the height of a parallelogram when its:

- a area = 10 m^2 and base = 5 m
- b area = 28 cm^2 and base = 4 cm
- c area = 2.5 mm^2 and base = 5 mm

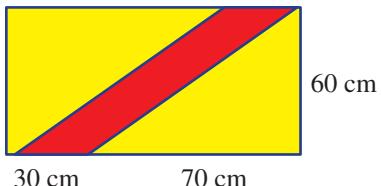
- 7 Find the base of a parallelogram when its:

- a area = 40 cm^2 and height = 4 cm
- b area = 150 m^2 and height = 30 m
- c area = 2.4 km^2 and height = 1.2 km

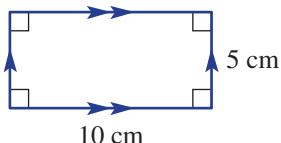
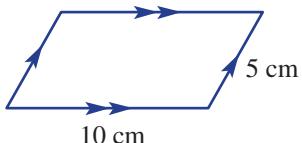
- 8 A large wall in the shape of a parallelogram is to be painted with a special red paint, which costs \$20 per litre. Each litre of paint covers 5 m^2 . The wall has a base length of 30 m and a height of 10 m. Find the cost of painting the wall.

- 9 A proposed rectangular flag for a new country is yellow with a red stripe in the shape of a parallelogram, as shown.

- a Find the area of the red stripe.
- b Find the yellow area.



- 10 Explain why this parallelogram's area will be less than the given rectangle's area.



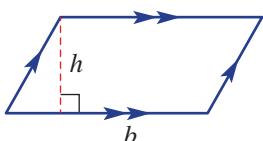
- 11 A parallelogram includes a green triangular area, as shown.

What fraction of the total area is the green area? Give reasons for your answer.



- 12 The area of a parallelogram can be thought of as twice the area of a triangle. Use this idea to complete this proof of the rule for the area of a parallelogram.

Area = twice triangle area



$$= 2 \times \underline{\hspace{2cm}}$$

$$= \underline{\hspace{2cm}}$$

Glass façade

13

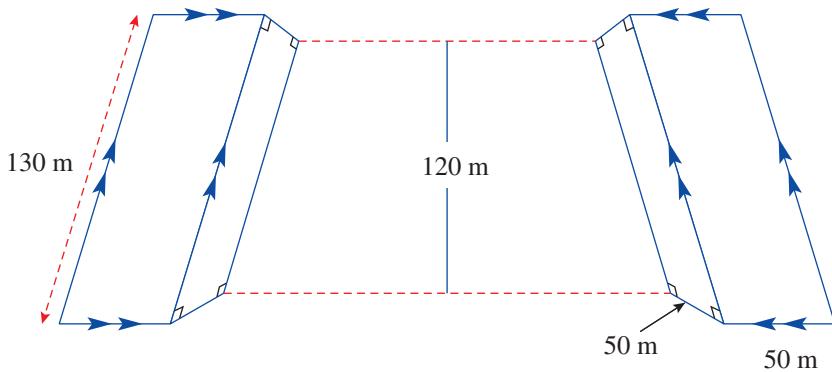
11F

ENRICHMENT



- 13 The Puerta de Europa (Gate of Europe) towers are twin office buildings in Madrid, Spain. They look like normal rectangular glass-covered skyscrapers but they lean towards each other at an angle of 15° to the vertical. Two sides are parallelograms and two sides are rectangles. Each tower has a vertical height of 120 m, a slant height of 130 m and a square base of side 50 m.

All four sides are covered with glass. If the glass costs \$180 per square metre, find the cost of covering *one* of the towers with glass. (Assume the glass covers the entire surface, ignoring the beams.)



11G

Area of composite shapes

EXTENDING



Interactive



Widgets



HOTsheets



Walkthroughs

The areas of more complicated shapes can be found by dividing them up into more simple shapes, such as the rectangle and triangle. We can see this in an aerial view of any Australian city. Such a view will show that many city streets are not parallel or at right angles to each other. As a result this causes city blocks to form interesting shapes, many of which are composite shapes made up of rectangles and triangles.

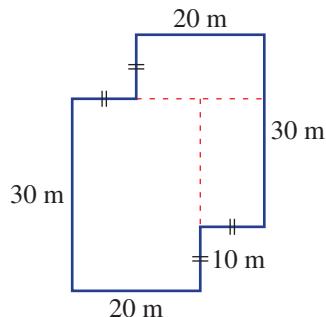
Let's start: Dividing land to find its area

Working out the area of this piece of land could be done by dividing it into three rectangles, as shown.

- Can you work out the area using this method?
- What is another way of dividing the land to find its area? Can you use triangles?
- What is the easiest method to find the area? Is there a way that uses subtraction instead of addition?

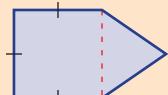


Streets, parks and buildings form complex shapes that can be made up of triangles and rectangles.



Key ideas

- Composite shapes** are made up of more than one simple shape.
- The area of composite shapes can be found by adding or subtracting the areas of simple shapes.



A square plus a triangle

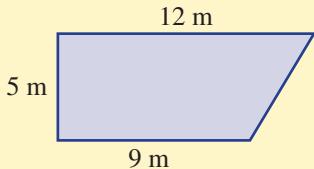


A rectangle subtract a triangle

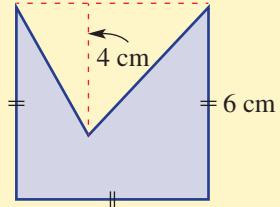
Example 10 Finding the area of composite shapes

Find the area of each of these composite shapes.

a



b

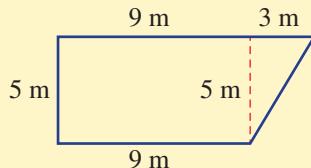


SOLUTION

a $A = l \times w + \frac{1}{2}bh$
 $= 9 \times 5 + \frac{1}{2} \times 3 \times 5$
 $= 45 + 7.5$
 $= 52.5 \text{ m}^2$

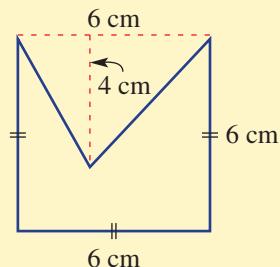
EXPLANATION

Divide the shape into a rectangle and triangle and find the missing lengths.



b $A = l^2 - \frac{1}{2}bh$
 $= 6^2 - \frac{1}{2} \times 6 \times 4$
 $= 36 - 12$
 $= 24 \text{ cm}^2$

Subtract the triangle ($\frac{1}{2} \times 6 \times 4$) at the top of the shape from the larger square (6×6).

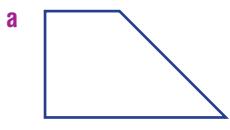
**Exercise 11G**

1–3

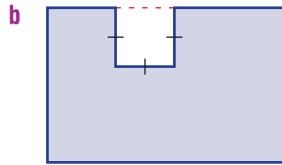
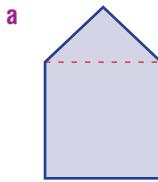
3

UNDERSTANDING

- 1 Copy these diagrams and draw a dotted line where you might divide these shapes into two more simple shapes.



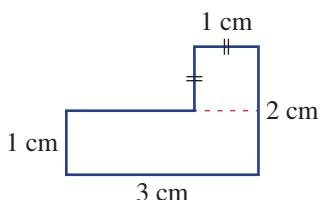
- 2 To find the area of each of the following shapes, decide if the easiest method would involve the *addition* of two shapes or the *subtraction* of one shape from another.



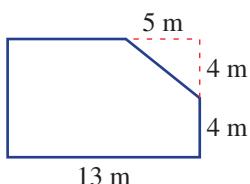
11G

UNDERSTANDING

- 3 Copy and complete the solutions for the areas of these shapes.

a

$$\begin{aligned} A &= l^2 + \underline{\hspace{2cm}} \\ &= 1^2 + 3 \times \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} + \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} \text{ cm}^2 \end{aligned}$$

b

$$\begin{aligned} A &= lw - \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} \times 8 - \frac{1}{2} \times \underline{\hspace{2cm}} \times \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} - \underline{\hspace{2cm}} \\ &= \underline{\hspace{2cm}} \text{ m}^2 \end{aligned}$$

4, 5

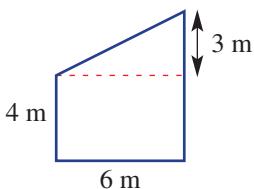
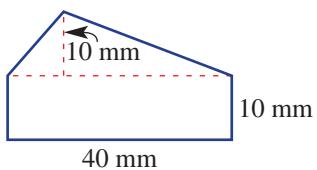
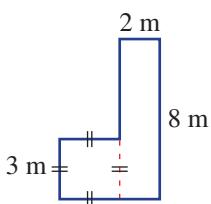
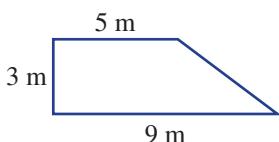
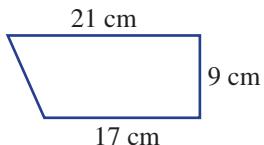
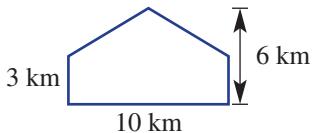
4, 5

4–5(½)

Example 10

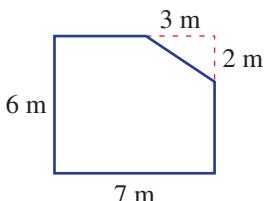
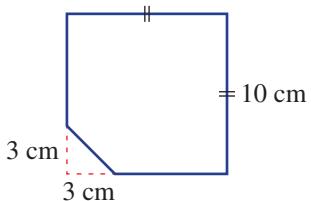
FLUENCY

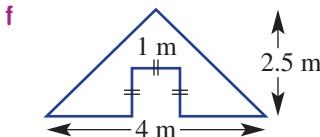
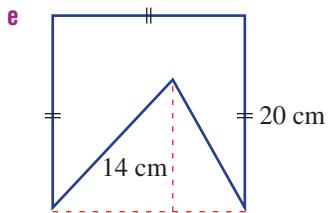
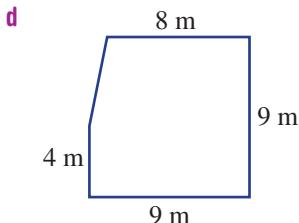
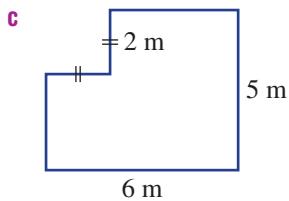
- 4 Find the area of these composite shapes by adding together the area of simpler shapes.

a**b****c****d****e****f**

Example 10

- 5 Use subtraction to find the area of these composite shapes.

a**b**

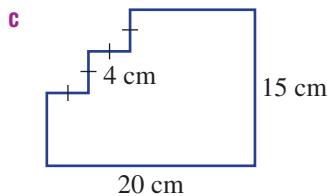
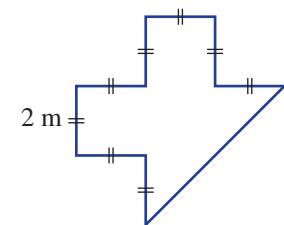
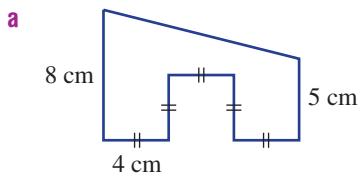


6, 7

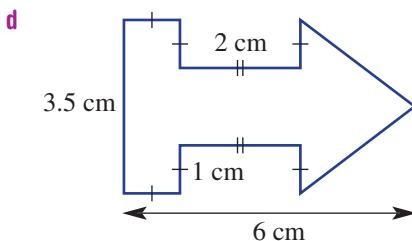
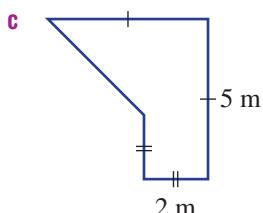
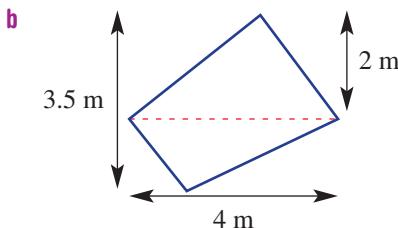
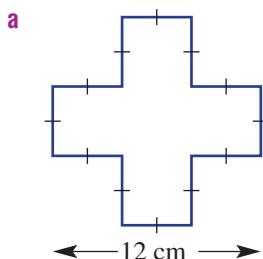
7, 8

7–9

- 6 Find the areas of these composite shapes.



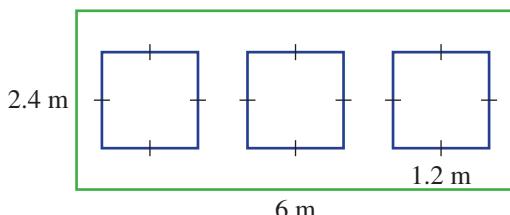
- 7 By finding the missing lengths first, calculate the area of these composite shapes.



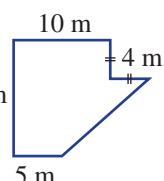
11G



- 8 A wall has three square holes cut into it to allow for windows, as shown. Find the remaining area of the wall.



- 9 A factory floor, with dimensions shown opposite, is to be covered with linoleum. Including underlay and installation, the linoleum will cost \$25 per square metre. The budget for the job is \$3000. Is there enough money in the budget to cover the cost?



PROBLEM-SOLVING

10

10

10, 11

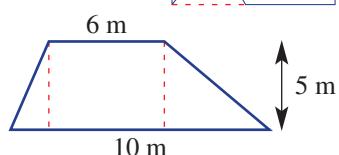
- 10 Explain why using subtraction is sometimes quicker than using addition to find the area of a composite shape. Refer to the diagram as an example.



REASONING

- 11 The 4-sided shape called the trapezium has one pair of parallel sides.

- a For the trapezium shown opposite, is it possible to find the base length of each triangle on the sides? Justify your answer.
- b Can you come up with a method for finding the area of this trapezium using the rectangle and triangles shown in the diagram? Use diagrams to explain your method.



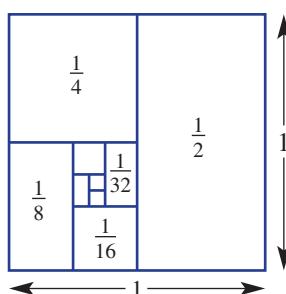
Adding to infinity

—

—

12

- 12 The square given opposite, which has an area of 1 unit, is divided to show the areas of $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, ...



ENRICHMENT

- a Similar to the one shown opposite, draw your own square, showing as many fractions as you can. Try to follow the spiral pattern shown. Note: The bigger the square you start with, the more squares you will be able to show.

- b i Write the next 10 numbers in this number pattern.

$$\frac{1}{2}, \frac{1}{4}, \frac{1}{8}, \dots$$

- ii Will the pattern ever stop?

- c What is the total area of the starting square?

- d What do your answers to parts b ii and c tell you about the answer to the sum below?

$$\frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + \dots \text{ (continues forever)}$$



Progress quiz

11A

- 1 Which metric unit would be most appropriate for measuring the lengths of:
- the height of the classroom?
 - the width of your thumb
 - the distance from Sydney to Canberra?

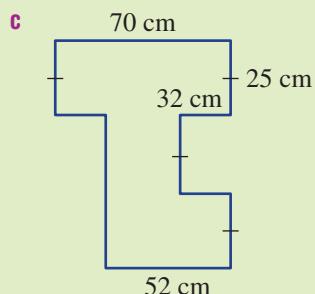
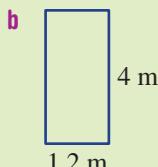
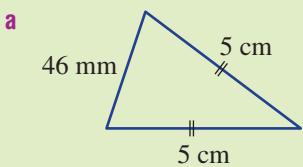
Ext

11B

- 2 Convert to the units given in brackets.
- | | | |
|------------|---------------|-----------------|
| a 4 m (cm) | b 2 m (mm) | c 3.5 cm (mm) |
| d 3 km (m) | e 1.45 km (m) | f 23 000 m (km) |

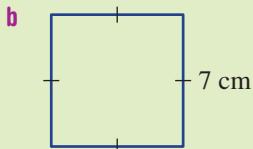
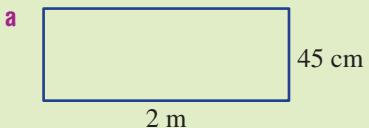
11C

- 3 Find the perimeter of each of these shapes.



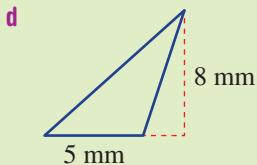
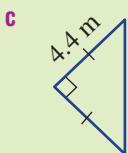
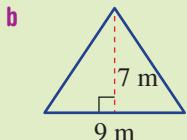
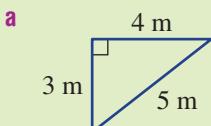
11D

- 4 Find the area of this rectangle and square.



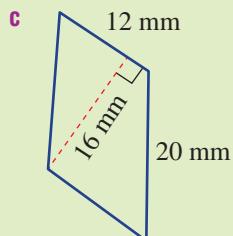
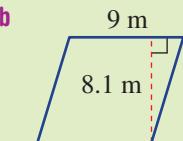
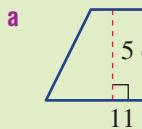
11E

- 5 Find the area of each given triangle.



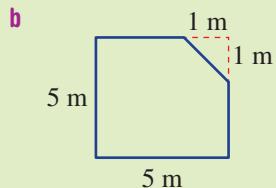
11F

- 6 Find the area of these parallelograms.

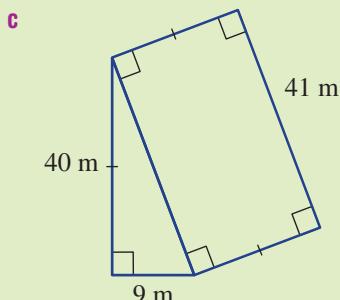


11G

- 7 Find the area of these composite shapes.



Ext



11C/D

- 8 The perimeter of a square made of thin wire is 60 cm. Find:

- the area of this square
- the area of a rectangle made with this wire, if its length is twice its width
- the number of smaller squares that can be made from this wire if each square has an area of 4 square centimetres

11H Volume of rectangular prisms



Interactive



Widgets



HOTsheets



Walkthroughs

The amount of space inside a three-dimensional (3D) object is called volume. Volume is measured in cubic units such as the cubic centimetre, which is 1 cm long, 1 cm wide and 1 cm high. Just like the topics of length and area, different units can be selected, depending on the size of the volume being measured. For example, the volume of water in the sea could be measured in cubic kilometres and the volume of concrete poured from a cement mixing truck could be measured in cubic metres.

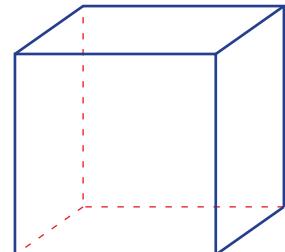


The Pacific Ocean contains hundreds of thousands of cubic kilometres of water.

Let's start: Volume

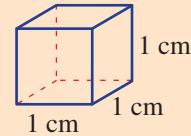
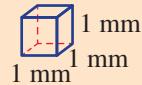
We all know that there are 100 cm in 1 m, but do you know how many cubic centimetres are in 1 cubic metre?

- Try to visualise 1 cubic metre – 1 metre long, 1 metre wide and 1 metre high. Guess how many cubic centimetres would fit into this space.
- Describe a method for working out the exact answer. Explain how your method works.



- Volume** is measured in cubic units.
- The common metric units for volume include:
 - cubic millimetres (mm^3)
 - cubic centimetre (cm^3)

(Not drawn to scale.)

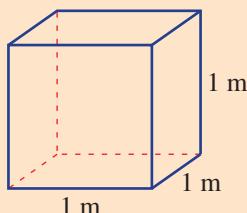


Key ideas

Key ideas

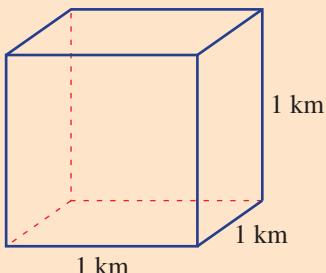
- cubic metre (m^3)

(Not drawn to scale.)



- cubic kilometre (km^3)

(Not drawn to scale.)



- The volume of a **rectangular prism** is given by the formula:

$$V = \text{length} \times \text{width} \times \text{height}$$

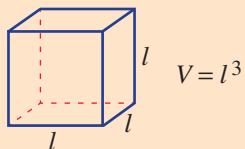
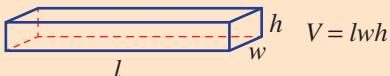
$$= lwh$$

- A rectangular prism is also called a **cuboid**.

- The volume of a **cube** is given by:

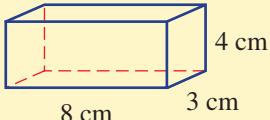
$$V = l \times l \times l$$

$$= l^3$$



Example 11 Finding the volume of a cuboid

Find the volume of this rectangular prism.



SOLUTION

$$\begin{aligned} V &= lwh \\ &= 8 \times 3 \times 4 \\ &= 96 \text{ cm}^3 \end{aligned}$$

EXPLANATION

Use the formula for the volume of a rectangular prism, then substitute the three lengths into the formula.

Exercise 11H

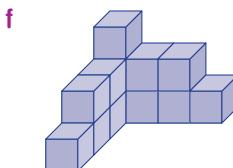
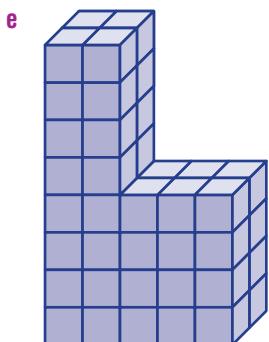
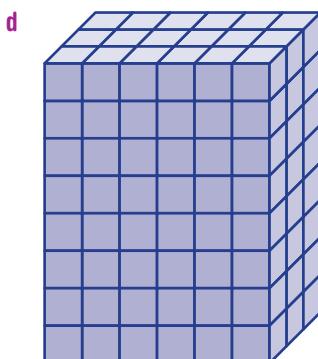
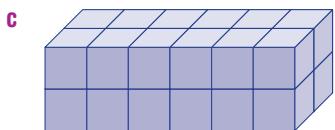
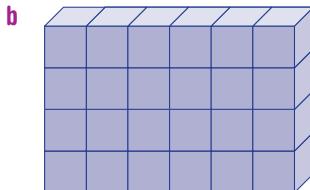
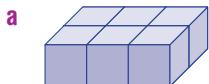
1, 2

2

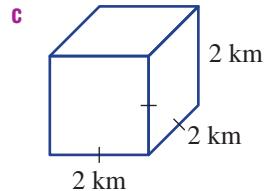
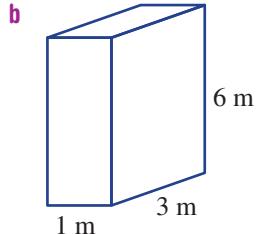
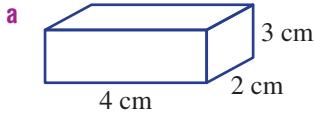
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UNDERSTANDING

- 1** For each of these solids, count the number of cubic units to find its volume.



- 2** Copy and complete the working shown for each of these solids.



$$V = lwh$$

$$= 4 \times \underline{\hspace{1cm}} \times \underline{\hspace{1cm}}$$

$$= \underline{\hspace{1cm}} \text{ cm}^3$$

$$V = lwh$$

$$= 1 \times \underline{\hspace{1cm}} \times \underline{\hspace{1cm}}$$

$$= \underline{\hspace{1cm}} \text{ }$$

$$V = lwh$$

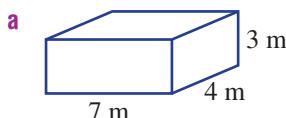
$$= 2 \times \underline{\hspace{1cm}} \times \underline{\hspace{1cm}}$$

$$= \underline{\hspace{1cm}} \text{ km}^3$$

11H

Example 11

- 3 Find the volume of these rectangular prisms.

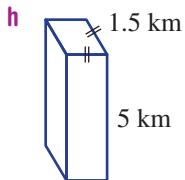
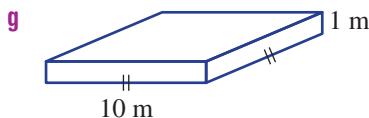
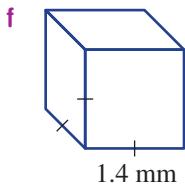
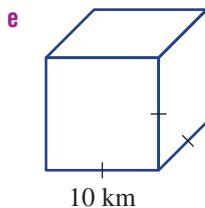
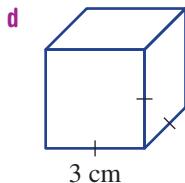
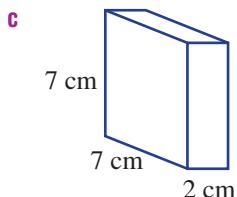
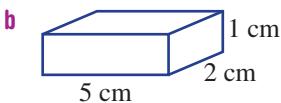


3–6

3(½), 4–7

3(½), 4–7

FLUENCY



- 4 A fruit box is 40 cm long, 30 cm wide and 20 cm high. Find its volume.
- 5 A shipping container is 3 m wide, 4 m high and 8 m long. Find its volume.
- 6 A short rectangular ruler is 150 mm long, 40 mm wide and 2 mm thick. Find its volume.
- 7 There is enough ice on Earth to fill a cube of side length 300 km. Find the approximate volume of ice on Earth.

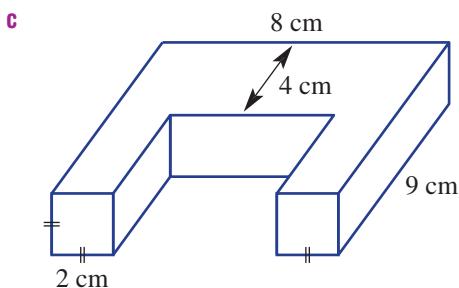
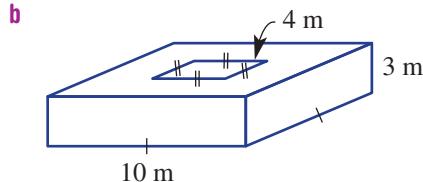
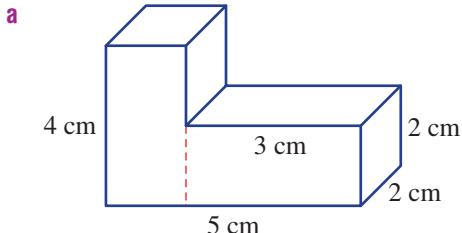


8, 9

9, 10

9–11

- 8** These solids are made up of more than one rectangular prism. Use addition or subtraction to find the volume of the composite solid.



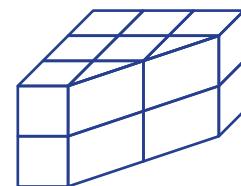
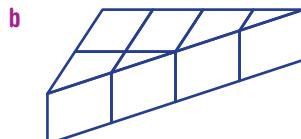
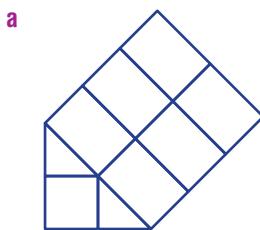
- 9** A box measuring 30 cm long, 20 cm high and 30 cm wide is packed with matchboxes, each measuring 5 cm long, 2 cm high and 3 cm wide. How many matchboxes will fit in the box?
- 10** The outside dimensions of a closed wooden box are 20 cm by 20 cm by 20 cm. If the box is made from wood that is 2 cm thick, find the volume of air inside the box.
- 11** a The area of one face of a cube is 25 cm^2 . Find the cube's volume.
b The perimeter of one face of a cube is 36 m. Find the cube's volume.

12

12

12, 13

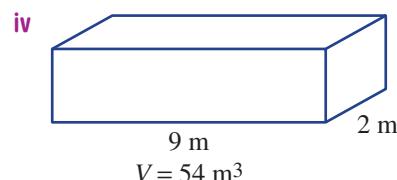
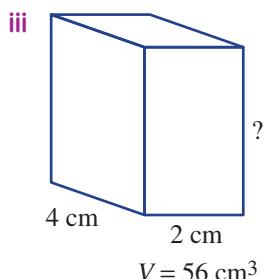
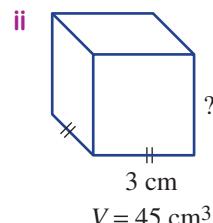
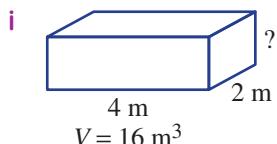
- 12** We can find the area of this shaded triangle by thinking of it as half a rectangle. Use the same idea to find the volume of each of these solids.



11H



- 13 a** Find the height of these rectangular prisms with the given volumes. Use trial and error if you prefer.



b Can you explain a method that always works for finding the height of a rectangular prism?

c Use V , l and w to write a rule for h .

REASONING

Cubic conversions

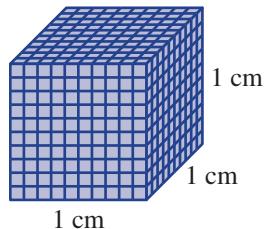
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14

ENRICHMENT

- 14 a** The diagram shows a 1 cm^3 block that is divided into cubic millimetres.



- How many mm^3 are there along one edge of the cube?
- How many mm^3 are there in one layer of the cube?
(Hint: How many cubes sit on the base?)
- How many layers of mm^3 are there in the cube?
- Use your answers from parts i to iii above to now calculate how many mm^3 there are in 1 cm^3 .

b Use a similar method to calculate the number of:

- cm^3 in 1 m^3
- m^3 in 1 km^3

c Complete the diagram shown.

$$\begin{array}{ccc} \times \underline{\quad} & \times \underline{\quad} & \times \underline{\quad} \\ \text{km}^3 & \text{m}^3 & \text{cm}^3 \\ \div \underline{\quad} & \div \underline{\quad} & \div \underline{\quad} \\ & & \text{mm}^3 \end{array}$$

111

Capacity

CONSOLIDATING



Interactive



Widgets



HOTsheets



Walkthroughs

Capacity relates to the volume of fluid or gas that a container can hold. For example, the capacity of a water tank may be 5000 litres, or a farmer's water allocation might be 300 megalitres (meaning 300 million litres). The basic unit is the litre, which contains 1000 cm^3 of space. Other common metric units for capacity include the millilitre, kilolitre and megalitre. There is a clear link between capacity and volume, as they both relate to the space occupied by a three-dimensional object.



Irrigation channels carry megalitres of water to farms.

Let's start: Water containers

Wil, Tony and Ethan each bring a container to collect some water from a fountain.

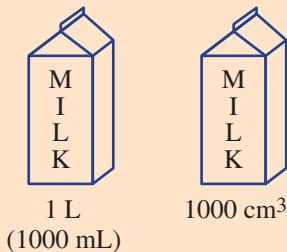
- Wil says his container holds 2 litres.
- Tony says his container holds 2000 cm^3 .
- Ethan says his container holds 2000 millilitres.

Who can collect the most water? Give reasons for your answer.

- **Capacity** is the volume of fluid or gas that an object can hold.
- Common metric units include:
 - 1 litre (L) = 1000 millilitres (mL)
 - 1 kilolitre (kL) = 1000 litres (L)
 - 1 megalitre (ML) = 1000 kilolitres (kL)

$$\begin{array}{ccccccc}
 & \times 1000 & \times 1000 & \times 1000 \\
 \text{ML} & \curvearrowright & \text{kL} & \curvearrowright & \text{L} & \curvearrowright & \text{mL} \\
 & \div 1000 & \div 1000 & \div 1000
 \end{array}$$

- Relating volume and capacity
 - $1 \text{ cm}^3 = 1 \text{ mL}$
 - $1 \text{ m}^3 = 1000 \text{ L} = 1 \text{ kL}$



Key ideas



Example 12 Converting units for capacity

Convert to the units shown in brackets.

a 500 mL (L)

b 3 ML (L)

SOLUTION

$$\begin{aligned} \mathbf{a} \quad 500 \text{ mL} &= 500 \div 1000 \\ &= 0.5 \text{ L} \end{aligned}$$

$$\begin{aligned} \mathbf{b} \quad 3 \text{ ML} &= 3 \times 1000 \text{ kL} \\ &= 3 \times 1000 \times 1000 \text{ L} \\ &= 3\,000\,000 \text{ L} \end{aligned}$$

EXPLANATION

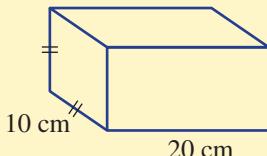
When converting to a larger unit, divide.
There are 1000 mL in 1 L.

There are 1000 kL in 1 ML and 1000 L in 1 kL. So 1 ML is 1 million litres.



Example 13 Converting cm^3 to litres

Find the capacity of this container, in litres.



SOLUTION

$$\begin{aligned} V &= 20 \times 10 \times 10 \\ &= 2000 \text{ cm}^3 \\ &= 2000 \text{ mL} \\ &= 2000 \div 1000 \text{ L} \\ &= 2 \text{ L} \end{aligned}$$

EXPLANATION

$$\begin{aligned} V &= lwh \\ 1 \text{ cm}^3 &= 1 \text{ mL} \\ \text{There are } 1000 \text{ mL in 1 litre.} \end{aligned}$$

Exercise 11I

1–3

3

—

UNDERSTANDING

- 1 Complete these sentences.

- a 1 mL contains the volume of _____ cm^3 .
- b 1 L contains _____ mL.
- c 1 L contains _____ cm^3 .
- d 1 kL contains _____ L.
- e 1 ML contains _____ kL.

UNDERSTANDING

- 2** Circle or write down which volumes are the same.

a 1 L, 10 kL, 1000 mL, 1 m^3 , 1000 cm^3

b 1 m^3 , 100 L, 1000 L, 1000 ML, 1 kL

3 From options **A** to **F**, choose the capacity that best matches the given container.

| | |
|--------------------------|-----------------|
| a teaspoon | A 18 L |
| b cup | B 250 mL |
| c bottle | C 10 kL |
| d kitchen sink | D 20 mL |
| e water tank | E 45 ML |
| f water in a lake | F 0.8 L |

4(½), 5–9

4(½), 5–9

4(½), 5, 6, 7(½), 9(½)

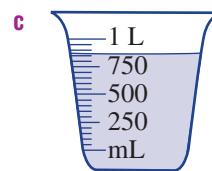
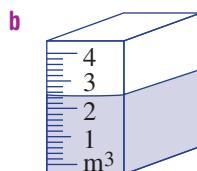
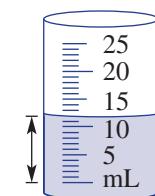
Example 12

- 4 Convert to the units shown in brackets.

| | | | |
|----------------|------------------|-----------------|-----------------|
| a 2 L (mL) | b 0.1 L (mL) | c 6 ML (kL) | d 24 kL (L) |
| e 2000 L (kL) | f 3500 mL (L) | g 70 000 mL (L) | h 2500 kL (ML) |
| i 0.257 L (mL) | j 9320 mL (L) | k 3.847 ML (kL) | l 47 000 L (kL) |
| m 0.5 kL (L) | n 91 000 kL (ML) | o 0.42 L (mL) | p 170 L (kL) |

FLUENCY

- 5** Read these scales to determine the amount of water in each of the containers.



- 6 A cup of 200 mL of water is added to a jug already containing 1 L of water. Find the total volume in:

- a** mL **b** L

Example 12

- 8 A farmer purchases 3.3 ML of water for her apple orchard. How many litres is this?



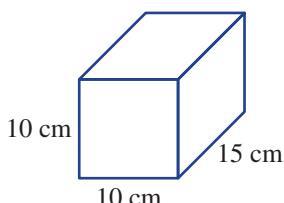
11I

Example 13

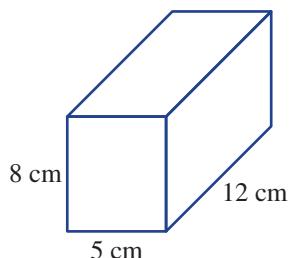


- 9 Find the capacity of each of these containers, in litres.

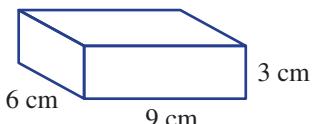
a



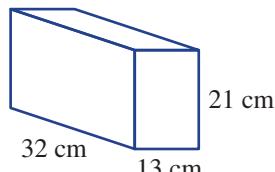
b



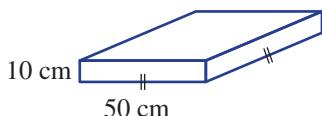
c



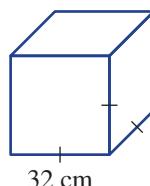
d



e



f



FLUENCY

10, 11

11, 12

12–14



- 10 A swimming pool in the shape of a rectangular prism has length 50 m, width 25 m and depth 2 m. Find the swimming pool's:

a volume, in m^3

b capacity, in L



- 11 A dripping tap leaks about 10 mL every minute.

a If there are 50 drips per minute, find the volume of one drip.

b Find the approximate volume of water, in litres, that has leaked from a tap after the following time periods.

- i 100 minutes ii 1 hour
iii 1 day iv 1 year



PROBLEM-SOLVING



- 12 A dose of 12 mL of medicine is to be taken twice each day from a 0.36 L bottle. How many days will it take to finish the medicine?



- 13** A gas bottle contains 50 L of liquid gas. If the liquid gas is used at a rate of 20 mL per minute, how many hours will the gas bottle last?
- 14** A city's dams have 2 million megalitres of water and the average daily consumption of the city's people is 400 L per day per person. If the city's population is 5 million people, how long will the dam supply last without further water catchment?

15

15

15, 16

- 15** If x is any number, then x litres is the same as $1000 \times x = 1000x$ millilitres because there are 1000 mL in 1 L. Write expressions for x L in the following units.

a cm³**b** m³**c** kL**d** ML

- 16 a** A rectangular prism has length l cm, width w cm and height h cm. Write an expression for the capacity of the container measured in:
- i** cm³ **ii** mL **iii** L **iv** kL
- b** A rectangular prism has length l m, width w m and height h m. Write an expression for the capacity of the container measured in:
- i** m³ **ii** L **iii** kL **iv** ML

Added depth

—

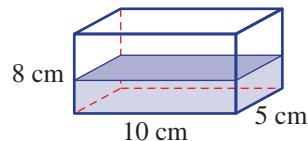
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17



- 17** A container is 10 cm long, 5 cm wide and 8 cm high.

- a** Find the depth of water when the following amounts of water are poured in. (Remember: 1 mL = 1 cm³.)
- i** 400 mL **ii** 200 mL **iii** 160 mL



- b** After adding 200 mL, a further 30 mL is added. What is the increase in depth?

- c** A 1-litre container of milk has a base area of 8 cm by 7 cm. After 250 mL of milk is poured out, what is the depth of the milk remaining in the container? Give your answer to the nearest mm.



11J

Mass and temperature

CONSOLIDATING



Interactive



Widgets



HOTsheets



Walkthroughs

The scales for both mass and temperature are based on the properties of water. In France in 1795, the gram was defined as being the weight of 1 cm³ of water at 0°C. Later it was redefined to be the weight at 4°C, as this is considered to be the temperature at which water is the most dense. So, 1 litre of water is very close to 1 kilogram, which is the basic unit for mass.

Other units for mass include the tonne, gram and milligram. A small car has a mass of about 1 tonne and a 20-cent coin has a mass of about 11 grams.

Temperature tells us how hot or cold something is. Anders Celsius (1701–1744), a Swedish scientist, worked to define a scale for temperature. After his death, temperature was officially defined by:

- 0°C (0 degrees Celsius) – the freezing point of water.
- 100°C (100 degrees Celsius) – the boiling point of water (at one standard degree of pressure).

This is still the common understanding of degrees Celsius. As mentioned in Chapter 10, Fahrenheit is another scale used for temperature. This is investigated further in the Enrichment questions.



A small car has a mass of about 1 tonne.

Let's start: Choose a unit of mass

Name five objects of which their mass would commonly be measured in:

- tonnes
- kilograms
- grams
- milligrams.

Is it possible for the temperature to drop below 0°C? How is this measured and can you give examples of places or situations where this might be the case?



Ice melts at 0°C.

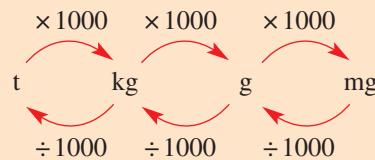
■ The basic unit for mass is the **kilogram** (kg). 1 litre of water has a mass that is very close to 1 kilogram.

■ Metric units for mass include:

- 1 **gram** (g) = 1000 **milligrams** (mg)
- 1 **kilogram** (kg) = 1000 **grams** (g)
- 1 **tonne** (t) = 1000 **kilograms** (kg)

■ The common unit for temperature is **degrees Celsius** ($^{\circ}\text{C}$).

- 0°C is the freezing point of water.
- 100°C is the boiling point of water.



Key ideas

Example 14 Converting units of mass

Convert to the units shown in brackets.

a 2.47 kg (g)

b $170\ 000 \text{ kg}$ (t)

SOLUTION

$$\begin{aligned} \text{a } 2.47 \text{ kg} &= 2.47 \times 1000 \text{ g} \\ &= 2470 \text{ g} \end{aligned}$$

$$\begin{aligned} \text{a } 170\ 000 \text{ kg} &= 170\ 000 \div 1000 \text{ t} \\ &= 170 \text{ t} \end{aligned}$$

EXPLANATION

$1 \text{ kg} = 1000 \text{ g}$
Multiply because you are changing to a smaller unit.

$1 \text{ t} = 1000 \text{ kg}$
Divide because you are changing to a larger unit.

Exercise 11J

1–3

3

—

1 Circle or write down the pair of equal mass measurements.

a 1 kg , 100 g , 1000 g , 10 t

b 1000 mg , 10 kg , 1 g , 1000 t

2 From options A to F, choose the mass that best matches the given object.

a human hair

A 300 g

b 10-cent coin

B 40 kg

c bottle

C 100 mg

d large book

D 1.5 kg

e large bag of sand

E 13 t

f truck

F 5 g

UNDERSTANDING

11J

UNDERSTANDING

FLUENCY

- 3 From options **A** to **D**, choose the temperature that best matches the description.

- | | |
|-----------------------------|--------------------------------|
| a temperature of coffee | A 15°C |
| b temperature of tap water | B 50°C |
| c temperature of oven | C -20°C |
| d temperature in Antarctica | D 250°C |

4(½), 5–10

4(½), 5–11

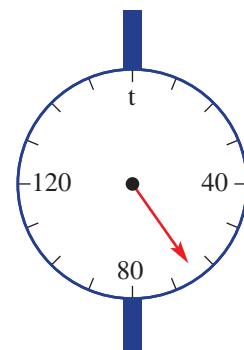
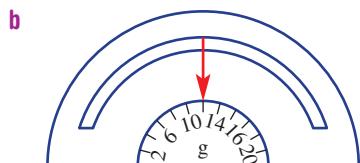
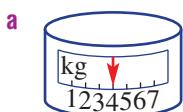
4(½), 5, 6(½), 7–11

Example 14

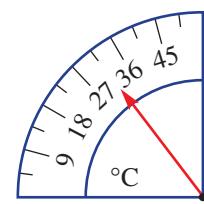
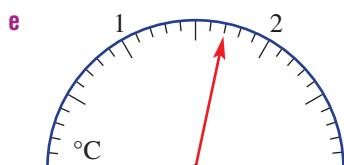
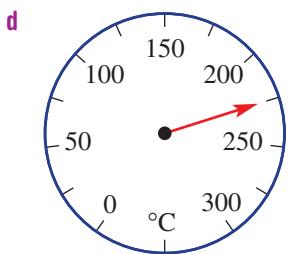
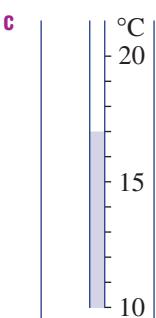
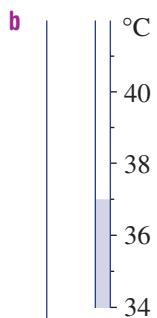
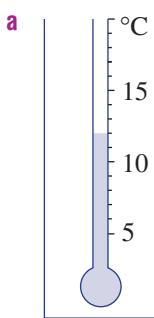
- 4 Convert to the units shown in brackets.

- | | | | |
|-----------------------------------|--------------------------------------|--------------------------------------|-------------------------------|
| a $2\text{ t} (\text{kg})$ | b $70\text{ kg} (\text{g})$ | c $2.4\text{ g} (\text{mg})$ | d $2300\text{ mg} (\text{g})$ |
| e $4620\text{ mg} (\text{g})$ | f $21\,600\text{ kg} (\text{t})$ | g $0.47\text{ t} (\text{kg})$ | h $312\text{ g} (\text{kg})$ |
| i $27\text{ mg} (\text{g})$ | j $\frac{3}{4}\text{ t} (\text{kg})$ | k $\frac{1}{8}\text{ kg} (\text{g})$ | l $10.5\text{ g} (\text{kg})$ |
| m $210\,000\text{ kg} (\text{t})$ | n $0.47\text{ t} (\text{kg})$ | o $592\,000\text{ mg} (\text{g})$ | p $0.08\text{ kg} (\text{g})$ |

- 5 Read these mass scales.



- 6 Read these temperature scales.





12, 13

13, 14

14-16

- 12** Arrange these mass measurements from smallest to largest.

a 2.5 kg, 370 g, 0.1 t, 400 mg
b 0.000 32 t, 0.41 kg, 710 g, 290 000 mg

13 The highest and lowest temperatures recorded over a 7-day period are as follows.

| Day | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|--|----|----|----|----|----|----|----|
| Lowest temperature ($^{\circ}\text{C}$) | 8 | 6 | 10 | 9 | 7 | 8 | 10 |
| Highest temperature ($^{\circ}\text{C}$) | 24 | 27 | 31 | 32 | 21 | 19 | 29 |

a Which day had the largest temperature range?
b What is the largest temperature drop from the highest temperature on one day to the lowest temperature on the next day?
c What would have been the final temperature on Day 7 if the temperature increased from the minimum by 16°C ?

PROBLEM-SOLVING

- 14** A 10 kg bag of flour is used at a rate of 200 g per day. How many days will the bag of flour last?

15 A boat has a weight limit of 3.5 t carrying capacity. Loaded onto the boat are 1500 tins of coffee at 500 g each, 36 bags of grain at 20 kg each, 190 boxes of tobacco at 5.5 kg each and 15 people, averaging 80 kg each. Is the load too much for the weight limit of the boat?

11J



- 16** A truck tare mass (i.e. mass with no load) is 13.2 t. The truck's gross mass is 58.5 t. This is the total maximum mass allowed, including the load.

- What is the maximum load the truck can carry?
- The truck is loaded with 120 timber beams at 400 kg each. Will it exceed its gross weight limit?



PROBLEM-SOLVING

17

17, 18

18, 19

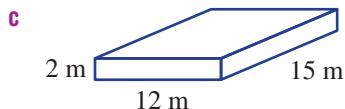
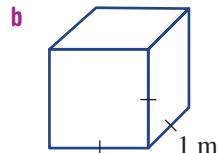
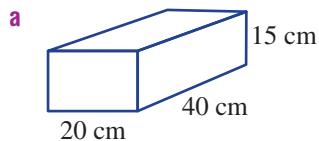
REASONING

- 17** Water weighs 1 kg per litre. What is the mass of these volumes of water?

- 1 mL
- 1 kL
- 1 ML



- 18** The containers shown below are filled with water. Calculate the mass of water in each container, in kg.



- 19** The kelvin (K) is a temperature unit used by many scientists, where 273 K is approximately 0°C. (The kelvin used to be called the 'degree kelvin' or °K.) An increase in 1 K is the same as an increase in 1°C.

- Write the following temperatures in °C.
i 283 K ii 300 K iii 1000 K
- Write the following temperatures in kelvins.
i 0°C ii 40°C iii -273°C



Liquid nitrogen freezes at -210°C and boils at -196°C.

Fahrenheit

20

11J

ENRICHMENT

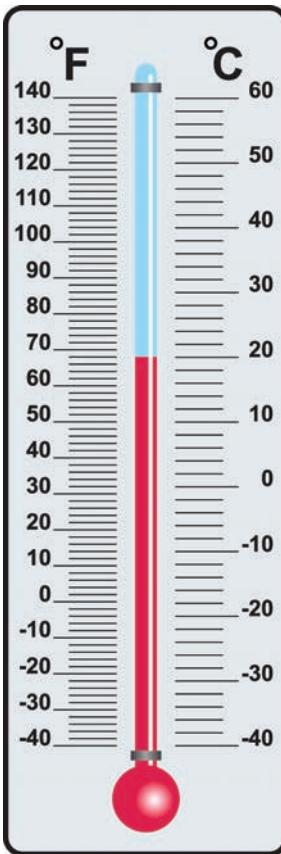


- 20** Daniel Fahrenheit (1686–1736) proposed the Fahrenheit temperature scale in 1724. It was commonly used in Australia up until the mid-twentieth century, and is still used today in the United States.

32°F is the freezing point of water.

212°F is the boiling point of water.

- What is the difference between the temperature, in Fahrenheit, for the boiling point of water and the freezing point of water?
- 1°F is what fraction of 1°C ?
- 1°C is what fraction of 1°F ?
- To convert from $^{\circ}\text{F}$ to $^{\circ}\text{C}$, we use the formula $C = (F - 32) \times \frac{5}{9}$. Convert these Fahrenheit temperatures to $^{\circ}\text{C}$.
 - 32°F
 - 68°F
 - 140°F
 - 221°F
- Find the rule to convert from $^{\circ}\text{C}$ to $^{\circ}\text{F}$. Test your rule to see if it works and write it down.

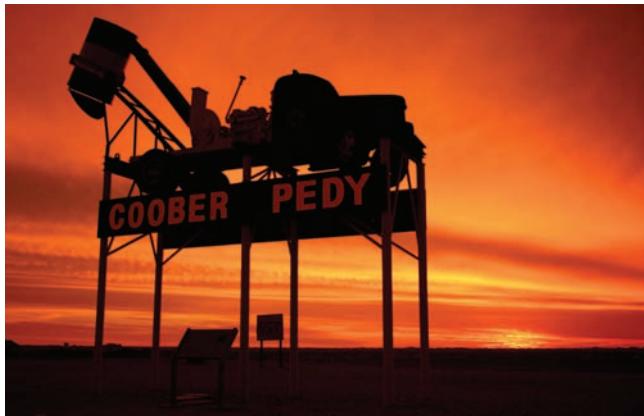




Investigation

Opal mining

Greg, Sally and Alston apply for a mining licence to look for opals at Coober Pedy in South Australia. They are required to choose an area and mark it out with special orange tape so that others will know which areas are already taken. Their length of tape is 200 m.



Square mining areas

They first decide to mark out an area as a square.

- Make a drawing of their square area.
- Calculate the side length and area and show this on your diagram. Also show any working.

Rectangular mining areas

They then change the mining area and experiment with different side lengths.

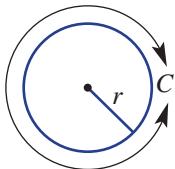
- Show three possible lengths and areas for rectangular mining sites.
- Complete a table similar to the one below. Fill in the missing numbers for the side lengths given, then add your own rectangle measurements from part a above.

| Length | Width | Perimeter | Area |
|--------|-------|-----------|------|
| 10 | | 200 | |
| 20 | | 200 | |
| 35 | | 200 | |
| | | 200 | |
| | | 200 | |
| | | 200 | |

- Are there any rectangles that give a larger area than the square mining area from above?

Circular mining areas

They now decide to try to arrange the tape to form a circle. For this section you will need the rule to calculate the distance around a circle (circumference). The circumference C is given by $C = 2 \times \pi \times r$ where r is the length of the radius and $\pi \approx 3.14$.



- Calculate the radius of the circle correct to one decimal place. Use a trial and error (guess and check) technique and remember that the circumference will be 200. Explain and show your method using a table of values.
- Calculate the area of the circular mining area correct to the nearest square metre. Use the special rule for the area of a circle A which is given by $A = \pi \times r^2$.

The largest area

Compare the areas marked out with the 200 m tape by Greg, Sally and Alston. Comment on any differences. Which shape gives the largest area for the given perimeter? Would your answer be the same if any shape were allowed to be used? Explain.





Problems and challenges



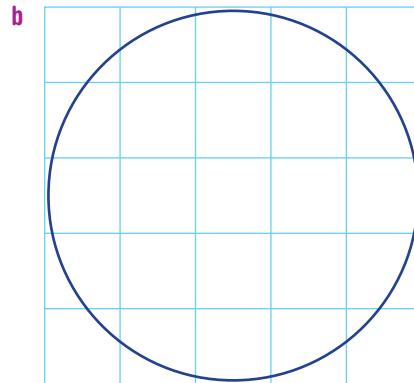
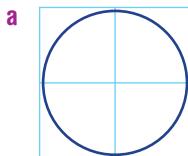
Up for a challenge? If you get stuck on a question, check out the 'Working with unfamiliar problems' poster at the end of the book to help you.

- 1 Without measuring, state which line looks longer: A or B? Then measure to check your answer.



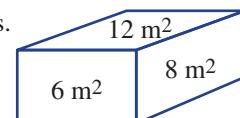
- 2 You have two sticks of length 3 m and 5 m, both with no scales. How might you mark a length of 1 m?

- 3 Count squares to estimate the area of these circles if each grid square is 1 cm across.



- 4 A house roof has 500 m^2 of area. If there is 1 mm of rainfall, how much water, in litres, can be collected from the roof?

- 5 Work out the volume of this rectangular prism with the given face areas.

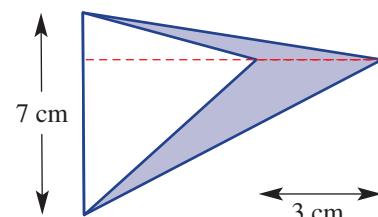


- 6 Find the area of the shaded region.

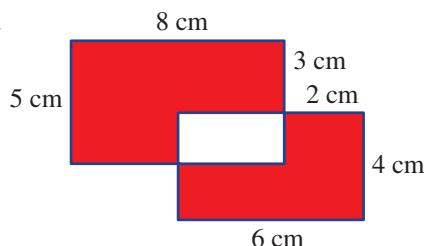
- 7 A cube of side length 20 cm contains 5 L of water.

a What is the depth of water in the cube?

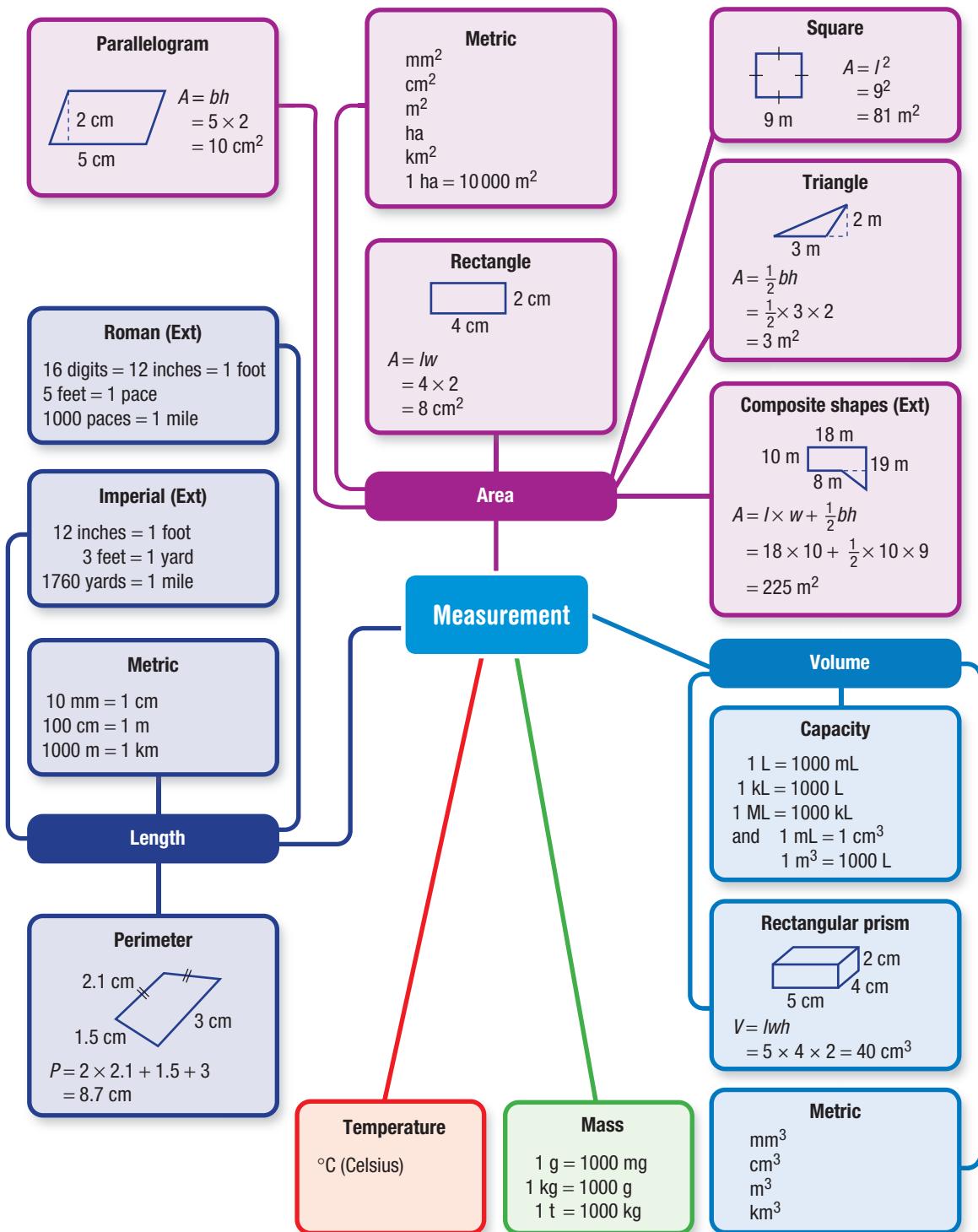
b What is the increase in depth if 1.5 L is added to the cube of water?



- 8 These two rectangles overlap, as shown. Find the total area of the shaded region.

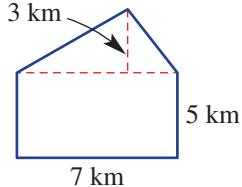
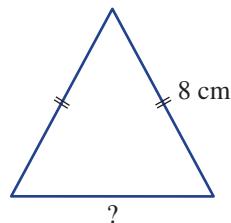


Chapter summary



Multiple-choice questions

- 11A** 1 Which of the following are imperial units?
Ext A cm B pace C digit D yard E litre
- 11B** 2 Shonali buys 300 cm of wire that costs \$2 per metre. How much does she pay for the wire?
Ext A \$150 B \$600 C \$1.50 D \$3 E \$6
- 11C** 3 The triangle given has a perimeter of 20 cm. What is the missing base length?
Ext A 6 cm B 8 cm C 4 cm
D 16 cm E 12 cm
- 11D** 4 The area of a rectangle with length 2 m and width 5 m is:
Ext A 10 m^2 B 5 m^2 C 5 m D 5 m^3 E 10 m
- 11E** 5 A triangle has base length 3.2 cm and height 4 cm. What is its area?
Calculator A 25.6 cm^2 B 12.8 cm C 12.8 cm^2 D 6 cm E 6.4 cm^2
- 11F** 6 The total area of this composite shape is:
Calculator **Ext** A 56 km^2 B 45.5 km^2 C 35 km^2
D 10.5 km^2 E 24.5 km^2
- 11G** 7 A cube has a side length of 3 cm. Its volume is:
Calculator A 27 cm^3 B 9 cm^2 C 3 cm D 9 cm^3 E 36 cm^3
- 11H** 8 2000 cm^3 is the same as:
Calculator A 2 m^3 B 2 L C 2 kL D 2 mL E 2 t
- 11I** 9 9 tonnes of iron ore is being loaded onto a ship at a rate of 20 kg per second. How many minutes will it take to load all of the 9 tonnes of ore?
Calculator A 0.75 min B 45 min C 7.3 min D 450 min E 7.5 min
- 11J** 10 The base length of a parallelogram is 10 cm and its area is 30 cm^2 . The parallelogram's height is:
Calculator A 10 cm B 3 cm C 30 cm D 3 cm^2 E 10 m^2



Chapter review

Short-answer questions

11A

- 1** a Using the Roman system, state how many:

i digits in 1 foot

- b Using the imperial system, state how many:

i feet in 1 yard

- c Using the metric system, state how many:

i millimetres in 1 cm

ii paces in 1 mile

ii inches in 1 foot

ii centimetres in 1 km

11B

- 2** Convert to the units shown in brackets.

a 5 cm (mm)

b 200 cm (m)

e 7.1 kg (g)

f 24 900 mg (g)

i 4000 mL (L)

j 29 903 L (kL)

m 1 day (min)

n 3600 s (min)

c 3.7 km (m)

d 421 000 cm (km)

g 28 490 kg (t)

h 0.009 t (g)

k 0.4 ML (kL)

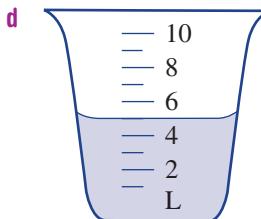
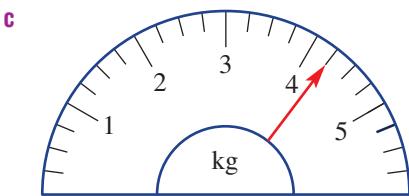
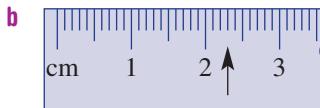
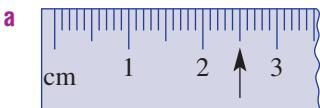
l 0.001 kL (mL)

o 84 h (days)

p 2.5 h (s)

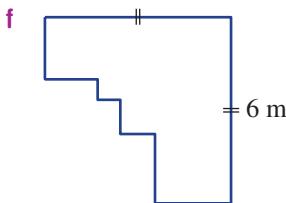
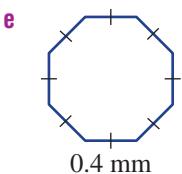
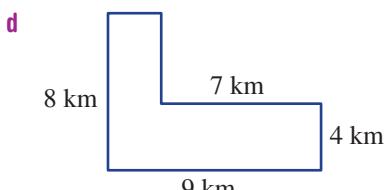
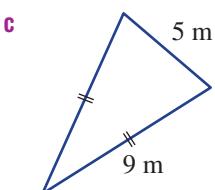
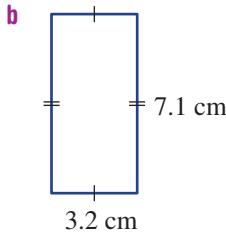
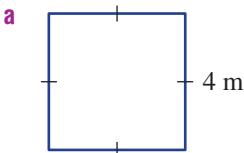
11B

- 3** Read these scales.



11C

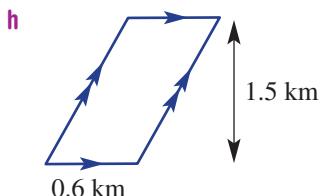
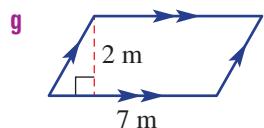
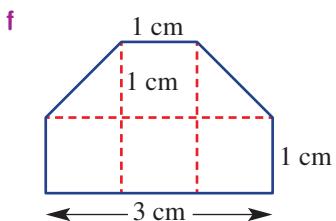
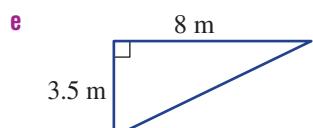
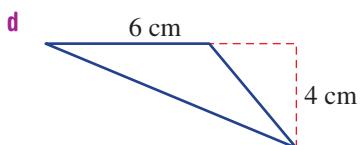
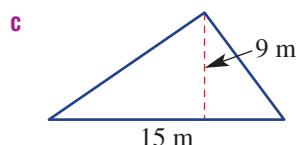
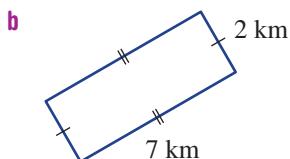
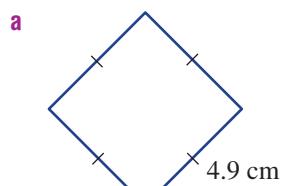
- 4** Find the perimeter of these shapes.



Chapter review

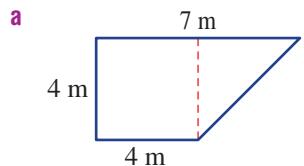


- 11D/E/F/G** 5 Find the area of each of the following shapes.

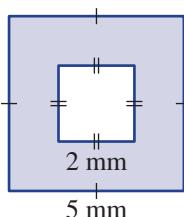


- 6 Find the area of these composite shapes.

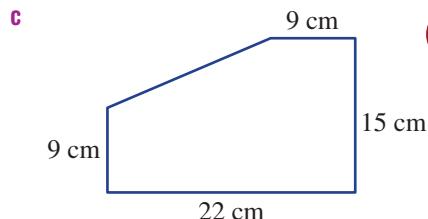
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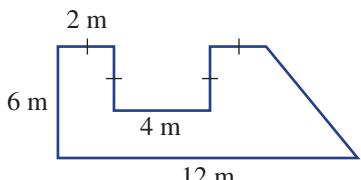
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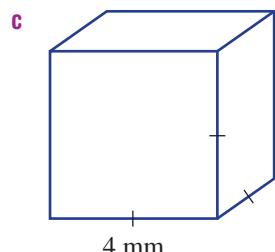
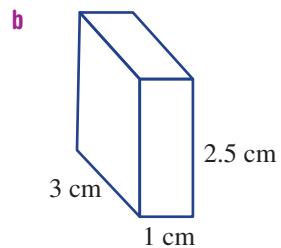
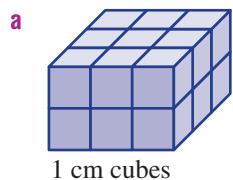


Ext



11H

- 7 Find the volume contained in each of these solids.



Chapter review

11I

- 8 A rectangular fish tank is of length 60 cm, width 40 cm and height 30 cm. Give the tank's capacity in:

a cm^3 b mL c L

11J

- 9 Arrange these measurements from smallest to largest.

a 3 t, 4700 kg, 290 000 g, 45 mg

b 50 000 mL, 1 ML, 51 L, 0.5 kL



Extended-response questions



- 1 A truck carries a large rectangular container of dimensions 6 m long, 3 m wide and 2 m high. The truck weighs 15.4 tonnes without its load.

a Find the area of the base of the container in:

i m^2 ii cm^2 b Find the volume of the container in m^3 .

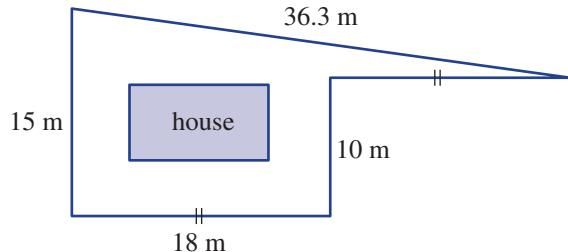
c How many litres of water could the truck hold in the container?

d Since 1 L of water weighs 1 kg, give the weight of the truck if the container was filled with water. Give your answer in tonnes.

e The truck completes three journeys, which take, on average, 1 hour, 17 minutes and 38 seconds per trip. What is the total time for the three journeys?

- 2 Lachlan builds a race track around the outside of his family house block. The block combines rectangular and triangular area, as shown in the diagram.

a How far is one complete circuit of the track?



b Lachlan can jog 10 laps at about 33 seconds each. What is the total time, in minutes and seconds, that it takes him to complete the 10 laps?

c What is the total area of the block?

d The house occupies 100 m^2 and the rest of the block is to have instant turf, costing \$12 per square metre. What will be the cost for the instant turf?e The house sits on a concrete slab that is 50 cm deep. What is the volume of concrete, in m^3 ?