CHAPTER

11

Measurement of 2D and 3D Shapes

LET'S EXPLORE!

DISCUSS

Do you agree with the designer or the student? Why? What else might they need to consider?

11.1 Measurement of Area

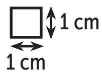
YOU WILL LEARN TO

- convert between the units of measuring area (cm^2, m^2, ha, mm^2)

Recall

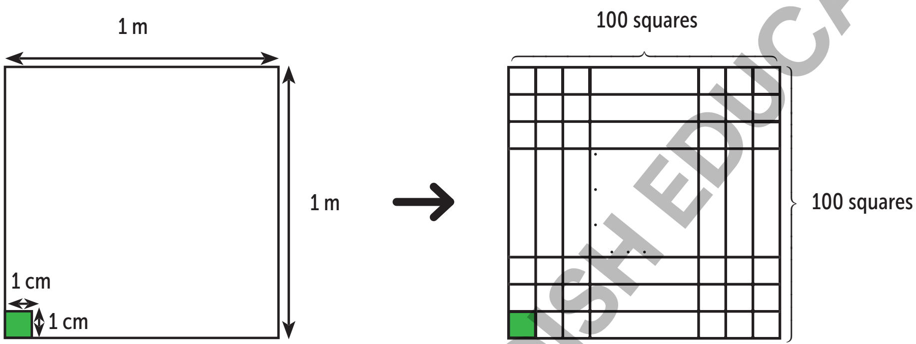
The **area** of a 2D shape is the amount of space inside it.

Area of the square = 1 cm × 1 cm = 1 cm^2



Units of Area

Square centimetre (cm^2) and **square metre (m^2)** are standard units for measuring area. How many one-centimetre squares can fit into a one-metre square?



From the representation, 10 000 squares of 1 cm^2 can fit into a square of 1 m^2.

Area of 1 m^2 square = 1 m × 1 m = 100 cm × 100 cm = 10 000 cm^2

$$1\ m^2 = 10\ 000\ cm^2$$

Note!

A quick way to convert is as follows:

1 m = 100 cm

1 m^2 = 100^2 cm^2

= 10 000 cm^2

∴ Conversely, 10 000 squares of 1 cm^2 = 1 square of 1 m^2.

Then, 1 square of 1 cm^2 = $\frac{1}{10\ 000}$ square of 1 m^2.

$$1\ cm^2 = \frac{1}{10\ 000}\ m^2$$

Think!

We know that 1 cm = 10 mm.

Explain why 1 cm^2 = 100 mm^2.

For larger areas, **square kilometre (km^2)** is also used.

Area of 1 km^2 square = 1 km × 1 km = 1000 m × 1000 m = 1 000 000 m^2

$$1\ km^2 = 1\ 000\ m^2 \text{ or } 1\ m^2 = \frac{1}{1\ 000\ 000}\ km^2$$

Hectare (ha) is another unit for measuring area.

$$1\ ha = 10\ 000\ m^2$$

Think!

We know that 1 m = 1000 mm.

How do you express 1 m^2 in mm^2?

Example 1

Convert each of the following measurements to the required units.

a 1.4 m^2 to cm^2

b $26\,000\text{ cm}^2$ to m^2

Solution:

a $1\text{ m}^2 = 10\,000\text{ cm}^2$

$1.4\text{ m}^2 = (1.4 \times 10\,000)\text{ cm}^2$

$= 14\,000\text{ cm}^2$

b $1\text{ cm}^2 = \frac{1}{10\,000}\text{ m}^2$

$26\,000\text{ cm}^2 = 26\,000 \times \frac{1}{10\,000}\text{ m}^2$

$= 2.6\text{ m}^2$

Try! Convert each of the following measurements to the required units.

a 0.8 m^2 to cm^2

b 7000 cm^2 to m^2

(a) 8000 cm^2 (b) 0.7 m^2

Example 2

Convert each of the following measurements to the required units.

a 1.5 km^2 to m^2

b $500\,000\text{ m}^2$ to km^2

c 4.5 ha to m^2

d $20\,000\text{ m}^2$ to ha

e 2.5 cm^2 to mm^2

f 5600 mm^2 to cm^2

Solution:

a $1\text{ km}^2 = 1\,000\,000\text{ m}^2$

$\therefore 1.5\text{ km}^2 = 1.5 \times 1\,000\,000\text{ m}^2$

$= 1\,500\,000\text{ m}^2$

b $1\,000\,000\text{ m}^2 = 1\text{ km}^2$

$1\text{ m}^2 = \frac{1}{1\,000\,000}\text{ km}^2$

$\therefore 500\,000\text{ m}^2 = \frac{500\,000}{1\,000\,000}\text{ km}^2$

$= 0.5\text{ km}^2$

c $1\text{ ha} = 10\,000\text{ m}^2$

$\therefore 4.5\text{ ha} = 4.5 \times 10\,000$

$= 45\,000\text{ m}^2$

d $1\text{ m}^2 = \frac{1}{10\,000}\text{ ha}$

$\therefore 20\,000\text{ m}^2 = \frac{20\,000}{10\,000}$

$= 2\text{ ha}$

e $1\text{ cm}^2 = 100\text{ mm}^2$

$\therefore 2.5\text{ cm}^2 = 2.5 \times 100$

$= 250\text{ mm}^2$

f $1\text{ mm}^2 = \frac{1}{100}\text{ cm}^2$

$\therefore 5600\text{ mm}^2 = \frac{5600}{100}$

$= 56\text{ cm}^2$

Try! Convert each of the following measurements to the required unit.

a 2.3 km^2 to m^2

b $400\,000\text{ m}^2$ to km^2

c 2.7 ha to m^2

d $45\,000\text{ m}^2$ to ha

e 12 cm^2 to mm^2

f 8400 mm^2 to cm^2

(a) $2\,300\,000\text{ m}^2$ (b) 0.4 km^2 (c) $27\,000\text{ m}^2$ (d) 4.5 ha (e) 1200 mm^2 (f) 84 cm^2

Practice 11A

Concept-Building Questions

1 Convert each of the following measurements to cm^2.

a $4\ m^2$ b $20\ m^2$ c $3.1\ m^2$ d $0.008\ m^2$

2 Convert each of the following measurements to m^2.

a $20\ cm^2$ b $900\ cm^2$ c $5060\ cm^2$ d $17\ 000\ cm^2$

3 Convert each of the following measurements to the units in brackets.

a $81.5\ cm^2\ (m^2)$ b $1.25\ m^2\ (cm^2)$

c $1283\frac{3}{10}\ cm^2\ (m^2)$ d $8\frac{4}{11}\ m^2\ (cm^2)$

4 Convert each of the following to the required units.

a $6.2\ km^2$ to m^2 b $0.25\ km^2$ to m^2 c $12.1\ km^2$ to m^2

d $6\ 500\ 000\ m^2$ to km^2 e $125\ 000\ m^2$ to km^2

5 Convert each of the following to the required units.

a 3.4 ha to m^2 b 0.56 ha to m^2 c 12.1 ha to m^2

d $4500\ m^2$ to ha e $13\ 000\ m^2$ to ha

6 Convert each of the following to the required units.

a $12\ cm^2$ to mm^2 b $15.6\ cm^2$ to mm^2 c $140\ mm^2$ to cm^2

d $2500\ mm^2$ to cm^2 e $41\ m^2$ to mm^2 f $180\ 000\ mm^2$ to m^2

Context-Based Questions

7 A large cardboard has length 2 m and breadth 1.2 m.
Calculate its area in

i m^2 ii cm^2

8 Find the area of the land in m^2.

9 Ameera argues that $4.2\ km^2 = 4200\ m^2$. Do you agree? Explain.

Workbook Exercise 11.1

YOU WILL LEARN TO

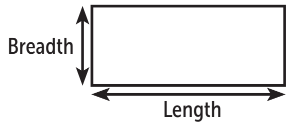
11.2 Area of Triangles and Compound Shapes

- find the area of triangles
- find the area of a compound figure

Area of Triangles

Knowledge-Building Task

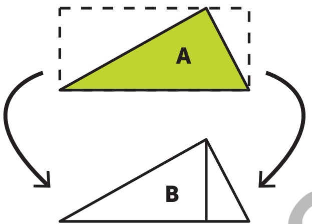
1. Cut an A4-sized piece of paper into four equal rectangles. Label them rectangles 1, 2, 3 and 4. Measure and record the length and breadth of one rectangle. Then find its area.



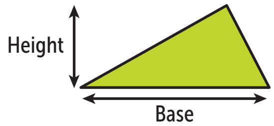
Rectangle 1

2. Using rectangle 1, mark a point anywhere on one side of the length of the rectangle. Then draw a line from the point to each corner on the opposite side of the rectangle and shade the triangle as shown.

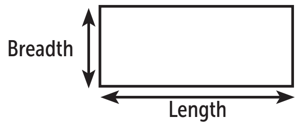
3. Cut along the lines of the triangle and rearrange the two unshaded triangles to form another triangle as shown. How do the areas of triangles A and B compare to the area of rectangle 1?



4. Compare the base and height of triangle A to the length and breadth of rectangle 1. What do you notice?

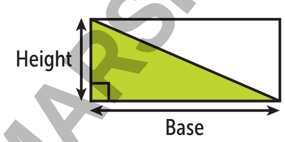


Triangle A

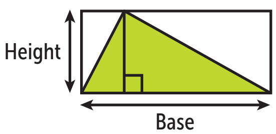


Rectangle 1

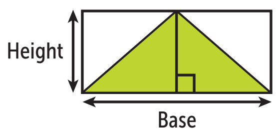
5. Repeat steps 2 to 5 with the remaining rectangles 2, 3 and 4. Use different points in step 2 each time as shown.



Rectangle 2



Rectangle 3



Rectangle 4

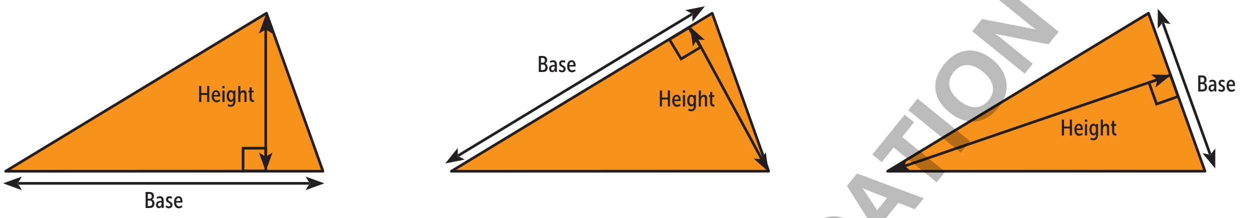
6. Write the area of a triangle using its base and height.

From the task, notice that the area of a triangle is half the area of a rectangle with the same base length and height.

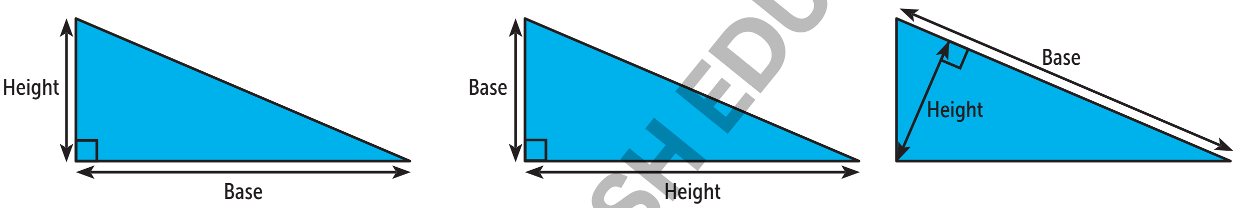
$$\text{Area of triangle} = \frac{1}{2} \times \text{base} \times \text{height}$$
$$= \frac{1}{2} \times b \times h$$

For a triangle, there are several ways to define its base and the corresponding height.

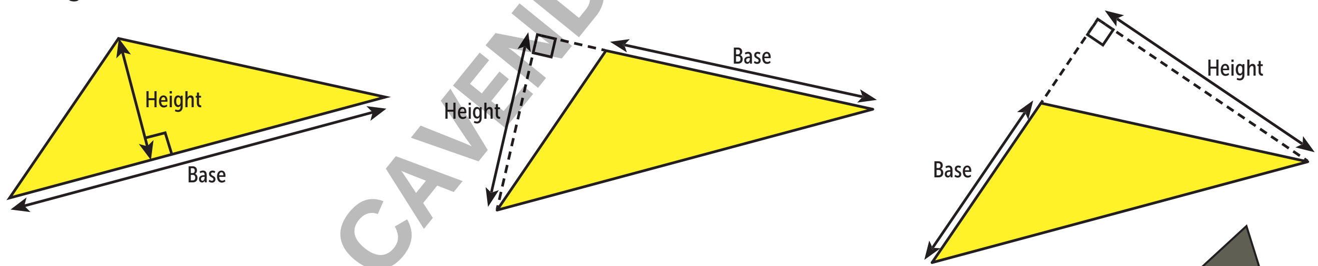
Triangle 1



Triangle 2



Triangle 3

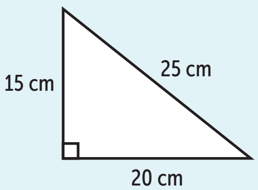


The height of a triangle may not lie inside the triangle.

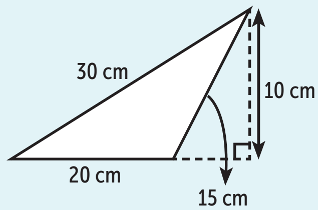
Example 3

Find the area of each of the following triangles.

a



b



Solution: **a** Area of triangle = $\frac{1}{2}$ × base × height

Area of triangle = $\frac{1}{2}$ × 20 cm × 15 cm

= 150 cm^2

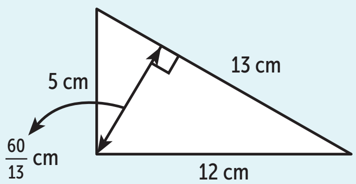
b In this case, we take b = 20, h = 10

Area of triangle = $\frac{1}{2}$ × 20 × 10

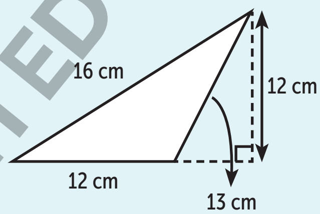
= 100 cm^2

Try! Find the area of each of the following triangles.

a



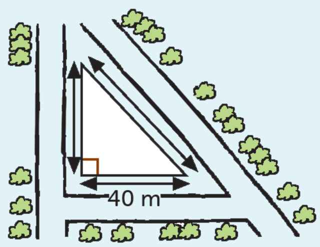
b



(a) 30 cm^2 (b) 72 cm^2

Example 4

The area of the triangle plot of land is 600 m^2. Given that the perimeter is 120 m and the base is 40 m, find the length of the longest side of the triangle.



Solution: Area = $\frac{1}{2} \times b \times h$

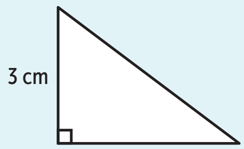
$600 = \frac{1}{2} \times 40 \times h$

h = 30 m

Length of longest side = 120 – 40 – 30 = 50 m

Try!

The area of the triangle is 6 cm². The perimeter is 17 cm.
Given that the height is 3 cm, find the longest side of the triangle.



5 cm

Compound Shapes

Consider the following figures.

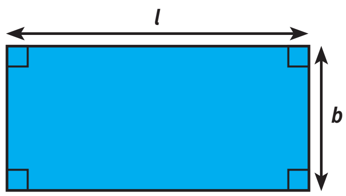


Figure 1

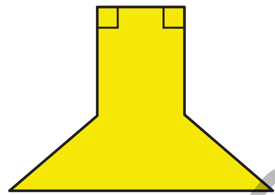


Figure 2

Figure 1 is a rectangle. The area of Figure 1 can be calculated using the formula,

$$\text{Area of rectangle} = l \times b$$

To find the area of Figure 2, observe that it is made up of two figures, a **rectangle** and a **trapezium**.

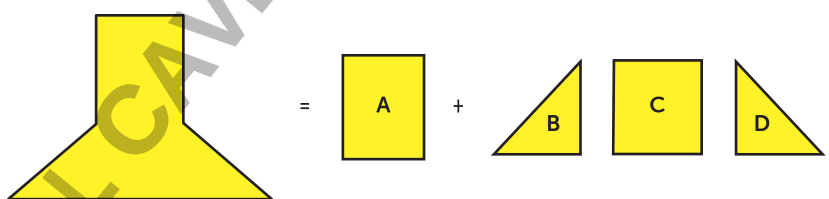
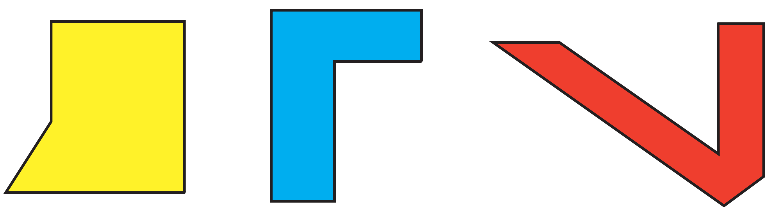


Figure 2

Area of Figure 2 = area of rectangle A + area of triangle B + area of rectangle C + area of triangle D

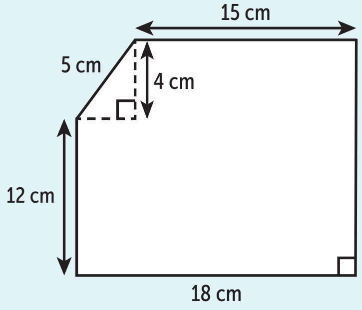
Think! What other ways can you split Figure 2 into basic shapes?

Many figures in real life can be made up of more than one shape. For the following compound shapes, find out what basic shapes they are made up of.

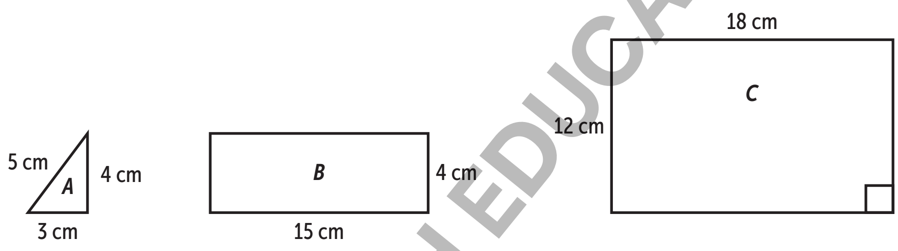


Example 5

Find the area of the figure.



Solution:

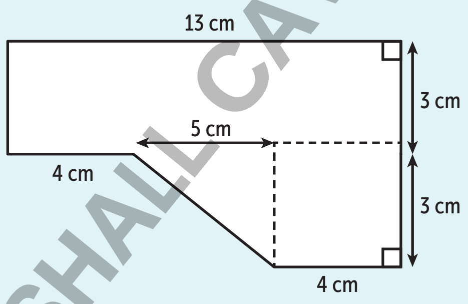


Area of the figure = area of A + B + C

$= \frac{1}{2} \times 3 \times 4 + 15 \times 4 + 18 \times 12$

$= 282 \text{ cm}^2$

Try! Find the area of the figure.

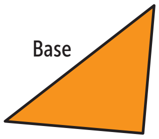


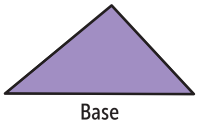
58.5 cm^2

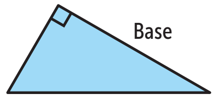
Practice 11B

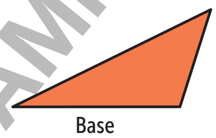
Concept-Building Questions

1 Given the base of each of the following triangles, mark its corresponding height.

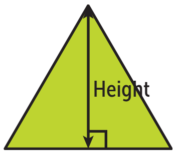
a 

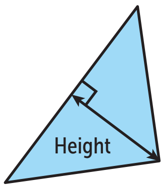
b 

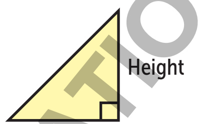
c 

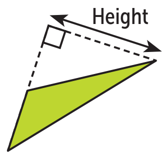
d 

2 Given the height of each of the following triangles, mark its corresponding base.

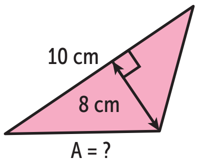
a 

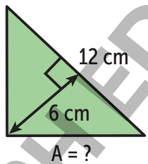
b 

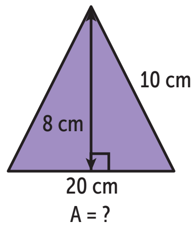
c 

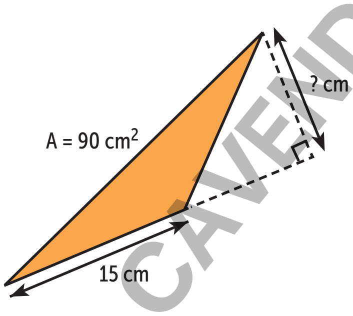
d 

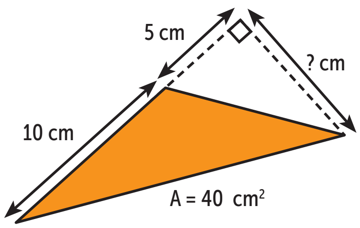
3 Find the missing numbers.

a 

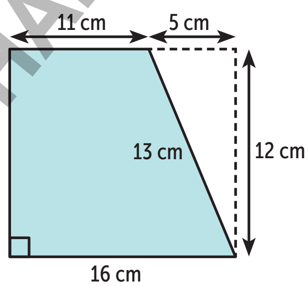
b 

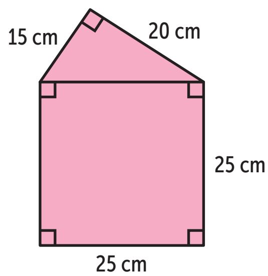
c 

d 

e 

4 Find the area of each of the following figures.

a 

b 

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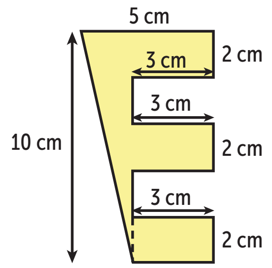
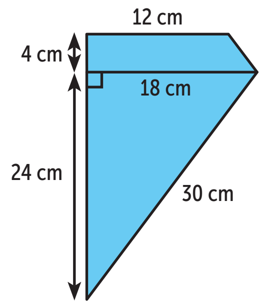


d



Context-Based Questions

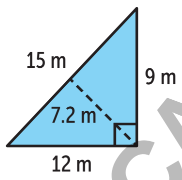
5 The diagram shows a triangular pond.

Find the area of the pond in two ways.

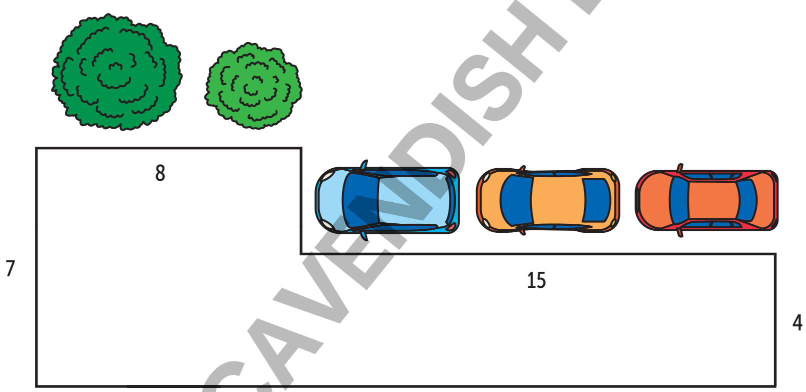
a Using 12 m as the base.

b Using 15 m as the base.

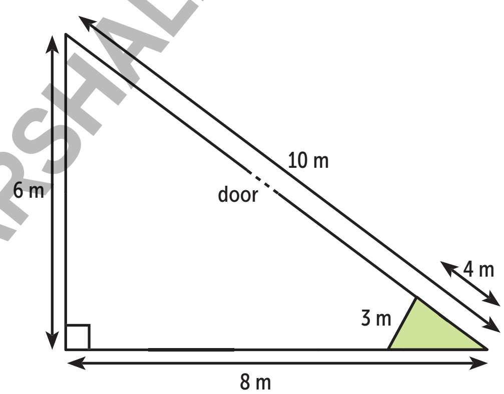
What do you observe?



6 The diagram shows the floor plan of a school compound. All dimensions are in metres. Calculate the area of the floor plan.



7 The diagram shows the floor plan of a shop in a shopping centre. The shaded part of the shop is not occupied. Find the area of the shop that is occupied.



Workbook Exercise 11.2

Personalised AI-DRIVEN Assessment

11.3

3D Shapes and Measurement of Volume

YOU WILL LEARN TO

- find the faces, vertices and edges of 3D shapes

Properties of 3D Shapes

As we have seen in the previous chapters, A 3D shape has volume instead of being 'flat' on a piece of paper.

Figure 1 shows examples of 3D shapes.

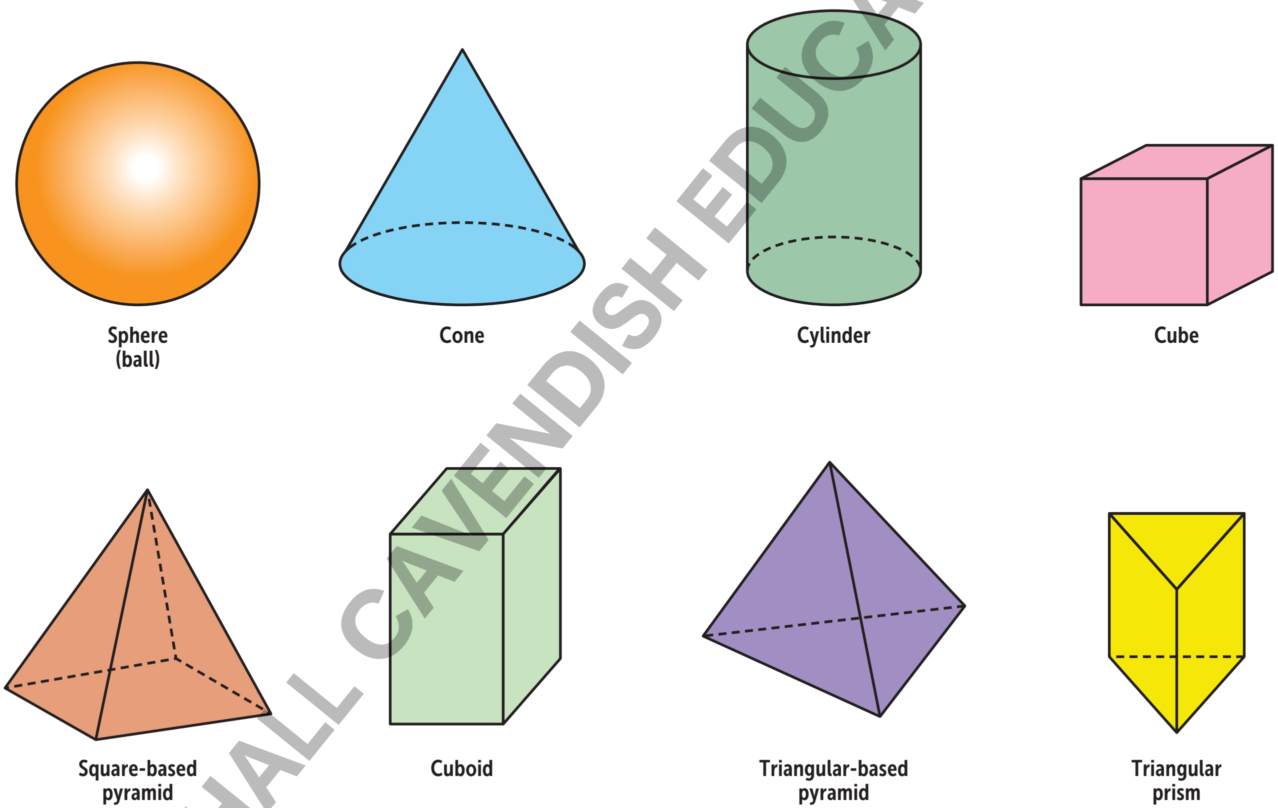
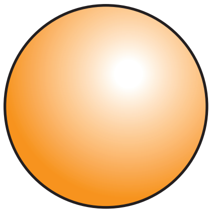


Figure 1

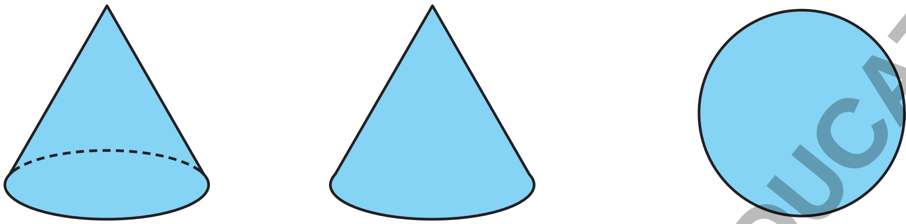
We can classify the 3D shapes in Figure 1 into two categories: those with a curved surface and those without a curved surface.

A sphere has only one curved surface.



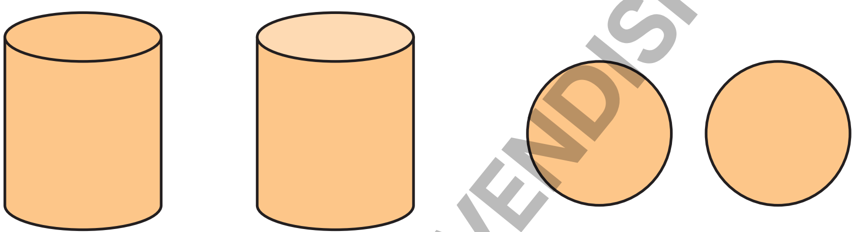
Sphere
(ball)

A cone has one curved surface and one flat surface.



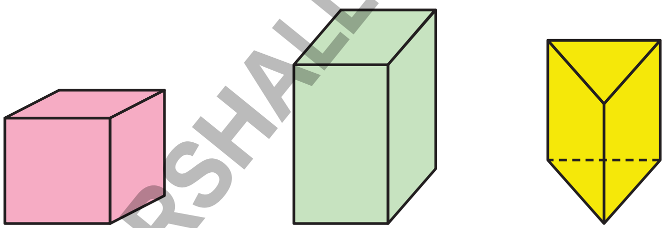
Cone   Curved surface   Circular base

A cylinder has one curved surface and two flat surfaces.



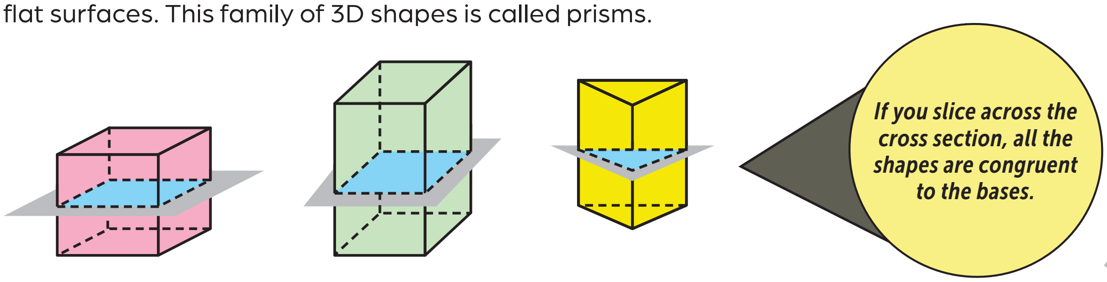
Curved surface   Circular bases

All the other 3D shapes in Figure 1 have only flat surfaces.
They are called **polyhedra**.



Cube   Cuboid   Triangular prism

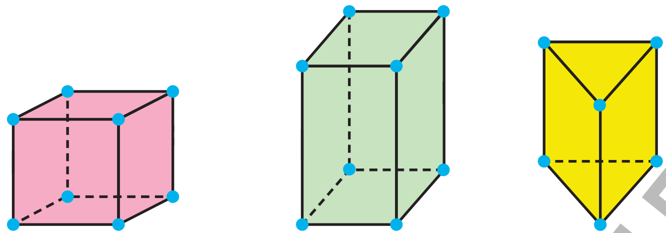
Consider the three shapes. They have uniform cross-sectional area and only flat surfaces. This family of 3D shapes is called prisms.



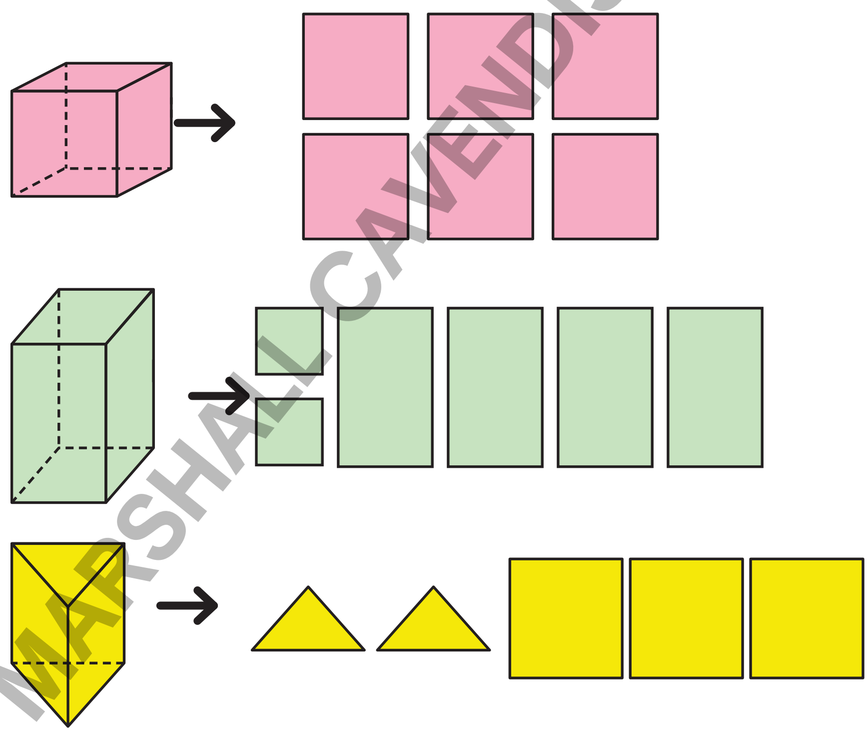
In all the above 3D shapes,

1. The **edges** are the lengths of the sides. A cube and cuboid have 12 edges each. The triangular prism has 9 edges.

2. The **vertices** are the points where any two edges meet.
   A cube and cuboid have 8 vertices each. A triangular prism has 6 vertices.



3. The **faces** are the flat surfaces of the shape.

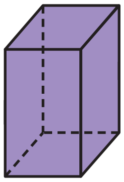
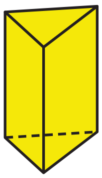
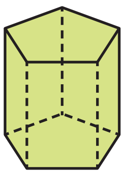
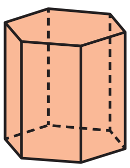


Note! A face is flat. So we do not consider a curved surface to be a face.

The cube and cuboid have 6 faces each. The triangular prism has 5 faces.

Knowledge-Building Task

(a) Consider each of the following solids and complete the number of edges (E), vertices (V) and faces (F) of the solids.

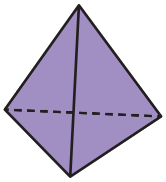
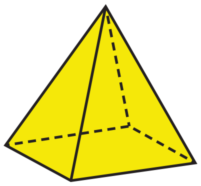
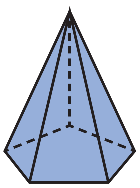
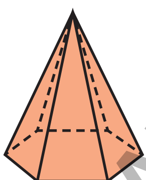
Prism	Number of Edges (E)	Number of Vertices (V)	Number of Faces (F)
			
			
			
			

(b) What do you observe about the number of edges? Generalise the pattern that you observe. Using this pattern, convince yourself that the number of edges is always divisible by 3.

(c) Convince yourself that the number of vertices is always an even number.

Knowledge-Building Task

(a) Consider each of the following solids and complete the number of edges (E), vertices (V) and faces (F) of the solids.

Pyramid	Number of Edges (E)	Number of Vertices (V)	Number of Faces (F)
			
			
			
			

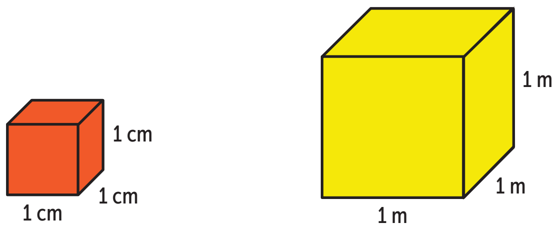
(b) What do you observe about the number of edges?
Generalise the pattern that you observe. Using this pattern, convince yourself that the number of edges is always an even number.

(c) Convince yourself that the number of faces in the pyramids equals the number of vertices.

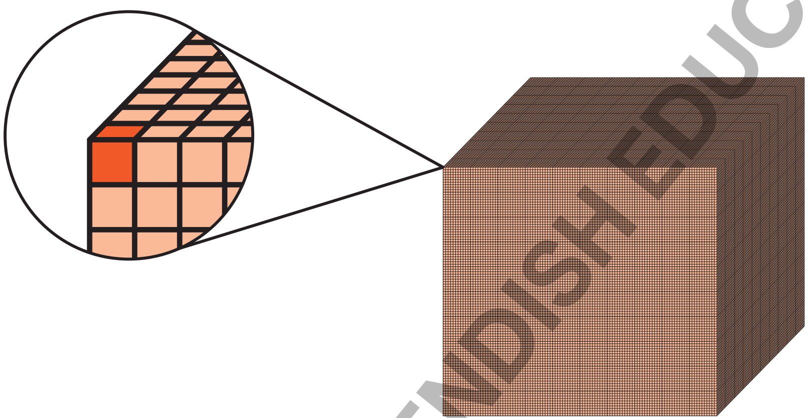
Volume

Volume is the measure of the amount of space inside a 3D object.

The volume of a cube measures the space inside the cube. A cube of size 1 cm by 1 cm by 1 cm has a volume of 1 cm^3. A cube of length 1 m has a volume of 1 m^3.



How many 1 cm^3 cubes are needed to fill a cube of length 1 m?



It can be seen from the above that we need 100 × 100 × 100 cubes of length 1 cm to fill up a cube of length 1 m.

Volume of cube of length 1 m = 1 m × 1 m × 1 m
$= 100 \text{ cm} \times 100 \text{ cm} \times 100 \text{ cm}$
$= 1\,000\,000 \text{ cm}^3$

1 m = 100 cm
So, $1 \text{ m}^3 = (100)^3 \text{ cm}^3$
$= 1\,000\,000 \text{ cm}^3$

Volume of cube of length 1 cm = 1 cm × 1 cm × 1 cm
$= \frac{1}{100} \text{ m} \times \frac{1}{100} \text{ m} \times \frac{1}{100} \text{ m}$
$= \frac{1}{1\,000\,000} \text{ m}^3$

$1 \text{ cm} = \frac{1}{100} \text{ m}$
So, $1 \text{ cm}^3 = \left(\frac{1}{100}\right)^3 \text{ m}^3$
$= \frac{1}{1\,000\,000} \text{ m}^3$

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

$1 \text{ cm}^3 = \frac{1}{1\,000\,000} \text{ m}^3$

Example 6

Convert each of the following.

a $2.5\ m^3$ to cm^3 **b** $2000\ cm^3$ to m^3

Solution:

a

$$1\ m^3 = 1\,000\,000\ cm^3$$

$$\begin{aligned}2.5\ m^3 &= 2.5 \times 1\,000\,000\ cm^3\\ &= 2\,500\,000\ cm^3\end{aligned}$$

b

$$1\ cm^3 = \frac{1}{1\,000\,000}\ m^3$$

$$\begin{aligned}2000\ cm^3 &= 2000 \times \frac{1}{1\,000\,000}\ m^3\\ &= \frac{2}{1\,000}\ m^3\\ &= 0.002\ m^3\end{aligned}$$

Try! Convert each of the following.

a $1.3\ m^3$ to cm^3 **b** $950\ cm^3$ to m^3

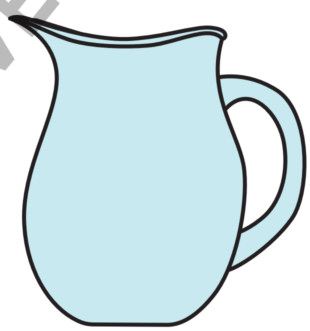
(a) $1\,300\,000\ cm^3$ (b) $\frac{19}{20\,000}\ m^3$

In real life, we also use millilitre (m*l*) and litre (*l*) to measure volume.

$$1\ ml = 1\ cm^3$$

$$\begin{aligned}1\ l &= 1000\ ml\\ &= 1000\ cm^3\end{aligned}$$

300 m*l*



1.5 *l*

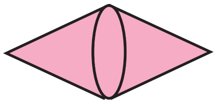
$300\ ml = 300\ cm^3$

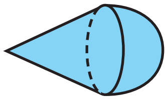
$$\begin{aligned}1.5\ l &= 1.5 \times 1000\ cm^3\\ &= 1500\ cm^3\end{aligned}$$

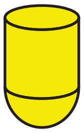
Practice 11C

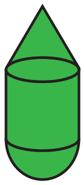
Concept-Building Questions

1 For each of the following shapes, state the number of curved surface(s) and the number of flat face(s).

a 

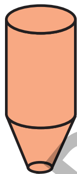
b 

c 

d 

e 

Low Res.

f 

2 Convert each of the following to cm^3.

a 12 m^3 b 100 m^3

3 Convert each of the following to m^3.

a 60 000 cm^3 b 750 000 cm^3

4 Convert each of the following to cm^3.

a 45 ml b 12 ml c 2.3 l d 1.8 l

e 4.8 m^3 f 5.3 m^3 g 7.4 m^3

5 Convert each of the following to m^3.

a 280 cm^3 b 75.3 cm^3 c 3.8 l d 7.2 l

6 Convert the following to l.

a 2 m^3 b 8.5 m^3 c 2.8 m^3

Context-Based Questions

7 The standard Olympic pool has a length 50 m and breadth 25 m with a depth of 2 m. Find the volume of the pool in

a m^3 b cm^3 c l

8 Waleed argues that 2.5 m^3 equals 250 cm^3. Do you agree? Explain.

Workbook Exercise 11.3

Personalised AI-DRIVEN Assessment

11.4 Volume of Cubes and Cuboids

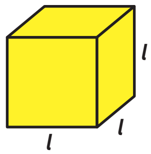
YOU WILL LEARN TO

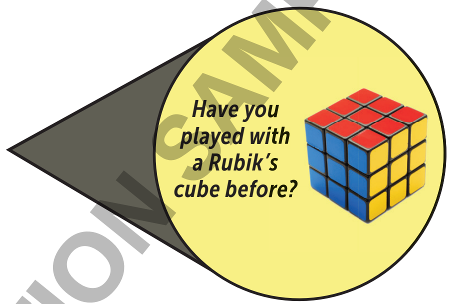
- find the volume of a cube and a cuboid

A cube is a three-dimensional solid whose sides are perpendicular to one another.

The edges of a cube are equal.

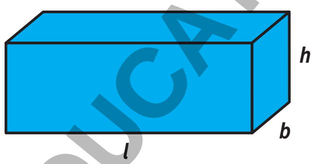
All the edges of the cube have the same length, *l*.



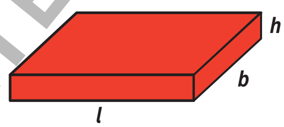


A cuboid has sides which are perpendicular to one another. However, its edges may not be equal.

A cuboid has length, *l*, breadth, *b* and height, *h*.

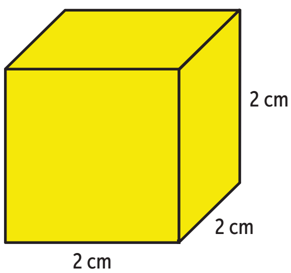


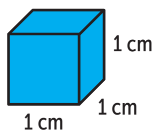
The volume of a solid, cube or cuboid measures the amount of space inside it.



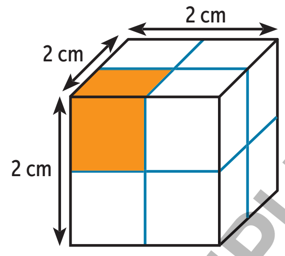
Volume of a Cube

Consider a cube of length 2 cm. How many cubes of length 1 cm are needed to fill it up?





By dividing the big cube into small cubes of 1 cm^3, we can see that we need 8 cubes of length 1 cm to fill up the big cube shown.

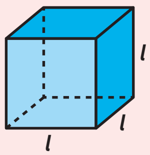


Therefore,

Volume = $8 \times 1\ cm^3$
= $8\ cm^3$

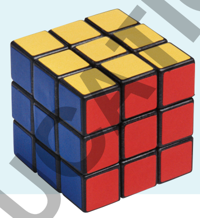
Alternatively, Volume = $l \times l \times l$
= $2\ cm \times 2\ cm \times 2\ cm$
= $8\ cm^3$

Volume of cube = length × length × length
= $l \times l \times l$
= l^3

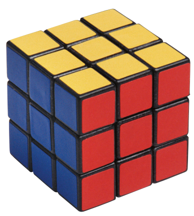


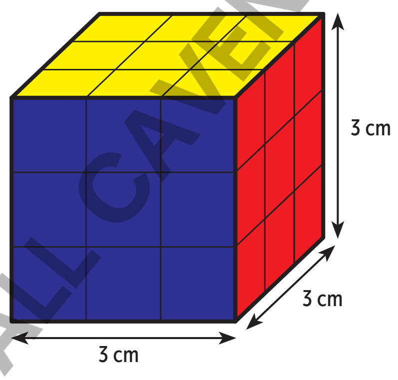
Example 7

The solid is made up of 27 cubes of length 1 cm.
Find the volume of the solid.



Solution:





Method 1

Volume of one cube of length 1 cm
= $1\ cm^3$
Volume of 27 cubes of length 1 cm
= $27 \times 1\ cm^3$
= $27\ cm^3$

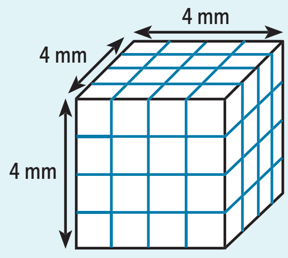
Method 2

Volume of solid = $3\ cm \times 3\ cm \times 3\ cm$
= $27\ cm^3$

The volume of the solid is $27\ cm^3$.

Try!

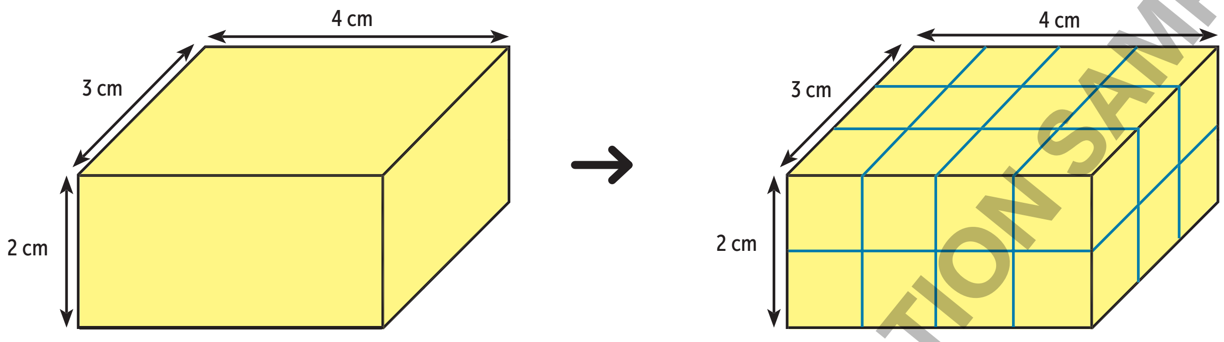
The solid is made up of 64 cubes of length 1 mm.
Find the volume of the solid.



$64\ mm^3$

Volume of a Cuboid

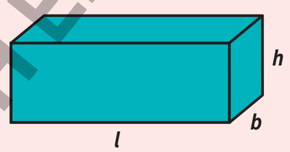
Consider a cuboid 4 cm by 3 cm by 2 cm. To calculate its volume, we try to pack it with cubes of length 1 cm.



Find the number of cubes of sides 1 cm that can fill up the cuboid. Convince yourself that the volume of the cuboid is 24 cm^3.

In general, for a cuboid with length l, breadth b and height h, what is its volume?

Volume of cuboid = length × breadth × height
$= l \times b \times h$



Check that the formula can be applied to the above cuboid.

Example 8

Find the volume of the gift box which is 12 cm long, 8 cm wide and 5 cm tall.

Solution: Volume of the box = length × breadth × height

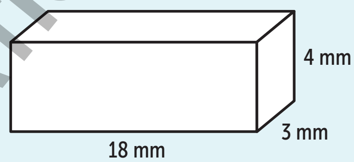
= 12 cm × 8 cm × 5 cm

= 480 cm^3

The volume of the gift box is 480 cm^3.

Try!

If the cuboid on the right is 18 mm long, 3 mm wide and 4 mm tall, find its volume.

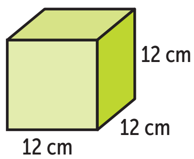


216 mm^3

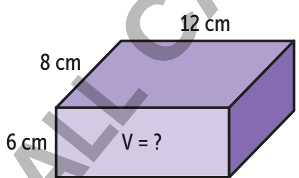
Practice 11D

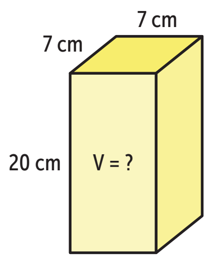
Concept-Building Questions

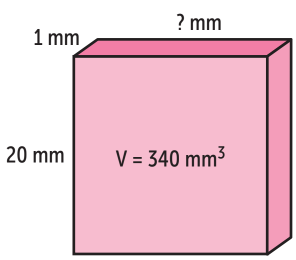
1. Find the volume of a cube of length 12 cm.

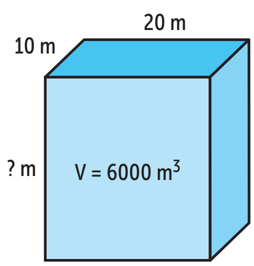


2. Find the missing numbers.

a 

b 

c 

d 

3. Find the volume of each rectangular box with the following dimensions.

   a. $l = 3$ cm, $b = 2.5$ cm, $h = 1.5$ cm
   b. $l = 8$ cm, $b = 5$ cm, $h = 3.5$ cm

Context-Based Questions

4. A fish tank has length 1.2 m, width 80 cm and height 50 cm.

Find the capacity of the tank. Give your answer in

   a. cm^3
   b. m^3

5. A cardboard box has length 28 cm, width 10 cm and height 12 cm.

   a. Find the volume of the cardboard box.
   b. How many cubes of length 1 cm can be put inside the cardboard box?
   c. How many cubes of length 2 cm can be put inside the cardboard box?
   d. Felix wants to find out the maximum number of cubes of length 3 cm that can be put inside the cardboard box. He calculated the answer this way.

      $(28 \times 10 \times 12) \div (3 \times 3 \times 3) = 124.4$

      He then concluded that the maximum number of cubes is 124. Critique his solution and answer.

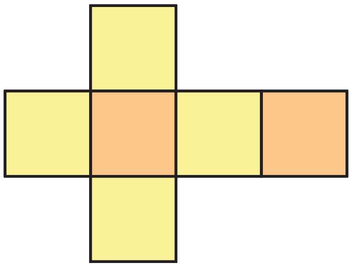
Workbook Exercise 11.4

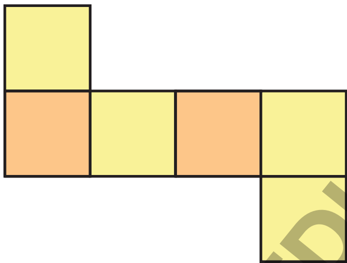
Personalised AI-DRIVEN Assessment

11.5	Surface Area of Cubes and Cuboids	YOU WILL LEARN TO • find the surface area of a cube and a cuboid

Nets of a Cube

Each set of squares shown can be folded into a cube. These two figures are **nets of a cube**.



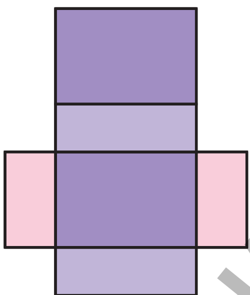


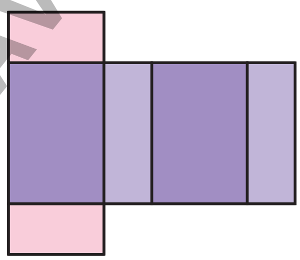
The net of a cube consists of 6 squares.

Think! What is the properties of the net of an open-cubic container. Draw two possible nets of an open cube.

Nets of a Cuboid

The following sets of rectangles, when folded, can form a cuboid. They are **nets of a cuboid**.

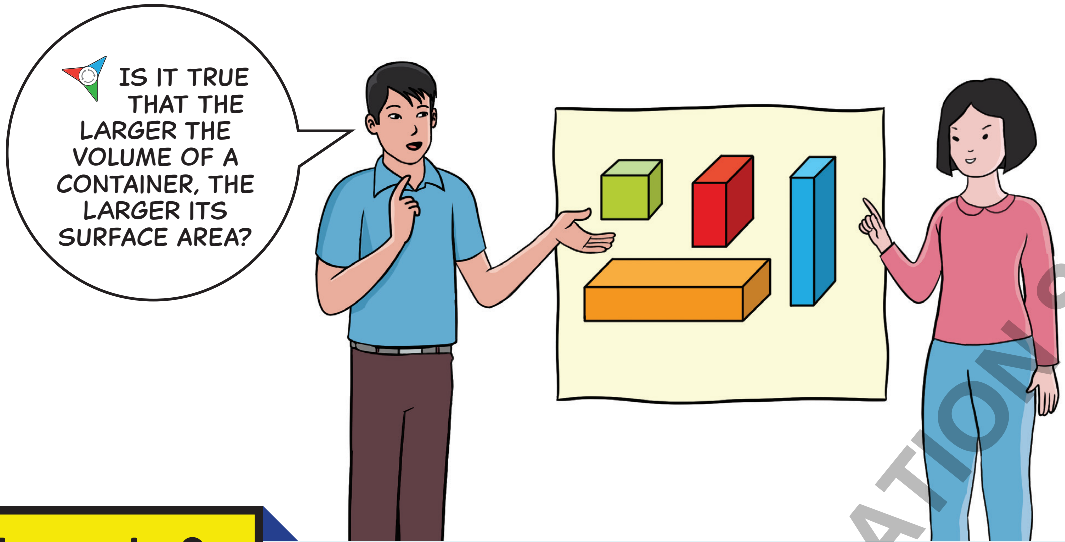




The net of a cuboid consists of 6 rectangles.

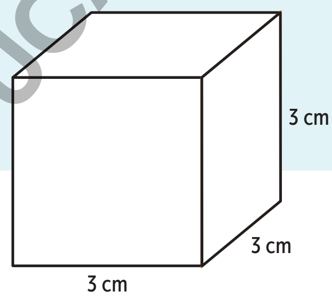
Think! How many other ways are there to draw the net of a cube?

To find the surface area of a cube or cuboid, first find the area of each of its faces, then sum them up. A net helps us to identify all the faces of a cube or cuboid.



Example 9

Find the surface area of the cube in two ways.
Critique the methods. Explain.



Solution: The cube has 6 square faces.

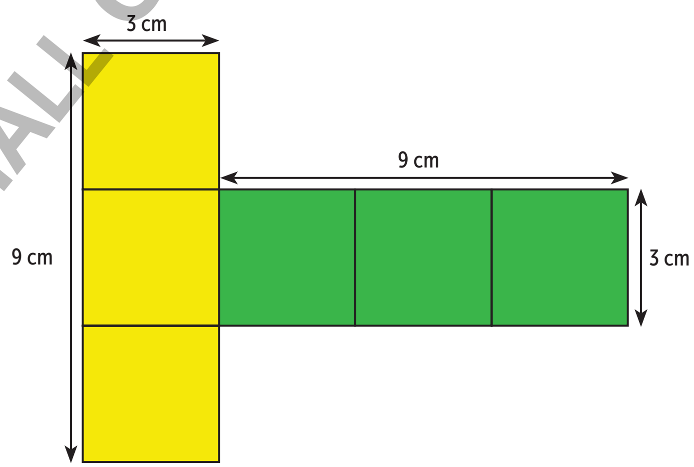
Area of each square = 3 cm × 3 cm
= 9 cm^2

Area of 6 square faces = 6 × 9 cm^2
= 54 cm^2

The surface area of the cube is 54 cm^2.

The surface area of the cube is the same as the area of its net.
We can also use the net of the cube to find the surface area of the cube.

A possible net of the cube is as shown.



Method 1

We can break up the net into two rectangles.

Area of green rectangle = 3 cm × 9 cm

= 27 cm^2

Area of yellow rectangle = 3 cm × 9 cm

= 27 cm^2

Surface area of cube = area of 2 rectangles

= 27 cm^2 + 27 cm^2

= 54 cm^2

Method 2

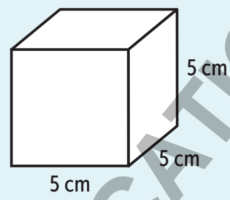
Surface area of cube = sum of area of 6 squares

= 6 × 9 cm^2

= 54 cm^2

Method 1 breaks up the net of a cube into 2 rectangles while Method 2 uses the number of square faces in the cube to calculate the surface area. Method 2 is more direct.

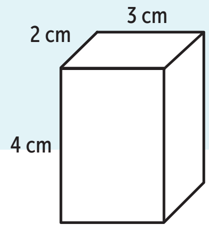
Try! Find the total surface area of the cube.



150 cm^2

Example 10

Find the total surface area of a cuboid 2 cm by 3 cm by 4 cm.



Solution: The net of the cuboid is as shown.

Area of 2 green rectangles = 2 × 3 cm × 4 cm

= 24 cm^2

Area of 2 yellow rectangles = 2 × 2 cm × 4 cm

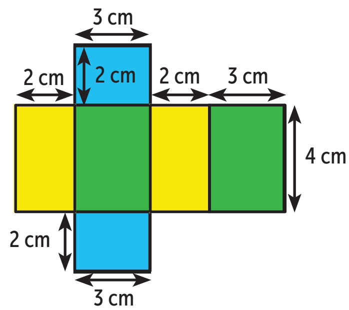
= 16 cm^2

Area of 2 blue rectangles = 2 × 2 cm × 3 cm

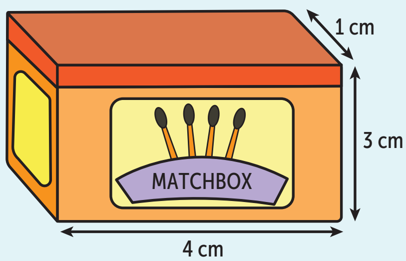
= 12 cm^2

Total surface area = 24 cm^2 + 16 cm^2 + 12 cm^2

= 52 cm^2



Try! Find the surface area of the matchbox.

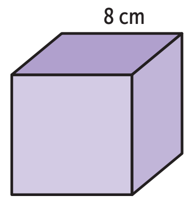


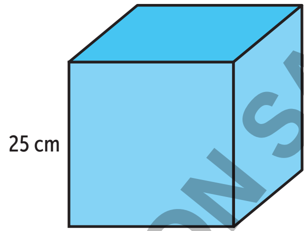
38 cm^2

Practice 11E

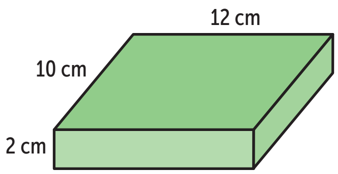
Concept-Building Questions

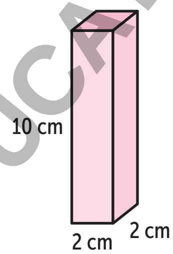
1 Find the total surface area of the following cubes.

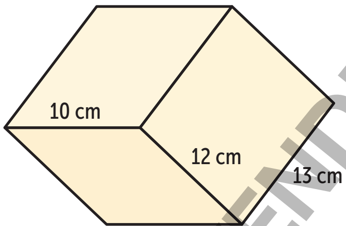
a


b


2 Find the total surface area of the following cuboids.

a


b


c


Context-Based Questions

3 Ramli is hired to paint the outer surface of a cuboid with dimensions 2 m by 3 m by 5 m. He is paid $5 for every 1 m^2 he paints. How much will he be paid for painting the cuboid?

4 The surface area of a cube is 24 cm^2. Find the length of the cube.

Workbook Exercise 11.5

Personalised AI-DRIVEN Assessment

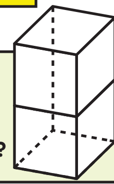
11.6 Volume and Surface Area of Compound Shapes

YOU WILL LEARN TO

- find the volume and surface area of compound shapes

Think!

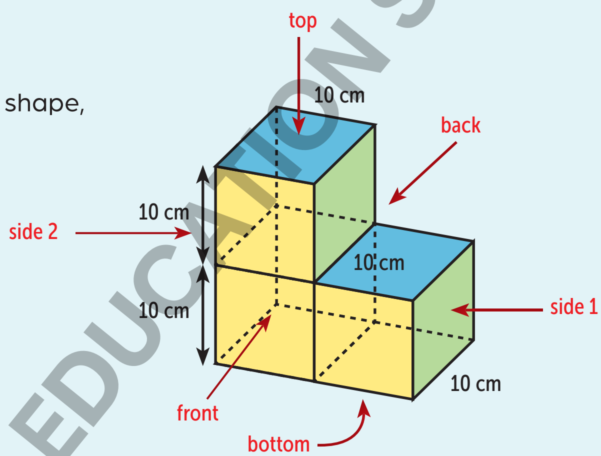
The diagram shows a solid made up of two cubes. Do you think the volume of the solid is the sum of the volume of the two cubes? What about the surface area?



Example 11

Find the volume and total surface area of the compound shape, which consists of 3 cubes put together.

*A **compound** shape is made up of more than one solid.*



Solution: Volume of the compound shape = 3 × volume of one cube

= 3 × (10 cm × 10 cm × 10 cm)

= 3 × 1000 cm^3

= 3000 cm^3

Number of square faces making up the compound shape = 2 × (3 + 2 + 2)

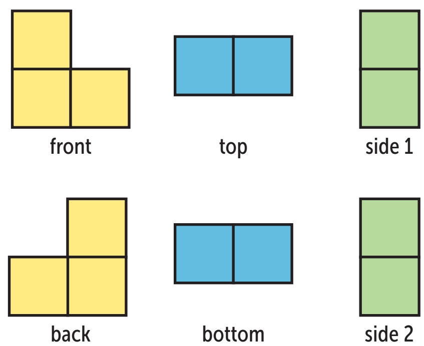
= 14

Area of 1 square face = 10 cm × 10 cm

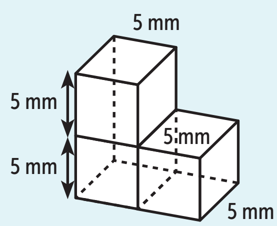
= 100 cm^2

Total surface area = 14 × 100 cm^2

= 1400 cm^2



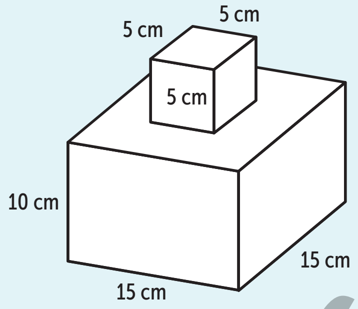
Try! Find the volume and total surface area of the compound shape.



Volume = 375 mm^3, Total surface area = 350 mm^2

Example 12

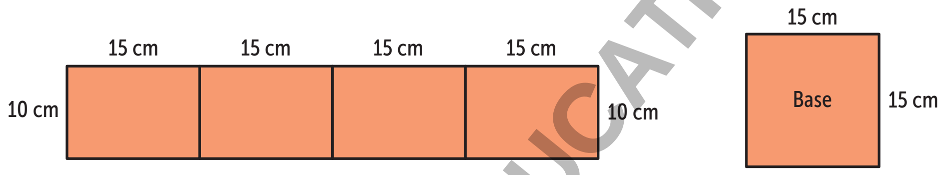
Find the volume and surface area of the solid.

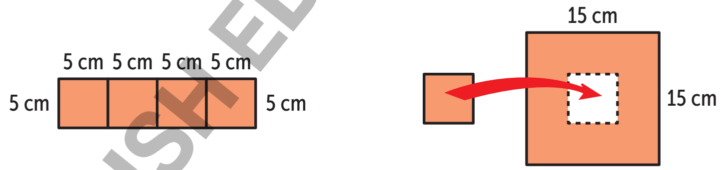


Solution: Volume = $[(15 \times 15 \times 10) + (5 \times 5 \times 5)]$ cm^3

= $(2250 + 125)$ cm^3

= 2375 cm^3

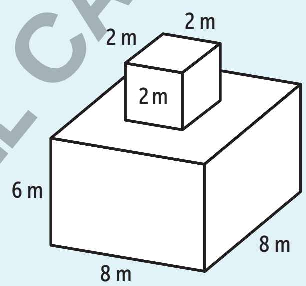




Total surface area = $[(15 \times 10 \times 4) + (15 \times 15 \times 2) + (5 \times 5 \times 4)]$ cm^2

= 1150 cm^2

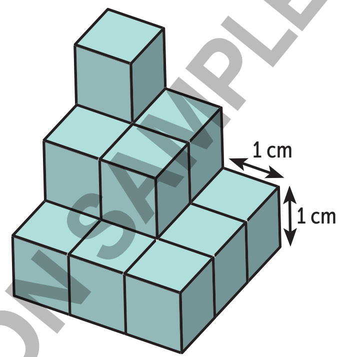
Try! Find the volume and surface area of the solid.



Volume = 392 m^3, Surface area = 336 m^2

Practice 11F

1 Look at the figure.

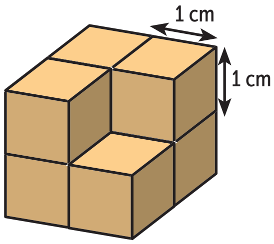


a Ruhie says, "Since the surface area of a small cube is 6 cm^2, the total surface area of the figure is 6 x 14 cm^2." Is Ruhie correct? Explain.

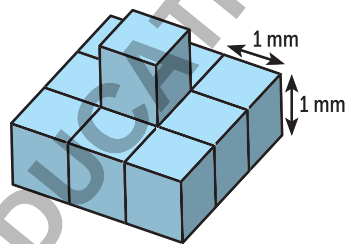
b Raj says, "Since the volume of a small cube is 1 cm^3, the total volume of the figure is 14 × 1 cm^3." Is Raj correct? Explain.

2 Find the volume and surface area of the following compound solids which are made up of cubes of length 1 cm.

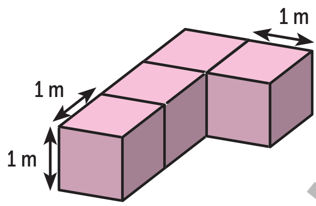
a



b

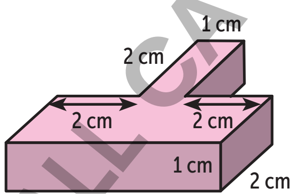


c

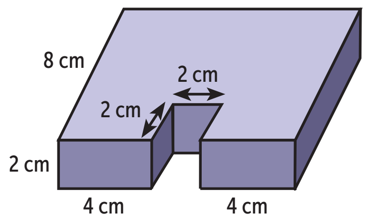


3 For each of the following solids, find its volume and surface area.

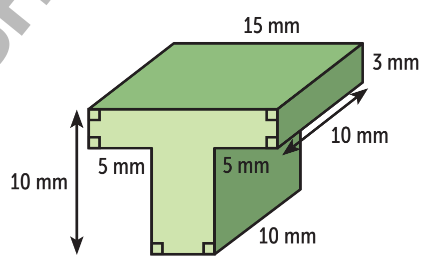
a



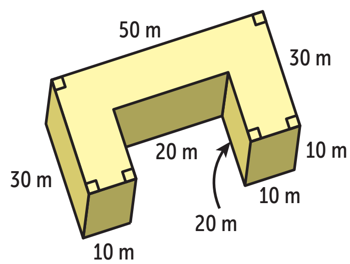
b



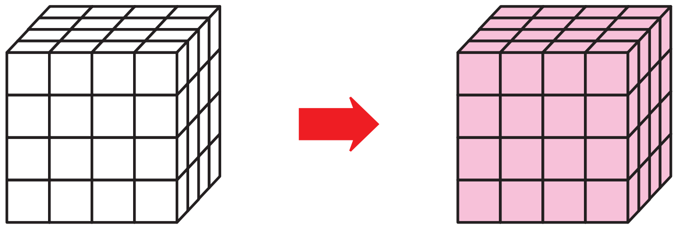
c



d



4 A 4 cm by 4 cm by 4 cm cube is as shown. All the sides of the cube are painted as shown.



a What is the total surface area painted?

b When the cube is dismantled, how many 1-cm cubes are not painted on any sides?

Workbook Exercise 11.6

Personalised AI-DRIVEN Assessment

Performance Task

Find the Volume and Surface Area

Look for objects in the shape of cubes and cuboids. Draw or take a picture of each object you found. Find their volume and surface area. Draw a scale drawing of their net.

Write down your working and answers clearly and use the scoring rubric to guide you.

Scoring Rubric

Task	Level 1 (Score 1 point)	Level 2 (Score 2 points)	Level 3 (Score 3 points)	Level 4 (Score 4 points)
How many objects did I find?	I found only one object that looks like a cube.	I found one object that looks like a cube and one that looks like a cuboid.	I found one object that looks like a cube and two objects that look like a cuboid.	I found two objects that look like a cube and two objects that look like a cuboid.
Finding volume and surface area (Score only when at least three objects are found.)	I could find either the volume or surface area but not both.	I could find the volume and surface area but with major inaccuracies.	I could find both the volume and surface area but with minor inaccuracies.	I could find both the volume and surface area accurately.
Drawing nets (Score only when at least three objects are found.)	I could draw the net but not according to scale.	I could draw the net according to my scale but it is not accurate.	I could draw the net according to my scale but with minor inaccuracies.	I could draw the net accurately according to my scale.

Chapter 11 Key Ideas

Measurement of 2D and 3D Shapes

Area

Standard units are cm^2, m^2, km^2, mm^2

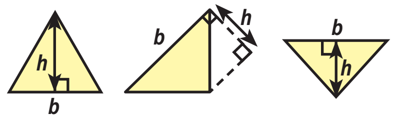
$1\ m^2 = 10\ 000\ cm^2$ | $1\ cm^2 = \frac{1}{10\ 000}\ m^2$

$1\ km^2 = 1\ 000\ 000\ m^2$ | $1\ m^2 = \frac{1}{1\ 000\ 000}\ km^2$

$1\ ha = 10\ 000\ m^2$ | $1\ m^2 = \frac{1}{10\ 000}\ ha$

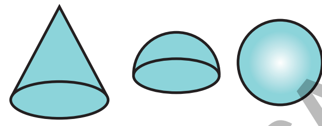
$1\ cm^2 = 100\ mm^2$ | $1\ mm^2 = \frac{1}{100}\ cm^2$

Area of triangle = $\frac{1}{2} \times b \times h$

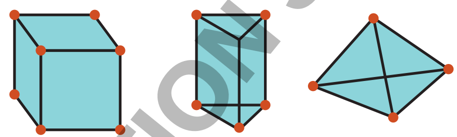


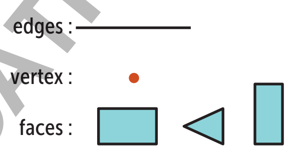
3D Solids

(a) with curved surface



(b) without curved surface

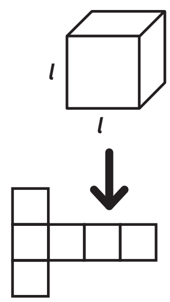




Surface Area can be visualised using net figures.

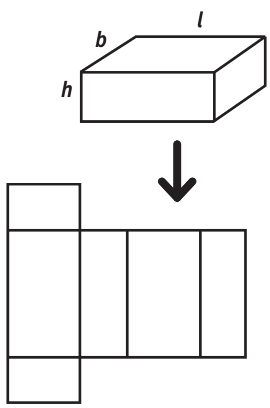
Total surface area of cube

$= 6 \times l \times l$



Total surface area of cuboid

$= 2[(l \times b + l \times h + b \times h)]$



Volume is the amount of space inside a solid.

Standard units of volume

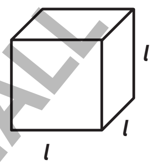
$1\ m^3 = 1\ 000\ 000\ cm^3$

$1\ cm^3 = \frac{1}{1\ 000\ 000}\ m^3$

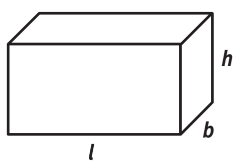
$1\ ml = 1\ cm^3$

$1\ l = 1000\ ml = 1000\ cm^3$

Volume of cube = $l \times l \times l$



Volume of cuboid = $l \times b \times h$



Chapter 11 Revision

1 Convert each of the following to cm^2.

a $0.4\ m^2$ b $3\ m^2$ c $1.56\ m^2$

2 Convert each of the following to m^2.

a $3000\ cm^2$ b $40\ cm^2$ c $600\ 000\ cm^2$

3 Convert each of the following to m^2.

a $2.5\ km^2$ b $0.5\ km^2$ c $12.2\ km^2$

4 Convert each of the following to km^2.

a $6\ 000\ 000\ m^2$ b $750\ 000\ m^2$

5 Convert each of the following to mm^2.

a $42\ cm^2$ b $3.8\ cm^2$

6 Convert each of the following to cm^2.

a $120\ mm^2$ b $48\ mm^2$

7 Convert each of the following to m^2.

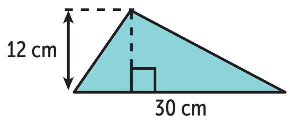
a 2.4 ha b 0.56 ha

8 Convert each of the following to ha.

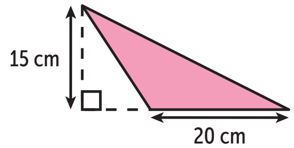
a $13\ 000\ m^2$ b $412\ 000\ m^2$

9 Find the area of each of the following triangles.

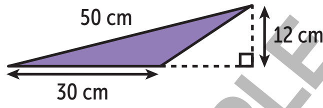
a



b

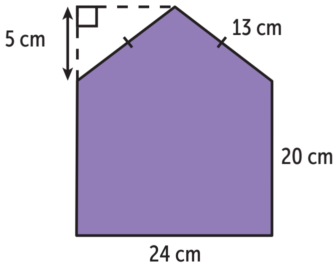


c

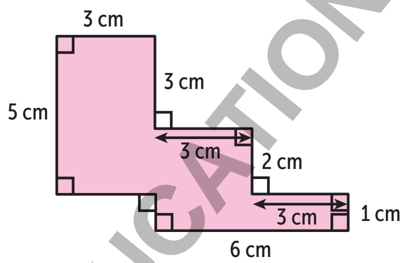


10 Find the area of each of the following figures.

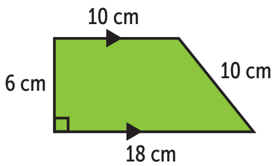
a



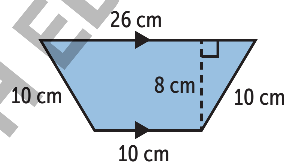
b



c



d



11 **a** Convert each of the following to cm^3.

i $5\ m^3$ **ii** $0.006\ m^3$

b Convert each of the following to m^3.

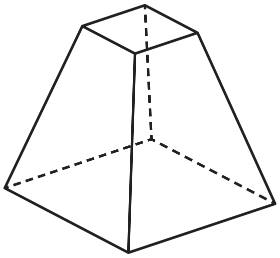
i $76\,000\ cm^3$ **ii** $250\,000\ cm^3$ **iii** $3\ cm^3$

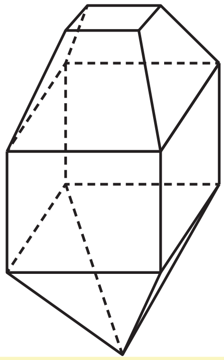
12 Convert each of the following to cm^3.

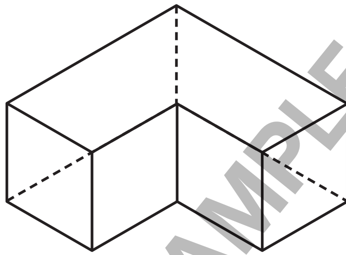
a 2.5 *l* **b** 0.52 *l*

c 68 m*l* **d** 120 m*l*

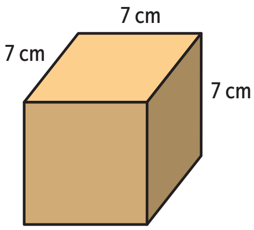
13 Find the number of faces, vertices and edges of the following solids.

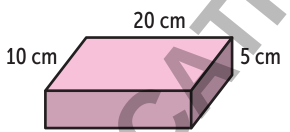
a


b


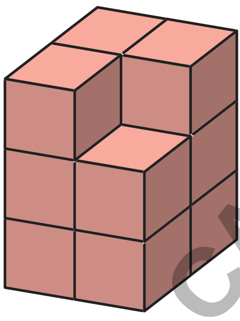
c


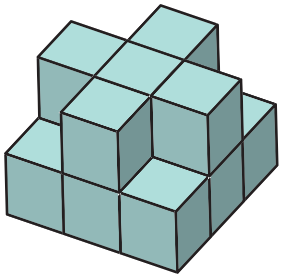
14 Find the volume and surface area of the following cubes and cuboids.

a


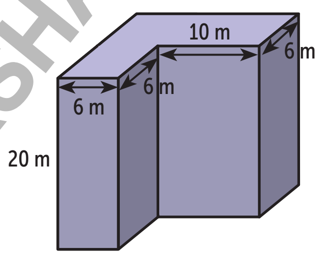
b


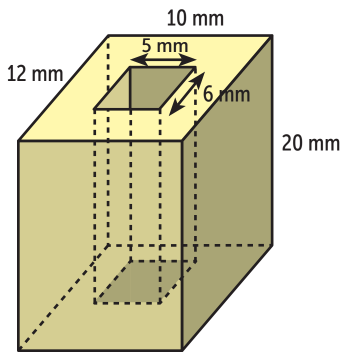
15 Find the volume and surface area of the following compound solids which are made up of cubes of length 1 cm.

a


b


16 Find the volume and surface area of the following solids.

a


b


Use the following self-assessment checklist to see if you have understood the concepts.

	Objectives	Questions	Score
1	Convert between m^2 and cm^2	1a, b, c 2a, b, c	/6
2	Convert between km^2 and m^2	3a, b, c 4a, b	/5
3	Convert between cm^2 and mm^2	5a, b 6a, b	/4
4	Convert between m^2 and ha	7a, b 8a, b	/0
5	Calculate area of triangles	9a, b, c	/3
6	Calculate area of compound shapes	10a, b, c, d	/4
7	Convert between cm^3, m^3, ml and l	11a (i), (ii); b (i), (ii), (iii) 12a, b, c, d	/9
8	Find the faces, vertices and edges of 3D shapes	13a, b, c	/3
9	Find the volumes and surface areas of cubes, cuboids and compound shapes	14a, b 15a, b, c 16a, b	/5
		Total	/39