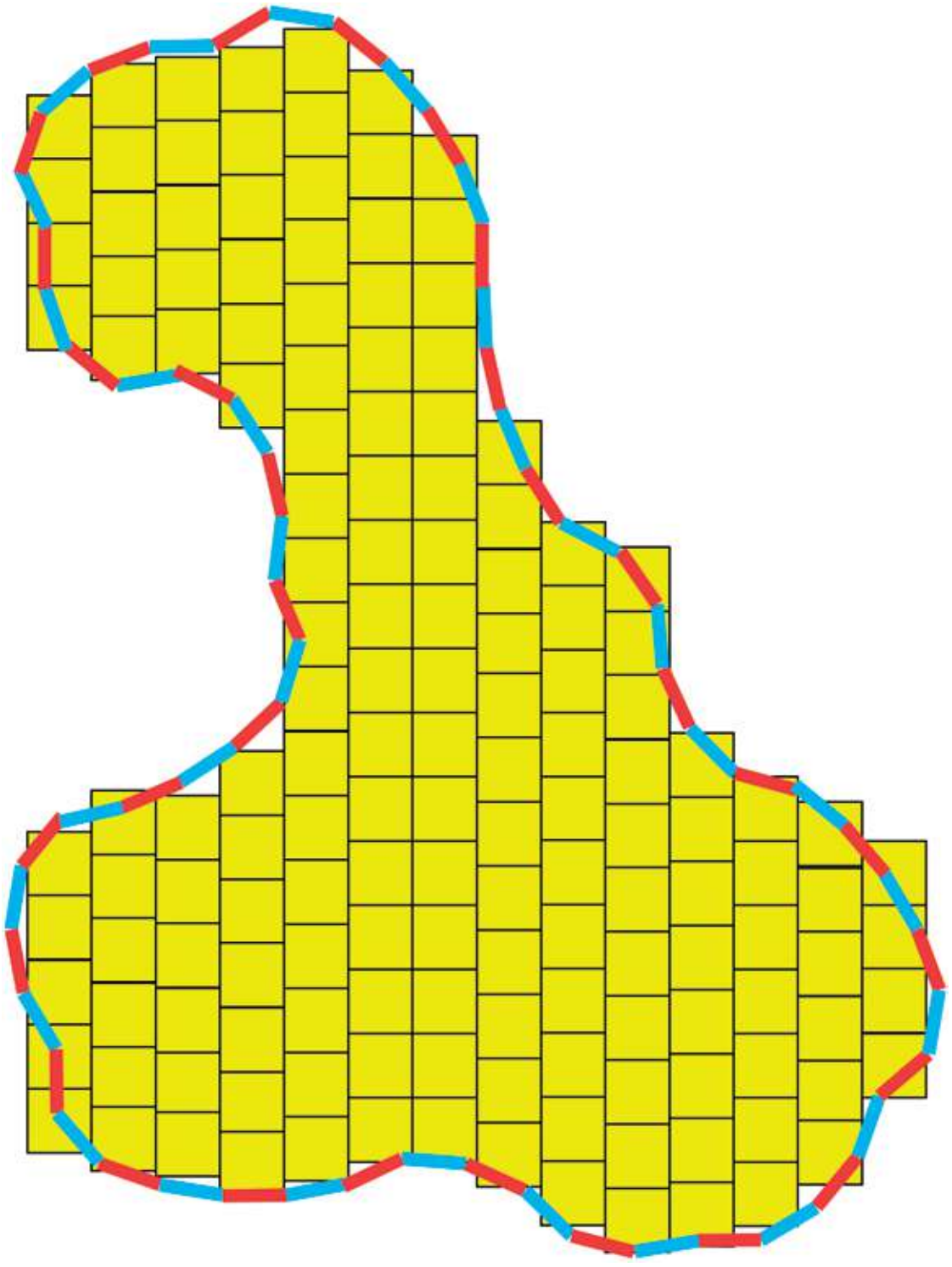
Chapter 9
Perimeter and area of 2D shapes

You will remember from Grade 6 that perimeter is the distance around the outermost border of something. Area is the size of a flat surface of something. In this chapter, you will learn to use different formulae to calculate the perimeter and area of squares, rectangles and triangles. You will solve problems using these formulae, and you will also learn how to convert between different units of area.



How big is it?

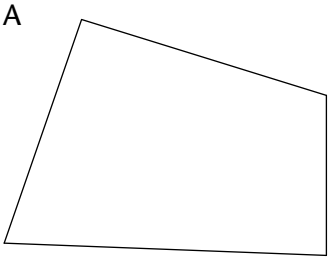
9 Perimeter and area of 2D shapes

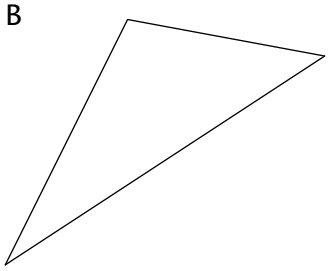
9.1 Perimeter of polygons

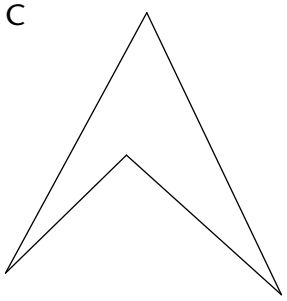
The **perimeter** of a shape is the total distance around the shape, or the lengths of its sides added together. Perimeter (P) is measured in units such as millimetres (mm), centimetres (cm) and metres (m).

MEASURING PERIMETERS

1. (a) Use a compass and/or a ruler to measure the length of each side in figures A to C. Write the measurements in mm on each figure.
   (b) Write down the perimeter of each figure.

A 

B 

C 

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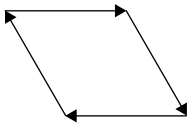
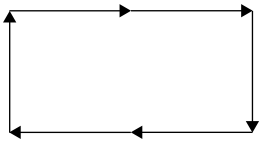
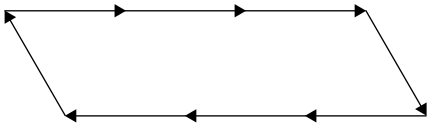
2. The following shapes consist of arrows that are equal in length.
   (a) What is the perimeter of each shape in number of arrows?
   (b) If each arrow is 30 mm long, what is the perimeter of each shape in mm?

A 

B 

C 

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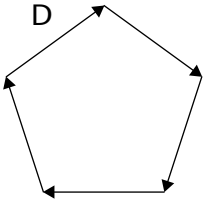
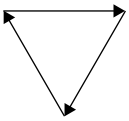
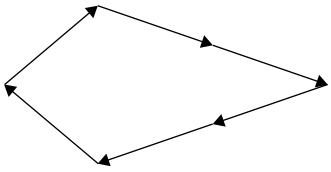
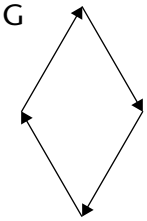
D 

E 

F 

G 

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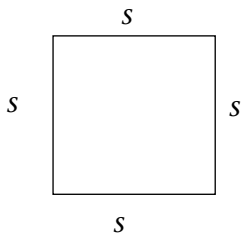
9.2 Perimeter formulae

If the sides of a square are all s units long:

Perimeter of square $= s + s + s + s$

$= 4 \times s$

or $P = 4s$



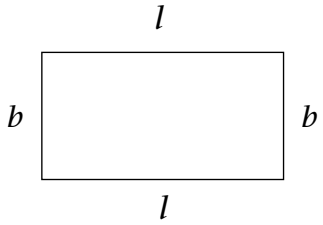
If the length of a rectangle is l units and the breadth (width) is b units:

Perimeter of rectangle $= l + l + b + b$

$= 2 \times l + 2 \times b$

$= 2l + 2b$

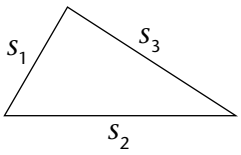
or $P = 2(l + b)$



A triangle has three sides, so:

Perimeter of triangle $= s_1 + s_2 + s_3$

or $P = s_1 + s_2 + s_3$



APPLYING PERIMETER FORMULAE

1. Calculate the perimeter of a square if the length of one of its sides is 17,5 cm.

   .....

2. One side of an equilateral triangle is 32 cm. Calculate the triangle's perimeter.

   .....

3. Calculate the length of one side of a square if the perimeter of the square is 7,2 m. (Hint: $4s = ?$ Therefore $s = ?$)

   .....

   .....

4. Two sides of a triangle are 2,5 cm each. Calculate the length of the third side if the triangle's perimeter is 6,4 cm.

   .....

   .....

5. A rectangle is 40 cm long and 25 cm wide. Calculate its perimeter.

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6. Calculate the perimeter of a rectangle that is 2,4 m wide and 4 m long.

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7. The perimeter of a rectangle is 8,88 m. How long is the rectangle if it is 1,2 m wide?

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8. Do the necessary calculations in your exercise book in order to complete the table. (All the measurements refer to rectangles.)

	Length	Breadth	Perimeter
(a)	74 mm	30 mm	
(b)	25 mm		90 mm
(c)		1,125 cm	6,25 cm
(d)	5,5 cm		22 cm
(e)	7,5 m	3,8 m	
(f)		2,5 m	12 m

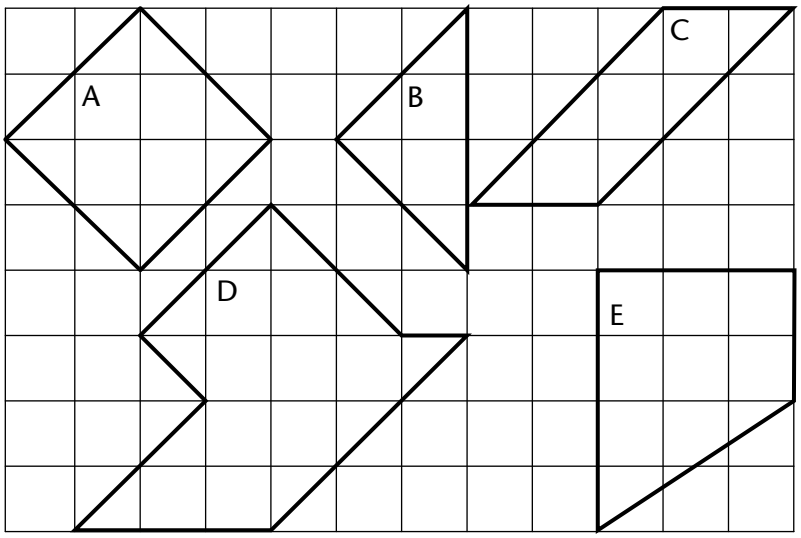
9.3 Area and square units

The **area** of a shape is the size of the flat surface surrounded by the border (perimeter) of the shape.

Usually, area (A) is measured in square units, such as square millimetres (mm^2), square centimetres (cm^2) and square metres (m^2).

SQUARE UNITS TO MEASURE AREA

1. Write down the area of figures A to E below by counting the square units. (Remember to add halves or smaller parts of squares.)



A is .... square units.

B is .... square units.

C is .... square units.

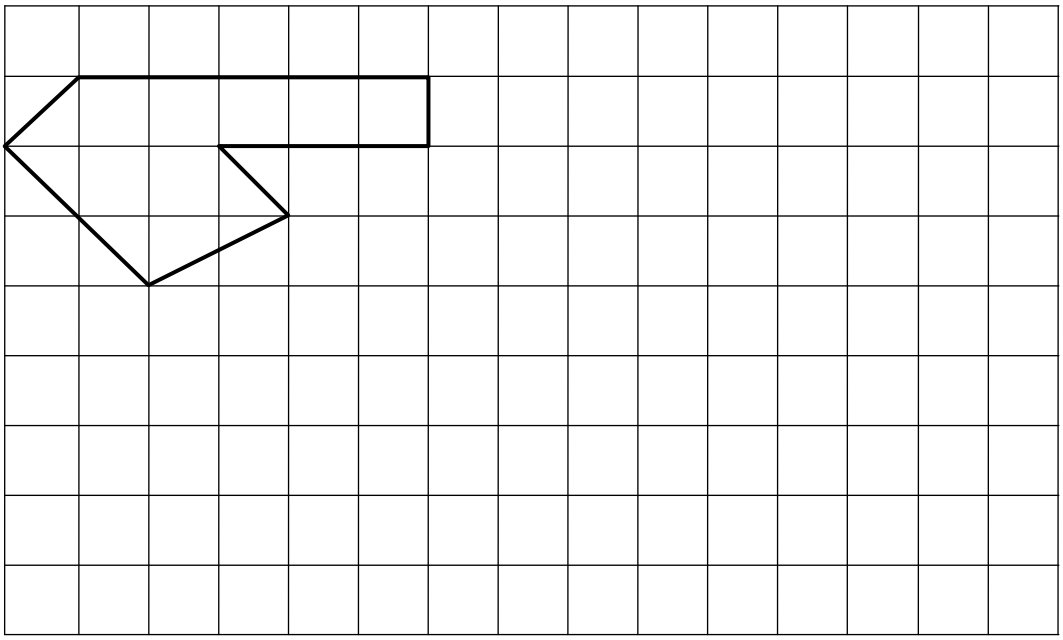
D is .... square units.

E is .... square units.

2. Each square in the grid below measures 1 cm^2 (1 cm × 1 cm).

   (a) What is the area of the shape drawn on the grid? .....

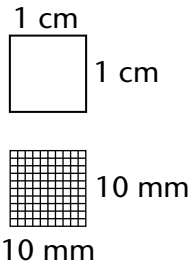
   (b) On the same grid, draw two shapes of your own. The shapes should have the same area, but different perimeters.



CONVERSION OF UNITS

The figure on the right shows a square with sides of 1 cm.
The area of the square is one square centimetre (1 cm²).

How many squares of 1 mm by 1 mm (1 mm²) would fit into the 1 cm² square? ..... Complete: 1 cm² = ... mm²



To change cm² to mm²:

1 cm² = 1 cm × 1 cm
= 10 mm × 10 mm
= 100 mm²

Similarly, to change mm² to cm²:

1 mm² = 1 mm × 1 mm
= 0,1 cm × 0,1 cm
= 0,01 cm²

We can use the same method to convert between other square units too. Complete:

From m² to cm²:	**From cm² to m²:**
1 m² = 1 m × 1 m = ... cm × ..... cm = ... cm²	1 cm² = 1 cm × 1 cm = 0,01 m × 0,01 m = ... m²

So, to convert between m², cm² and mm² you do the following:

- cm² to mm² → multiply by 100
- m² to cm² → multiply by 10 000
- mm² to cm² → divide by 100
- cm² to m² → divide by 10 000

Do the necessary calculations in your exercise book. Then fill in your answers.

1. (a) 5 m² = ... cm²
   (b) 5 cm² = ... mm²
   (c) 20 cm² = ... m²
   (d) 20 mm² = ... cm²

2. (a) 25 m² = ... cm²
   (b) 240 000 cm² = ... m²
   (c) 460,5 mm² = ... cm²
   (d) 0,4 m² = ... cm²
   (e) 12 100 cm² = ... m²
   (f) 2,295 cm² = ... mm²

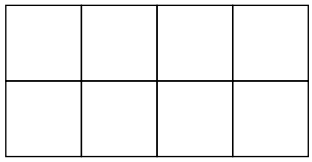
9.4 Area of squares and rectangles

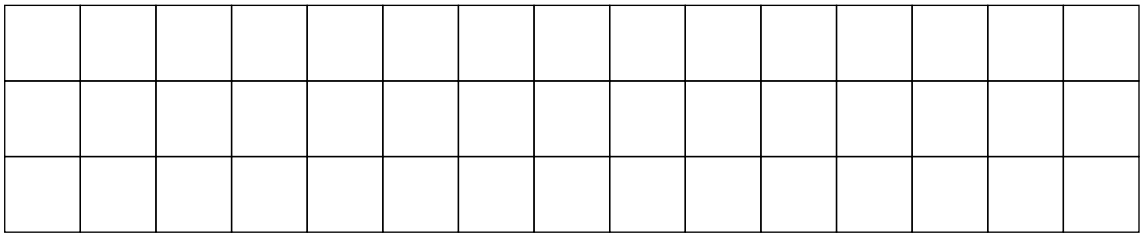
INVESTIGATING THE AREA OF SQUARES AND RECTANGLES

1. Each of the following four figures is divided into squares of equal size, namely 1 cm by 1 cm.

A 

B 

C 

D 

(a) Give the area of each figure in square centimetres (cm^2):

Area of A: ..... Area of B: .....

Area of C: ..... Area of D: .....

(b) Is there a shorter method to work out the area of each figure? Explain.

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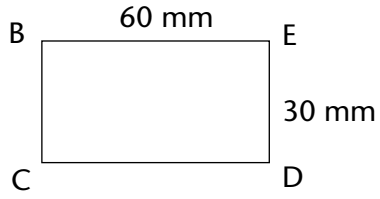
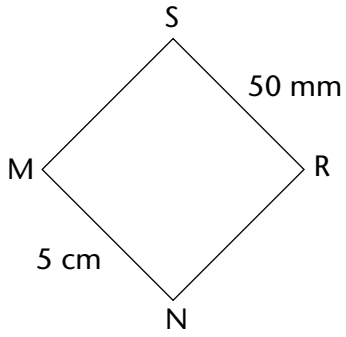
2. Figure BCDE is a rectangle and MNRS is a square.





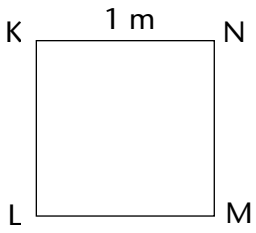
(a) How many cm^2 (1 cm × 1 cm) would fit into rectangle BCDE? .....

(b) How many mm^2 (1 mm × 1 mm) would fit into rectangle BCDE? .....

(c) What is the area of square MNRS in cm^2? .....

(d) What is the area of square MNRS in mm^2? .....

3. Figure KLMN is a square with sides of 1 m.



(a) How many squares with sides of 1 cm would fit along the length of the square? .....

(b) How many squares with sides of 1 cm would fit along the breadth of the square? .....

(c) How many squares (cm^2) would therefore fit into the whole square? .....

(d) Complete: 1 m^2 = ... cm^2

A quick way of calculating the number of squares that would fit into a rectangle is to multiply the number of squares that would fit along its length by the number of squares that would fit along its breadth.

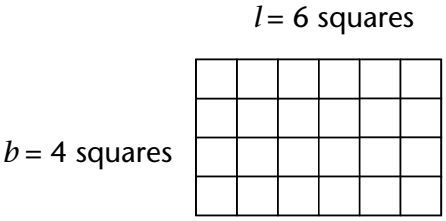
FORMULAE: AREA OF RECTANGLES AND SQUARES

In the rectangle on the right:

Number of squares = Squares along the length × Squares along the breadth

= 6 × 4

= 24



From this we can deduce the following:

Area of rectangle = Length of rectangle × Breadth of rectangle

$A = l \times b$

(where A is the area in square units, l is the length and b is the breadth)

Area of square = Length of side × Length of side

$A = l \times l$

$= l^2$

(where A is the area in square units, and l is the length of a side)

The units of the values used in the calculations must be the same. Remember:

- 1 m = 100 cm and 1 cm = 10 mm
- 1 cm^2 = 1 cm × 1 cm = 10 mm × 10 mm = 100 mm^2
- 1 m^2 = 1 m × 1 m = 100 cm × 100 cm = 10 000 cm^2
- 1 mm^2 = 1 mm × 1 mm = 0,1 cm × 0,1 cm = 0,01 cm^2
- 1 cm^2 = 1 cm × 1 cm = 0,01 m × 0,01 m = 0,0001 m^2

Examples

1. Calculate the area of a rectangle with a length of 50 mm and a breadth of 3 cm. Give the answer in cm^2.

   Solution:

   Area of rectangle $= l \times b$

   $= (50 \times 30)\ mm^2$ or $A = (5 \times 3)\ cm^2$

   $= 1\ 500\ mm^2$ or $= 15\ cm^2$

2. Calculate the area of a square bathroom tile with a side of 150 mm.

   Solution:

   Area of square tile $= l \times l$

   $= (150 \times 150)\ mm^2$

   $= 22\ 500\ mm^2$

   The area is therefore $22\ 500\ mm^2$ (or $225\ cm^2$).

3. Calculate the length of a rectangle if its area is $450\ cm^2$ and its width is 150 mm.

   Solution:

   Area of rectangle $= l \times b$

   $450 = l \times 15$

   $30 \times 15 = l \times 15$ or $450 \div 15 = l$

   $30 = l$ $30 = l$

   The length is therefore 30 cm (or 300 mm).

APPLYING THE FORMULAE

1. Calculate the area of each of the following shapes:

   (a) a rectangle with sides of 12 cm and 9 cm

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   (b) a square with sides of 110 mm (answer in cm^2)

   .....

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(c) a rectangle with sides of 2,5 cm and 105 mm (answer in mm^2)

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(d) a rectangle with a length of 8 cm and a perimeter of 24 cm

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2. A rugby field has a length of 100 m (goal post to goal post) and a breadth of 69 m.
   (a) What is the area of the field (excluding the area behind the goal posts)?

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   (b) What would it cost to plant new grass on that area at a cost of R45/m^2?

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   (c) Another unit for area is the hectare (ha). It is mainly used for measuring land. The size of 1 ha is the equivalent of 100 m × 100 m. Is a rugby field greater or smaller than 1 ha? Explain your answer.

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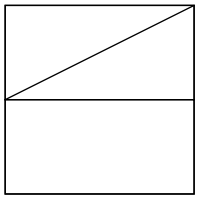
3. Do the necessary calculations in your exercise book in order to complete the table. (All the measurements refer to rectangles.)

	Length	Breadth	Area
(a)	m	8 m	120 m^2
(b)	120 mm	mm	60 cm^2
(c)	3,5 m	4,3 m	m^2
(d)	2,3 cm	cm	2,76 cm^2
(e)	5,2 m	460 cm	m^2

4. Figure A is a square with sides of 20 mm. It is cut as shown in A and the parts are combined to form figure B. Calculate the area of figure B.

A



B

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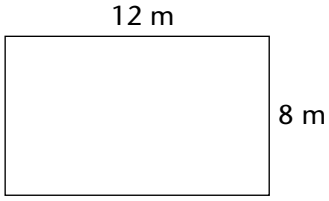
5. Margie plants a vegetable patch measuring 12 m × 8 m.



(a) What is the area of the vegetable patch?

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(b) She plants carrots on half of the patch, and tomatoes and potatoes on a quarter of the patch each. Calculate the area covered by each type of vegetable?

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(c) How much will she pay to put fencing around the patch? The fencing costs R38/m.

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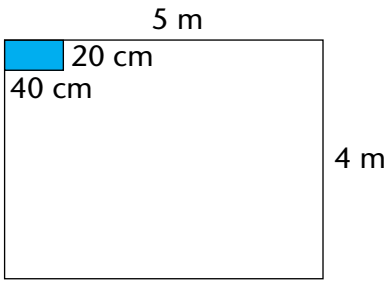
6. Mr Allie has to tile a kitchen floor measuring 5 m × 4 m. The blue tiles he uses each measure 40 cm × 20 cm.



(a) How many tiles does Mr Allie need?

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(b) The tiles are sold in boxes containing 20 tiles. How many boxes should he buy?

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DOUBLING A SIDE AND ITS EFFECT ON AREA

When a side of a square is doubled, will the area of the square also be doubled?

The size of each square making up the grid below is 1 cm × 1 cm.

1. (a) For each square drawn on the grid, label the lengths of its sides.
   (b) Write down the area of each square. (Write the answer inside the square.)
2. Notice that the second square in each pair of squares has a side length that is double the side length of the first square.
3. Compare the areas of the squares in each pair; then complete the following:
   When the side of a square is doubled, its area

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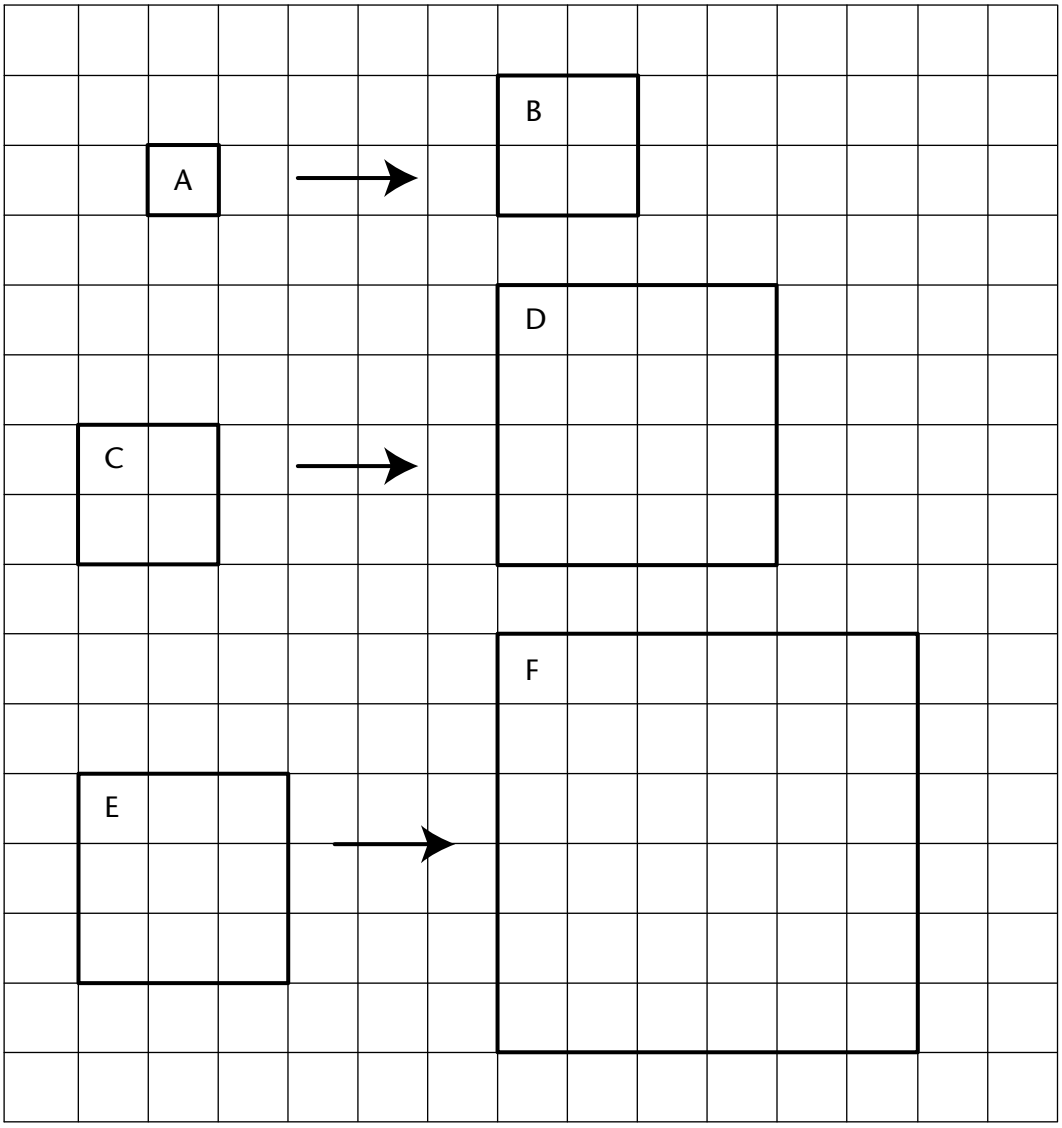
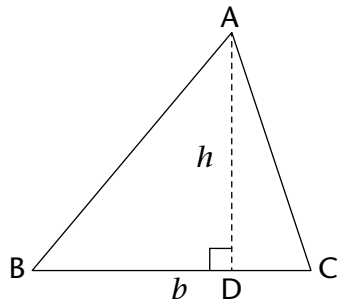


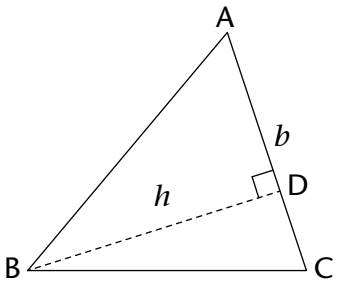
9.5 Area of triangles

HEIGHTS AND BASES OF A TRIANGLE

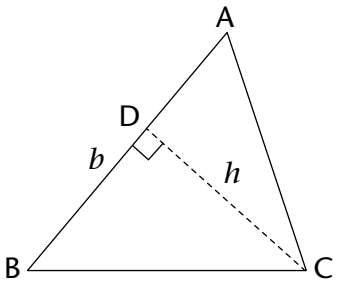
The **height (*h*)** of a triangle is a perpendicular line segment drawn from a vertex to its opposite side. The opposite side, which forms a right angle with the height, is called the **base (*b*)** of the triangle. Any triangle has three heights and three bases.



AD = height
BC = base

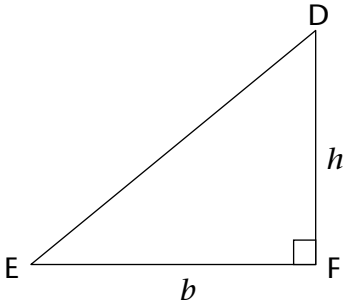


BD = height
AC = base

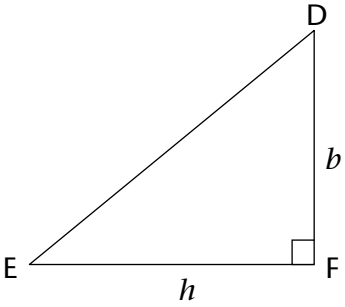


CD = height
AB = base

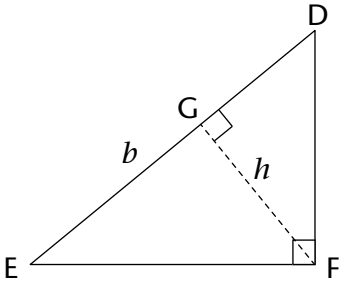
In a right-angled triangle, two sides are already at right angles:



DF = height
EF = base

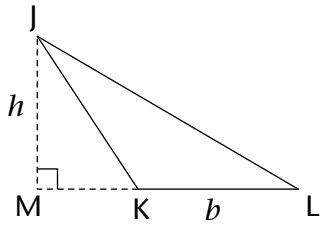


EF = height
DF = base

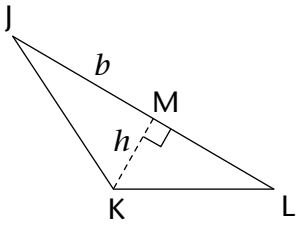


FG = height
DE = base

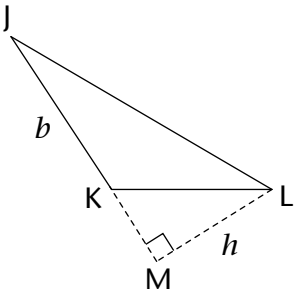
Sometimes a base must be extended outside of the triangle in order to draw the perpendicular height. This is shown in the first and third triangles below. Note that the extended part does not form part of the base's measurement:



JM = height
KL = base

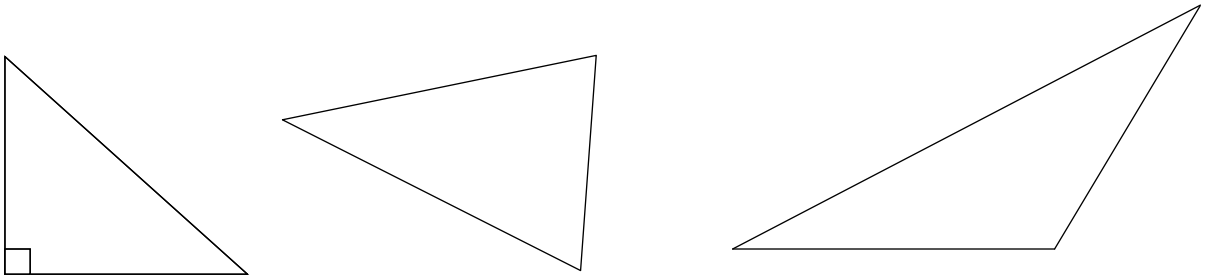


KM = height
JL = base



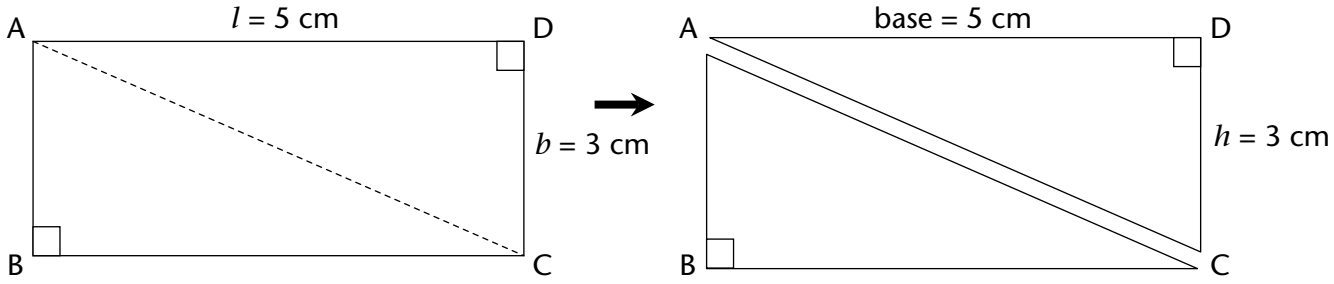
LM = height
JK = base

1. Draw any height in each of the following triangles. Label the height (h) and base (b) on each triangle.
2. Label another set of heights and bases on each triangle.



FORMULA: AREA OF A TRIANGLE

ABCD is a rectangle with length = 5 cm and breadth = 3 cm. When A and C are joined, it creates two triangles that are equal in area: ΔABC and ΔADC.



Area of rectangle $= l \times b$

Area of ΔABC (or ΔADC) $= \frac{1}{2}$ (Area of rectangle)

$= \frac{1}{2}(l \times b)$

In rectangle ABCD, AD is its length and CD is its breadth.
But look at ΔADC. Can you see that AD is a base and CD is its height?

So instead of saying:

Area of ΔADC or any other triangle $= \frac{1}{2}(l \times b)$

we say:

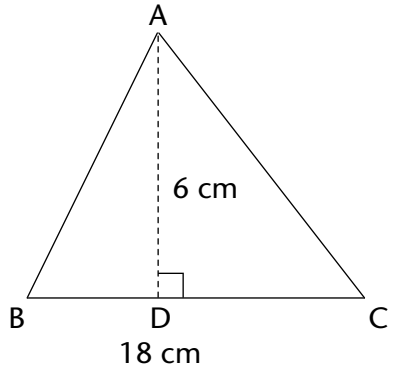
Area of a triangle $= \frac{1}{2}$ (base × height)

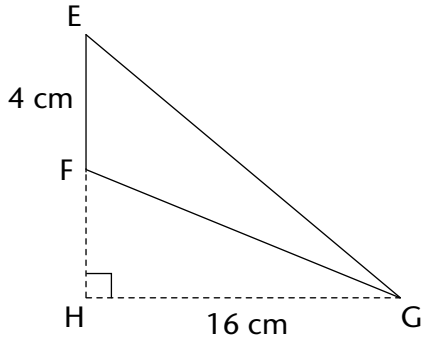
$= \frac{1}{2}(b \times h)$

In the formula for the area of a triangle, b means 'base' and not 'breadth', and h means perpendicular height.

APPLYING THE AREA FORMULA

1. Use the formula to calculate the areas of the following triangles: ΔABC, ΔEFG, ΔJKL and ΔMNP.





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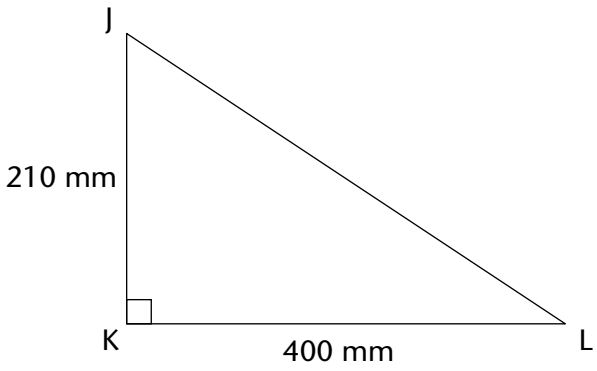

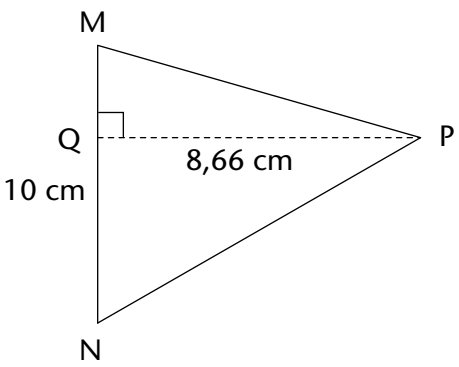

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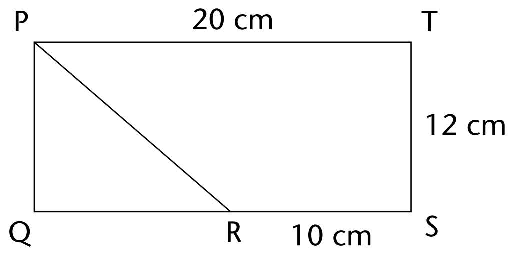
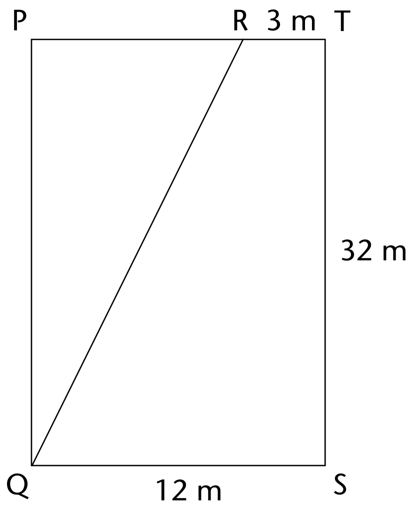
2. PQST is a rectangle in each case below. Calculate the area of ΔPQR each time.

(a)



(b)



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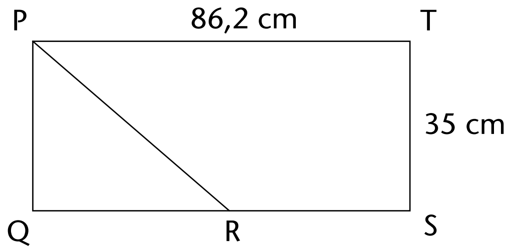
(c) R is the midpoint of QS.



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3. In ΔABC, the area is 42 m^2, and the perpendicular height is 16 m. Find the length of the base.

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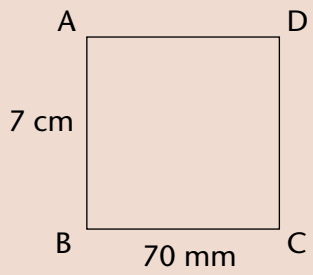
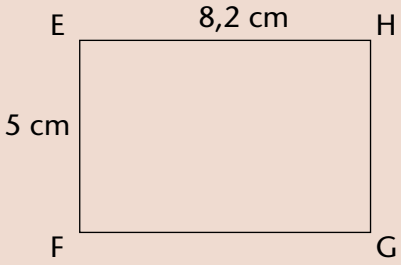
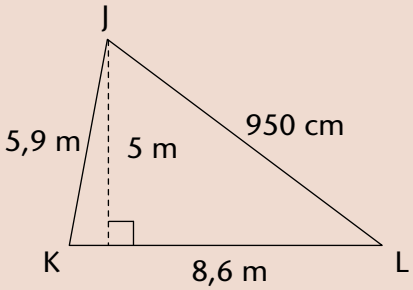
WORKSHEET

1. Calculate the perimeter (P) and area (A) of the following figures:







$P =$ ..... $P =$ ..... $P =$ .....

$A =$ ..... $A =$ ..... $A =$ .....

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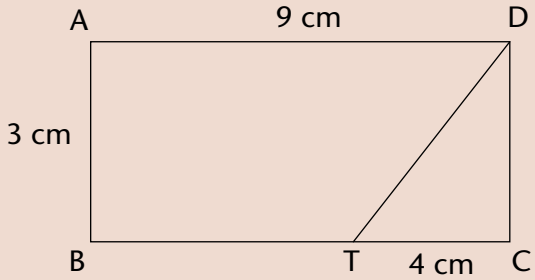
2. Figure ABCD is a rectangle:
AB = 3 cm, AD = 9 cm and TC = 4 cm.



(a) Calculate the perimeter of ABCD.

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(b) Calculate the area of ABCD.

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(c) Calculate the area of ΔDTC.

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(d) Calculate the area of ABTD.

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