

CHAPTER 9

Perimeter And Area Of 2d Shapes

CONTENTS

1	Perimeter of polygons	1
2	Perimeter formulae	1
3	Area and square units	2
4	Area of squares and rectangles	4
5	Area of triangles	7
6	Exercises	10
6.1	Exercise 1	10
6.2	Exercise 2	10
6.3	Exercise 3	11
6.4	Exercise 4	12
6.5	Exercise 5	14
7	Answers for Exercises	15
7.1	Exercise 1	15
7.2	Exercise 2	16
7.3	Exercise 3	16
7.4	Exercise 4	17
7.5	Exercise 5	18

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1 PERIMETER OF POLYGONS

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.

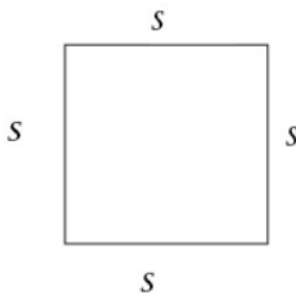
The **perimeter** of a shape is the total distance around the shape, or the lengths of its sides added together. Perimeter (P) is measured in units such as millimetres (mm), centimetres (cm) and metres (m).

Measuring perimeters

2 PERIMETER FORMULAE

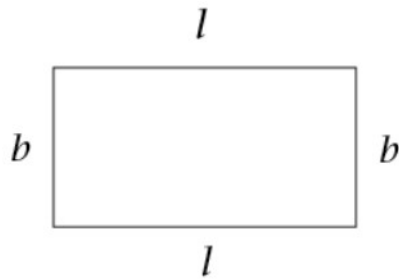
If the sides of a square are all s units long:

$$\begin{aligned}\text{Perimeter of square} &= s + s + s + s \\ &= 4 \times s \\ \text{or } P &= 4s\end{aligned}$$



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

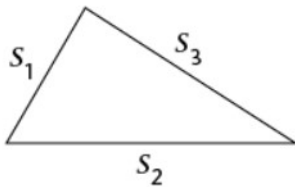
$$\begin{aligned}\text{Perimeter of rectangle} &= l + l + b + b \\ &= 2 \times l + 2 \times b \\ \text{or } P &= 2(l + b)\end{aligned}$$



A triangle has three sides, so:

$$\text{Perimeter of triangle} = s_1 + s_2 + s_3$$

$$\text{or } P = s_1 + s_2 + s_3$$



Applying perimeter formulae

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.

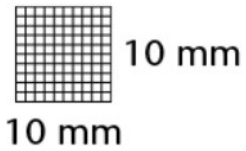
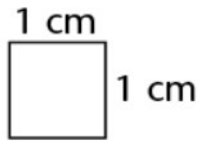
Usually, area (A) is measured in square units, such as square millimetres (mm^2), square centimetres (cm^2) and square metres (m^2).

Square units to measure area

Conversion of units

The figure below shows a square with sides of 1 cm . The area of the square is one square centimetre ($1\ cm^2$).

How many squares of 1 mm by 1 mm ($1\ mm^2$) would fit into the $1\ cm^2$ square?



To change cm^2 to mm^2 :

$$1 \text{ cm}^2 = 1 \text{ cm} \times 1 \text{ cm}$$

$$= 10 \text{ mm} \times 10 \text{ mm}$$

$$= 100 \text{ mm}^2$$

Similarly, to change mm^2 to cm^2 :

$$1 \text{ mm}^2 = 1 \text{ mm} \times 1 \text{ mm}$$

$$= 0,1 \text{ cm} \times 0,1 \text{ cm}$$

$$= 0,01 \text{ cm}^2$$

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

NOTE

So, to convert between m^2 , cm^2 and mm^2 you do the following:

- cm^2 to mm^2 → multiply by 100
- m^2 to cm^2 → multiply by 10 000
- mm^2 to cm^2 → divide by 100
- cm^2 to m^2 → divide by 10 000

4 AREA OF SQUARES AND RECTANGLES

Investigating the area of squares and rectangles

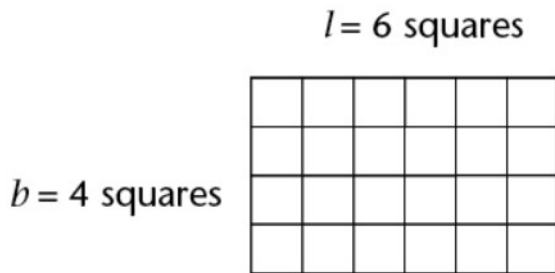
NOTE

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 below:

$$\begin{aligned}\text{Number of squares} &= \text{Squares along the length} \times \text{Squares along the breadth} \\ &= 6 \times 4 \\ &= 24\end{aligned}$$



From this we can deduce the following:

NOTE

$$\text{Area of rectangle} = \text{Length of rectangle} \times \text{Breadth of rectangle} \quad (1)$$

$$A = l \times b \quad (2)$$

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

$$\text{Area of square} = \text{Length of side} \times \text{Length of side} \quad (3)$$

$$A = l \times l \quad (4)$$

$$= l^2 \quad (5)$$

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:

- $1\text{ m} = 100\text{ cm}$ and $1\text{ cm} = 10\text{ mm}$
- $1\text{ cm}^2 = 1\text{ cm} \times 1\text{ cm} = 10\text{ mm} \times 10\text{ mm} = 100\text{ mm}^2$
- $1\text{ m}^2 = 1\text{ m} \times 1\text{ m} = 100\text{ cm} \times 100\text{ cm} = 10000\text{ cm}^2$
- $1\text{ mm}^2 = 1\text{ mm} \times 1\text{ mm} = 0,1\text{ cm} \times 0,1\text{ cm} = 0,01\text{ cm}^2$
- $1\text{ cm}^2 = 1\text{ cm} \times 1\text{ cm} = 0,01\text{ m} \times 0,01\text{ m} = 0,0001\text{ m}^2$

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:

$$\begin{aligned} \text{Area of rectangle} &= l \times b \\ &= (50 \times 30)\text{ mm}^2 && \text{or } A = (5 \times 3)\text{ cm}^2 \\ &= 1500\text{ mm}^2 && \text{or } = 15\text{ cm}^2 \end{aligned}$$

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

Solution:

$$\begin{aligned} \text{Area of square tile} &= l \times l \\ &= (150 \times 150)\text{ mm}^2 \\ &= 22500\text{ mm}^2 \end{aligned}$$

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

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

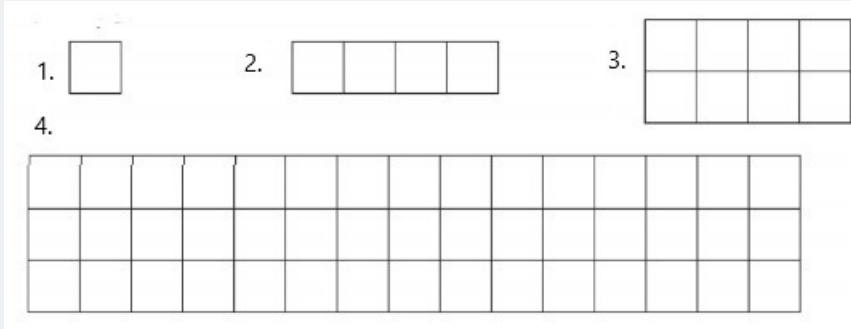
Solution:

$$\begin{aligned} \text{Area of rectangle} &= l \times b \\ 450 &= l \times 15 \\ 30 \times 15 &= l \times 15 && \text{or } 450 \div 15 = l \\ 30 &= l && 30 = l \end{aligned}$$

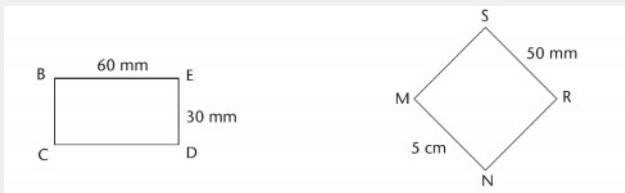
The length is therefore 30 cm (or 300 mm).

INVESTIGATION

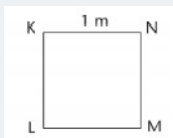
1. Each of the following four figures is divided into squares of equal size, namely 1 cm by 1 cm. Give the area of each figure in square centimetres (cm^2). Give the area of each figure in square centimetres (cm^2).



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



- 2.1 How many cm^2 ($1 \text{ cm} \times 1 \text{ cm}$) would fit into rectangle $BCDE$?
- 2.2 How many mm^2 ($1 \text{ mm} \times 1 \text{ mm}$) would fit into rectangle $BCDE$?
- 2.3 What is the area of square $MNRS$ in cm^2 ?
- 2.4 What is the area of square $MNRS$ in mm^2 ?
3. Figure $KLMN$ is a square with sides of 1 m.



- 3.1 How many squares with sides of 1 cm would fit along the length of the square?
- 3.2 How many squares with sides of 1 cm would fit along the breadth of the square?
- 3.3 How many squares cm^2 would therefore fit into the whole square?
- 3.4 Complete: $1 \text{ m}^2 = ? \text{ cm}^2$

ANSWERS TO INVESTIGATION

1.1 A: 1 cm^2

B: 4 cm^2

C: 8 cm^2

D: 45 cm^2

1.2 Yes, multiply the number of rows by the number of columns.

2.1 18

2.2 1 800

2.3 25 cm^2

2.4 $2\,500 \text{ mm}^2$

3.1 100

3.2 100

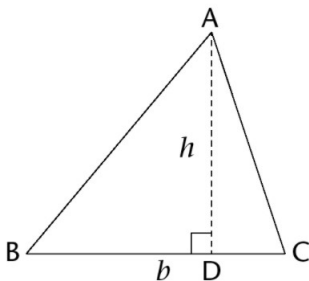
3.3 10 000

3.4 $10\,000 \text{ cm}^2$

5 AREA OF TRIANGLES

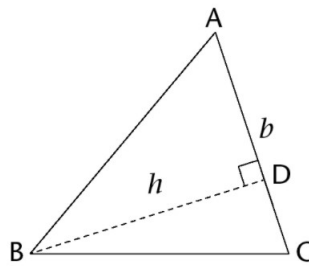
Heights and bases of a triangle

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.



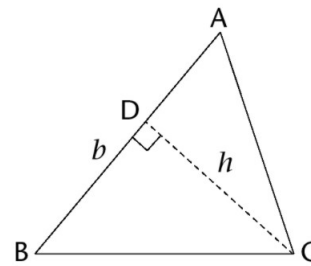
AD = height

BC = base



BD = height

AC = base

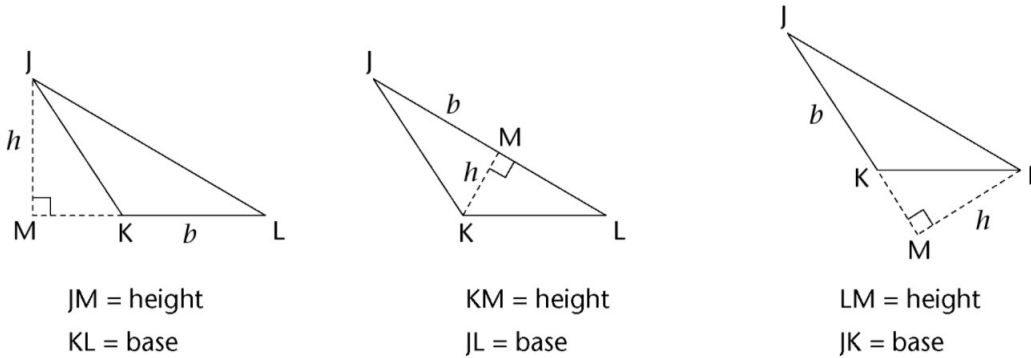


CD = height

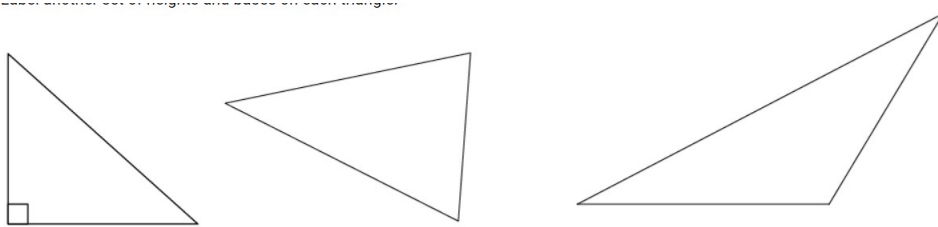
AB = base

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

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:

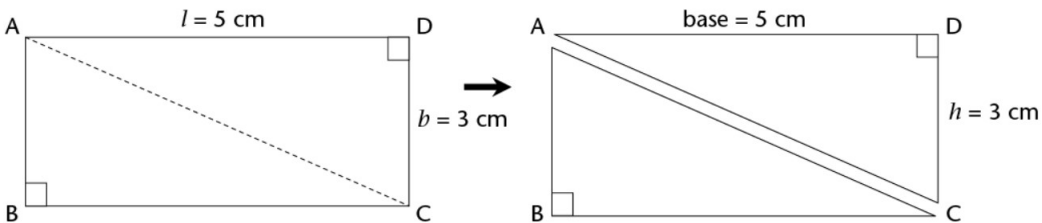


1. Draw any height in each of the following triangles. Label the height (h) and base (b) on each triangle.
2. Label another set of heights and bases on each triangle.



Formula: area of a triangle

$ABCD$ is a rectangle with $length = 5\text{ cm}$ and $breadth = 3\text{ cm}$. When A and C are joined, it creates two triangles that are equal in area: $\triangle ABC$ and $\triangle ADC$.



Area of rectangle = $l \times b$

$$\begin{aligned}\text{Area of } \triangle ABC \text{ (or } \triangle ADC) &= \frac{1}{2}(\text{Area of rectangle}) \\ &= \frac{1}{2}(l \times b)\end{aligned}$$

In rectangle $ABCD$, AD is its length and CD is its breadth.

But look at ADC . Can you see that AD is a base and CD is its height?

So instead of saying:

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

we say:

NOTE

$$\begin{aligned}\text{Area of a triangle} &= \frac{1}{2}(\text{base} \times \text{height}) \\ &= \frac{1}{2}(b \times h)\end{aligned}$$

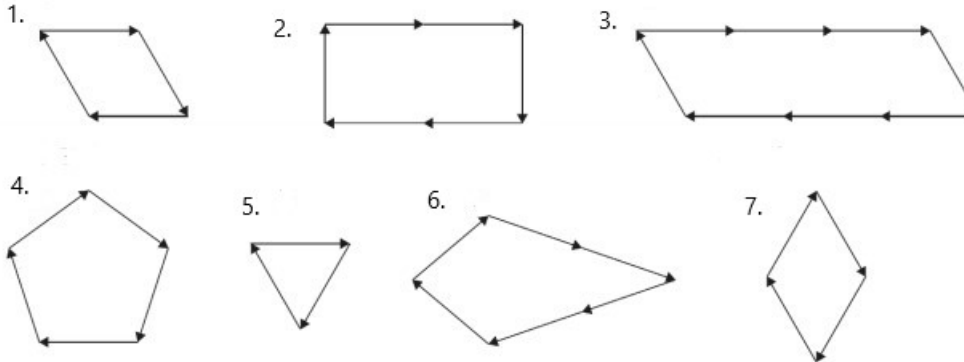
NOTE

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

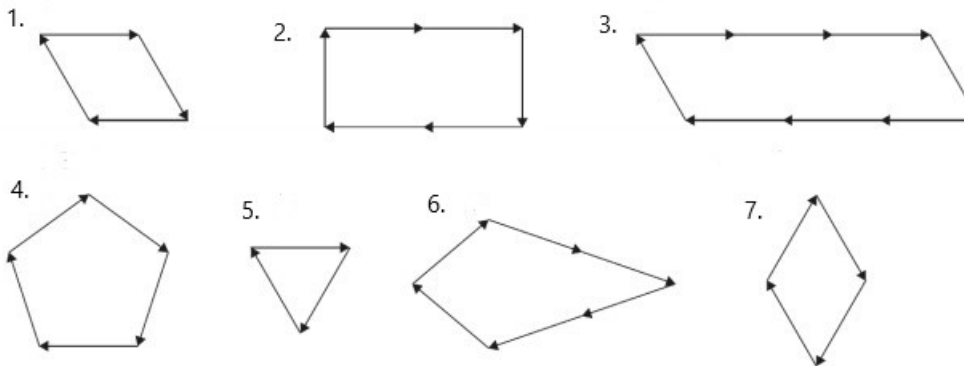
6 EXERCISES

6.1 Exercise 1

1. The following shapes consist of arrows that are equal. What is the perimeter of each shape in number of arrows?



2. If each arrow is 30 mm long, what is the perimeter of each shape in millimeters?



6.2 Exercise 2

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

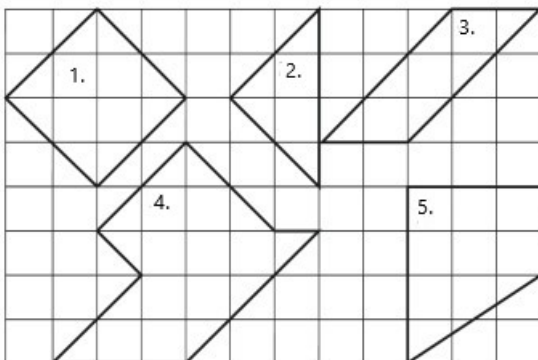
5. A rectangle is 40 cm long and 25 cm wide. Calculate its perimeter.
6. Calculate the perimeter of a rectangle that is 2,4 m wide and 4 m long.
7. The perimeter of a rectangle is 8,88 m. How long is the rectangle if it is 1,2 m wide?
8. Do the necessary calculations and then copy and complete the table. (All the measurements refer to rectangles.)

	Length	Breadth	Perimeter
1.	74 mm	30 mm	
3.		1,125 cm	6,25 cm
5.	7,5 m	3,8 m	

	Length	Breadth	Perimeter
2.	25 mm		90 mm
4.	5,5 cm		22 cm
6.		2,5 m	12 m

6.3 Exercise 3

1. In your book, write down the area of figures 1 to 5 below by counting the square units. (Remember to add halves or smaller parts of squares.)



2. Convert the following.

2.1 5 m^2 to cm^2

2.2 5 cm^2 to mm^2

2.3 20 cm^2 to m^2

2.4 20 mm^2 to cm^2

3. Convert the following

3.1 25 m^2 to cm^2

3.2 $240\,000 \text{ cm}^2$ to m^2

3.3 460.5 mm^2 to cm^2

3.4 0.4 m^2 to cm^2

3.5 $12\,100 \text{ cm}^2$ to m^2

3.6 2.295 cm^2 to mm^2

6.4 Exercise 4

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

1.1 a rectangle with sides of 12 cm and 9 cm

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

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

1.4 a rectangle with a length of 8 cm and a perimeter of 24 cm

2. A rugby field has a length of 100 m (goal post to goal post) and a breadth of 69 m.

2.1 What is the area of the field (excluding the area behind the goal posts)?

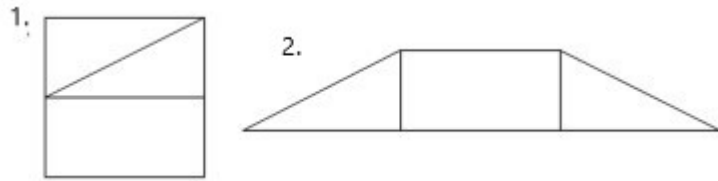
2.2 What would it cost to plant new grass on that area at a cost of $\text{R}45/\text{m}^2$?

2.3 Another unit for area is the hectare (ha). It is mainly used for measuring land. The size of 1 ha is the equivalent of $100 \text{ m} \times 100 \text{ m}$. Is a rugby field greater or smaller than 1 ha? Explain your answer.

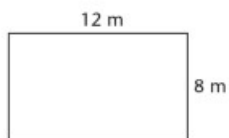
3. Do the necessary calculations and then complete the table below. (All the measurements refer to rectangles.)

	Length	Breadth	Area
1.	m	8 m	120 m^2
2.	120 mm	mm	60 cm^2
3.	3,5 m	4,3 m	m^2
4.	2,3 cm	cm	$2,76 \text{ cm}^2$
5.	5,2 m	460 cm	m^2

4. Figure 1. is a square with sides of 20 mm. It is cut as shown in 1. and the parts are combined to form figure 2. Calculate the area of figure 2.

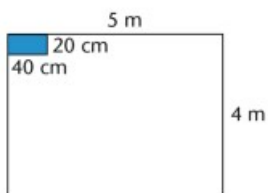


5. Margie plants a vegetable patch measuring $12\text{ m} \times 8\text{ m}$.



- 5.1 What is the area of the vegetable patch?
 5.2 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?
 5.3 How much will she pay to put fencing around the patch? The fencing costs R38/m

6. Mr Allie has to tile a kitchen floor measuring $5\text{ m} \times 4\text{ m}$. The blue tiles he uses each measure $40\text{ cm} \times 20\text{ cm}$.



- 6.1 How many tiles does Mr Allie need?
 6.2 The tiles are sold in boxes containing 20 tiles. How many boxes should he buy?

7. Consider a perfect square for the following questions

7.1 Complete the table concerning a square.

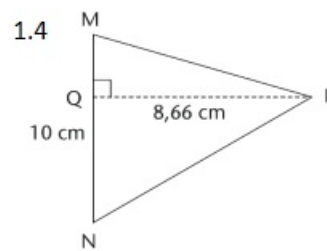
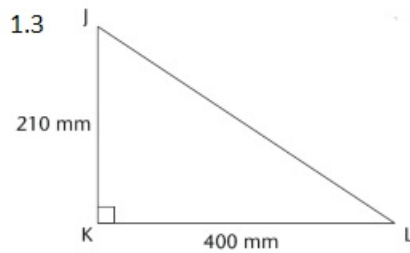
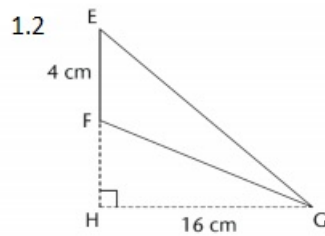
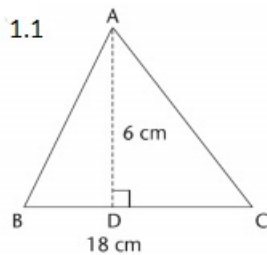
Length of each side in cm	1	2	3	4	5	6
Area of square in cm^2	A	B	C	D	E	F
Perimeter in cm	G	H	I	J	K	L

7.2 By how much does the perimeter increase when the length of the sides increase by 1 cm?

7.3 By how much does the area increase when the length of the sides increase by 1 cm?

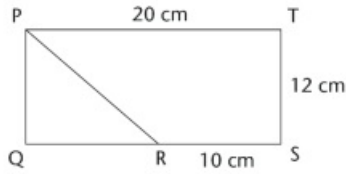
6.5 Exercise 5

1. Use the formula to calculate the areas of the following triangles: $\triangle ABC$, $\triangle EFG$, $\triangle JKL$ and $\triangle MNP$

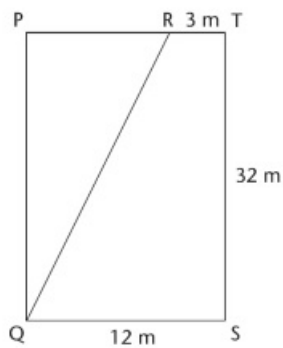


2. PQST is a rectangle in each case below. Calculate the area of $\triangle PQR$ each time.

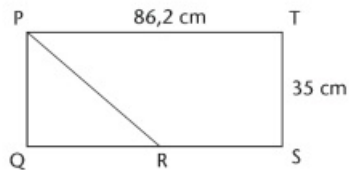
2.1



2.2



2.3 R is the midpoint of QS.



3. In $\triangle ABC$, the area is 42 m^2 , and the perpendicular height is 16 m. Find the length of the base.

7 ANSWERS FOR EXERCISES

7.1 Exercise 1

- 1.1 A: four arrows
B: six arrows
C: eight arrows
D: five arrows
E: three arrows
F: six arrows
G: four arrows

- 1.2 A: 120 mm
B: 180 mm
C: 240 mm
D: 150 mm
E: 90 mm
F: 180 mm
G: 120 mm

7.2 Exercise 2

1. 70 cm
2. 96 cm
3. 1.8 m
4. 1.4 cm
5. 130 cm
6. 12.8 m
7. 3.24 m

- 8.1 208 mm
- 8.2 120 mm
- 8.3 2 cm
- 8.4 5.5 cm
- 8.5 22.6 m
- 8.6 3.5 m

7.3 Exercise 3

- 1.1 8 square units
- 1.2 4 square units
- 1.3 6 square units
- 1.4 14 square units
- 1.5 9 square units

- 2.1 50 000 cm^2
- 2.2 500 mm^2
- 2.3 0.002 m^2
- 2.4 0.2 cm^2

- 3.1 250 000 cm^2

3.2 24 m^2

3.3 4.605 cm^2

3.4 $4\,000 \text{ cm}^2$

3.5 1.21 m^2

3.6 229.5 mm^2

7.4 Exercise 4

1.1 108 cm^2

1.2 121 cm^2

1.3 $2\,625 \text{ mm}^2$

1.4 32 cm^2

2.1 $6\,900 \text{ m}^2$

2.2 $R310\,500$

2.3 Smaller. A hectare is $10\,000 \text{ m}^2$ The area of a rugby field is $6\,900 \text{ m}^2$.

3.1 15

3.2 50

3.3 15.05

3.4 1.2

3.5 23.92

4.1 400 mm^2

5.1 96 m^2

5.2 Carrots: 48 m^2

Tomatoes and potatoes: 24 m^2

5.3 $R1\,520$

6.1 250 tiles

6.2 13 boxes

-
- 7.1 A: 1
B: 4
C: 9
D: 16
E: 25
F: 36
G: 4
H: 8
I: 12
J: 16
K: 20
L: 24

7.2 4 cm

7.3 The increase varies, and the increases are 3 cm^2 , 5 cm^2 , 7 cm^2 , 9 cm^2 , 11 cm^2

7.5 Exercise 5

- 1.1 54 cm^2
1.2 32 cm^2
1.3 $42\,000\text{ mm}^2$
1.4 43.3 cm^2
2.1 60 cm^2
2.2 144 m^2
2.3 754.25 cm^2
3.1 $5, 25\text{ m}$