1 Use the x^2 key on your calculator to evaluate the following.

a 3^2	**b** 4^2	**c** 10^2	**d** 8^2
e 11^2	**f** 17^2	**g** 15^2	**h** 22^2
i 0.6^2	**j** 0.5^2	**k** 1.8^2	**l** 2.3^2
m 4.9^2	**n** 5.2^2	**o** 6.83^2	**p** 9.54^2

2 Use the $\sqrt{\ }$ key on your calculator to evaluate the following.

a $\sqrt{25}$	**b** $\sqrt{49}$	**c** $\sqrt{36}$	**d** $\sqrt{144}$
e $\sqrt{169}$	**f** $\sqrt{400}$	**g** $\sqrt{625}$	**h** $\sqrt{1089}$
i $\sqrt{0.04}$	**j** $\sqrt{0.81}$	**k** $\sqrt{1.21}$	**l** $\sqrt{4.41}$
m $\sqrt{13.69}$	**n** $\sqrt{29.16}$	**o** $\sqrt{237.16}$	**p** $\sqrt{400.8004}$

3 Use the $\sqrt{\ }$ key and FIX function on your calculator to round the following as stated.

The word 'surd' is the name for square root numbers that do not work out exactly.

a Round correct to 1 decimal place.

i $\sqrt{18}$ **ii** $\sqrt{7}$ **iii** $\sqrt{23}$ **iv** $\sqrt{82}$

b Round correct to 2 decimal places.

i $\sqrt{215}$ **ii** $\sqrt{386}$ **iii** $\sqrt{436}$ **iv** $\sqrt{721}$

c Round correct to 3 decimal places.

i $\sqrt{0.7}$ **ii** $\sqrt{1.9}$ **iii** $\sqrt{2.85}$ **iv** $\sqrt{6.04}$

d Round correct to 4 decimal places.

i $\sqrt{12.93}$ **ii** $\sqrt{8.062}$ **iii** $\sqrt{156.4}$ **iv** $\sqrt{387.69}$

4 $\sqrt{2} = 1.414\,213\,562$ and $\sqrt{3} = 1.732\,050\,808$ correct to 9 decimal places.

a Write $\sqrt{5}$, $\sqrt{6}$ and $\sqrt{7}$ correct to 9 decimal places.

b Do any of your answers terminate or recur?

c Is $\sqrt{4}$ irrational? Explain.

Decimal numbers that are both non-terminating and non-recurring are called irrational numbers.

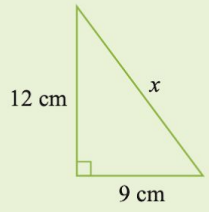
Walt to solve Pythagorean theorem problems

Success criteria - I know the rule and how to apply it. To find, shorter sides and hypotenuse

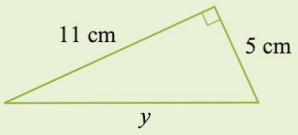
EXAMPLE 1

Calculate the length of the hypotenuse in each right-angled triangle.

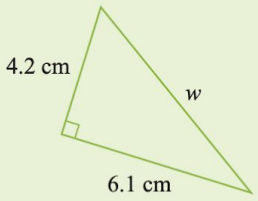
a



b



c



a $a^2 + b^2 = c^2$

$12^2 + 9^2 = x^2$

$144 + 81 = x^2$

$\therefore 225 = x^2$

$\sqrt{225} = x$

$\therefore x = 15$

The hypotenuse is 15 cm.

b $a^2 + b^2 = c^2$

$11^2 + 5^2 = y^2$

$121 + 25 = y^2$

$\therefore 146 = y^2$

$\therefore y = \sqrt{146}$

The hypotenuse is $\sqrt{146}$ cm (surd form).

c $a^2 + b^2 = c^2$

$4.2^2 + 6.1^2 = w^2$

$17.64 + 37.21 = w^2$

$\therefore 54.85 = w^2$

$\sqrt{54.85} = w$

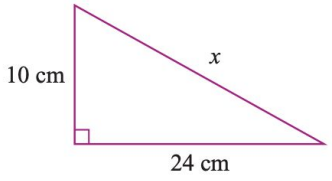
$\therefore w = 7.4$

The hypotenuse is 7.4 cm (1 decimal place).

Notice that when calculating the 'unknown' side, the answer may be a whole number, expressed as a surd or as a decimal correct to a certain number of decimal places.

Use Pythagoras' theorem to calculate the length of the hypotenuse. (All answers are integers.)

a



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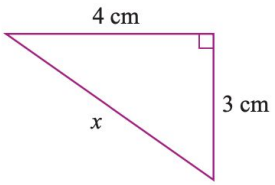

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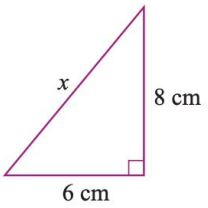

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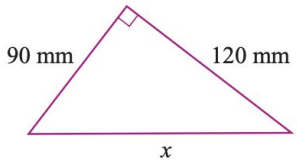

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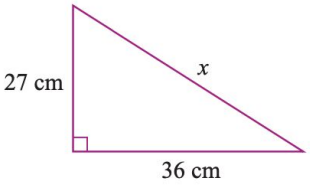

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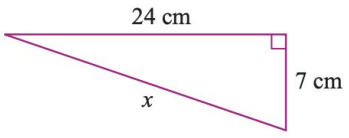
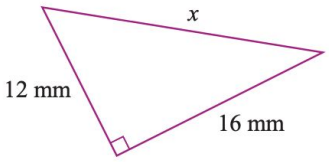
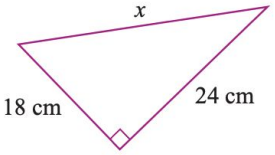


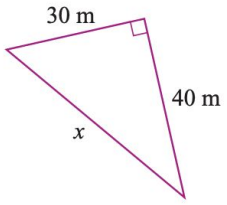
g



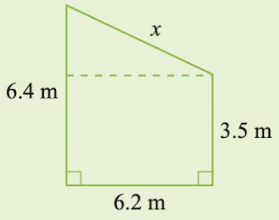
h



i



Calculate the value of x in the diagram correct to 1 decimal place.



Look at the shaded triangle.

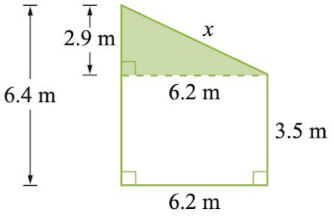
Short side of triangle $= 6.4 - 3.5 = 2.9$ m.

$c^2 = a^2 + b^2$

$x^2 = 2.9^2 + 6.2^2 = 46.85$

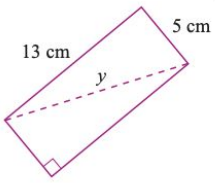
$\therefore x = \sqrt{46.85} = 6.8447\ldots$

$x = 6.8$ (1 decimal place)

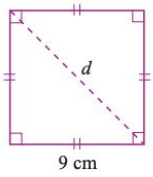


9 Calculate the value of each pronumeral correct to 1 decimal place.

a



b



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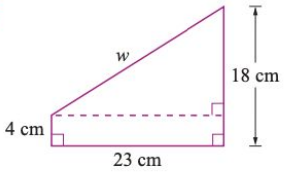

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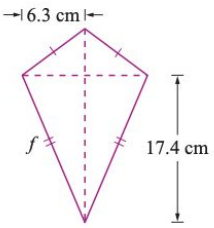

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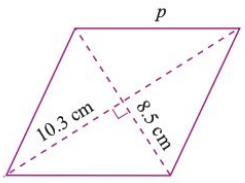

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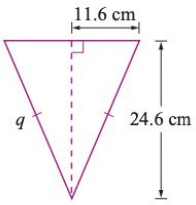
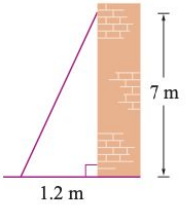
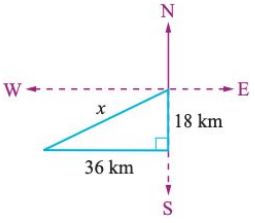


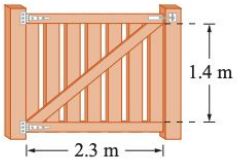
10 The foot of a ladder is placed 1.2 m from a vertical wall. If the ladder reaches 7 m up the wall, what is the length of the ladder to the nearest centimetre?



11 A ship sails 18 km due south and then 36 km due west. How far is the ship from its starting point correct to 1 decimal place?



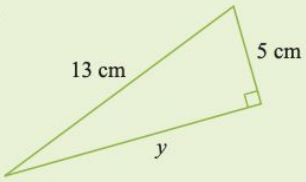
12 A gate is 2.3 m wide with a height of 1.4 m. Calculate the length of the diagonal of the gate correct to 1 decimal place.



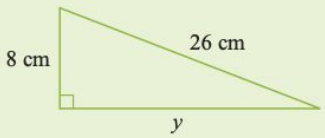
Finding a shorter side

Calculate the value of the pronumeral y that marks one of the shorter sides to the level of accuracy stated.

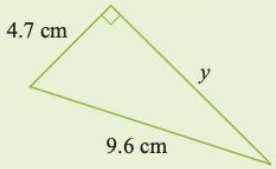
a



b surd form



c correct to 1 decimal place



a $a^2 = c^2 - b^2$
$y^2 = 13^2 - 5^2$
$= 169 - 25$
$= 144$
$\therefore y = \sqrt{144}$
$= 12$ cm

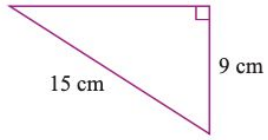
b $a^2 = c^2 - b^2$
$y^2 = 26^2 - 8^2$
$= 676 - 64$
$= 612$
$\therefore y = \sqrt{612}$ cm (surd form)

c $a^2 = c^2 - b^2$
$y^2 = 9.6^2 - 4.7^2$
$= 92.16 - 22.09$
$= 70.07$
$\therefore y = \sqrt{70.07}$
$= 8.4$ cm (1 decimal place)

Exercise 10D

1 Find the value of the pronumeral in each triangle. All answers are integers.

a



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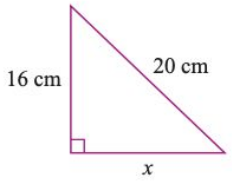

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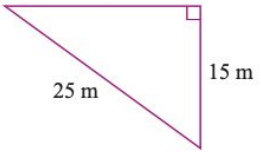

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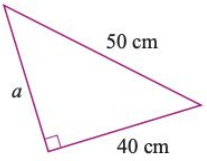

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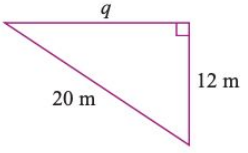

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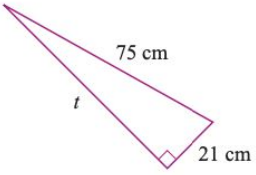

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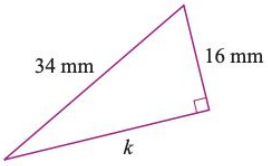

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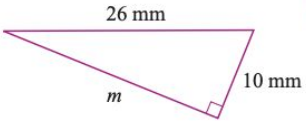

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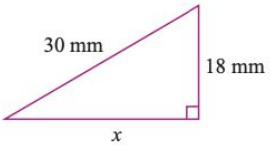
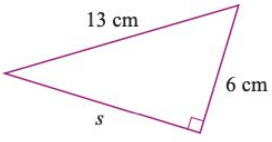


2 Find the length of the unknown short side giving your answer as a surd ($\sqrt{\ }$).

a



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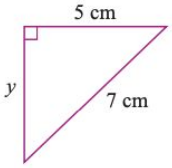

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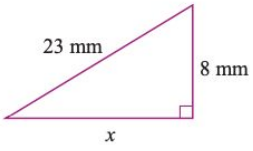

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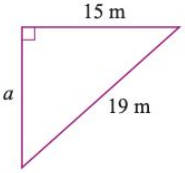

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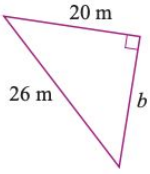

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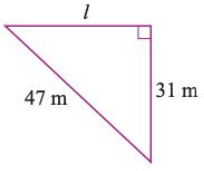

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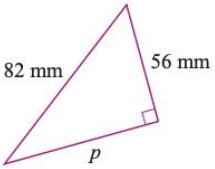

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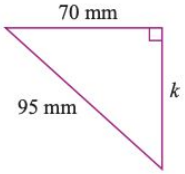

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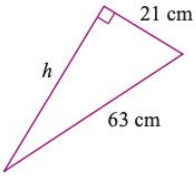
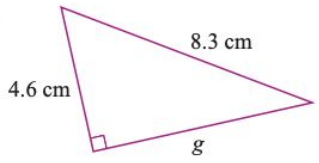


3 Find the length of the unknown short side correct to 1 decimal place.

a



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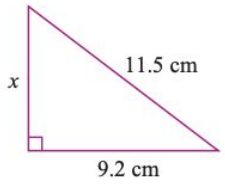

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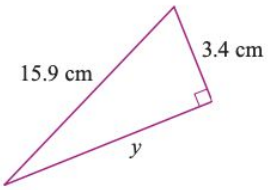

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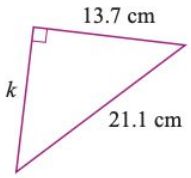

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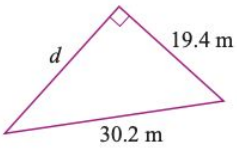

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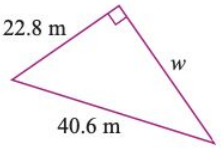
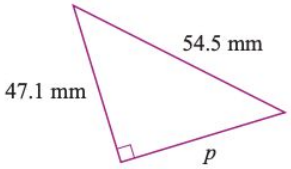


g



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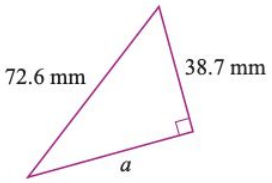

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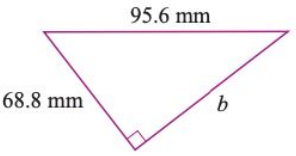
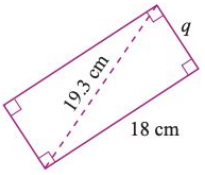
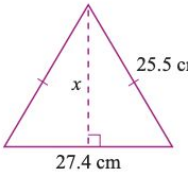


4 Find the value of each pronumeral correct to 2 decimal places.

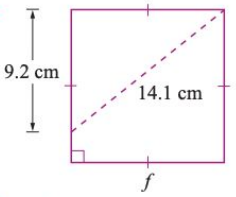
a



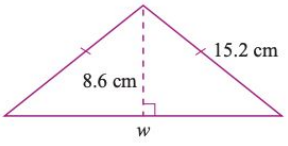
b



c



d



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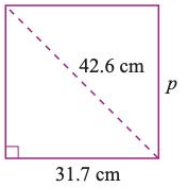

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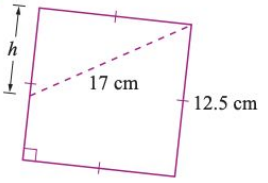

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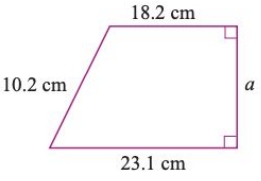
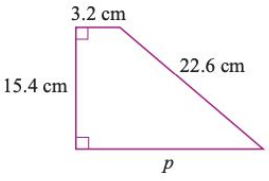


h



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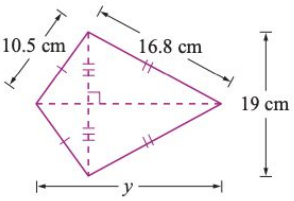
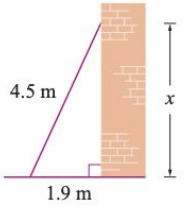
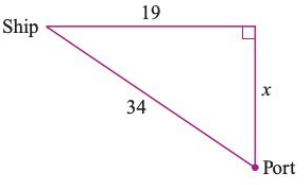


5 A ladder 4.5 m in length is placed 1.9 m from the base of a vertical wall. How far does the ladder reach up the wall to the nearest centimetre?



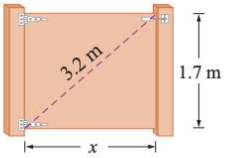
6 The diagram shows that a ship sails 34 nautical miles from its port. It then sails 19 nautical miles due east, so that it is directly north of the port. How far is the ship from the port?



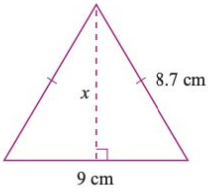
7 A gate has a height of 1.7 m and a diagonal of 3.2 m.

a Find the width of the gate to the nearest centimetre.

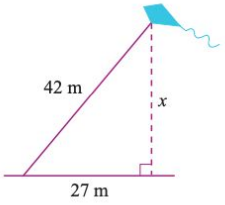
b Calculate the area of the piece of wood used to make the gate.



8 For this triangle, use the dimensions given to find the length of the altitude of the triangle from the apex to the base to the nearest millimetre.



9 A kite is flying with 42 m of string which is anchored to the ground. If the horizontal distance from where the string is anchored is 27 m, find the height of the kite above the ground to the nearest centimetre.



E Problem solving using Pythagoras' theorem

- Draw a neat, clear diagram of the situation.
- Mark on the diagram known lengths and right angles.
- Use a symbol, such as x, to represent the unknown length.
- Decide whether you are finding the hypotenuse or one of the short sides.
- Write down the Pythagorean theorem for the given situation.
- Write your answer in sentence form (where necessary).

Exercise 10E

Give your answers to 2 decimal places as necessary.

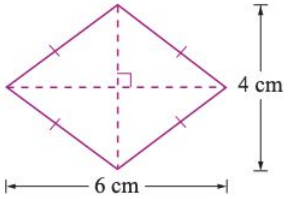
1 Find the length of a diagonal of a 12 cm by 12 cm square.

2 Find the length of a diagonal of a 7 cm by 11 cm rectangle.

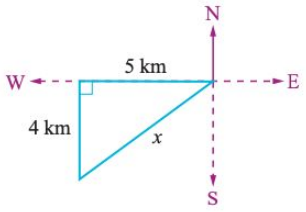
3 What is the longest length of iron rod that can be placed on the floor of a 4 m by 5 m garden shed?

4 A gate has height 1.2 m and diagonal 2.3 m. How wide is the gate?

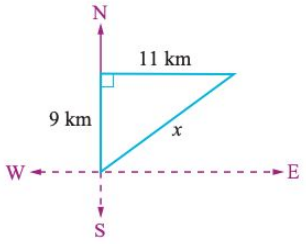
5 A rhombus has diagonals of length 4 cm and 6 cm. Find the length of its sides.



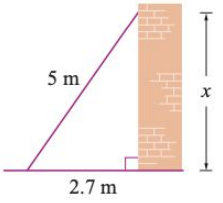
6 A ship sails 5 km due west and then 4 km due south. How far is the ship from its starting point?



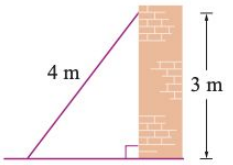
7 A ship sails 9 km north then 11 km east. How far is the ship from its starting point?



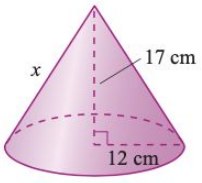
8 A ladder 5 m long is placed against a wall. It is 2.7 m from the wall. How far up the wall does the ladder reach?



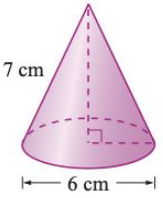
9 A ladder is 4 m long and reaches 3 m up the wall. How far is the foot of the ladder from the base of the wall?



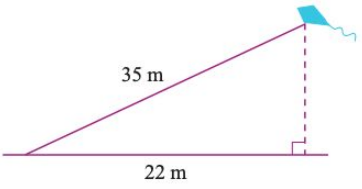
10 A cone has height 17 cm and radius 12 cm. Calculate the slant height.



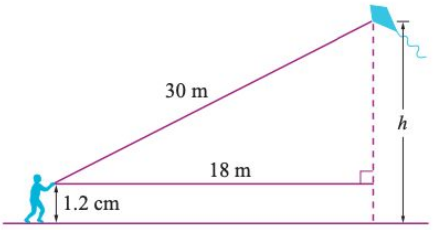
11 A cone has slant height of 7 cm and the diameter of its base is 6 cm. Find the height of the cone given that the cone is symmetrical.



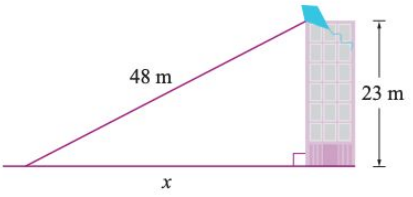
12 A kite is flying with 35 m of string. The string is anchored to the ground. If the horizontal distance from where the string is anchored is 22 m, find the height of the kite above the ground.



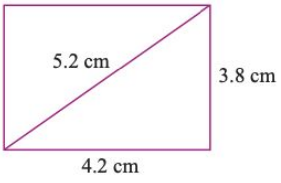
13 Oliver holds the end of the string of a kite 1.2 m above the ground. The string is 30 m long and the horizontal distance to the kite is 18 m. Find the height of the kite above the ground.



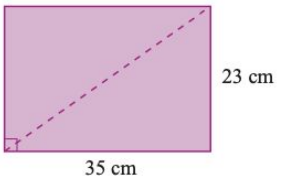
14 A kite is flying with 48 m of string let out. At this time it is level with the top of a 23 m tall building. What is the horizontal distance from the kite to the end of the string?



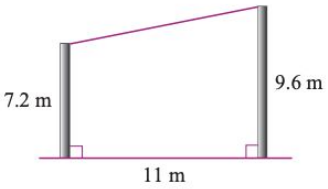
15 Korabita measures out an area of ground to be concreted as shown in the diagram. To check the floor is rectangular he measures the diagonal to be 5.2 m. Is the area measured a rectangle? Explain your answer.



16 The size of a computer screen size is the measure of the diagonal rounded to the nearest centimetre. What size would be quoted for the computer screen shown in the diagram?

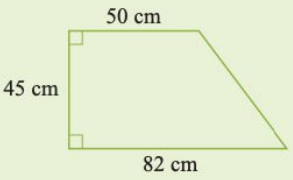


17 Two posts are 7.2 m tall and 9.6 m tall and 11 m apart on level ground. Calculate the length of string required to stretch from the top of one post to the top of the other.



EXAMPLE 1

Find the perimeter of this plane figure to the nearest centimetre.

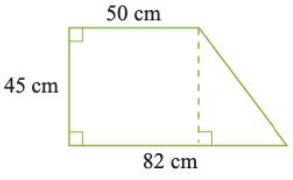


Draw a perpendicular line to make a right-angled triangle.
The triangle has height 45 cm and length $82 - 50 = 32$ cm.
Use Pythagoras' theorem to find the length of the hypotenuse.

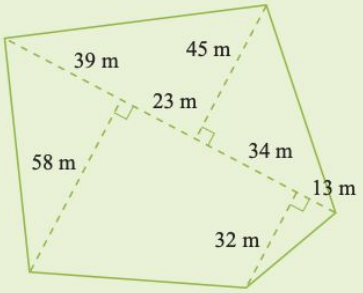
$c^2 = 45^2 + 32^2 = 3049$

$c = \sqrt{3049} = 55.2$

Perimeter $= 82 + 45 + 50 + 55.2 = 232.2 = 232$ cm

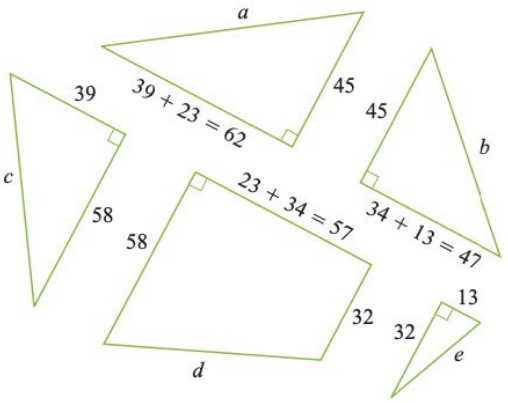


A surveyor makes the following measurements of a field. By using Pythagoras' theorem to find the missing side lengths, calculate the perimeter.



Split the figure into a number of triangles and a trapezium and write the dimensions on each known side. Write a letter on each side that needs to be calculated.

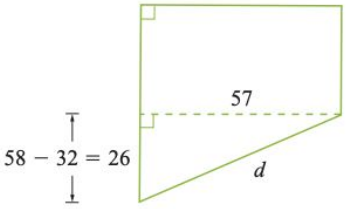
$a^2 = 45^2 + 62^2$
$= 5869$
$\therefore a = \sqrt{5869} = 76.6$
$b^2 = 45^2 + 47^2$
$= 4234$
$\therefore b = \sqrt{4234} = 65.1$
$c^2 = 39^2 + 58^2$
$= 4885$
$\therefore c = \sqrt{4885} = 69.9$
$e^2 = 32^2 + 13^2$
$= 1193$
$\therefore e = \sqrt{1193} = 34.5$



EXAMPLE 2 CONTINUED

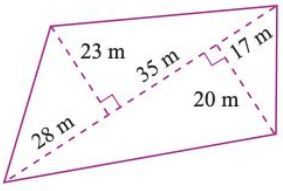
Calculate d using the technique from the Example 1.

$d^2 = 57^2 + 26^2 = 3925$
$\therefore d = \sqrt{3925} = 62.6$
Perimeter $= 76.6 + 65.1 + 69.9 + 34.5 + 62.6$
$= 308.7$ m
≈ 309 m

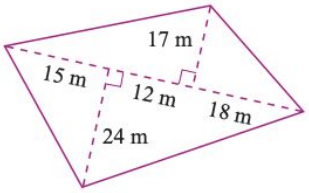


19 A surveyor makes the following measurements of a field. Use Pythagoras' theorem to find the missing side lengths and calculate the perimeter.

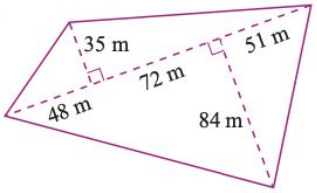
a



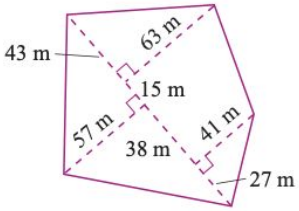
b



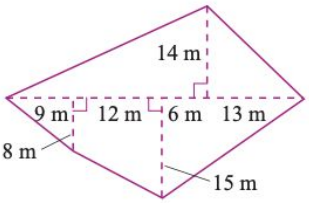
c



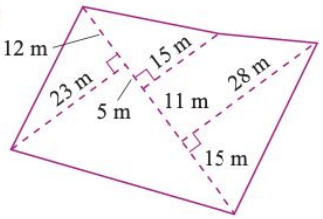
d



e



f

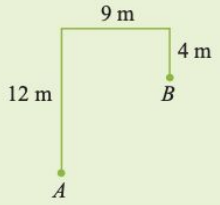


Extension

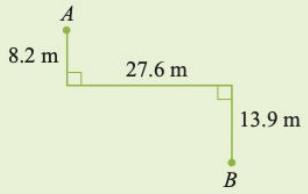
EXAMPLE 3

Find the distance AB correct to 2 decimal places.

a

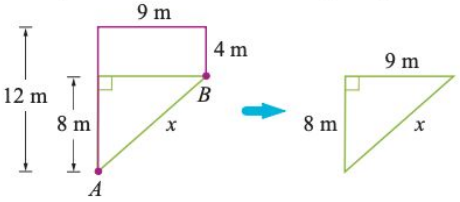


b



Joint the points A and B to form a right-angled triangle.

a



$a^2 + b^2 = c^2$

$9^2 + 8^2 = x^2$

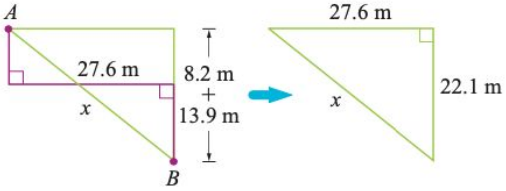
$81 + 64 = x^2$

$x^2 = 145$

$\therefore x = \sqrt{145} = 12.04$

AB is 12.04 m (2 decimal places)

b



$a^2 + b^2 = c^2$

$22.1^2 + 27.6^2 = x^2$

$488.41 + 761.76 = x^2$

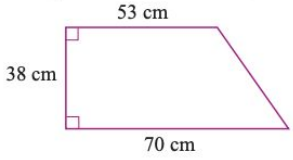
$x^2 = 1250.17$

$\therefore x = \sqrt{1250.17} = 35.36$

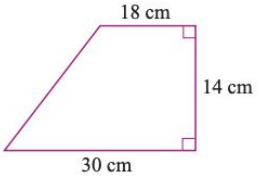
AB is 35.36 m (2 decimal places)

18 Find the perimeters of these figures correct to the nearest centimetre.

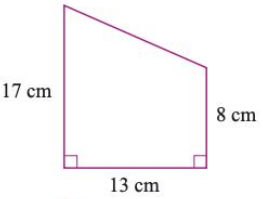
a



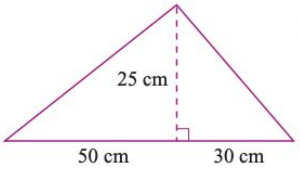
b



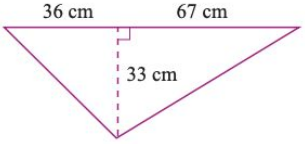
c



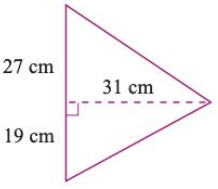
d



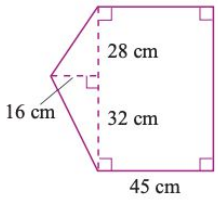
e



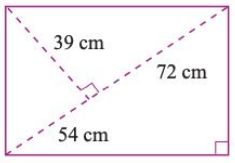
f



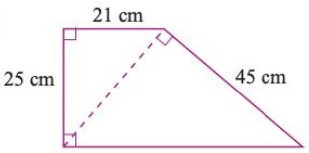
g



h

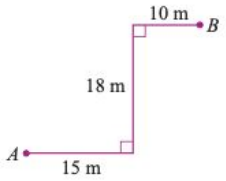


i

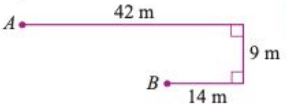


20 Find the distance AB correct to 2 decimal places.

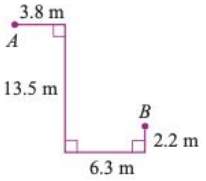
a



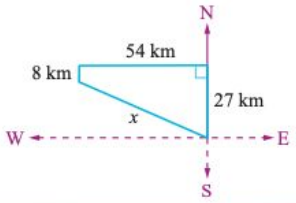
b



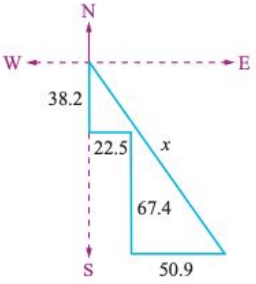
c



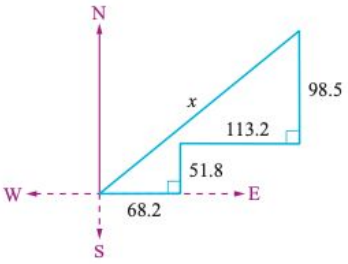
21 A cyclist rides 27 km north, then turns directly west and cycles 54 km, and finally turns south and rides a further 8 km. Calculate the cyclist's distance from his starting point, giving the answer to the nearest metre.



22 A ship sails 38.2 km due south then turns directly east and sails a further 22.5 km. From this point it is decided that the ship is to sail a further 67.4 km due south and then finally sail directly east for a further 50.9 km. Calculate the ship's distance from its original starting point correct to 1 decimal place.



23 A ship sails 68.2 km due east then turns directly north and sails a further 51.8 km. From this point the ship sails a further 113.2 km east and then turns directly north and sails 98.5 km. Calculate the ship's distance from its original starting point correct to 1 decimal place.



Check your answers

1 **a** 9 **b** 16 **c** 100 **d** 64
e 121 **f** 289 **g** 225 **h** 484
i 0.36 **j** 0.25 **k** 3.24 **l** 5.29
m 24.01 **n** 27.04 **o** 46.6489 **p** 91.0116

2 **a** 5 **b** 7 **c** 6 **d** 12
e 13 **f** 20 **g** 25 **h** 33
i 0.2 **j** 0.9 **k** 1.1 **l** 2.1
m 3.7 **n** 5.4 **o** 15.4 **p** 20.02

3 **a** **i** 4.2 **ii** 2.6 **iii** 4.8 **iv** 9.1
b **i** 14.66 **ii** 19.65 **iii** 20.88 **iv** 26.85
c **i** 0.837 **ii** 1.378 **iii** 1.688 **iv** 2.458
d **i** 3.5958 **ii** 2.8394 **iii** 12.5060 **iv** 19.6898

4 **a** $\sqrt{5} = 2.236\,067\,977$
$\sqrt{6} = 2.449\,489\,743$
$\sqrt{7} = 2.645\,751\,311$
b No **c** No, as $\sqrt{4} = 2$.

5 **a** 26 cm **b** 5 cm **c** 10 cm
d 150 mm **e** 45 cm **f** 25 cm
g 20 mm **h** 30 cm **i** 50 m

6 **a** $\sqrt{185}$ mm **b** $\sqrt{394}$ cm **c** $\sqrt{1130}$ cm
d $\sqrt{90}$ mm **e** $\sqrt{80}$ cm **f** $\sqrt{520}$ mm
g $\sqrt{74}$ cm **h** $\sqrt{637}$ m **i** $\sqrt{1753}$ m

7 **a** 5.0 cm **b** 6.4 km **c** 10.2 cm
d 7.4 cm **e** 16.5 cm **f** 12.8 cm
g 19.0 cm **h** 14.2 cm **i** 27.8 cm

8 **a** 4.243 cm **b** 1.414 cm **c** 7.071 cm

9 **a** 13.9 cm **b** 12.7 cm **c** 26.9 cm
d 18.5 cm **e** 13.4 cm **f** 27.2 cm

10 7.10 m **11** 40.2 km
12 2.7 m **13** 18.6 km

Exercise 10D

1 **a** 12 cm **b** 12 cm **c** 20 m
d 30 cm **e** 16 m **f** 72 cm
g 30 mm **h** 24 mm **i** 24 mm

2 **a** $\sqrt{133}$ cm **b** $\sqrt{24}$ cm **c** $\sqrt{465}$ mm
d $\sqrt{136}$ m **e** $\sqrt{276}$ m **f** $\sqrt{1248}$ m
g $\sqrt{3588}$ mm **h** $\sqrt{4125}$ mm **i** $\sqrt{3528}$ mm

3 **a** 6.9 cm **b** 6.9 cm **c** 15.5 cm
d 16.0 cm **e** 23.1 m **f** 33.6 m
g 27.4 mm **h** 61.4 mm **i** 66.4 mm

4 **a** 6.96 cm **b** 21.51 cm **c** 10.69 cm
d 25.07 cm **e** 28.46 cm **f** 11.52 cm
g 8.95 cm **h** 19.74 cm **i** 18.33 cm

5 4.1 m **6** 28.2 nautical miles
7 **a** 2.71 m **b** 4.6 m^2
8 7.4 cm **9** 32.17 m

Exercise 10E

1 16.97 cm **2** 13.04 cm
3 6.40 m **4** 1.96 m
5 3.61 cm **6** 6.40 km
7 14.21 km **8** 4.21 m
9 2.65 m **10** 20.81 cm
11 6.32 cm **12** 27.22 m
13 25.2 m **14** 42.13 m
15 No, diagonal should be 5.7 m.
16 42 cm **17** 11.26 m

18 **a** 203 cm **b** 80 cm **c** 54 cm
d 175 cm **e** 227 cm **f** 123 cm
g 218 cm **h** 297 cm **i** 147 cm

19 **a** 185 m **b** 123 m **c** 432 m
d 351 m **e** 100 m **f** 136 m

20 **a** 30.81 m **b** 29.41 m **c** 15.16 m

21 57.245 km **22** 128.6 km
23 235.6 km