Worksheet - Pythagoras' theorem

Year: Year 9 · 20

Show your working.

Question 1

Question 1 – Finding the hypotenuse *(Section A · Skills practice)*

The hypotenuse is the longest side, opposite the right angle. Use $c^2 = a^2 + b^2$ to find it in each right-angled triangle. Give exact answers.

a. Shorter sides 6 cm and 8 cm.
b. Shorter sides 5 cm and 12 cm.
c. Shorter sides 7 cm and 24 cm.
d. Shorter sides 9 cm and 40 cm.

Question 2

Question 2 – Hypotenuse with a decimal answer *(Section A · Skills practice)*

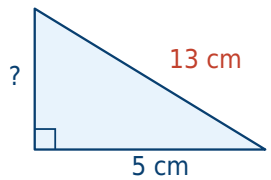
Find the hypotenuse of each triangle. Give your answer to 2 decimal places if it is not exact.

a. Shorter sides 4 cm and 7 cm.
b. Shorter sides 2.5 cm and 6 cm.
c. Shorter sides 10 cm and 10 cm.
d. Shorter sides 3.2 cm and 4.5 cm.

Question 3

Question 3 – Finding a shorter side *(Section A · Skills practice)*

When you know the hypotenuse, subtract: $a^2 = c^2 - b^2$. Find the missing side.



a. Hypotenuse 13 cm, one side 5 cm.
b. Hypotenuse 17 cm, one side 8 cm.
c. Hypotenuse 10 cm, one side 7 cm. Give 2 decimal places.
d. Hypotenuse 9.5 cm, one side 6 cm. Give 2 decimal places.

Question 4

Question 4 – Is it right-angled? *(Section A · Skills practice)*

The converse of Pythagoras' theorem says that if $a^2 + b^2 = c^2$ for the three sides of a triangle, it has a right angle. Check each triangle.

a. 5 cm, 12 cm, 13 cm
b. 7 cm, 8 cm, 11 cm
c. 9 cm, 12 cm, 15 cm
d. 6 cm, 7 cm, 9 cm

Question 5

Question 5 – Pythagorean triples *(Section A · Skills practice)*

A Pythagorean triple is a set of three whole numbers that fit $a^2 + b^2 = c^2$. Multiples of a triple are also triples, for example $3, 4, 5$ gives $6, 8, 10$.

a. Write the triple that is 4 times $3, 4, 5$.
b. Find the missing number in $8, 15, ?$ (the hypotenuse).
c. Find the missing number in $?, 24, 25$.
d. Show that $20, 21, 29$ is a triple.

Question 6

Question 6 – Distance between two points *(Section A · Skills practice)*

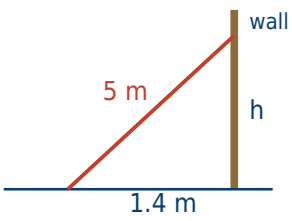
To find the distance between two points on a grid, make a right-angled triangle with the horizontal and vertical differences as its shorter sides.

a. $(1, 2)$ and $(7, 10)$
b. $(-2, 3)$ and $(3, -9)$
c. $(0, 0)$ and $(5, 5)$ (to 2 dp)
d. $(-4, -1)$ and $(4, 5)$

Question 7

Question 7 – The ladder and the wall *(Section B · Real-life practice)*

A decorator leans a 5 m ladder against a vertical wall. The foot of the ladder is 1.4 m from the wall on level ground.



a. How high up the wall does the ladder reach?
b. The decorator needs to reach a window sill 4.2 m high. How far from the wall must the foot be? Give your answer to 2 decimal places.
c. Safety advice says the foot should be one metre away for every four metres of height. Is the foot in part (a) safely placed? Explain.
d. What is the longest ladder that could reach 6 m up a wall with its foot 2.5 m from the wall?

Question 8

Question 8 – Football pitch diagonal *(Section B · Real-life practice)*

A football pitch is 100 m long and 64 m wide. A player runs along the diagonal from one corner to the opposite corner.

a. Find the length of the diagonal to the nearest tenth of a metre.
b. The player runs at 6 m per second. Find the time taken, to the nearest second.
c. Another player runs along two sides instead. How much further does she run?
d. The grounds staff mark the pitch edges with white paint. One tin marks 300 m. How many tins are needed for the perimeter?

Question 9

Question 9 – The widescreen television *(Section B · Real-life practice)*

A television screen is 88 cm wide and 50 cm tall. The shop describes screens by the length of their diagonal.

a. Work out the diagonal to the nearest centimetre.
b. Convert this to inches (1 inch = 2.54 cm), to the nearest inch.
c. A cinema screen has the same shape but the width is 11 m. Find its height.
d. Find the diagonal of the cinema screen.

Question 10

Question 10 – The park shortcut *(Section B · Real-life practice)*

Jake lives 300 m east and 400 m north of the park gate. He can walk along the two straight paths or take a shortcut across the grass.

a. Find the length of the shortcut.
b. Jake walks at 1.25 m per second. How long does each route take?
c. How many seconds does the shortcut save?
d. The grass shortcut is 45 m wide along most of its length. A sign says the grass can be walked on if the path is at least 30 m wide. Does the sign allow it?

Question 11

Question 11 – Pitching the tent *(Section B · Real-life practice)*

A ridge tent has a vertical pole 1.8 m tall in the middle of each end. The floor is 2.4 m wide, so each sloping side starts 1.2 m from the pole. The tent is 3 m long.

a. Find the length of each sloping side of the end triangle.
b. Find the area of the canvas on both sloping sides (ignore the ends).
c. The canvas costs £6.50 per square metre. Find the cost, to the nearest pound.
d. How tall must the pole be for a sloping side of exactly 2.5 m?

Question 12

Question 12 – A wheelchair ramp *(Section B · Real-life practice)*

A ramp is built to climb 0.8 m, with a horizontal length of 6 m.

a. Find the length of the ramp surface to 2 decimal places.
b. The non-slip surface costs £18 per metre of ramp length. Find the cost.
c. The ramp is 1.2 m wide. Find the area of the ramp surface.
d. Building rules say the ramp must not be steeper than 1 in 12 (rise 1 for every 12 along). Does this ramp meet this rule?

Question 13

Question 13 – The sailing boat *(Section B · Real-life practice)*

A sailing boat leaves the harbour and sails 8 km east, then 15 km south.

a. How far is the boat from the harbour in a straight line?
b. The boat sails back along the straight line at 6 km per hour. How long does the return take?
c. Express the time in hours and minutes.
d. The harbour master says the boat should be within 20 km of the harbour. Is it?

Question 14

Question 14 – The delivery drone *(Section B · Real-life practice)*

A delivery drone flies from the roof of a warehouse straight to a customer's garden. The garden is 96 m away horizontally and the drone must climb 40 m.

a. Find the length of the flight path.
b. The drone's battery allows 120 m. Is the flight possible?
c. The drone travels at 10 m per second. How long does the flight take?
d. The same drone has to deliver to a garden 72 m across and 30 m up. Which flight is shorter?

Question 15

Question 15 – Triangle fact file *(Section C · Problem solving)*

The table shows four right-angled triangles. Find the missing lengths, all in centimetres.

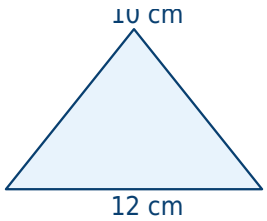
Triangle	Side a	Side b	Hypotenuse c
A	9	12	?
B	?	24	26
C	8	?	17
D	6	6	?

a. Complete the table. Give answers to 1 decimal place if not exact.
b. Which triangles are isosceles?
c. Find the perimeter of triangle A and triangle D.
d. A fifth triangle has sides 10, 10.5 and 14.5. Is it right-angled?

Question 16

Question 16 – Isosceles triangle area *(Section C · Problem solving)*

An isosceles triangle has a base of 12 cm and two equal sides of 10 cm. A line is drawn from the top to the middle of the base.



a. Explain why the height splits the base into two parts of 6 cm.
b. Find the height of the triangle.
c. Find the area of the triangle.
d. Find the perimeter.
e. Find the area of an equilateral triangle with side 10 cm, to 1 decimal place.

Question 17

Question 17 – Triangle on a map *(Section C · Problem solving)*

Three villages $A(2, 1)$, $B(8, 9)$ and $C(14, 1)$ are plotted on a map where each unit is 1 km.

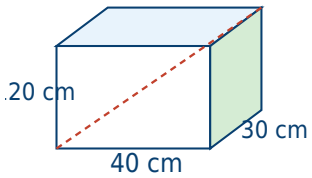
a. Find the distance AB.
b. Find the distance BC and AC.
c. What type of triangle is ABC?

d. Find the perimeter and the area of the triangle.
e. A bus costs £0.45 per kilometre. Find the cost of a journey $A \to B \to C \to A$.

Question 18

Question 18 – The longest rod in the box *(Section C · Problem solving)*

A shipping box is 40 cm wide, 30 cm deep and 120 cm tall. A factory worker wants to know the longest straight rod that fits inside.

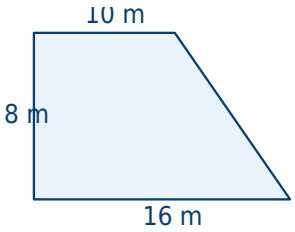


a. Find the diagonal of the base.
b. Use this diagonal and the height to find the length of the diagonal through the box.
c. Can a rod 1.3 m long fit in the box? Explain.
d. Can a 1.4 m rod fit?
e. The box is made of card costing £0.004 per cm^2. Find the cost of the card for the six faces.

Question 19

Question 19 – The trapezium garden *(Section C · Problem solving)*

A garden is a trapezium with two parallel sides of 10 m and 16 m. The distance between the parallel sides is 8 m, and one of the other sides is perpendicular to both.



a. Find the length of the sloping side.
b. Find the perimeter.
c. Fencing costs £9.50 per metre. Find the cost of fencing the whole garden.
d. Find the area of the garden.
e. Turf costs £4.80 per square metre. Find the cost to cover the garden.

Question 20

Question 20 – Challenge: generating triples *(Section D · Challenge)*

Here is a rule that makes Pythagorean triples: take a whole number $n > 1$ and write $n^2 - 1$, $2n$ and $n^2 + 1$.

a. Use $n = 2, 3, 4, 5$ and write the triples.
b. Show that $(n^2 - 1)^2 + (2n)^2 = (n^2 + 1)^2$ by expanding.
c. Use $n = 6$ to write a new triple and check it.
d. Is the triple for $n = 3$ a multiple of a smaller triple? What is it?
e. Find the perimeter and area of the triangle for $n = 4$.