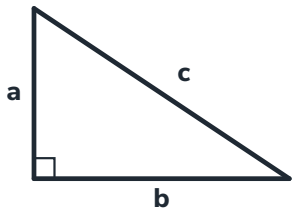
GCSE · MATHS · FOUNDATION & HIGHER (H = HIGHER ONLY)

Pythagoras in 2D & 3D

Learn with Fred
cheat sheet

In a **right-angled triangle**, the square on the **hypotenuse** equals the sum of the squares on the other two sides. Spot the right angle first, then pick **add** or **subtract**.

1 The theorem



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

- **c** is the **hypotenuse**: the longest side, opposite the right angle.
- It only works in **right-angled** triangles.
- The answer is a **length**, so square root at the end.

2 Pythagorean triples

Whole numbers that fit exactly

3, 4, 5	5, 12, 13	8, 15, 17
9 + 16 = 25	25 + 144 = 169	64 + 225 = 289

Multiples work too, like 6, 8, 10. Also 7, 24, 25.

3 Finding the hypotenuse

Square, ADD, square root

Example

Shorter sides 6 cm and 9 cm. Find c.

$c^2 = 6^2 + 9^2$

$c^2 = 36 + 81 = 117$

$c = \sqrt{117} =$ **10.8 cm**

4 Finding a shorter side

Square, SUBTRACT, square root

Example

Hypotenuse 9 cm, one side 5 cm. Find a.

$a^2 = 9^2 - 5^2$

$a^2 = 81 - 25 = 56$

$a = \sqrt{56} =$ **7.48 cm**

The hypotenuse is always the **biggest** number, so it comes first in the subtraction.

5 3D diagonals (Higher)

Use Pythagoras twice

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

a, b, c length, width and height of the cuboid

Cuboid 3 cm × 4 cm × 12 cm

$d^2 = 3^2 + 4^2 + 12^2$

$d^2 = 9 + 16 + 144 = 169$

$d = \sqrt{169} =$ **13 cm**

Same thing in two steps: the base diagonal is $\sqrt{(9 + 16)} = 5$ cm, then $5^2 + 12^2 = 169$.

Watch out

- ✕ Forgetting the **square root** at the end. 117 is c^2, not c.
- ✕ **Adding** when you should **subtract** to find a shorter side. The hypotenuse is never the one you take away.
- ✕ Using it in a triangle with **no right angle**.

Exam tips

- Write $a^2 + b^2 = c^2$ first, then substitute. You can pick up method marks even if the arithmetic slips.
- In 3D, **draw each right-angled triangle separately** and label it.
- Check whether the question wants an exact answer (like $\sqrt{56}$) or a rounded decimal.

Try it: a ladder 6.5 m long leans against a wall with its foot 2.5 m from the wall. How high up the wall does it reach?

Check your answer with Fred: scan the code or go to **learnwithfred.co.uk/cs** to try Learn with Fred free.