MATHEMATICS · GRADES 10-12

The Pythagorean theorem in trigonometry

Difficulty level: Advanced

Mathematics: Grades 10-12

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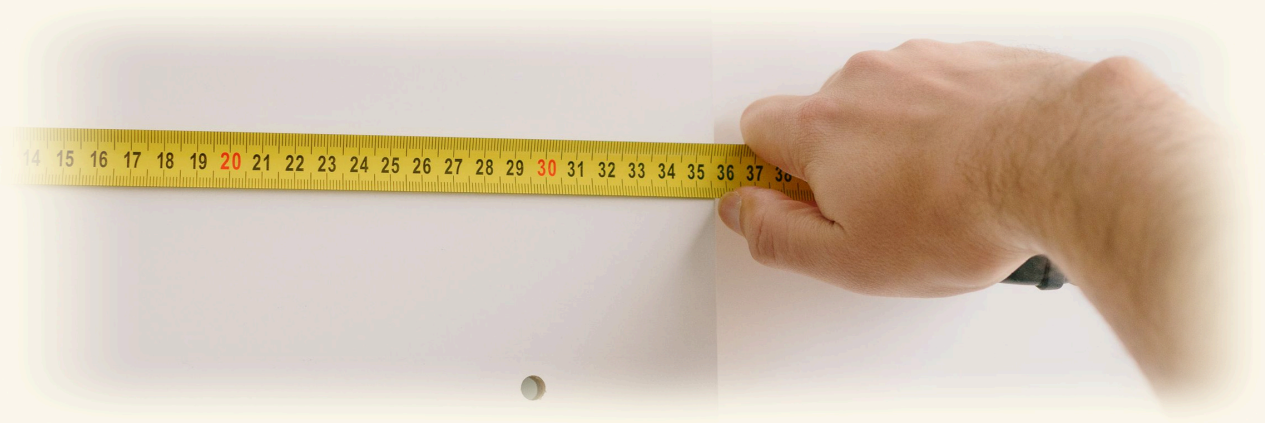
Overview of the concept

This is how you find a missing side of a right triangle, like the length of a brace across a corner or the distance straight across a field, when trigonometry has already given you the other two sides. Once you know two sides, the third follows from the relationship between them, and you do not need another angle at all. That is handy on a building site or a survey, where two sides are measured and the third has to be worked out. It is the same idea builders use to check a corner is square, applied to a triangle you already know two sides of.



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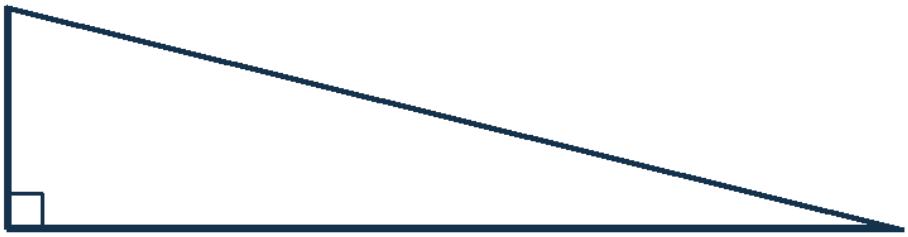
Rule

The Pythagorean theorem: in a right triangle, the square of the hypotenuse equals the sum of the squares of the other two sides, $a^2 + b^2 = c^2$.

If you know any two sides, the third follows from it.



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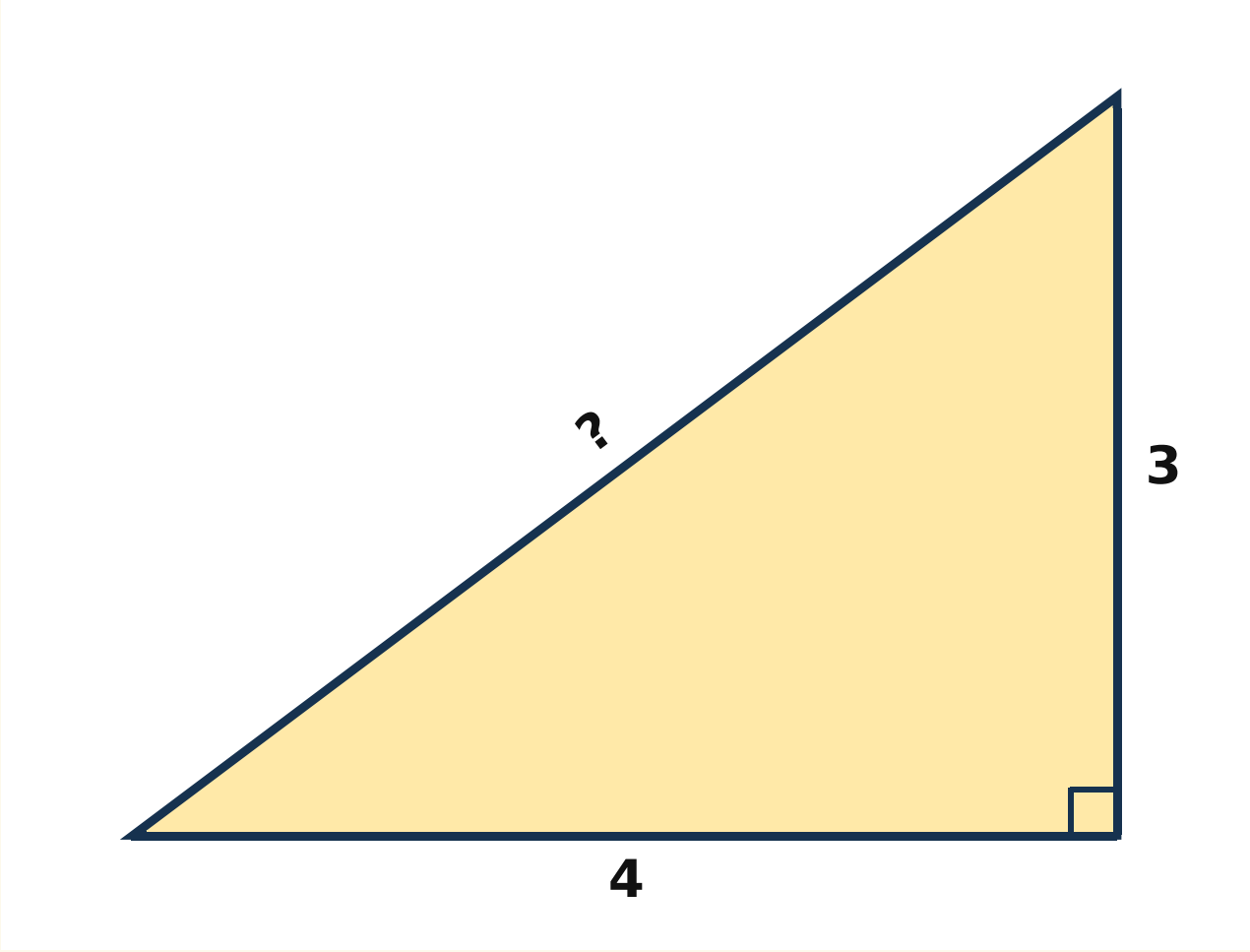
Worked examples

EXAMPLE 1

Q One side is 3 and the other side is 4. Find the hypotenuse.



SOLUTION

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

$c^2 = 3^2 + 4^2 = 9 + 16 = 25$

Take the square root: hypotenuse = 5

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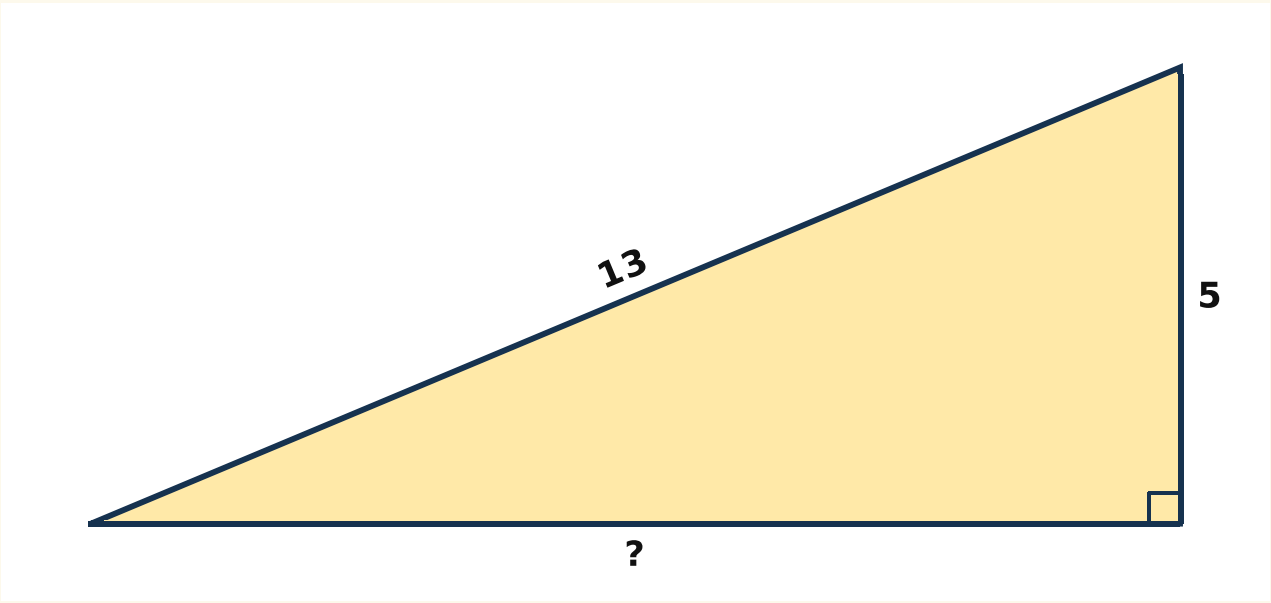
EXAMPLE 2

Q Hypotenuse 13, one side is 5. Find the other side.



SOLUTION

$b^2 = 13^2 - 5^2 = 169 - 25 = 144$

Take the square root: $b = \sqrt{144} = 12$

The other side is 12.

Practice questions

1 A ladder leans 6 m out and 8 m up. Find the ladder's length.

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2 **Can a triangle with sides 5, 12, and 13 be a right triangle?**

A Yes

B No

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3 **A ladder is 10 m long and reaches 6 m out. How high does it reach?**

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4 **Find the diagonal of a rectangle 7 m by 24 m.**

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5 What is the distance between the points $(0, 0)$ and $(9, 12)$?

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6 A square has side 10 m. What is the length of its diagonal, to the nearest whole metre?

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7 A right triangle has legs 20 m and 21 m. What is its perimeter, in metres?

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8 A right triangle has hypotenuse 26 and one leg 10. What is the area of the triangle, in square metres?

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9 A student says the hypotenuse equals the sum of the legs. What does the Pythagorean theorem really say?

A. The square of the hypotenuse equals the sum of the squares of the two sides

B. The hypotenuse equals the sum of the two sides

C. The square of one side equals the sum of the squares of the hypotenuse and the other side

D. The hypotenuse equals the difference of the two sides

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10

If the legs of a right triangle are doubled, what happens to the hypotenuse?

A It doubles

B It stays the same

C It quadruples

D It halves

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ANSWER KEY

1. 10

2. Yes

3. 8

4. 25

5. 15

6. 14

7. 70

8. 120

9. The square of the hypotenuse equals the sum of the squares of the two sides

10. It doubles

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