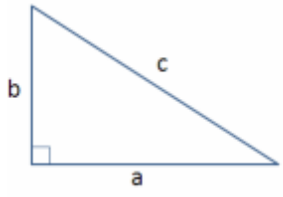
# PYTHAGOREAN THEOREM

The Pythagorean theorem has many applications. One common application of the theorem is in the design and building of structures, in which case it is used wherever a "right", or 90-degree angle is required. The framing of roofs and the squaring of walls and foundations, where it is very important that the corners are square, are just some design and build tasks that rely on this basic principle of mathematics.

## KEY POINTS

**The Pythagorean theorem:**

- describes the relationships among the sides of right-angled triangles
  - right-angled triangles are triangles that contain one angle of exactly 90 degrees
- states that:




In a right-angled triangle, the square of the hypotenuse (longest side of the triangle and usually called c) is equal to the sum of squares of the other two sides (a and b).

It is written as $a^2+b^2=c^2$

- allows workers to find the length of the third side of a right-angled triangle, provided the lengths of two of the sides are known.
- is sometimes called the "3, 4, 5" method because, if a side of a corner is measured as 3 (in., cm, ft., m etc.), and the other side is measured as 4 in the same units (in., cm, ft., m etc.), the hypotenuse will always be 5 (in., cm, ft., m etc.), *if the corner is square*.

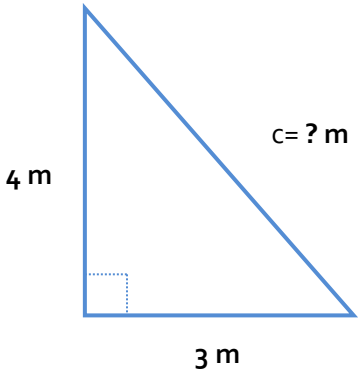
## STEPS

1. Check that you have the measurements for 2 of the sides of the triangle.
2. Label the longest side of the triangle as "c".
3. Label the other 2 sides of the triangle as "a" and "b" (it doesn't matter which side is which).
4. Calculate the squared numbers by multiplying each number by itself, for example: $5^2$ is the same as 5 x 5.
5. Insert the squares of the known numbers into the formula: $a^2+b^2=c^2$.
6. If the unknown number is for side "c", add $a^2 + b^2$ to find the value of $c^2$.
7. If the unknown number is side "a" or "b", subtract the *square* of the known number from the *square* of "c". (See the ladder example below.)
8. Calculate the square root of the missing number using a calculator. (Type in the number then press the square root (√) button.)

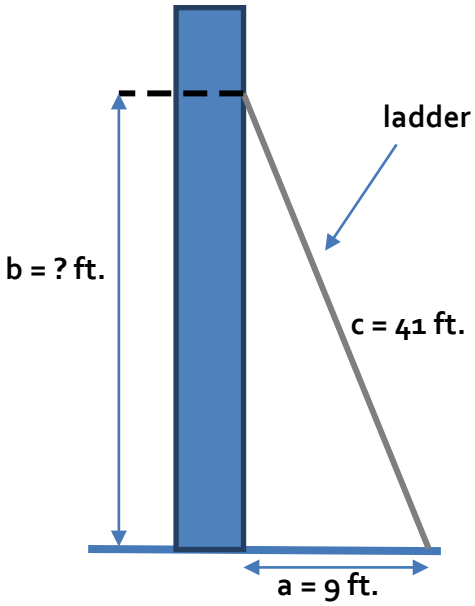
## EXAMPLES

Here is an example of the Pythagorean theorem shown as the "3, 4, 5" method frequently used in construction. Remember, to be able to describe "c" you need to find the square root of $c^2$.

$a^2+b^2=c$
$3^2 + 4^2 = c^2$
$(3x3) + (4x4) = c^2$
$9 + 16 = c^2$
$c^2 = 25$
$\sqrt{25} = 5$
$c = 5$ m




Here is an example of the theorem used in the case of ladder placement.




A 41 ft. ladder is placed against a wall. The bottom of the ladder touches the ground 9 ft. from the base of the wall.

How high above the ground does the ladder touch the building?

$a^2+b^2=c^2$
$9^2 + b^2 = 41^2$
$81 + b^2 = 1681$
$b^2 = 1681 - 81$
$b^2 = 1600$
$b = \sqrt{1600}$
$b = 40$ ft.

The standard rule of safety when positioning a ladder is that for every 4 units of height, to the point where the ladder leans against the wall, the base of the ladder should be 1 unit away from the surface on which the top rests. This ladder is not properly positioned to be considered safe. It touches the wall at 40 ft. The base should be 10 ft. from the wall and it is only 9.

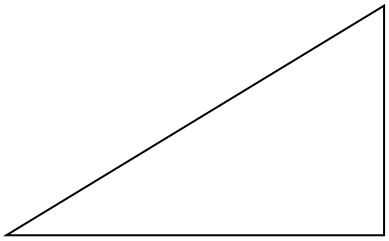
*Think you understand how to use Pythagorean theorem?*

*Try it yourself on the next page.*

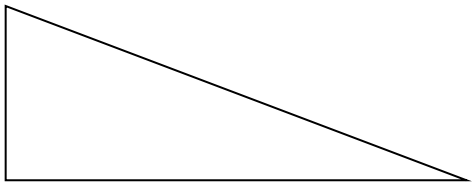
## USING THE SKILL

**In the Workplace:** use the Pythagorean theorem any time you need to measure a shape to determine whether it has a 90° angle and you know the measurements of two of the sides or as part of the process to find the volume of shapes. This could be when you are working on a foundation, framing, planning a roof, building a staircase, or installing pipe to name just a few instances.

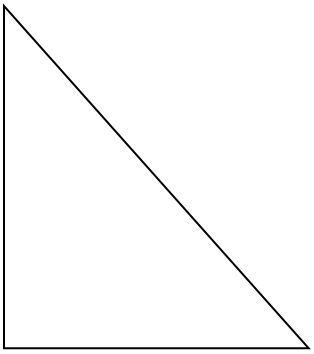
Practice the Pythagorean theorem calculation by completing the questions on the next two pages. Round your answers to the nearest tenth.



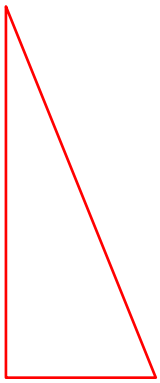
a = 8 cm
b = 5 cm
c= ? cm



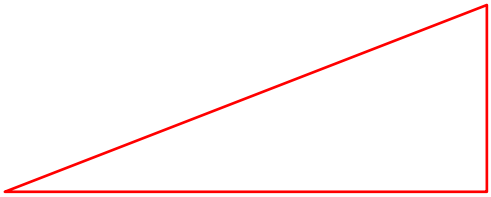
a = ? m
b = 3 m
c= 10 m



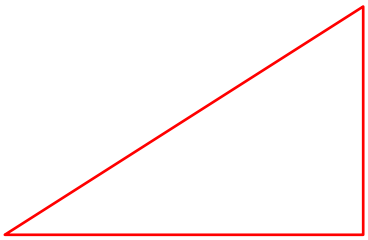
a = 12.5 cm
b = ? cm
c= 18.5 cm



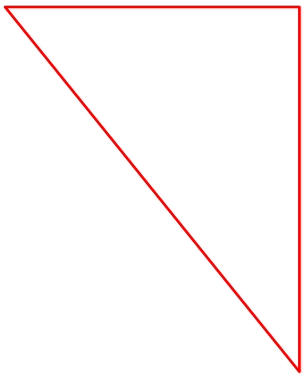
a = 12 ft.
b = 32 ft.
c= ? ft.



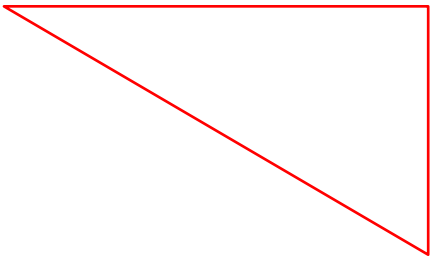
a = 36 mm
b = ? mm
c= 45 mm



a = 15 mm
b = 13mm
c= ? mm



a = 13 m
b = 17 m
c= ? m



a = ? m
b = 1.7 m
c= 3.3 m

## REFLECTION

How do you use the Pythagorean theorem at work? When do you use it?