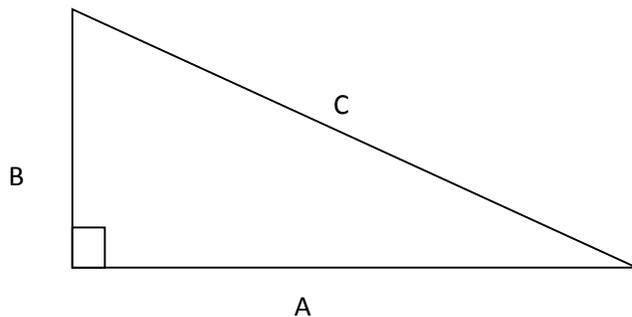


## Using Pythagoras to Calculate the Length of an Unknown Side

The Pythagorean Theorem is a mathematical rule which gives a quick and efficient method of finding the third side in any right-angled triangle. The name looks and sounds scary, but the use is straightforward and quick to learn. Pronounce the word like this [pie-thag-or-ee-an].

If you know the length of any two sides in any triangle that has a  $90^\circ$  angle, shown by a small square in that angle, then you can work out the length of the missing side.

In your carpentry assessment, you will NOT be given this rule, so you need to know it well.



$$\text{Side } A^2 + \text{Side } B^2 = \text{Side } C^2 \text{ and}$$

$$\text{Side } B^2 + \text{Side } A^2 = \text{Side } C^2$$

so

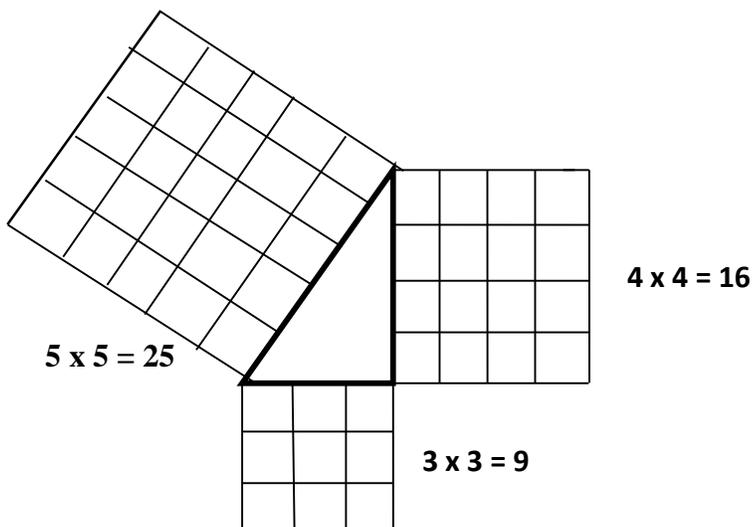
$$\text{Side } C^2 - \text{Side } B^2 = \text{Side } A^2 \text{ and}$$

$$\text{Side } C^2 - \text{Side } A^2 = \text{Side } B^2$$

as there is a  $90^\circ$  angle between sides A and B.

The rule is “The square of the hypotenuse is the sum of the squares of the other two sides.” Can you tell which side is the [hi-pot-a-newss]? It is Side C opposite the right angle.

Here is a diagram to prove that is true:



If you square each side of a right-angled triangle, you can see what happens.

The square of a side with length 5 has 25 squares. It is opposite the right angle so it is the **Hypotenuse**. The side with length 4 has 16 squares; it is sometimes called the **Altitude**. The side with length 3 can be called the **Base** and has 9 squares. Their squares (16 + 9) add up to 25 squares = the same as the number of squares off the hypotenuse.

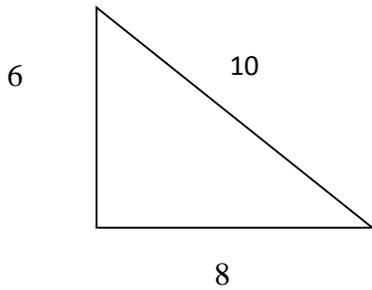
In the construction trades, other terms are often used:

**Hypotenuse** = **travel**

**Altitude** = **rise**

**Base** = **run**

The **3 – 4 – 5 Method** is a popular term for this rule, as it is an easy way to show how the rule works. However, you can see that other numbers can be used instead of 3, 4 and 5.

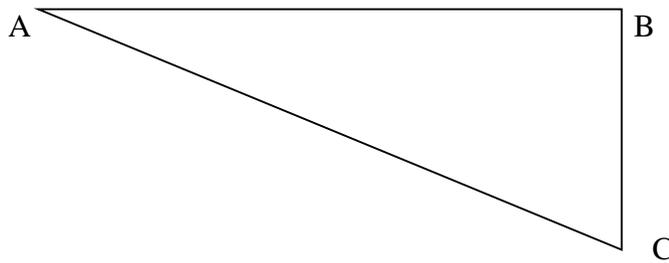


$$6^2 + 8^2 = 10^2 \quad \text{so} \quad 36 + 64 = 100$$

If you don't know the length of the long side opposite the right angle, you can work it out:

$6^2 + 8^2 = 100 = 10^2$  so the length of the third side is the square root of  $100 = 10$ .

Practice Exercise 1



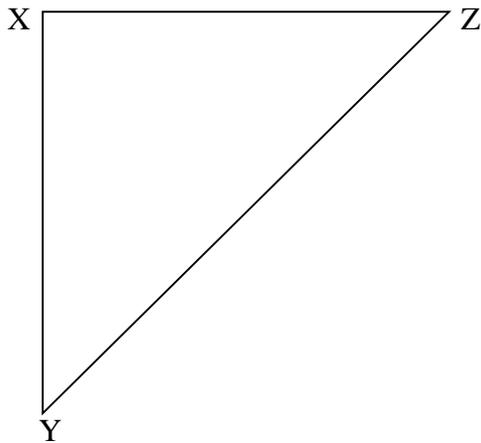
If the line AB is 12 cms long and the line BC is 9 cms long, what is the length of the line AC?

Ans.  $AB^2 + BC^2 = AC^2$

$$12^2 + 9^2 = AC^2$$

$$144 + 81 = 225 \text{ cms}^2 \text{ so } AC = 15 \text{ cms}$$

Practice Exercise 2



If the line XZ is 20 inches long and the line ZY is 25 inches long, how long is line XY?

Ans.  $ZY^2 - XZ^2 = XY^2$

$$25^2 - 20^2 = XY^2$$

$$625 - 400 = 225$$

$$XY = \sqrt{225} = 15 \text{ inches}$$

Ex. 1: Find the length of the missing dimension in each of the right-angled triangles in the following problems, based on the information given: *Hint: Always draw a diagram and label it with the information you are given and mark the unknown part as  $x$  or  $y$  or your favourite letter.*

1. Base / Run = 9 cms and Altitude / Rise = 12 cms. What is the length of the Hypotenuse / Travel?
2. Two shorter sides of a right-angled triangle are 12' and 16'. How long is the other side?
3. With an altitude of 15 metres and a hypotenuse of 25 metres, what is the distance of a gate from a house?
4. The hypotenuse is 15 meters. One side is 10 meters. How long is the third side? (Use a calculator. Don't worry if you do not find an even number.)
5. The base of a single stair is 9", while the hypotenuse from one stair tread to another is 15". What is the height (altitude / rise) of a single stair?
6. A triangular roof system needs to be constructed for a renovation. The length of the **bottom** of the triangle on one side of the roof is 12', while the **rise** of the rafter (the perpendicular dimension) is 5'. How long should the **rafter** (the hypotenuse) be?

*Construction workers use the Pythagorean Theorem in many situations e.g. ensuring square corners in buildings, calculating measurements for stairs, laying out perimeters (outlines) of buildings, working out the length of rafters, etc. = you **must** know how to use it!*

**Answers on the next page**

Answers to Exercise 1:

- 1) 15 cms      (2) 20'      (3) 20'      (4) 11.18 m      (5) 12"      (6) 13'