

# Calculating Diagonals

by Sophia



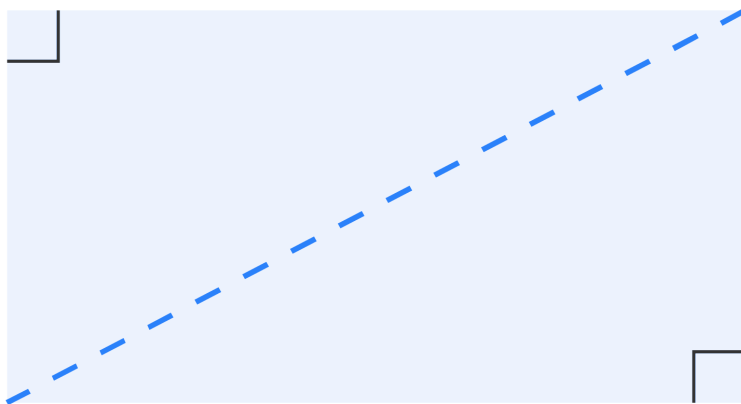
## WHAT'S COVERED

In this lesson, you will learn how to calculate the diagonal length of a rectangle using the Pythagorean Theorem. Specifically, this lesson will cover:

1. [Calculating Diagonals](#)
2. [The Pythagorean Theorem](#)
3. [Applications](#)

## 1. Calculating Diagonals

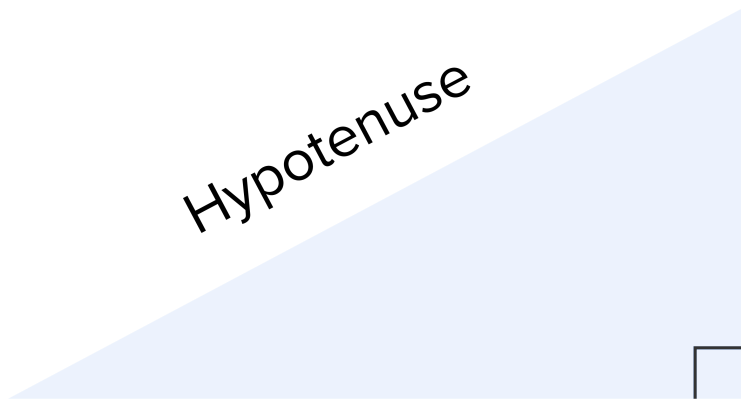
A diagonal connects two non-adjacent vertices in an enclosed shape. Below is an example of a diagonal of a rectangle:



Notice that the diagonal of the rectangle connects two opposite corners. It also creates two congruent triangles. Congruent means of equal measure, so the two triangles are the same size and take up the same amount of

space. We should also point out that the triangles are right triangles because one of their angles is a 90-degree angle (taken from the 90-degree angles of the rectangle).

Let's take a closer look at the rectangle and the two triangles that the diagonal created. The sides of the rectangle correspond to the vertical and horizontal legs of the right triangle. What about the diagonal? We can refer to the diagonal as the hypotenuse of the right triangle. (The hypotenuse is always opposite of the right angle.)



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## 2. The Pythagorean Theorem

To calculate the length of the diagonal, we can use **Pythagorean Theorem** to calculate the length of the hypotenuse. The Pythagorean Theorem uses the side lengths of the other legs of the right triangle in order to find the length of the hypotenuse:



### FORMULA TO KNOW

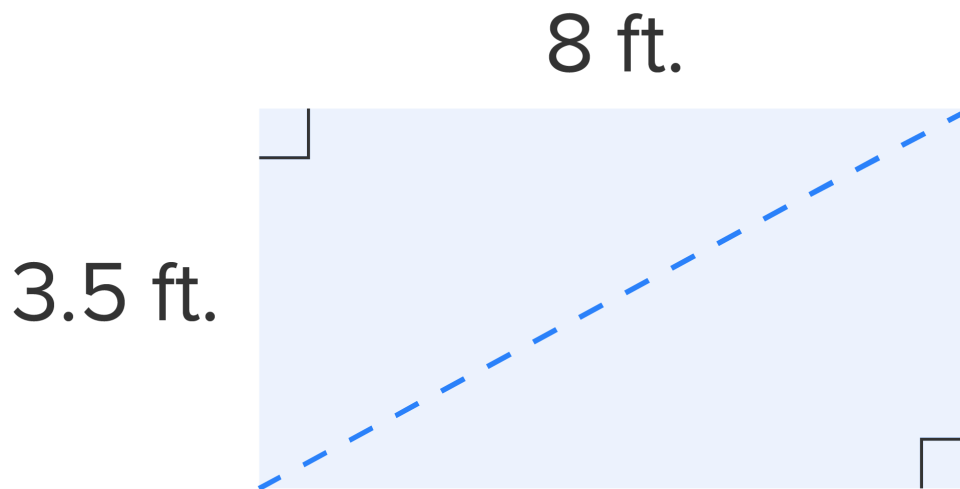
#### Pythagorean Theorem

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

$$c = \sqrt{a^2 + b^2}$$

If we take the sum of the squares of the side lengths, this equals the square of the hypotenuse leg. We'll just need to take the square root of the sum in order to express the length of the hypotenuse.

⇒ **EXAMPLE** Suppose you have the following right triangle with side lengths of 3.5 feet and 8 feet.



We can substitute 3.5 feet and 8 feet into  $a$  and  $b$ , respectively, and apply the Pythagorean Theorem:

$$a^2 + b^2 = c^2 \quad \text{Use the Pythagorean Theorem and substitute the measurements of the leg}$$

$$(3.5 \text{ ft})^2 + (8 \text{ ft})^2 = c^2 \quad \text{Square 3.5 ft and 8 ft and evaluate}$$

$$12.25 \text{ ft}^2 + 64 \text{ ft}^2 = c^2 \quad \text{Add } 12.25 \text{ ft}^2 \text{ and } 64 \text{ ft}^2$$

$$76.25 \text{ ft}^2 = c^2 \quad \text{Apply the square root of both sides}$$

$$\sqrt{76.25 \text{ ft}^2} = \sqrt{c^2} \quad \text{Evaluate}$$

$$8.73 \text{ ft} = c \quad \text{Our Solution, rounded to the tenth place}$$

Another method to solve is to rewrite the Pythagorean Theorem, isolating  $c$  on one side of the equation. Then, we can substitute  $a$  and  $b$  into the equation, and calculate the length of the diagonal. This is shown in the example below:

⇒ **EXAMPLE** Use the same right triangle above, with side lengths of 3.5 feet and 8 feet.

$$a^2 + b^2 = c^2 \quad \text{Start with the Pythagorean Theorem and take the square root of both sides}$$

$$\sqrt{a^2 + b^2} = c \quad \text{Substitute the measurements of the leg}$$

$$\sqrt{(3.5 \text{ ft})^2 + (8 \text{ ft})^2} = c \quad \text{Square 3.5 ft and 8 ft}$$

$$\sqrt{12.25 \text{ ft}^2 + 64 \text{ ft}^2} \quad \text{Add } 12.25 \text{ ft}^2 \text{ and } 64 \text{ ft}^2$$

$$\sqrt{76.25 \text{ ft}^2} = c \quad \text{Take the square root}$$

$$8.73 \text{ ft} = c \quad \text{Our Solution, rounded to the tenth place}$$

### 3. Applications

We can apply the Pythagorean theorem to find the diagonal length for squares and rectangles found in the real world.



#### DID YOU KNOW

Television manufacturers state the screen size of each TV based on the length of its diagonal. If you have a 32-inch television at home, your TV screen measures 32 inches across its diagonal. This same convention is used for screens on computer monitors and smartphones.



#### TRY IT

Rudy measures the height and width of the television screen in his dorm room. The screen is 19.6 inches high and 34.9 inches long.

Which standard size TV does Rudy have?



Using the Pythagorean theorem, you will find that Rudy has a standard 40-inch television. The calculations are as follows:

$$a^2 + b^2 = c^2 \quad \text{The Pythagorean theorem}$$

$$\sqrt{(19.6 \text{ in})^2 + (34.9 \text{ in})^2} = c \quad \text{Substitute 19.6 for } a \text{ and 34.9 for } b.$$

$$\sqrt{1,602.17 \text{ in}^2} = c \quad \text{Square 19.6 and 34.9, then add together.}$$

$$40.0 \text{ in} = c \quad \text{Calculate the square root and round to the tenths place}$$



#### SUMMARY

The diagonal of a rectangle or square corresponds to the hypotenuse of a right triangle. To **calculate the diagonal**, we can use the **Pythagorean Theorem**, which we use for right triangles, to calculate the diagonal of a rectangle or square. There are two different forms of the Pythagorean Theorem.

Remember that  $c$  in our formula has to be the hypotenuse, but  $a$  and  $b$  can be either of the legs of our right triangle.

Source: ADAPTED FROM "BEGINNING AND INTERMEDIATE ALGEBRA" BY TYLER WALLACE, AN OPEN SOURCE TEXTBOOK AVAILABLE AT [www.wallace.ccfaculty.org/book/book.html](http://www.wallace.ccfaculty.org/book/book.html). License: Creative Commons Attribution 3.0 Unported License



**Pythagorean Theorem**

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

$$c = \sqrt{a^2 + b^2}$$