

Lesson 29

WORDS TO KNOW

Pythagorean theorem

USE THE PYTHAGOREAN THEOREM
TO SOLVE RIGHT TRIANGLES NY-8.G.7

INTRODUCTION

Real-World Connection

Sayid rides his bike from school to a bookstore and then from the bookstore to a computer shop. The bookstore is on a straight path 4 miles east of the school. The computer shop is on a straight path 3 miles north of the bookstore. How can Sayid use the Pythagorean theorem to find the straight-path distance directly from school to the computer shop? Let's practice the skills in the **Guided Instruction** and **Independent Practice** and see how long the path is at the end of the lesson!



What I Am Going to Learn

- How to use the Pythagorean theorem to solve for unknown side lengths in real-world problems

What I May Already Know

- I know how to evaluate expressions for specific values of the variables.
- I know how to solve equations with one variable.

Vocabulary in Action

The **Pythagorean theorem** is about the relationship of the sides in a right triangle.

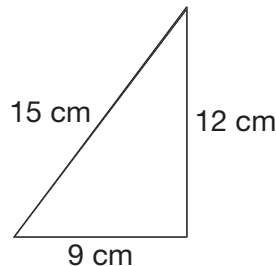
- If a and b are the lengths of the triangle legs, and c is the length of the hypotenuse, then $a^2 + b^2 = c^2$.
- If two side lengths are known, the third side length can be found:
 $a^2 = c^2 - b^2$ $b^2 = c^2 - a^2$ $c^2 = a^2 + b^2$

TURN AND TALK

If the sum of the square of the legs did not add to the square of the hypotenuse, what would that tell you about the triangle?

EXAMPLE

The lengths of the sides of a triangle are 9 cm, 12 cm, and 15 cm. Is the triangle a right triangle?



If the triangle is a right triangle, the Pythagorean theorem will confirm it.

Step One Substitute the side lengths into the formula.

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

$$9^2 + 12^2 = 15^2$$

Step Two Solve the equation.

$$81 + 144 = 225$$

Step Three Check to see if the equation is true.

$$225 = 225$$

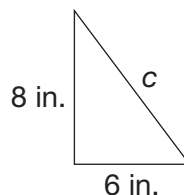
The triangle is a right triangle.

If one side length is unknown, enter the known values into the equation and solve for the missing side length.

EXAMPLE

The lengths of the legs of a right triangle are 8 inches and 6 inches.

What is the length of the hypotenuse?



Step One Substitute the side lengths into the formula.

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

$$8^2 + 6^2 = c^2$$

THINK ABOUT IT

$c = 10$ because $10 \times 10 = 100$, and $c^2 = 100$. 10 is the square root of 100.

Step Two Solve the equation.

$$64 + 36 = c^2$$

$$100 = c^2$$

$$10 = c$$

Step Three What is the length of the hypotenuse?

The hypotenuse is 10 inches long.

GUIDED INSTRUCTION

1. The length of one leg of a right triangle is 12 inches. The hypotenuse is 13 inches. Find the length of the other leg.

Step One Substitute the known values into the equation.

$$b^2 = c^2 - a^2$$

$$b^2 = 13^2 - 12^2$$

Step Two Solve the equation.

$$b^2 = 169 - 144$$

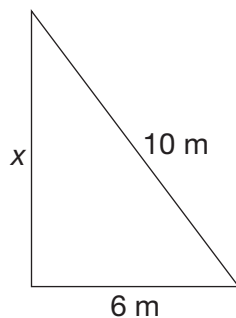
$$b^2 = 25$$

$$b = 5$$

Step Three Find the length of the leg.

The length of the leg is 5 inches.

2. Find the perimeter of the right triangle.



Step One Substitute the known values into the equation.

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

$$x^2 + 6^2 = 10^2$$

TURN AND TALK

If side c had been 11 inches, what would the length of side b be? Would it be a whole number?

Step Two Solve the equation.

$$x^2 + 36 = 100$$

$$x^2 = 100 - 36$$

$$x^2 = 64$$

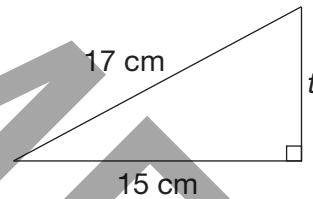
$$x = 8$$

Step Three Add the side lengths to find the perimeter.

$$6 + 8 + 10 = 24$$

The perimeter of the triangle is 24 meters.

3. The right triangle below shows the lengths of two sides.



What is the missing side length in centimeters?

- (A) 2
- (B) 8
- (C) 12
- (D) 32

► TIPS AND HINTS

You can check your answer by substituting it back into the equation. Then make sure both sides of the equation are equal.



Learning Together

Working in a small group, match up in pairs to take an arm wrestling position with right hands clasped, but try to form a right triangle rather than arm wrestling. When forming pairs, consider the different arm lengths. In each pair, remember to keep one arm at a right angle to the table. Take a photo of each right triangle you are able to form as well as each effort that does not work because the hypotenuse is too short, such as shown in the image.



How Am I Doing?

What questions do you have?

How can you tell if a triangle with side lengths of 3, 5, and 6 inches is a right triangle?

How can you find the length of a ramp if you know the height and the horizontal distance of the ramp?

Circle the sign that shows how you are doing with the skill.



I am stuck.



I almost have it.

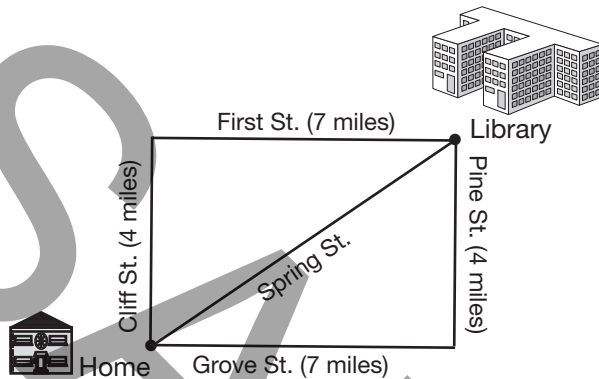


I understand the skill.

INDEPENDENT PRACTICE 1

1

The map below shows an area where Ms. Guzman often walks.



THINK ABOUT IT

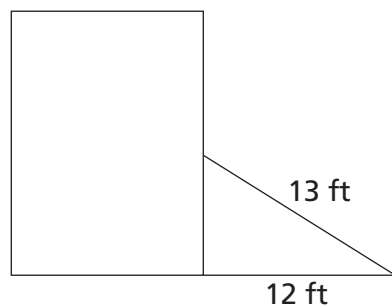
Will a diagonal road always create a more direct route?

Ms. Guzman usually takes Grove Street to Pine Street, or Cliff Street to First Street, to get to the library. Now there is a new road that might be a more direct route. Which is closest, in miles, to the length of Spring Street?

- | | | | |
|---|---|---|----|
| A | 3 | C | 11 |
| B | 8 | D | 65 |

2

The image below shows the layout of Kyra's house and the triangular garden she is planning.



TIPS AND HINTS

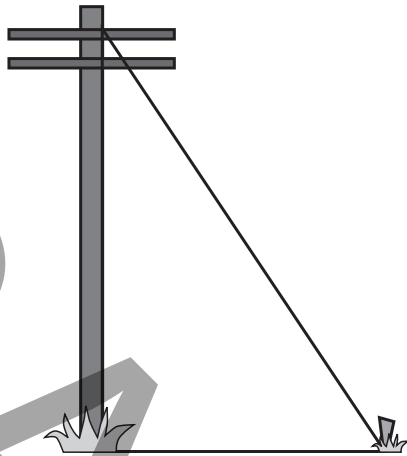
Every right triangle has a hypotenuse, and the hypotenuse is always longer than either of the legs.

Kyra has two lengths of fencing to make her flower garden. She will use the fence to make a triangle. Part of her home will make up the third side of the garden. What length of her home, in feet, will be needed to form the third side of the garden?

- | | | | |
|---|---|---|----|
| A | 5 | C | 14 |
| B | 7 | D | 25 |

3

The diagram below shows a telephone pole outside of Roger's house.



◀ SKETCH IT

Visualize or draw the triangles on grid paper in small to-scale form. If some numbers are not possible, then some choices are eliminated.

The pole is 20 feet high and the cable between the pole and the ground is 25 feet. What is the distance, in feet, between the stake, which is holding the cable in the ground, and the base of the pole?

A 5

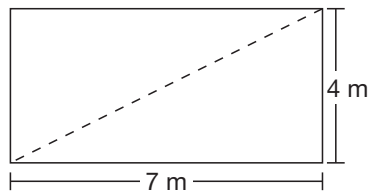
C 30

B 15

D 45

4

A dance teacher separated her studio in half by painting a dashed line across the studio floor as shown below.



◀ THINK ABOUT IT

Why does placing a dashed line from corner to corner automatically create right triangles?

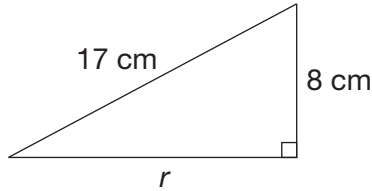
Between which two consecutive integers is the length, in meters, of the dashed line?

The length is between _____ and _____ meters.

Explain your answer.

INDEPENDENT PRACTICE 2

- 1 The right triangle below shows the lengths of two sides.



What is the length, in centimeters, of side r ?

- A 9
B 15
C 25
D 64
- 2 The leg lengths of right triangles are given. Which triangle has a hypotenuse with a length less than 12 units?

- A 4, 3
B 5, 12
C 15, 8
D 16, 12

- 3 Three friends are playing catch. Zoe is in a straight path 12 feet to the west of Alex. Jin is in a straight path 9 feet to the north of Alex. How far apart, in feet, are Jin and Zoe?

- A 3
B 15
C 21
D 225

4

How many units long is the hypotenuse of a right triangle with leg lengths of 3 units and 4 units?

- A 6
- B 5
- C 4
- D 3

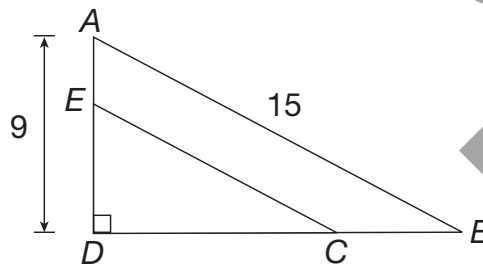
5

Two side lengths of right triangles are given. Which is missing a hypotenuse length greater than 10?

- A 8, 15
- B 7, 6
- C 4, 2
- D 2, 8

6

The figure below shows two right triangles where $ED = (2)(AE)$ and $DC = (2)(CB)$.

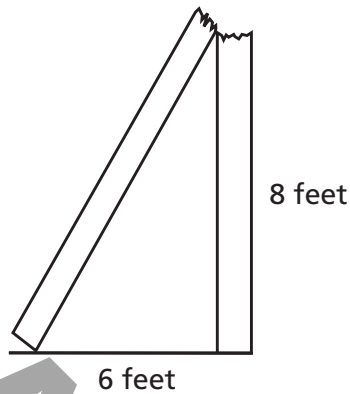


What is the length of DC ?

- A 12
- B 8
- C 6
- D 4

7

A sign broke during a storm. The diagram below shows how it fell.



What was the original height, in feet, of the sign?

- A 10
- B 14
- C 18
- D 24

8

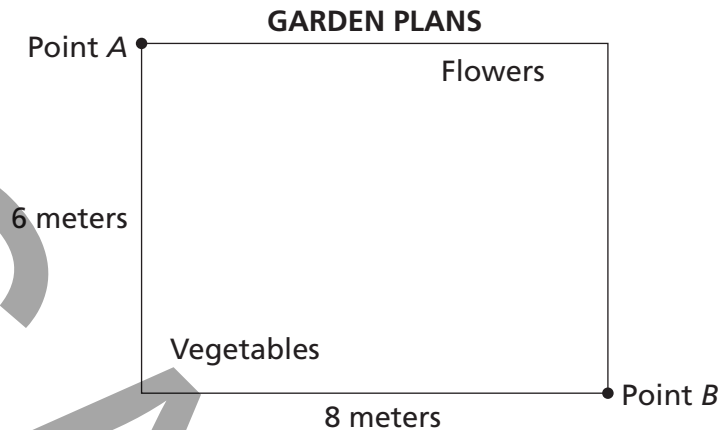
Lisa drew two legs of a right triangle. One leg measured 16 centimeters and the other measured 12 centimeters. She says the hypotenuse length should be 10 centimeters. Is she correct?

Answer _____ yes or no

Explain your answer.

9

Mohammed is planning to start a garden. Below is a diagram of his plans.



He would like to put fencing in his garden to divide it into two areas. One area is for vegetables and one is for flowers. He needs to find the distance from Point A to Point B. How can he use the Pythagorean theorem to find this distance?

Explain your answer.

If Mohammed shortens all sides of his garden by half, what will be the distance between the new Point A and Point B?

Show your work.

Answer _____ meters

Explain your answer.

EXIT TICKET

NY-8.G.7

Now that you have mastered applying the Pythagorean theorem, let's solve the problem in the **Real-World Connection**.

Sayid rides his bike from school to a bookstore, and then from the bookstore to a computer shop. The bookstore is on a straight path 4 miles east of the school. The computer shop is on a straight path 3 miles north of the bookstore. Use the Pythagorean theorem to find the straight-path distance directly from school to the computer shop.

Pythagorean Theorem