



Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Student Exploration: Pythagorean Theorem

**Vocabulary:** converse, hypotenuse, legs (of a rt. triangle), Pythagorean Theorem, right triangle

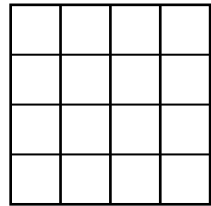
**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

1. The area of a two-dimensional figure is the amount of space inside it.

A. One way to find the area of the large square to the right is to count the square units inside it. What is the area? \_\_\_\_\_

B. What is the length of each side of the square? \_\_\_\_\_

C. How can you use the side length to find the area? \_\_\_\_\_

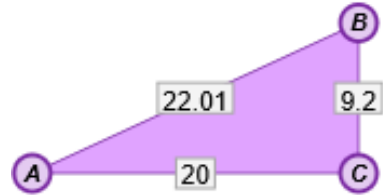


2. In general, what is the area ( $A$ ) of a square with side lengths of  $s$ ? \_\_\_\_\_

### Gizmo Warm-up

In the *Pythagorean Theorem* Gizmo, you can create different triangles and explore the relationships among their side lengths.

1. With **Show values** selected on the **PYTHAGOREAN** tab, drag the vertices to create a variety of right triangles.



A. A **right triangle** has one  $90^\circ$  angle. Are all the triangles you created right? \_\_\_\_\_

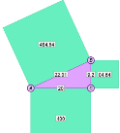
B. Where is the longest side of a right triangle located, relative to the right angle?  
\_\_\_\_\_

2. Select **Show labels**. Drag the vertices again to explore more right triangles.

A. The sides labeled  $a$  and  $b$  are the **legs** of the triangle. Where are the legs located, relative to the right angle? \_\_\_\_\_

B. The side labeled  $c$  is the triangle's **hypotenuse**. Where is the hypotenuse located, relative to the right angle? \_\_\_\_\_



<b>Activity A:</b> <b>Discovering the Pythagorean Theorem</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>Turn on <b>Show values</b> and <b>Show squared side lengths</b>.</li> </ul>	
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1. Be sure the **PYTHAGOREAN** tab is selected.

A. In the Gizmo, create four different right triangles. Fill in the following table for each triangle. (Recall that  $a$  and  $b$  = leg lengths, and  $c$  = hypotenuse length.)

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

B. In a complete sentence, describe the relationship you can see in the table above.

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C. Now write an equation to show how  $a^2$ ,  $b^2$ , and  $c^2$  are related in the right triangles.

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This is the **Pythagorean Theorem**. Test more right triangles to verify that this is always true. (Note: You should have found that, in right triangles,  $a^2 + b^2 = c^2$ .)

2. In the Gizmo, create a right triangle with side lengths 9, 12, and 15. With **Show squared side lengths** and **Show values** still turned on, select **Show squares**.

A. What are the areas of the three squares shown? \_\_\_\_\_

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B. Do those three areas satisfy the Pythagorean Theorem? \_\_\_\_\_

Explain. \_\_\_\_\_

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**(Activity A continued on next page)**

**Activity A (continued from previous page)**

3. If three whole numbers  $a$ ,  $b$ , and  $c$  can be the side lengths of a right triangle (and therefore satisfy  $a^2 + b^2 = c^2$ ), the three numbers are called a *Pythagorean triple*.

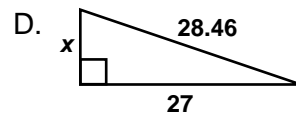
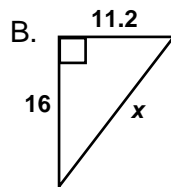
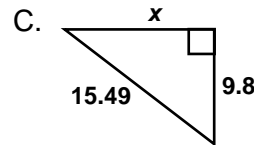
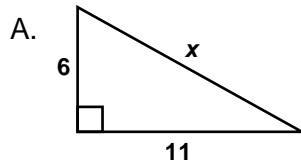
A. Do 8, 10, and 12 form a Pythagorean triple? \_\_\_\_\_ Explain. \_\_\_\_\_

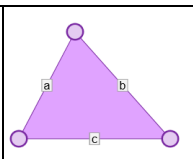
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Check your answer in the Gizmo.

- B. The numbers 7, ?, and 25 form a Pythagorean triple. Find the missing leg length. Show your work in the space to the right. Then check your answer in the Gizmo.

4. Find the value of  $x$  in each right triangle below. Show your work, and round answers to the nearest hundredth. Then check your answers in the Gizmo. (Note: Assume that any missing leg length is an integer.)



<b>Activity B:</b> <b>The converse of the Pythagorean Theorem</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Select the <b>CONVERSE</b> tab.</li> <li>• Select <b>Show values</b> and turn on <b>Show squared side lengths</b>.</li> </ul>	
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1. Drag the vertices to create several triangles. Watch the values under **Show squared side lengths**.

A. Which letter is used to indicate the longest side:  $a$ ,  $b$ , or  $c$ ? \_\_\_\_\_

B. Click on **Show angle measures**. Drag the vertices to build a triangle for which  $a^2 + b^2 = c^2$ . Is your triangle right, acute, or obtuse? \_\_\_\_\_

Experiment with a variety of triangles to check if this is always true.

C. If  $a^2 + b^2 = c^2$ , is it possible to build a triangle that is not a right triangle? \_\_\_\_\_

D. Write an “if-then” statement to describe any triangle for which  $a^2 + b^2 = c^2$ .

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This is the *converse of the Pythagorean Theorem*. (The **converse** is what results from reversing the hypothesis and conclusion of a conditional statement.)

2. Drag the vertices to build a triangle for which  $a^2 + b^2 < c^2$ . Is your triangle right, acute, or obtuse? \_\_\_\_\_ Create several triangles verify your answer.

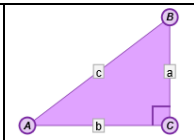
3. Drag the vertices to build a triangle for which  $a^2 + b^2 > c^2$ . Is your triangle right, acute, or obtuse? \_\_\_\_\_ Look at a few more triangles to check this.

4. Determine the type of triangle with the given set of side lengths. Show your work.

A.  $a = 8, b = 15, c = 17$

B.  $a = 6, b = 15, c = 18$

C.  $a = 7, b = 10, c = 12$

<b>Activity C:</b> <b>Real-world problems</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Be sure <b>Show values</b> is turned on.</li> </ul>	
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1. Lea leaves her house and drives 6 miles south to meet her friend, Trina. Then Lea and Trina drive 10 miles west to school.

- A. Draw a labeled sketch of Lea’s drive in the space to the right.
  
- B. If Lea doesn’t meet Trina, she can drive to school along a straight path. Draw this path in the figure above. How can you find the length of the straight path?

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C. Find the length of Lea’s path, to the nearest hundredth of a mile. Show your work to the right. Then check your answer in the Gizmo.

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D. How much farther does Lea drive when she meets Trina? \_\_\_\_\_

2. Lea’s brother Roger is using an extension ladder to wash windows on the second floor of their house.

- A. To wash the first window, Roger extends the ladder to 20 feet long. He places the base of the ladder 6 feet from the side of the house. Sketch a labeled picture of this to the right.
  
- B. How far up the house will the 20-foot ladder reach, to the nearest tenth of a foot? Show your work in the space to the right.

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C. Roger extends the ladder to 25 feet. He wants it to reach a window 24 feet above the ground. How far must the base of the ladder be from the house to do this? Show your work to the right. Then check your answer in the Gizmo. (Hint: You will need to build the triangle horizontally, not vertically, to make it fit in the Gizmo.)

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