Carpentry (46.0201) T-Chart

Stake out a building foundation using the Pythagorean Theorem	=	Apply the properties of rational and irrational numbers to solve real-world or mathematical problems

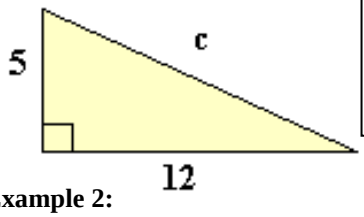
Program Task: 505 Stake out a building foundation using the Pythagorean Theorem.

Program Associated Vocabulary:
PYTHAGOREAN THEOREM, PERIMETER, OPPOSITE OPERATIONS, POWERS, ROOTS (SQUARE ROOTS), VARIABLE, 3-4-5 RULE

Program Formulas and Procedures:

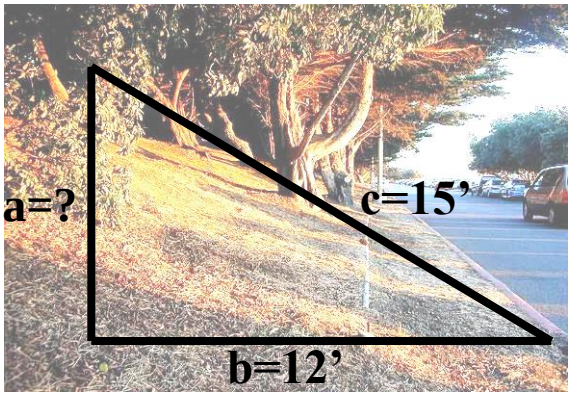
$a^2 + b^2 = c^2$ where "c" (the hypotenuse) is the longest side.

Example 1:



Where a = 5 and b = 12
$a^2 + b^2 = c^2$
$5^2 + 12^2 = c^2$
$25 + 144 = c^2$
$169 = c^2$
$c = 13$

Example 2:
To determine setback, you need to calculate the height of the berm (a) pictured below:



$a^2 + b^2 = c^2$ where b = 12' & c = 15'

$a^2 + b^2 = c^2 \rightarrow a^2 + 12^2 = 15^2$

$a^2 + 144 = 225 \rightarrow a^2 = 225 - 144$

$a^2 = 81$

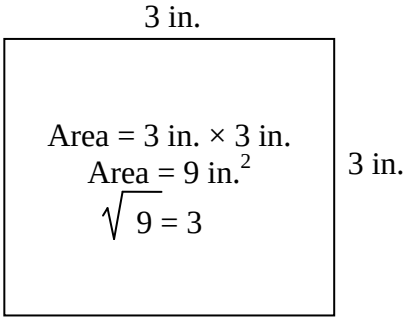
a = 9' The berm is 9' high

PA Core Standard: CC.2.1.HS.F.2

Description: Apply the properties of rational and irrational numbers to solve real-world or mathematical problems.

Math Associated Vocabulary:
PERIMETER, CIRCUMFERENCE, AREA, VOLUME, OPPOSITE OPERATIONS, POWERS, ROOTS (SQUARE ROOTS), VARIABLE, HYPOTENUSE

Formulas and Procedures:
Find Square Root:



Nearest Estimation Method to find Square Root:

Example: Estimate the square root of 7.

1. Pick two perfect squares closest to the number you want to find the square root of; choose one perfect square greater than the number you want to find the square root of and one perfect square less than the number you want to find the square root of. Two perfect squares below and above 7 are 4 and 9.
2. Since 7 is closer to 9 than it is to 4, then $\sqrt{7}$ must be between $\sqrt{4} = 2$ and $\sqrt{9} = 3$ but closer to $\sqrt{9} = 3$.
3. An estimate around 2.6 to 2.7 would be fine.

Instructor's Script – Comparing and Contrasting

Finding square roots of numbers is not an isolated skill for carpenters. Carpenters must be able to use the Pythagorean Theorem, find the square root of the measurement (which often is not a whole number), and then must be able to convert that measurement to feet, inches, and fractional inches. For example, sample problem #1, on page 3, yields an answer of 18.601 feet. In math class, we might round that to 18.6 feet. A carpenter must be able to convert the decimal part of the answer to inches and fractions of an inch, such as 18' 7 3/16".

Common Mistakes Made By Students

Unfamiliar with the calculator – Students who borrow calculators or keep switching between styles and models have to know how to take the square root of 4, using both methods. Some calculators require the student to press the number 4 then the square root button, and others require the square root button before the number 4.

Confusing the $^{x}\sqrt{}$ Button and the $\sqrt{}$ Button – Scientific calculators will have an $^{x}\sqrt{}$ Button and the $\sqrt{}$ Button. The $^{x}\sqrt{}$ Button is used for calculating other roots like a cubed root. Square roots must be found using the $\sqrt{}$ Button.

Estimation – Most errors from estimation without a calculator will come from not knowing perfect squares or not being able to find the middle between other values quickly and easily.

Confusing Square Root and Dividing by Two - Students often think that finding the square root means dividing by two.

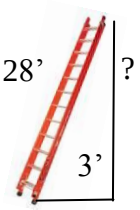
CTE Instructor's Extended Discussion

The reason that carpenters use square root and need to solve the answer to the closest 1/16 of an inch is because the building needs to be built square. Using the Pythagorean Theorem when laying out the foundation plan or floor plan will produce an accurate and square building.

Carpentry (46.0201) T-Chart

Problems	Career and Technical Math Concepts	Solutions
1. You are building an above ground planter box 6’ wide by 8’ long. To check for square, how many feet must the diagonal or “corner to corner” measurement equal?		
2. The diagonal measurement of a wall (c) is 20’ and the height (a) is 12’ long, how long is wall (b)?		
3. The bottom of a 28’ ladder (c) is placed 3’ (b) from the base of a wall. If the top of the ladder is touching the top of the building (not protruding above the wall) how high is the wall?		
Problems	**Related, Generic Math Concepts**	**Solutions**
4. You want to draw a square box and fill it with 144 one-inch squares, how many inches must each side of your box measure?		
5. A square garden box has an area of 8 square units. What is the length of a side of the square to the nearest tenth?		
6. In celebration of your town's 200th birthday, you are given permission to paint a large image of the town's founder on the side of Town Hall. The town council stipulates that the mural must be square so that it fits in with other artists' work in the bigger picture. They tell you that you will have 140 square feet of "canvas" on which to paint. What is the maximum height that your image can be assuming the founder is not shown leaning diagonally?		
Problems	**PA Core Math Look**	**Solutions**
7. Find $\sqrt{324}$. a) 16 b) 17 c) 18 d) 19		
8. Which of the following is the approximate value of $\sqrt{5}$? a) 3.4 b) 2.5 c) 2.2 d) 1.8		
9. Find $\sqrt{1144900.}$ a) 1060 b) 1070 c) 1080 d) 1090		

Carpentry (46.0201) T-Chart

Problems	Career and Technical Math Concepts	Solutions
1.	You are building an above ground planter box 6’ wide by 8’ long. To check for square, how many feet must the diagonal or “corner to corner” measurement equal?	$a^2 + b^2 = c^2$ where $a = 6' \& b = 8'$ $6^2 + 8^2 = c^2 \rightarrow 36 + 64 = 100$ $c^2 = 100 \rightarrow c = \sqrt{100}$ $c = 10'$
2.	The diagonal measurement of a wall (c) is 20’ and the height (a) is 12’ long, how long is wall (b)?	$a^2 + b^2 = c^2$ where $= a = 12' \& c = 20'$ $a^2 + b^2 = c^2 \rightarrow 12^2 + b^2 = 20^2$ $144 + b^2 = 400 \rightarrow b^2 = 400 - 144$ $b^2 = 256 \rightarrow b = \sqrt{256} \rightarrow b = 16$
3.	The bottom of a 28’ ladder (c) is placed 3’ (b) from the base of a wall. If the top of the ladder is touching the top of the building (not protruding above the wall) how high is the wall?	 $a^2 + b^2 = c^2 \rightarrow 3^2 + b^2 = 28^2$ $b^2 = 784 - 9 \rightarrow b^2 = 775$ $b = \sqrt{775} \rightarrow b = 27.838'$
Problems	**Related, Generic Math Concepts**	**Solutions**
4.	You want to draw a square box and fill it with 144 1-inch squares, how many inches must each side of your box measure?	Find the square root of 144 (inches). The box should be 12 inches on all sides.
5.	A square garden box has an area of 8 square units. What is the length of a side of the square to the nearest tenth?	A square has 4 equal sides so $s^2 = 8$. A side = $\sqrt{8}$ 8 is between 4 and 9, and much closer to 9. So $\sqrt{8}$ is between 2 and 3, much closer to 3.
6.	In celebration of your town's 200th birthday, you are given permission to paint a large image of the town's founder on the side of Town Hall. The town council stipulates that the mural must be square so that it fits in with other artists' work in the bigger picture. They tell you that you will have 140 square feet of "canvas" on which to paint. What is the maximum height that your image can be assuming the founder is not shown leaning diagonally?	Find the square root of 140. The painting can be 11.83 feet tall, or **just under** 11' 10" tall. .83’ = 9.96”
Problems	**PA Core Math Look**	**Solutions**
7.	Find $\sqrt{324}$. a) 16 b) 17 c) 18 d) 19	c) 18
8.	Which of the following is the approximate value of $\sqrt{5}$? a) 3.4 b) 2.5 c) 2.2 d) 1.8	c) 2.2
9.	Find $\sqrt{1144900}$. a) 1060 b) 1070 c) 1080 d) 1090	b) 1070