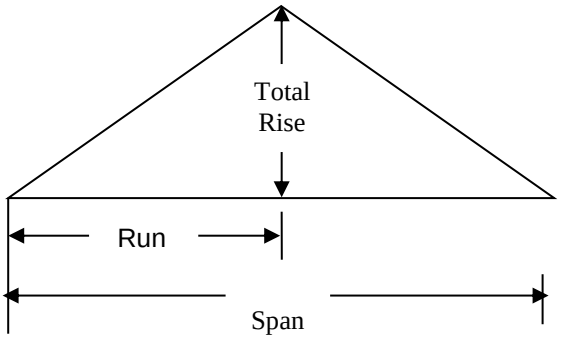
Carpentry (46.0201) T-Chart

Find rafter length using the Pythagorean Theorem	=	Understand and apply the Pythagorean Theorem to solve problems

Program Task: Find the rafter length using the Pythagorean Theorem.

Program Associated Vocabulary:
ANGLE, DIAGONAL, DIMENSION, FOOT, FRACTION, INCH, PITCH, PYTHAGOREAN THEOREM, RISE, RUN

Program Formulas and Procedures:
A carpenter will use the Pythagorean Theorem when finding the rafter length of a building. The rafter length is the hypotenuse or the diagonal. To determine the rafter length the carpenter will look on the floor plan to get the run and total rise measurements.



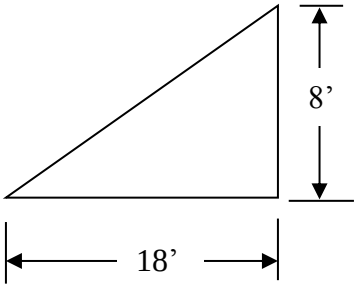
Example: What is the rafter length is the run is 18 ft. and the total rise is 8 ft.?

$a^2 + b^2 = c^2 \rightarrow 8^2 + 18^2 = c^2$

$64 + 324 = c^2 \rightarrow 388 = c^2$

$\sqrt{388'} = \sqrt{c^2} \rightarrow 19.69' = c$

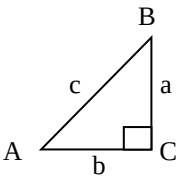
Rafter length = 19' $8\frac{3}{8}$"



PA Core Standard: CC.2.3.8.A.3
Description: Understand and apply the Pythagorean Theorem to solve problems.

Math Associated Vocabulary:
HYPOTENUSE, DIAGONAL, LEG, RIGHT ANGLE, RIGHT TRIANGLE, PYTHAGOREAN THEOREM, SQUARE ROOT, SQUARE

Formulas and Procedures:



a = leg b = leg c = hypotenuse	**Pythagorean Theorem:** $a^2 + b^2 = c^2$

Example 1: Solve for the hypotenuse, c, when given both legs.
A rectangle has side measurements of 8 inches and 12 inches. Find the length of the diagonal.

Step 1: Substitute known values into the Pythagorean theorem.

$$a^2 + b^2 = c^2 \quad 8^2 + 12^2 = c^2$$

Step 2: Square and add each number as directed by the theorem.

$$64 + 144 = c^2 \rightarrow 208 = c^2$$

Step 3: Take the square root of each side to solve for c.

$$\sqrt{208} = \sqrt{c^2} \rightarrow 14.4 = c$$

Example 2: Solve for a leg when given the hypotenuse and the other leg.
A right triangle has a hypotenuse that measures 10 inches and one of the legs measures 6 inches. Find the length of the other leg.

Step 1: Substitute known values into Pythagorean theorem.

$$a^2 + b^2 = c^2 \rightarrow 6^2 + b^2 = 10^2$$

Step 2: Square each number as directed by the theorem.

$$6^2 + b^2 = 10^2 \rightarrow 36 + b^2 = 100$$

Step 3: Subtract from both sides to isolate the variable.

$$36 - 36 + b^2 = 100 - 36 \rightarrow b^2 = 64$$

Step 4: Take the square root of each side to solve for the variable.

$$b^2 = 64 \rightarrow \sqrt{b^2} = \sqrt{64} \rightarrow b = 8$$

Instructor's Script - Comparing and Contrasting
In the example shown on the carpentry side of the T-Chart, the student must be able to use the Pythagorean Theorem to solve for the hypotenuse (c). In many CTE applications the diagonal is the missing dimension of the triangle. It is also important to show students how to solve for one of the legs of the right triangle. The computation is slightly different and more complex and this knowledge will provide them with the ability to use the Pythagorean Theorem in other settings and situations.

Common Mistakes Made By Students
Incorrectly identifying a, b, and c – Students will often confuse the hypotenuse with one of the legs or incorrectly substitute values into the equation. One way to avoid this is to recognize that diagonal often is used to describe a hypotenuse and label your hypotenuse right away by quickly identifying the right angle and marking the side opposite the right angle.

Inability to manipulate the equation to solve for a or b – Solving for the hypotenuse is much simpler than solving for a leg of a right triangle. Students need to be given many opportunities to solve for all the variables in the Pythagorean Theorem.

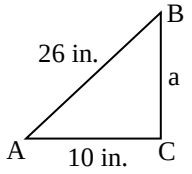
Inability to recognize the Pythagorean Theorem in multiple contexts – The Pythagorean Theorem appears in many contexts in standardized testing. Sometimes a test question will describe a right triangle and ask the student to solve for the missing side. Other times, the right triangle is drawn and the student must solve for the missing side. In many cases, a more complex picture is drawn and the student must use the Pythagorean Theorem to solve part of the problem. In these cases, it is not obvious that the Pythagorean Theorem is needed and the student must be able to select and use the theorem.

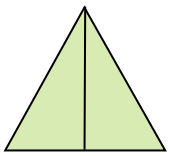
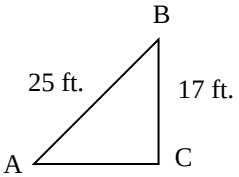
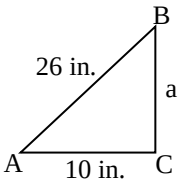
CTE Instructor's Extended Discussion
There are many times that carpenters solve for the hypotenuse of right triangles; some other examples for when carpenters will use the Pythagorean Theorem or the 3-4-5 method are staking out a building, laying out footer and foundation wall lines, squaring floor systems, laying out wall lines and checking walls for square.

Students may need to be reminded about how to convert an answer from the decimal form to feet and inches. Using the carpentry example on page 1, the answer given in the left-hand column is 19.6977'. To convert this to feet and inches, take the decimal part (.6977) and multiple it by 12. $0.6977 \times 12 \approx 8.372$. This is approximately equal to $8\frac{3}{8}$ inches. ($\frac{3}{8} = 0.375$)

When given a dimension in feet and inches, students need to be able to convert it to decimal feet.
For example: 34'4". To convert 4 inches to a decimal you need to divide by 12. $4 \div 12 = .3333\ldots$ So 34'4" = 34.333 ft.

Carpentry (46.0201) T-Chart

Problems	Career and Technical Math Concepts	Solutions
1. Determine the diagonal for a concrete rectangular pad that measures 40' × 32'.		
2. A carpenter needs to square a wall before he installs OSB sheathing. If the wall is 55’ 8” long and 8’ high, what is the diagonal measurement of a wall?		
3. The span of a house is 30’; the total rise is 8’; what is the line length of the rafter?		
Problems	**Related, Generic Math Concepts**	**Solutions**
4. A tent has two slanted sides that are both 5’ long and the bottom is 6’ across. What is the height of the tent in feet at the tallest point?		
5. Three sides of a triangle measure 9’, 16’ and 20’. Determine if this triangle is a right triangle.		
6. On a baseball diamond, the bases are 90’ apart. What is the distance from home plate to second base using a straight line?		
Problems	**PA Core Math Look**	**Solutions**
7. The lengths of the legs of a right triangle measure 12 meters and 15 meters. What is the length of the hypotenuse to the nearest whole meter?		
8. In a right triangle ABC, where angle C is the right angle, side AB is 25 feet and side BC is 17 feet. Find the length of side AC to the nearest tenth of a foot.		
9. In the given triangle, find the length of a. 		

Problems	Career and Technical Math Concepts	Solutions
1. Determine the diagonal for a concrete rectangular pad that measures 40' × 32'.		$a^2 + b^2 = c^2 \rightarrow 40^2 + 32^2 = c^2$ $1600 + 1024 = c^2 \rightarrow 2624 = c^2$ $\sqrt{2624} = c \rightarrow 51.225 = c$ c = 51'$2\frac{11}{16}$"
2. A carpenter needs to square a wall before he installs OSB sheathing. If the wall is 55' 8" long and 8' high, what is the diagonal measurement of a wall?		$a^2 + b^2 = c^2 \rightarrow 55'8"^2 + 8^2 = c^2$ $3098.81' + 64' = c^2 \rightarrow 3162.81' = c^2$ $\sqrt{3162.81} = c \rightarrow 56.239 = c$ c = 56'$2\frac{7}{8}$"
3. The span of a house is 30'; the total rise is 8'; what is the line length of the rafter?		$a^2 + b^2 = c^2 \rightarrow 8^2 + 15^2 = c^2$ $64 + 225 = c^2 \rightarrow 289 = c^2$ $\sqrt{289} = c \rightarrow 17' = c$ c = 17'
Problems	**Related, Generic Math Concepts**	**Solutions**
4. A tent has two slanted sides that are both 5' long and the bottom is 6' across. What is the height of the tent in feet at the tallest point?		$a^2 + b^2 = c^2$ $a^2 + 3^2 = 5^2$ $a^2 + 9 = 25$ $a^2 = 16$ a = 4 ft. 
5. Three sides of a triangle measure 9', 16' and 20'. Determine if this triangle is a right triangle.		$a^2 + b^2 = c^2$ $16^2 + 9^2 = 20^2$ $256 + 81 \neq 400$ Therefore, it is not a right triangle.
6. On a baseball diamond, the bases are 90' apart. What is the distance from home plate to second base using a straight line?		$90^2 + 90^2 = c^2$ $8100 + 8100 = c^2$ $16200 = c^2$ $\sqrt{16200} = c$ 127.28 ft. = c
Problems	**PA Core Math Look**	**Solutions**
7. The lengths of the legs of a right triangle measure 12 meters and 15 meters. What is the length of the hypotenuse to the nearest whole meter?		$a^2 + b^2 = c^2$ $12^2 + 15^2 = c^2$ $144 + 225 = c^2$ $369 = c^2$ $\sqrt{369} = c$ $19 = c$ c = 19 m.
8. In a right triangle ABC, where angle C is the right angle, side AB is 25 feet and side BC is 17 feet. Find the length of side AC to the nearest tenth of a foot.		$a^2 + b^2 = c^2$ $17^2 + b^2 = 25^2$ $289 + b^2 = 625$ $b^2 = 336$ $\sqrt{b^2} = \sqrt{336}$ b = 18.3 ft. 
9. In the given triangle, find the length of a. 		$a^2 + b^2 = c^2$ $a^2 + 10^2 = 26^2$ $a^2 + 100 = 676$ $a^2 = 576$ $a = \sqrt{576}$ a = 24 in.